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U.S. DOE, 1984, REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE, SOUTH SALT LAKE, SALT LAKE COUNTY, UTAH - (USED AS A REFERENCE IN OU1 AND OU2 FS REPORTS)

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REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE SOUTH SALT LAKE SALT LAKE COUNTY, UTAH

VOLUME I - TEXT

JULY, 1984
U.S. DOE

TEXT

6442

DOE/EIS-0099-F

Final Environmental Impact Statement

REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE SOUTH SALT LAKE, SALT LAKE COUNTY UTAH

VOLUME I - TEXT

July, 1984

U.S. DEPARTMENT OF ENERGY

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DOE/EIS-0099-F

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1 SUMMARY

1.1 BACKGROUND

The Vitro site is a 128-acre property 4 miles south-southwest of the center of Salt Lake City, Utah, in the city of South Salt Lake (Figures 1-1 and 1-2). The entire site is owned by Central Valley Water Reclamation Facility (CVWRF) Board, which operates waste-water treatment plant No. 1 on adjacent property north of the central portion of the Vitro site.

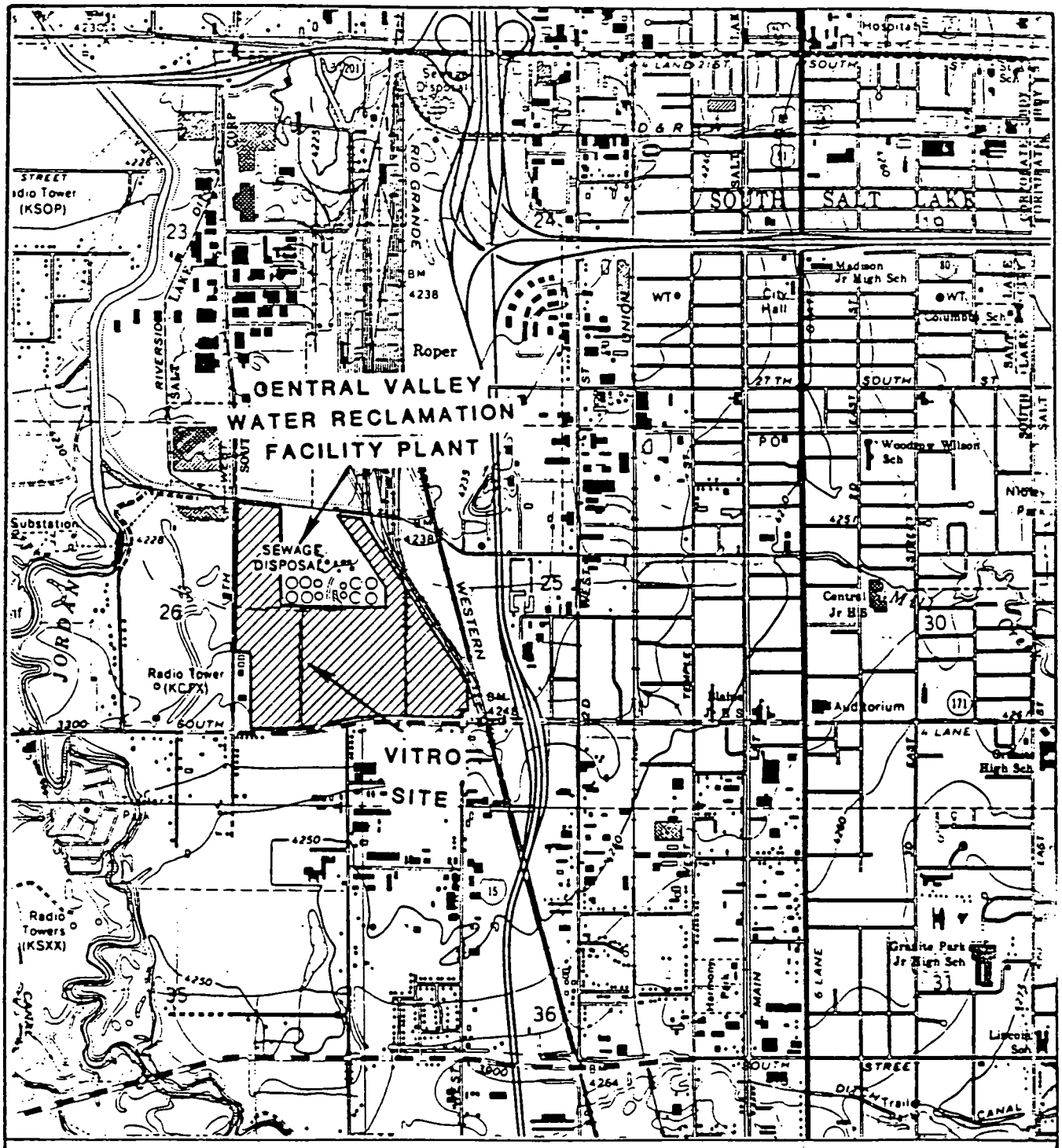
The site is bounded on the north by the CVWRF plant and Mill Creek, on the east by the tracks of the Denver and Rio Grande Western Railroad, on the south by 3300 South Street, and on the west by 900 West Street. An industrial area occupies a 225-foot wide, 5.4-acre strip along the west edge of the south half of the site facing 900 West Street.

From 1951 to 1964 the Vitro Chemical Company of America processed uranium ore for sale to the U.S. Atomic Energy Commission at a mill in the southeast corner of the site. When the plant was dismantled in 1970, the radioactively-contaminated materials from the processing operations (approximately 1.9 million dry tons of uranium mill tailings and over 1 million dry tons of other contaminated material) remained on the site piled as high as 16 feet in some spots. Over the years some of the tailings were removed for use in construction projects elsewhere in the Salt Lake City area. It is estimated that about 100 off-site properties contain contaminated materials from these construction projects; the bulk of the tailings, however, remain at the Vitro site.

In 1978, Congress passed Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), having expressly found that uranium mill tailings may pose a potential health hazard to the public. The Environmental Protection Agency (EPA) was charged with the responsibility for promulgating radiological and nonradiological standards for remedial action at inactive millsites. The Department of Energy (DOE) was authorized to enter into cooperative agreements with affected states or Indian tribal governments to perform remedial actions to bring the radiation levels at sites under their jurisdiction within the EPA standards. All remedial actions were to be performed with the concurrence of the Nuclear Regulatory Commission (NRC), which, at the conclusion of the remedial action, would issue a license for long-term maintenance and surveillance of disposal sites.

On November 8, 1979, the DOE designated the Vitro site as eligible for remedial action under UMTRCA. The DOE and the State of Utah entered into a cooperative agreement effective January 30, 1981, to perform remedial action on this site. During summer 1984, the cooperative agreement will be modified to designate the State of Utah as the party to perform remedial actions on the uranium mill tailings and to reflect changes to the agreement that result from this designation.

In 1980, the State of Utah evaluated a number of potential off-site disposal areas that could be used if the Vitro site were to be cleaned up and



BASE MAP REFERENCE. USGS 7 1/2 - MINUTE TOPOGRAPHIC QUADRANGLE MAP, "SALT LAKE CITY SOUTH, UTAH" DATED 1963 (PHOTOREVISED 1969 AND 1976).

FIGURE 1-1

GENERAL VITRO SITE AREA.

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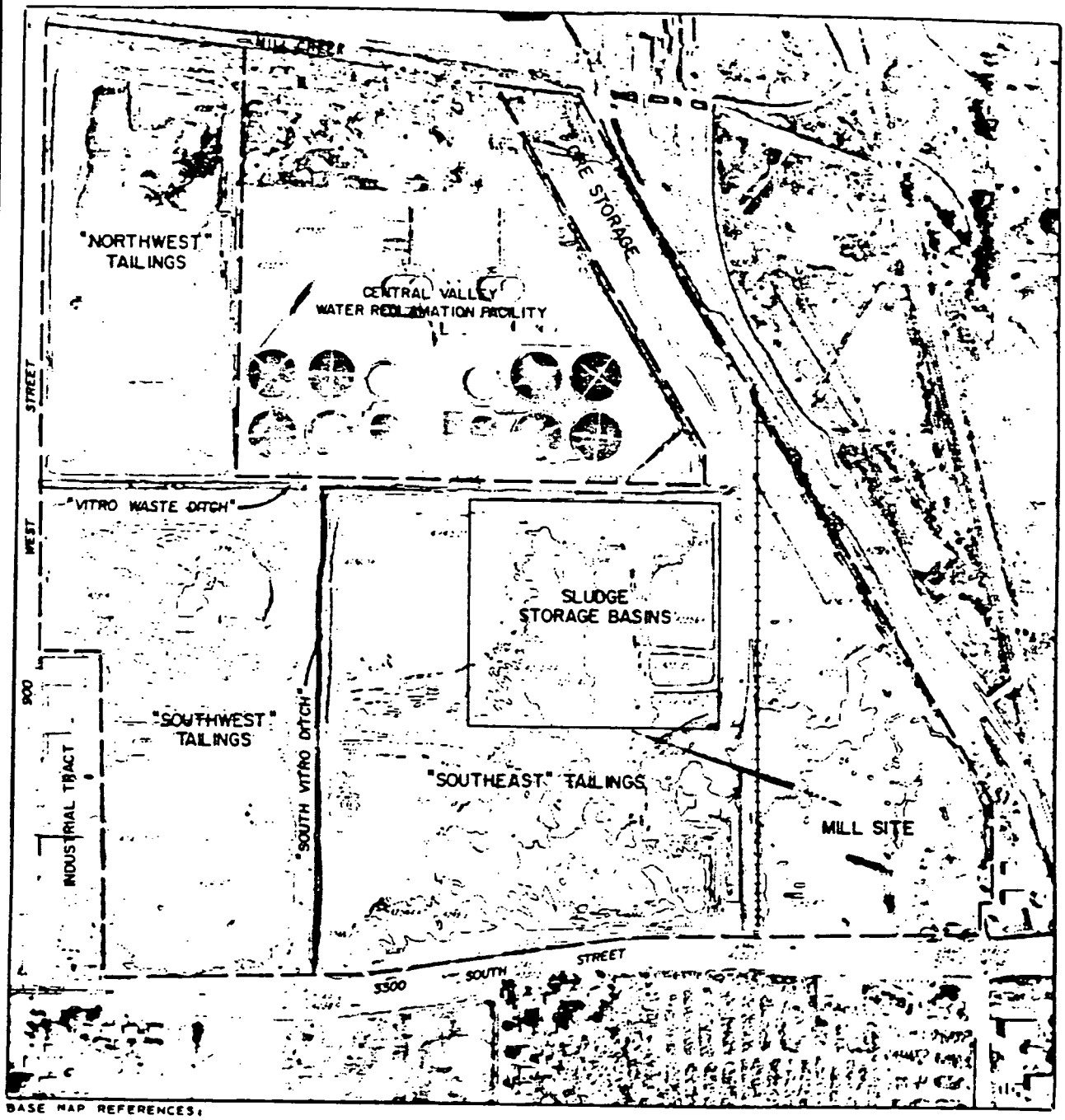

BASE MAP REFERENCES:
AIRPHOTO FROM FORD, BACON & DAVIS UTAH INC., DATE UNKNOWN. OUTLINE OF PROPOSED EXPANSION BY CDON, KING AND KNOWLTIN ENGINEERS, SALT LAKE CITY, UTAH.

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SCALE

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FIGURE 1-2. SITE CONDITIONS - VITRO SITE.

contaminated materials moved elsewhere. Utah nominated three sites to the DOE, all of which are in Tooele County west of Salt Lake City (Figure 1-3). The DOE made an independent evaluation of these and picked a site hereinafter called the South Clive site as the best of the three because of its environmental and geotechnical superiority. It is 85 road or rail miles west of the Vitro site on the eastern edge of the Great Salt Lake Desert and is owned by the State of Utah.

1.2 DESCRIPTION OF ALTERNATIVES

Three alternatives have been evaluated for remedial actions at the former Vitro Chemical Company site. They are as follows:

1. No action.

2. Stabilization of the contaminated material at the Vitro site.

3. Decontamination of the Vitro site and disposal of the contaminated material at the South Clive site.

The specific actions associated with these alternatives are outlined in Table 1-1. The material handling and resource volumes, manpower, and duration for each alternative are listed in Table 1-2.

Several other alternatives are not considered in this document since the DOE determined that they would not represent reasonable alternatives. These are stabilization at other state-nominated locations (because, as noted above, they are less desirable than the South Clive site), stabilization at two much more remote sites in Utah (because their distance makes them less cost-effective with no compensating benefits), stabilization at other locations in Salt Lake Valley (because these offer no clear advantages economically or environmentally over stabilization in place).

Title I of UMTRCA directs the DOE to consider the practicability of reprocessing the tailings in designated inactive uranium mill tailings sites in order to recover their residual uranium and other mineral values. Pursuant to that law, the DOE sought expressions of interest in reprocessing by notices in the Federal Register, in the Commerce Business Daily, and in a public press release. Several expressions of general interest were received, but none specific to the Vitro tailings. The DOE has completed detailed assays of Vitro and other tailings to follow up on these expressions of interest. However, the results of these assays indicate that reprocessing of the Vitro tailings is not economic at present-day prices for uranium. Therefore, the reprocessing alternative has been considered by the DOE as not being a reasonable alternative for purposes of this document.

1.2.1 Alternative 1 - no action

This alternative would consist of performing no remedial action, thereby allowing the present situation at the Vitro site to continue.

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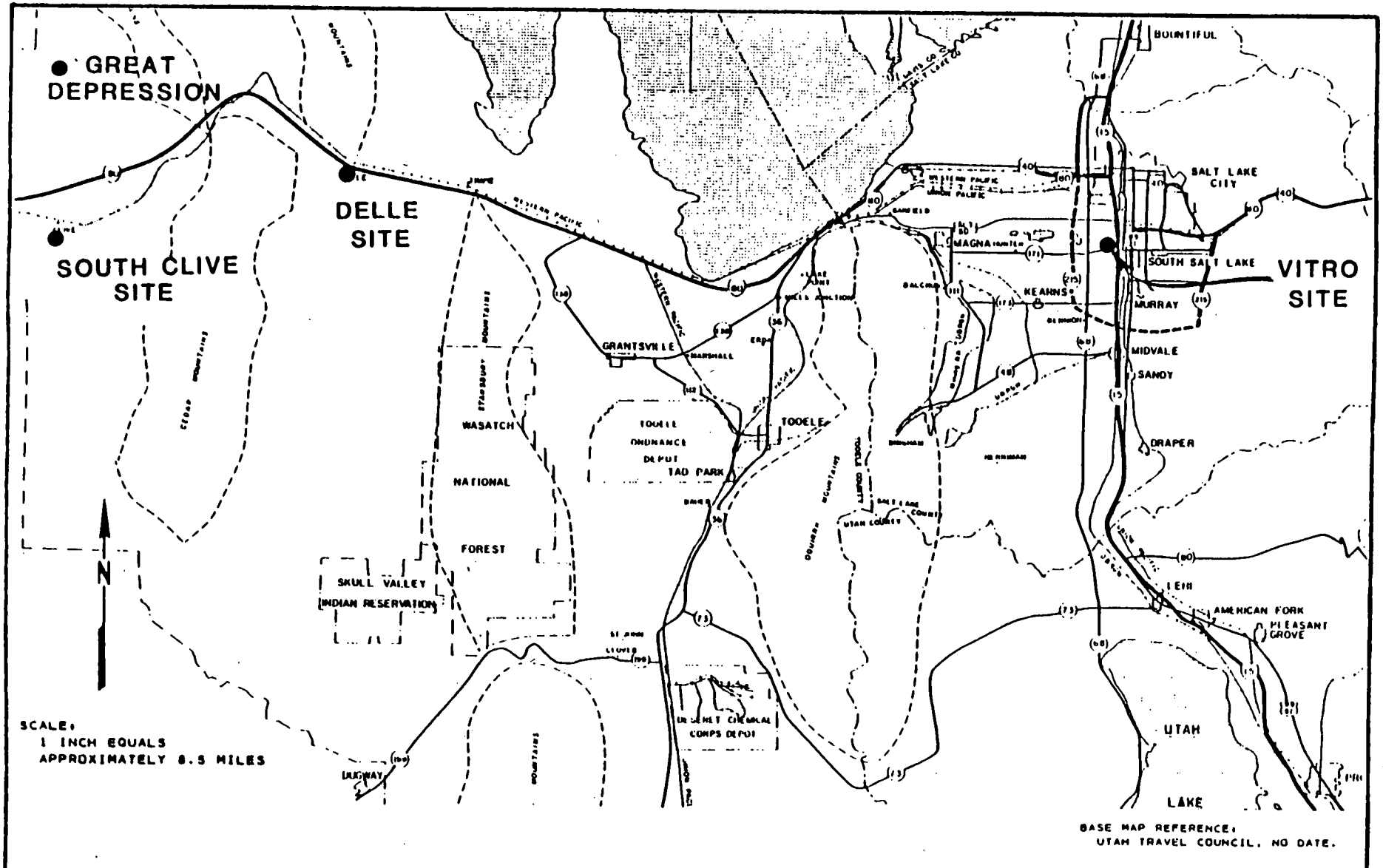

FIGURE 1-3 LOCATION OF STATE-NOMINATED ALTERNATE SITES

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Table 1-1. Summary of specific actions associated with alternatives

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Alternative 1. No Action:

1. No remedial action would be taken.
2. No monetary cost would be incurred.

Alternative 2. Stabilization on the Vitro site:[a]

1. Preparation of 53-acre embankment area, including liner system.
2. Conveyance of contaminated material to a 53-acre embankment area, creating a 45-foot-high mound prior to covering.
3. Restoration of outlying areas within the Vitro site from which contaminated materials were excavated by placing imported soils to original grade.
4. Cover contaminated materials with 3 feet of radon barrier soils and 1 to 2 feet of pit run rock.
5. Estimated total cost: $31.2 million.[a]

Alternative 3. Decontamination at Vitro site; stabilization of material south of Clive:

1. Excavation and conveyance of contaminated material to a stockpile area on Vitro site (train option).
2. Preparation of railroad track "spurs" at South Clive and Vitro sites; preparation of roads near South Clive site.
3. Transportation of contaminated material and rubble by unit trains or trucks to South Clive site.
4. Restoration of excavated areas at Vitro site by placing imported soils to original grade.
5. Preparation of South Clive site disposal area and excavation of embankment.
6. Placement of contaminated materials in embankment (1100 x 2000 feet, 6 feet deep).
7. Cover of contaminated materials with 5 feet of locally available soil and 1 to 2 feet of pit run rock.
8. Estimated total cost: $63.8 million (train) or $67.7 million (truck).

---

[a] The designs included in this EIS are based upon available information and supporting engineering analyses. It is recognized that there are "margins of error" or "risks" associated with these analyses and that with additional field and laboratory analysis these "margins of error" or "risks" could be reduced. For example, the design for Alternative 2 does not include provisions for preloading (to reduce excessive differential settlement) based upon the analyses to date; however, the State of Utah has indicated that differential settlement may indeed be more of a concern than indicated by the engineering analyses included in this EIS. If preloading were to be required, based upon engineering analyses and cost estimates prepared by the state, an additional 3.0 million cy of fill would be needed for about 2.5 years to preload the site prior to tailings placement. This would increase the cost of Alternative 2 by $10.8 million to $42.0 million (letter from State of Utah Department of Transportation to the Department of Health, December 19, 1983).

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Table 1-2. Estimated quantities and other pertinent data associated with remedial action operations

Item description	Estimated volume (cubic yards)
Alternative 1- No Action:	
Quantities, personnel, rates not applicable	
Alternative 2 - Stabilization on the Vitro site:[a]	
Contaminated Material Relocation	
Excavation outside embankment area	1,370,000
Relocation in embankment area	850,000
Windblown and vicinity properties (spread and compact)	150,000
Rubble	80,000
Preload System[a]	(3,000,000)
Liner System	
Subbase (random fill)	220,000
Base (granular soil)	300,000
Liner (fine grained soil)	190,000
Embankment Cover	
Radon barrier (silty sand)	290,000
Erosion barrier (pit run rock)	155,000
Restoration (select fill)	710,000
Average number of construction personnel	82
Project duration	2.5 years
Alternative 3 - Stabilization at South Clive site: train option	
Vitro site:	
Rail spur construction	
Excavation of contaminated materials	180,000
Subgrade and subballast (select fill)	94,000

Table 1-2. (continued)

Item description	Estimated volume (cubic yards)
Contaminated materials	
Tailings and contaminated subsoils	2,220,000
Windblown and vicinity properties	150,000
Rubble	80,000
Restoration (select fill)	945,000
South Clive site:	
Access road construction	
Road subgrade (compacted fill)	27,000
Gravel surface	31,000
Rail spur construction	
Subgrade (compacted fill)	98,000
Subballast (select compacted fill)	10,000
Embankment construction	2,450,000
Cover	
Radon barrier	460,000
Erosion barrier, ditches and perimeter roads (pit run rock)	202,000
Average number of construction personnel	85
Project duration	3 years
Alternative 3 - Stabilization at South Clive site: truck option	
Vitro site:	
Contaminated materials	
Tailings and contaminated subsoils	2,220,000
Windblown and vicinity properties	150,000
Rubble	80,000
Restoration (select fill)	1,040,000
South Clive site:	
Access road construction	
Road subgrade (compacted fill)	27,000
Gravel surface	44,000

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Table 1-2. (continued)

Item description	Estimated volume (cubic yards)
Embankment construction	2,450,000
Cover	
Radon barrier (excavated from embankment)	460,000
Erosion barrier, ditches and perimeter roads (imported pit run rock)	202,000
Average number of construction personnel	135
Project duration	3 years

[a] The designs included in this EIS are based upon available information and supporting engineering analyses. It is recognized that there are "margins of error" or "risks" associated with these analyses and that with additional field and laboratory analysis these "margins of error" or "risks" could be reduced. For example, the design for Alternative 2 does not include provisions for preloading (to reduce excessive differential settlement) based upon the analyses to date; however, the State of Utah has indicated that differential settlement may indeed be more of a concern than indicated by the engineering analyses included in this EIS. If preloading were to be required, based upon engineering analyses and cost estimates prepared by the state, an additional 3.0 million cy of fill would be needed for about 2.5 years to preload the site prior to tailings placement. This would increase the cost of Alternative 2 by $10.8 million to $42.0 million (letter from State of Utah Department of Transportation to the Department of Health, December 19, 1983).

1.2.2 Alternative 2 - stabilization at the Vitro site

In this alternative, all on-site tailings and contaminated materials plus those brought in from vicinity properties would be stabilized above grade on a 53-acre area including the southcentral and southeast portions of the Vitro site which would have to be acquired by the State of Utah. The tailings and contaminated material would be placed on a liner system to protect groundwater quality. After stabilization, the release of radon into the air would be reduced to the final EPA standard by a cover of soil. The tailings and other contaminated material would first have to be removed from the stabilization area to allow construction of the liner system. This would be done incrementally over the 53-acre area until the liner system was completed. Contaminated materials would be transported to the stabilization area from elsewhere on the site by truck. Material for the cover and fill for excavations left in other portions of the site is available commercially in Salt Lake Valley. The final stabilized mound would be about 50 feet high. It

would have sloping sides, about 5 horizontal to 1 vertical. It would be stabilized against wind and water erosion by a layer of pit run rock. Finally, ownership of the 53-acre disposal area would be transferred from the State to the DOE and the NRC would issue a license for its long-term maintenance and surveillance (includes monitoring). The remainder of the Vitro site would be released to the CVWRF Board for any use compatible with local land-use controls.

1.2.3 Alternative 3 - decontamination of the Vitro site and disposal of the Vitro material at South Clive

In this alternative all tailings and contaminated materials, including those temporarily stored at the Vitro site from clean-up of vicinity properties, would be stabilized in an excavation at the South Clive site. The industrial strip to the west of the Vitro site would be cleaned up like other vicinity properties; its acquisition would not be necessary.

Contaminated material would be transported from the Vitro site to the South Clive site by either train or truck. For the train option, two 54-car unit trains consisting of covered gondola cars would transport 5400 tons per day. For the truck option, a fleet of 77 trucks would be required to transport the same quantity of tailings to the South Clive site.

Spurs to handle the trains would be built from existing rail lines into both the Vitro site and the South Clive site. A road from the Clive overpass (I-80) would be necessary for access to the embankment. Disposal would be in an excavation about 6 feet deep. The bottom of the excavation would be at least 15 feet above the ground-water table. After being deposited in the excavation, contaminated materials would be covered with 5 feet of on-site cover material derived from the excavation. A 1- to 2-foot-thick layer of pit run rock would be placed over the radon barrier cover to provide protection from erosion. Pit run rock would have to be imported to the site but is available from the nearby Cedar Mountains. Revegetation would not be attempted at the South Clive site because of the arid climate. The state would transfer ownership of the South Clive site to the DOE and the NRC would issue a license for its long-term maintenance and surveillance. The Vitro site would be backfilled to original ground level and released to the CVWRF Board for any use compatible with local land-use controls.

1.3 THE AFFECTED ENVIRONMENT

Although the straight-line distance between them is only 65 miles, the Vitro and the South Clive sites are distinctly different in their settings. The former is in the densely populated Salt Lake Valley; the latter is in the almost completely uninhabited and much drier Great Salt Lake Desert to the west. Three mountain ranges lie between the two locations, but the transportation corridors connecting them follows flat land to the south of Great Salt Lake and to the north of the mountains.

The Vitro site is located in an area that has been and continues to be developed for small industry and warehousing. There is some open land nearby, but the prospects are that it will be built on before the turn of the

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century. The street (3300 South Street) on the southern edge of the site is also Utah Highway 171 leading east and west from an interchange off Interstate 15; it carries traffic at the rate of 28,000 vehicles per day.

Much of the Vitro site has been altered by excavations and deposition of tailings, rubble, and sewage sludge. It is easily accessible. A road up its center from 3300 South Street leads to a sewage facility; and only there do gates, fences, and signs prevent the curious visitor from going farther. Vegetation on the site is sparse. The industrial buildings along 900 West Street on the southwest side of the site back right up to a steep bank of tailings.

Some 437,000 people live within 6 miles (10 km) of the Vitro site; 8600 live within 1.2 miles (2 km).

The Salt Lake Valley is semi-arid. Its climate is a result of its location deep in the continent with the Wasatch Mountain range to the east 5000 to 6000 feet higher than the valley and the vast Great Salt Lake to the northwest. Temperatures range from a little under freezing (28°F) in January to 77°F in July. Normal extremes range from nighttime lows of 18°F in January to daytime highs of 93°F in July. The average rainfall is about 15 inches per year, reaching a maximum in the spring. Prevailing winds are from the south through southeast; strong winds tend to come from the west or northwest. Thunderstorms are common in the summer. There is some snow in the winter.

Bedrock below the Vitro site is covered by a thick sequence of alluvial unconsolidated Quaternary deposits at least 500 feet deep overlying semiconsolidated Tertiary clay, sand, and gravel. These deposits carry two principal ground-water systems, a shallow water-table system, and a deeper partially confined system. The water table in the upper system ranges seasonally from 2 to 5 feet below the ground surface, but locally extends up into the base of the tailings. The deeper system is at a higher potential head than the shallower, so that water from the deeper system flows up into the shallow system rather than vice versa.

The shallow water-table system flows slowly to the northwest into the Jordan River, about 1500 feet distant. The Jordan River and its tributaries constitute the main surface-water drains for the valley, discharging into the Great Salt Lake some miles to the north. The drainage ditches within the site and Mill Creek along its northern edge discharge into the Jordan River.

The front of the Wasatch Range is apparently a still-active normal fault. Motion on it or its tributary faults could produce accelerations in rock of as much as 0.3g to 0.55g at the Vitro site.

The area around the Vitro site is an urban ecosystem with vegetation, birds, and wildlife of the sorts that have accommodated themselves to the presence of man. No endangered or threatened species are known to be present.

The Vitro site contains 2.9 million tons of tailings and other contaminated materials. It is estimated that there are 1500 curies of Ra-226 in secular equilibrium with radon and its daughter products in the tailings.

The South Clive site is in the eastern edge of the Great Salt Lake Desert, 3 miles west of the Cedar Mountains, 2.5 miles south of Interstate 80, and 1 mile south of a switch point called Clive on the tracks of the Union Pacific system. The area is uninhabited and only occasionally used for grazing and off-road vehicles.

The South Clive area is arid desert. Data from the Wendover meteorological station 40 miles to the west suggest that temperatures are similar to those at the Vitro site, normally ranging from 27°F in January to 79°F in July. Normal extremes range from nighttime lows of 19°F in January to daytime highs of 92°F in July. The average rainfall at Wendover is only 5 inches per year. Thunderstorms occur in the summer. There is some snow in the winter.

Knowledge of the geology of the South Clive site is incomplete. Holes drilled in preparation for this report indicate that the surface alluvial material is at least 150 feet deep. This soil contains a water-table ground-water system that is 20 to 30 feet below the surface. The regional direction of ground-water flow is to the west, but locally the flow is to the northeast. There are no perennial surface water bodies within 2 miles, nor even gullies indicating intermittent channelized flow; from this it is inferred that runoff on the hills to the east percolates into the ground before it reaches the South Clive site.

The South Clive site is located in a region which contains active faulting. Active fault studies indicate maximum expected accelerations in bedrock of 0.37 g.

Ecologically, the area around the South Clive site is a desert scrubbrush community. No endangered or threatened species are known to be present.

Background radiation levels at the South Clive site are low and similar to those near the Vitro site. The background gamma radiation level is about 12 μR/hr and the atmospheric radon concentration is about 0.3 pCi/l.

The transportation corridors between the Vitro and the South Clive sites consist principally of Interstate 80 (and its connecting roads in Salt Lake City) and the tracks of the Union Pacific and the Denver and Rio Grande Western Railroads. There are a number of towns south of the corridors, noteably Tooele (population 14,335) and Grantsville (population 4419).

1.4 ENVIRONMENTAL IMPACTS

Attention is focused in this section on the principal environmental impacts of the three alternatives studied. Table 1-3 is a comparative summary of these impacts.

The major impact of Alternative 1, no action, would be the continued, uncontrolled presence of the Vitro tailings in the heart of the densely populated Salt Lake Valley. Radiation levels and radon fluxes and concentrations would remain above the EPA-proposed standards near the site. These exposures would continue to cause 0.6 deaths in 3 years from lung

Table 1-3. Comparisons of the impacts of the alternatives

	Alternative 1	Alternative 2	Alternative 3 (train)		Alternative 3 (truck)	
Radiological short-term						
Excess external dose (man-rem):						
Population (6 miles)	330/3 years	150/3 years	150/3 years		150/3 years	
Work force	—	65/3 years	280/3 years		350/3 years	
Excess bronchial dose (man-rem):						
Population (6 miles)	28,000/3 years	15,000/3 years	15,000/3 years		15,000/3 years	
Work force	—	480/3 years	740/3 years		600/3 years	
Excess cancer deaths:						
Population (6 miles)	0.6/3 years	0.3/3 years	0.3/3 years		0.3/3 years	
Work force	—	0.02/3 years	0.05/3 years		0.05/3 years	
Radiological long-term, after remedial action						
Excess external dose (man-rem):						
Population (6 miles)	110/year	none	none		none	
Excess bronchial dose (man-rem):						
Population (6 miles)	9,400/year	negligible	none		none	
Excess cancer deaths:						
Population (6 miles)	0.2/year	none	none		none	
Air Quality short-term[a]	No effect		Vitro	Clive	Vitro	Clive
Emissions in tons per year						
TSP		317.5	313.8	235.3	448.1	560.8
SO_2		3.1	30.4	30.4	21.8	21.8
CO		8.1	87.1	87.1	201.6	201.6
NO_x		40.0	246.7	246.7	181.7	181.7
HC		2.5	51.7	51.7	33.6	33.6
Exhaust Particulates		2.0	15.7	15.7	11.0	11.0
Topography	No effect	At Vitro A mound 50 ft high on 53 acres.	At Vitro Site is returned to grade. At Clive A mound 34 ft high on 55 acres.		same as train option	
Soils	No effect	At Vitro Import[b] 1,865,000 cu yds of soils, rock, and clay.	At Vitro Import[b] 1,040,000 cu yds of soil. At Clive Import[b] 1,040,000 cu yds of rock.		same as train option	
Surface Water	Continued low-level contamination of ditches and creeks at Vitro site.	No further contamination of ditches and creeks at Vitro	At Vitro No possibility of future contamination. At Clive		same as train option	

Table 1-3. (Continued)

	Alternative 1	Alternative 2	Alternative 3 (train)	Alternative 3 (truck)
Land Use	No effect: The tailings continue to interfere with CVWRF Board proposed expansion plans.	About 60 % of site released for use by CVWRF Board.	At Vitro 100% of site released for use. At Clive 60 acres of land in restricted use.	same as train option
Populations & Employment	No effect			
Number of short-term[a] jobs		215	207	317
Number of long-term[c] jobs		0	705	705
Transportation	No effect	8.5% maximum increase in traffic along haul route (5400 South)[b] to Vitro site	4% maximum increase in traffic along haul route to Vitro site (there is no traffic at Clive).[b]	negligible increase on I-80; 4% maximum increase in traffic along haul route to Vitro site[b]
Use of Energy	None			
Electricity (kwh)		400,000	800,000	800,000
Engine fuel (gal)		2,520,000	6,970,000	7,121,000
Occupational Accidents[c]	None			
Expected deaths		0.15	0.14	0.52
Expected number of disabling injuries		12	27	25
Cost of Project	None			
In millions of 1982 dollars		$31.2	$63.8	$67.7
Annual Economic Benefits Attributable to Development of a Temporary Industrial Park on Vitro Site (In millions of 1983 dollars (gross)	None[d]	Unknown[e]	$11.0	$11.0

[a]For 3-year duration of projects in Alternative 2 and 3 only; generally zero effect after 3 years.
[b]Import from commercial soil suppliers.
[c]Long-term jobs include direct (271) and indirect (434) employment associated with the temporary industrial park (see Appendix I for explanation of temporary industrial park).
[d]Impact on region could be mitigated by development on an alternate site.
[e]Under Alternative 2, 20 acres will be available for development. Impact depends on type of development undertaken.

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cancer. The nearest resident to the Vitro tailings pile would continue to receive an annual exposure of more than one rem.

In addition, no remedial action would mean continued interference of the tailings with the proposed expansion plans of the Central Valley Water Reclamation Facilities (CVWRF) Board; additional sewage facilities will be needed to serve the population growth projected for the Salt Lake Valley.

Either Alternative 2 or Alternative 3 would be designed to meet the final EPA standards. The radon flux standard would be met by adding enough cover so that by the time radon gas has diffused through the cover, most of the gas would have decayed into solid daughter products that would move no further. The longevity of this cover would be ensured by armoring its surface with pit run rock to prevent wind and water erosion.

In Alternative 2, ground-water systems would be protected by the use of a liner system that would elevate the tailings above the water table. Also, the liner system would reduce the rate of water movement from the tailings into sediments beneath the embankment. This reduction in moisture migration may be expected to increase the effectiveness of geochemical processes (e.g., sorption and precipitation) in reducing the rates of aqueous contaminant migrations from the stabilized tailings.

In Alternative 3, the tailings would be at least 15 feet above the water table at the South Clive site. No liner is needed because net infiltration through a low permeability cover and the tailings would not be sufficient to substantially further degrade the poor ground-water quality beneath the Clive site. Alternative 3 would also eliminate any possibility of further contamination of ground water at the Vitro site by removal of the tailings.

In Alternative 2 or Alternative 3, aquifer restoration does not seem warranted because the range of calculated cost:benefit ratios is high (4.1 to infinity) and there is no ground water use in the possibly contaminated area.

Surface-water systems would be protected in Alternative 2 both indirectly by the protection of ground water indicated above (since the ground water at the Vitro site discharges into the Jordan River) and directly by the cover diverting runoff, thus keeping it from percolating into the tailings. In Alternative 3, there is no surface water to protect at the South Clive site. In Alternative 3, contaminated wash-down water from cleaning railcars or trucks would be impounded and evaporated if contaminant levels exceeded applicable limits. Removal of the tailings to the South Clive site would also eliminate any possibility of further surface-water contamination at the Vitro site.

Alternative 2, stabilization on the Vitro site, would not completely eliminate interference with the proposed expansion plans of the CVWRF Board, because 53 acres of the site would be used for in-place stabilization of the mill tailings. However, development of the parcel (approximately 20 acres) in the southwest corner of the site might permit land uses consistent with the CVWRF Board's approved Master Plan. Therefore, Alternative 2 might require some revision of the board's plans.

Either Alternative 2 or Alternative 3 would reduce the long-term radiation exposures being experienced by people living in the Salt Lake Valley. Alternative 2 would reduce the fluxes causing these exposures. Alternative 3 would eliminate them entirely and not expose other people, inasmuch as no one lives near the South Clive site.

In the short term, the process of carrying out either Alternative 2 or Alternative 3 would expose workers and the public near the Vitro site to some radiation during the time required for the remedial action. This public exposure is estimated to be 15,000 manrems for both alternatives, respectively, resulting in an additional 0.3 death from cancer.

From points of view other than radiological, the work required in either Alternative 2 or Alternative 3 is much like that of any large earth-moving project, with noise, dust, and additional truck traffic. There is the possibility of some industrial accidents occurring among the remedial-action workers.

The direct employment impact of either Alternative 2 or Alternative 3 on the economy of the Salt Lake Valley will not be significant. This is because direct construction employment under Alternative 2 will average 82 jobs; under Alternative 3, an average of 85 (train) or 135 (truck) jobs would be created. However, there may be a small effect on the much smaller economy of Tooele County.

Under Alternative 3, the development by the CVWRF Board of a temporary industrial park (see Appendix I for details) on the CVWRF Board's 3300 South Street frontage property is projected to have direct and indirect employment impacts of 271 jobs and 434 jobs, respectively. The gross economic benefits of such a development to the region have been estimated at $11.0 million per year.

Inmigration in response to employment opportunities created by construction activity under Alternatives 2 or 3 and the temporary industrial park under Alternative 3 is expected to be minimal.

Finally, there is a difference in construction costs among the three alternatives. Construction costs associated with Alternative 1 would be zero. Alternative 2 would cost approximately $31.2 million, including land costs. Alternative 3 would cost approximately $63.8 (train) or $67.7 (truck) million.

1.5 REMEDIAL ACTIONS

Additional information on the remedial-action activities at the two sites will be published as indicated in Table 1-4.

1.6 MAINTENANCE AND SURVEILLANCE

After all of the cleanup work is finished, the DOE, or another Federal agency charged with custody of the disposal site, would continue to monitor the final disposal site to ensure that the remedial-action program continues to comply with the EPA standards (40 CFR 192). This could include measurements of parameters such as air and water contaminant levels as specified by the NRC in its license, and maintenance of the site as required. The EPA standards (40 CFR 192) would have to be met before the remedial action is considered officially completed.

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Table 1-4. Document publication schedule - Salt Lake City remedial-action project

Document type	Scheduled publication date
Final site documents	
Remedial action plan	Summer 1984
Site conceptual design	Summer 1984
Site design criteria	Summer 1984
Site characterization report	Summer 1984
Final design and specifications	Fall 1984
Site licensing plan	1986
Site surveillance and maintenance plan	1986

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2 PURPOSE AND NEED

2.1 INTRODUCTION

In the metropolitan area of Salt Lake City, Utah, there is an abandoned uranium mill waste storage area (Figure 1-1). The mill was operated by the Vitro Chemical Company of America which processed uranium ore for sale to the U.S. Atomic Energy Commission from 1951 to 1964. When the plant was dismantled in 1970, the radioactively-contaminated materials from the processing operations remained on the site. These materials, called tailings, are mostly in the form of finely crushed rock, much like sand, and are piled up to 16 feet high over more than 100 acres of partly fenced land. Some of the tailings were removed and used in construction projects in the Salt Lake City area. It is estimated that 100 properties in the area have been affected by these construction activities. The bulk of the tailings, however, remain at the Vitro site.

2.2 PURPOSE AND NEED

In 1978, Congress passed Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), based on their finding that uranium mill tailings located at inactive (and active) mill sites may pose a potential health hazard to the public. UMTRCA charges the EPA with the responsibility for promulgating radiological and nonradiological standards for inactive mill sites. Under UMTRCA the U.S. Department of Energy (DOE) is authorized to enter into cooperative agreements with affected states or Indian tribal governments to perform remedial actions to bring the radiation levels at the sites in their jurisdiction within the EPA standards. The DOE will fund 90 percent of the remedial-action-cleanup costs (except on Indian land where DOE will fund 100 percent); the affected state will provide the remaining 10 percent. All remedial actions must be performed with the concurrence of the U.S. Nuclear Regulatory Commission (NRC), which will issue a license for long-term maintenance and surveillance of the site following completion of remedial action.

Title I of the UMTRCA identified 22 sites, including the Vitro site, to be designated by DOE for remedial action, which was done on November 8, 1979. As a result, the DOE and the State of Utah entered into a cooperative agreement effective January 30, 1981 for remedial action at the Vitro site. During summer 1984, the cooperative agreement will be modified to designate the State of Utah as the party to perform remedial actions on the uranium mill tailings and to reflect changes to the agreement that result from this designation.

The purpose of the actions analyzed in this EIS is to implement the remedial action program by stabilizing and controlling potentially hazardous radioactive materials associated with the former Vitro uranium mill, including those materials recovered in the cleanup of vicinity properties. The program to clean up vicinity properties was addressed in a separate environmental assessment (EA) prepared for it (DOE, 1982) and is not discussed in the EIS.

The need for remedial action at the Vitro site rests on the need to remove a potential health hazard posed by radioactive materials. The U.S. Congress, in considering Public Law 95-604, heard testimony explaining this potential hazard and recommending that efforts be made to keep the radioactive materials from being dispersed (U.S. Congress, 1978, pp. 7451-7456). Congress, therefore, included in the law a finding that "uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public . . . ." The severity of the hazard is difficult to measure precisely because the immediate effects of such low-level radioactivity are not pronounced enough to be clearly recognizable. The principal effect on public health to be expected from the Vitro site contamination would be a long-term increase in lung cancer among people living in the surrounding area. One estimate of this increase, presented to Congress in 1978, was that the Vitro tailings might produce about one additional cancer each year in the Salt Lake City area (U.S. Congress, 1978, p. 7453). Because about 44 lung cancers occur each year in that area (HEW, 1968), an increase of 1 cancer would be impossible to demonstrate conclusively. The estimated severity of the hazard, therefore, rests on predictions made by mathematical calculations rather than on direct measurements of health effects.

The estimated hazard presented to Congress in 1978 was based on such calculations; since then, more detailed calculations have been performed by the U.S. Environmental Protection Agency as part of its efforts to set standards for the remedial action (EPA, 1980). The EPA calculations emphasized the health effects caused by inhalation of radon-daughter products that are produced by the radon emitted from the Vitro site. These calculations suggest that the Vitro site contamination might produce 0.7 to 0.8 fatal cancers each year in the population within 6 miles of the site; an additional 0.04 to 0.05 fatal cancers might appear each year among people living between 6 and 50 miles away. The risk would be greatest for people close to the site and would decrease for people living at greater distances.

Radioactive materials associated with the Vitro site, then, could be expected to produce fewer than one human fatality a year in the surrounding population; that fatality would be indistinguishable among the thousands of deaths each year in the metropolitan area. These small numbers do not, however, fully reveal the hazard, because the radioactive decay taking place in the contaminated material will continue to produce radioactive elements for thousands of years into the future. In thousands of years, the total number of deaths caused by the radioactivity could become large, although it would still be small in comparison with the total number of deaths from all causes. For example, if the EPA estimates are correct, 740 to 850 additional lung cancer cases might have appeared in the population within 50 miles of the Vitro site after 1000 years had elapsed. According to the testimony given before Congress,

> "The health effects of this radon production are tiny as applied to any one generation, but the sum of these exposures can be made large by counting far into the future . . . Whether it is meaningful to attach significance to radiation exposures thousands of years in the future, or conversely, whether it is justifiable to ignore them, are questions

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without easy answers. The most satisfactory approach is to require every reasonable effort to dispose of tailings in a way that minimizes radon diffusion into the atmosphere" (testimony of NRC Chairman J.M. Hendrie, p. 7452 in U.S. Congress, 1978).

This kind of reasoning establishes the primary need for the remedial actions at the Vitro site. In terms of actual numbers of fatalities, the effects of the tailings will remain an indiscernably small fraction of the deaths that will occur from other causes near the site. Making a "reasonable effort," however, will eliminate the potential hazard. For this reason Congress chose to provide a program of assessment and remedial action at mill tailings sites in which DOE establishes the required remedial actions at inactive tailings locations, including the former Vitro site.

REFERENCES FOR CHAPTER 2

DOE (U.S. Department of Energy), 1982. Environmental Assessment of Preliminary Cleanup Activities at Offsite Properties Contaminated by Tailings from the Inactive Uranium Mill Site Near Salt Lake City, Utah, DOE/EA-0186, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1980. Draft Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites, EPA 520/4-80-011, Washington, D.C.

HEW (U.S. Department of Health, Education and Welfare), 1968. Vital Statistics of the United States, Volume II - Mortality, National Center for Health Statistics, Washington, D.C.

U.S. Congress, 1978. U.S. Code, Congressional and Administrative News, 95th Congress--Second Session, Vol. 6, "Legislative History," pp. 7433-7478, Washington, D.C.

3 ALTERNATIVES FOR THE REMEDIAL ACTION

3.1 INTRODUCTION

The mission of the Uranium Mill Tailings Remedial Action (UMTRA) Project at South Salt Lake is to carry out a cleanup program according to the EPA standards for the disposal of tailings and for the cleanup of open lands and structures. An objective of the UMTRA Project is to combine at one location the tailings, the contaminated soils, and the other contaminated materials from the site and the vicinity properties. The final disposal site will be owned by the Federal government and its maintenance and surveillance will be licensed by the NRC. By combining and stabilizing all tailings and contaminated materials at one disposal site, potential health effects caused by exposure to the tailings will be minimized, and all other presently contaminated areas will be cleaned up sufficiently to be released for unrestricted use.

3.1.1 EPA standards

General

Pursuant to the requirements of UMTRCA, EPA has promulgated health and environmental standards to govern cleanup, stabilization, and control of residual materials at inactive uranium mill tailings sites and associated vicinity properties. The promulgated standards establish requirements for long-term stability and radiation protection and provide procedures for ensuring the protection of ground-water quality.

In developing the standards, EPA determined "that the primary objective for control of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces such as wind, rain and flood waters" and that "a secondary objective should be to reduce radon emissions from tailings piles." (Ref. preamble to Standards for Remedial Actions at Inactive Uranium Processing Sites, 40 CFR Part 192.) These conclusions were based on a determination that the most significant public health risks associated with inactive tailings were posed by exposure to people living and working in structures contaminated by relocated tailings. EPA further concluded that the potential for contamination of ground water and surface water should be evaluated on a site-specific basis.

The EPA standards are discussed in the following paragraphs and are summarized in Table 3-1.

Long-term stability

Isolation and stabilization of tailings in order to prevent misuse by man and dispersal by natural forces is the primary objective of the EPA standards. Accordingly, long-term stability was emphasized in the development and promulgation of the standards. This is consistent with the guidance provided by the legislative history of UMTRCA, which stresses the importance of avoiding remedial actions which would be effective only for a short period of time and which would require future Congressional consideration.

PART 192 - HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

SUBPART A - Standards for the Control of Residual Radioactive Materials from Inactive Processing Sites

192.02 Standards

Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second, or
(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

SUBPART B - Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than -

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building -

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

SUBPART C - Implementation (condensed)

192.20 Guidance for Implementation

Remedial action will be performed with the "concurrence of the Nuclear Regulatory Commission and the full participation of any state that pays part of the cost" and in consultation as appropriate with other government agencies and affected Indian tribes.

192.21 Criteria for Applying Supplemental Standards

The implementing agencies may apply standards in lieu of the standards of Subparts A or B if certain circumstances exist, as defined in 192.21.

192.22 Supplemental Standards

"Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of 192.21."

(a) ". . .the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standards as is reasonable under the circumstances."

(b) ". . .remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable."

(c) "The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specific location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies [and] shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section."

Ref: Federal Register, Volume 48, No. 3, January 5, 1983, 40 CFR Part 192.

TABLE 3-1 EPA STANDARDS

The EPA standard-setting process distinguished "passive controls," such as thick earthen and rock covers from "active controls" such as semi-permanent covers, fences, warning signs, and restrictions on land use. Active controls could be expected to need frequent replacement or other major repairs requiring the appropriation and expenditure of public funds. In setting the standards, EPA called for designs which rely primarily on passive controls.

The standards are framed as a longevity requirement which recognizes the difficulty in predicting very long-term performance with a very high degree of confidence. In establishing the longevity requirement, EPA concluded that existing knowledge permits the design of control systems that have a good expectation of lasting at least 1000 years. Therefore, a design objective of 1000 years was established to be satisfied whenever reasonably achievable, but in any case with a minimum performance period of 200 years.

The standards recognize the need for institutional controls such as custodial maintenance, monitoring, and contingency response measures. In its preamble to the standards, EPA calls for such controls to be provided as an essential backup to the primary passive controls.

Radon emissions control

EPA identified a reduction of radon emissions from tailings piles as the second objective in its standards for the control of tailings. In developing the standards, it considered several alternative approaches and selected an emission limitation as the primary form of the standard. In addition, it established an equivalent concentration limit as an alternative form of the standard for use in cases where the DOE determined that the alternative was appropriate.

In establishing the emission limitation for tailings piles, EPA sought to reduce both the maximum risk to individuals living very near to the sites and the risk to the population as a whole. With regard to individuals very near disposal sites, EPA estimates that exposure to radon emissions will be reduced by more than 96 percent. The radon standard of 20 pCi/m^2sec on the disposal site or 0.5 pCi/l outside the disposal site will limit the increase in radon concentration attributable to a pile to a small increase above the background radon level near the disposal site. Both standards are design standards with compliance to be determined on the basis of predicted rather than measured emission rates and concentrations. EPA states that "post-remediation monitoring will not be required to show compliance, but may serve a useful role in determining whether the anticipated performance of the control system is achieved."

In establishing the radon standard, EPA determined that the emission limitation could be achieved by well-designed thick earthen covers and that such control techniques would be compatible with those required to meet the longevity standard.

Water-quality protection

EPA reviewed available water-quality data at inactive tailings sites and determined that there was little evidence of recent movement of contaminants into ground water. They also determined that any degradation of ground-water

quality should be evaluated in the context of potential beneficial uses of the ground water as determined by background water quality and the available quantity of ground water.

Rather than establish specific numerical limitations for contaminant discharges or ground-water quality, EPA determined that the most appropriate course of action would be to require site-specific analyses of potential future contaminant discharge and case-by-case evaluation of the significance of such a discharge. The implementation guidelines for the EPA standards call for adequate hydrologic and geochemical surveys at each site as a basis for determining whether specific water-producing measures should be applied.

Specific site assessments must include monitoring programs sufficient to establish background ground-water quality through one or more upgradient wells and to identify the present movement and extent of contaminant plumes associated with the tailings piles. They further call for judgements of the need for restoration or prevention, or both, to be guided by EPA's hazardous waste management system and relevant state and Federal water-quality criteria. Decisions on specific actions to protect or restore water quality are to be guided by such factors as the technical feasibility of improving the aquifer, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water source, the availability of alternative water supplies, and the degree to which human exposure is likely to occur.

UMTRCA requires that the standards promulgated by EPA ". . .to the maximum extent practicable, be consistent with the requirements of the Solid Waste Disposal Act, as amended." In setting the standard, EPA determined that the statutory requirement for NRC to concur with the selection and performance of remedial actions and to issue licenses encompassing "monitoring, maintenance, or emergency measures necessary to protect public health and safety" were consistent with the EPA regulations implementing the Solid Waste Disposal Act (47 FR 32274, July 26, 1982). Accordingly, EPA established the implementation procedures requiring case-by-case evaluations of existing and potential contamination at sites. Decisions regarding monitoring or remedial actions will be guided by relevant considerations in the hazardous waste management systems.

Cleanup of lands and buildings

The EPA evaluated the risk associated with the dispersal of tailings off the site and concluded that the principal risk to man is the exposure to radon daughter products inside buildings. EPA therefore stated that the objective of the cleanup of tailings from around existing structures is to achieve an indoor radon daughter concentration (RDC) of less than 0.02 WL. For open lands, the purpose of removing the contamination is to remove the potential for excessive indoor radon daughter concentrations that might arise from new construction on contaminated land. The 5 pCi/g and 15 pCi/g Ra-226 concentration limits for 15-cm surface and subsurface layers were considered adequate to limit indoor RDCs to below 0.02 WL. A secondary concern was to limit exposure to people from gamma radiation.

Standards state that residual radioactive materials should be removed from buildings exceeding 0.03 WL. In cases where levels are between 0.02 and 0.03 WL, the use of sealants, filtration devices, or ventilation devices is encouraged to avoid the excessive costs of additional removal of contaminated material to meet the objective of 0.02 WL.

3.1.2 NRC concurrence

The DOE will select and execute a plan of remedial action that will satisfy the EPA standards. In conformance with the UMTRCA, the required NRC concurrence in proposed remedial actions will be for the purpose of ensuring compliance with these standards.

The NRC is required by the UMTRCA to license the final tailings-disposal sites following completion of the remedial action. Section 104(f) (2) of the act states that "upon completion of the remedial action program . . . such property and minerals shall be maintained pursuant to a license issued by the Commission (the NRC) in such manner as will protect the public health, safety, and the environment. The Commission may . . . require the Secretary (of the DOE) or other Federal agency having custody of such property and minerals to undertake such monitoring, maintenance, and emergency measures as necessary to protect public health and safety and other actions as the Commission deems necessary . . . ."

3.2 DESCRIPTION OF THE ALTERNATIVES

The remaining sections of this chapter describe the alternative remedial actions for eliminating the potential hazards associated with the inactive Vitro site. The descriptions of these alternatives are followed by a comparative summary of the environmental impacts that would be associated with the alternatives.

3.2.1 Background

The Vitro site (Figures 3-1 and 3-2) encompasses an area of about 128 acres and is located 4 miles south-southwest of the center of Salt Lake City, at the northeast corner of the street intersection of 3300 South and 900 West. The Central Valley Water Reclamation Facility (CVWRF) sewage-treatment plant is located on adjacent property north of the central portion of the site. The entire site is presently owned by the CVWRF Board.

The site is bounded on the north by the CVWRF and the channel of Mill Creek, on the east by the tracks of the Denver and Rio Grande Western Railroad, on the south by 3300 South Street and on the west by 900 West Street. A 5.4-acre industrial area occupies a 225-foot wide strip adjacent to the west edge of the south half of the site facing 900 West Street. Another industrial facility is situated adjacent to the southeast corner of the site. The nearest residences to the Vitro site are about 300 feet away from its southwestern corner, across 3300 South Street.

The site can be roughly divided into four areas: the former mill and ore storage area, and three former tailings storage areas labeled "northwest," "southwest," and "southeast" on Figure 3-2. The southwest and southeast

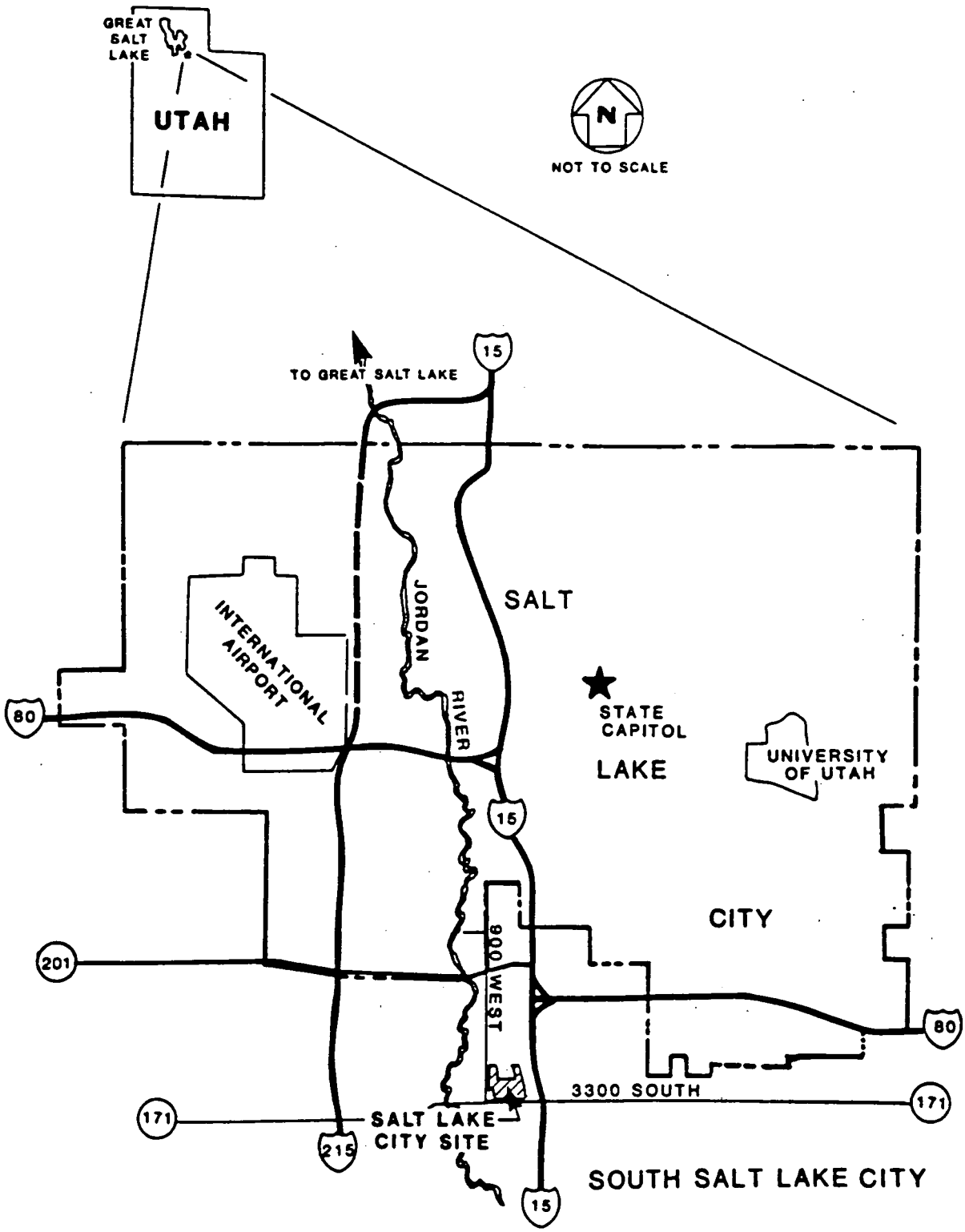

FIGURE 3-1
LOCATION MAP OF THE SALT LAKE CITY SITE
SOUTH SALT LAKE CITY, UTAH

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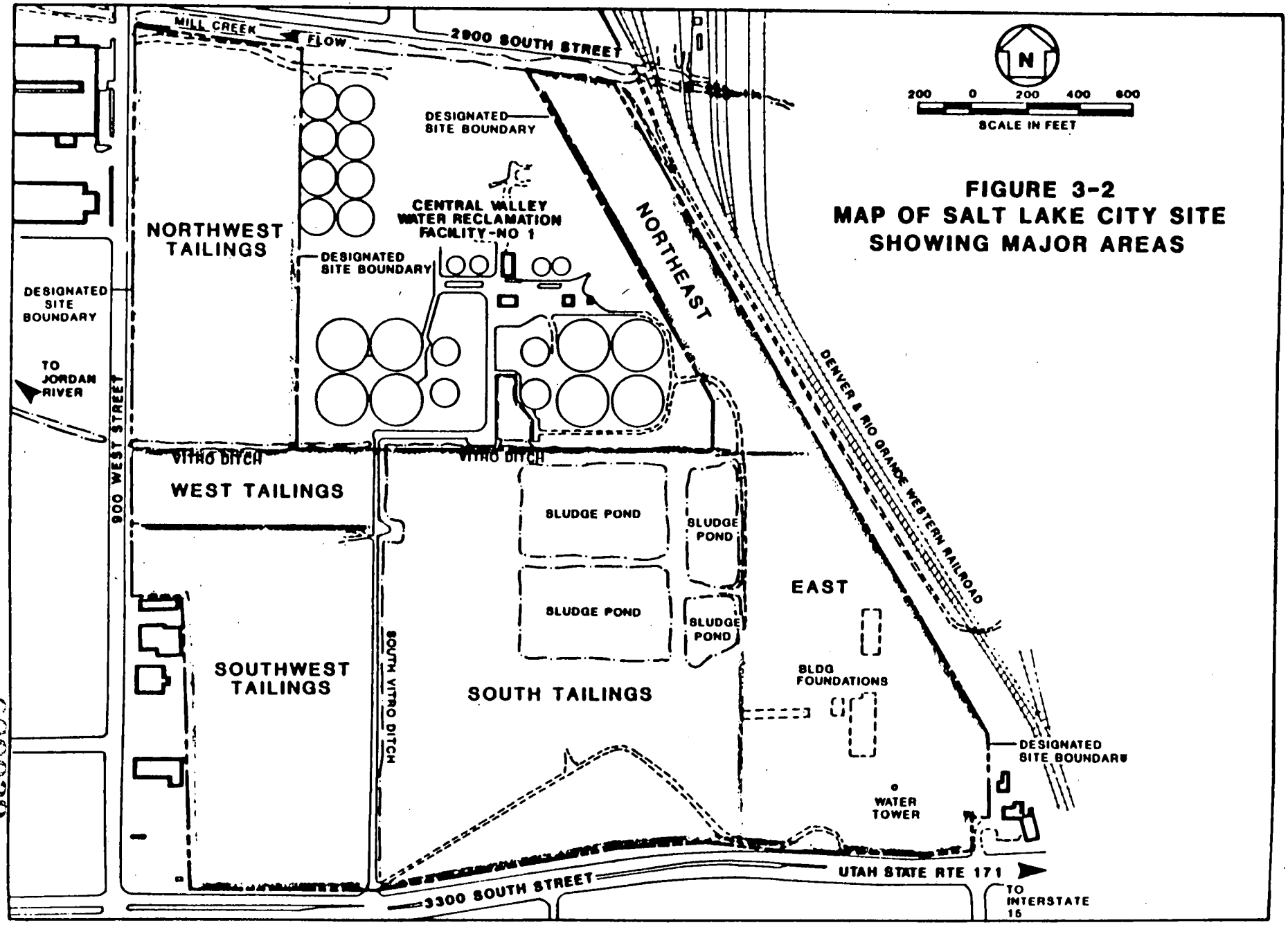

FIGURE 3-2
MAP OF SALT LAKE CITY SITE
SHOWING MAJOR AREAS

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tailings areas are separated by the South Vitro Ditch, which is part of a storm-sewer system that gathers surface water from areas south of the site. The northwest and southwest tailings areas are separated by the Vitro Waste Ditch, which carries treated water from the CVWRF. The eastern portion of the Vitro site was used for the ore processing mill, ore storage, and transportation facilities. The buildings were removed, but various foundations and concrete supports were left in place or were buried at the site. This portion of the site remains at approximately natural ground surface level. The remaining structures include a water tower and railroad tracks.

Since 1970, after milling operations at the Vitro site were terminated, the surface of the site has been altered considerably in several places. In the northwest tailings area, approximately 13 acres are covered with sludge from the CVWRF sewage-treatment plant. The northern half of the southwest tailings area contains an excavation approximately 10 feet deep and 600 feet long in the east-west direction. Excavated material on the order of 20 feet in height lies to the north and to the south of the excavation. Small amounts of debris and concrete rubble are scattered across the southwest and southeast tailings areas.

At present, off-site property cleanup projects are bringing contaminated material onto the southeast tailings and stockpiling it in a fenced low-lying area. Some of the imported material is concrete rubble, but most of it is sandy tailings that were originally taken from the site for use as fill. A recently-constructed system of unlined sludge ponds in the north portion of the southeast tailings area is currently accumulating sludge from the CVWRF plant.

Estimates of the contaminated materials that are involved in the remedial action are summarized in Table 3-2.

Table 3-2. Contaminated materials on Vitro site

Material	Volume (cubic yards)
Tailings and other contaminated materials	2,220,000
Rubble	80,000
Off-site windblown	50,000
Off-site other than windblown	100,000
TOTAL	2,450,000

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There are two basic strategies available for carrying out the remedial actions at the Vitro site: the first strategy is to stabilize the tailings and other contaminated materials at the Vitro site; the second strategy is to transport the materials to a new disposal site and decontaminate the Vitro site (DOE, 1982a).

The primary difference between a site that has been decontaminated and one that contains stabilized, radioactively contaminated material is that a decontaminated site will contain no material above the EPA standards and will be available for unrestricted use. A stabilized site will meet the EPA standards but will still contain the radioactive material and, therefore, must remain undisturbed to protect the containment. Thus, its future use will be permanently restricted.

Three alternative actions have been specifically developed for dealing with the tailings and other contaminated materials at the Vitro site. These alternatives are:

- Alternative 1 -- No action.
- Alternative 2 -- Stabilization of all material on the Vitro site.
- Alternative 3 -- Decontamination of the Vitro site and transfer of all contaminated material to a new disposal site (i.e., South Clive site) located 1 mile south of Clive, Tooele County, Utah.

These three alternatives are believed to span the spectrum of reasonable alternatives for the remedial action. Other alternatives were identified but eventually eliminated from further consideration as reasonable alternatives in this EIS; these considered-but-rejected alternatives are briefly discussed in Section 3.2.5, and in more detail in Appendix C.

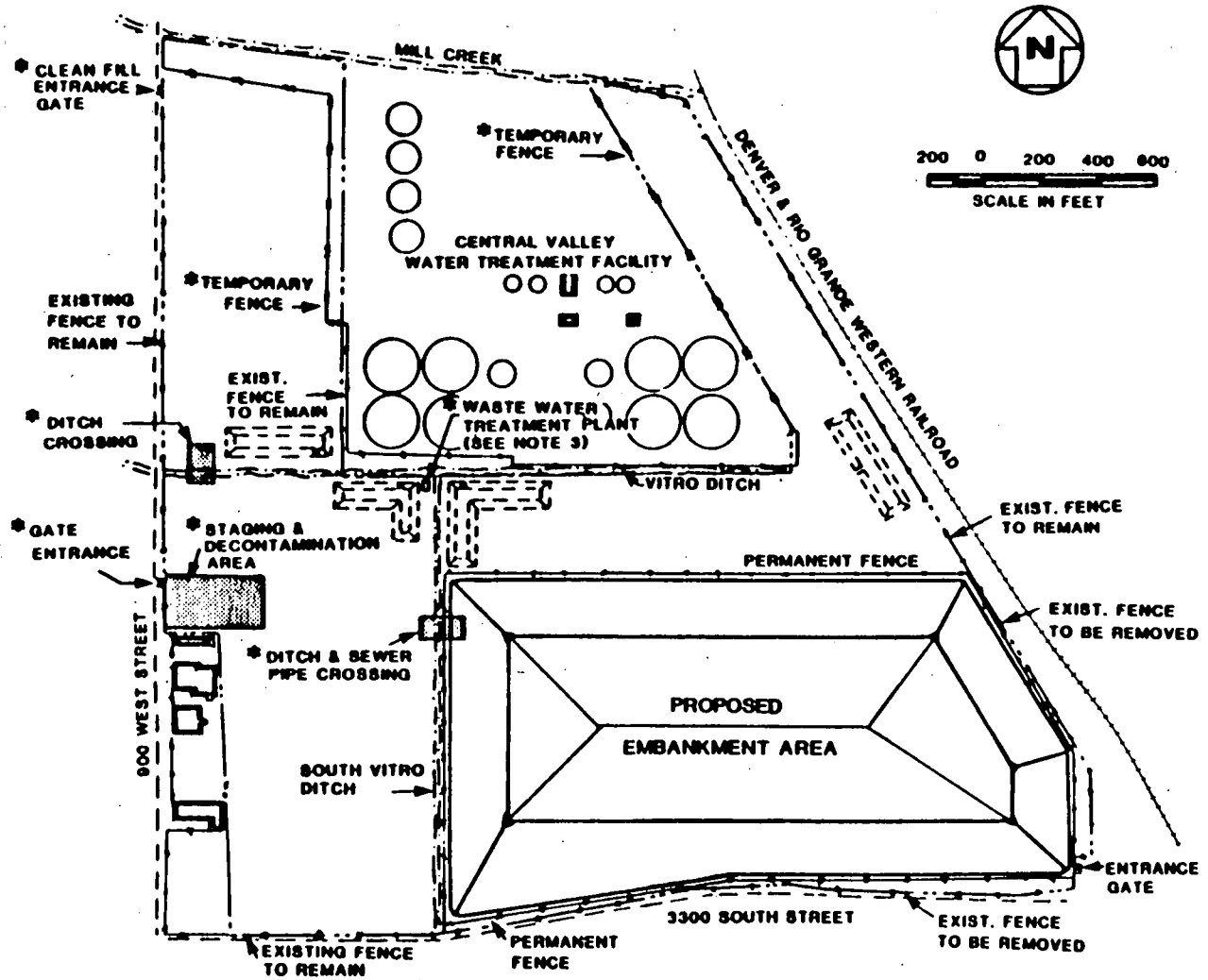
3.2.2 Alternative 1 -- no action

This alternative would entail leaving the Vitro site in its present condition and under the control of its present owners, the CVWRF Board.

3.2.3 Alternative 2 -- stabilization on the Vitro site

In this alternative, all tailings and contaminated materials would be stabilized on a 53-acre area at the Vitro site (Figure 3-3). The location of this area was chosen to minimize interference with the ongoing expansion of the CVWRF waste-treatment plant site and to release the maximum amount of land for unrestricted use.

Before stabilization of wastes could begin, the required 53 acres of the site would be acquired by the State of Utah and permission to clean up the remainder of the 128-acre tract would be obtained from the CVWRF Board. The materials obtained in the cleanup of vicinity properties would be deposited on the Vitro site, to be later stabilized with the on-site materials.



NOTES

1 FOR BOUNDARY SURVEY AND BASIS OF BEARINGS SEE "VITRO PLANT SITE SURVEY" DATED NOVEMBER 2, 1982 PREPARED BY WESTERN DESIGN CONSULTANTS FOR FORD, BACON & DAVIS UTAH INC

2 AERIAL TOPOGRAPHY BY OLYMPUS AERIAL SURVEY INC, SALT LAKE CITY, UTAH DATED SEPTEMBER 18, 1982

3 WASTE WATER TREATMENT PLANT TO BE LOCATED AS REQUIRED DURING CONSTRUCTION SEQUENCE

LEGEND

- SLOPE
- INDICATES INTERIM CONSTRUCTION
- PERMANENT FENCE
- TEMPORARY FENCE
- PROPERTY BOUNDARY
- SEDIMENTATION POND
- EMERGENCY SPILLWAY

FIGURE 3-3
PLOT PLAN SHOWING THE STABILIZED PILE
SOUTH SALT LAKE SITE

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Construction at the site would begin with site preparation, including the following activities:

1. Preparation of the staging area.
2. Clearing of trees and brush.
3. Installation of the construction storm drainage system.
4. Excavation of the sedimentation basins.
5. Installation of a waste-water treatment system.

These activities are described in detail in Appendix A.

After site preparation, the following construction activities would proceed sequentially.

1. Demolition of foundations and rubble.
2. Excavation of tailings and contaminated materials.
3. Preloading to reduce risk from excessive differential settlement (see footnote to Table 1-1).
4. Placement of a liner system in the embankment area.
5. Placement of tailings and contaminated materials in the embankment area.
6. Placement of a cover system over the tailings and other contaminated materials.
7. Placement of fill to restore decontaminated areas to natural grade.
8. Revegetation of restored areas.

Each of these activities are described in detail in Appendix A, and are briefly described in the following paragraphs.

Demolition

Rubble, foundations, and the abandoned rail spur would be reduced in size and incorporated into the embankment. These materials would be placed in the lower portions of the embankment, above the post-remedial action ground-water level, in such a manner as to eliminate voids and to prevent settlement. Building foundations in the embankment area which would not interfere with the construction or integrity of the embankment would be left in place.

The water tower would be dismantled, decontaminated if necessary, and disposed of in a public landfill or sold as scrap.

Excavation of tailings and contaminated materials

Tailings would be dewatered. This would be accomplished in layers by scraping, trenching and drying, excavating the dewatered material until a new level is reached which is too wet for handling, and repeating the process. Excavation could alternate between sections of the site to allow for the drying process. Underlying contaminated clayey soils may not have sufficient strength to support scrapers. These materials, as well as one foot of the tailings above them, could be excavated with backhoes.

Excavation in the areas to be restored would be to the 15 pCi/g (Ra-226) limit. This is estimated to be two feet below the tailings/natural soil interface. Table 3-3 shows the volumes and types of excavations.

Dewatering water would be pumped from the excavation trenches and drained to the sedimentation basins for treatment prior to discharge.

Preloading (see note to Table 1-1)

After excavation and stockpiling of tailings and contaminated materials, 3,000,000 cy of noncontaminated material would be trucked in to cover the 53-acre disposal site with fill for preloading. The preload would stay in place for approximately 2.5 years (determination of the time would be based on field measurements of settlement to determine the amount and rate of settlement). Once settlement has slowed and the amount of settlement that would take place due to the construction of the embankment has taken place, 2,000,000 cy of the preload material would be hauled away for disposal. The remaining material would be used in the construction of the liner system and for fill around the site.

Liner system placement

The liner system would be placed as the embankment area tailings and contaminated materials are excavated. The system would consist of a compacted subbase of sufficient thickness to be above the post-remedial action ground-water elevation, a three-foot granular capillary break layer base, and two feet of compacted, fine-grained soil under the embankment area. A fleet of 35 trucks that contain about 18.5 cy, making 5 trips per day, could haul in the required 220,000 cubic yards of subbase material, 300,000 cubic yards of granular base material, and 190,000 cubic yards of liner material in 220 days (Table 3-3).

Placement of tailings and other contaminated materials

Tailings and other contaminated materials would be placed in controlled lifts in the embankment area. Tailings sands and slimes would be mixed during placement and compacted to form a dense, stable material. For purposes of reducing radon emissions and providing an upper capillary break, sandy tailings would be identified and incorporated into the upper portion of the embankment. The purpose of the upper capillary break would be to limit or eliminate upward migration of moisture-transported contaminants. The benefits of placement of sandy tailings in the upper portion of the embankment would outweigh the disadvantage of the slight increase of net infiltration into the tailings.

Placement of cover system

The cover would be constructed of two basic layers: a lower compacted earthen layer to act as a radon and water infiltration barrier and an upper

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pit run rock layer for surface stability. A typical section through the embankment is shown in Figure 3-4. A fleet of 35 trucks (18.5 cy capacity) making 5 trips per day, would haul in the required 290,000 cubic yards of radon barrier material and 155,000 cubic yards of pit run rock in 140 days (Table 3-3). The cover materials would be dumped from the trucks, spread with dozers, and compacted.

Placement of restoration fill

During the relocation of contaminated material into the tailings embankment, large portions of the existing site would be excavated to below ground level. These areas would be restored with uncontaminated fill to the approximate elevation of the surrounding terrain and contoured to provide surface drainage. A fleet of 35 trucks with 18.5 cy capacity trailers, making 5 trips per day, would haul in the required 710,000 cubic yards of fill in 220 days (Table 3-3). The fill materials would be spread with dozers and compacted.

Revegetation

All areas of the site disturbed by the remedial action except for the embankment cover would be prepared and seeded with native grasses. Site preparation requirements (mulch and fertilizer) would be assessed after the fill material has been analyzed as a plant growth medium.

3.2.4 Alternative 3 preferred alternative--decontamination of the Vitro site and stabilization at the South Clive site

In this alternative, all tailings and contaminated material would be transported to the South Clive site, which is located on a section of state land about 85 miles west of Salt Lake City (Figure 3-5). There, they would be stabilized partially below grade on a 55-acre area in the northern part of the section. The location of this site was chosen to assure long-term isolation of the tailings while taking advantage of major transportation routes.

Before stabilization of the waste could begin, the 60 acres of the South Clive site would be withdrawn from state lands and permission obtained from the CVWRF Board to clean up the 128-acre Vitro site. The materials obtained in the cleanup of vicinity properties would be delivered to the Vitro site for transportation to the South Clive site for final stabilization.

There are two options to this alternative: transport of the tailings and contaminated materials by train or by truck. Each option is discussed separately as appropriate.

Table 3-3. Material volumes - stabilization on the Vitro site

Item description	Quantity cubic yards
Excavation	
Excavation of dry tailings (excavate with scraper)	170,000
Excavation of wet tailings (dewater and excavate with scraper)	1,380,000
Excavation of saturated contaminated materials (excavate with backhoe)	670,000
Rubble	80,000
Other contaminants	150,000
(Preload Sytem)[a]	(3,000,000)
Liner System	
Subbase	220,000
Base	300,000
Liner	190,000
Cover	
Radon barrier soil (silty sand)	290,000
Erosion barrier, ditches and perimeter road (pit run rock)	155,000
Restoration	
Select fill	710,000

[a]See footnote to Table 1-1

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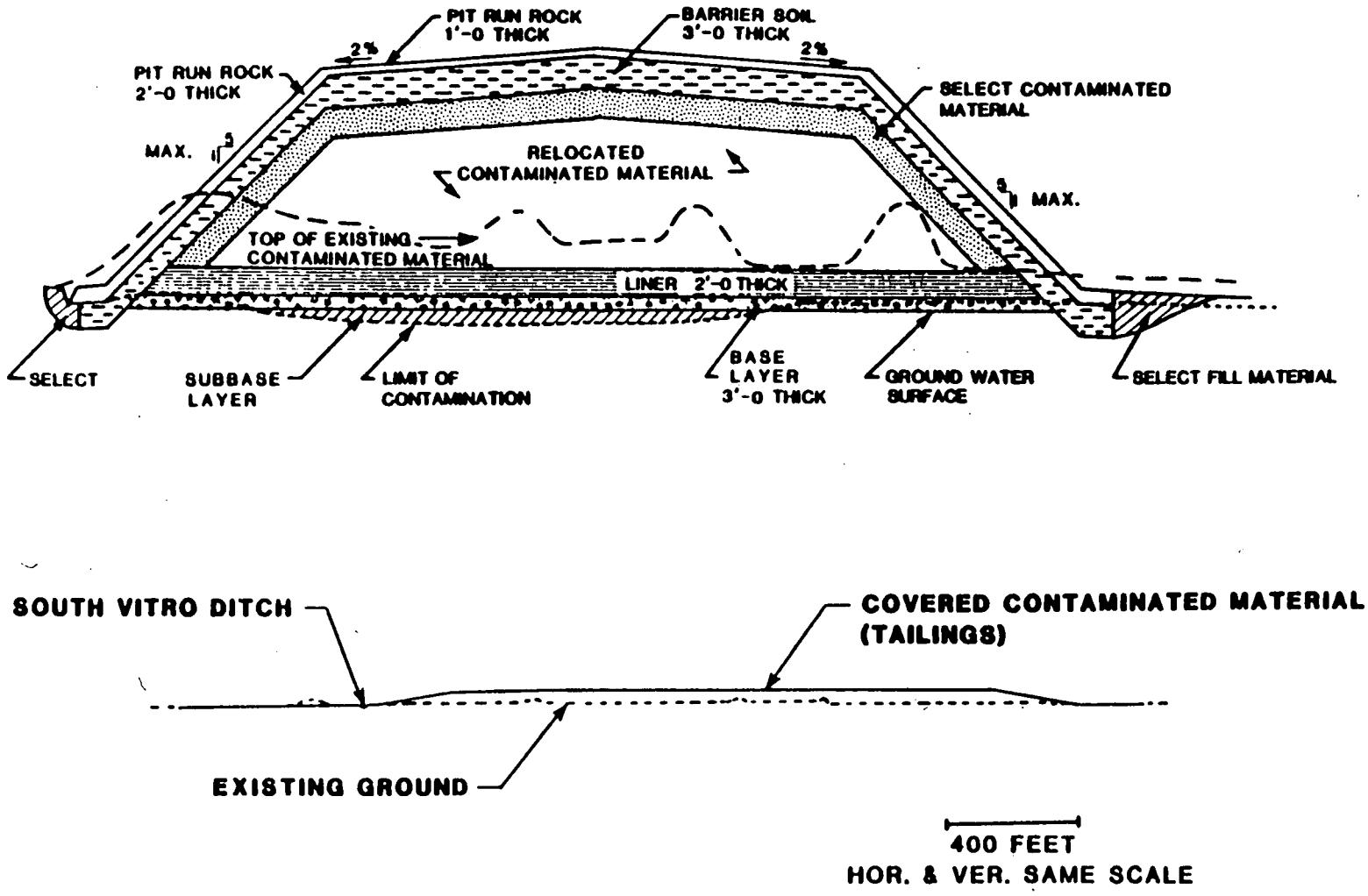

FIGURE 3-4
TYPICAL LINER AND EMBANKMENT SECTION
SOUTH SALT LAKE SITE

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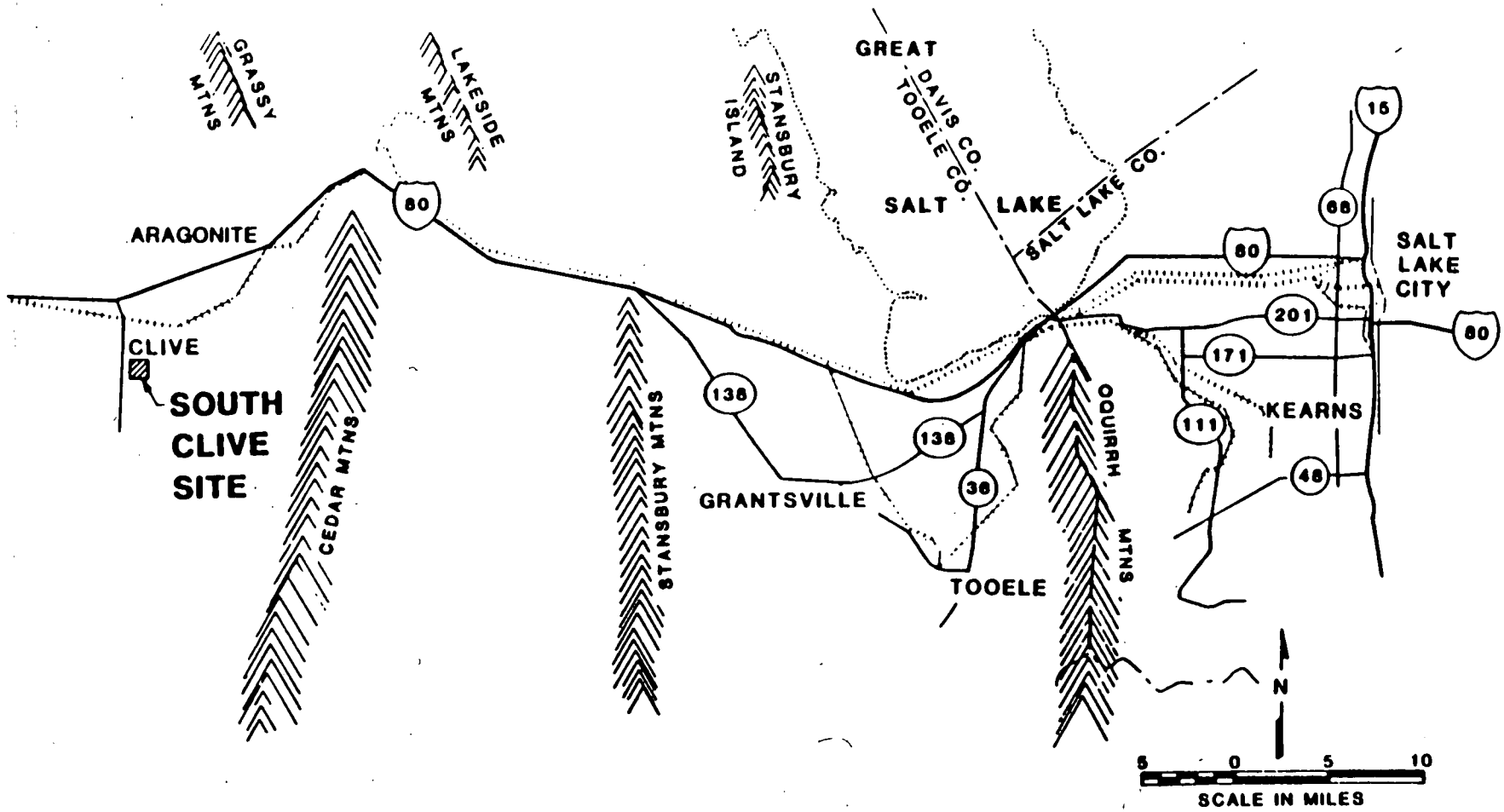

FIGURE 3-5
SOUTH CLIVE VICINITY MAP

Construction would begin with site preparation at the Vitro and South Clive sites, including the following activities (Figures 3-6 and 3-7):

1. Preparation of a staging area at each site.

2. Clearing of trees and brush.

3. Installation of a construction storm drainage system.

4. Excavation of the waste-water retention basins.

5. Installation of a waste-water treatment system at the Vitro site.

6. Installation of a dewatering system at the Vitro site.

These activities are described in detail in Appendix A.

After site preparation, the following construction activities (train transport) would proceed sequentially:

1. Construction of a railroad loadout spur at Vitro and the railroad spur and unloading facilities at the South Clive site.

2. Construction of an access road from I-80 to the South Clive site.

3. Demolition of foundations and rubble.

4. Excavation of the disposal site and stockpiling of the soil for cover material.

5. Excavation and loading of tailings and other contaminated materials into train cars.

6. Unloading and placement of the tailings and contaminated materials into the South Clive embankment area.

7. Placement of a cover system over the tailings and contaminated materials.

8. Removal of the railroad spur and placement of fill at the Vitro site to restore decontaminated areas to natural grade.

9. Revegetation of restored areas.

10. Removal of the railroad spur and installation of a permanent fence around the South Clive embankment.

For the truck option, the following activities would proceed sequentially:

1. Construction of haul road from I-80 to the South Clive site.

2. Demolition of foundations and rubble.

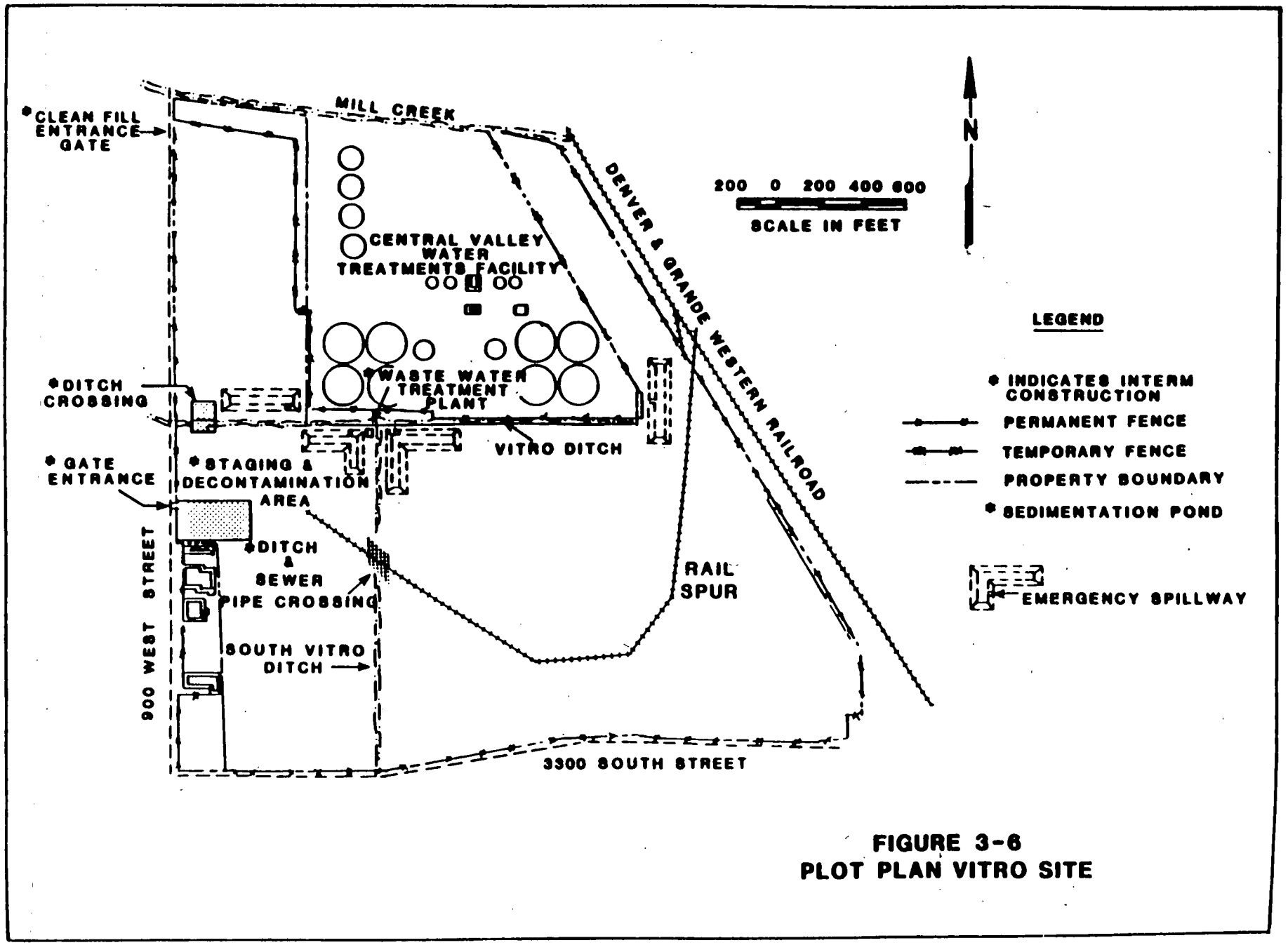

FIGURE 3-6
PLOT PLAN VITRO SITE

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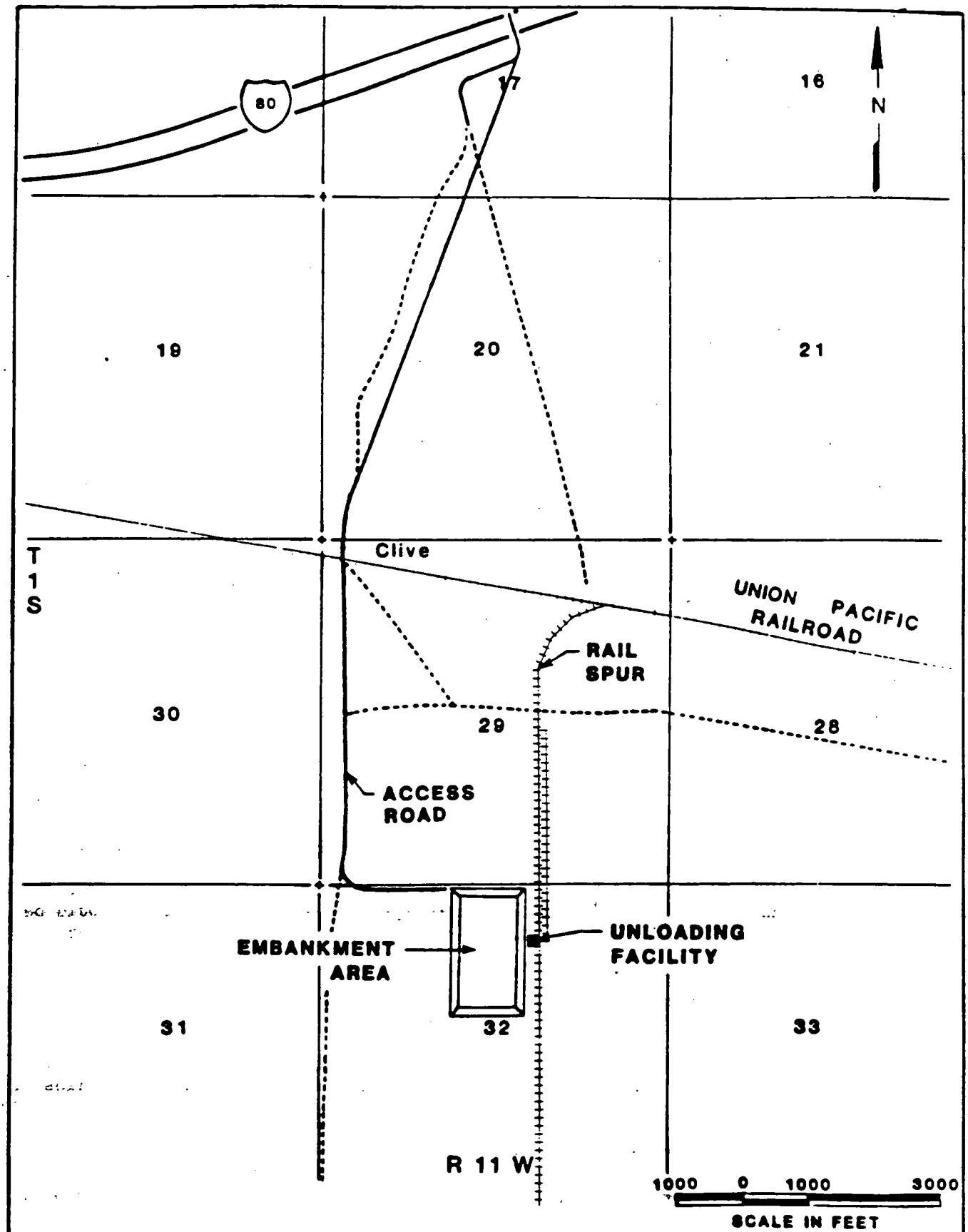

FIGURE 3-7
PLOT PLAN FOR SOUTH CLIVE

3. Excavation of the embankment area and stockpiling of cover material at the South Clive site.

4. Excavation and loading of tailings and contaminated materials into trucks.

5. Unloading and placement of the tailings and contaminated materials into the South Clive embankment area.

6. Placement of a cover system over the tailings and contaminated materials.

7. Placement of fill to restore decontaminated areas at the Vitro site to natural grade.

8. Revegetation of restored areas.

9. Installation of a permanent fence around the South Clive disposal site.

The major activities for each transportation option are briefly described in the following paragraphs and are documented in detail in Appendix A.

Construction of railroad spurs

For the train option, tailings and any contaminated subsoils would be excavated from an area 3,800 feet long and 120 feet wide to accommodate both the railroad and loading areas. The area would then be filled with clean subbase material and the ballast, ties, and tracks installed.

A railroad spur, 3,800 feet long will be installed, curving across the site from the northeast corner toward the southwest corner of the Vitro site.

Concurrently, a 13,800-foot-long railroad spur and run-around track would be constructed south from the Union Pacific mainline alongside the South Clive site and ending near the south edge of the site. Subbase would be excavated from the land alongside the track, compacted, and then the ballast ties and rails installed. Additionally, a roto-dumper and a rotating stacker would be installed to unload and stack the tailings and contaminated materials for final placement.

Construction of haul road to South Clive site

For the truck option, the existing access from the Aragonite exit from I-80 to the South Clive site will need to be resurfaced. About seven miles of the frontage road will need to be upgraded to carry 35-ton loading; additionally, 2.7 miles of new, two-lane gravel road will be constructed from the frontage road to the South Clive site.

For the train option, a vehicle access road (2.7 miles, two-lane gravel) will be constructed from the frontage road to the site. Frontage road will also be upgraded and maintained for light-duty traffic.

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Demolition

Rubble, foundations, and the abandoned rail spur would be reduced in size and transported by either side-dump railroad cars or dump trucks and incorporated into the embankment. These materials would be placed in the lower portions of the embankment in such a manner as to eliminate voids and to prevent settlement.

The water tower would be dismantled, decontaminated if necessary, and disposed of in a public landfill or sold as scrap.

Excavation of tailings and contaminated materials

Tailings would be dewatered. This would be accomplished in layers by scraping, trenching and drying, excavating the dewatered material until a new level is reached which is too wet for handling, and repeating the process. Excavation could alternate between sections of the site to allow for the drying process. In some areas, the underlying contaminated clayey soils may not have sufficient strength to support scrapers. These materials, as well as one foot of the tailings above them, could be excavated with backhoes.

The excavated material would be loaded into either the trains or trucks and transported to the South Clive site. Two unit trains, each of 54 cars, or 77 trucks are required to relocate 5,400 tons of tailings per day.

Excavation in the areas to be restored would be to the 15 pCi/g (Ra-226) limit. This is estimated to be two feet below the tailings/natural soil interface. Table 3-4 shows the volumes and types of excavations.

Dewatering water would be pumped from the excavation trenches and drained to the sedimentation basins for treatment prior to discharge.

Unloading and placement of tailings and other contaminated materials

For the train option, the unit train will be pushed through a roto-dumper which will unload the cars into a conveyor leading to a rotary stacker. Rubble will be unloaded from the side dump cars in an area just to the south of the roto-dumper. Scrapers or trucks will then be used to move the tailings and contaminated materials to the final location in the embankment. If the truck option is selected, the tailings and contaminated materials will be dumped directly in the embankment area to be spread by scrapers.

Tailings and other contaminated materials would be placed in controlled lifts in the embankment area. Tailings sands and slimes would be mixed during placement and compacted to form a dense, stable material. For purposes of reducing radon emissions and providing an upper capillary break, sandy tailings would be identified and incorporated into the upper portion of the embankment.

Table 3-4. Material volumes - relocation to South Clive

Item description	Quantity cubic yards
Excavation	
Excavation of dry tailings (excavate with scraper)	170,000
Excavation of wet tailings (dewater and excavate with scraper)	1,380,000
Excavation of saturated contaminated materials (excavate with backhoe)	670,000
Rubble	80,000
Other contaminants	150,000
Cover	
Radon barrier soil (silty sand)	460,000
Erosion barrier, ditches and perimeter road (pit run rock)	202,000
Restoration	
Select fill	1,040,000

Placement of cover system

The cover would be constructed of two basic layers: a lower compacted earthen layer to act as a radon and water infiltration barrier and an upper pit run rock layer for surface stability. A typical section through the embankment is shown in Figure 3-8.

The soils for the earthen layer would be stockpiled during excavation of the disposal area and would be placed in controlled lifts with the completion of each section of the embankment. The 460,000 cubic yards of cover would be placed by scrapers and dozers and compacted . The 202,000 cubic yards for the 2-foot-thick pit run rock layer would be handled by three 20.5 ton trucks and trailer rigs from a quarry in the nearby mountains in 640 days, making 8 trips per day.

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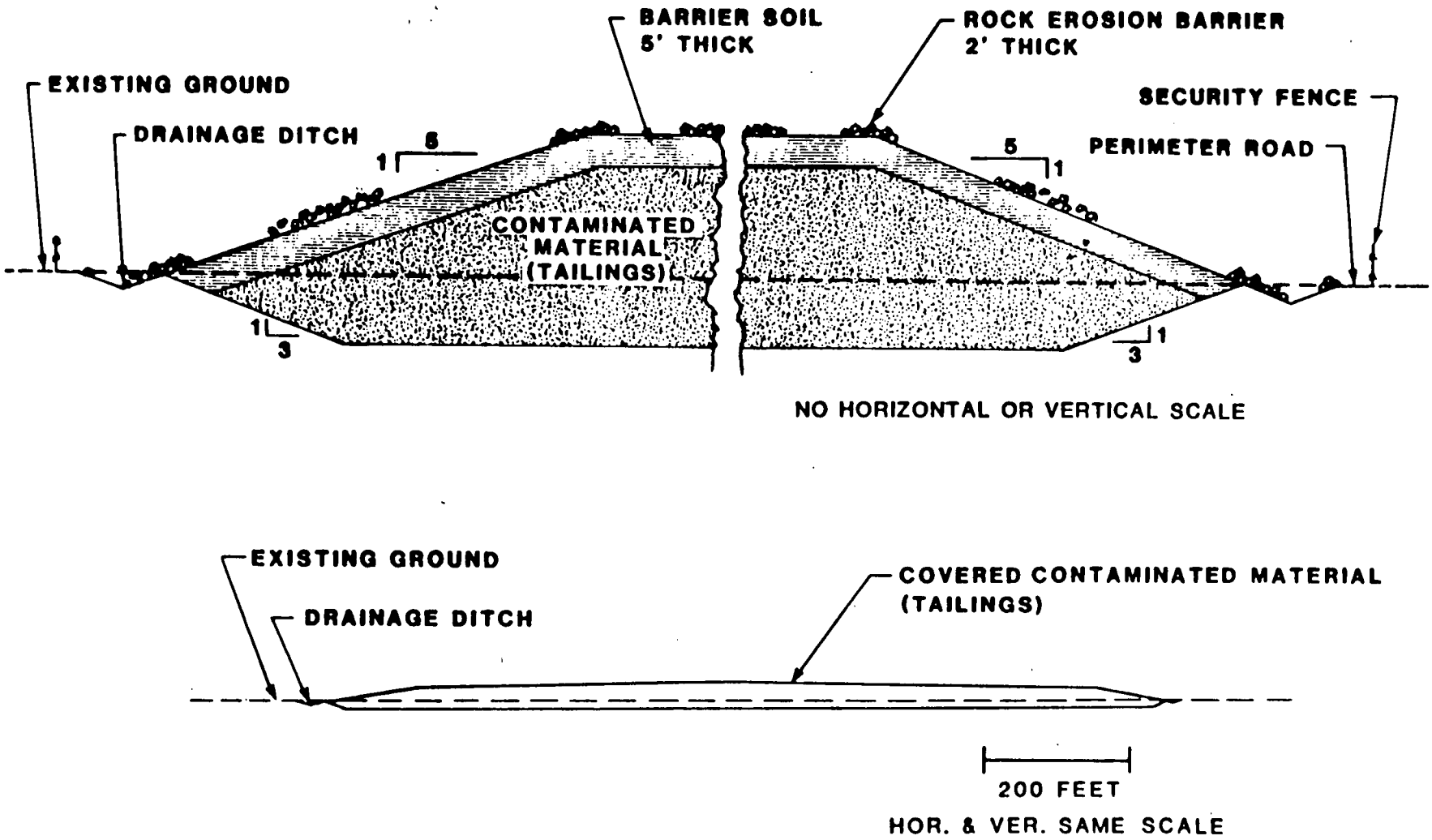

FIGURE 3-8
TYPICAL SECTION OF THE EMBANKMENT
SOUTH CLIVE SITE

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Placement of restoration fill

During the relocation of contaminated material to the South Clive tailings embankment, large portions of the existing site would be excavated to below ground level. These areas would be restored with uncontaminated fill to the approximate elevation of the surrounding terrain and contoured to provide surface drainage. For the truck option, a fleet of 19 trucks and trailers would haul in the required 1,040,000 cu yds of fill (Table 3-4) by making 5 trips a day for 625 days. The train option would require 945,000 cu yds of fill to be hauled in since 95,000 cu yds would be placed during the construction of the railroad spur. After the track is removed, 17 trucks would be required to deliver this reduced volume making 5 trips per day for 625 days. The fill material would be spread with dozers and compacted.

At the South Clive site, restoration is required for the train option to backfill the roto-dumper and rotary stacker area. Excess cover material that was excavated during the embankment construction will be spread in these areas with dozers and compacted. The spur line would be removed and the R.O.W. graded to conform with the adjacent land.

Revegetation

All disturbed areas of the Vitro and South Clive sites disturbed by remedial action, except for the embankment area, would be prepared and seeded with native grasses. Site preparation requirements (mulch and fertilizer) would be assessed after the fill material has been analyzed as a plant growth medium. For the train option, the spur line R.O.W. from the South Clive site to the mainline would also be revegetated.

3.2.5 Alternatives eliminated from further consideration

Four classes of remedial-action alternatives were identified but eliminated from further consideration as not reasonable for one or more of the following reasons: the alternatives were obviously inferior to the considered alternatives in both their cost effectiveness and environmental benefits; the alternatives were sufficiently similar to the considered alternatives as to make detailed consideration of them superfluous; the alternatives were contrary to the EPA standards or the NRC's expressed guidelines for uranium mill tailings disposal as these guidelines were understood in 1981. These considered-but-rejected alternatives and reasons for their rejection are discussed in the sections that follow and, in more detail, in Appendix C.

3.2.5.1 Stabilization at other state-nominated locations

The State of Utah nominated three areas for the long-term disposal of tailings and residues from the Vitro site (VTSSC, 1980). One of these areas was the South Clive site; the other two areas were the "great depression" located about 8 miles north of Clive, Utah, and a section of state land located approximately 3 miles west of Delle (Tooele County), Utah (see Figure 1-3). Both of the latter two areas were found to be less desirable from a

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geotechnical point of view and had drawbacks relative to transportation in that direct access to them from convenient rail drop-off points would require the crossing of I-80 at points distant from overpasses on that highway. The need for an intermediate transport step (by truck from rail drop-off points to the site) and the need for new road construction would make these two areas more costly as disposal sites than the South Clive site. In addition, they ranked lower in terms of overall environmentally desirable characteristics for a waste-disposal site than the South Clive site. Accordingly, the DOE determined that these sites did not represent reasonable alternatives.

3.2.5.2 Stabilization in eastern Utah

Two areas in eastern Utah were also examined as disposal areas. One area is about 3 miles north of Woodside, Emery County, Utah and about 156 road miles from Salt Lake City. The other is 9 miles south of Crescent Junction, Grand County, Utah, about 215 road miles from Salt Lake City. Both areas appear to be geotechnically acceptable. The Woodside area is typical of the two and is discussed below.

Consideration was given to the Woodside area in response to a proposal submitted to the State of Utah recommending the use of an existing fleet of trucks that currently (1980) haul coal from Emery and Carbon County areas to the Kennecott copper mill near Salt Lake City. The trucks normally return empty to the Woodside area, so it was suggested that they could be diverted to the Vitro site and loaded with tailings for the return trip. The DOE evaluated this proposal and found that it would require 9 years to move the tailings in this way, and at a cost of $14.09 per ton (truck transport to the South Clive area would cost $8.50 per ton). Thus, this alternative would be neither cost effective nor timely relative to the considered alternatives; accordingly, it was determined to be an unreasonable alternative by the DOE.

3.2.5.3 Stabilization at other locations in Salt Lake Valley

The DOE examined the alternative of moving the Vitro tailings to other locations within the Salt Lake Valley and concluded that, relative to stabilization at the Vitro site, there would be no clear economic or environmental benefits to be realized in such a move unless the new locations afforded special opportunities for isolation and reduction of remedial-action costs. Examples of such alternatives would be the stabilization of the wastes in some large, isolated public construction project such as highway interchanges or airport runways. However, no such opportunities were known to be available or foreseen to be available, and so no reasonable alternatives in this category were identified by the DOE. Other such alternatives are discussed in Appendices B and C.

3.2.5.4 Reprocessing of the Vitro tailings

The DOE is required by the UMTRCA, Title I, to determine the practicability of reprocessing the Vitro tailings. Since the final determination of practicability has not been made, this class of alternatives cannot be entirely rejected at this time. However, preliminary studies show that reprocessing of the Vitro tailings is not economic at present-day prices for

uranium (see Section C.4, Appendix C). Using what would currently be the most economical process (heap leaching) and reprocessing the tailings on the site, a firm would incur a net loss on the order of $23 million at present-day uranium and vanadium prices. This loss would be in addition to the cost of stabilizing residues from reprocessing. Therefore, the reprocessing alternatives have been considered as being unreasonable for purposes of this document. Should these alternatives become practicable in the near future, DOE will examine the need for a supplement to the EIS.

3.3 ENVIRONMENTAL IMPACTS

In this section attention is focused on the principal environmental impacts of the three alternatives studied. A tabular comparison of all impacts is presented in Table 1-3.

3.3.1 Comparison of impacts

Radiological impacts are foremost among the public's concerns. Alternative 1 would perpetuate the present situation; an estimated 0.6 additional cancer deaths would occur in a three-year period in the Salt Lake Valley. Either Alternative 2 or Alternative 3 would reduce this toll. In Section F.3.1 of Appendix F it is conservatively assumed that radon is being emitted from the surface of these tailings at an areal flux of 560 picocuries per square meter per second (pCi/m^2s). Either of the latter two alternatives would reduce this flux to the EPA standard. The estimated number of excess lung cancers would be similarly reduced. During the 3-year time taken for the remedial action this flux will be gradually reduced, either because (in Alternative 2) the tailings are stabilized under an earthen cover or because (in Alternative 3) the tailings are actually hauled away. The levels of contaminated dust would increase because of excavation and loading of the tailings; however, calculations show that this source of radiation exposure would be about a hundred-fold less important than the radon exposure. The potential radiation exposure of the public during remedial action is estimated to be 15,000 manrem for both alternatives; both would result in an additional estimated 0.3 deaths from cancer. The workers themselves would have the largest individual exposures of all persons. It is estimated that they would receive doses of about 6 rem apiece during the 3 years of remedial action.

Alternative 1 would have no effect on existing air quality in Salt Lake or Tooele Counties. The impacts of Alternatives 2 and 3 on air quality would be short-term in each case; the combustive emissions from construction activities in Alternatives 2 and 3 would be within limits allowed by the State of Utah. However, particulate emissions during Alternatives 2 and 3 would exceed Federal primary and secondary air quality standards.

There would be no impact on topography or soils under Alternative 1. In Alternative 2, a permanent, smoothly-contoured pile about 50 feet high would be constructed on 53 acres in the southeast portion of the Vitro site and the remaining 75 acres of the site would be leveled to local grade; about 1.9 million cubic yards of soil, gravel, and clay would be imported from

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commercial sources to complete this alternative. In Alternative 3, all 128 acres of the Vitro site would be returned to local grade, requiring about 1.0 million cubic yards of imported soil for backfill. A permanent, smoothly-contoured mound 34 feet high would cover 55 acres at the South Clive site; about 647,000 cubic yards of gravel or crushed stone would be imported to provide an erosion-resistant cover for this mound.

EPA water standards would be met by either Alternative 2 or Alternative 3. However, Alternative 2 would rely on an engineered barrier, natural materials, and maintenance of the existing pressure gradients in the hydrologic system beneath the tailings to protect the potable confined aquifer and the potable lower portion of the unconfined aquifer. Alternative 3 would simply remove the tailings as a potential source of contamination at the Vitro site and place it in an area of poor-quality, shallow ground water. In Alternative 1, the potential for contamination of surface water and ground water would continue.

Alternative 1 would have no effect on existing ecosystems at the Vitro site or the South Clive site. In Alternatives 2 and 3, the small biotic community on the 128-acre Vitro site would be destroyed; about 200 acres of desert scrubland and associated habitat at the South Clive site would also be disturbed or destroyed in Alternative 3.

Next to radiological impacts, the impacts on land use would be the most important. Alternative 1, leaving the present situation unchanged, would mean that the CVWRF Board might be constrained in expanding the capacity of the sewage-treatment plant to 100 million gallons per day (mgd), because its plans require the use of land now covered with tailings. Alternative 2, though it would leave 53 acres covered with tailings, would free 75 acres for the CVWRF Board to use. Alternative 3 would free all of the land for CVWRF Board use.

Alternatives 1 and 2, as now formulated, would not require the acquisition of a 5.4-acre industrial strip on the southwest side of the Vitro site.

Removal of the tailings from the 128-acre Vitro site would permit development in accordance with the CVWRF's approved Master Plan. In 1979, the CVWRF bought approximately 29 acres of frontage property along 3300 South Street from Richards-Moench for $62,500 per acre. This land was purchased under the assumption that the federal government would remove the tailings and make the land available to the CVWRF. The CVWRF Board has stated that it will develop a temporary industrial park on the 3300 South Steet frontage property if Alternative 3 is the adopted remedial action. Based on an analysis of the economic impacts of the remedial action options, it is estimated that the development of a temporary industrial park would generate approximately $11.0 million a year in gross economic benefits to the region. Alternative 2, which would make approximately 75 acres available to the CVWRF, may permit a portion of the proposed development set forth in the CVWRF's approved Master Plan. To the extent a temporary industrial park is developed on the property, a regional economic benefit also would result under Alternative 2.

Alternative 1 would produce no construction-intensive impacts such as those on populations and employment, transportation networks, energy-consumption patterns, and occupational health and safety. Alternatives 2 and 3 would produce relatively minor and similar impacts in all of these areas.

Alternative 2 would create short-term (at most, 2.5-year) jobs for a maximum of 104 construction workers. The income and taxes from these jobs would have little effect on the Salt Lake City economy and social infrastructure. Transportation networks in Salt Lake County would not be seriously affected by Alternative 2; at most, there would be a 8.5 percent increase in traffic on 5400 South Street owing to deliveries of soil; increases in traffic along the remainder of the haul route would be less. About 2.5 million gallons of diesel fuel and 0.4 million kilowatt hours of electrical power would be expended in the implementation of Alternative 2. According to recent incidence rates, one should expect 0.015 fatal work accidents and about 12 disabling injuries during the 2.5-year term of Alternative 2.

Alternative 3 would create a maximum of 130 (train) or 153 (truck) short-term construction jobs in Salt Lake and Tooele counties. Again, the jobs created by Alternative 3 would have little effect on the Salt Lake County economy although there could be small-but-measurable effects in Tooele County. The effects of Alternative 3 along the haul routes to the Vitro site would be less (maximum increase of 4 percent) than those of Alternative 2. About 7 million gallons of diesel fuel and 0.8 million kilowatt hours of electrical power would be expended in the implementation of Alternative 3--more than 2 times the energy expenditures of Alternative 2. Finally, one should expect a few more occupational accidents in Alternative 3 than Alternative 2 because of the larger work force involved: according to 1980 incidence rates, 0.014 (train) or 0.52 (truck) fatal work accidents and 27 (train) or 25 (truck) disabling injuries should be expected.

The final matter in which there is a great difference among the alternatives is cost. It is indicated in Appendix A that Alternative 2 would cost $31.24 million in 1983 dollars; Alternative 3 would cost between $63.78 (train) and $67.68 (truck) million.

3.3.2 Mitigating measures

The potential environmental impacts from remedial-action alternatives could be made smaller through the use of appropriate mitigating measures. A number of these have been incorporated into the plans for Alternative 2 and Alternative 3. These include dust control, material containment, rail car or truck washdown, elimination of public access to the sites, and the provision, where necessary, of protective equipment for use by remedial action workers. Additional measures are described in Section 5.19.

There are even mitigating measures possible for Alternative 1. The cleanup of vicinity properties is already under way. Other measures, which depart somewhat from strict no action and which would not bring the site into conformity with the EPA standards, but which would improve the present

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situation, include: (1) fencing and posting the property to keep people off it and to prevent further off-site uses of contaminated material, (2) sprinkling to control dust, and (3) covering with a sufficient layer of soil to support vegetation and thus to reduce further wind and water erosion.

In Alternative 2, stabilization at the Vitro site, a possible mitigation measure would be a land exchange. One of the possibly serious consequences of this alternative is that it would interfere with the plans of the CVWRF board to expand the capacity of their sewage treatment plant by taking away land the board was planning on using. The State of Utah could acquire vacant land adjacent to the Vitro site and transfer it to the CVWRF board in exchange for the 53 acres used for the stabilization area and not available to the board. The board would still have to adjust its present plans, but would be less land-limited in doing so.

3.3.3 Summary of major impacts

Alternative 1 would leave unchanged the present unacceptable level of radiation exposure to the people of Salt Lake Valley. Thus, Alternative 1 would not meet the EPA standards; either of the other two alternatives would. For this reason alone, Alternative 1 is unacceptable.

Alternative 1 would completely interfere with the expansion plans of the CVWRF Board. Alternative 2 would free more than half of their land for use in expansion. Alternative 3 would free all of it.

Alternative 1 would result in the continued contamination of surface and ground waters. Either Alternative 2 or 3 would meet the EPA standards. Alternative 2 would raise the tailings out of the ground-water system and retard movement of contaminants from the tailings to the ground water for a long period of time. Alternative 3 would eliminate the possibility of future ground-water contamination at the Vitro site.

The direct monetary cost of the remedial-action portion of Alternative 1 would be zero, that of Alternative 2 would be 31.24 million, and that of Alternative 3 between $63.78 and $67.68 million. The estimated remedial action costs for the train and truck transportation mode for Alternative 3 differ slightly. However, due to the conceptual nature of the design and the accuracy of the associated estimates, the costs for either transportation mode, should be considered essentially equivalent.

REFERENCES FOR CHAPTER 3

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DOE (U.S. Department of Energy), 1982b. Environmental Assessment of Preliminary Cleanup Activities at Offsite Properties Contaminated by Tailings from the Inactive Uranium Mill Site Near Salt Lake City, Utah, DOE/EA-0186, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1982. Environmental News, Office of Public Affairs, December 15, promulgated January 5, 1983, 48FR590.

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FBDU (Ford, Bacon and Davis Utah Inc.) 1981. Engineering Assessment of Inactive Uranium Mill Tailings, Vitro Site, Salt Lake City, Utah, DOE/UMT-0102, prepared for U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico 87115.

VTSSC (Vitro Tailings Site Selection Committee), 1980. "Vitro Tailings Site Selection Committee Report," dated June 20; signed by Blaine N. Howard (Chairman), Earl Peirce, Fitzhugh Davis, Dan Blake, Robert Cunliffe, and Dane Finerfrock; copies available on request to Uranium Mill Tailings Remedial Action Project Office, DOE Albuquerque Operations Office, Albuquerque, New Mexico.

4 AFFECTED ENVIRONMENT

Described in this chapter are those features of the existing environment that may be affected by the alternative remedial actions discussed in Chapter 3.

4.1 REGIONAL SETTING

The region potentially affected by the alternatives under consideration consists of Salt Lake and Tooele counties in Utah. These two counties are very different. Salt Lake County is heavily urban; less than 0.9 percent of the 1980 population lived in rural areas. Nearly 63 percent of Salt Lake County is privately owned, and 6.7 percent of its land area is residential.

In contrast to Salt Lake County, 82.6 percent of Tooele County's land area is Federally owned and over 28 percent of the county's population is rural. The county population is largely concentrated in Tooele City, Grantsville, and Wendover. The vast majority of the 4.43 million acres in the county is arid open rangeland. It is characterized by broad, flat basins and old lake bed deposits occasionally interrupted by small mountain ranges.

4.2 DESCRIPTION OF THE AFFECTED AREAS

4.2.1 The Vitro site and surroundings

The Vitro site covers an area of approximately 128 acres. It is located about 4 miles south-southwest of the center of Salt Lake City, just northeast of the street intersection of 3300 South and 900 West. Figures 3-1 and 3-2 are, respectively, a map and a plot plan that show the general site area. The adjacent developed land to the northern-center of the site is the Central Valley Water Reclamation Facility (CVWRF) sewage-treatment plant No. 1. The entire Vitro site is presently owned by the CVWRF Board. Land-use patterns in the vicinity of the Vitro site are shown in Figure E-2 of Appendix E.

Tailings storage was in the western and southern portions of the Vitro site and included three impoundments referred to as the northwest, southwest, and southeast tailings areas (see Figure 3-2). The southwest and southeast areas are divided by the South Vitro Ditch which contains slow moving surface water. The Vitro Waste Ditch carries treated water from the CVWRF plant and divides the northwest and southwest tailings areas. Three surficial variations occur within the tailings areas. First and most obvious is the standing water in the northwest area where approximately 13 acres are covered with sludge from the CVWRF sewage-treatment plant. The quantity of sludge is estimated to be in excess of 6000 cubic yards (cy). The second variation consists of the excavated pit, approximately 10 feet deep and 600 feet long,

which is located in the northern half of the southwest tailings area. Material excavated from the pit is piled approximately 20 feet high along its edges. Water is standing in the bottom of this excavation, showing the elevation of the local water table. The third noticeable feature is the abundance of concrete debris in the southeast tailings area. This material was used during earlier attempts at stabilization (FBDU, 1981).

The eastern portion of the Vitro site was used for the ore processing mill, ore storage, and transportation. The buildings were removed but various foundations and concrete supports were left in place or buried on the site. This portion of the site remains at approximately natural ground-surface level where existing structures include a water tower and railroad tracks. At present, off-site cleanup projects are importing contaminated material onto the southeast tailings and stockpiling it in a fenced, low-lying area. Some of the imported material is concrete rubble, but for the most part it is sandy tailings that were originally taken from the site and used as fill. It is estimated that the total quantity of off-site material that will be stockpiled at the Vitro site is approximately 150,000 cy. This includes off-site wind-blown material that will be recovered from areas immediately surrounding the site.

The generally sparse vegetation includes grasses and herbaceous plants. Surface drainage is poor to nonexistent with several seasonal ponds on the tailings surface. Surface elevations within the site range between 4235 and 4250 feet above sea level.

The Vitro site contains an accumulation of a variety of materials. Besides the sludge and rubble mentioned above, the tailings areas include uranium tailings, vanadium tailings, and embankment materials. Material for dikes was excavated initially from within the projected impoundment areas. The average depth of excavation was on the order of 4 feet below the surrounding grade. Available information indicates that the tailings were not deposited uniformly within the impoundment areas. The nonuniformity reflects changes in the refining process, the variety of ore sources, and differential sorting of particle sizes from the discharge point. The northwest area primarily contains relatively clean medium and fine sands while the southwest area includes a high proportion of slimes and was not as deeply excavated. The southeast area contains the bulk of the tailings with occasional zones of cinders. These tailings grade from predominantly fine sands on the east to slimes on the west. The berms surrounding the tailings are composed of loose, medium-fine sands with some tailings contamination. Materials within the tailings ponds are generally slimes or silty sands. The slimes are fine-grained soils primarily of silt sizes, with little material in the clay-size range. The slimes are slightly plastic in the moist state and retain a considerable amount of fluid. Dry densities are low for both the slimes and the sands; however, the sands are much drier (MSRD, 1982).

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4.2.1.1 The 5.4-acre industrial tract

The 5.4-acre industrial tract adjacent to the southwest side of the Vitro site is shown in Figure 3-2. It consists of six separately owned tracts: (1) less than one acre owned by Pey Development Co.; (2) an approximately 1-acre tract on the north end of the strip owned by WON-DOOR Corporation; (3) an approximately 1-acre tract south of tract (1) that is owned by Harrington & Co.; (4) an approximately 1-acre tract south of tract (3) that is owned by Abel and Sarah Paulsen; (5) an approximately 0.5-acre tract south of tract (4) that is owned by Blaine and Verla Berrett; and (6) a 2.2-acre tract south of tract (5) that is owned by Steve and Helen Pappas.

These six tracts are zoned for industrial use and three of them have been included in the DOE's list of properties eligible for remedial action under the vicinity property cleanup program. The buildings and land on this 5.4-acre strip are contaminated by windblown tailings and the buildings would require some excavation and reconstruction in order to meet the EPA standards for cleanup of structures; similarly, the open lands within the 5.4-acre strip would require excavation in order to meet EPA standards. These cleanup activities would cause a temporary loss of jobs for no more than a dozen people (DOE, 1982).

Other details of the area surrounding the Vitro site are supplied in Appendix E and in the engineering assessment (FBDU, 1981).

4.2.2 The South Clive site and surroundings

The proposed disposal site near Clive, Tooele County, Utah is located approximately 65 miles in a straight-line distance due west of Salt Lake City and consists of the 1-square-mile area designated as Section 32, Township 1 South, Range 11 West. The northern boundary of the site area is approximately 1 mile south of Clive which is a railroad siding for the Union Pacific System. The railroad right-of-way servicing this siding extends from the Salt Lake City area westward toward Nevada. Highway access to the site is provided by U.S. Interstate 80 which passes approximately 2.5 miles to the north of the site. A dirt trail intersects the highway north of Clive, extends in a southerly direction, and runs along the site's western boundary.

As shown in Figures 3-5 and 3-6, the site is located within a relatively flat topographic area along the eastern edge of the Great Salt Lake Desert. The desert area extends for approximately 60 miles from the Nevada-Utah border on the west to a series of north-south trending mountain ranges on the east. In the vicinity of the site, the eastern border of the desert is formed by the Cedar Mountains which rise to elevations on the order of 7700 feet (approximately 3500 feet above the desert floor). The proximity of this mountain range results in a surficial drainage pattern for the site which is generally in a westerly direction.

The site has minimal topographic relief with a slight downward gradien that is relatively uniform toward the southwest (see Figure 3-7). Th axi relief within the square-mile area is on the order of 11 feet. Vegetation across the site is sparse and is typical of semi-desert low shrubland.

4.2.3 The transportation corridors

The train transportation corridor is the western district of the Union Pacific System route that more or less follows I-80 to the west of Salt Lak City (see Figure 3-5); more specifically, it is the railroad right-of-way bordering the route to be taken by trains from the Vitro site to within a m of the South Clive site. The length of this corridor is approximately 85 miles. It begins at the Roper Railroad Yard on the east side of the Vitro site and runs northward to where the Rio Grande Railroad merges with the Un Pacific System at about 3rd West and I-80 in Salt Lake City. The Union Pacific System maintains the remaining portion of the corridor that would r to an unloading point at Clive, from which a rail spur would be constructed the South Clive site.

The truck haul route between the Vitro and South Clive sites would use 900 West, 2100 South, and I-80 to the Aragonite exit. From there, trucks would follow the frontage road to the Clive overpass and then follow the improved county road to the site.

4.3 CLIMATE

The project region is in the Intermountain Plateau climatic zone that extends between the Cascade-Sierra Nevada Ranges and the Rocky Mountains an is classified as a middle-latitude dry climate or steppe. The climate is characterized by hot and dry summers, cool springs and falls, and moderately cold winters.

4.3.1 Weather patterns

Mountain ranges tend to restrict the movement of weather systems into t two-county area, but the area is occasionally affected by well-developed storms in the prevailing regional westerlies. The mountains act as a barri to frequent invasions of cold continental air. Precipitation is generally light during the summer and early fall and reaches a maximum in spring when storms from the Pacific Ocean are strong enough to move over the mountains. During the late fall and winter months, high pressure systems tend to settl over the area for as long as several weeks at a time. Under these condition smoke and haze accumulate in the lower levels of the stagnant air, frequent becoming associated with fog and obstructing visibility. Aside from the altitude and the mountains, the most influential natural condition affect

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the regional climate is the Great Salt Lake. This large inland body of water, which never freezes over because of its high salt content, tends to moderate downwind temperatures.

The local weather varies among the Vitro site, the transportation corridors, and the South Clive site. The Vitro site is semi-arid while the South Clive site is arid desert. The transportation routes encompass the transition between the two. Each of these areas is discussed in the following sections.

4.3.2 Temperature

Data from the Wendover meteorological station (about 50 miles due west of the South Clive site) suggest that temperatures at the South Clive site are similar to but slightly warmer than those at the Vitro site. The extreme temperatures have ranged from -19 to 112°F. Normal monthly temperatures have ranged from 27.4°F in January to 79.3°F in July, with an annual average of 52.2°F. The daily normal minimums ranged from 18.8 to 66.6°F for January and July, respectively, while the normal daily maximums ranged from 36 to 92°F for the same months.

According to U.S. Weather Bureau records for Salt Lake City, from 1928 to 1978 the extreme temperatures near the Vitro site should have ranged from -30 to 107°F. The normal monthly temperatures (1941-1970) ranged from 28°F in January to 76.7°F in July, with an annual average of 51°F. The normal daily minimums for January and July have been 18.5 and 60.5°F, respectively, while the normal daily maximums for the same months were 37.4 and 92.8°F, respectively.

Temperatures for the transportation corridors would not differ significantly from those at the two sites. The only notable difference would be a slight reduction in extreme high temperatures at higher altitudes along the corridors.

4.3.3 Precipitation

Less precipitation occurs at the South Clive site, which is on the eastern edge of the Great Salt Lake Desert, than at the Vitro site. Normal annual precipitation at the Wendover meteorological station, which is here taken to be typical of the South Clive site, is only 4.88 inches. The lowest normal monthly precipitation is 0.29 inches in January, while June has the highest with 0.73 inches.

The climate at the South Clive site is arid, which means that evapotranspiration is at least five times precipitation. The climate of Salt Lake City is semi-arid, which means that the evapotranspiration-to-precipitation ratio is 5 or less (Weaver and Clements, 1938).

The maximum recorded 24-hour precipitation at Wendover was 1.33 inches and the maximum monthly precipitation was 3.01 inches. No precipitation in a month's time has been recorded many times. Snowfall is light; the maximum monthly amount recorded in 35 years was 14.6 inches in January; all other monthly maximums have been less than 10 inches. The maximum 24-hour snowfall was 8.5 inches in February of 1967, which is also the highest monthly total on record for February.

On the basis of weather records for Salt Lake City, precipitation at the Vitro site should be greater than at the South Clive site. The normal annual precipitation for Salt Lake City is 15.17 inches, with a normal monthly high of 2.12 inches in April and monthly low of 0.70 inches in July. Annual precipitation usually varies between 10 and 20 inches. The maximum monthly total in 50 years was 4.90 inches and occurred in April 1944. Months with no precipitation have been recorded but are rare. The maximum 24-hour amount recorded was 2.41 inches in April 1957. The Salt Lake area has received annual snowfall amounts ranging from less than 20 to 117 inches, with an average of 58.5 inches. A maximum 24-hour snowfall of 18.1 inches was recorded in December 1972.

Precipitation data for the transportation corridors are not available but precipitation probably decreases with distance from the Great Salt Lake.

4.3.4 Winds

No wind data are available for either the South Clive site or the transportation corridors. The maximum peak gust recorded at Dugway Proving Ground, 40 miles southeast of the South Clive site, during the period 1957 to 1965, was 71 miles per hour.

On the basis of weather records for Salt Lake City, the prevailing winds at the Vitro site should be generally from the southeast and south-southeast and have a mean speed of 8.7 miles per hour. The mean monthly wind speed varies from 9.5 miles per hour in April to 7.5 in December. The highest one-minute duration wind speeds have generally been from the west or northwest, the high being 71 miles per hour in March and the lowest high 52 miles per hour in January. Wind distributions assumed for the Vitro site are tabulated in Section G.2 of Appendix G.

4.3.5 Storms

Based on a 39-year data record for Wendover, the South Clive site has an annual average of 48 days with 0.01 inches or more of precipitation; they are evenly distributed throughout the year. Thunderstorms occurred on 29 days per year over a 5-year period, the monthly maximum being 8 days in June. Snowfalls of 1.0 inch or more occurred an average of 3 days per year over a 25-year period. An average of five days per year had heavy fog over a five-year period. Over 8 years, an average of 152 days per year were clear, 92 were partly cloudy, and 121 were cloudy.

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During the period from 1928 to 1978, the Salt Lake City area had an annual average of 88 days with 0.01 inch or more of precipitation; 10 of those days occurred in each of the months of January, March, and April. On the average, only four days of measurable precipitation have occurred in July. Thunderstorms occurred on an average of 35 days per year, with a high of 7 days in July and none in November, December, or January. Snowfalls of 1 inch or more have occurred on an average of 18 days per year. Heavy fog has generally occurred 11 days per year but during the winter months only. On the average, 127 days per year have had clear skies, 104 have been partly cloudy, and 134 cloudy.

4.4 AIR QUALITY

The Vitro site is located in Salt Lake County and the South Clive site is located in Tooele County. The National Ambient Air Quality Standards (NAAQS) are used to classify the counties as being below the NAAQS (attainment) or above the NAAQS (nonattainment). Tooele County is classified as meeting all NAAQS. Salt Lake County is classified as nonattainment for TSP (total suspended particulates) and ozone. Only Salt Lake City is in nonattainment status for carbon monoxide. The Utah State implementation plan requires that appropriate measures be taken in Salt Lake City to reach the NAAQS by 1985. However, the TSP annual geometric mean concentration for Salt Lake City for 1981 was 67 micrograms per cubic meter, which is less than the NAAQS annual geometric mean of 75 micrograms per cubic meter. The ambient TSP concentrations at the Vitro site were measured in a year-long monitoring program that was initiated in January 1982. Measurements of TSP were made five times a month with high-volume air samplers at two locations on the Vitro site. The monthly means of data obtained through 1982 have ranged from 53 micrograms per cubic meter to 149 micrograms per cubic meter; the average annual mean for stations north and south of the site are 69 and 91 micrograms per cubic meter respectively.

Tooele County, which includes the South Clive site, is in attainment status for all NAAQS. TSP measurements at the South Clive site have yielded monthly means that range from 5 micrograms per cubic meter to 42 micrograms per cubic meter; the average annual mean is about 18 micrograms per cubic meter.

4.5 SURFACE AND SUBSURFACE FEATURES

The following subsections summarize geologic features that could affect the suitability of the South Clive site and the Vitro site for stabilization of residual radioactive wastes and other contaminated materials.

4.5.1 Physiography and topography

The South Clive site is located within a relatively flat area along the eastern edge of the Great Salt Lake Desert. The desert area extends for approximately 60 miles from the Nevada border on the west to a series of north-south-trending mountain ranges on the east. The eastern edge of the desert in the vicinity of the site is formed by the Cedar Mountains, which rise to elevations of approximately 7700 feet (approximately 3500 feet above the desert floor). The proximity of this mountain range results in a generally westward slope to the site, with drainage into the Great Salt Lake Basin. The site has a topographic relief of less than 11 feet.

The Salt Lake City area is located in a large basin drained by the Jordan River and located between the Wasatch Mountains to the east and the Oquirrh Mountains to the west. The original topography of the Vitro site has been modified; the undisturbed elevations range from 4235 to 4250 feet and the drainage is to the northwest, toward the Jordan River.

4.5.2 Geologic features

Because of the lack of detailed subsurface data concerning the bedrock, the exact depth to and relationships among various bedrock units at the South Clive site are unknown. Lone Mountain, located 3 miles east of the site, has a core of Paleozoic rocks. These include, from west to east, the Grandeur Member of the Park City Formation, an unnamed Permian formation, and Unit 5 of the Oquirrh Formation (Maurer, 1970). These well-indurated limestones and sandstones strike slightly east of north (approximately N12E) and dip steeply (72 to 74 degrees) to the west. Lone Mountain represents the west limb of a north-trending anticline, which is in turn located on the upper plate of the Lone Mountain Thrust Fault, a slightly northwest-trending Laramide (early Tertiary) low-angle fault.

The scattered, low hills about 1.5 miles west of the site (see Figure 3-6) also contain outcrops of Paleozoic Oquirrh Formation (Moore and Sorensen, 1979). These rocks may represent the northern extent of a slightly northeast-trending overturned anticline. The South Clive site may be located in the syncline between this anticline and the Lone Mountain anticline to the east.

The Grayback Hills 3.5 miles northwest of the South Clive site (just north of Interstate 80) are formed by remnants of Late Tertiary (Miocene-Pliocene) basalt and basaltic andesite flows (Moore and Sorensen, 1979). These flows are the only apparent evidence near the site of Late Tertiary tectonism.

Bedrock below the Vitro site is buried under a thick sequence of alluvial deposits. Arnow et al. (1970) indicate on a structure contour map that the unconsolidated Quaternary deposits below the site are at least 500 feet thick. However, the Tertiary "bedrock" underlying the Quaternary deposits also consists of semiconsolidated clay, sand and gravel, interspersed with lava and cemented layers of sand and gravel (Arnow et al., 1970). These

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semiconsolidated Tertiary sediments extend to a depth of 2200 feet below the mill site (Mattick, 1970). Because of the thicknesses of the Cenozoic deposits, the types of pre-Tertiary rocks existing below the site are unknown but they have no bearing on the suitability of the site because of their depth.

Structure

The most obvious geologic structure associated with the Clive and Salt Lake City areas is normal faulting. During the Miocene, Pliocene, and Pleistocene Epochs (1 to 25 million years ago), normal faults west of the Wasatch Range uplifted and tilted large blocks of the earth's crust into north-south-trending "basin and range" structures. The "range" portion of these structures include the Cedar Mountains east of Clive and the Oquirrh Mountains west of Salt Lake City. The "basins" include the Great Salt Lake Desert and the Salt Lake Valley.

As further described in Section 4.5.4, the South Clive site lies in a region which contains active faulting. Studies described in Appendix H show that seismogenic sources include zones of faulting along the east flank of the Cedar Mountains, the east flank of the Newfoundland Mountains, the west flank of the Stansbury Mountains, and within Puddle Valley. The density of possible seismogenic sources is considerably less than along the Watsatch Front located about 65 miles east of the site.

The Vitro site is located in an area of potentially active faulting. The Wasatch Fault is a north-south-trending, 150-mile-long normal fault zone which separates the Wasatch Mountains to the east from the Great Basin to the west. Considerable geologic evidence indicates that the Wasatch Fault has been active during Recent time. Furthermore, Cook (1970) indicates that vertical displacements of as much as 20 feet have occurred in a single event on the Wasatch Fault within the past 300 years. The potential seismic hazard at the Vitro site is addressed in more detail in Section 4.5.4 and in Appendix H.

Soils

Surface and subsurface conditions at the South Clive site and vicinity were evaluated through the drilling, logging, and sampling of 13 exploration borings. The logs of the exploration borings are available in the UMTRA Project Office in Albuquerque, New Mexico.

Surficial soils encountered in the 13 exploration borings generally consisted of light brown to tan, sandy to clayey silt. These soils were classified as either stiff or very stiff and were noted to contain a small pinhole structure and bedding layers that ranged from approximately 0.06 to 1.0 inch in thickness. The thickness of surficial soil varied from 3.0 feet in Borings SC-4 and SC-5 (northern edge of site) to 11.0 to 12.0 feet in Borings SC-2 and SC-3 (southern edge of site).

Underlying the surficial material is an interlayered lacustrian deposit ranging from relatively clean fine- and medium-grained sands to silty

clays. This interlayered soil sequence appears to be random and no definite pattern or predominant material type could be correlated among individual borings. In general, the soils are layered but varied in thickness from about 0.1 inch in stringers to 4 feet. The cohesive materials encountered were generally classified as stiff to very stiff while the cohesionless materials were generally medium dense to dense. This interlayered sequence extends to depths between 45 and 51 feet below the existing grade.

Beneath the interlayered sequence the predominant material becomes a grayish-brown to brown silty sand with a consistency classification ranging from medium dense to very dense. In Boring SC-1, drilled to a depth of 250.8 feet, the material was continuous below a depth of 51 feet with minor variations in silt or clay content and occasional zones where thin stringers of finer-grained materials were encountered. At a depth of 75 feet, zones were noted that contained coarse sand and gravel. At a depth of approximately 128 feet, the material was classified as very dense and remained consistent to the depth penetrated.

Soils data for the Vitro site are available in the UMTRA Project Office in Albuquerque, New Mexico, and were included in Appendix A of the DEIS.

4.5.3 Mineral resources

Small amounts of sand, gravel, and ground water have been produced from the alluvium surrounding the Cedar Mountains east of the South Clive site. One source of gravel near the South Clive site was documented to be in Section 18, T1N, R9W (Maurer, 1970, p. 173). Sources nearer the site may be located on the west flank of Lone Mountain in Section 34, T1S, R11W and Section 3, T2S, R11W. However, no aggregate has been produced in the Lone Mountain area or within the South Clive site. Because of the large quantity and widespread distribution of sand and gravel, the very small population and the resulting small demand, and the long distance to any large market, the potential for sand and gravel production in the vicinity of the South Clive site is very small.

The Vitro site is located in a valley that contains thick clay, silt, and sand deposits. The deposits immediately underlying the site have no known characteristics that differ from those underlying surrounding areas. These deposits therefore, have no known economic value and no potential for near-term development.

4.5.4 Seismic Hazard

The following paragraphs briefly review the seismic history of the region, the Maximum Credible Earthquake, and its recurrence interval. A more detailed evaluation of the potential earthquake effects on the Vitro and South Clive sites is attached as Appendix H.

000072

Seismotectonic Setting-South Clive

The South Clive site is located within the Great Basin in the Basin-and-Range Province (BAR) in western Utah. The site is in a transition zone between exposed BAR horsts and grabens (mountain ranges and valleys) to the east and buried BAR horsts and grabens to the west. The site area does not have recorded historical seismicity but nearby seismogenic areas and geologic structures could pose a hazard to the site.

Seismogenic sources (active faults) which could pose a hazard to the site include fault zones along the east flank of the Cedar Mountains, the east flank of the Newfoundland Mountains, the west flank of the Stansbury Mountains, and within Puddle Valley. Other fault zones in the site region do not show evidence of being active.

The historical earthquake data base is from 1850 through 1978 and magnitude 5.5 and larger earthquakes are shown in Table 4-1. The 1934 Hansel Valley event is the only moderate to large historical earthquake to pose significant hazard to the site, but this hazard is less than that associated with nearer seismogenic structures.

Maximum Credible Earthquakes and Recurrence Interval - South Clive

To assess the hazard to the site and to determine site design criteria, it is necessary to establish a Maximum Credible Earthquake (MCE) for each seismogenic fault which could affect the site. The MCEs calculated for the seismogenic sources affecting the South Clive site range in value from M_S of 6.8 to 7.3. These result in mean maximum expected accelerations in bedrock at the site of from 0.19 g to 0.31 g with expected variations of $\pm$ 0.06 g. The MCE's were calculated using total length fault rupture, and recurrence intervals similar to other Basin and Range tectonic settings, in excess of 10,000 years for each individual fault.

Seismotectonic Setting--Vitro

The Vitro site is located along the Wasatch Front which delineates the boundaries between the Great Basin to the west and the Colorado Plateau in southeastern Utah and the Middle Rocky Mountains in northeastern Utah. The Wasatch Front is part of a distinct north-trending zone of elevated seismic activity which extends from northern Arizona to northwestern Montana. This zone, known as the Intermountain Seismic Belt, has experienced at least 15 recorded earthquakes with Richter magnitudes greater than 5.5 in 129 years of record. The largest of these 15 earthquakes was a magnitude 7.1 event which occurred in 1959 at Hebgen Lake, Montana.

Historical earthquake documentation has been completed from the period of 1850 until 1980. Table 4-1 is a listing of the largest earthquakes from 1850 through 1978 in the Utah region. Two of these earthquakes (1910 and 1914) may be directly related to the Wasatch Fault. The most damaging earthquakes of the north central region of Utah occurred in Hansel Valley in 1934 and in Cache Valley in 1962.

Based on earthquake history and geologic evidence, the Salt Lake City region contains numerous young faults, including the Hansel Valley, East Cache, Wasatch, and unnamed faults along the west flank of the Oquirrh Mountains south of the Great Salt Lake.

Table 4-1: Largest Earthquakes in the Utah Region 1850 Through 1978[a]

Local Date	Lat (°N)	Long (°W)	Intensity I_o	Magnitude M_L	Location
1884 Nov 10	42.0	111.3	VIII	(6)	Bear Lake Valley
1887 Dec 5	37.1	112.5	VII	(5-1/2)	Kanab
1900 Aug 1	40.0	112.1	VII	(5-1/2)	Eureka
1901 Nov 13	38.8	112.1	IX	(6-1/2+)	Richfield
1902 Nov 17	37.4	113.5	VIII	(6)	Pine Valley
1909 Oct 5	41.8	112.7	VIII	(6)	Hansel Valley
1910 May 22	40.8	111.9	VII	(5-1/2)	Salt Lake City
1914 May 13	41.2	112.0	VII	(5-1/2)	Ogden
1921 Sep 29	38.7	112.2	VIII	(6)	Elsinore
1921 Oct 1	38.7	112.2	VIII	(6)	Elsinore
1934 Mar 12	41.7	112.8	IX	6.6	Hansel Valley (Kosmo)
1959 Jul 21	37.0	112.5	VI	5.5+	Utah-Arizona border (Kanab)
1962 Aug 30	42.0	111.7	VII	5.7	Cache Valley (Logan)
1966 Aug 16	37.5	114.2	VI	5.6	Nevada-Utah border
1975 Mar 28	42.1	112.5	VIII	6.0	Idaho-Utah border (Pocatello Valley)

[a]Table includes earthquakes of maximum Modified Mercalli intensity (I_o) of VII or greater, or of Richter magnitude 5.5 or greater. Magnitudes in parentheses are estimated from I_o. Sample area: 36°45'N - 42°30'N, 108°45'W - 114°15'W. Aftershocks are excluded.

Source: Arabasz et al., (1979).

000074

Due to the close proximity of the Wasatch Fault to the Vitro site (Figure 4-1) and its suspected activity, the earthquake risk from this fault system is greater than the risk from earthquakes generated by rupture of the other fault systems mentioned above.

In terms of current criteria, an active fault is defined as a structure which has experienced displacement in the last 10 to 12 thousand years. The northern portion of the Wasatch Fault has been thoroughly identified as falling within the active fault category. There have been no surface faulting events along the Wasatch Fault during the past 130 years (approximate). Geologic evidence, however, identifies multiple displacement episodes in the northern portion of the fault system. The segment of the Wasatch Fault zone closest to the Vitro site is the East Bench Fault about 3 mi east of the site (Figure 4-2). No detailed displacement history is available for this fault segment; however, its geomorphic expression definitely indicates movement during the Quaternary Period.

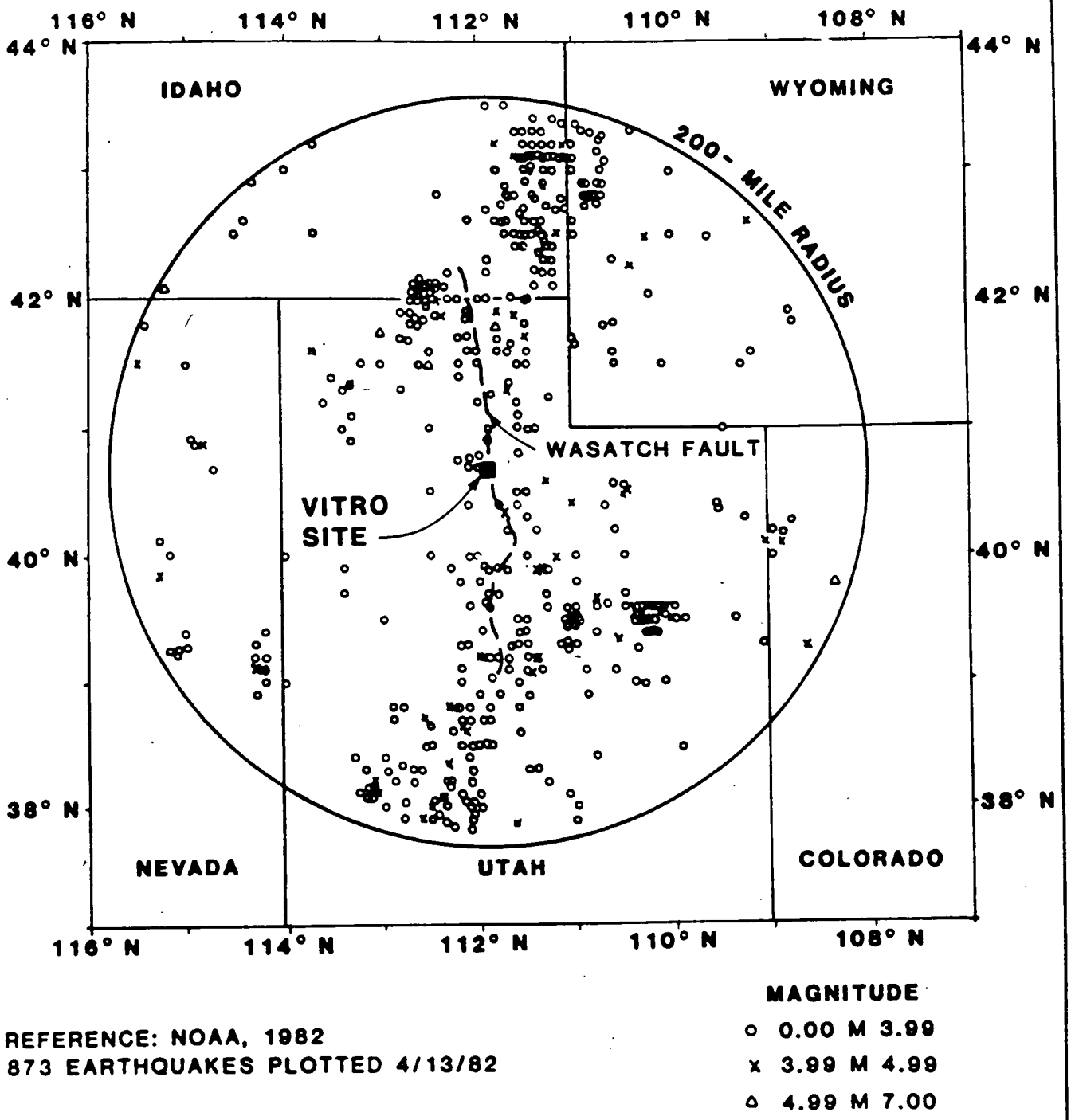
Maximum Credible Earthquake and recurrence interval-Vitro

To assess the hazard to the embankment at Vitro due to seismic events, it is necessary to establish the Maximum Credible Earthquake (MCE). The design hazard is based on the Maximum Credible Earthquake. Studies by others to quantify the MCE and its recurrence interval for the Wasatch Front are still ongoing; however, sufficient analyses have been completed to establish reasonable design criteria.

Based upon the current knowledge of recurrence intervals of earthquakes along the Wasatch Front, it is likely that a Richter magnitude 7.0 or greater earthquake somewhere along the front will cause ground shaking at the Vitro site within the next 200 years. The East Bench Fault segment is the closest fault to the site and would cause the most intense ground shaking if rupture were to occur at that location. The return period of a large event (6.5 to 7.5 magnitude) is estimated to be about 50 to 660 years for the entire Wasatch Front, but the return period for a similar large event along the East Bench Fault would be several times longer. It is not possible to assign a specific MCE and recurrence interval for this fault, but based on results from various investigators, the MCE would probably be about magnitude 7.5 and the recurrence interval between 1000 and 2000 years. The MCE for the Vitro site would be in the range of magnitude 6.0 to 7.5. If this event occurred on a nearby fault such as the East Bench, on-site ground accelerations in rock would be about 0.3 to 0.55 g.

Analysis of selected failure surfaces of the slopes of the embankment indicates the minimum ground acceleration that could cause possible minor damage is about 0.23 g. This ground acceleration could be associated with an earthquake event of lesser magnitude than the MCE.

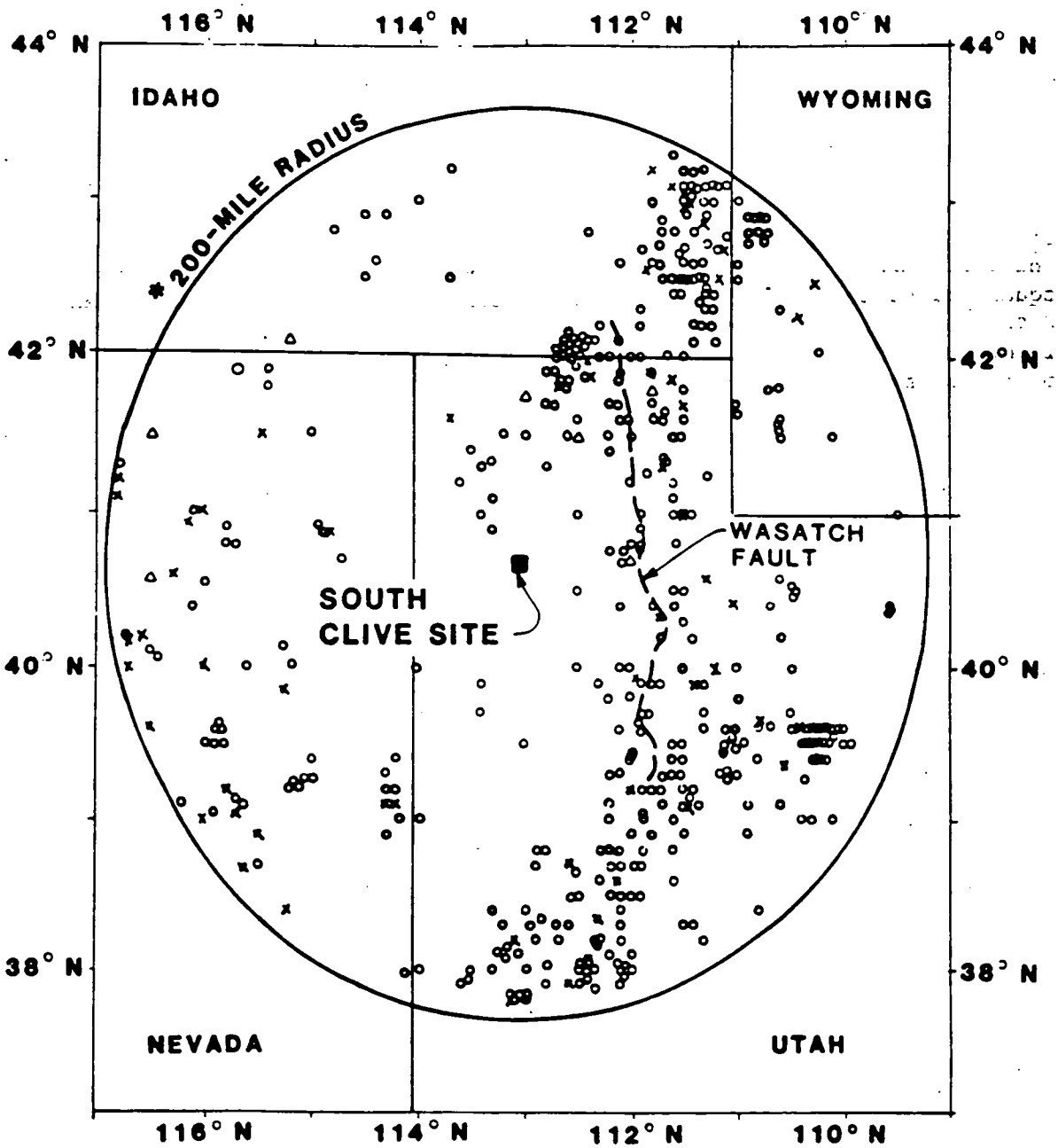
Due to the proximity of the active faults, the interbedded nature of the foundation soils, and the effects of damping/amplification on a specific earthquake event, a return period of the predicted yield acceleration of 0.23 g cannot be ascertained with any confidence level.



REFERENCE: NOAA, 1982
873 EARTHQUAKES PLOTTED 4/13/82

FIGURE 4-1
EARTHQUAKE EPICENTERS WITHIN A 200 - MILE RADIUS OF THE VITRO SITE

000076



REFERENCE: NOAA. 1982
881 EARTHQUAKES PLOTTED 8/23/82

*Vertical scale exaggerated on NOAA's computer plot.

MAGNITUDE
o 0.00 M 3.99
x 3.99 M 4.99
Δ 4.99 M 7.00

FIGURE 4-2
EARTHQUAKE EPICENTERS WITHIN A 200-MILE RADIUS OF THE SOUTH CLIVE SITE

4.6 WATER

The following subsections describe existing surface-water and ground-water systems potentially affected by alternative remedial actions, their quality and current utilization.

4.6.1 Surface water

The Vitro site, the South Clive site, and the transportation routes all lie within the Great Basin drainage, a closed basin having no outlet. Much of the basin drains to the Great Salt Lake, which covers an area of about 1700 square miles and contains about 16 million acre-feet of water (Keck and Hassibe, 1979). Because of its high salt content (around 25 percent), most forms of aquatic life cannot survive in the lake. The largest species is the brine shrimp, which is less than half an inch long.

The Vitro site and about 57 miles of the transportation corridors ultimately drain to the Great Salt Lake (Figure 4-3). About 5 miles of the corridors drain to the Puddle Valley depression, which is normally dry. The South Clive site and the remaining 8 miles of the transportation routes drain into the normally dry Ripple Valley depression on the eastern fringe of the Great Salt Lake Desert.

The arid to semi-arid climate that prevails profoundly affects the surface-water regime. With the exception of Timpie Springs, effectively all perennial watercourses are in Salt Lake County and most of them are man-made. Within 1 mile of the transportation corridors, there are 73 watercourses and more than 50 ponds or lakes shown on U.S. Geological Survey quadrangle maps. Of the 73 watercourses, 3 are natural perennial drainages, 3 are aqueducts, and 10 are perennial man-made canals. The remaining 57 are shown as intermittent or ephemeral streams; most are probably ephemeral, that is, they flow only in direct response to precipitation. Of the 50-plus ponds, 16 are shown as perennial, 4 are salt evaporators, and the rest are intermittent or ephemeral. Some of the intermittent ponds in the vicinity of the Great Salt Lake are merely depressions with elevations such that fluctuations in the ground-water table probably determine whether water is present on the surface. Three of the perennial ponds are associated with industrial use. All of the perennial water bodies are within the Great Salt Lake drainage basin; none is closer than 28 miles to the South Clive site.

No surface-water bodies are present on the South Clive site. The nearest stream channel ends about 2 miles east of the site and is typical of all the drainages along the transportation corridors within about 20 miles of the South Clive site. Streamflows from higher elevations usually evaporate and infiltrate into the ground before reaching lower, flatter land. The stream channels are well defined in their upper reaches, but as they approach the flatlands the size of the channel reduces until there is no evidence of a stream. In extreme events, such as a Probable Maximum Flood (PMF), sheet flow could pass over the South Clive site but it would be nonchannelized.

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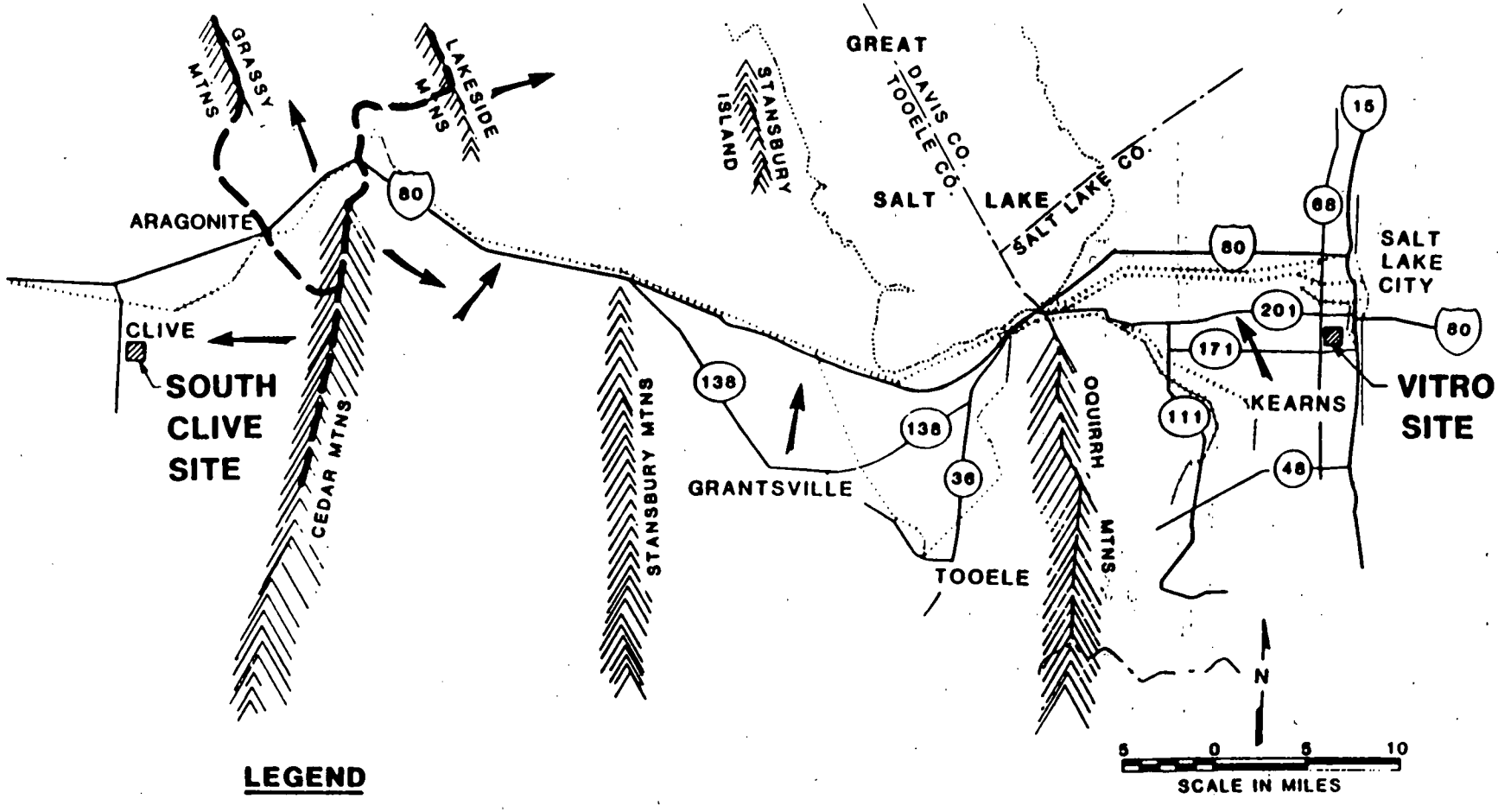

LEGEND

DRAINAGE BASIN DIVIDE

OVERALL FLOW DIRECTION

FIGURE 4-3
SURFACE DRAINAGE PATTERNS

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Four surface water bodies are in close proximity to the Vitro site. The Jordan River flows north to the Great Salt Lake and is about 1500 feet west of the site. Jordan River flows are regulated, being the outlet for Utah Lake, and average about 380 cubic feet per second (USGS, 1980). Mill Creek, a perennial stream, flows along the north edge of the site. This creek empties directly into the Jordan River and has a mean average flow of about 10 cubic feet per second (FBDU, 1981). Two flowing drainages are on the Vitro site (see Figure 3-2). The Vitro Waste Ditch flows from east to west, bisecting the approximate western half of the site and empties into the Jordan River. The South Vitro Ditch flows from south to north and joins the Vitro Waste Ditch near the center of the site. The South Vitro Ditch and the Vitro Waste Ditch have average flows of about 3 and 24 cubic feet per second, respectively (FBDU, 1981). The site does not contribute runoff to the South Vitro ditch except in severe rains; the ditch is primarily fed by ground water.

None of the surface water bodies in the vicinity of the Vitro site, the transportation corridors, or the South Clive site are used for drinking purposes and most have no beneficial use. The first body of water east of the South Clive site that is utilized is 28.1 miles distant. At this point, a perennial stream flows from Big Spring (1000 feet south of I-80) to the Timpie Springs Waterfowl Management Area, about 2000 feet north of I-80. No other perennial stream crosses the transportation routes within Tooele County. In Salt Lake County, 11 perennial, man-made watercourses cross the transportation corridors between Lake Point Junction (mile 53) and I-15 (mile 70.5). The 11 watercourses are used for industrial flood control and irrigation purposes. The largest of these streams is the Surplus Canal, which was constructed in the late 1800s to divert Jordan River floodwaters away from central Salt Lake City. The Surplus Canal diversion is about 1 mile downstream of the Vitro site. It has been effective, and neither it nor the Jordan River are expected to overtop their banks near the transportation corridors or the Vitro site in floods with a recurrence interval of 500 years or less, according to preliminary studies conducted for the Federal Emergency Management Agency.

There are ten perennial water bodies within 500 feet of the railroad or highway along the transportation corridors but the only major body is the Great Salt Lake. Of the remaining nine, four are salt evaporators for industrial use and controlled by the operating salt companies. Two other ponds are subjected to direct runoff from industrial operations (e.g., a slag dump at mile 54). A group of ponds east of Timpie, at miles 30 through 33, are located in an area of low ground with a high water table that results in large areas of very shallow (less than 1 foot deep) standing water with no definable outlet. Another pond, at mile 59.3, is also the result of ground water and covers less than 1 acre with no visible inlet or outlet. The last perennial pond within 500 feet of the transportation corridors lies between two sets of railroad tracks from miles 58.5 to 60.6 and has no apparent use.

Description of watersheds

The South Clive site lies to the west of the Cedar Mountains in a relatively flat basin. The streams within the watershed do not normally reach the site; the channels end 2 miles east of the site. This indicates that

flows normally infiltrate or evaporate before reaching the South Clive site. There is no outlet for the watershed and any water that flows by the site would pond in a playa several miles to the west. The watershed above the site covers approximately 46 square miles (Figure 4-4).

The Vitro site lies within the drainage system of Salt Lake City and County. The flow regimes of the two major streams in close proximity to the site, the Jordan River and Mill Creek, are regulated by the various interconnecting canals which have been constructed throughout the area and are not subject to natural variations. These canals are designed for short-term floods (typically 50- to 100-yr flood events), but for long time periods or a Probable Maximum Flood their controls would fail and, thus, their effects can be ignored. The effective drainage area of the Jordan River is about 3100 square miles, while that of Mill Creek is about 32 square miles. The Jordan River Basin starts at the headwaters of the Provo River and includes Deer Creek Reservoir and Utah Lake. The flow of the Jordan River is controlled by gates and pumps on Utah Lake, which is a natural lake that has been artificially modified to control its water level.

Historical floods

No data on historical floods are available for either the South Clive site or the Tooele County portion of the transportation corridors. Flow records, from December 1942 to the present, are available for the Jordan River/Surplus Canal. The Surplus Canal diversion is about 1 mile downstream of the Vitro site. Almost all of the flood flow is diverted through the Surplus Canal; since 1952, the maximum flow in the Jordan River just downstream of its confluence with the Surplus Canal has been limited to 200 cubic feet per second. The maximum combined flow was about 2300 cubic feet per second in September of 1978 (USGS, 1980). No records are available for Mill Creek, which is on the north edge of the Vitro site.

Some flow data (USGS, 1980) are available for the drainages along the transportation corridors within Salt Lake County, but the periods of record are generally short. The maximum recorded flows in the vicinity of I-80 are 790 and 1390 cubic feet per second for the Jordan River and Surplus Canal, respectively. Peak flows at gaging stations near I-80 and the Great Salt Lake have been less than 400 cubic feet per second. These gaging stations are along the transportation corridor at miles 66.2, 59.8, and 56.5, respectively (Figure 4-3).

Synthetic flood analyses

The Probable Maximum Flood (PMF) for the South Clive site resulting from a 6-hr Probable Maximum Precipitation (PMP) of 9.7 inches over the 46-square-mile drainage area was calculated using dam design techniques (US DOI, 1977). The results of the analysis indicate that the PMF would have a peak flow of 45,000 cfs.

Estimates of peak flood flows near the Vitro site were developed using two different sources. The HEC-1 program was used to develop PMF hydrographs.

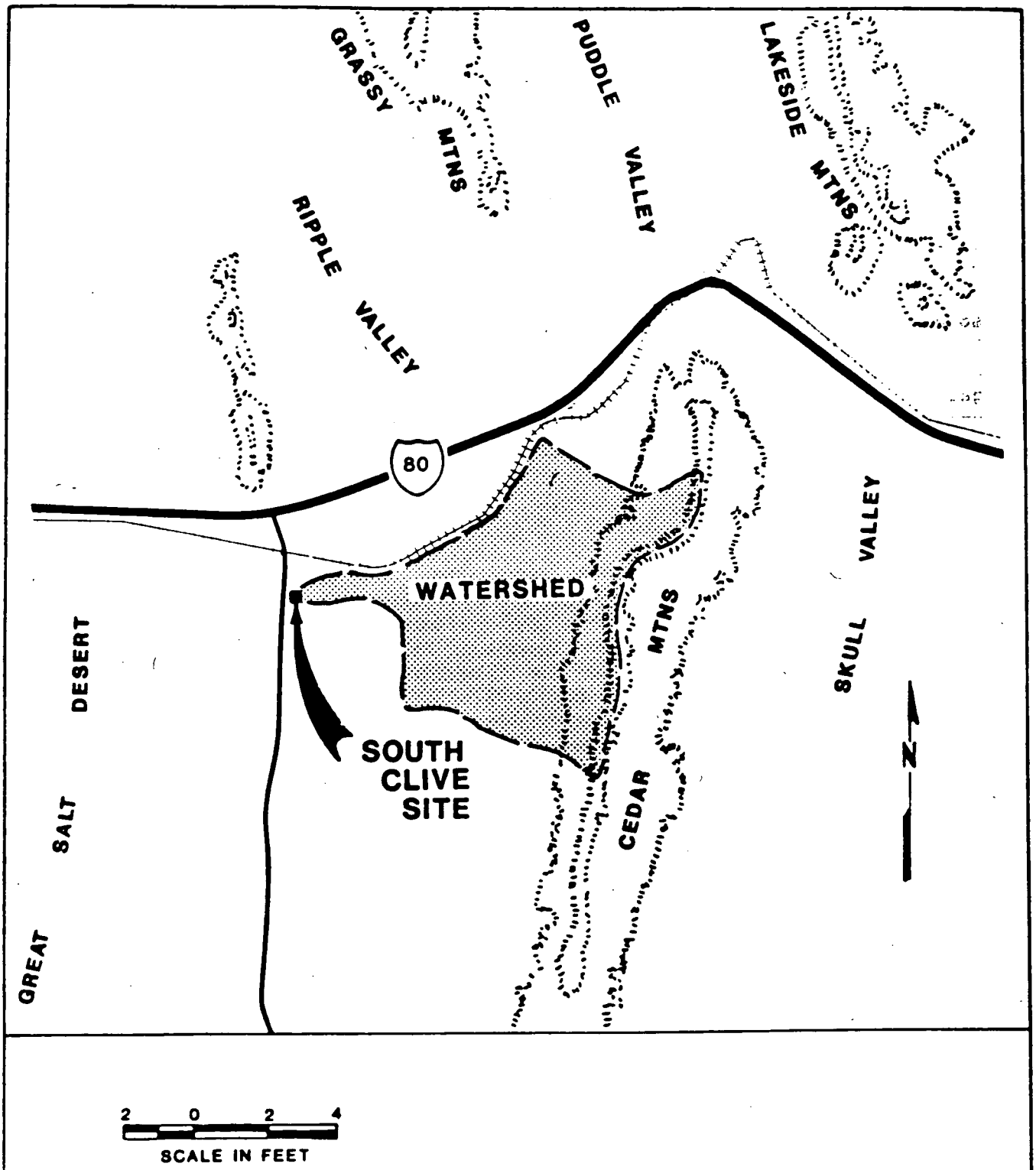


FIGURE 4-4
SOUTH CLIVE WATERSHED

Flood flows for 100- and 500-year return periods were obtained from the Federal Emergency Management Agency (FEMA, 1980). The FEMA studies presented flood values for the Jordan River above the Surplus Canal as 2000 and 2700 cubic feet per second for the 100- and 500-year return periods, respectively. Preliminary indications are that these floods would not overtop the banks of the river at the Vitro site. The FEMA studies presented a 100-year flood of 600 cubic feet per second for Mill Creek at the Vitro site, which should also stay within the channel. The FEMA studies also indicate that the Jordan River would stay within its banks near I-80 under the 100- and 500-year flood conditions.

The PMF for the Jordan River was developed at its confluence with Mill Creek, just downstream of the Vitro site. Two kinds of PMF were calculated: one for a general, 72-hour storm over the entire drainage, and the other for a local, 6-hour storm over a 500-square-mile area at the downstream end of the basin with a 24-hour general storm occurring simultaneously on the remainder of the basin. The general 72-hour PMF would be the more severe of the two, resulting in a peak flow of 414,000 cubic feet per second. The corresponding flood elevations were calculated using the HEC-2 program (Hydrologic Engineering Center, 1979) along with the slope-area method for uniform flow computations. The water-surface elevation resulting from a peak flow of 414,000 cubic feet per second near the Vitro site was calculated as about 4276 feet. This elevation is about 11 feet above the existing ground near the Vitro site and would create flow velocities of approximately 3 to 4 feet per second.

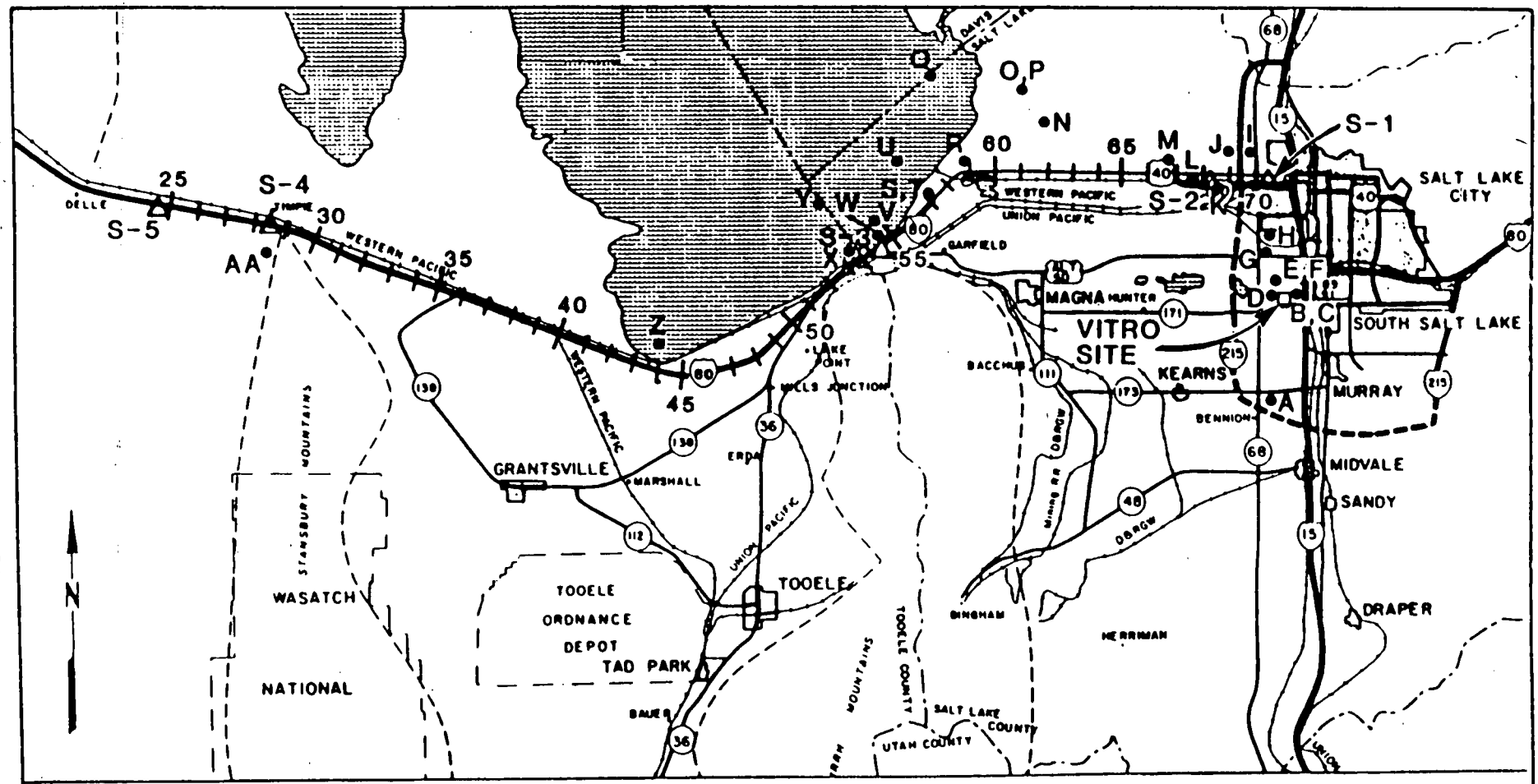
The PMF for Mill Creek was also developed for the Vitro area. The HEC-2 (Hydrologic Engineering Center, 1979) analysis showed that the natural topography of the Jordan River Valley limits the water-surface elevation and peak flow velocity to about 4237 feet and 2.1 feet per second, respectively, at the Vitro site.

Water quality and utilization

The project region can be divided into two areas regarding water quality and use: Salt Lake County and Tooele County. Generally speaking, water-quality data are available for Salt Lake County but not for Tooele County.

Figure 4-5 shows locations of sampling points for the water quality monitoring program. State of Utah and the U.S. Geological Survey sampling stations are also indicated.

Water-quality data are generally unavailable for Tooele County, which is a reflection of the lack of water and population centers. The only water quality station is at the source of Big Spring near Timpie (S.4 at mile 28.5 on Figure 4-5). The spring feeds a waterfowl management area and has no other uses. The water is very hard and very high in dissolved solids, primarily sodium and chloride (salt). Moderate concentrations of arsenic, nickel, copper, and silver are also present.



LEGEND

30 35 Mileage on I-80 from South Clive Overpass

• N Water quality stations from State of Utah and U.S. Geological Survey

△ S-3 Project monitoring stations

BASE MAP REFERENCE: UTAH TRAVEL COUNCIL, NO DATE.

SCALE: 1 INCH EQUALS APPROXIMATELY 6.2 MILES

FIGURE 4-5
LOCATIONS OF WATER QUALITY SAMPLING STATIONS

000084

Numerous watercourses are monitored in Salt Lake County, but this discussion deals only with the water quality of streams in the immediate vicinity of the transportation corridors and the Vitro site, which are effectively at the downstream end of Salt Lake County. By the time water nears the affected areas, much of it is return flow from irrigation and industrial purposes, and is being routed to the Great Salt Lake as a means of disposal.

The water quality of the streams in Salt Lake County is reasonably well known, and is discussed by Hely et al. (1971). The water is very hard, and softening is desirable for most purposes. Water from the Jordan River is unsuitable for municipal or domestic use without treatment. This also applies to connected canals such as the Surplus Canal, North Point Consolidated Canal, and Goggin Drain. The Jordan River is organically polluted, has a high dissolved-solids content (>1000 mg/l), and contains very fine sediment which is difficult to remove. The water would probably be suitable for industrial cooling and ore processing uses. Water from the Jordan River is generally acceptable for irrigation but is marginal for stock watering because of the organic pollution.

The water quality of the Garfield and Kennecott Drains, and Lee Creek (miles 52.7, 66.2, and 59.8, respectively, as numbered on Figure 4-5) is much poorer than that of the Jordan River. It is unlikely that these waters would be suitable for industrial or irrigation uses.

Great Salt Lake water is used for two industrial purposes: mineral extraction and brine shrimp production. The lake is also used for recreation such as sailing, swimming, and game-bird hunting. The salinity of the water, up to eight times that of sea water, precludes most other uses.

Surface-water quality samples were taken from five locations along the transportation corridors (see Figure 4-5) to develop background data on the qualities of waters between the South Clive site and the Vitro site. Sample analyses indicate that both primary and secondary drinking water standards are exceeded: lead exceeded standards at all locations; chloride at locations 2, 3, 4, and 5; cadmium at locations 3 and 5; and chromium, silver, iron, and manganese at location 3. Results from analyses for major cations and anions, general parameters, metals, total metals, and radiochemistry are included in Appendix D.

The waters of Vitro and South Vitro ditches were analyzed for several metals (As, Ba, Cd, Cr, Mo, Pb, U) and pH. These results are reported in Table D-24, Appendix D.

4.6.2 Ground water

Existing ground-water conditions at the Vitro site are described in the following sections. The data and detailed analyses supporting this description are presented in Appendix D.

Vitro site. The Vitro site is located within the Jordan River Valley in South Salt Lake, Utah. The ground-water regime of this valley is generally characterized by two aquifer systems, a near-surface unconfined system and a deeper confined system. The unconfined system is principally recharged by upward flow from the confined aquifer and surface infiltration (Figure 4-6). The confined system is recharged by infiltration into porous materials on the flanks of the Wasatch Mountains to the east and the Oquirrh Mountains to the west. Near the site, both aquifers flow toward the west-northwest (Figures 4-6 and 4-7). The unconfined aquifer discharges into surface-water courses such as Mill Creek and the Jordan River.

The general stratigraphy of the Jordan River Valley in the vicinity of the site consists of several hundred feet of unconsolidated to poorly consolidated alluvial and lacustrine deposits of interbedded and highly lenticular sands, silty sands, silts, and clays. The fine-grained deposits were laid down in the lake environment of the prehistoric Lake Bonneville. The coarser-grained soils were deposited as alluvium, probably along the margins of this prehistoric lake as the levels fluctuated and lowered to its present condition, the Great Salt Lake.

The field investigations in the vicinity of the Vitro site indicate that approximately the upper 85 feet of subsoil consist of interbedded fine sand, silty sand, clay, and silt. These beds are often laterally discontinuous and vary in thickness from a few inches to several feet. Generally, the upper 50 to 70 feet of this complex profile form the unconfined aquifer system. The unconfined aquifer generally overlies strata of interbedded layers of low-permeability clays and silts. Because the materials of the unconfined aquifer are very similar to the underlying aquitard, the thickness of the unconfined aquifer varies and can only be estimated. Potentiometers installed between 10 and 60 feet below the ground surface revealed water levels at slightly below or slightly above the ground surface. Potentiometers installed below 70 feet revealed water levels 7.5 to 15 feet above the ground surface. Thus, in the vicinity of the tailings pile, the unconfined aquifer appears to be about 60 feet thick. The interbedded strata of this aquifer system produce water at variable rates. Results of a pump test and pumping for water-sample collection indicate that water yield can be much less than 1 gpm for the silts and clays and greater than 1 gpm, probably approaching 10 gpm, for the fine sands and silty sands. Detailed well logs of the recent investigation by the Technical Assistance Contractor (TAC) (1983) for the shallow wells are available for inspection at the DOE Uranium Mill Tailings Remedial Action Project office in Albuquerque, New Mexico.

The stratigraphy below a depth of about 85 feet also consists of interbedded silts, clays, and sands. The sand layers are generally coarser-grained than the overlying beds described above. In some instances the sand layers contain considerable gravel.

Recent work by Dames and Moore (1982) and the TAC (1983) included monitoring and pump wells to a maximum depth of about 130 feet below the ground surface. The wells that penetrated to a depth of about 70 feet or greater, below the ground surface, encountered ground water under artesian pressure. The hydraulic head levels ranged from about 7.5 feet above land

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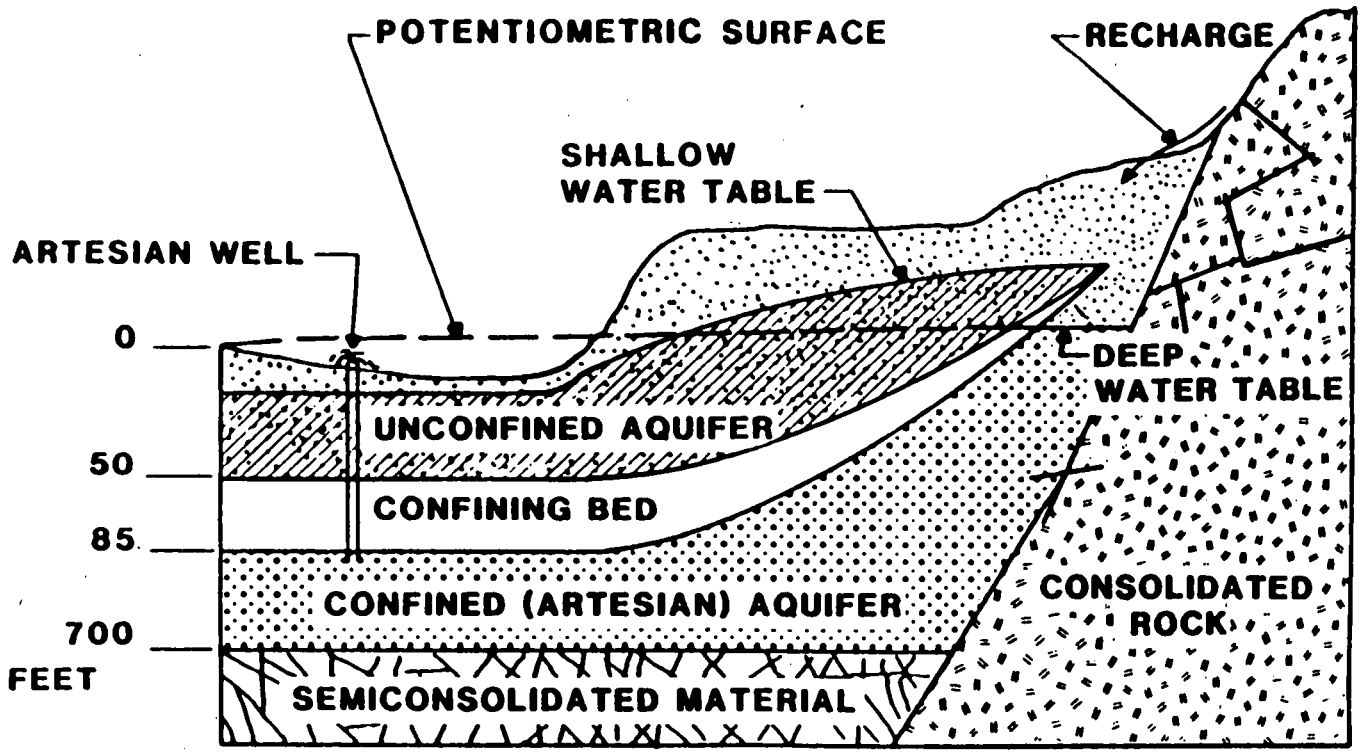

FIGURE 4-6
GENERALIZED GROUNDWATER HYDROGEOLOGY
FOR THE SOUTHERN SALT LAKE CITY AREA

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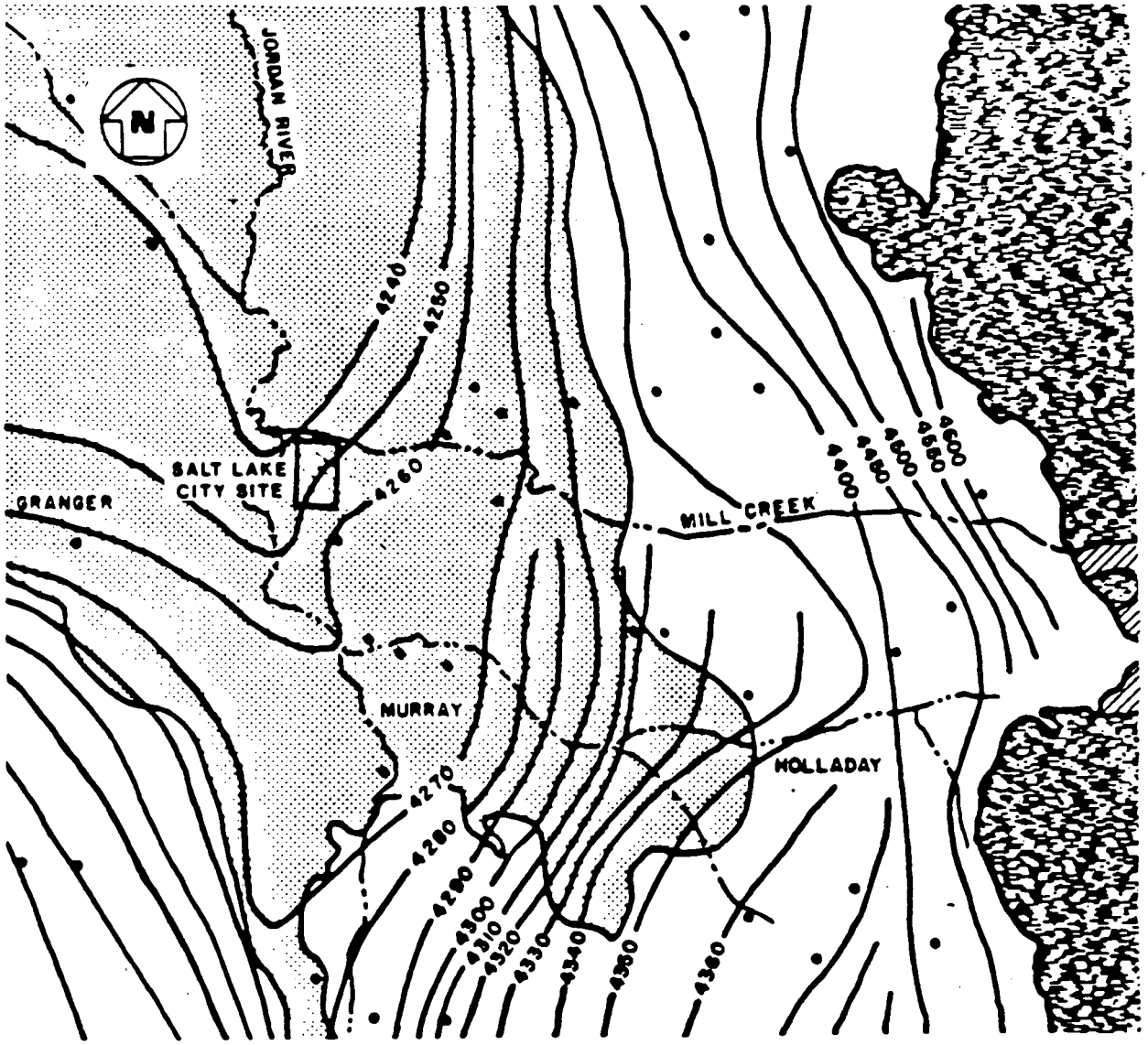

VALLEY FILL PERMEABILITY VARIABLE

ROCKS OF MODERATELY HIGH AND HIGHEST PERMEABILITY

ROCKS OF MODERATELY LOW AND LOWEST PERMEABILITY

AREA OF ARTESIAN FLOW - FEBRUARY, 1969

4250 WATER-LEVEL CONTOUR

NOTE

ADAPTED FROM HELY, MOWER, AND HARR, 1971.

FIGURE 4-7
POTENTIOMETRIC SURFACE MAP OF THE CONFINED (ARTESIAN) AQUIFER FOR THE SOUTHERN SALT LAKE AREA

surface for the well at 70 feet to a maximum of 15 feet above land surface for the wells at depths of about 130 feet. It is reported that this artesian aquifer system extends to depths of 500 to 800 feet below the ground surface (Hely et al., 1971).

Flow rates from 2-inch open potentiometers in the artesian aquifer ranged from a few gpm to several tens of gpm (TAC, 1983). Pump testing of an 8-inch well produced a sustained yield of about 300 gpm. Even though the producing sand layers of the confined aquifer are separated by clay and silt layers, monitoring of potentiometers at various depths in the aquifer during a long-term pump test indicates the sand layers are hydraulically connected. Detailed well logs of the recent investigation by the TAC (1983) for the deeper wells are also available for inspection at the DOE UMTRA office in Albuquerque, New Mexico.

Based on the well logs, a simplified subsurface cross-section, Figure 4-6, was constructed to illustrate the conditions described above. Again it should be noted that the subsurface strata consist of numerous laterally discontinuous layers of silt, clay, and sand of variable thickness.

The relationship of the two aquifers with regard to recharge, discharge, and movement of ground water, as determined by a recent pump test by the TAC (1983) and a previous study by Hely et al., (1971) are described in detail in Appendix D of this document.

The background water quality or chemistry of the two aquifer systems is substantially different. The upper unconfined aquifer water is characterized by a brackish quality with high total dissolved solids, generally 2000 ppm or greater. The unconfined water quality generally improves with depth and approaches the quality of the confined ground water. This water has limited use for domestic or agricultural purposes due to marginal quality and low yields. The confined aquifer water generally has dissolved solids values of about 300 ppm. The confined aquifer is a principal supply of domestic, agricultural, and industrial water in the Jordan River Valley.

Levels of sodium, sulfate, chloride, iron, total dissolved solids, and uranium in the unconfined ground water downgradient (west-northwest) and beneath the tailings pile are greater than those in the upgradient unconfined ground water. No elevated levels of molybdenum (Mo), arsenic (As), selenium (Se), radium (Ra-226 and Ra-228), vanadium (V), thorium (Th-230), and lead 210 (Pb-210), attributable to the tailings pile, have been found downgradient of the pile boundary.

Elevated levels of iron, sulfate, and chloride were found in the confined aquifer water beneath and downgradient of the pile boundary. None of the radionuclides and metals listed above, which would be associated with the tailings pile, were found in levels above background in the confined aquifer water. These constituents are less mobile than the sulfates and chlorides and probably were adsorbed or precipitated in the low permeability clay and silt layers in the unconfined aquifer or aquitard.

The relatively good water quality of the artesian aquifer in the Salt Lake area is maintained by the upward vertical hydraulic gradient between the

two aquifers which prevents downward migration of the naturally occurring brackish unconfined aquifer. Current utilization (pumping) of the confined aquifer in the Salt Lake City area has not significantly reduced the areal extent of the flowing artesian conditions which are present in the valley or the head levels of the aquifer as compared to levels measured in the early 1900's (Hintze and Miller, 1975), and as such, this upward gradient has been and is currently maintained in the Salt Lake area. Much heavier utilization of the artesian aquifer would reduce the head levels and possibly reverse the upward vertical hydraulic gradient. This condition would then cause downward flow of the brackish unconfined aquifer waters. The presence of the several feet of confining clay and silt layers would retard flow to low velocities if the vertical hydraulic gradient were reversed; however, the downward driving force would be present.

The migration of the unconfined aquifer waters to the confined aquifer would increase the dissolved solids levels even in areas well away from any possible influence from the tailings pile. This condition would degrade the artesian water and it could eventually make it non-potable. Thus, this scenario will restrict the long-term, heavy utilization of the confined aquifer, irrespective of the contamination noted in the unconfined aquifer system associated with the tailings pile.

The evidence of elevated iron, chloride, and sulfate in the confined aquifer beneath and downgradient of the pile probably reflects the condition involving localized heavy utilization of the confined aquifer. Heavy pumping during operation of the Vitro plant may have lowered the head levels of the artesian system and reversed the direction of the vertical flow.

The analytical analyses of the background wells in the unconfined aquifer (presented in Appendix D) generally show that concentrations of chloride, sulfate, and total dissolved solids are in excess of the EPA secondary drinking water standards. In addition, some of the background samples contained iron and arsenic in excess of the EPA secondary and primary drinking water standards, respectively.

The background water quality of the confined aquifer is generally in compliance with the primary EPA drinking water standards except for total dissolved solids which are around 300 ppm. This value is, however, less than the upper limit for the EPA's secondary drinking water standard.

South Clive site

The South Clive site is located within the Great Salt Lake Desert. The two major ground-water systems in the area are the valley fill and the alluvial fans bordering the Desert. Recharge to the alluvial fans occurs in the mountains bordering the Desert; in the vicinity of the site this would be the Cedar Mountains east of the site. It is believed that ground water in the alluvial fans recharges the valley fill. Direct infiltration of incident precipitation is not believed to be a significant component of the total ground-water regimen at the South Clive site.

Ground-water levels measured in monitoring wells installed at the South Clive site vary from about 20 to 30 feet below the ground surface. The

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principal direction of ground-water flow within the South Clive region is to the west. Locally, however, the direction of ground-water flow is modified by both the surface topography and by the stratigraphy at depth. Within the South Clive site, the direction of ground-water movement appears to be mainly to the northeast. The hydraulic gradient in this direction is small, approximately 3 feet per mile.

The permeabilities of valley-fill materials beneath the South Clive site range from about 0.28 to 2.8 feet per day, which are consistent with the interbedded very fine- to fine-grained sands and clays. The calculated transmissivities from the results of pumping tests conducted on the site ranged from 0.8 to 166 ft^2 per day with a mean value of approximately 40 ft^2 per day.

Ground-water samples from each of the five monitoring wells installed at the South Clive site were obtained and analyzed for major cations and anions, metals, and radiochemistry. The analytical results for samples from each of the five wells were compared with the EPA primary and secondary drinking water standards. Sulfate, chloride, and total dissolved solids (TDS) concentrations in all wells exceeded the EPA secondary drinking water standards. Total hardness was high, indicating that the ground water is hard to very hard. This is supported by the reported high concentrations of calcium, bicarbonate, sodium, and magnesium. Based on reported total dissolved solids levels, the ground water at the South Clive site is classified as "briny" (Hem, 1970). In two or more wells, arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver exceeded EPA primary drinking water standards; iron and manganese exceeded EPA secondary drinking water standards. Analytical results for the radionuclide parameters indicate that gross alpha, gross beta, and uranium oxide (U_3O_8) exceeded EPA's drinking water standards in two or more of the wells.

Other than the five monitoring wells installed for this program, there are no existing ground-water wells on or near the South Clive site. The closest known wells to the South Clive site are approximately 3 miles northwest and 3.4 miles east. The well west of the site has been destroyed; one of the two wells east of the site is in current use to water livestock--the second well was destroyed (see Table D-32, Appendix D). The high salinity of the ground water in the South Clive area may limit its use without treatment to industrial uses. In the Bonneville Salt Flats to the west, high salinity ground waters are used for mineral extraction.

4.7 ECOSYSTEMS

The existing ecosystem of the Vitro site and that for the South Clive site are described below in terms of soils, vegetation, wildlife, and endangered species. These descriptions are based both on literature and on field surveys.

4.7.1 Soils

The soil survey of the Salt Lake Area (SCS, 1974) listed Chipman silty clay loam, saline alkali, and Ironton loam as the principal soils of the Vitro site. The Vitro site is now covered by unconsolidated tailings material.

The U.S. Soil Conservation Service (SCS, 1981) described and mapped the soil of the South Clive site as Iosepa silt loam. Because this soil unit is the only soil delineated on the site, no soil map is included here.

General characteristics

The soil at the South Clive site is classified as having a horizon of clay and alkali (sodium) accumulation. The soil lacks moisture for plant growth for long periods and is low in organic matter (USGS, 1970). Soils of this type are periodically saturated with water in some subhorizon within 1 meter of the surface (SCS, 1975a).

When the surface soils are dry, as they are most of the time, they are powdery and easily lofted into the air by wind action or traffic of any kind. The wind erosion group to which they are assigned by the SCS is 4L, Moderate. Such a soil can lose as much as 86 tons per acre/year (Craig and Turelle, 1964), which is equivalent to a foot of surface soil being removed by wind in 24 years.

Physical and chemical properties

Soil samples were collected from a trench located in the NW corner of the South Clive site. Soil samples were also obtained from soil cores in each of the four corners, in the center of the site and surrounding adjacent area. Laboratory analysis of physical and chemical properties are listed in Table 4-2.

The highly saline, slowly permeable soils in this extremely arid location are unsuitable for re-establishing a lasting, self-sustaining vegetation to protect the soil covering the disposed materials. Even if the low precipitation could be overcome by irrigation, the nature of the soils would impose insurmountable problems that would prevent satisfactory plant cover within 10 to 20 years.

The high clay content at depths of 4 to 15 inches (Table 4-2) and the sodium content combine to give the South Clive site soils natural properties for compaction (USDA, 1954) to form an impervious soil layer. The highly toxic sodium concentration will act as a barrier to all but the most shallowly rooted plant species, and the density of the clay will deter burrowing by animals. In addition to plant growth inhibitory properties listed in Table 4-4, boron was present in levels that are hazardous for plant growth.

The soil of the site has properties that make it unsuitable for most plant growth and, therefore, for revegetation in land reclamation.

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Table 4-2. Physical-chemical properties of soils at the South Clive site and vicinity.

Sample number	Depth	pH	EC[a] mmhos per cm	Saturation percent	Particle size percentage			Soil texture	OM %[b]	Milliequivalents per liter			SAR[c]
					Sand	Silt	Clay			Sodium	Calcium	Magnesium	
1[d]	0-4"	7.8	24	37.2	29.2	45.6	25.2	Loam	1.70	227	27.8	9.5	53
2[e]	0-4"	8.1	23	40.1	31.2	44.8	24.0	Loam	2.09	234	10.7	6.1	81
1	4-7"	8.1	19	45.4	29.0	43.2	27.8	Clay Loam	1.96	180	8.2	3.4	75
2	4-7"	8.4	22	52.8	24.0	40.0	36.0	Clay Loam	1.63	237	6.0	4.7	102
1	7-15"	8.2	24	51.6	21.0	47.2	31.8	Clay Loam	1.61	222	7.8	5.9	85
2	7-15"	8.5	26	62.3	26.0	43.0	31.0	Clay Loam	1.51	278	6.1	6.8	109
1	15-24"	8.2	30	68.7	23.2	58.0	18.8	Silt Loam	1.40	289	13.0	13.0	80
2	15-24"	8.6	23	97.5	17.0	80.0	3.0	Silt	1.23	241	4.6	6.3	103
1	24-31"	8.1	53	66.8	18.6	76.0	5.4	Silt Loam	1.25	469	31.0	34.0	82
2	24-31"	8.3	33	93.7	17.0	81.0	2.0	Silt	0.91	335	21.8	17.6	76
1	31-51"	8.1	63	77.3	8.2	84.6	7.2	Silt	1.32	559	25.4	38.0	99
2	31-51"	8.3	40	78.6	9.0	85.0	6.0	Silt	1.06	421	40.5	23.5	74

[a]EC = Electrical conductivity.
[b]OM = Organic matter.
[c]SAR = Sodium adsorption ratio.
[d]Sample 1: soil obtained from diagnostic horizons from excavated trench.
[e]Sample 2: soil obtained from 5 cores with soil samples composited from depths corresponding to Sample No. 1. The 5 cores were taken from each corner and center of Section 32, South Clive site.

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4.7.2 Vegetation

The vegetation of the South Clive site is a homogeneous, semi-desert low shrubland, primarily composed of shadscale (Atriplex confertifolia). The shrubland is part of the Northern Desert Shrub Biome of the Cold Desert Formation (Oosting, 1956) and has been described by Kuchler (1964) as a Saltbush (Shadscale)-Greasewood Shrub complex. Plant communities identified on the site are Shadscale-Gray Molly (Kochia americana var. vestita), a transitional community type of Shadscale-Gray Molly-Black Greasewood (Sarcobatus vermiculatus), and Black Greasewood-Gardner Saltbush (Atriplex nuttallii). Vegetation patterns of the South Clive site are correlated with soil salinity and corresponding shifts in presence or abundance of species. All three communities are low in species diversity. Seep-weed or inkweed (Suaeda torreyana) and scattered perfoliate pepperweed (Lepidium perfoliatum) are the only prominent understory species of the Shadscale-Gray Molly community. This community occurs over most of the South Clive site, although black greasewood becomes prominent enough on the eastern quarter to form a Shadscale-Black Greasewood-Gray Molly community. Except for black greasewood and occasional stands of halogeton (Halogeton glomeratus) the composition is similar to the more prominent Shadscale-Gray Molly community.

The Black Greasewood-Gardner Saltbush community type is floristically the most diverse, but only occurs in the extreme northeast corner and eastern edge of the South Clive site (Figure 4-8). In addition to Gardner saltbush, the flora is composed of all species found in the other communties except halogeton.

The South Clive site occurs in the Desert Alkali range site, which is rated by the Bureau of Land Management (BLM) as being poor for grazing or forage production (Olsen, F., Range Conservationist, BLM, Salt Lake City, Utah, personal communication, April 9, 1981). However, the vegetation forms an important ground cover and deterrent to soil erosion, and provides habitat for wildlife species. Annual production of the three community types ranged from 152 to 517 pounds per acre, air dry. Annual production for the range site is given as 50 to 200 and 500 to 1500 pounds per acre during unfavorable and favorable years respectively (SCS, 1975b). Livestock carrying capacity with such production would range from 3 to 80 acres per animal-unit month.

The vegetation of the Vitro site is characterized as early successional and, although quite sparse because of disturbance, is relatively diverse. Species noted on the site include reed (Phragmites spp.), alkali muhly (Muhlenbergia asperifolia), alkali sacaton (Sporobolus airoides), saltgrass (Distichlis spp.), cattail (Typha spp.), bulrush (Scirpus spp.), filaree (Erodium cicutarium), reed fescue (Festuca aurundinacea), white top (Cardaria draba), rubber rabbitbrush (Chrysothamnus nauseosus), horseweed (Conyza spp.), thistle (Cirsium spp.), fox tail barley (Hordeum jubatum), cheatgrass brome (Bromus tectorum), Russian thistle (Salsola kali), tamarisk (Tamarix pentandra), and Siberian elm (Ulmus pumila).

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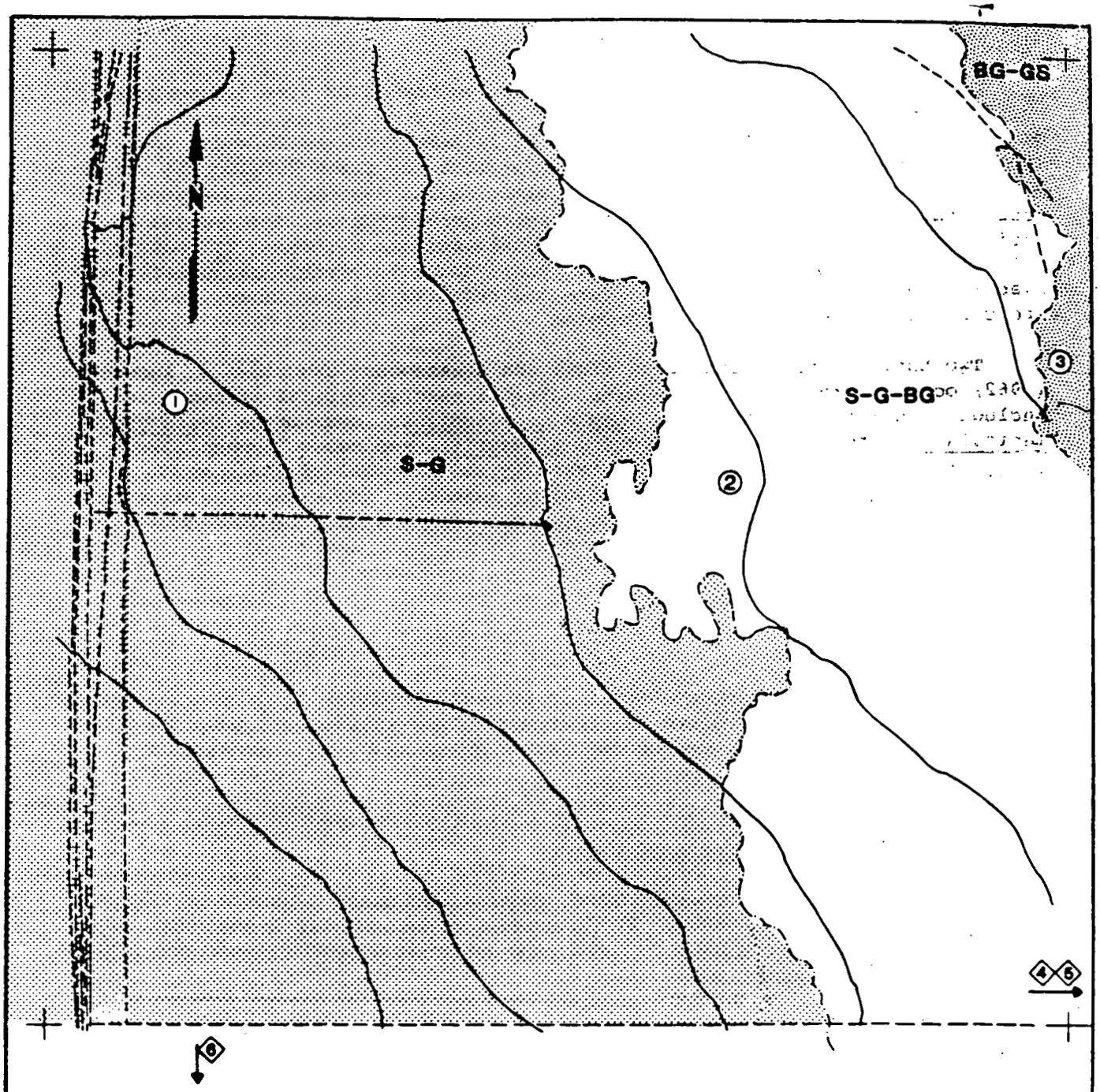

LEGEND

S-G	SHADSCALE-GRAY MOLLY
S-G-BG	SHADSCALE-GRAY MOLLY-BLACK GREASEWOOD
BG-BS	BLACK GREASEWOOD- GARDNER SALTBUSH
①	SAMPLE PLOT
◇4	OFF-SITE SAMPLE PLOT

BASE MAP REFERENCE:
AERO-GRAPHICS, INC., SALT LAKE CITY UTAH

SCALE:
1 INCH EQUALS
APPROXIMATELY 750 FEET

FIGURE 4-8

VEGETATION MAP OF THE SOUTH CLIVE SITE

4.7.3 Terrestrial wildlife

No wildlife studies have been conducted on the Vitro site for purposes of this document. However, earlier studies commissioned by Ford, Bacon, Davis Utah Inc. (FBDU, 1980) developed a list of 24 mammalian and 39 avian species that would normally be found in association with the plant life on the Vitro site. The predominant mammals are the black-tailed jackrabbit, Townsend ground squirrel, Ord's kangaroo rat, western harvest mouse, deer mouse, and striped skunk. The predominant avian species are the killdeer, California gull, cliff swallow, Brewer's sparrow, house sparrow, western meadowlark, and black-billed magpie. While amphibians and reptiles are not identified, they are undoubtedly represented on the site.

Two habitat types (shadscale flats and greasewood) described by Egoscue (1962) occur on the South Clive site. Animal species typical of the site include black-tailed jackrabbit (*Lepus californicus*), deer mouse (*Peromyscus maniculatus*), horned lark (*Eremophila alpestris*), and desert horned lizard (*Phrynosoma platyrhinos*); species diversity is low. All of these animal species could use the site for breeding or nesting. Jackrabbits, deer mice, and grasshopper mice (*Onychomys leucogaster*) were the only mammals collected during field surveys for this EIS.

4.7.4 Aquatic biota

Aquatic ecosystems do not occur on or near the South Clive site, although surface water is present along the transportation corridor and near the Vitro site. The aquatic ecosystems of the latter areas have not been studied.

4.7.5 Endangered and threatened species

No threatened or endangered plant species are known to occur in the Salt Lake Valley (U.S. F&WS, 1980). No threatened or endangered animal species are known to occur on the Vitro site, and none would be expected since the site is located in a major urban area.

No important plant or animal species, as defined by NRC (1980), are known to occur on the South Clive site and no known important habitats have been identified in the area (Olsen, F., Range Conservationist, BLM, Salt Lake City, Utah, personal communication, April 9, 1981; Day, D., Director Utah Division of Wildlife Resources, letter dated 27 March 1981).

No threatened or endangered plant species are known to occur in the vicinity of the South Clive site. The Great Basin fishhook cactus (*Sclerocactus pubispinus*) is currently under review for threatened status (U.S. F&WS, 1980). This species is associated with gravelly beach terraces of Pleistocene Lake Bonneville in western Tooele County and is not expected to occur in the Clive area (Welsh and Thorne, 1979; Tisdale, J., Acting Area Manager, U.S. F&WS, Salt Lake City, Utah, letter dated May 12, 1981).

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Similarly, no threatened or endangered animal species are known to occur on the South Clive site (Tisdale, J., Acting Area Manager, U.S. Fish and Wildlife Service, Salt Lake City, Utah, letter dated May 12, 1981). However, the Utah Division of Wildlife Resources (Day, D., Director, Utah Division of Wildlife Resources, Salt Lake City, Utah, letter dated 27 May 1981) reports that the area is used for foraging by bald eagles (Haliaeetus leucocephalus) during the winter.

4.8 RADIATION

The radiation environment at and near the Vitro site, the South Clive site, and the transportation corridors is summarized in this section. The radiological units of measure are picocuries (pCi) or microcuries (μCi) per liter (l) or gram (g). Radiological dose rates and exposure are presented in microroentgens/hour (μR/hr) and millirem/year. For purposes of this EIS and considering the type of radiation, the roentgen and rem may be considered equivalent.

The radiation environment currently at the Vitro site, the South Clive site, and the transport corridor between the two sites has been obtained from the literature and from field monitoring programs. A more extensive discussion of the radiation environment and radiological matters in general is provided in Appendix F.

4.8.1 Vitro site

The environmental radiological levels for the area surrounding the Vitro site have been characterized in previous studies (EPA, 1975; FBDU, 1981; ORNL, 1977; MSRD, 1982; BFEC, 1983).

Radioactive airborne particulate concentrations were measured in the vicinity of the tailings piles at the Vitro site by the EPA (1975). The average airborne radionuclide concentrations were determined at the CVWRF sewage-treatment plant No. 1 (approximately 0.1 mile north of the southeast tailings area) following a one-year sampling period during which 26 consecutive two-week samples were collected and analyzed. Average concentrations of the nine radionuclides reported at this location ranged from 6.5×10^{-5} pCi/l (Po-210) to 2.5×10^{-8} pCi/l (U-235).

Several studies to determine ambient-air radon concentrations near the Vitro site have been undertaken (FBDU, 1981; ORNL 1977, Schearer and Sills, 1969; Monsanto, 1983). The only long-term measurements are those done by Monsanto using Passive Environmental Radon Monitors (PERMs). Forty sampling locations in the vicinity of the Vitro site were used to define the average ambient radon concentrations. These averaged about 3 pCi/l at the edge of the site and decreased to background concentrations (roughly 0.25 pCi/l) at distances of 1 to 2 miles from the site.

Gamma radiation levels have been measured and found to decrease rapidly with distance from the tailings pile. On the pile itself gamma radiation levels range from 100 to 1200 μR/hr. At 0.1 mile from the edge of the pile the gamma radiation level has fallen to 45 μR/hr, and at 0.5 miles from the pile the gamma radiation level has reached background for Salt Lake City--about 12 μR/hr (FBDU, 1976 and 1981). The range of typical background values is 9 to 17 μR/hr (FBDU, 1976).

Background concentrations of radionuclides in soils have been measured in and around Salt Lake City by a number of investigators (ORNL, 1977). Results are generally comparable and are typified by the ORNL results, which indicate the following values (geometric mean plus or minus geometric standard deviation): Ra-226, 1.5 ± 1.2 picocuries per gram, and U-238, 2.0 ± 3.6 picocuries per gram. In addition, soil samples were collected by ORNL (1977) from 58 locations within about 400 to 1000 meters of the (south) sediment pile and analyzed for radioactivity. Samples were collected at the surface and at one foot depth and were analyzed for Ra-226. Concentrations in surface samples ranged from background levels (about 1 pCi/g) away from the pile to over 100 pCi/g of Ra-226 near the pile. On the site, the highest observed concentration was 560 pCi/g. Samples obtained from the one-foot depth ranged from background to 460 pCi/g of Ra-226.

On the pile, a statistically designed sampling program conducted by Mountain States Research and Development (MSRD, 1982) has resulted in pile-averaged values of 40 pCi/g U-238, 560 pCi/g Ra-226, and 560 pCi/g Th-230. The latter two radionuclides were measured in the MSRD samples by Bendix Field Engineering (BFEC, 1983).

Sediment samples from the Jordan River, Mill Creek, and the Vitro drainage ditch were collected and analyzed for U-238, Th-230, Ra-226, and Pb-210 (ORNL, 1977). Results showed no contamination in Jordan River sediments, and slightly elevated levels (roughly twice estimated background) in Mill Creek sediments. The drainage ditch sediments, however, were shown to contain relatively elevated concentrations of all three radionuclides. Ra-226 concentrations range from 60 to 120 pCi/g, while Th-230 concentrations ranged up to 284 pCi/g which was higher than any other reported radionuclide.

4.8.2 The South Clive site

Radiation levels currently existing at the South Clive site have been determined from monitoring programs conducted by Dames & Moore and Argonne National Laboratory (ANL). Monitoring has also been conducted at two additional points near Clive, one to the north and one to the southeast (Figure 4-9). The data described below are the result of 3 months of monitoring (December 1981 through February 1982).

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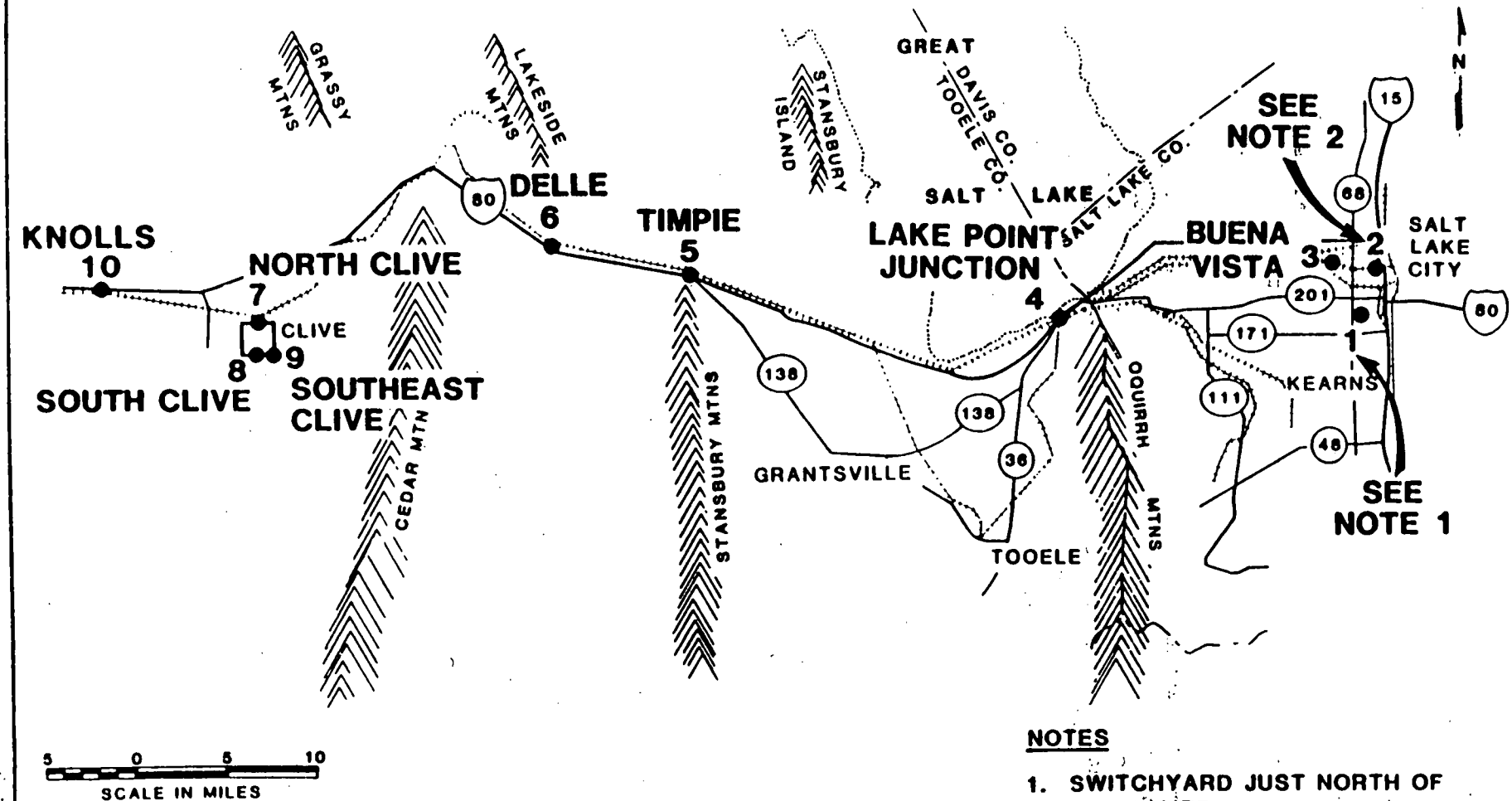

NOTES

1. SWITCHYARD JUST NORTH OF VITRO SITE
2. TWO MILES NORTH OF VITRO SITE

FIGURE 4-9
LOCATIONS OF RADIOLOGICAL MONITORING STATIONS

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Using the track etch method, ANL measured ambient air concentrations of Rn-222 at the three locations surrounding Clive. The 3-month average Rn-222 concentration at the South Clive site was 0.31 pCi/l. All of the values obtained for the Clive area were below 1 pCi/l.

A general survey of terrestrial and cosmic gamma radiation levels was also conducted by ANL in the area surrounding Clive. These radiation levels should be compared with the gamma radiation levels found on the Vitro site. The measurements were performed quarterly using thermoluminescent dosimeters (TLDs). During the 3-month period, the average exposure rates for Clive-South, Clive-Southeast, and Clive-North were 16.2, 14.1, and 11.6 μR/hr respectively.

Surface-soil samples (to a depth of 5 centimeters) were collected at 300-meter intervals in each of eight compass directions out to a distance of 1500 meters from the center of the South Clive site. All of the samples were analyzed for Ra-226. Samples collected 1500 meters from the center were also analyzed for Th-230, U-238, and Pb-210. The surface-soil radionuclide concentrations found at the South Clive site are in secular equilibrium, with the exception of slightly elevated concentrations of Pb-210 probably due to atmospheric deposition. The surface-soil concentrations of Ra-226 ranged from 0.9 to 1.2 picocuries per gram dry weight (pCi/g); those of U-238 ranged from 0.7 to 1.0 pCi/g; those of Th-230 ranged from 1.2 to 1.6 pCi/g; and those of Pb-210 ranged from 1.1 to 2.3 pCi/g. These concentrations agree with the approximately 1 pCi/g average for surface soils of the contiguous United States (LASL, 1978).

Subsurface-soil samples were collected at the center of the South Clive site and at a distance 750 meters from the center in each of the four compass directions and at 3 depth intervals. The ranges of radionuclide concentrations found in samples from 0 to 20 cm, 40 to 60 cm, and 80 to 100 cm depths were not significantly different from the ranges of radionuclide concentrations found in the surface-soil samples.

Samples of vegetation and wildlife taken near the South Clive site were assayed to determine natural radionuclide concentrations in the local biota. These results show vegetation concentrations averaging 5.4 pCi/kg (wet wt.) for uranium, 6.0 pCi/kg (wet wt.) for Th-230, 3.1 pCi/kg (wet wt.) for Ra-226, 198.0 pCi/kg (wet wt.) for Pb-210, and 48.0 pCi/kg (wet wt.) for Po-210. The greater concentrations of Pb-210 and Po-210 are attributed to atmospheric deposition of these radon daughters.

The results of analyses on rabbit flesh show a similar pattern with the averages for U-238, Th-230, and Ra-226 being 0.5, 0.5, and 0.6 pCi/kg (wet wt.), respectively. The Pb-210 and Po-210 averages were 4.0 and 8.0 pCi/kg (wet wt.), respectively.

4.8.3 The transportation corridor

The radiation environments currently existing along the transportation route from the tailings piles at Vitro to the South Clive site have also been monitored by Dames & Moore and ANL. The Delle and Knolls monitoring sites are located on the transport corridor (see Figure 4-9).

The 3-month average ambient-air Rn-222 concentrations at the Delle and Knolls sites were 0.35 pCi/l and 0.23 pCi/l, respectively.

Ambient gamma exposure rates were measured at four locations along the transportation routes (see Figure 4-9). Integrated external exposure rate measurements were performed quarterly using thermoluminescent dosimeters. The average exposure rates were 12.8 μR/hr at Lake Point Junction, 15.1 μR/hr at Timpie, 10.0 μR/hr at Delle, and 10.2 μR/hr at Knolls.

The radionuclide concentrations in the soil along the transportation routes were evaluated by obtaining and analyzing soil samples taken at the Delle and Knolls sites. These samples were analyzed for U-238, Ra-226, Th-230, and Pb-210. The analyses show that the surface-soil concentrations of these radionuclides at Delle and Knolls are not significantly different from the corresponding values measured at the South Clive site.

4.9 LAND USE

Regional land-use patterns are very different in heavily urbanized Salt Lake County and the more rural Tooele County. Salt Lake County population is almost entirely urban; 99.1 percent of its population lived in urban areas according to the 1980 census compared to 72.0 percent in Tooele County. The Federal government owns and controls the greatest percentage of land in Tooele County, 82.6 percent of the county land area of 4.43 million acres. The greatest portion (1,948,417 acres) of the Federal land is public domain administered by the Bureau of Land Management (BLM). The U.S. Department of Defense controls the next greatest portion of 1,558,862 acres, with national forests occupying 152,223 acres (Utah State Department of Agriculture, 1981). These and other differences between the two areas are indicated in Table 4-3.

Table 4-3. Land use and ownership for Tooele County, 1970, and Salt Lake County, 1976

Use or ownership	Tooele County Acres	Tooele County Percent of total	Salt Lake County Acres	Salt Lake County Percent of total
Federal land	3,659,502	82.6%	110,335	22.6%
Residential and accessory use	1,546	0.0	32,614	6.7
Commercial	240	0.0	4,342	0.9
Industrial	50,885	1.2	14,924	3.1
Agriculture	39,776	0.9	58,041	11.9
Other private lands	425,107	9.6	na[b]	
State lands (no highways)	218,640	4.9	4,286	0.9
Highways, roads & streets	13,651	0.3	23,079	4.7
Railroads	3,000	0.1	na	
Indian land	17,763	0.4	0	
Public & quasi-public, in municipalities	588	0.0	na	
Small waters (excluding all of more than 40 acres)[a]	22	0.0	243	0.0
Totals	4,430,720	100.0%	488,960	100.0%

[a]Water areas of 2 to 40 acres and streams less than 0.125 mile in width.
[b]na = not available.

Source: Mountain Area Planners, 1972; Utah State Department of Agriculture, 1981.

4.9.1 Vitro site

The entire 128-acre Vitro site is owned by the CVWRF Board, operator of the sewage treatment plant to the north of the site. Land ownership in the vicinity of the site is predominantly private. Local land owners include the Denver & Rio Grande Railroad Company, Zions Utah Bancorporation, Paul W. Buehner, Jr., the Utah State Retirement Fund, American Smelting & Refining, Westerners, Inc., Petersen Investors and Western Dry Mix. The status and ownership of the 5.4-acre industrial tract on the southwest side of the Vitro site are described in Section 4.2.1.

Historic land use

The Vitro site was used for an alumina plant during World War II. That plant was converted to produce uranium beginning in May 1951, and sold the output to the Atomic Energy Commission under procurement contracts until February 1964. The plant was then converted to produce commercial vanadium, operating until July 1968. Plant demolition was completed during 1970.

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The site is part of a 1979 annexation by the City of South Salt Lake of a portion of unincorporated Salt Lake County. Land use within a 0.5-mile radius of the site began to change from predominantly agricultural and vacant to other uses in 1979. In 1974, a construction moratorium imposed by the Salt Lake City-County Board of Health banned construction within a 0.5-mile radius of the site. This ban was lifted in 1979.

Present land use

The CVWRF sewage-treatment plant No. 1 is located north of the Vitro site (see Figure 4-10). This facility has been in operation since its initial construction in 1954. The present land use within 0.5 mile of the Vitro site boundaries is as follows (FBDU, 1981):

Land use	Percent of area within 0.5 mile of the site (503 acres)
Residential	6%
Commercial	5
Industrial	18
Transportation/utility	28
Agriculture	16
Vacant (excluding Vitro site)	27

About 500 people occupied the residential areas within 0.5 mile of the Vitro site in 1980 (FBDU, 1981). The nearest residences to the Vitro site appear to be about 300 feet away from its southwestern corner, across 3300 South Street (see Figure E-2 in Appendix E).

Future land use and development

The CVWRF Board, which owns the 128-acre site, has indicated that several projects involving the site are planned (personal communication from Mr. Rodney Dahl, CVWRF Board, April 1982). Figure 4-10 shows the location of these projects.

The existing sewage-treatment facility is being expanded to a capacity of 50 million gallons per day (mgd). A further expansion to a capacity of 100 mgd is planned around the year 2000. Access roads and sewage pipelines will be extended by about 300 feet onto the tailings area.

A plan currently under consideration is to create a temporary industrial park on a 300-to-500-foot-wide strip of property along 3300 South Street. The property would be on a "lease only basis" to allow future development. In the meantime, the industrial park would provide lease revenue to the CVWRF Board.

The Wasatch Front Regional Council is currently considering leasing 10 to 15 acres of land in the area formerly occupied by the Vitro mill for a Resource Recovery Facility which would burn solid waste to generate electricity.

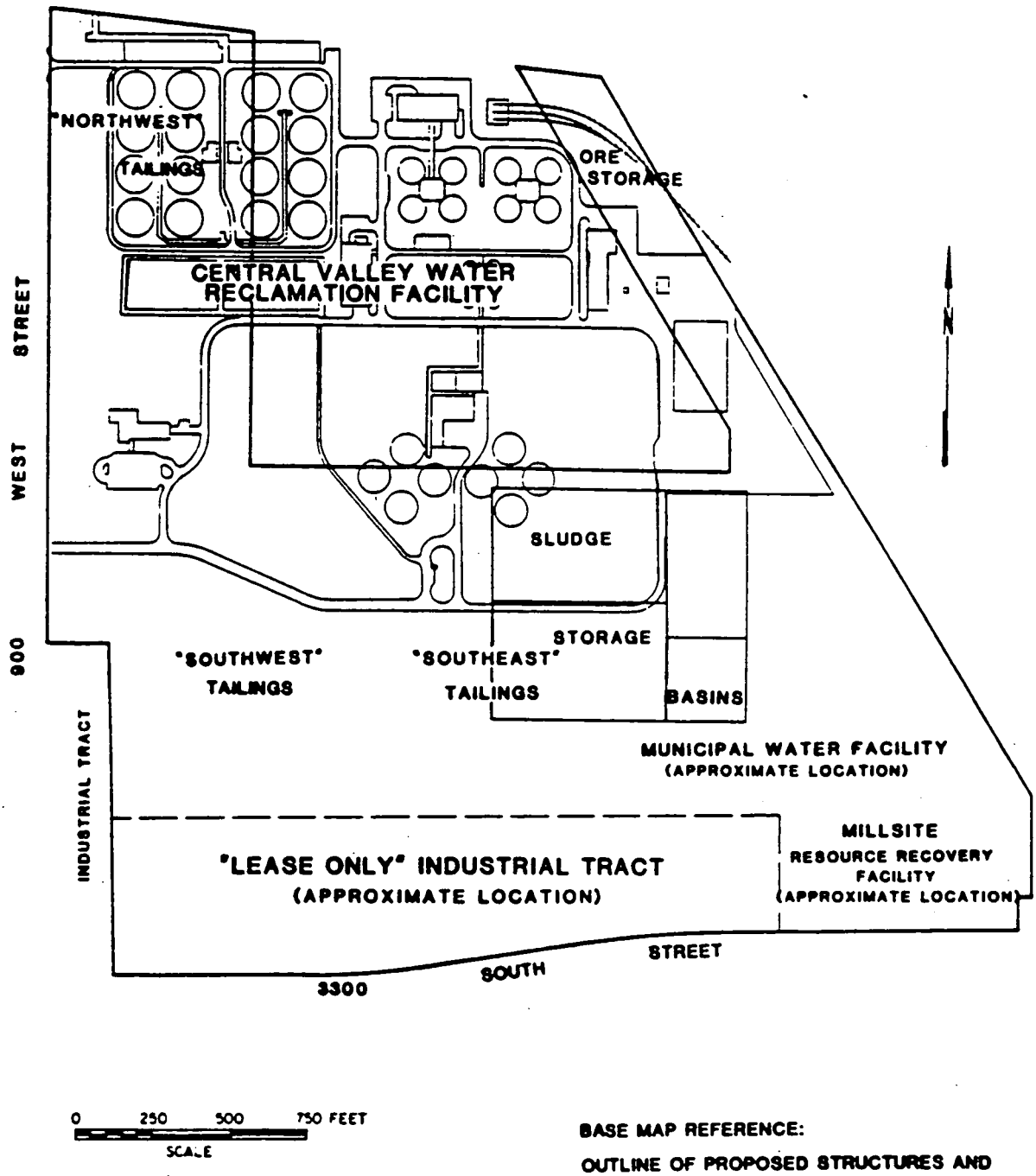

FIGURE 4-10

CVWRF PROPOSED SITE DEVELOPMENT

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There are several wells at the site near the old mill. The quantities and qualities of water vary from well to well. Present plans call for a portion of the water to be utilized by the local municipal system. A small portion of the site would be required for the facilities to handle the water.

Finally, the CVWRF is in need of space for sludge-storage basins and sludge disposal. Future sludge-storage basins would extend into what is now the southeast tailings area, which is currently being used for sludge disposal.

The City's Master Plan contains estimates of the absorption of vacant land zoned for industrial use in South Salt Lake. The "high estimate" projects that between 82 and 84 percent of the City's available industrial acreage will be absorbed by 1990. This development scenario assumes the following "major economic stimuli": (1) deployment of the MX missile system in western Utah; (2) increased extraction of coal reserves in Utah's Overthrust Belt; and (3) continued development of statewide water and power projects. The "low estimate" assumes a moderate national and/or regional recession. Under this scenario, 58 percent of the available industrial land will be absorbed by 1990. Because of the low average income of the city's population, as well as its proximity to the Salt Lake City business district, retail and commercial development in the future are expected to be minimal. South Salt Lake's forecasted growth will be predominately in wholesaling, distribution, and office/warehouse (70 percent) and industrial uses (16 percent), with the remaining 14 percent being a combination of retailing, office and service businesses (Vanwagoner and Associates, 1980). It is generally agreed by the CVWRF Board, South Salt Lake and Salt Lake County officials that the "highest and best" use for the area is primarily in wholesaling and warehousing functions.

4.9.2 South Clive site

The South Clive site is owned by the State of Utah. Most lands within a 10-mile radius are public domain administered by the BLM, with scattered lands owned by the State of Utah or privately.

Present land use

Lands within a 10-mile radius of the South Clive site are rarely used, because of their remoteness from urbanized areas, the poor soil conditions, and sparse vegetation characteristic of the region. Sheep grazing and recreational-vehicle driving are the primary uses made of the area but such uses are apparently light. A state grazing lease is held for the site itself (Section 32, Township 1 South, Range 11 West) by the Skull Valley Company. Numerous trails in the area indicate that it has been used on occasion for recreational vehicle purposes. The only other use of lands within a 10-mile radius is for transportation. The Interstate 80 highway and the Union Pacific railway pass 2.5 miles and 1 mile north, respectively, of the site.

Future land use and development

Factors that could cause land-use changes in the South Clive site vicinity in the intermediate to long-range future include: development of crops that are salt-resistant through genetic engineering and economical means of growing them; a Federal decision to use the area for defense purposes; or other major changes in technology, raw materials requirements, or other societal support functions that cannot be foreseen at this time.

Given existing technologies, however, development of the area for any purpose appears unlikely because of its unproductive soil, and its remoteness from population centers.

4.10 AMBIENT SOUND LEVELS

Humans can hear a large range of sound pressures. The decibel (dB) is used to express these sound levels over a wide physical range. The human ear does not perceive sound at low frequencies in the same manner that it does at higher frequencies. Sounds at low frequency do not seem as loud as those of equal intensity at higher frequencies. The A-weighting network is provided in sound analysis systems to simulate the human ear. A-weighted sound levels are expressed in units of decibels and are used throughout this section unless noted otherwise.

Several Federal agencies have established guidelines and standards for sound level emission (noise). These agencies have also recommended ambient sound levels for public health. The EPA (1974) recommended a 70 dB L_{eq} (24) exposure limit (ambient sound level) as a guideline for continuous exposure and a 55 dB (L_{dn}) as the level where ambient noise is an annoyance to outdoor activity. These are only guidelines and not regulatory standards. ($L_{eq(24)}$ represents the sound energy averaged over a 24-hour period while L_{dn} represents the L_{eq} with a 10 dB increase for noise that occurs at night.) The Federal Highway Administration (1976) established a 70-decibel standard for noise levels during the peak hour of traffic. This standard is used as an indication of what is an acceptable limit for highway noise. The EPA (1976 a,b) established noise emission standards for various types of construction equipment, railroad operations, and specific vehicles. These are true standards which must be met by the manufacturer and maintained by the operator.

No measurements of ambient sound levels were made at the Vitro or South Clive sites; instead, sound levels were characterized at these sites on the basis of proximity to highways and industrial areas, and the like, according to typical values of ambient sound levels that have been measured in similar situations (National Academy of Sciences, 1977).

Vitro site

Ambient sound levels were determined by the existing land uses and by the area's population density. The predominant land use in the area is

000106

transportation/utility (28 percent) and vacant (27 percent). The population density in the area within 0.5 miles of the site is about 630 people per square mile. The area of interest is crossed by I-15, secondary roads, and the railroad. Based on the area's population density the ambient day-night sound level (L_{dn}) would be about 50 decibels, as shown in Table 4-4. Actual ambient sound levels at the residential area to the east of the site, however, are higher because I-15 contributes significantly to area sound levels. It is estimated that the day-night sound levels experienced by populations residing to the east of the site range from about 65 dB for homes nearest to I-15 to 50 dB for locations further from the highway.

Table 4-4. Typical values of day-night sound levels, L_{dn} [a]

Land use description	Population density (people/mi^2)	L_{dn}, dB
Rural, undeveloped	20	35
Rural, partially developed	60	40
Quiet suburban	200	45
Normal suburban	600	50
Urban	2,000	55
Noisy urban	6,000	60
Very noisy urban	20,000	65

[a]Day-night sound level (L_{dn}) is an EPA description of environmental sound. It is the average of daytime and nighttime A-weighted sound levels with nighttime sound given a penalty of 10 decibels.

Source: National Academy of Sciences, 1977.

Trailer courts along the Jordan River and residential areas to the south, west, and northwest are further from the Interstate I-15 but are closer to the site and adjacent industrial activity (see Figure 4-3 in FBDU, 1981). Day-night sound levels for these areas are estimated to be between 60 and 65 dB. The lower value is due to the local traffic, railroad, and I-15 contributions. The higher value is due to additional sounds contributed by the industrial activities including the water treatment plant. 3300 South Street is a major traffic artery generating high noise levels (Rodney Stone, South Salt Lake City Building Department, personal communication, June 1982).

The South Clive site

The area south of Clive is rural, undeveloped, and populated by few people. On the basis of population density, the day-night sound levels near the stabilization area will be less than 35 dB.

The transportation corridors

Sound levels along the transportation corridors outside of Salt Lake City are similar to those described above for the area south of Clive. Near I-80 (or along the corridors), day-night sound levels are estimated to be about 55 to 60 dB. At six hundred feet away from the highway, the sound levels should be about 35 to 40 dB.

4.11 SCENIC, HISTORICAL, AND CULTURAL RESOURCES

4.11.1 History

South Salt Lake was incorporated in 1938, primarily in order to apply for a Public Works Administration grant for Federal financial aid to build a sewer system. The population at the time of incorporation was 4000. In 1950, the town's first post office was built and it became a third-class city. The city's population had grown to 5000. South Salt Lake expanded its boundaries in 1955 by annexing to Eighth West Street. During the 1950s, the city grew and became a major industrial center, but by 1970, the city's residential population was declining. In 1979, the city annexed approximately 900 acres, extending its boundaries from Mill Creek to 3300 South Street and from the Jordan River to Seventh East Street, thereby increasing its population to 10,500. The daytime population increases to about 40,000 because of the large commercial-industrial sector of the city.

The South Clive site has probably been used for grazing since the early settlers. No events of historical significance are known to have occurred on the site. The Donner Trail probably passed north of the site, but the trail's exact location is unknown.

4.11.2 Scenic qualities

The vicinity of the Vitro site is in transition from a rural agricultural area to a commercial-industrial area with scattered residential development. Some grazing lands remain but many of these are being converted to warehouse and industrial uses. The dominant visual elements are the urban features that have recently been constructed (Interstate 15, the commercial-industrial area to the southeast of the site, and the warehouses located northwest of the site, for example) and the front range of the Wasatch Mountains.

The South Clive site is located in the Basin and Range physiographic province which covers nearly all of Nevada and parts of California, Oregon, Idaho, Arizona, New Mexico, and Texas. It is characterized by broad, flat basins occasionally interrupted by small mountain ranges. The area within a 10-mile distance of the South Clive site is typical of this province. Because of the flatness of the terrain, vistas of 30 miles are common.

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The BLM Visual Resource Inventory and Evaluation system (BLM, 1978) was used to rate the scenic quality of the South Clive site relative to the physiographic province. This rating system employs a scale of 0 to 33, with higher ratings (19 or above) indicating that special management attention is required. This numerical rating system is shown below, with the ratings for the South Clive site underlined.

Scenic-Quality Rating

Category	Score		
	High	Medium	Low
Landform	5	3	1
Vegetation	5	3	1
Water	5	3	0
Color	5	3	1
Influence	5	3	0
Scarcity	6	2	1
Cultural modification	2	0	-4
	33 = maximum score		0 = minimum score

The total score of 12 for the South Clive Site is a low-to-medium rating for scenic quality, indicating that no special management attention is necessary.

4.11.3 Places of archaeological, historical, or cultural significance

No sites of archaeologic, historic, or cultural significance are known to exist at the Vitro mill site or within a 0.5-mile radius of it (see Appendix C of DOE, 1982).

On August 24-26, 1981, an intensive cultural resource inventory of an area inclusive of the South Clive site was conducted by the Archaeological-Environmental Research Corporation. No cultural resource sites were identified during the inventory but one isolated artifact was found. This artifact consisted of four pieces of broken purple glass from some unknown historic glass object. It does not appear that such a find indicates the existence on the site of significant archaeologic artifacts.

The Ground to Air Pilotless Aircraft Launch Site and Blockhouse is listed in the National Register of Historic Places and is approximately 10 miles west of Clive at Knolls. To the southeast of Clive (approximately 23 air miles) is the site of the Iosepa Settlement Cemetery. These are the historical sites closest to the transportation corridor between the Vitro and the South Clive sites.

4.12 SOCIOECONOMIC CHARACTERISTICS

4.12.1 Populations

According to the 1980 census (U.S. Department of Commerce, 1981), the state of Utah had a total population of 1,461,037, an increase of 37.9 percent since 1970. Most of the state's population (80.4 percent) lived in urban areas (places of 2500 or more), predominately on the Wasatch Front. The median age of Utah residents in 1980 was 24.2 years, lowest in the nation. "Baseline" population projections indicate that by the year 2000 the state could increase its total population to 2.3 million persons, 60 percent over that of 1980 (Utah State Planning Coordinator, 1981).

The populations of Salt Lake County and Tooele County increased by less than the state mean during the 1970-80 period, 35.0 and 20.8 percent, respectively. However, it is expected that approximately 65 percent of the state's growth to the year 2000 will occur in the Wasatch Front Multi-County Planning District, including Davis, Morgan, Salt Lake, Tooele, and Weber Counties (Utah State Planning Coordinator, 1981). The sources of demographic information in the following descriptions are the decennial census counts, unless otherwise indicated.

City of South Salt Lake

The population of South Salt Lake decreased at an average annual rate of 2.0 percent during the 1960-1970 period, from 9520 in 1960 to 7810 in 1970. It then grew by an average annual rate of 3.1 percent during the 1970s, reaching 10,561 in 1980. Virtually all of this growth between 1970 and 1980 was caused by expansion of the city's boundaries. South Salt Lake can be characterized as an area with small families, in life cycle stages either before or after the child-rearing stage. The proportion of families with incomes below poverty level in 1970 was 10.3 percent, higher than the statewide average of 9.2 percent.

Vitro site vicinity

Population counts were conducted for the area within 0.5 mile of the Vitro site by Ford, Bacon, & Davis Utah Inc. (FBDU, 1981). These counts indicated that 497 persons resided in the area, with average residential densities generally increasing with distance from the site. Average population density within 0.5 mile of the Vitro site was about one person per acre. Beyond 0.5 mile, density increased rapidly to 4.3 persons per acre within 2 miles. The daytime population increases to about 40,000 because of the large commercial-industrial sector of the city.

Tooele City

Tooele City's population grew from 9133 in 1960 to 12,539 in 1970, an average annual increase of 3.2 percent. In the following decade the growth rate decreased to 1.3 percent per year, to a 1980 city population of 14,335.

The average household size in Tooele City was 3.38 persons in 1970, slightly less than the statewide average. A relatively high proportion of its population was married (69 percent of males versus 56.6 percent for the state) and its birth rate (435 live births per 100,000 population) was about equal to the state average (436 live births per 100,000 population).

South Clive site

An estimated 25,526 people resided within 50 miles of the South Clive site at the time of the 1980 Census, but most of the area is uninhabited. The closest residents lived 15-20 miles to the northeast of the site. The largest number lived 30-50 miles to the east and southeast of the site in the Tooele-Grantsville area. Table 4-5 presents estimates of the 1980 population within 50 miles of the South Clive site by compass direction and radial distance.

Table 4-5. Population wheel for South Clive site

	Miles from site									
Direction	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
N										
NNE										
NE										
ENE				7						
E					10		2,676	1,757	1,349	821
ESE					28		25	119	14,206	3,209
SE					20	19	6	48	117	10
SSE										
S										
SSW										
SW										
WSW										
W										1,099
WNW										
NW										
NNW										
Total				7	58	19	2,707	1,924	15,672	5,129

Population projections

A growth rate averaging about 3.1 percent is assumed most probable for Salt Lake County through the year 2005 because it corresponds to the growth rate of the county from 1970 to 1978. The development of synthetic fuels within the state, however, could create short-term rapid growth which should then taper off. If rapid developments in the energy field occur, the growth rate could go up to "7.0 percent declining," meaning in 25 years the growth rate will taper off to zero (FBDU, 1981).

It is projected that Tooele County will increase its population at an annual rate of 3.8 percent until 1985; thereafter, its growth rate will decline. This projection is based on expected energy development and subsequent employment opportunity that should also taper off. It is expected that the largest percentages of growth will occur in the City of Tooele, Grantsville, and Wendover (Mountain Area Planners, 1972).

4.12.2 Economic structures

Utah's most prominent employment sectors in 1979 were government with a 24 percent share of total wage and salary employment, services with a 16.4 percent share, retail trade at 17.0 percent, and manufacturing with 15.4 percent (U.S. Department of Commerce, 1981). Per capita income in 1979 was $7182, which placed Utah below both the Rocky Mountain state and national averages.

County and local economic conditions

Salt Lake County, which is the State of Utah's central economic area, exhibits the same general economic health as the state as a whole. Its unemployment rate in 1980 averaged 5.1 percent, compared to a 5.4 percent statewide average (Utah Department of Employment Security, 1980). The County unemployment rate has been increasing since 1979. In 1982 it was 7.4 percent and in May 1983 it stood at 8.3 percent (seasonally adjusted). Based on the 2.5 employment multiplier used by the Utah State Planning Coordinator's Office for the Wasatch Front planning area, the basic-nonbasic employment multiplier for Salt Lake County is estimated at approximately 2.5 jobs supported by every job created in the basic, or export, sector of the economy. With regard to the temporary industrial park, it is estimated that each direct employee at the industrial park will generate an additional 1.6 jobs in the local economy (Division of Community Development, State of Utah, 1983 and State Planning Coordinator's Office, State of Utah, 1983).

Economic data reveal that the Tooele County economy is stable due to the intensiveness of Federal military employment but, like most rural areas in the state, it has a relatively high unemployment rate and underdeveloped secondary economy. Unemployment in Tooele County was 9.9 percent in 1982 (State of Utah, Job Service, 1983). Employment at the Deseret Test Center and Army Depot was primarily responsible for the Federal government employment share of 49.7 percent of the total 1979 wage and salary jobs in the County. Mining is the second most important sector of the export base of the County, providing 7.3 percent of the wage and salary jobs. The basic-to-nonbasic employment multiplier for Tooele County (assuming that all Federal and mining employment, 75 percent of all employment in the manufacturing sector, and 10 percent of all state and local government employment can be classified as basic) is estimated to be 1.5 jobs for every job created in the basic sectors.

Per capita income in Tooele County in 1979 was $6782, 94.4 percent of the statewide average (U.S. Department of Commerce, 1981).

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City of South Salt Lake

The economy of the City of South Salt Lake is based primarily in manufacturing, transportation, and wholesale and retail trade (Utah Department of Employment Security, 1980). The large industrial tax base in South Salt Lake permits the city to levy a relatively low city property tax (the 1982 mil levy was 6.25).

City of Tooele

The economy of the city of Tooele, the economic and population center of Tooele County, closely resembles that of Tooele County described above. The city's 1981 property tax rate was 25.16 mils.

4.12.3 Governmental structures

South Salt Lake, Tooele City, and Grantsville all have similar governmental structures, being governed by a mayor and five councilmen. Likewise, both Tooele and Salt Lake Counties are governed by three elected county commissioners who make certain decisions, such as those concerning zoning, and oversee the provision of services in their respective counties. For instance, Salt Lake County provides flood protection and health services to the City of South Salt Lake but delegates to the city the responsibility for maintenance of county roads located within the city. Special districts, though not governmental entities, are important in both counties, providing services such as sewage treatment and public education.

4.12.4 Housing

The total number of housing units in Tooele County increased from 6455 to 8566, an increase of 32.7 percent, between 1970 and 1980 (U.S. Department of Commerce, 1981). Housing unit growth was greatest, percentage-wise, in the Grantsville area, at 64.8 percent, but Grantsville's 1980 housing stock was still small at only 1348 units. The 1980 Census preliminary count indicated that 5 percent of all units in Grantsville were vacant. Tooele City's housing stock grew by 26.5 percent, to 4877 units. Preliminary 1980 vacancy rate data available from the Bureau of Census indicate that approximately 5.3 percent of the units are vacant. The county averaged 3.23 persons per dwelling unit in 1980.

4.12.5 Community services

Tooele County

Total enrollment in the Tooele County School District was 7011 students during the 1981-82 school year, 2.5 percent higher than during the 1979-80

school year (Tooele County Schools, 1981). It appears that enrollment will increase in the short-term future at about the same rate (1.2 percent per year) as in the recent past. In the short term, this rate of enrollment growth is not expected to cause physical-capacity or fiscal problems since the system is not experiencing significant overcrowding and has some excess bonding capacity.

Police protection is provided to the unincorporated areas in the County by a sheriff and 14 deputies (an average of 2.0 officers per 1000 population), and by a 20-member Jeep Patrol (Tooele County Chamber of Commerce, 1980). The County Sheriff also directs the County volunteer fire department which has 18 fire trucks at 9 fire substations located in Vernon, Clover, Terra, Ophir, Stockton, Pine Canyon, Lake Point, Stansbury Park, and Grantsville.

The County's single hospital, with 36 beds, is located in Tooele City and has a low average occupancy rate of 35 to 38 percent. Other medical services include two health clinics and one mental health clinic serving out-patients on a 24-hour basis. Ambulance service is provided for the County by a company in Tooele with one ambulance and three other vehicles (Tooele County Chamber of Commerce, 1980).

The County operates one public library housing 48,786 volumes, two bookmobiles and a storage facility in Grantsville that is open to the public (University of Utah Planning Program, 1981).

City of South Salt Lake

South Salt Lake is governed by a mayor and five councilmen. The city employs a part-time licensed engineer (Utah Industrial Development Division, 1981).

Education in the City of South Salt Lake and other nearby areas is provided by the Granite School District, one of four districts in Salt Lake County. Total District enrollment was 61,485 in September 1981, only about 2360 of whom were residents of South Salt Lake. The four schools that service the bulk of South Salt Lake, however, are expected to continue to have stable enrollments. No crowding problems exist or are expected in these schools.

The South Salt Lake Police Department employs 22 officers (2.0 officers per 1000 population) as well as a public relations specialist, lieutenant, and chief. It operates 17 vehicles and has 3 to 4 patrolmen on duty at any hour, providing an average response time of 2 to 3 minutes. The South Salt Lake Fire Department employs 16 men on a full-time basis and has 25 volunteers. Firefighting equipment includes two ladder trucks, two squad trucks, three pumper trucks and one utility/service truck. Response time is two to three minutes. The American Insurance Association rating for South Salt Lake is 5.

South Salt Lake utilizes a gravity water system from six wells. The system's storage capacity and peak pumping capacity (utilizing booster pumps) is 9 million gallons per day (mgd). The average pumping capacity is 5.5 mgd.

The sewage-treatment facility for South Salt Lake is a combination primary clarifier, trickling filter and anaerobic digester. The design average flow capacity is 3 mgd, current average flow is 2.4 mgd.

Located north of the Vitro site is the Salt Lake City Suburban Sanitary District No. 1 treatment plant (the CVWRF sewage-treatment plant of Figure 4-10). This system is bio-filter primary sedimentation type with a design average flow capacity of 17.25 mgd. The CVWRF Board is currently building a new facility on the site utilizing a portion of the existing plant; operation is planned for 1987. This plant will have a design average flow of 50 mgd and is expected to provide adequate treatment until the year 2000. Once completed, this system will replace the South Salt Lake and the Salt Lake City Suburban District No. 1 plants as well as the 7.5-mgd Granger-Hunter District plant, the 8-mgd Cottonwood District plant, and the 4-mgd Murray City plant.

4.12.6 Transportation networks

Existing vehicle entry to the Vitro site is from the south at 3300 South Street, which is also Utah State Highway 171. Highway 171 extends west through Granger, Hunter, and Magna where it intersects with Utah State Highway 111 (Figure 4-11). The annual average of daily traffic counts near the Vitro site on Highway 171 is 24,850.

It is expected that access to the Vitro site during the proposed remedial action would be via a new entry point on 900 West Street approximately 1200 feet north of 3300 South Street. All haul trips and miscellaneous delivery will be directed away from 3300 South Street. The expected haul route and its current average daily traffic volume are shown in Table 4-6.

The haul route between the Vitro and South Clive sites (truck option) would use 900 West Avenue, 2100 South Street (State Highway 201), and Interstate 80. Traffic volumes for 900 West Avenue and 2100 South Street to Interstate 80 are shown in Table 4-6 and Figure 4-11. At the intersection of State Highway 201 and Interstate 80 the annual average daily traffic volume is 15,515. This volume decreases to 4,560 vehicles per day north of Grantsville and to 3,465 vehicles per day at the South Clive site.

TABLE 4-6

Current and projected average daily traffic (ADT) along the haul route

Roadway Section		1982[a] ADT	Estimated 1986[b] ADT
900 West Between	2100 S & 3300 S	9,300	10,265
2100 South Between	900 W & 1200 W	56,775	62,670
	1700 W & 3200 W	40,285	44,470
	3200 W & 3600 W	27,600	34,465
	3600 W & 5600 W	25,325	27,950

Table 4-6 (Continued)

Roadway Section		1982[a] ADT	Estimated 1986[b] ADT
5600 West Between	2100 S & 3500 S	10,725	11,840
	3500 S & 4100 S	8,350	9,215
	4100 S & 5400 S	7,225	7,975
5400 South Between	5600 S & West	4,200	4,635

[a]UDOT 1984

[b]Assuming a 2.5% per year increase in traffic

The Denver and Rio Grande Western Railroad forms the east boundary of the Vitro site. Any westward-bound rail shipments from the site would be transported north into Salt Lake City and then west along the Union Pacific line. Rail lines are also shown in Figure 4-11. Traffic counts for this railroad route are not available. However, railroad officials have indicated there would be no difficulty in accommodating the type and volume of traffic anticipated in Alternative 3.

4.12.7 Recreation

In Tooele County, the greatest number of recreational facilities available are for recreation with off-road vehicles, with open space, playgrounds, tennis courts, and softball fields next. The Wasatch National Forests provide a total of 936 sites for outdoor activities such as fishing, hiking, camping and picnicking, and hunting (Utah Travel Council, 1979). State Parks within Tooele County include the Great Salt Lake State Park Saltair Beach, located 15 miles west of Salt Lake City, the Bonneville Salt Flats, and Danger Cave located near Wendover. The salt flats are listed in the National Register of Historic Places and consist of approximately 44,000 acres of the remains of ancient Lake Bonneville that at one time covered nearly one-third of the state.

Recreational use of land within a 5-mile radius of Clive is limited to occasional recreational vehicle use and jackrabbit hunting. Off-road vehicle use near the site is rare due to the number of mud flats in the vicinity.

In Salt Lake County, facilities for softball, playgrounds, open space, soccer, tennis, and swimming are the most numerous with football, golf, and picnicking next. South Salt Lake has 3 parks for general picnic and recreation purposes, 1 ballfield, and borders a public golf course.

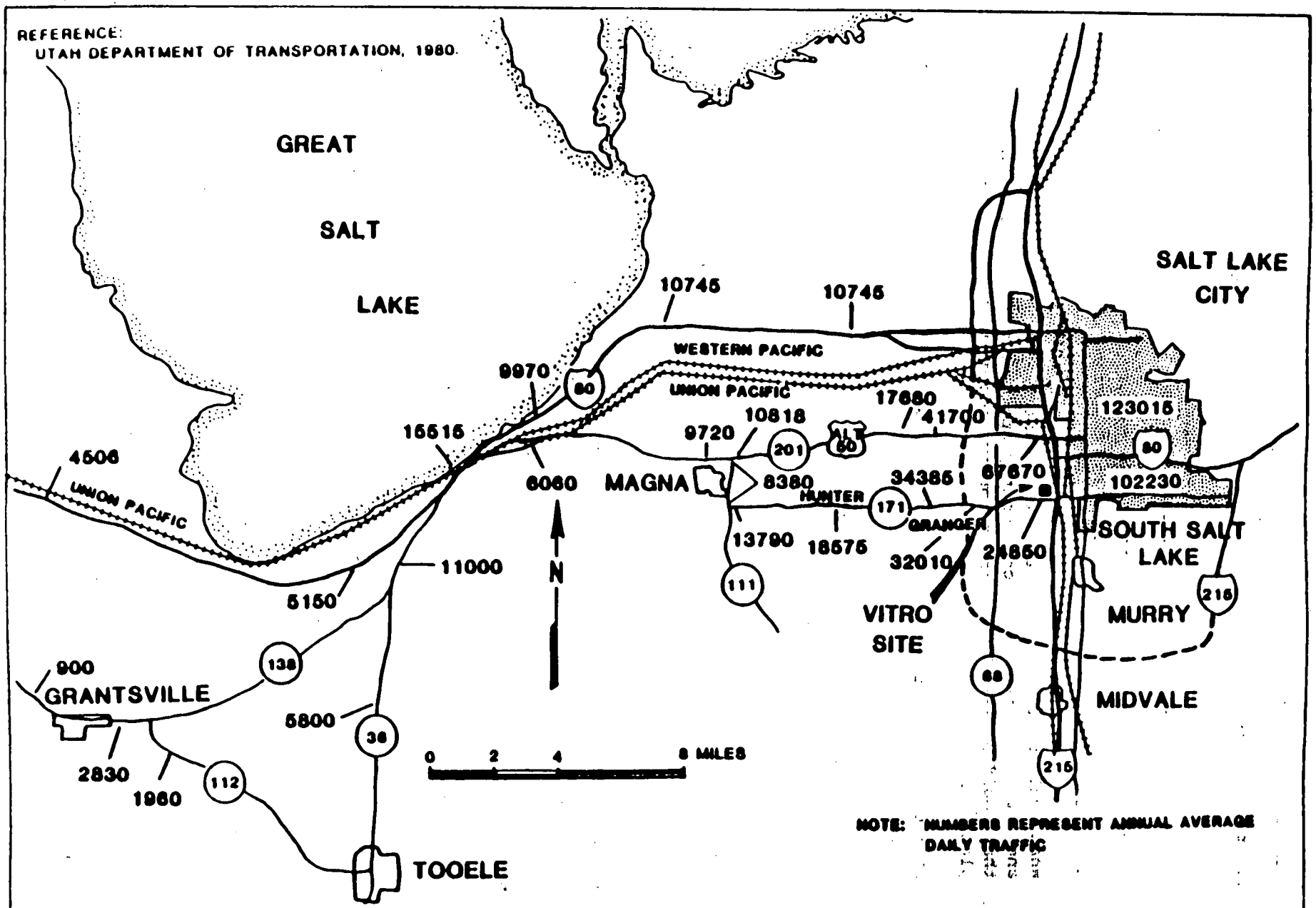

FIGURE 4-11. TRANSPORTATION ROUTES AND TRAFFIC VOLUMES

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4.12.8 Public concerns regarding the remedial action project

Indications of public concern were received during the scoping meetings for this EIS, held in South Salt Lake City and Tooele City on May 5 and 6, respectively, 1981. The matters of concern mentioned most frequently during the public scoping meetings were the following ones.

- What are the radiological effects upon physical health of the proposed actions? Tooele County speakers were concerned with long-term effects and the effects of transportation accidents.

- What would be the indirect effects of the proposed actions on economic and social structures? Tooele County speakers mentioned the stigma that would be attached to their county should the Vitro wastes be placed there.

- How would the proposed actions affect current land-use plans, policies, and controls? This concern was expressed exclusively by officials of South Salt Lake and Salt Lake County, who mentioned concern over economic losses caused by the presence of the Vitro tailings: loss of tax revenues, delays in completion of sewage-treatment facilities, and inhibition of development in a potentially prosperous industrial area.

- What would be the effects of the proposed actions upon the quality of surface and near-surface waters? Concern was expressed that the Great Salt Lake would become contaminated.

These issues are addressed throughout the EIS.

Following the publication and distribution of the DEIS in February 1983, notice of its availability was published in the Federal Register on February 18, 1983 (48 FR 7294). The notice also announced the date for closing the comment period as April 4, 1983. Inserted in the DEIS was the notice of the public hearings to be held in Tooele on March 22 and in South Salt Lake on March 23, 1983. The DEIS was sent to more than 30 individuals, as well as to Federal and state agencies, elected officials, organizations, and public libraries. News releases were also disseminated announcing the dates and locations of the public hearings.

In preparation of the public hearings, a public meeting was announced and held on March 8 in Tooele and March 9, 1983, in South Salt Lake.

Comments received on the DEIS are summarized and answered in Chapter 6 of this FEIS; the DEIS has also been modified to reflect the comments received.

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5 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of the three alternative remedial actions described in Section 3.2 and Appendix A are assessed in this chapter.

5.1 RADIOLOGICAL IMPACTS

5.1.1 Introduction

This section assesses the incremental radiological impacts resulting from each of the alternatives and indicates the methods used to perform the assessments. The data and information used to perform these impact assessments are detailed in Appendix F. Radiation doses and health effects for both the general population within 6 miles (10 km) of the Vitro site and the remedial action workers assigned to the Vitro and South Clive sites are included. Radiation doses and health effects are estimated for the transportation workers and the population along the transportation corridors for Alternative 3.

5.1.2 Exposure pathways

There are five principal environmental pathways by which individuals could be exposed to radioactivity during remedial action (Figure 5-1). These are (1) inhalation of radon and radon daughters, (2) exposure to direct gamma radiation from the tailings pile, (3) inhalation or ingestion of windblown radioactive particulates, (4) ingestion of ground or surface water contaminated by radioactive materials, and (5) ingestion of contaminated foods produced in areas contaminated by tailings.

For the calculation of health effects, only those pathways capable of producing the largest radiation exposures are considered. These are the first two above. Exposures via the latter three pathways are much smaller than the doses from radon daughter inhalation and direct gamma exposures. The inhalation of suspended particulates from the tailings pile results in relatively small radiation exposures for workers on the pile, and negligible exposures to the public (Appendix F, Section F.4). The ingestion of ground water is an insignificant pathway since there is no evidence that potable water drawn from deeper ground-water systems beneath the Vitro site have been contaminated (Section 4.6.2). The ingestion of surface water is an insignificant pathway since off-site surface waters near the Vitro site are not used for drinking purposes (Section 4.6.1). The ingestion of plant material that has been "dusted" with wind blown tailings, or the ingestion of animal food products (i.e., meat, milk, and eggs) from animals that have ingested such plant material is judged to be an insignificant pathway since the Vitro site lies downwind from the majority of the agricultural lands that are nearby.

The health effects from radon releases arise from inhaling radon daughters--the radionuclides resulting from the decay of radon. Radon is an inert gas produced from the radioactive decay of Ra-226. As a gas radon can diffuse through the tailings and into the atmosphere where it is transported

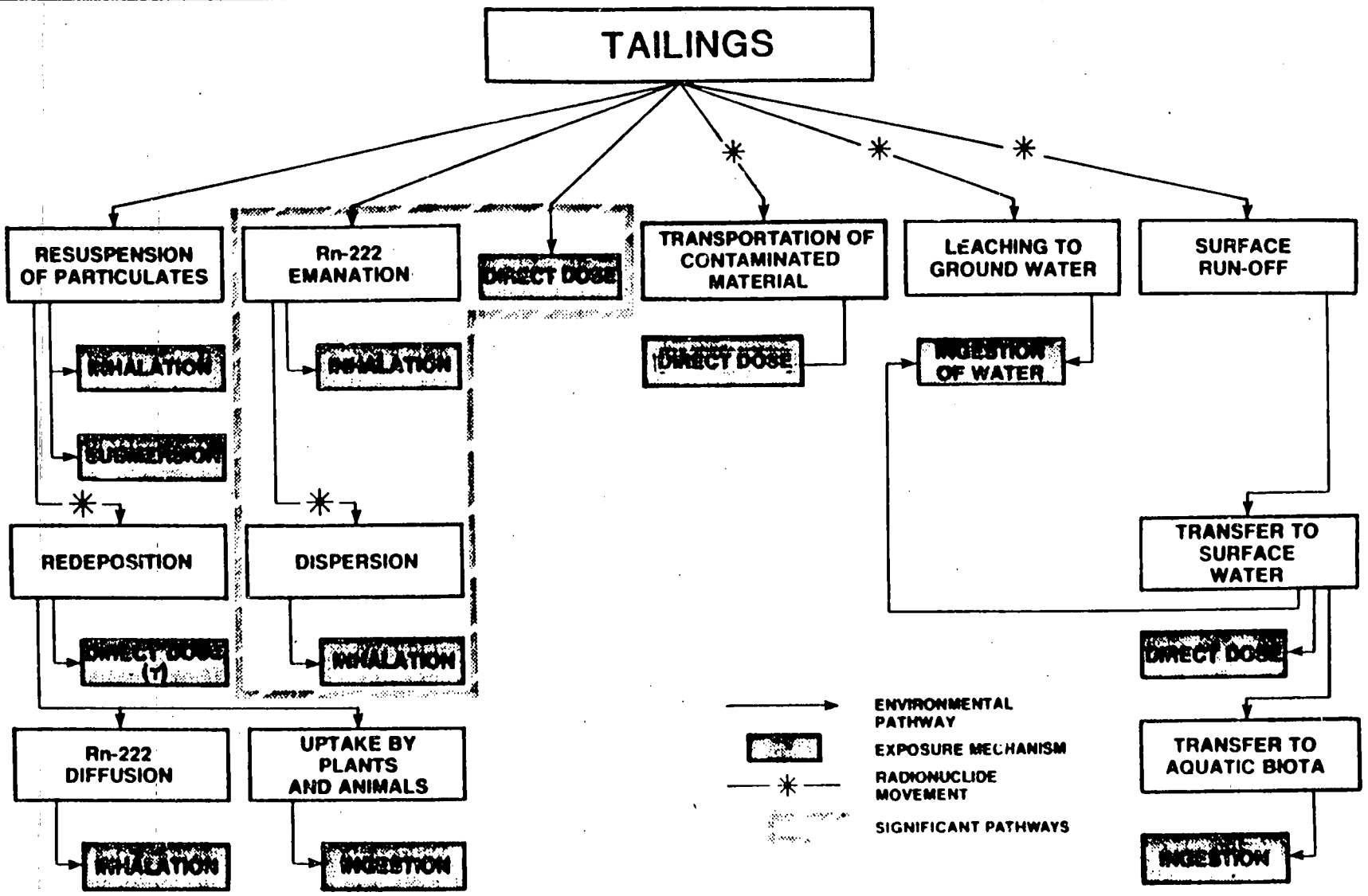

FIGURE 5-1
POTENTIAL RADIATION EXPOSURE PATHWAYS TO THE GENERAL PUBLIC AND REMEDIAL-ACTION WORKERS.

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by wind over large areas. In the atmosphere, radon decays into its solid daughter radionuclides which attach to airborne dust particles and may be inhaled. These dust particles with the attached radon daughters may adhere to the lining of the respiratory tract--bronchia and lungs. The decay of the radon daughters releases radiation to the bronchial and lung tissue.

Gamma radiation is emitted by many radionuclides of the U-238 decay series. Gamma radiation is independent of atmospheric conditions and travels in a straight line until it interacts with matter, just as do x-rays. Gamma radiation omitted from the tailings delivers an exposure to the whole body. Gamma radiation becomes negligible due to interactions with air at about 1 km from the perimeter of the tailings.

Exposure to radon daughters and gamma radiation from the unstabilized tailings at the Vitro site currently impacts the general population and nearby workers. As remedial action is implemented, the exposures are anticipated to increase as the tailings are disturbed and transported. But as remedial action progresses and following its completion, the exposures will be greatly reduced due to the isolation of the radioactive materials from the environment. Each alternative includes the construction of a thick earthen cover which cannot be penetrated by gamma radiation from the tailings. The thick earthen cover will also serve as a barrier to the diffusion of radon from the tailings into the atmosphere. Although most of the radon will decay before escaping into the atmosphere, some will escape and may produce small exposures to surrounding populations. The radon release rate through the cover will be no greater than the allowable rate set by EPA standards (Section 3.1.1).

5.1.3 Methods of impact assessment

Radiation doses to the general population beyond 1 kilometer (km) from the site were evaluated using the computer code MILDOS (NRC, 1981). MILDOS provides estimates of the potential radiation doses to individuals in the vicinity of a typical uraninum mill tailings disposal site. The input required by MILDOS includes (1) population distribution data, (2) meteorological data, and (3) radionuclide release data. The data used are discussed and presented in Appendices F and G.

The required radionuclide release data include (1) the radon emission rate from the pile surface, (2) radionuclide release rates for particulate emissions, and (3) the time periods over which the releases occur. Since the minimum time step in MILDOS is 2 years, some averaging of releases on shorter time scales is required.

The surface Rn-222 releases completely dominate the radionuclide emissions due to particulate sources (wind erosion and mechanical suspension of dust by earth moving equipment); thus the population and worker radiation exposures result primarily from radon releases (Section F.5, Appendix F). To illustrate the magnitude of the difference between exposures resulting from radon daughters and particulate inhalation, the latter is calculated for remedial action workers for Alternative 2 (Section F.4, Appendix F).

Since MILDOS does not calculate radiation exposures within 1 km of the site, these were estimated for remedial action workers, nearby workers, and the nearby general population using measurements of gamma radiation exposure rate and radon concentrations in air (Appendix F.5).

For Alternative 3, persons near the rail or truck transportation corridors may be exposed to gamma radiation from passing vehicles carrying radioactive materials from the Vitro site to the South Clive site. Although the time of exposure to such persons is small and radiation exposure from a vehicle low, the exposure from passing vehicles is calculated in Section F.5 of Appendix F. These calculations are based on average tailings radionuclide content, vehicle speed, and the exposure rate for a vehicle.

Estimates of cancer deaths in excess of those occurring normally in a population, as caused by radiation exposure, were made using the following risk factors (Section F.2, Appendix F):

- 20 lung cancer deaths in the exposed population for each 1,000,000 person-rem of dose equivalent commitment from inhalation of radon daughters (National Academy of Science, 1980; Evans et al., 1981).

- 120 cancer deaths in the exposed population for each 1,000,000 person-rem of dose equivalent from exposure to gamma radiation (National Academy of Science, 1980; Cohen, 1981).

A wide range of risk factors are accepted by experts who attempt to relate cancer deaths to radiation exposure. The ones given above are believed to be appropriate for the exposures from uranium mill tailings and to estimate realistically the cancer deaths associated with a given dose equivalent.

5.1.4 Radiological impacts

Estimates of the radiation dose equivalent commitments to the general population during remedial action under the three alternatives are presented in Table 5-1. The potential excess cancer deaths are given in Table 5-1, as well. These estimates were made using the methods outlined in Section 5.1.3 and detailed in Appendix F. The expected excess cancer deaths were obtained from the dose equivalent commitments by multiplying by the risk factors noted in Section 5.1.3. The doses and health effects to the general population are calculated for a 6-mile radius around the Vitro site. No person lives within 15 miles of the South Clive site, so only remedial action workers will be exposed there.

The maximally exposed individual would be one who resides about 300 feet from the southwestern corner of the Vitro site (Figure 1-1). That person could receive an annual gamma radiation dose equivalent of about 0.5 rem (EPA, 1980) in addition to about a 0.6-rem dose equivalent commitment from radon daughter exposure (Section F.5, Appendix F).

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Table 5-1 Estimates of 3-year excess population dose equivalent commitments to the general public during remedial action, and expected excess cancer deaths caused by remedial action (based on a 3-year period for each alternative).

Organ	Population dose equivalent commitment (person-rem)											
	(no action) Alt 1			Alt 2			Alt 3 (train)			Alt 3 (truck)		
	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]
Whole body	114	9.0	220	36	4.5	110	36	4.5	110	36	4.5	110
Bone	n.e.[d]	9.1	240	n.e.	4.6	120	n.e.[d]	4.6	120	n.e.	4.6	120
Lung	n.e.	9.0	220	n.e.	4.5	110	n.e.	4.5	110	n.e.	4.5	110
Bronchial epithelium	1,152	3,600	27,000	570	1,800	14,000	570	1,800	14,000	570	1,800	14,000
	Expected excess deaths											
	(no action) Alt 1			Alt 2			Alt 3 (train)			Alt 3 (truck)		
	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]	1 km[a]	1-2 km[b]	1-10 km[c]
Cancer from whole-body gamma-ray exposure	0.014	0.0011	0.026	0.0043	0.0005	0.013	0.0043	0.0005	0.013	0.0043	0.0005	0.013
Lung cancer from doses to the bronchial epithelium	0.023	0.072	0.54	0.0114	0.036	0.28	0.0114	0.036	0.28	0.0114	0.036	0.28
Total	0.037	0.073	0.57	0.016	0.037	0.29	0.016	0.037	0.29	0.016	0.037	0.29

[a]Population is 500 persons.
[b]Population is 8,617 persons.
[c]Population is 437,361 persons.
[d]Not estimated.

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Estimates of the radiation dose equivalent commitments to the remedial action workers for each alternative are presented in Table 5-2 along with the potential resulting excess cancer deaths.

The single most important pathway to the general population is the inhalation of radon daughters and the subsequent irradiation of the tracheobronchial system. For the remedial action workers, the more important pathway is gamma radiation exposure of the whole body. In order to put the estimated dose commitments in perspective, the estimated normal background radiation doses and EPA guidelines are presented in Table 5-3.

In the population of the U.S., about one person in six dies of cancer. This means that approximately 73,000 of the 438,000 persons who live within 6 miles of the Vitro site may be expected to die of cancer, regardless of the presence of the unstabilized tailings piles. The estimated increase in deaths due to Alternatives 2 or 3 would be about 0.4 person, an increase of 0.0005 percent. For remedial action workers the estimated increase is about 0.08 percent in Alternative 2, and about 0.20 to 0.30 percent in Alternative 3.

5.1.5 Radiological impacts of transportation accidents

Alternative 2 does not require off-site transportation of contaminated materials and it is hard to conceive of a transportation accident that would have radiological consequences involving persons other than remedial action workers. For remedial action workers the consequences of an on-site transportation accident would be largely nonradiological and would add nothing to their exposure. Nonradiological accidents are estimated in Section 5.12.

Alternative 3 involves the transport of 2.5 million cubic yards of contaminated material from the Vitro site to the South Clive site about 85 miles away. Both train and truck transport options could result in accidental spillage of material as a consequence of a transportation accident. Conceivably a loaded unit train could be derailed and overturned at some point on the route, spilling part or all of its 5400-ton load onto the railbed. Such an accident is not probable; based on estimates of the probability of its happening during the 634 train trips required, 0.05 spills reasonably could occur (Section F.3). The cleanup of the roadbed would be done promptly and the several-day exposure of the cleanup crew would be small compared to the 3-year exposure of remedial action workers at the Vitro and South Clive sites. Notification of the spill would be made to the appropriate authorities as required under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The truck option for transport to South Clive involves 97,800 truck trips over 3 years, and the probability for an accident leading to a tailings spill is somewhat greater than for train transport; about 7 spills reasonably could occur during the 3 years of remedial action. However, the radiological consequences are minimal considering the limited quantity of contaminated material involved and the short period of time that would be required for a cleanup (a day or less). Again, the exposures are small compared to that of the remedial-action workers at the Vitro and South Clive sites.

Table 5-2 Estimates of excess collective dose equivalent commitments to the remedial-action workers and expected excess cancer deaths caused by remedial action

	Population dose commitment (person-rem)							
	Alt 1	Alt 2	Alt 3 (train)			Alt 3 (truck)		
		Vitro	Vitro	Transport	South Clive	Vitro	Transport	South Clive
Whole body	0	65	163	4	109	179	68	103
Bronchial epithelium	0	480	420	0	320	380	0	220

Effect	Expected excess deaths							
	Alt 1	Alt 2	Alt 3 (train)			Alt 3 (truck)		
		Vitro	Vitro	Transport	South Clive	Vitro	Transport	South Clive
Cancer from whole-body gamma-ray exposure	0	0.0078	0.020	0.0005	0.013	0.021	0.008	0.012
Lung cancer from doses to the bronchial epithelium	0	0.0096	0.008	0	0.006	0.008	0	0.004
Total	0	0.017	0.028	0.0005	0.019	0.029	0.008	0.016

[a]Based on worker hours of exposure in Tables A.4, A.7, and A.8.

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Table 5-3. Background radiological levels and EPA limits

Parameter	Background dose per individual (mrem)	Background population dose (person-rem/yr) General public[a] 2 km	10 km	Workers[b] Alt 2	Alt 3a (train)	Alt 3b (truck)
Background external whole-body dose	105	905	46,000	25	23	22
Bronchial dose from ambient radon[c]	1,630	5,400	273,000	150	140	130
EPA indoor limit for whole-body gamma dose[d]	280	2,400	122,000	67	62	58
EPA indoor limit for bronchial dose[e]	5,400	47,000	2,400,000	1,300	1,200	1,100

[a]8,617 people living with 2 km; 437,361 within 10 km.
[b]Based on all workers in Tables A-4, A-7, and A-8 whether or not they receive occupational exposures. These total 240, 220, and 204 persons, respectively.
[c]From background of 0.25 pCi/l of radon or 0.0025 WL.
[d]From 20 μR/hr + 12 μR/hr background.
[e]From the gamma limit plus the radon-daughter limit of 0.02 WL.

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5.1.6 Comparison of radon-222 emissions with the EPA standards

As indicated in Section 3.1, the EPA has issued standards to be met in remedial actions such as those proposed in Alternatives 2 and 3. One of the standards is a limit on the radon flux from the surface of the stabilized disposal site. The limit is a flux of 20 picocuries per square meter per second (Table 3-1).

The average radon flux from the Vitro tailings pile is estimated to be 560 pCi/m^2s (Section F-3). Formulae for calculating the amount of cover needed to reduce the radon flux from a source to a given level have been used to estimate the cover requirements for Alternatives 2 and 3 (Section A.4.6.1). The cover designs are intended to limit the radon flux to less than 20 pCi/m^2s for both Alternatives 2 or 3.

Areas of the Vitro site that are decontaminated under Alternatives 2 or 3 would be backfilled with uncontaminated soil materials and will have radon fluxes in the range of natural radon fluxes.

5.2 IMPACTS ON AIR QUALITY

Alternative 1

The existing Vitro site has an unquantified fugitive emission from blowing dust. This is a variable emission because surface crusting, precipitation and wind velocity produce different effects at different times. The concentrations for total suspended particulates at this location were monitored and are referenced in Section 4.4 as indicators of what would continue with no action. The 1-year TSP monitoring program began in January 1982. The highest 24-hour concentration measured was 184 g/m^3 which occurred on August 16, 1982. For comparison, the 24-hour primary and secondary National Ambient Air Quality Standards are 260 and 150 g/m^3, respectively.

Alternative 2

The air quality impacts during stabilization at the Vitro site would be associated with the earthmoving activities and the equipment utilized in those activities. The diesel-fueled construction equipment used in earthmoving would produce exhaust emissions (based on AP-42; EPA, 1977) of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates that are estimated at 8.1, 2.5, 40.0, 3.1, and 2.0 tons per year, respectively. Ambient air concentrations from these emissions were estimated by scaling the modeling results for particulate emissions resulting in annual concentrations of approximately 20 micrograms per cubic meter (g/m^3) for nitrogen oxides and less than 4 micrograms per cubic meter for the other parameters. Exhaust emissions would have little impact on the air quality off the site, and are probably exempt from air quality permit analyses under Part III of the Utah Air Conservation Regulations.

The greatest emissions will be fugitive dust related to the earthmoving activities. Unmitigated fugitive dust emissions are estimated to be 317.5

tons per year using algorithms currently acceptable to EPA, Region VIII and the Division of Environmental Health, Utah Department of Health (March 1982). Mitigation would reduce this emission load to approximately 258.3 tons per year. Fugitive dust emissions were estimated for material removed via bulldozer, scrapers, graders, and front-end loaders, and transport via scrapers, bulldozers, graders, and haul trucks. The assumptions used in the emissions calculations have included reasonably available control measures such as water spray, in accordance with the Utah Air Conservation Regulations and the 1982 Utah State Implementation Plan.

The impact on air quality was assessed with the atmospheric dispersion model, Industrial Source Complex (ISC) model. Hourly meteorological data from the Salt Lake City National Weather Service for 1980, and emission rates for each earthmoving activity were input to the model to calculate the maximum concentration to be expected under typical conditions. The results presented here were scaled from the modelling runs used for the DEIS. The highest annual average and 24-hour average concentrations off the site are predicted to be 42.5 and 415.5 g/m^3, respectively. These concentrations would occur along the southern boundary of the Vitro site. The predicted fugitive dust impacts decrease rapidly with distance from their source because of particle deposition. The maximum particulate concentrations along the street south of the site are estimated to be 4.3 and 48.6 g/m^3 for the annual and 24-hour averages, respectively.

The maximum predicted concentrations resulting from stabilization and the appropriate National Ambient Air Quality Standards (NAAQS) are shown in Table 5-4. The primary NAAQS were established to protect public health; the secondary NAAQS were established to protect public welfare. The predicted impact of stabilization at the Vitro site would be about 57 percent of the primary annual standard and about 160 percent of the primary 24-hour standard.

Table 5-4. Estimated fugitive dust concentrations and National Ambient Air Quality Standards

	Annual average concentration (g/m^3)	24-hour average concentration (g/m^3)
Maximum predicted Vitro offsite concentration	42.5	415.5
Primary NAAQS[a]	75[b]	260
Secondary NAAQS[a]	60[b]	150

[a]Utah Ambient Air Quality Standards are the same as the National Ambient Air Quality Standards (NAAQS).
[b]Geometric mean.

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Alternative 3

The air quality impacts from either transportation option of Alternative 3 would be temporary and would result from site preparation, tailings removal, and site restoration operations at the Vitro site, the transportation of contaminated materials to the South Clive site, and site preparation and stabilization activities at the South Clive site. The vehicular emissions at the Vitro site and the South Clive site would be from heavy construction equipment performing earthmoving. The construction equipment at the Vitro site and the South Clive site and the haul trucks or trains needed to transport materials between these two sites would have emissions (based on AP-42; EPA, 1977) of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides and particulates that are estimated at 201.59, 33.59, 181.68, 21.81, and 11.02 tons per year, respectively, for the truck option, and 87.14, 51.71, 246.68, 30.35, and 15.70 tons per year, respectively, for the train option. The ambient air concentrations from these emissions were estimated by scaling the modeling results for particulate emissions resulting in annual concentrations of about 46 micrograms per cubic meter for nitrogen oxides and less than 5 micrograms per cubic meter for the other parameters at the Vitro site. The South Clive site would have annual predicted maximum concentrations of approximately 11 micrograms per cubic meter for nitrogen oxides and less than 2 cubic meters for the other parameters. Much of the air pollutants would be dispersed along the haul routes.

Fugitive dust emissions from earthmoving activities at both the Vitro site, the South Clive site, and along the haul routes are estimated to be 313.8 tons per year at the Vitro site, 235.3 tons per year at the South Clive site and 379.5 tons per year along the extent of the haul routes for the train option. The truck option would produce fugitive dust emissions of 448.1 tons per year at the Vitro site, 560.8 tons per year at the Clive site, and 1698.7 tons per year distributed along the haul routes. All of these estimates were produced using algorithms currently acceptable to EPA, Region VIII and the Division of Environmental Health, Utah Department of Health (March 1982). The impacts on the air quality at each of the sites were estimated separately with atmospheric dispersion models and input meteorology appropriate for each site. The Industrial Source Complex (ISC) model was used with 1980 Salt Lake City National Weather Service data to calculate the maximum concentrations expected at the Vitro site; the VALLEY model was used with Dugway Proving Ground meteorological data for 1957 to calculate the maximum concentrations expected at the South Clive site. In each case, emission estimates for each earthmoving acitivity were input to the appropriate dispersion models. Results presented below were scaled from DEIS model runs. Dispersion models were not used for prediction of impacts along the haul routes. The emission would be widely distributed and would not be expected to have significant impacts.

The maximum predicted annual and 24-hour off-site concentrations of particulate matter at the Vitro site are 43.8 and 313.1 g/m^3, respectively, for the train option. Similar concentrations predicted for the truck option are 62.5 and 447.2 g/m^3, respectively. These concentrations would be expected to occur along the southern boundary of the site. Because of

particle deposition, the train option concentrations would decrease to 3.3 and 36.6 g/m^3, respectively, at 0.5 km from the southern site boundary. Similarly, the truck option concentrations would decrease to 4.7 and 52.3 g/m^3, respectively, at 0.5 km from the southern site boundary. This distance is the location of the closest street to the site.

The maximum predicted annual and 24-hour concentrations of particulate matter off the site, due to the South Clive activities, are 48.5 and 241.3 g/m^3, respectively for the train option. Similar concentrations predicted for the truck option are 115.9 and 574.7 g/m^3, respectively. These concentrations would be expected to occur approximately 0.4 km north of the northern site boundary. The nearest human activity is about 6 km north of the site, the approximate location of the Interstate Highway 80. At 6 km, the annual and 24-hour particulate concentrations are predicted to be 1.4 and 16.1 g/m^3, respectively, for the train option and 3.4 and 38.4 g/m^3, respectively, for the truck option, based on the modeling results.

The estimated impacts of the fugitive emissions on the air quality with stabilization south of Clive are summarized in Table 5-5. The Utah and National Ambient Air Quality Standards are also presented for comparison. The maximum predicted impact at the Vitro site would be about 58 and 120 percent of the Federal primary annual and 24-hour standards, respectively, for the train option, and 83 and 172 percent of the same standards, respectively, for the truck option. The maximum predicted impact at the South Clive site would be about 65 and 92 percent of the Federal primary annual and 24-hour standards, respectively, for the train option, and 154 and 221 percent of the same standards, respectively, for the truck option.

Table 5-5. Fugitive dust impacts, Alternative 3

	Train option	Truck option
Average annual TSP (tons/yr)		
Total	928.8	2720.1
Vitro site	313.8	448.1
Clive site	235.3	560.8
Haul routes	379.5	1698.7
Annual concentration (g/m^3)		
Vitro site	43.8	62.5
Clive site	48.5	115.9
24-hour concentrations (g/m^3)		
Vitro site	313.1	447.2
Clive site	241.3	574.7

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Table 5-5. (continued)

		Train option	Truck option
Primary NAAQS[a]	Annual[b]/24-hr	75[b]/260	
Secondary NAAQS[a]	Annual[b]/24-hr	60[b]/150	

[a]Utah Ambient Air Quality Standards are the same as the National Ambient Air Quality Standards (NAAQS).
[b]Geometric mean.

5.3 IMPACTS ON TOPOGRAPHY, SOILS, AND MINERAL RESOURCES

5.3.1 Impact on topography

The no-action alternative would not alter the topography of either the Vitro site or the South Clive site.

Alternative 2 would affect only the Vitro site. A flat-topped mound, 50 feet high, with sideslopes of 1 vertical to 5 horizontal, would be formed on a 53-acre area occupying the southcentral and southeast portion of the site. The remainder of the tract would be recontoured to the natural elevation of the surrounding terrain (approximately 4235 feet above mean sea level) and revegetated.

Alternative 3 would affect both the Vitro site and the South Clive site. At the Vitro site, the entire 128-acre tract now containing the tailings would be recontoured to the natural elevation of the surrounding terrain. At the South Clive site, approximately 55 acres of the presently flat terrain would be occupied by a flat-topped mound, approximately 34 feet high, with sideslopes of 1 vertical to 5 horizontal.

5.3.2 Impacts on soils

No soils would be affected by the no-action alternative. In both Alternatives 2 and 3, however, soils imported from commercial sources would be used for either backfill, liner, and/or cover at the Vitro site. The estimated amounts of materials to be imported are given in Table 5-6.

Table 5-6. Materials that must be imported to Vitro site

Work or material	Quantity (cubic yds)	
	Alternative 2	Alternative 3
Seepage control lining		
(a) Subbase	220,000	---
(b) Base	300,000	---
(c) Liner	190,000	---
Restoration grading	710,000	1,040,000
Cover-radon and erosion barriers	445,000	---
Total	1,865,000	1,040,000

In Alternative 3, soils removed from the South Clive excavation would be reused in the construction of the reclamation cover. In addition, about 244,000 cubic yards of gravel or quarried bedrock would be needed for the erosion barrier, access roads, and drainage ditches at the South Clive disposal area; this material is available in the Cedar Mountains to the east of the site, and could probably be obtained from commercial sources.

5.3.3 Impacts on mineral resources

The no-action alternative would not affect mineral resources. Neither Alternative 2 nor 3 would affect the negligible mineral resources of the South Clive site (see Section 4.5.3). However, both of the action alternatives would result in the setting apart, under the control of the Federal government, the residual mineral values of the uranium mill tailings presently on the Vitro site. The potential mineral products that would be lost at either the Vitro site (Alternative 2) or the South Clive site (Alternative 3) are estimated below (DOE, 1982).

Product	Total lbs
U_3O_8	659,452
V_2O_5	4,198,565
Mo	762,458

5.3.4 Longevity of conceptual designs against wind erosion, water erosion, and earthquakes

In addition to radon flux standards, the EPA standards also have a longevity requirement: that there be a reasonable expectation that the disposal configurations adopted for the remedial action meet the standards for up to 1000 years, to the extent reasonably achievable, and in any case for at least 200 years. The assessesment of the longevity of the disposal configurations used in Alternatives 2 and 3 are discussed in the following subsections.

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Alternative 2

The disposal configuration in Alternative 2 would include a 4- to 5-foot cover composed as follows: 1 foot (2 feet on the side slopes) of pit run rock, underlain by 3 feet of silty soils. The presence of the pit run rock layer would protect the stabilized pile indefinitely against wind and water erosion.

The disposal configuration at the Vitro site would also be subject to the long-term effects of flooding and earthquakes. One possible design criterion for flood protection is the Probable Maximum Flood (NRC, 1977). Design criteria for long-term protection against earthquakes that pertain to earthwork structures such as these are discussed in terms of allowable safety factors in Section A.3.2.2 of Appendix A, and Appendix H.

In Appendix A, Section A.3.2.2, it is shown that the Probable Maximum Flood (PMF) of the Jordan River would inundate the Vitro site area to depths of up to 10 feet. During the passage of the PMF peak, a duration of about 40 hours, water velocities near the embankment would be between 4 and 5 feet per second. Six-inch mean diameter pit run rock on the pile side slopes could withstand flood velocities of 14 feet per second. The Vitro site disposal configuration would, therefore, not be damaged by the PMF.

A seismic evaluation of the embankment at the Vitro site has been performed (SH&B, 1983; and Appendix H). Seismically induced liquefaction of the subsurface sandy materials could occur in the event of a Maximum Credible Earthquake (MCE). However, during construction the embankment materials will be dewatered, mixed, and recompacted and thus will not be susceptible to liquefaction. Minor cracking (a few inches) of the cover could occur if the foundation soils liquify. Minor cracking could also result from earthquake-induced ground motions of lesser intensity, occurring every 50 to 400 years. Cracking of the cover would only require minor repair.

Alternative 3

The disposal configuration at the South Clive site in Alternative 3 includes a cover that would be composed of a 5-foot layer of compacted natural soils protected by a 2-foot surficial layer of pit run rock. The presence of the coarse granular layer would protect the stabilized pile indefinitely against wind and water erosion.

The disposal configuration at the South Clive site would also be subject to the long-term effects of flooding and earthquakes. One possible design criterion for flood protection is the Probable Maximum Flood (NRC, 1977). Design criteria for long-term protection against earthquakes that pertain to earthwork structures such as these are discussed in terms of allowable safety factors in Section A.6.2.2 of Appendix A, and Appendix H.

The Probable Maximum Flood (PMF) that would impact the South Clive site would be the result of a 6-hour, 9.7-inch rainfall (PMP) on the 46-square-mile

drainage area east of the site. It would have a peak flow of about 83,000 cfs and reach depths of up to 5.5 feet deep in the ditch surrounding the embankment. The correlating velocities are 2.0 fps with a peak of 10 fps at the embankment toe. The 5-inch mean diameter pit run rock covering the side slopes can withstand these velocities. Thus, the South Clive embankment would not be damaged by the PMF.

The seismic evaluation performed for the South Clive site (Appendix H) indicates that the chance of seismically induced liquefaction in the site subsoils is remote. First, the ground water is about 20-30 feet below the surface and is below several layers of unsaturated silty sand. Second, these sand layers are of medium to high densities. These factors, combined with the relatively large static overburden pressures applied to the saturated soils layers, indicate that significant liquefaction due to an MCE event is improbable and only minor cracking would occur. Most of these cracks would be self-healing and result in only minor cover repairs.

5.4 IMPACTS ON WATER

5.4.1 Impacts on surface waters

The no-action alternative would have no effect on present quantities or uses of the surface-water systems associated with the Vitro site or the transportation corridor. There are no perennial surface-water systems associated with the South Clive site.

Under the no-action alternative, surface runoff from the Vitro site might reach the two on-site ditches (the Vitro Waste Ditch and the South Vitro Ditch) and cause temporary water-quality degradation. The topography of the existing site is such that surface runoff does not reach these ditches except in heavy rains. The effects of a PMF at the unstabilized Vitro site on the quality of local surface waters are unknown; but the radiological effects would be miniscule in comparison with other effects of the flood such as damage of property and loss of life.

Under either Alternatives 2 or 3, waste waters generated by dewatering activities at the Vitro site would either be discharged to Mill Creek (after treatment) if radiological and chemical analyses indicate they meet the discharge-permit standards, or they would be stored in temporary evaporation ponds on the site. Both procedures would operate under National Pollutant Discharge Elimination System (NPDES) permits. Further water-quality protection would be provided by the installation of dikes around evaporation ponds and wet areas being excavated.

Neither Alternatives 2 or 3 would have any effect on surface-water quantities at either the South Clive site or the Vitro site. At either site, the water necessary for construction would be provided by on-site wells or existing wells in the vicinity, impounded water, or from the South Salt Lake community system. Alternative 2 would have long-term beneficial impacts on surface-water conditions at the Vitro site. The stabilized mound with its cover would inhibit rain from percolating into the tailings. Improved site

drainage would also reduce sediment and contaminant loading to the Vitro ditches. Alternative 3 would eliminate the possibility for future contamination of surface water at the Vitro site.

Neither Alternative 2 nor Alternative 3 would have any predictable effects on the quantity or quality of surface waters along the transportation corridors. Some contamination of the Great Salt Lake would be possible if a transportation accident occurred in which one of the unit trains or trucks were overturned at a point where the railroad bed/I-80 is adjacent to the lake, but such an accident would be highly improbable (see Section 5.1.5).

The waste waters generated by construction activities at the Vitro site in Alternative 3 would be handled in the same way as Alternative 2. The amount of waste water to be handled would be larger in Alternative 3 because of the need to wash down the unit trains or trucks that leave the construction site. The amount of dewatering would be minimized, as much as practicable, by construction practices and schedules; it is estimated that 150 gallons per minute of discharge from dewatering may have to be handled for brief periods of time. Train wash-down would require about 2,000 gallons of water each working day, this wash-down water would be obtained from on-site wells. However, because this water would be recycled only 600 gallons per day would be required for make-up. Truck wash-down would require several times as much water; about 2,300 gallons per day would be required for make-up.

Dewatering requirements at the South Clive site in Alternative 3 would be minimal because the bottom of the excavation would be at least 15 feet above the ground-water table. Train or truck wash-down water requirements at the South Clive site would be the same as those for the Vitro site in Alternative 3.

5.4.2 Impacts on ground waters

Alternative 1

The no-action alternative would have no effect on ground-water systems along the transportation corridors or at the South Clive site.

Under the no-action alternative, the potential for degradation of ground-water quality at depth beneath the Vitro site would continue to exist. This potential is, however, limited due to the hydrogeologic setting. As discussed in Section 4.6.2, the Vitro site is located within an area of regional ground-water discharge. The upward gradient and migration of ground water precludes the downward migration of leachate and associated contaminants from the uranium mill tailings. The upward gradient and direction of ground-water flow could be reversed, however, as a result of increased pumping and ground-water withdrawals in the vicinity of the Vitro site.

In the no-action alternative there would also be a potential for lateral migration of leachate and associated contaminants within the shallow ground-water system beneath the site. Data for the Vitro site indicate that the ground water within the shallow system directly beneath the site is contaminated. Because of the low gradients, low hydraulic conductivity, and

sorption of contaminants on soil particles, the rates of lateral contaminant migration within the upper flow system would be very small, that is, only a few feet per year.

Alternative 2

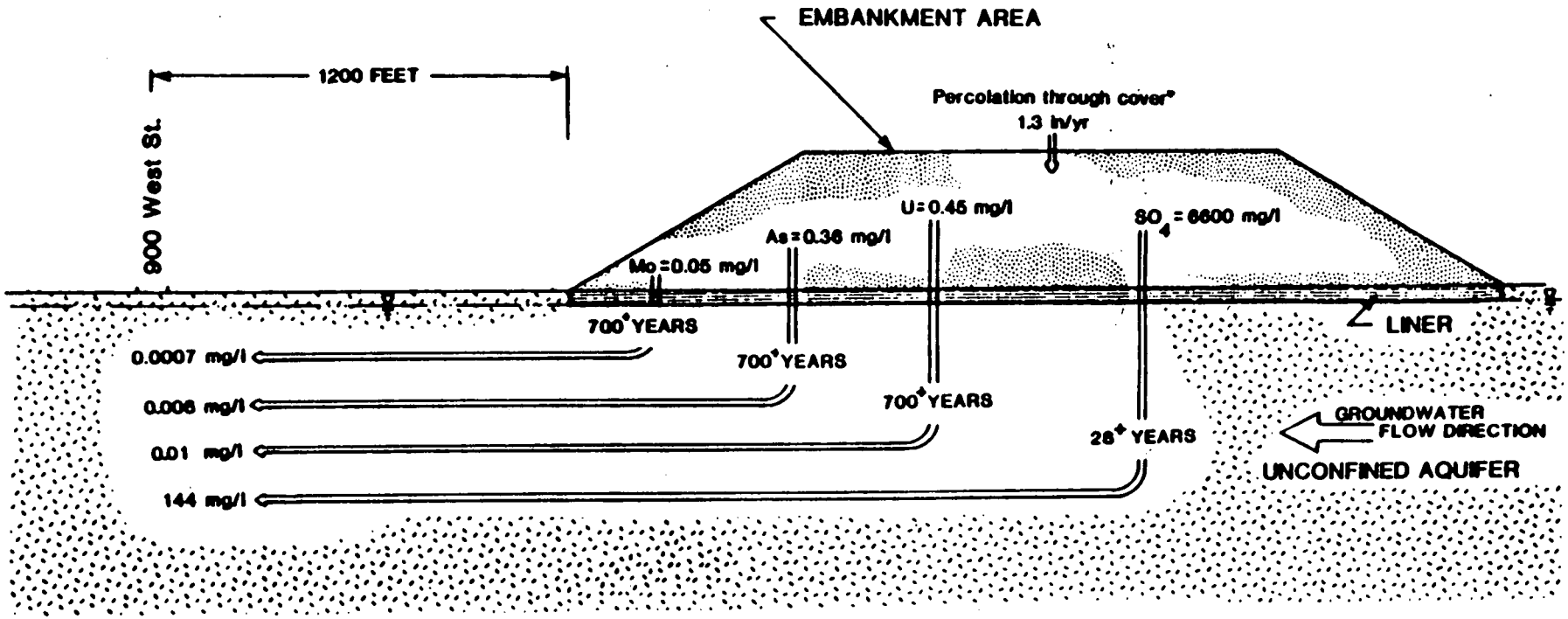
Under Alternative 2, there would be a limited potential for the degradation of water quality in the confined aquifer system in the vicinity of the Vitro site. At present, the vertical hydraulic gradient in the area is upward from the confined system to the unconfined system, effectively precluding the downward migration of contaminants. The vertical hydraulic gradient can be reversed by heavy pumping in the vicinity of the Vitro site, as evidenced by relic contamination of the confined aquifer probably associated with pumping of process water at the former Vitro mill site, or other heavy pumping of the confined system in the area. This potential contamination would not include the migration of radionuclides and trace metals, which are effectively sorbed in the unconfined system. The lack of minor and trace constituents and radionuclides in the contaminated samples from the confined aquifer suggests that the potential contamination would be limited to high concentrations of total dissolved solids, sulfate, chloride, and other major ions, and would be due in part to the poor background water quality in the unconfined system.

The remedial action would decrease potential trace metal contamination of the ground water to insignificant concentrations. Based upon a worst-case analysis, transport of uranium, molybdenum, and arsenic from the base of the encapsulated tailings to the water table would require a minimum of 700 years. A probable-case analysis resulted in a delay time of 7700 years for these parameters to reach the water table. Once the contaminants entered the unconfined aquifer, downgradient concentrations would be insignificant. Concentrations of uranium, molybdenum, and arsenic are predicted to be 0.01, 0.001, and 0.008 mg/l, respectively, at 900 West Street (Figure 5-2) (see Appendix D).

Alternative 3

Under Alternative 3 there would be a minimal potential for degradation of water quality in the vicinity of the South Clive site. The ground water at the site is already characterized by a briny quality, with levels of many constituents (major ions, metals, total dissolved solids, uranium) exceeding EPA primary or secondary drinking water standards, often by a large amount. The water might be suitable only for some industrial uses without extensive treatment. There are no identified uses of ground water in the near vicinity (3 miles) of the South Clive site. Alternative 3 would also have the beneficial effect of eliminating any possibility of future contamination of ground water at the Vitro site.

The design will minimize the potential for transport of contaminants away from the tailings. The cover will reduce the potential for infiltration, which is already believed to be minimal in the area due to the low incident precipitation and high potential evapotranspiration. Some seepage would be expected to reach the ground water as a result of moisture redistribution



NOTE: ALL CONCENTRATIONS
ARE ABOVE BACKGROUND

FIGURE 5-2
TRACE METAL CONCENTRATIONS
AFTER REMEDIAL-ACTION

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within the tailings. The impact of this seepage on the ground water is expected to be minimal for several reasons:

- The volume of seepage would be expected to be small, and would occur over a long period of time.

- The existing poor quality of the ground water makes it difficult to significantly degrade it.

- The hydraulic head gradient in the ground water is small, limiting the velocity of ground-water movement away from the site to a maximum of 0.6 feet per year.

- In 1000 years the ground water flowing away from the site would move only a fraction (3/100) of the distance to the closest identified well.

Under Alternatives 2 and 3, a relic contaminant plume would persist in the unconfined aquifer downgradient of the Vitro site Appendix D.3.2. This plume would consist of elevated concentrations of total dissolved solids (TDS), sulfate and other major ions, and uranium. The plume would move toward the Jordon River at a velocity of 0.3 to 1.6 feet per day, so that the tail of the plume would reach the river in about 4 to 24 years. Initial concentrations of contaminants would be the same as currently found, decreasing slightly over time, as mixing would take place in the unconfined system. The plume would be greatly diluted as it neared the river, eventually discharging into the river at levels representing only a minor addition to background concentrations.

Aquifer restoration of the relic plume was assessed (see Section D.3.6 for details). Given the boundary conditions and ground-water quality of the unconfined aquifer, the maximum possible volume of contaminated ground water was considered. The cost-benefit calculations were bounded by:

- The treatment rate and required treatment time (3 years at 1000 gpm and 6 years at 500 gpm).

- The time required for the contaminant plume to dissipate naturally (4.4 years to 23.7 years).

- The method of assessing net benefit (net benefit calculated by volume of contaminated and potentially contaminated ground water and net benefit calculated by spatial apportionment).

By using the three sets of bounds, a matrix of eight cost-benefit ratios was calculated. These ratios ranged from 4.1 to infinity. Aquifer restoration does not seem warranted given the high cost-benefit ratios and the absence of ground-water use in the maximum area of the contaminant plume.

Although the likelihood of human health impacts from uncontrolled use of the unconfined acquifer downgradient of the Vitro site is considered very small, DOE will review with NRC and the State of Utah the desirability of mitigation measures to limit the use of this ground water.

5.5 IMPACTS ON ECOSYSTEMS

This section describes the impacts of the three alternatives on vegetation and wildlife. Impacts on soils are described in Section 5.3.2.

The no-action alternative would not affect existing vegetation and wildlife at the Vitro site, the South Clive site, or along the transportation corridors.

Alternative 2 would not affect existing vegetation and wildlife at the South Clive site or along the transportation corridors. At the Vitro site, implementation of Alternative 2 would result in the destruction of existing vegetation and marginal wildlife habitat on the 128-acre site. Since the biological productivity of these disturbed and developed areas is so low, such a loss would not be appreciable. No endangered, threatened, or rare species would be affected by Alternative 2.

At the Vitro site, implementation of Alternative 3 would also result in the loss of vegetation, wildlife, and marginal wildlife habitat that exists on the entire 128-acre site; because present productivity is low, this loss would not be appreciable. Long-term changes in vegetation and wildlife habitat would depend upon the uses made of the 128-acre, decontaminated site by the CVWRF Board; consideration of these changes is not within the scope of this EIS.

At the South Clive site, up to 200 acres of the existing plant community (shadscale-gray molly) and its attendant habitat for wildlife would be destroyed or disturbed. This type of plant community is neither unique nor particularly valuable in any way. None of the flora or fauna in the potentially disturbed area are endangered or threatened. Displacement of individuals during construction at both the South Clive site and the Vitro site could result in a temporary increase in the populations and stress of individuals in the areas surrounding both sites. Road kills of animals near the South Clive site and along the transportation corridors would be minimal. Otherwise, Alternative 3 would not have any predictable effect on existing vegetation and wildlife in or near the transportation corridors.

5.6 IMPACTS ON LAND USE

The impacts on land use that would be associated with the three alternatives under consideration would be both short-term and long-term.

Alternative 1

With the no-action alternative, lands on the Vitro site are expected to continue to be developed by the CVWRF Board according to their short-range plans (Section 4.9 1); the impacts of a no-action alternative on the long-range plans of the CVWRF Board are not predictable. Lands in the site's vicinity would probably continue to be developed for warehousing and industrial purposes. As evidenced by the gradual lifting of the building moratorium imposed during the early 1970s for the area near the site, fears that severe health hazards to workers in the area may be posed by the tailings have partially subsided.

The no-action alternative would not affect land use at the South Clive site or along any transportation corridor.

Alternative 2

Alternative 2 would not affect land use at the South Clive site or along the adjacent transportation corridor; however, as explained below, planned long-term use of the 128-acre Vitro site might be partly constrained by Alternative 2.

Under Alternative 2, some types of land uses may be feasible on portions of the site once stabilization is complete. These uses may include some expansion of the CVWRF sewage-treatment plant now operating in the northcentral portion of the site and industrial and warehouse facilities; however, construction of warehouses, commercial, or industrial facilities, which are common to the area, might not be feasible if there are restrictions on the placement of building foundations near the stabilized mound.

The 53-acre tailings stabilization area (Figure 3-3) would not be suitable for any other use, including the planned expansion of the CVWRF sewage-treatment plant. The area along 3300 South Street that is planned for industrial, commercial, or warehouse lease under the alternative of stabilization south of Clive may not be useable. The northern portion of the Vitro site would be available for expansion of the CVWRF plant, although expansion as currently planned would not be feasible. About 20 acres in the southwest portion of the Vitro site would be available for development. Development in this area could include expansion of the CVWRF plant, leasing for industrial, commercial, or warehouse uses, construction of the waste-recycling facility proposed by the Wasatch Front Regional Council of Governments, construction of the planned municipal ground-water facility, or other uses, depending upon foundation restrictions that may apply.

The long-term impacts of Alternative 2 on CVWRF expansion are not predictable; they would depend upon the CVWRF Board's response to the need for major changes in plans. The short-term impacts on the CVWRF of Alternative 2, the impacts to be realized over the next 5 to 10 years, would occur mainly in the form of lost income from forgone leases on properties in the southern part of the site (the "lease-only" properties shown in Figure 4-7). This loss of potential income is estimated to be $7,840 per year per acre leased. (Appendix I).

It is anticipated that stabilization at the Vitro site would not affect future land uses in the vicinity. The surrounding area is no longer under the building moratorium imposed during the 1970s and development of its vacant lands, primarily for warehouse and wholesaling uses, has resumed. Most vacant and agricultural lands in the vicinity are planned for warehouse, industrial, and commercial uses, the proximity to major rail and road transport routes being ideal for these uses. It is possible that stabilization would encourage more rapid development in the area than would the no-action alternative; companies may be less willing to move to the area if unstabilized tailings continue to be located there.

Alternative 3

Decontamination of the Vitro site and the transport of the tailings from that site to the South Clive site would result in land use impacts at both sites and along the transportation corridors linking them. These impacts would consist of the following:

1. Permanent preemption of about 60 acres of land at the South Clive site for the stabilization area and ancillary facilities. The current uses of the area (sheep grazing and possibly some recreational vehicle and jackrabbit hunting activity) would not be possible within the area preempted by the disposal site.

2. Opening of the entire 128-acre Vitro site for development.

3. Establishing incentives for more rapid warehouse, wholesaling, and industrial development in the vicinity of the Vitro site.

During the 3-year construction phase of Alternative 3, approximately 200 acres of land on the South Clive site, and along the bed of the railroad spur or truck access road leading into it from Clive, would be preempted from current uses. Sheep grazing, hunting, or recreational-vehicle driving would be temporarily prohibited on the lands affected by the construction operations. Following completion of the 3-year construction phase, about 60 acres (55 acres for embankment, 5 for ancillary facilities) of land at the South Clive site would be permanently removed from use by the public, or by the State of Utah as a source of revenue from leases. The loss of lease revenue to the State is estimated to be between $25 and $150 per year per section leased.

Decontamination of the entire 128-acre Vitro site would permit the site to be used for virtually any purpose. The owners of the site, the CVWRF Board, may use most of the site for expansion of the waste-water treatment plant and the area along 3300 South Street may be developed for wholesaling, warehousing, or industrial purposes.

5.7 IMPACTS ON SOUND LEVELS

Alternative 1

The no-action Alternative would not affect ambient sound levels that prevail at the Vitro site, the South Clive site, or in the transportation corridor that connects the two sites.

Alternative 2

In Alternative 2, the major noise impact would be due to the excavation and consolidation of the contaminated material to the 53-acre embankment area, and the preparation, grading, and restoration of the embankment area. The embankment area is in the southeast corner of the Vitro site and is in close proximity to the populated areas to the west and south.

A noise-prediction model (Kessler et al., 1978) was used that considers the number of and maximum noise level from each piece of equipment used at the site, the percentage of time this equipment operates in its noisiest mode, and the distance from the center of site activity to nearby noise-sensitive areas. The noise-level extrapolation model is conservative (i.e., its results are higher than would be realized) as no attenuation for air absorption, berms, or foliage are considered in the model.

For these calculations, all equipment was assumed to be located at the center of the embankment area. This assumption would also cause the computation to overstate the resulting noise levels. Table 5-7 lists the emission and use factors used in these calculations. Equipment use, by phase, is shown in Appendix A, Section A.9.

The distances from the center of the site to noise-sensitive areas to the south and west are 1,060 and 1,700 feet, respectively. These distances have been scaled from FBDU, 1981, Figures 2-1 and 4-1.

Table 5-7. Equipment noise emissions and use factors

Equipment	Use factor	Emission factor (dB @ 50 ft)
D-8 dozer	0.5	88
Front-end loader (cat. 988)	0.5	88
Scraper	0.6	91
Backhoe	0.2	77
Water truck	0.5	89
Haul truck	0.5	86
Compactor	0.1	82
Grader	0.4	88

Source: Kessler et al., 1978

The estimated ambient sound levels during the remedial action are shown in Table 5-8. The background ambient sound levels shown in the table are only approximate, having been estimated and not measured. Section 4.10 discusses the method used to make these estimates.

Table 5-8. Estimated operation ambient sound levels

Residences	Background ambient sound levels L_{dn} (dB)	Operation ambient sound levels L_{dn} (dB)	Change in L_{dn} (dB)
Along 3300 So. St.	65	73	8
To the west	60	69	9

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Ambient sound levels would change by about 8 dB at the residences to the south and by about 9 dB at the residences to the west. The residents of the homes to the west may experience some noise impact during the period of operation. The noise impact for the residents to the south would be minimal. During operation, day-night sound level (L_{dn}) values would approach the EPA's short-term goals of L_{dn} = 70 dB, but since this area is zoned industrial the operation should be in compliance with South Salt Lake's noise ordinance limits of 80 dB during daytime. Construction noise would be minimized during the night.

Alternative 3

Noise emissions projections were estimated using the methodology described under Alternative 2. The inputs for the model were obtained from Appendix A, Section A.9. The results of the noise modelling effort are presented in Table 5-9. This table displays the expected noise emission for each phase of the remedial action, and for each of the two optional transportation methods at the Vitro and South Clive sites. Emission rates 500 feet from the center of the Vitro site range from 76.2 dB to 72.5 dB depending upon the remedial-action phase and transportation option. Emission rates 500 feet from the center of the South Clive site range from 78.3 dB to 73.8 dB depending on the remedial-action phase and transportation option.

Table 5-9. Alternative 3 noise emission projections (dB @ 500 feet)

Construction phase	Vitro site (train option)	Vitro site (truck option)	South Clive site (train option)	South Clive site (truck option)
Site preparation	75.9	72.5	76.1	74.7
Tailings relocation	76.2	75.0	na	na
Embankment construction	na	na	78.3	73.8
Site restoration	74.1	74.1	na	na

na = not applicable

The estimated operational day-night sound level (L_{dn}) at homes to the south and west of the Vitro site are 69.8 dB and 65.4 dB, respectively. This would result in an L_{dn} change of 5 dB, at each residential area. Thus, the noise impact on residents living in the homes near the Vitro site for this alternative would approximately be the same as the impact of Alternative 2. Day-night sound levels would approach the U.S. EPA's short-term goals of L_{dn} = 70 dB during operation, but since this is an industrial zone, South Salt Lake's noise-ordinance limits of 80 dB for daytime activity should be met. Construction noise would be minimized during the night.

Railroad operations or highway operations will not significantly add to present rail or highway traffic noise. Very little change in ambient day-night sound levels will result. If, for example, the railroad and highway traffic doubles (a very remote possibility), the ambient sound can expect to increase by about 3 dB. This change will not be significant. In addition, very few people reside along this route. Thus, little noise impact is anticipated.

The noise emissions projections for the South Clive site are also shown in Table 5-9. No noise impacts would be expected from the remedial action since very few people reside in the area of the proposed site and there are no noise-sensitive land uses within 15 miles of the site. Noise attenuation would be expected to reduce the maximum South Clive emission to below the background level of 35 dB within 7000 feet of the source.

5.8 IMPACTS ON SCENIC, HISTORICAL, AND CULTURAL RESOURCES

The impacts of the alternatives on scenic, historical, and cultural resources are not expected to be significant.

There are no historical or cultural resources of significance at either the Vitro site or the South Clive site, or along the transportation corridors. Hence, none of the 3 alternatives would affect historical or cultural resources. Other scenic values would be changed by the 3 alternatives; these changes are discussed below.

Alternative 1 would not affect scenic values at the South Clive site or in the transportation corridors, but minor changes in scenic values at the Vitro site could occur with development of the site by the CVWRF Board.

Alternative 2 would not affect scenic values at the South Clive site or in the transportation corridors. This alternative would change the visual character of the Vitro site. Long-term changes in the topography of the site are described in Section 5.3.1. During the remedial action, the direct visual impact at the Vitro site would result from site preparation and grading, erection of a security fence, and the piling and covering of tailings in the southeastern portion of the site. During the construction period, the increased activity at the site and related traffic would be visually obvious to nearby travellers and residents. Once stabilization is complete, the tailings piles (approximately 50 feet in height) and a security fence would be visible from nearby areas. These visual elements would be similar to the present appearance of the site.

The visual impacts at the Vitro site during the construction phase of Alternative 3 would be similar to those described for Alternative 2. With Alternative 3, visual impacts at the South Clive site would result from construction and stabilization activities and the continued presence of the tailings at the site. Construction of the rail spur or truck-access roads, and tailings disposal area would cause increased activity in the area which would be visible to travellers on I-80 and persons working in or touring the area. The tailings piles, the security fencing and the access roads would remain visible once stabilization is complete. Their appearances would contrast somewhat with the surroundings, which show little evidence of

human activity except for the existing rail line north of the site and south of I-80. However, the impact would be small because (1) most of the facilities would be about 2 miles from I-80, the nearest common vantage point, and would be seen by most viewers only at a distance, and (2) because the area is not visually attractive. As described in Section 4.11.2, a scenic-quality rating of 12 was assigned to the South Clive site, indicating no special management attention regarding visual resources is required.

5.9 IMPACTS ON POPULATIONS AND EMPLOYMENT

Alternative 1

Populations and employment trends described in Section 4.12.1 would be unaffected by the no-action alternative.

Alternative 2

Alternative 2 would not measurably affect populations and employment in Tooele County, the county in which the South Clive site is located. The impact of this alternative in Salt Lake County is described below.

Manpower requirements for Alternative 2 are shown in Table A-4 of Appendix A. Direct employment generated by the project would average 82 jobs during construction and stabilization while peak employment is estimated at 104 jobs. This level of employment represents less than 0.1 percent of the total Salt Lake County employment.

To the extent that purchases of construction materials and equipment (sand and gravel and heavy machinery) would cause supplying firms to increase employment, additional indirect employment effects would be realized. These effects would be small, since the materials and equipment requirements of the project would be relatively small. Additional service-sector employment caused by the respending of workers' wages (the "multiplier effect" described in Section 4.12.2) would also be small due to the low level of project employment. Assuming a regional multiplier of 2.5 (or 1.5 service sector jobs supported by every job created in the basic sector), 123 jobs would be supported in the service sectors of the local economy during construction.

Thus, a maximum of about 215 jobs could result from the project in the Salt Lake metropolitan area economy (assuming that 10 jobs are created by purchase of construction materials and machinery). This level of employment is less than 0.1 percent of the total employment in Salt Lake County of 273,848 during the second quarter of 1982 (Utah Department of Employment Security, 1982).

Based on the following considerations, inmigration in response to employment opportunities created during construction is assumed to be zero.

- Unemployment in Salt Lake County is currently 7.5 percent (State of Utah, Job Service, May 1983).

- Unemployment among heavy equipment operators in the Salt Lake City area is currently 20 to 25 percent (State of Utah, Job Service, June 1983).

- Unemployment among truck drivers in the Salt Lake City area is currently 10 to 15 percent (State of Utah, Job Service, June 1983).

- Skilled construction workers from as far away as Provo and Ogden are willing to commute to the Salt Lake City area to take advantage of employment opportunities (State of Utah, Job Service, June 1983).

Alternative 3

Alternative 3 would affect populations and employment in Tooele County and in Salt Lake City. The impacts on populations and employment in both districts are described below.

Manpower requirements for Alternative 3 are shown in Tables A-7 and A-8 in Appendix A. Direct employment generated by the project at both sites would average 85 jobs for the rail transport option and 135 jobs for the truck transport option. Peak employment under rail transport and truck transport would be 130 jobs and 153 jobs, respectively. This level of employment would represent a maximum addition to Salt Lake County's total current employment of under 0.1 percent. Assuming that a maximum of one-half of the construction jobs are created in Tooele County, they would represent an addition of under 1.0 percent to Tooele County employment.

In addition, the CVWRF has stated that it will develop a temporary industrial park on the 3300 South Street portion of the Vitro site if Alternative 3 is the adopted remedial action. Based on this assertion, it is estimated that operation of the temporary industrial park will create 271 direct jobs and 434 indirect jobs in the regional economy (see Appendix H). This corresponds to less than 0.3 percent of total employment in Salt Lake County as of the second quarter of 1982 (273,848; Utah Department of Employment Security, 1982).

Stabilization south of Clive might also add employment in supplying firms due to purchase of construction materials, supplies, and machinery (such as heavy equipment, trucks, and rail cars). This effect would be short-term and small. The respending of project workers' wages would also increase employment in other economic sectors due to the "employment multiplier" process described in Section 4.12.2. If an average employment multiplier of 2.2 is realized in the Salt Lake and Tooele County economies, a maximum of 102 to 162 service-sector jobs would be supported (by basic sector employment) in the region in response to the respending of wages by 85 to 135 project employees. (The ranges reflect the different manpower requirements associated with the transportation options.)

6.16 MAINTENANCE AND MONITORING

A number of statements (3 written and 2 oral) thought the discussion inadequate regarding maintenance of the final disposal site after remedial action and monitoring of effluents both during and after remedial action. The issues are summarized below, followed by the DOE's responses to them.

1. Comment.
There is not enough discussion of these matters in the DEIS. Surely some maintenance will be needed after the work is done, even with the best designed plans. And even more certainly, the work sites will have to be monitored during the remedial action, to assure the safety of the workers and of residents, and after the remedial action to check on the performance of the design and to be able to take further action if required. The DEIS makes no firm commitments in these matters. (6, 18, 202, 203, 215)

"Active surveillance and monitoring will have to continue indefinitely if it is left in the heart of the Salt Lake Valley." (202)

Response.
The DOE agrees that maintenance and monitoring will be necessary, regardless of the alternative. Details of the plans for these activities are available in the UMTRA Project Environmental Health and Safety Plan, the Project Licensing Plan, and the Remedial Action Plan. These documents will be subject to review and approval by the NRC and the state and will be available to the public at the reading rooms and libraries listed at the beginning of Section 6.21.

The program under consideration for doing the remedial action includes both environmental and occupational monitoring with systems designed to detect the low levels of radioactivity that may be transported by air or water.

The long-term surveillance and monitoring program will be designed to assure that the final site remains undisturbed and continues to function as designed. The surveillance will consist of periodic walkovers with an emphasis on examining erosion protection features, cover and fence integrity, and other engineered features such as diversion channels and vegetation. Ground water may also be sampled. Maintenance will be needed.

2. Comment.
The level of maintenance and monitoring required will surely be greater if stabilization on site is chosen rather than removal of the tailings to the South Clive site.

Response.
The DOE agrees, insofar as maintenance and monitoring after completion of the remedial action is concerned. However, the degree of monitoring required during the remedial action will be greater if the tailings are

moved than if they remain in place. The Vitro site will have to be monitored under either alternative; the South Clive site and the transportation route will have to be monitored only if the tailings are moved.

6.17 MITIGATION MEASURES

Several statements (5 written and 7 oral) commented on possible mitigation measures. These comments are summarized below together with the DOE's responses to them.

1. Comment.
Several commenters suggested ways to make moving the tailings to South Clive more palatable.

   - Tooele citizens suggested that if the tailings are moved, Utah licensed contractors should be given a 5 percent preferential treatment in all bidding procedures; Tooele County contractors should be given an additional 5 percent incentive. The Federal Government should pay Tooele County for the use of its land; payment might be in lieu of taxes. Payment should be at the rate assessed for chemical plant locations and should be distributed to the local governments which represent the citizens of Tooele County. (7, 205)

   - A Tooele resident said, "give us the property in there ((Vitro)) ... in exchange for this property out here ((South Clive))." (9)

   - Another Tooele resident said that profits would be made from relocating the tailings and that half of these profits should go to Tooele. (12)

   - Also, Tooele should be given a written guarantee to protect the county against any possible, unexpected effects and a guarantee that no other waste material would be placed in Tooele County. (12)

   Response.
   Although the DOE recognizes the concerns of the commenters, the DOE has no plans for preferential treatment of contractors, compensation of Tooele County for use of its land, distribution of Federal payments for land, or for provisions of guarantees.

2. Comment.
Several commentors suggested ways to make stabilization in place more palatable.

   - Comment a
     The mayor of South Salt Lake said that stabilization in place is "out of the question unless the DOE is willing to compensate the City, School District, County, and State for the loss of potential revenue and community economic strength should the area have been allowed to develop." (17, 109)

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- Response a
  This subissue is beyond the scope of this EIS. See the response to Issue 1.

- Comment b
  A private citizen asked if anything could be done to compensate for the CVWRF's loss of land. (2)

- Response b
  The CVWRF Board would of course be compensated for any land used in the implementation of Alternative 2. The amount and manner of compensation would be determined outside of the NEPA process.

- Comment c
  He also suggested that warning monuments be placed about the site. Appropriate warnings would include the following: no irrigation within the area; radon barriers beneath all buildings; elevated air intakes for building ventilation; reburial of all excavated tailings; containment of all water lines. (2)

- Response c
  Some types of warning monuments would probably be required by the NRC as a condition of granting a license to maintain and monitor a uranium mill tailings disposal site. The DOE believes that advocating "radon barriers beneath all buildings" and "elevated air intakes for building ventilation" will not be needed.

- Comment d
  Another citizen implied that people in the Vitro area must absorb higher health care insurance rates. (36)

- Response d
  This citizen seems to imply that people or businesses located relatively near the site have higher health-insurance bills than their counterparts who are located well away from the site. No evidence of a difference in insurance rates was supplied by the commenter, so no further response is possible. In any case, cleanup of the site and stabilization of the tailings will eliminate the conditions that insurance companies might cite as justification for charging higher rates to policyholders located near the tailings pile.

3. Comment.
   In reference to page 33 of the DEIS, the EPA suggested a way to minimize the chances of erosion of a stabilized pile by appropriately choosing and maintaining a vegetative cover. The plant species must be chosen so that the integrity of the cover material is not breached by deep-rooted plants. The material over the clay cap should be thick enough to preclude a saturated zone over the clay, creating a zone that would encourage deep-rooted species. To maintain a healthy plant community, it should be periodically cropped or grazed. Temporary runoff and sediment-control measures may be needed for a few years until adequate plant cover is established. (204)

Response.
Subsection 3.2.3.5 of the DEIS mentions the possibility of establishing self-sustaining vegetation on the cover of the stabilized tailings in Alternative 2. The cover design for Alternative 2 has been revised in this FEIS.

4. Comment.
Several comments discussed minimizing the possibility of adverse health effects or accidental exposures.

- Comment a
  The mitigating measures during remedial actions (Section 5.19) are important for reducing the radiation exposure of construction workers and the public and should be fully implemented. (215)

- Response a
  Agreed.

- Comment b
  When the tailings are being transported by rail, the cars should be sealed; they should be washed down afterwards. Average train speeds of less than 10 miles per hour would reduce the chance of an accident that might release the tailings. Tailings should be moved during hours of least vehicle movement on Interstate 80. (110)

- Response b
  The maximum train speeds for the unit trains proposed in Alternative 3 will be determined by the Denver and Rio Grande Western Railroad or the Union Pacific System. The DOE believes that restrictions on the hours of train operation would serve no purpose and would needlessly prolong the time required to complete Alternative 3.

- Comment c
  "Worker exposures during remedial action can be lessened by the wearing of respirators, frequent relocation to work areas not containing radioactive materials, and other shielding measures. DOE should list what mitigation measures it plans to require for contractors employing remedial workers." (110)

- Response c
  The means for reducing worker exposure that are mentioned by the commenter are reasonable and, if necessary, will be employed during remedial action. The methods to be used to minimize worker exposure during the South Salt Lake portion of the remedial action will be described in the Remedial Action Plan, a document that will be reviewed and concurred in by the state and the NRC.

- Comment d
  A Tooele official suggested that high levels of radon and radon-daughter products in structures over the existing site could be reduced by incorporating greater rates of air exchange within the structures. (6)

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o Response d
There are no structures on the existing 128-acre Vitro site. Increased ventilation as a means of reducing radon and radon-daughter products, has been and may again be used as an option for remedial action on those vicinity properties for which removal of underlying contaminated material would be impractical or excessively expensive.

6.18 ARCHAEOLOGY

Comment.
One man spoke in the hearings saying that the South Clive site is a likely location for archeological artifacts. (22)

Response.
As indicated in Section 4.11.3 of the DEIS and this FEIS, the South Clive site has been surveyed by professional archaeologists. No cultural resource sites were identified but one isolated artifact was found: four pieces of broken purple glass from some unknown historic glass object. Such a find does not indicate the existence on the site of significant archeologic artifacts.

6.19 EDITORIAL COMMENTS

Six written statements included comments which are editorial in nature. These are listed below.

1. Comment.
More effort should be given to explaining concepts and technical jargon. The Glossary and List of Acronyms are helpful, but could be more extensively referenced in the text. (110)

Response.
The DOE has attempted to reduce the use of technical jargon in the introductory chapters of this FEIS (Chapters 1-3). The reader is also urged to consult the Glossary and List of Acronyms for definition of unfamiliar terms.

2. Comment.
On page 110, Table 5-3 is very confusing, mixing backgrounds and the limits from the EPA standards translated to dose. Furthermore, it appears that the proposed, not the final, standards were used for inference. (204)

Response.
Table 5-3, "Background Radiological Levels and EPA Limits," has been revised in this FEIS. Proposed standards were indeed used for inferences in the DEIS since the final standards had not been published by the time the DEIS was ready for printing. The final EPA standards are addressed in Section 3.1.1 of this FEIS.

3. Comment.
On page F-14, in common physics and chemistry parlance, "standard temperature" is 0°C, not 70°F. (204)

Response.
Agreed.

4. Comment.
On pages F-19 to the end, presumably the rest of the monitoring data from the TLD's, etc. will be presented in the final EIS. (204)

Response.
A summary of these data is included in the FEIS.

5. Comment.
On page 74, "may" should be changed to "will" in the statement "The high salinity of the ground water in the South Clive area may limit its use . . ." (209, 214)

Response.
Agreed.

6. Comment.
On page 59, the value for horizontal acceleration at Vitro is 21 percent g; on page 116, the value is 23 percent g. Which is correct? (209, 214)

Response.
The 23 percent g value is correct.

7. Comment.
There are mathematical discrepancies between Tables 1.1, 1.2, and 1.3 for Alternatives 2 and 3. (209)

Response.
These tables have been revised for this FEIS.

8. Comment.
Several commenters pointed out typographical errors.

- On page 22, paragraph 5, line 1, "affect" should be "affects." (204)
- On Page 48, "Dave Finerfrock" should be "Dane Finerfrock." (204)
- On page 59, the figure for horizontal acceleration is 21 percent g or 0.21 g, but cannot be 0.21 percent g, as indicated in the text. (209)
- On page 79, Section 4.8, the second sentence of the introductory paragraph should read: "Radiological dose rates and exposure are presented in millirem/year and microroentgens/hour, respectively." (110)

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- On page 116 reference is made to "Choar, 1969;" the references on page 143 list "Chow, 1969." (110)

- On page F-11, Pb-201 should be Pb-210; on page F-41, 100 m should be 100 μm. (204)

Response.
All of these typographical errors have been corrected in the material that is common to the DEIS and this FEIS.

6.20 OUT-OF-SCOPE COMMENTS

The CEQ regulations governing the preparation of environmental documents such as this FEIS state that "the NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment." In the present instance there is the problem of what should be done about the Vitro tailings. The decision to be made is to choose among the reasonable alternatives for remedial action. This FEIS is intended to provide the environmental input to that decision, but it will not be the only input; there will also be policy and financial inputs.

However, a number of the comments made orally and in writing on the DEIS are not really relevant to the environmental inputs to that decision. In spite of their not really being relevant to the purpose of this FEIS, the DOE does recognize their existence in the subsections that follow, even though a number have been mentioned earlier. The DOE has attempted a response to some of these out-of-scope comments.

6.20.1 Personal Preferences

Some letters and statements did not discuss any specific issues in the DEIS but expressed the authors' preference for one or another of the alternatives examined in that document. Even those letters and statements that did comment on specific issues usually also stated preferences. These preferences distribute themselves as follows:

Persons and Groups	Alternative 2 In Place	Alternative 3 South Clive	Some other alternative	No preference stated	Totals
Tooele County persons and officials	15	0	2	2	19
Salt Lake Valley persons and officials	2	34	3	1	40
State Officials	0	4	0	2	6
Other area persons	1	1	0	0	2
National agencies	0	1	0	2	3
Totals	18	40	5	7	70

(No one preferred no action.) This summarization lumps letters and oral statements together and removes potential double entries such as the same person speaking twice or giving an oral statement, and also submitting written comments.

Generally speaking, the attitude of the Tooele people was: don't bring it here, but we don't want to wish it on the Salt Lake Valley people either. The "other" entries refer to people who were trying to suggest alternatives that wouldn't require the tailings to remain in the valley. The general attitude of the Salt Lake people was complementary: they didn't want it left in the valley, but they didn't like wishing the problem on Tooele County. They did not as much say, "take it to Tooele" as, "take it away from here."

A few of the letters expressed disapproval of one or another national policy or direction. Things mentioned, inter alia, included the nuclear freeze, the monster of a nuclear age, the MX racetrack, Love Canal, and Times Beach.

6.20.2 Bias

The issue of bias in the Vitro DEIS was raised in 3 letters and 7 oral statements. These comments can be summarized as follows:

- Although it does not explicitly state a preference, the DEIS reflects a bias towards moving the tailings to South Clive and does not present the facts in an objective manner. (2, 4, 6)

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- The document lacks candor concerning the issues and problems associated with the Vitro site and stabilization in place. Its cost figures are loaded by omission of important costs on the one hand and by exaggeration of costs on the other. It appears that the DEIS is attempting to justify stabilization in place. (15, 18, 23, 110, 209, 210)

- The DEIS does not recognize the strength of the personal feelings of the many people affected by the alternatives proposed. (39)

- The DEIS was prepared by people in Denver, Albuquerque, and Washington and therefore does not keep the best interests of the local people in mind. (14, 17, 41)

Response.
The DOE and its contractors have made every effort to be objective in the preparation and writing of the FEIS. Responsible opposing viewpoints have been considered in the analysis and resolutions of comments made on the DEIS. The individuals involved in its preparation are not all nonlocals; the engineering staff who designed the alternatives in the DEIS live in Salt Lake City and work for a firm (Dames & Moore) that has wide experience in the engineering of foundations for buildings in the Salt Lake Valley.

6.20.3 State Standards and Licensing

Three oral statements raised the issue of conformance to state standards in performing remedial actions on the Vitro pile. These comments can be summarized as follows:

- The EPA standards are inadequate, as evidenced by their being less stringent than the state standards in such aspects as acceptable concentrations of heavy metals in ground water. Also, the stabilization in place alternative is equivalent in a number of respects to a sanitary landfill, and there too the local standards are much more stringent than the design for that alternative would imply. In such instances the DOE should conform to local rules and standards. (1, 15, 23)

Response.
The legislation that forms the basis for the DOE's Uranium Mill Tailings Remedial Action program (PL95-604) directs the DOE to take its remedial actions in conformance with regulations promulgated by the EPA and calls for the concurrence of the NRC and consultation with the affected state or Indian tribe. The final EPA regulations call for judgments about measures for the protection of surface and ground water to be made on a case-specific basis guided by relevant state and Federal water quality criteria.

6.20.4 Public Participation

The issue of public participation was raised in 1 letter and 3 oral statements. These comments, without response, may be summarized as follows:

- The public hearings were conducted well and the opportunity for public participation was appreciated. (28, 39, and others)

- How will the DOE respond to public comments? (37, 110)

- "No matter how technically sound a solution may be, people will not accept a decision which is forced upon them without their being consulted." (39)

6.20.5 Private Profit

A number of persons at the hearings in Tooele spoke of the profit that would be made by persons in the Salt Lake Valley after the Vitro tailings are removed and the land is made available for other uses. One said, "give us the land they're going to make millions on," presumably in compensation for having to accept the tailings in Tooele County. (4, 14)

On the other hand, a person working for the Salt Lake County Commission was indignant that these persons should think that the Valley people were "greedily trying to build the tax base." (21)

Response.
These comments reflect a misunderstanding of the economics of what will happen if the tailings are moved to South Clive. The land belongs to a semipublic agency working for the public good, the Central Valley Water Reclamation Facility, and the direct profit will accrue to that agency to be reflected in lower tax rates (or more likely, a slower rate of increase of those rates) imposed on the people it serves. The indirect gain will come from such things as rise in the land values, but will also include a rise in public tax revenues.

6.20.6 Proper Use of Taxpayers' Money

A few people (in 1 written and 4 oral statements) said that money was being wasted on this project. These comments varied from the point of view that the risks do not warrant any action to the point of view that things could be done at a much smaller expense. (4, 22, 34, 53, 105)

Response.
The DOE believes that no action at all is indefensible, not only because the EPA standards would not be met, but also and more importantly because these tailings have been badly misused by having been taken away and used for fill material elsewhere. This lack of control would continue indefinitely if no action were taken.

The suggestions for reduction of cost are discussed above in Section 6.10.

6.20.7 Decision-Making Process

The question of how the final decision would be made was raised in 10 written and 14 oral comments. The comments are summarized below.

- Several commenters felt that cost was being or would be used to justify the stabilization in place option, with health, safety, and environmental considerations being given a lower priority. "Cost should be of secondary importance." Decisions should not be forced upon people. (1, 6, 14, 20, 23, 33, 39, 45, 50, 53, 107, 110, 202, 206, 207) One person stated that DOE "has no authority to use cost as a justification for lesser environmental controls." (110)

- On the other hand, one person wrote that stabilization in place meets the UMTRCA requirements for health, safety, and environmental protection; also the cost of stabilization in place, compared to the cost of relocation and disposal, bears a more reasonable relationship to any potential benefits which may be derived. (104)

- The Governor and others said that the DOE will make the decision, but the state must concur, per the cooperative agreement between the DOE and the State of Utah. The governor said, "the Act anticipates a mutually satisfactory course of action through the implementation of a cooperative agreement. The implicit preference found in the draft EIS does not accomplish a mutually satisfactory resolution of the problem." The mayor of South Salt Lake said, "Should the Governor's and Department of Energy's decision for remedial action differ, the City of South Salt Lake and Salt Lake County will face the prolonged dilemma of no action being taken on a situation that jeopardizes the well-being of the entire community." (17, 109, 209, 213)

- One person spoke of a "recent trend toward downplaying of health risks from dangerous wastes all over the country." (38)

- Another citizen said that economic and social impacts should be studied, as well as environmental impacts. (39)

- Social and economic impacts are addressed throughout this FEIS. The reader is referred to Sections 5.9 through 5.11 and Appendix I.

- A Tooele resident told of a television news report (on March 22, 1983) which said the decision was already made to move the tailings to South Clive. (4)

- Another Tooele resident expressed concern that surveys taken at the public hearings might play a part in the decision-making process. She was concerned lest sheer numbers would be a deciding factor. (13)

- The purpose of the public hearing process is to solicit comments on the DEIS by the interested public as well as concerned agencies. The technical and environmental issues raised as a result of the hearing process are used as part of the decision process.

6.20.8 Manner of Response

The Southwest Research and Information Center (SRIC) of Albuquerque asked the DOE in its preparation of the FEIS to reproduce copies of all comments received on the DEIS in an appendix to the FEIS and to "address each specific comment and label its responses in the order they appear in the text of each commenter's statement." (110)

Response.
Altogether there were 79 oral and written sets of comments, as listed in Tables 6-1 and 6-2. The transcript of comments made orally is slightly over an inch thick and it is not practical to include the transcript in each copy of the FEIS; however, it is available in the numerous libraries and reading rooms listed at the beginning of Section 6.21. That section reproduces all written comments received.

Because of their number and because the same comments occurred repeatedly, the DOE is not responding to each comment separately, but, as this appendix shows, has responded to all comments by grouping together comments on the same subject and answering them collectively.

6.20.9 Other

A few other questions were raised in the public hearings (3 written and 7 oral statements) and are summarized below.

- The Governor said, "DOE is responsible for actual acquisition of the 69 acres ((at the Vitro site if the tailings are to be stabilized in place)). The State of Utah recognizes its responsibility to pay 10 percent of all agreed upon costs, but will not undertake responsibility for actual acquisition of the realty in question." One of his advisors added the phrase, "if stabilization on site is the preferred alternative or final decision made by DOE." (209, 212)

- The Governor and other state and local officials and residents said that the DOE was breaking past promises to move the tailings to a remote site. (21, 38, 48, 107, 209, 211, 212)

- A few people mentioned that Tooele County did not create the tailings problem nor did it receive any economic benefits (e.g., taxes, jobs) from them. The tailings are a Salt Lake problem. (4, 8, 37, 201)

- One woman said, "I have heard this called a Vitro Chemical Company. I want to know if my government stood behind the name of a chemical company and stacked that filthy stuff up for somebody else to clean up. Is that what happened?" She also wondered "why there is a company called Sakrete and a sand and gravel distributor right at the base of the Vitro site distributing things all over the city." (37)

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Table 6-1. Index of Commentors at the DEIS Hearings

Statement index number[a]	Name	Affiliation	Hearing location[b] and page number in transcript
1	James O. Mason, M.D., Dr.P.H.	Utah Department of Health	T 13
2	Dr. Volney Wallace		T 22
3	Milo Higley		T 32
4	Vira Emerick		T 33
5	Y. Stanley Perkes		T 36
6	Joe Urbanik	Tooele County Development Services	T 40
7	Harvey Wright	Tooele City Council	T 48
8	Reed Russell	Tooele County Commission	T 51
9	Margaret Casper		T 54
10	Stanley R. Weyland		T 55
11	Beverly J. White	State Legislator	T 55
12	John Pliny		T 58
13	Bernice Russell		T 64
14	Jerron Atkins		T 66
1	Dr. James O. Mason	Executive Director, Utah Department of Health	S 11
15	Rodney L. Dahl	General Manager, Central Valley Water Reclamation Facility Board	S 20, 39
16	James Weaver	Consulting Economist for the Central Valley Board	S 32
17	James W. Davis	Mayor, South Salt Lake	S 43
18	Dr. Harry L. Gibbons	City-County Health Department	S 51
19	Terry Holtzworth	County Water Department	S 62
20	Wilford Black	State Senator	S 64
21	Scott Brown	Administrative Assistant, Salt Lake County Commission	S 67
22	Robert Church		S 74
23	Bart Barker	Salt Lake County Commission	S 81
24	Richard M. Taggart	South Salt Lake Chamber of Commerce	S 87
25	Michael R. Embley	West Valley City Council	S 90
26	Leslie Warner	Citizens United for Responsible Use of Taxpayers' Money	S 92
27	Zelpha Sweat		S 95
28	Margaret P. Lee		S 98
29	Devan Berrett	Sierra Door Corp.	S 100
30	T. Truman Cope		S 101
31	John Spear	Local 1645, National Transportation Union	S 102
32	Carl S. Anderson, P.E.		S 104
33	Richard W. Wells	Wells Distributing Co.	S 105
34	George L. Gygi	State Legislator	S 107
35	Lester D. Baker, P.E.	Baker Engineers	S 111
36	Linda Cahoon		S 116
37	Mae Thomas		S 119

Table 6-1 (cont.)

Statement index number[a]	Name	Affiliation	Hearing location[b] and page number in transcript	
38	Frances Farley	Ex-State Senator	S	11
39	Gigi Brandt	League of Women Voters	S	16
40	Karl C. Dean		S	19
41	Jack Bratcher	Defenders of the Outdoor Heritage	S	24
42	B. Litzlower		S	25
43	George Bourne		S	29
44	Samuel S. Taylor	State Legislator	S	30
45	Udell Hill		S	33
46	Anthony Fischio	South Salt Lake City Council	S	34
47	Ruth H. Yates		S	36
48	Neff Peterson	Chairman, Central Valley Water Reclamation Facility Board	S	40
49	Edward B. Jackson		S	42
50	George Morrison		S	46
51	Jim Baker	Sierra Club	S	52
52	Sherry Adderly		S	54
53	Norman van Wagoner		S	55

Cross-Index to Table 6-1

52	Adderly	40	Dean	13	Russell, B.
32	Anderson	4	Emerick	8	Russell, R.
14	Atkins	25	Embley	31	Spear
51	Baker, J.	38	Farley	27	Sweat
35	Baker, L.	46	Fischio	24	Taggart
23	Barker	18	Gibbons	44	Taylor
29	Berrett	34	Gygi	37	Thomas
20	Black	3	Higley	6	Urbanik
43	Bourne	45	Hill	53	van Wagoner
39	Brandt	19	Holtzworth	2	Wallace
41	Bratcher	49	Jackson	26	Warner
21	Brown	28	Lee	16	Weaver
36	Cahoon	42	Litzlower	33	Wells
22	Church	1	Mason	10	Weyland
9	Casper	50	Morrison	11	White
30	Cope	5	Perkes	7	Wright
15	Dahl	48	Peterson	47	Yates
17	Davis	12	Pliny		

[a]Number code used in indexing the comments received.
[b]Key to hearing location: T = Tooele, Utah, March 22, 1983;
S = South Salt Lake, Utah, March 23, 1983.

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Table 6-2 Index of Persons Submitting Written Comments

Statement index number[a]	Name	Affiliation	Date of comment
101	Zettie M. Garcia	Citizen, Tooele, Utah	March 17
102	Karl C. Dean	Citizen, Salt Lake City	March 22
103	Custer L. Lynn	Citizen, Tooele, Utah	March 29
104	W. J. Shelley	Kerr-McGee, Oklahoma City	March 29
105	Marilynn W. Gianelo	Citizen, Salt Lake City	March 30
106	Evelyn Richards	Citizen, Park City, UT	April 7
107	Nanette Benowitz	League of Women Voters of Salt Lake	April 8
108	Lester D. Baker, P.E.	Baker Engineers, Ogden, UT	April 8
109	James W. Davis	Mayor, City of S. Salt Lake	April 8
110	Chris Shuey	Southwest Research & Information Center, Albuquerque, NM	April 11
111	Dr. Volney Wallace	Citizen, Tooele, Utah	April 18
201	Charles Stromberg et al.	Tooele County Commission	March 14
202	Harry L. Gibbons, M.D., M.P.H.	Salt Lake City-County Health Department	March 31
203	Bruce Blanchard	U.S. Department of the Interior Washington, DC	April 5
204	Steven J. Durham	U.S. Environmental Protection Agency, Denver, CO	April 6
205	John K. Cluff et al.	Tooele City Mayor and Council	April 6
206	Dan Marriott	Member of Congress Washington, DC	April 7
207	Rodney Dahl	General Manager, Central Valley Water Reclamation Facility	April 8
208	Wayne I. Baer	Salt Lake City-County Board of Health	April 7
209	Scott M. Matheson with 5 enclosures:	Governor of Utah	April 8
210	Nile Eatmon	Div. of Community Development	March 21
211	James O. Mason, M.D., Dr.P.H.	Utah Department of Health	January 19
212	Anonymous	(cost and other estimates)	March 29
213	Fred Nelson	Assistant Attorney General	March 21
214	William R. Lund	Utah Geological and Mineral Survey	March 25
215	John C. Villforth	National Center for Devices and Radiological Health, U.S. Public Health Service	April 22

[a]Number code used in indexing the comments received.

Table 6-3 Cross-Index of Commentors and Issues

Commenters[a]	Issues[b]
1	3.1, 4.1, 5.2, 6.3, 6.5, 8.1, 8.2, 9.3, 9.5, 10.1, 10.2, 10.3, 20.1, 20.3, 20.7
2	9.8, 12.4, 13.4, 17.2, 20.1, 20.2
3	5.3, 11.4, 20.1
4	5.3, 7.3, 9.7, 10.1, 11.2, 20.1, 20.2, 20.5, 20.6, 20.7, 20.9
5	5.4, 8.7, 11.5, 13.5, 14.1, 20.1
6	6.1, 7.1, 7.2, 8.1, 9.1, 9.2, 10.1, 14.2, 14.3, 15.1, 16.1, 17.4, 20.1, 20.2, 20.7
7	13.7, 15.1, 17.1, 20.1
8	11.2, 15.1, 20.1, 20.9
9	17.1, 20.1
10	9.5, 20.1
11	5.3, 7.1, 9.2, 15.1, 20.1
12	5.4, 7.4, 9.5, 13.7, 17.1, 20.1
13	5.3, 11.2, 15.1, 20.1, 20.7
14	7.1, 20.1, 20.2, 20.5, 20.7
15	1.1, 2.3, 6.2, 6.5, 8.2, 9.3, 9.5, 10.1, 10.2, 10.3, 13.1, 20.1, 20.2, 20.3
16	1.1, 1.2, 2.2, 10.1, 10.2, 20.1
17	3.1, 4.1, 10.2, 10.3, 13.2, 13.3, 15.2, 17.2, 20.1, 20.2 20.7
18	2.4, 5.2, 6.1, 6.2, 9.1, 9.4, 9.5, 13.1, 14.2, 16.1, 20.1, 20.2
19	6.1, 6.2, 9.1, 9.5, 20.1
20	8.2, 11.4, 13.2, 14.1, 20.1, 20.7
21	5.2, 10.2, 11.1, 13.3, 15.2, 20.1, 20.5, 20.9
22	9.7, 10.7, 12.5, 14.1, 18.1, 20.1, 20.6
23	1.1, 1.2, 1.3, 6.1, 9.3, 9.5, 10.1, 10.2, 20.1, 20.2, 20.3, 20.7
24	2.2, 9.5, 20.1
25	10.2, 20.1
26	8.8, 20.1
27	11.4, 20.1
28	4.1, 9.5, 20.1, 20.4
29	4.2, 20.1
30	15.2, 20.1
31	14.1, 20.1
32	9.8, 11.5, 20.1
33	11.4, 15.2, 20.1, 20.7
34	4.1, 11.4, 14.1, 20.1, 20.6
35	5.4, 9.5, 10.1, 10.6, 20.1
36	4.1, 11.4, 17.2, 20.1

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Table 6-3 (Cont.)

Commenters[a]	Issues[b]
37	20.1, 20.9
38	5.2, 20.1, 20.7 20.9
39	2.7, 6.1, 6.2, 10.6, 20.1, 20.2, 20.4, 20.7
40	9.8, 11.2, 20.1
41	4.1, 5.3, 20.1, 20.2
42	5.3, 9.8, 20.1
43	11.4, 20.1
44	15.2, 20.1
45	20.1, 20.7
46	10.2, 15.2, 20.1
47	4.1, 5.3, 11.4, 15.2, 20.1
48	4.1, 5.2, 20.1, 20.9
49	11.4, 20.1
50	5.3, 9.7, 14.1, 20.1, 20.7
51	2.1, 6.1, 6.2, 20.1
52	11.4, 14.1, 20.1
53	15.2, 20.1, 20.6, 20.7
101	20.1
102	5.3, 9.8, 11.2, 20.1
103	9.8, 20.1
104	10.5, 11.2, 20.1, 20.7
105	4.1, 6.2, 9.5, 15.2, 20.1, 20.6
106	6.2, 20.1
107	5.2, 6.1, 6.2, 9.5, 10.2, 13.1, 20.1, 20.7, 20.9
108	5.4, 10.1, 10.4, 20.1
109	3.1, 4.1, 10.2, 13.2, 13.3, 15.2, 17.2, 20.1, 20.7
110	1.3, 2.4, 6.1, 6.2, 6.3, 6.4, 7.5, 7.7, 9.2, 9.5, 9.6, 9.9, 10.2, 10.5, 10.8, 11.1, 11.3, 11.5, 12.3, 13.1, 17.4, 19.1, 19.8, 20.1, 20.2, 20.7, 20.8
111	6.2, 9.5, 9.8, 12.4, 13.4, 20.1
201	11.2, 15.1, 20.1, 20.9
202	2.4, 6.1, 6.2, 6.3, 9.1, 9.4, 9.5, 14.2, 16.1, 20.1, 20.7
203	5.3, 5.4, 6.2, 6.3, 16.1, 20.1
204	2.4, 6.1, 6.2, 6.3, 6.5, 8.5, 9.1, 9.4, 9.8, 10.2, 11.3, 11.5, 12.1, 12.2, 13.1, 13.6, 14.3 17.3, 19.2, 19.3, 19.4, 19.8, 20.1
205	10.5, 13.7, 17.1, 20.1

Table 6-3 (Cont.)

Commenters[a]	Issues[b]
206	4.1, 6.2, 6.5, 8.1, 8.2, 9.5, 10.1, 10.2, 10.3, 11.1, I3.3, 20.1, 20.7
207	1.1, 2.4, 6.2, 6.5 8.2 9.5, 10.2, 13.1, 20.1, 20.7
208	9.5, 20.1
209	1.1, 1.2, 2.4, 3.1, 4.1, 5.2, 6.1, 6.2, 6.3, 6.5, 7.1, 8.3, 8.4, 8.5, 8.6, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.8, 10.1, 10.2, 10.3, 11.1, 11.5, 13.1, 13.2, 13.3, 13.7, 14.2, 19.5, 19.6, 19.7, 19.8, 20.1, 20.2, 20.7, 20.9
210	10.2, 10.3, 13.3, 20.1, 20.2
211	3.1, 5.2, 5.4, 6. , 8.2, 9.5, 10.1, 10.2, 10.3, 13.3, 20.1, 20.9
212	1.1, 2.4, 3.1, 5.2, 6.1, 6.2, 6.3, 8.1, 9.1, 9.4, 9.5, 9.6, 9.8, 10.1, 10.2, 10.3, 13.1, 14.2, 20.1, 20.9
213	1.1, 1.3, 3.1, 10.1, 20.7
214	6.4, 6.5, 7.2, 7.6, 8.3, 8.4, 8.5, 8.6, 9.1, 9.2, 9.6, 11.5, 19.5, 19.6,
215	2.4, 11.6, 16.1, 17.4,

[a]Number code used in indexing the comments received; Tables 6-1 and 6-2 show the number code assigned to each commentor.

[b]Issues are identified by the section in which they appear and the order in which they appear in that section. For example, "9.4" refers to the fourth issue in Section 6.9.

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6.21 LETTERS RECEIVED DURING THE COMMENT PERIOD WRITTEN COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR REMEDIAL ACTIONS ON THE VITRO SITE, SOUTH SALT LAKE, UTAH

This section reproduces the written statements submitted on the draft environmental impact statement for remedial actions on the former Vitro Chemical Company site, South Salt Lake, Utah. Copies of all letters are available for public review at the following locations:

Freedom of Information Reading Room
Room 1E-190, Forrestal Building
U. S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Tooele Public Library
47 East Vine
Tooele, UT 84074

Salt Lake County Library
209 East 400 South
Salt Lake City, UT 84411

Salt Lake County Library
2480 South State
Salt Lake City, UT 84115

University of Utah
Library Office
Salt Lake City, UT 84112

Brigham Young University
Harold B. Lee Library
University Hill
Provo, UT 84604

Albuquerque Operations Office
National Atomic Museum
Kirtland Air Force Base East
Albuquerque, NM 87115

Library
Chicago Operations Office
9800 South Cass Avenue
Argonne, IL 60639

Library
Idaho Operations Office
550 Second Street
Idaho Falls, ID 83401

Library
Nevada Operations Office
2753 South Highland Drive
Las Vegas, NV 89114

Library
Oak Ridge Operations Office
Federal Building
Oak Ridge, TN 37830

Library
Richland Operations Office
Federal Building
Richland, WA 99352

Energy Resource Center
1333 Broadway
Oakland, CA 94612

Library
Savannah River Operations Office
Savannah River Plant
Aiken, SC 29801

Regional Energy/Environment Center
Denver Public Library
1357 Broadway
Denver, CO 80210

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REFERENCES FOR CHAPTER 6

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17 March 1983 101

[redacted]

RECEIVED
DOCUMENT CONTROL

24 MAY 1983

Project Manager
Uranium Mill Tailings
Albuquerque, N.M.

20.1 I would like to voice an objection to the moving of poisonous tailing from Salt Lake to Tooele.

When America dropped the first bomb on Japan she slapped herself on the back and boasted "that ended things in a hurry". Now we have learned the hard way that rather than ending things it was really "just the beginning".

In Tooele we are fighting to keep Vitro Tailings our of our back yard. Why? Because no one in Salt Lake or anywhere else in Utah wants the dust, the poison, the radiation and the death they represent.

The truly "hot potatoe" has arrived to haunt us all. The Nuclear age has spawned a monster more terrable than the story of Frankenstein, nothing but poison, death and lies to the people in America.

The stories about Di-Oxen, Love Canal, P.C.B. , Orange Agent all linked to Leaks, spills, blow-ups, tailings and water contamination are just beginning to surface. It is only the beginning of a greater horror.

Congress and some of the "War "Lords" say that we have to protect ourselves from a Nuclear Build-up from Russia. Ask the people in Pocatello, Idaho this morning if its Russia they are afraid of on March 27, 1983. They can tell you the horror they are facing this moment is not in Russia, but in their drinking faucetts. The people in St.George, Utah can tell you that their nightmares all are burried in the cemeteries.

To clean up all the tailings, pits and leaks has been estimated at from ten billion to 40 billions of dollars.

Twenty years down the road with the present policy where is the cost going to stand?

America and its people need to get behind a "NUCLEAR FREEZE. To worry about tailings and the problems sure to come is a case of "Locking the Barn door after the horse has been stolen.

DONT PARK IT AMERICA .....STOP IT.....FREEZE THE NUCLEAR BUILD-UP

Sincerely
Zettie M. Garcia
Zettie M. Garcia

Ref: Tailing meeting in Tooele, Utah
to be held 22 March 1983

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[redacted]

22 March 1983

Mr. James A. Morley
Project Manager
Uranium Mill Tailings Project Office
U. S. Dept. of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Morley:

Lack of time has precluded a detailed study of the Draft Environmental Impact Statement entitled, "REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE SOUTH SALT LAKE, SALT LAKE COUNTY, UTAH" and presentation of remarks at the public hearing on March 23. Nevertheless, a limited perusal of the document coupled with prior knowledge of reclamation efforts on Vitro, Durango, Grand Junction, Monticello, Rifle, Uravan and Tuba City waste accumulations prompts the following comments.

(1) Table 3.1 in the EIS indicates that according to the EPA remedial action is required if the EGR is greater than 0.02 mR/hr above background in dwellings; which, I assume, signifies almost constant contact. On page 80, 3rd para., it states that EGR levels range from 0.1 to 1.2 mR/hr on the pile, thru 45 microroentgen at .1 mile from the edge of the pile to background levels at .6 mile from the pile. Thus, indicating that limited intermittent contact with the pile would not present a major health hazard and would still permit usage of the land for many purposes, even including that of installation of the new sewage plant directly on the pile without any reclamation taking place.

14.2 Likewise, Table 1-3 indicates that the population within 6 miles of the pile might sustain excess lung cancer deaths of 0.24/year if no action is taken and on page 16, 2nd para., other calculations indicate the potential to increase to 0.7 to 0.8 total cancers. Hence, in that the tailing has been there a minimum of 19 years there should have arisen a minimum new cancer deaths of (19 X .24= 4.56 or 19 X .75= 14.25) yet to my knowledge none can be directly attributable to the tailing. On the same page, para 1, it states- "Because about 44 lung cancers occur each year in that area (NEM, 1968), an increase of 1 cancer would be impossible to demonstrate conclusively". Studies on the incidence of lung cancer at mine faces, when correlated with smokers or non-smokers, indicates that smoking is a much greater problem than radon emissions. Perhaps, some of the money being proposed for translocation of the tailing could be better spent in educating smokers that live within the affected area.

20.1 (2) Despite the above I do not recommend inaction on the waste pile but have some suggestions for implementation with alternatives 1 and 2 though, I unhesitatingly, support the alternative 2 concept of stabilization.

000125

A. Test drilling now underway may definitely mandate a lining installation under the tailing to prevent seepage from the pile into nearby aquifers. However, based upon previous studies which indicate that even with high concentrations of acids the solubility of uranium is only about 64 percent we might expect that the amount of deleterious ions entering the aquifers to be quite low if only water percolation is involved. Perhaps, a far simpler, much less expensive, stabilization procedure can be suggested, specifically:

1. Reduce the tailing pile to grade for whatever ultimate intermittent use determined to be best-municipal refuse recycling plant, municipal incinerator, sewage plant extension, recreation site, or whatever.

2. Place a relatively thin layer (4"?) of sodium bentonite clay over the entire surface, cover this with a thicker layer (6-12") of sewage sludge, top with 2 feet of soil and plant to a desired vegetation. The entire cost probably will not exceed $10,000 per acre and yet should achieve adequate
9.8 stabilization while preventing contamination of the aquifers from downward water percolation, inhibiting the radon emissions through the constantly moist layer of bentonite, provide a site for root growth in the sewage sludge so that the roots won't penetrate the tailing proper and tend to transpirate radon gas to the surface and reduce what little EGR there is to an even more acceptable amount..

(3) Should it be determined that movement of the pile is mandatory, another alternative to the Clive site is recommended. In that Kennecott produces about 100,000 tons/ day of copper tailing, perhaps, the slurried Vitro tailing can be added to the large tonnage of copper tailing being
9.3 discharged daily by the Kennecott mills to their 20 square mile tailing pond. Dilution of the emissions would be immediate and coverage would be achieved in a relatively short period of time.

A copy of my technical biography is enclosed to furnish information on my background.

Sincerely yours,

Karl C. Dean

Karl C. Dean

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[redacted]

29 March 1983

Project Manager
Uranium Mill Tailings Project Office
Albuquerque Operations Office
U. S. Department of Energy
P. O. Box 5400
Albuquerque, New Mexico 87115

Dear Sir:

1. Reference is made to:

a. Draft Environmental Impact Statement, February 1983, U. S. Department of Energy, DOE/EIS - 0099D.

b. Public hearing conducted on March 22, 1983, at the Senior Citizens Center, Tooele, Utah to receive comments on the DEIS concerning slightly radioactive mill tailings and other materials from the Vitro mill tailings site at South Salt Lake City, Utah.

2. It is recommended that the 69 acre area at the Vitro site (see pages 28 + 29 of Draft Environmental Impact Statement, February 1983, U. S. Department of Energy) be covered with the following:

a. A 4 foot layer of 40 to 70 mesh (0.2 to 0.4 mm grain size) sand.

b. A 3 foot layer of crushed stone, 3 ½ inch to 1 ½ inch size. (American Association of State Highway Officials Specification.).

c. A 2 foot layer of crushed stone, 2 ½ inch to 1 ½ inch size.

9.8 (A.A.S.H.O. Specificiation).

20.1 d. Surface radioactivity should be determined and recorded after the placement of sand in 2a and after the placement of crushed stone in 2b and after the placement of crushed stone in 2c. A determination should then be made as to whether or not an additional layer of 2 feet or less of crushed stone, 2 inch to 1 inch size (A.A.S.H.O. Specification) is required.

3. There should be no placement of a clay layer on the surface of the 69 acre disposal area (see page 28 of Draft EIS).

4. An appropriate number of settlement platforms with gauges should be positioned properly to measure the extent of embankment settlement and elapsed time for settlement due to the placement of the sand and crushed stone in preceding paragraph 2. These measurements are to control the rate of placing the sand and the crushed stone and to avoid embankment shear. A curve showing settlement or consolidation versus time should be plotted.

000175

5. Enclosed is an extract from "Soil Mechanics in Engineering Practice by Terzaghi and Peck." Your attention is invited to pages 400 and 401.

Yours truly,

Custer L. Lynn
Maj AUS Retired

[redacted]

29 March 1983

Project Manager
Uranium Mill Tailings Project Office
Albuquerque Operations Office
U. S. Department of Energy
P. O. Box 5400
Albuquerque, New Mexico 87115

Dear Sir:

For your information.

1. I have a B. S. in Chemical Engineering and retired February 1958 from the U. S. Army at Dugway Proving Ground, Utah.

2. I worked in the State of Utah Materials Laboratory, February 1958 to November 1960. Most of my work here was in the area of Soil Mechanics for the determination of settlement of embankments in the construction of highway overpasses.

3. During November 1960 to June 1976, I worked as Administrative Contracting Officer, GS-12, for the Department of The Air Force and The Department of The Navy on Research + Development and Production of rocket motors for Minuteman and Poseidon Missiles.

Yours truly,

Custer L. Lynn
Maj AUS Retired

6442

The author enclosed "Soil Mechanics in Engineering Practice" by Terzaghi and Peck, pp. 398-406.

This document is available at the repositories listed in Section 6.21.

KERR-McGEE CORPORATION

March 29, 1983

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13 APR 1983

Mr. James A. Morley
Project Manager
Uranium Mill Tailings Project Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Re: Draft Environmental Impact Statement: DOE/EIS-0099-D, Remedial Actions at the Former Vitro Chemical Company Mill, South Salt Lake, Salt Lake County, Utah (48 Fed. Reg. 7294, Feb. 18, 1983).

Dear Mr. Morley:

Kerr-McGee Corporation, Kerr-McGee Nuclear Corporation, and Kerr-McGee Chemical Corporation (hereinafter "Kerr-McGee") appreciate the opportunity to comment on the referenced draft environmental impact statement (DEIS) concerning the Vitro site. As discussed subsequently, Kerr-McGee recommends that the final environmental impact statement conclude that the contaminated materials be
20.1 stabilized in place, i.e., that alternative 2 in the DEIS is the preferred alternative.

Interest and Relationship of Kerr-McGee

Kerr-McGee operates uranium mines, a uranium mill, and a uranium conversion facility. It previously operated other nuclear fuel cycle facilities and non-fuel cycle facilities, some of which are currently in the process of being decontaminated and decommissioned. In addition, it has operated and has participated in the operation with other entities of facilities at sites that have been designated for remedial action under the Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604 (UMTRCA). Accordingly, both current and previous operations conducted by Kerr-McGee are related to the provisions and potential applications of the UMTRCA.

20.1 Stabilization in Place Is Recommended

Kerr-McGee recommends that, to the extent remedial action is undertaken at the Vitro site, it be consistent with alternative 2 of the DEIS -- stabilization
20.7 in place on site. This is adequate to protect the public health against potential risk, is environmentally sound, and is in keeping with the "reasonable effort" approach stated by the Congress in enactment of UMTRCA.

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James A. Morley
Page 2
March 29, 1983

a. Stabilization in Place Protects Public Health

The DEIS indicates, as do other analyses, that under the current conditions of the Vitro site, the potential health effects are quite small. The estimated effect due to inhalation of radon-daughters is less than one lung cancer case per year for the population of some 500,000 people. The risk due to external gamma radiation exposure or uptake of airborne particulates is much less. In all these instances, the estimated effects are hypothetical, upper limit and could well be zero.

Stabilization in place, as described in the DEIS, controls totally the potential for exposure to external gamma radiation, completely suppresses the potential for resuspension of radioactive particulates, and isolates the contaminated materials from the possibility of entering water systems.
11.2 The radon emanation will be suppressed to essentially a level comparable to that which is normally extant as background literally within the boundary of the site. While the stabilization in place process recommended in the DEIS goes beyond what is necessary, the net effect will be the reduction of what currently is a negligible, but calculatable risk, to an even more de minimis risk that is far, far less than the risks commonly and ordinarily accepted in society.

b. Stabilization in Place Is Environmentally Sound

The DEIS clearly shows that stabilization in place is environmentally sound. This alternative has only minimal impact on air quality, water, ecosystems, transportation and other pertinent factors, all of which are short-term and a function of the remedial process. After the remedial action is completed, there will be no environmental consequences other than the restricted use of the land on which the contaminated materials have been stabilized. Since the site is zoned for industrial use, and since the use of the site is consistent with this zoning, the environmental consequence cannot be viewed as negative.

20.7 c. Stabilization in Place Is Consistent With the Congressional Intent

In enacting the UMTRCA, the Congress stated that "(E)very reasonable effort should be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards ..." Stabilization in place meets this requirement in all aspects. Radon diffusion is minimized, water is protected and resuspension of materials is eliminated. The material is stabilized, disposed and controlled in a safe and environmentally sound manner. But an equally important consideration is that stabilization in place is reasonable, and its cost, compared to the cost for relocation and disposal, bears a more reasonable relationship to any potential benefits which may be derived.

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10.5 There are both monetary and non-monetary costs associated with the proposed remedial action. Based on the DEIS analysis, stabilization in place costs approximately one-half the transportation costs alone if the material were relocated for disposal. The overall cost estimated for relocation and disposal is at least four times that estimated for stabilization in place. There are no off-setting benefits associated with moving the material. To the contrary, there would be additional non-monetary costs involved with relocation that are not associated with stabilization on site. Relocation requires a larger work force and increased handling of the material, thereby enhancing the likelihood of work-related serious injuries, up to and including fatalities.

Relocation can not be justified. The additional funds and the increased potential for serious injuries are tremendous costs and are unreasonable in view of the fact that relocation offers no improvement in public health and environmental benefit. These substantial costs clearly outweigh any potential benefits.

General Comment

Kerr-McGee recognizes there are perceptions that uranium tailings piles pose a significant public health threat and that this threat can only be averted by disposing of the tailings at remote, unoccupied locations. These perceptions are not supported by the analyses in the DEIS, nor are they supported by independent analyses done by authoritative scientists or other governmental agencies.

For example, the Environmental Protection Agency, in its analysis of potential health effects attributable to all the inactive uranium tailings piles, estimated about two fatal lung cancers per year for the U.S. population. These two cases would be in addition to the some 92,000 lung cancer fatalities that normally occur annually in the U.S. populations. By any measure, the two additional potential cases would be considered an insignificant risk compared to the overall risk.

Kerr-McGee believes it is most important that DOE, in determining the remedial action alternative for the Vitro site, base its judgement on factors such as the significance of the risk illustrated above, the benefits that will possibly be derived, the costs involved and other genuine issues. The judgements should not be dictated by what is deemed advisable to allay unsupported fears and erroneous perceptions.

Sincerely yours,

W. J. Shelley

W. J. Shelley, Vice President
Nuclear Licensing and Regulations

es;dc

Marilyn W. Giamalo
[redacted]

March 30, 1983

Mr. James A. Morley, Project Manager
Uranium Mill Tailings Project Office
U. S. Dept. of Energy
P. O. Box 5400
Albuquerque, NM 87115

RECEIVED
DOCUMENT CONTROL
24 MAY 1983

Dear Mr. Morley:

20.1 The following are my comments for inclusion in the Final Environmental Impact Statement for remedial action at South Salt Lake City or Clive, Utah. I very strongly oppose trying to stabilize the tailings in place at the Vitro site in South Salt Lake City, which is absurd.

15.2 I have two reasons to be concerned. First and foremost is the fact that my children were brought up within six miles of the dump and we are aware that these children will later in life have a higher rate of cancer per hundred. How many more children have to face this situation?

6.2 The second concern centers around the possible contamination of the deep water aquifer below the dump site. I am well aware of the water problems facing the arid west. Our water situation in the Salt Lake Valley will become critical in the not too distant future. I worked for the Water Supply Forecast Center of the Weather Bureau until 1969, at which time there was increasing need to tap the aquifer.

9.5 Additionally, please consider the fact that the technology for stabilizing the tailings in place is questionable. I believe that if we don't move the tailings now, no matter the cost, and stabilize in place, it may well become necessary in the future to remove them. This is not cost effective and that should be seriously considered. I am currently Secretary-Treasurer of A-C Body, Inc., and have had enough business experience to see the folly in not solving the problem once and for all.

4.1 20.6 I am certainly more willing to pay taxes for the removal of the tailings than for putting the poorly conceived MX racetrack in our fragile desert area. Finally, haven't we studied this enough? I imagine the monies spent on studies could have paid for a good portion of the cost of removing the tailings?

Sincerely yours,

Marilyn W. Giamalo

Marilyn W. Giamalo

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To: DOE

Re: Vitro uranium mill tailings

28.1 [The Vitro uranium mill tailings should be removed from the present site

6.2 [because they are in a very populated area and also because the many wells in the area could become contaminated.

LEAGUE OF WOMEN VOTERS OF SALT LAKE

[redacted]

8 April 1983

Program Manager
Uranium Mill Tailings Remedial Action Program
U.S. Department of Energy
Albuquerque Operations Office, Suite 1700
5301 Central Avenue, N.E.
Albuquerque, New Mexico 87108

RECEIVED
DOCUMENT MANAGEMENT
25 APR 1983

Dear Sir:

The members of the League of Women Voters of Salt Lake have a strong interest in remedial action to remove the health hazard currently posed by uranium mill tailings at the Vitro site in south Salt Lake. We have studied the draft environmental impact statement (DEIS) comparing the effects of three proposed actions: (1) leaving the tailings as they are, (2) leaving them on site but stabilizing them by covering and possibly providing liners or slurry walls under and around them, and (3) moving them by train to be stabilized at a site 85 miles west, near Clive in Tooele County. League representatives have attended Department of Energy hearings in Salt Lake to listen and to present our criteria for choosing among these alternatives.

Alternative 1, no action, is clearly unacceptable to almost everyone.

The League's hazardous and radioactive waste disposal facility criteria state that sites should be avoided in areas of critical concern including:

—residential areas
—shorelines of rivers, lakes and streams
—natural hazard areas subject to flooding, earthquakes, and subsidence
—drinking water supply sources, including aquifers and recharge areas

20.1 On the basis of these four criteria, we find the South Salt Lake site clearly inferior to the Clive site.

Other critical concern areas we wish to avoid are:
—prime agricultural, grazing and forest lands
—rare or valuable ecosystems or geologic formations, significant wildlife habitat, and unique scenic or historic areas

These two criteria would be more likely to argue against a location like Clive. But as far as we can determine they do not. Although there is grazing land in the area, it is marginal rather than prime in quality.

6.2 We recognize that in exceptional cases, areas of critical concern may not be avoidable and that protection can be engineered. However, in the South Salt Lake case, we see the following obstacles to that course of
6.1 action. Local and state officials have criticized DOE analysis of current groundwater quality and flowpaths at this site, and we are pleased that

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6.1 your department has responded by addressing this concern. But there is reasonable doubt that additional data will be sufficient to satisfy local water and health officials by the time the decision point is reached. Although future uses of groundwater are not completely predictable, we believe from our previous study of Salt Lake water resources that an
6.2 expected shortage of municipal water in the valley is very likely to lead to intensified use of groundwater. As noted in the DEIS and by commenters, the subsequent effects of intensified use on underground flows will increase the likelihood of contamination. Furthermore, we have very
9.5 little reason to believe that the untried technology of clay liners and slurry walls (which are not even mandated, only suggested) would really prevent contamination, especially over the 1000 years required in an area of flood and earthquake danger. The addition of tons of soil cover weighty enough to prevent uneven ground subsidence (with probable subsequent liner cracks due to soil conditions at this site) would have adverse esthetic and cost features even if it worked.

20.9 Another reason to simply avoid this site rather than try to make it safe is that the Central Valley sewage treatment facility and the city of South Salt Lake have for many years expected the tailings to be moved.
5.2 They have planned to use this site and surrounding area for purposes which
10.2 will be of considerable benefit to them and the Salt Lake residents they serve. These purposes include more adequate and efficient sewage treatment,
13.2 energy resource recovery, and economic development.

In sum we have serious doubts that safety at the South Salt Lake site can be satisfactorily engineered, and there seem to be only two reasons to even try to do so. One is cost, and the other is the rights and sensibilities of the citizens of Tooele County. Regarding cost, we have heard testimony from state and local officials that the Clive alternative should cost only $10 million more than the South Salt Lake alternative, rather than $38 million
20.7 more as estimated by DOE, and we welcome DOE efforts to resolve this discrepancy. We believe total cost estimates certainly should include the costs to Central Valley users of modifying their plans, as well as the foregone benefits to South Salt Lake City of planned economic development. Whatever the outcome of current cost recalculations, cost should be of secondary importance compared to the health of present Salt Lake residents and the 15 to 20 future generations who will be affected by the remedial action taken.

As to effects on Tooele County residents, we feel confident that the remoteness of the Clive site from human populations, its hydrological conditions, and limited surface uses all argue against any adverse effects on local health, safety, water supply, or economic well-being. We believe any
20.1 fears they may have on this score are unfounded. Nor do we think they should feel "stigmatized" as a "dump" site. We hope that they and the general public are beginning to realize that safe, suitable sites for hazardous and radioactive waste disposal are assets absolutely essential to the welfare of all of us. As citizens of Salt Lake, we will be very grateful to our Tooele neighbors for helping to provide a solution to this health problem which has plagued us for so many years.

Sincerely yours,

Nanette Benowitz

Nanette Benowitz
President

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BAKER ENGINEERS

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108

8 April 83

Remedial Action Project Office
U.S. Dept. of Energy
5301 Central Ave., N.E., Suite 1700
Albuquerque, NM 87108

RE: Vitro Tailings - A FOURTH ALTERNATIVE

Dear Mr. Matthews:

Attached is our report regarding the proper action necessary to decontaminate the materials at the Vitro Site.

The Economic Evaluation (DOE/ALO-171) by Mountain States Research and Development was limited to studying the extraction of only three (3) products, namely: Uranium, Vanadium and Molybdenum. Leaching was the only method of extraction studied. We conditionally agree with their conclusion on page 3-1, that "it is not economic to reprocess the tailings at present market values for Uranium"; if Uranium, Vanadium and Molybdenium are the only marketable products to be considered; leaching is the only method of extraction, each of the products must be conpletely refined on site and the extraction of those three products has to show a clear profit.

We contend that:

5.4

1) there are many other marketable products that can be concentrated from the tailings;
2) the products can be sold as concentrates without the high cost of a full process plant for refinement on site;
3) any recovery of marketable values can help offset the total cost of decontaminating the site;
4) there are available processes that can concentrate the heavy specific gravities and when used in combination with a flotation process and a bacterial leach treatment; can recover a much higher percentage of the values in high concentrations.

20.1 It would seem that the proper decision would be to: a) protect the public health, b) conserve public funds, c) save natural and commercial resources, d) preserve property values, e) protect the future generations from hazardous and financial burdens and f) protect public lands from contamination that will last thousands of years. All of these obligations can be met if the tailings are processed and decontaminated on site. We feel that this is the only alternative that will comply with those obligations.

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20.1 Processing the tailings on site would have the least cost, take the shortest time to process and could meet the standard permissible toxic levels. There is the possibility that atleast part of the cost of processing could be refunded to the public coffers from market receipts.

We sincerely hope that this proposal will be considered and that the obligations to the public and future generations will prevail.

Sincerely,

Lester D. Baker

Lester D. Baker
Registered Professional
Consulting Engineer

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VITRO TAILINGS-
A FOURTH ALTERNATIVE

By: BAKER ENGINEERS

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We believe that the EPA permissible standards for radioactive and toxic materials can be reached on all contaminated materials.

VITRO TAILINGS - A FOURTH ALTERNATIVE

AN ECONOMIC EVALUATION

of the

VITRO MILL TAILINGS

in

South Salt Lake City, Utah

for the

U.S. Dept. of ENERGY

by

BAKER ENGINEERS

6030 South 2400 East
Ogden, Utah, 84403

Prepared by: Lester D. Baker
Registered Professional
Consulting Engineer

April 1983

* Utah, Idaho, Wyoming and Washington

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VITRO TAILINGS - A FOURTH ALTERNATIVE

INTRODUCTION:

We have reviewed the "Draft Environmental Impact Statement" (REIS) (DOE/EIS-0099-D) and the "Economic Evaluation of Inactive Uranium Mill Tailings" (Economic Evaluation)(UMTRA-DOE/ALO-171) by Mountain States Research and Development. We have copied two assays of the Vitro Tailings (see attachments Table C-1 and Table 5-A). Table C-1 is from EPA's "Final E.I.S. for Remedial Action Standards for Inactive Uranium Processing Sites" (EPA FINAL STDS) (EPA 520/4-82-013-1) and Table 5-A is from "Engineering Assessment of Inactive Uranium Mill Tailings (Engr Assessment) (DOE/UMT-0102) by Ford, Bacon & Davis, Utah, Inc.

We should note here that, try as we may, additional breakdown of the minerals in the tailings have been impossible to obtain.

CONCLUSIONS:

20.1 From the above studies and what other information we can find, we feel that the Vitro Tailings can and should be processed and decontaminated on site.

We have concluded that:

10.1 1) Altervative 2 in the DEIS grossly underestimates the total cost of that remedy.

10.4 2) Alternative 3 would cost more than 3 times the cost of reprocessing and decontaminating the tailings on site.

5.7 3) The assays in Tables C-1 and 5-A indicate that there are marketable products, if concentrated economically or uneconomically.

4) The radiation and toxicity can all be efficiently removed from the tailings, natural soil, process water, and ground water by the use bacterial biosorption. Numerous microbes, bacteria, cultures and fungi are available and each specialize in the uptake or adsorption of specific metals. They efficiently recover the values in solutions of less than 100 ppm, 50% or more of the uptake in the first 5 minutes. Some accumulate thousands of times higher concentrations than their envirnment. See attached studies.

5) There are available processes that can separate the heavy specific gravities and when used in combination with a flotation process and a bacterial leach treatment; can recover a much high percentage of the values in high concentrations.

6) The cost to concentrate all marketable, radioactive and toxic materials would be about $33,000,000 and could easily be processed within a 2.5 year time frame.

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JUSTIFICATION OF CONCLUSIONS:

1) Alternative 2 in the DEIS grossly underestimates the cost of that remedy by not including:

a) cost of 5.4 acre tract with 4 buildings.

b) cost of repair and maintenance of high volume, commercialized, arterial espressways used as haul roads.

c) traffic accidents, hazards and delays due to the additional heavy truck traffic on busy city streets.

10.1 d) removal of 60+ acres of prime commercial /industrial property from the tax roles.

e) cost of treating the radioactive and toxic contaminated ground water.

f) realistic haul distances. The type of clay for the liner may not be available in Salt Lake County.

g) actual cost of Alternative 2 would be higher than the cost of reprocessing and decontaminating the tailings on site.

2) Alternative 3 in the DEIS does not include:

a) costs of road repair and public losses incurred in hauling the million cub c yards of restoration materials to the Vitro Site. See points "b" and "c" of Alternative 2.

b) same costs of hauling oversized, contaminated material to South Clive by truck.

10.4 c) cost of treating the radioactive and toxic contaminated ground water at the Vitro Site.

d) the burden placed on future generations in regards to safely, public health, financial obligations and another potential cost of contamination clean-up.

e) the high initial cost and obligation that will continue forever should justify the processing and decontamination on site for less than one-third the amount.

5.4 3) EPA Final Stds and Engr Assessment assays (see attached Tables C-1 and 5-A) verify that there are many other marketable products that can be concentrated economically from the tailings.

4) There is some concern about the radiation from Radium, but we haven't found any information on the amount of Radium in the tailings. It isn't mentioned in either assay.

5) The Economic Evaluation study was limited to the extraction of only three (3) products, namely: Uranium, VAnadium and Molybdenum. None of these products show-up in the assays as having commercial values when extracted individually. When concentrated with other products, then separated as one of several concentrates, there is some commercial value.

The study evaluated several types of leaching, but limited their study to that one process. The chemical reagents (used in leaching) was estimated at over $6,300,000 per year for 2.7 years totaling over $17,000,000 of $42,700,000 cost of processing. The market value of their products was only $19,900,000.

10.4

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Each product was fully processed to a marketable form in separate high volume plants. The plants were designed to process all the product in only 2.7 years. This is a major capital expenditure for a extremely short useful life.

The concentrates of nearly all of the minerals are marketable at existing plants that are already processing that product.

The cost of reagents used in bacterial leaching is much less since the microbes do most of the "work". The ph of the solutions used in most bacterial leaching range between 4 and 7.

6) According to the two assays (Tables C-1 and 5-A) some of the minerals that appear to have marketable quantities are:

8.4

Uranium	Nickel	Barium
Vanadium	Tin	Copper
Molybdenum	Titanium	Gold
Rubidium	Tungston	Silver
Gallium	Cobalt	Chromium

THE FOURTH ALTERNATIVE:

PROCESS:

We would propose 5 circuits, each capable or processing 100 to 120 tons per hour. Processing only 8-hours per day, they could process the 2 million tons of tailings in 500 working days.

Each circuit would have a Grizzley, Feeder Bin, Water Wash Plant (or Trummel), Recovery Sluice System with hydrostatic separators (for heavy specific gravities), Bio-sorption Extraction Cell (for removing radioactive and toxic materials in solution), Water Revocery System, Extended Flotation Cell (for mineral with low specific gravities), and another Water Recovery System.

The Tailing materials would be placed on a leach pad for bacterial leaching, then after neutralization, they would be mixed with cement or lime for final emplacement. The tails would solidify to a point where there should be no dusting, leaching or escape of radon gases if there is any.

All ground water would be processed through a bio-sorption cell to extract all radioactive and toxic materials in solution. The contaminated natural soil would also be leached with the bacteria.

The process could be monitored constantly at several points to confirm the amount of remaining radioactive and toxic materials.

Two of the sewage treatment tanks proposed for future expansion of the neighboring sewage treatment company could be built and used for water storage and treatment.

The processing could be flexible enough to allow for the programs of the sewage treatment facility.

ADVANTAGES:

THE FOURTH ALTERNATIVE would have the following advantages and almost none of the possible disadvantages of the other alternatives.

1) The radioactive and toxic materials can be concentrated economically and sold to the commercial market along with other concentrated values.

2) The contamination of air, ground and water would be limited to the present site, and not spread along the roads, railroad tracks, or deposited at a second site to be monitored forever.

3) No need for monitoring a contaminated site.

4) The contaminated ground water and process water can be "cleaned" by bio-sorption and the radiation and toxic levels can be reduced to "acceptable" levels.

5) The Tailings would be processed in a "wet" condition which would minimize any dusting.

6) The final placement and compaction would be as "soil-cement" allowing no dusting, leaching or escape of radon gases or radiation, if there should be any.

7) There would be no need for importing more than a million cubic yards of restoration material, cover material or clay and gravel liners.

8) No offsite impact including:

a) contamination of air, water or ground.
b) exposure to other residents or wild life.
c) damage to roads, railroads, etc.
d) traffic problems, accidents, delays.
e) use of natural resources, such as: gravel, clays, fuel, etc.
f) use of commercial resources, such as: trucks, roads, railroads, tracks, loaders, conveyors, etc.
g) monitoring of a disposal site forever.
h) use of public funds without a beneficial gain or improvement for the public.

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PLANT COSTS

ITEM	AMOUNT
Site Preparation	$500,000
Engineering	500,000
Material Handling & Loading Equipt.	2,500,000
Process Circuits (5 reqd @ $800,000)	4,000,000
Separating and Handling Concentrates	1,000,000
Leach Equipment	1,000,000
Reagent & Chemical Storage	500,000
Reagent Process Equipment	1,500,000
Asphalt Leach Pads	2,000,000
Buildings	500,000
Water Tanks (future sewage tanks)	500,000
Plant Total	$14,500,000

OPERATING COSTS

Admin. and Supr.	$1,500,000
Operating Labor	4,500,000
Reagents and chemicals	2,500,000
Cement or Lime	1,500,000
Bacteria & Fungi	1,000,000
Supplies	500,000
Analytical Equipt. and Labor	800,000
Maintenance Supplies and Labor	700,000
Utilities	500,000
Overhead	500,000
Operating Total	$14,000,000
Subtotal	$28,300,000
+ 15% Contingencies	$4,300,000
PROJECT COST	$32,800,000

The author of Comment 108 also provided the following information:

Table C-1. Elements present in tailings from acid-leach mills and in typical soil (EPA 520/4-82-013-1).

The Mechanism of Uranium Biosorption by Rhizopus arrhizus. Tsezos, M. and B. Volesky. From Biotechnology and Bioengineering, Vol. XXIII, pp. 583-604.

Table 5-1. Assay results of composite Vitro tailings samples.

Biosorption of Uranium and Thorium. Tsezos, M. and B. Volesky. From Biotechnology and Bioengineering, Vol. XXIII, pp. 583-604.

Radiation Degradation and the Subsequent Enzymatic Hydroloysis of Waste Paper. From Biotechnology and Bioengineering, Vol. XXIV, pp. 991-997.

Sites of Metal Deposition in the Cell Wall of Bacillus subtilus.

Recovery of Heavy Metals by Microbes. Chiu, Y. 1972. Ph.D Thesis. University of Western Ontario, London, Ontario, Canada.

Bacterial Resistance to Toxic Metals Determined by Extrachromosomal R Factors. Silver, S., Schottel, J., and A. Weiss.

Approaches to the Study of Microbial Transformations of Metals. Brinckman, F.E., Iverson, W.P., and W. Blair.

Biodegradation of Chalcopyrite. A.E. Torma.

The Assimilation of Trace Metal Ions by the Marine Bacteria, Arthrobacter marinus and Pseudomonas cuprodurans. Jones, G.E., Royle, L.G., and L. Murray.

These documents are available at the repositories listed in Section 6.21.

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JAMES W. DAVIS
MAYOR

COUNCILMEN
BONNIE T. FARNSWORTH
RANDALL G. FITTS
HOWARD C. MOORE
GARY W. SESSIONS
ANTHONY F. FISCHIO

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RECEIVED
DOCUMENT CONTROL
19 APR 1983

ACTIONS FOR THE VITRO TAILINGS

WRITTEN COMMENTS

BY

JAMES W. DAVIS

MAYOR

CITY OF

SOUTH SALT LAKE

APRIL 8, 1983

I am James W. Davis, Mayor of the City of South Salt Lake. I am the Past President of the Salt Lake County Council of Governments, Past Chairman of the Wasatch Front Regional Council, Past Chairman of the Central Valley Water Reclamation Board, and a member of the Salt Lake City-County Board of Health, as well as a member of the Governor's Uranium Mill Tailings Task Force.

I am extremely concerned about the outcome of the uranium mill tailings at the Vitro site, which is located within my City's boundaries. My commitment to the residents of the City of South Salt Lake is to see that the tailings be moved to an environmentally acceptable remote site.

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The central purpose of my remarks today is to discuss with you the three alternatives listed in the Department of Energy Enivronmental Impact Statement and their affect on the well being of the South Salt Lake Community.

Before that discussion can take place it is important that you understand the nature of thim community and its people. The City of South Salt Lake was incorporated in 1938 and has since then provided all essential services to its 10,500 residents on a continuing basis.

The approximate five square mile city is located in the economic and transportation center of the Salt Lake Valley. The two major freeways serving the Rocky Mountain West I-15 and I-80 cross in the center of our City and the three major regional railroads pass through our boundaries. Stretching from 2100 South on the North to 3300 South on the South and from the center of the Jordan River (1400 West) to our irregular border along 500 and 700 East, the City occupies the favorable position of being Utah's "Center of Industry". Our City provides approximately 1/8 of the jobs for the people of the State of Utah; 40,000 jobs by recent estimates. The community is also the showcase of quality industrial parks within the State.

Because we are located in the center of the east Wasatch Front and tucked so neatly away in Salt Lake County, our presence plus the importance and flavor of our productive lifestyle gets lost by events that surround us.

I represent a community as separate and diverse in nature as any in Utah or the United States. We enjoy geographical integrity and financial security based on our own enterprise and activity. Don't be fooled because we blend our borders with other communities, we are as distinct and unique as Cedar City, Moab or Price. The only difference is that while they may be surrounded by farms and open space, we are surrounded by other cities.

The 10,500 people living in our City plus the 40,000 working here and the 180,000 travelling our surface streets, depend upon our City for essential services and protection while they are within our borders. Our 1979 Master Plan indicates that our City has one of the State's highest percentages of resident senior citizens and overall our residents have some of the lowest average annual incomes in Utah.

The economic importance of the land beneath the Vitro Tailings is important to <u>all</u> the people of the State of Utah; but of the highest value to the people who live and work within the boundaries of this community, the City of South Salt Lake.

Now that we have discussed the nature of my community, I would like to discuss with you the impact of Vitro on this City. I believe that if South Salt Lake was able to trade geographical location with Cedar City the problem of Vitro would be more easily understood.

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Suppose we could take the freeway into South Salt Lake in that type of geographical isolation. The first thing you would notice as we come to the crest of the hill from the South is the 3300 South freeway exit. Off to the
13.2 right of the exit is the Vitro site. On one of the cities highest valued parcels of ground is an area encompassing 69 acres which represents 6% of the total 3,700 acres of the City. This property sits idle instead of supplying services to the traveler, jobs to the City resident, or paying for itself in tax revenue. No, worse than idle, the site is blighted. No, worse than blighted, it is contaminated. The eyesore and menace of Vitro is that it has not only remained undeveloped itself, but adjacent property owners have been forced to abandon condemned
13.3 properties. Vacant fields sporting price tags of more than $193,000 per acre sit empty within 1/2 mile of the site because their value can't be realized on the open market. Plus the people throughout the entire area are caught in a continual time warp; listening while State, local and federal health and nuclear experts vacilate on whether or not the area is safe. For nearly 30 years the
15.2 4.1 Vitro health question has dangled precariously over our head. Sometimes a threat to our health, sometimes harmless. The only thing certain is that every five to ten years someone in Washington, Denver or Albuquerque is going to come to town with a new set of criteria to either soothe us or alarm us. If any alternative but complete removal is accepted this cycle of indecision will continue to haunt this community and our grandchildren beyond the fiftieth generation.

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I am also very concerned as I remember a statement extracted from the Utah State and Department of Energy Cooperative Agreement which indicates that Governor Scott M. Matheson must concur with the remedial action decided upon for the Vitro tailings. I quote "The detailed description of the work to be performed will be contained in a written Remedial Action Plan which will be developed
3.1 by the DOE and the State. The Remedial Action Plan will be attached as appendicies to this agreement, after having been approved by DOE and the State." The Governor has none on record supporting removal of the Vitro tailings from their present location. Should the Governor's and Department of Energy's decision for remedial action
20.7 differ, the City of South Salt Lake and Salt Lake County will face the prolonged dilemma of no action being taken on a situation that jeopardizes the well being of the entire community. It is imperative that the correct solution, satisfactory to those affected, be reached and remedial action started so all can be protected.

Obviously we're not expert enough to judge the health ramifications but by the Department of Energy's own assessment in the Environmental Impact Statement the land can't be safely used or left in its current accessible state unmonitored. Therefore, we are left to conclude that it is potentially harmful and must be permanently removed from its present location.

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Now let us discuss briefly other effects of Vitro on our isolated South Salt Lake model. The Utah State Division of Community Development states in their March 21, 1983 written testimony that the economic effect on South Salt Lake City is as follows:

Lost potential revenues over a 30-year period beginning this year, $226,789 in the first year to $270,185 per year in the 30th year,

Including:

Sales Tax $33,750 - 97,376

Business Licenses $8,250 - 22,750

Water Service $162,720 - 320,780

Sewer Service Fees $113,364 - 225,484

Gross Revenue $284,334 - 567,014

Cummulative Discounted Revenues $284,334 - 6,116,317

10.2 I believe it is clear that the people of my community are being harmed economically, socially and emotionally by the presence of Vitro chemicals tailing pile.

Now suppose that during the next 30 years the Department of Energy were to accept the option of moving the tailings away from this community and we were able to develop the land to its highest and best use. The 1979 South Salt Lake Master Plan envisions the eventual expansion of our 900 West business Industrial Park onto the Vitro properties. If the Department of Energy were to enable this to happen the following capital investment could occur over a 21-year period.

Capital Investment

Year	Number of Developed Acres	Capital Invest.	Additional Econ Activ Generated	Gross Invest Impact	Cumulative Discnt Econ Impact
1	35.0	$172,959,040	$242,142,656	$415,101,696	$415,101,696
2	36.7	1,450,234	2,030,328	3,480,562	418,385,245
3	38.4	2,072,751	3,549,859	3,549,859	421,444,607
4	40.1	1,500,877	2,112,427	3,621,304	424,485,124
5	41.8	1,539,090	2,154,726	3,693,816	427,410,972
6	43.5	1,569,747	2,197,646	3,767,393	430,226,187
7	45.2	1,601,293	2,241,811	3,843,104	432,935,423
8	46.9	1,633,284	2,286,597	3,919,881	435,542,368
9	48.6	1,666,163	2,332,628	3,998,791	438,051,259
10	50.3	1,699,486	2,379,280	4,078,766	440,465,474
11	52.0	1,733,253	2,426,555	4,159,808	442,788,789
12	53.7	1,767,909	2,475,073	4,242,982	445,023,439
13	55.4	1,803,454	2,524,836	4,328,290	447,174,467
14	57.1	1,839,443	2,575,221	4,414,664	449,244,234
15	58.8	1,876,321	2,626,850	4,503,171	451,235,991
16	60.5	1,913,643	2,679,100	4,592,743	453,152,382
17	62.2	1,915,854	2,732,595	4,684,449	455,107,039
18	63.9	1,990,953	2,787,334	4,778,287	456,881,525
19	65.6	2,030,941	2,843,317	4,874,258	458,589,191
20	67.3	2,071,818	2,900,545	4,972,363	460,232,672
21	69.0	2,113,138	2,958,394	5,071,532	461,813,950

10.2 In a 30-year period, the removal of the Vitro mill tailings could mean to our community over 900 jobs and the cumulative wages of workers of $142,602,961 which serves to strengthen the economic health of the City, County and State.

The importance to my town of moving Vitro is my foremost concern at this hearing. The alternative of doing nothing is out of the question. Alternative #2 of stabilizing in place is equally out of the question unless

17.2 the Department of Energy is willing to compensate the City, School District, County and State for the loss of potential revenue and community economic strength should the area have been allowed to develop.

20.1 The removal of the tailings to an off-site location is in my judgment the only reasonable possibility.

We respectfully urge you to remove the Vitro contamination from our worries, from our health, from our pocketbooks and most important from our future.

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9.5 The committee believes that uranium mill tailings should be treated [consistent] with the substantial hazard they will present until long after existing institutions can be expected to last in their present form. . . .The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time. (House Report No. 95-1480, Pt. I, p. 17, and Pt. II, p. 40; 1978)

Remedial Action Goals and Objectives in the Context of EPA's Standards

The committee's language was an affirmative statement of Congress's intent that stabilization and disposal of hazardous uranium tailings be designed to endure the disruptive forces of wind and water and the potential disposition of tailings by humans for as long as the tailings remain hazardous. To accomplish this goal, the U.S. Nuclear Regulatory Commission set a tailings-control "longevity period" of at least 1,000 years (NRC, 1980). The U.S. Environmental Protection Agency proposed a similar longevity requirement (EPA, 1981). As of January 5, 1983, EPA revised this requirement to ensure that control measures "will last. . .up to 1,000 years and, in any case, for a minimum of 200 years" (EPA, 1983; page 598). In each of these regulatory actions, longevity of control and minimization of long-term maintenance and surveillance were keystones to effective remedial action.

In adopting its final longevity standard, EPA specifically noted that the low-end of the longevity range was intended only to guide implementing agencies where uncertainties clearly made control up to 1,000 years impracticable (EPA, 1983; page 597). Otherwise, EPA affirmatively rejected institutional controls (such as fencing only and prolonged surveillance) in favor of "passive" engineering controls with the overriding goal of control for up to 1,000 years (EPA, 1983; page 597).

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The final inactive-site standards authorize DOE as the implementing

agency to conduct remedial action to control inactive tailings for as long as practicable, up to 1,000 years. Consequently, DOE's stabilization and disposal options must consider the practicability of long-term control and offer as alternatives for the proposed action engineering designs that will result in protection of the public and environment for up to 1,000 years.

Implementation of a Preferred Alternative

20.1 SRIC believes that Alternative 3 of this DEIS best meets the authority granted DOE and the long-term control mandated by EPA's inactive-site environmental standards and should be implemented as the preferred alternative for remedial action at the South Salt Lake, Utah, site.

Benefits of Alternative 3

Control and Longevity. One of three preliminary design options for Alternative 3 calls for 1) partial below-grade disposal, 2) a 4-foot clay liner (Sec. A.5.2.2., page A-65), and 3) a 6-foot cover (including a 2-foot clay cap). If implemented, this design will reduce seepage of toxic materials to groundwater and mitigate to the greatest extent of any of the three alternatives considered by the DEIS surface disruption of the tailings by natural and human forces. Radon diffusion would be reduced to near background release rates (assumed to be 1 to 2 pCi/m^2-sec [Sec. F-2.1.2, page F-46]) by the proposed cover design of Alternative 3 (Sec. A.5.2.3., page A-65; Figure A-27, page A-68) and surface runoff would be directed away from the stabilized impoundment by a riprap-lined diversion ditch (Fig. A-34, page A-86).

These controls will provide protection for up to 1,000 years as envisioned by the EPA standards and Congress's intent for long-term disposal.

Acquisition of the South Clive site by DOE with limited, periodic maintenance of the site and fencing to prevent access (controls which NRC may require through its statutory licensing authority [P.L. 95-604, Sec. 104]) will provide further assurance that the final disposal site will meet the 1,000-year stabilization objective.

Population Exposure. Implementation of Alternative 3 will remove a serious radiological hazard from the Salt Lake City area thereby eliminating the unnecessary and undemocratic excess radiation exposure of approximately 440,000 people (Tables 1-1 and 1-2, pages 6-7; Tables 5.1 and 5.2, pages 108-109). Disposal and stabilization at South Clive will be far removed from major population centers and at least 35 miles from the nearest community (Grantsville). Table 4-7 (page 92) shows that only 7 individuals live within
10.2 15 to 20 miles of the South Clive site. Stabilization at South Clive will eliminate excess external (gamma) and internal (alpha) radiation doses to Salt Lake City residents after remedial action, thereby eliminating 0.24 excess lung cancer deaths per year within 6 kilometers of the Vitro site (Table 1-3, page 12).

Land Use. Decontamination of the Vitro site will clear the entire 128 acres of hazards and allow the Central Valley Water Reclamation Facility
13.1 (CVWRF) Board to proceed with the planned expansion of its existing wastewater treatment facility (Sec. 3.2.4.7, page 42). Removal of the tailings from the Vitro site not only will increase property values in the area, but allow South Salt Lake and Salt Lake City to improve existing wastewater treatment facilities thereby protecting their citizens from another significant source of groundwater contamination.

10.5 Economics. Relocation of the tailings to the South Clive disposal site

will create more jobs than stabilization in place at the Vitro site (Tables 1-1 and Table 1-2, pages 6-7; Sec. 5.11, pages 133-135). While the economic gains from remote disposal will be small compared to the existing economies of Salt Lake and Tooele counties, they nonetheless will aide in the easing of growing employment problems without attracting a large immigration of new residents and concomitant strain on existing services.

Cost. The estimated cost of disposal at the South Clive site exceeds that of stabilization at the Vitro site by three to five times, depending on the type of seepage control measure that would be adopted for the stabilization-in- place alternative (Sec. A.5.4.5, Table A-26; pages A-90 to A-91). However, the benefits to be gained from disposal at South Clive far outweigh the extra cost of remote stabilization. Only a few of these benefits are outlined in the comments above; others are discussed below in SRIC's specific comments on Alternative 3. Many advantages and benefits of remote stabilization are addressed in the DEIS, including the elimination of potential contamination of municipal groundwater supplies (shallow and deep aquifers) in a growing industrial area of South Salt Lake.

Additionally, SRIC believes that stabilization in place at the existing Vitro site may make compliance with EPA's environmental standards difficult. Stabilization at Vitro may not afford the 1,000 years of protection envisioned by the standards, especially if a seepage-control liner is not incorporated in the final design or less than 6 feet of cover (including an initial clay cap) is emplaced on the contaminated materials. The preliminary stabilization-in-place design contemplates 25 feet of material above grade; the resulting mound (with tailings and contaminated material 19 feet above grade) will be subject to wind and water erosion and potential earlier disruption of engineered

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control features by human access to the site.

Concerns of Tooele County Residents

Tooele County residents have expressed concern that the disposal of uranium wastes at South Clive will needlessly exposure lands and people to excessive levels of radiation through surface disturbance of the tailings or accidents involving the release of tailings in the railroad transportation corridor (see the transcripts of public hearings held in Salt Lake City and Tooele, Utah, on March 22 and 23, 1983).

These concerns are well-founded. While the DEIS documents the effects of such occurrences (see Appendix F and Sec. 5 of the text), DOE should make every possible effort to ensure that transportation accidents and disruption of the tailings will not occur. The Alternative 3 option described above -- remote disposal at South Clive with at least 6 feet of cover material and additional riprapping -- provides the greatest assurance that the people and lands of Tooele County are adequately protected. Its implementation can be carried out safely if certain extra precautionary measures are taken. Some of these measures are described below.

The tailings should be stabilized below grade (yet above the regional water table) and the site fenced following stabilization as envisioned by Sec. 3.2.4.5, page 40. The site should be posted with radiation warning signs and all DOE access roads and railroad spurs should be removed. All use of lands
9.9 within one-half mile of the stabilized site should be prohibited. The federal government will take possession of the reclaimed site, thereby owning or controlling all lands within a 10-mile radius of the site (Sec. 5.15, page 138). Existing uses of the land for recreational vehicles and limited grazing

9.9 can be replaced by allowing those uses on other, nearby federal lands (Sec. 5.6, page 125).

Transportation of tailings should be governed by strict adherence to the American Association of Railroads restrictions on the transport of radioactive materials (Sec. A.5.4.2, page A-79), including the requirement of sealing all cars during transport of tailings and washing down the interiors of all cars after the unloading of each shipment. DOE should investigate reducing the average train speed of 10 miles per hour (Sec. 5.1.3, page 106) to reduce the potential for an accident that could release tailings to the environment inside the transportation corridor. Additionally, railroad schedules should be adjusted so that the one daily shipment of tailings to the South Clive site is conducted during hours of least vehicle movement on Interstate 80, including those hours when school buses are not loading or unloading children at rural locations within the transportation corridor.

Officials of Tooele County and the cities of Grantsville and Tooele should be kept regularly updated by DOE project managers and their contractors on the pace of remedial action at Vitro and the transportation of tailings. Open and frequent communication with local officials and residents and an ear toward their concerns will enable DOE to identify problems before they arise.

Strengths of the DEIS

The Department of Energy should be praised for compiling a document that is well organized, generally well edited and adequately referenced. Outside of the areas noted below under "Weaknesses," most of the conclusions were well supported with facts and analyses. Areas where the data was lacking or unknown were clearly identified as such. The appendices were particularly helpful in

assessing the three alternatives proposed in the text and in evaluating the other sites that were proposed by the State of Utah but rejected by DOE as possible disposal sites. The appendices also served to satisfy the requirements of the National Environmental Policy Act and the regulations of the President's Council on Environmental Quality.

Weaknesses of the DEIS

Language. Despite its strengths, however, the DEIS was weak in several areas. The first was in language. Very few members of the public without a background in uranium mill tailings management and radiation control would have difficulty understanding the terminology and analyses, especially those in the Appendices. While it is understandably difficult for DOE to use non-
11.1 technical language, more effort should have been given to explaining concepts and technical "jargon". This could have been done in a section of the Summary or as a special preface to the DEIS. The Glossary and List of Acronyms which follow Section 5 aided in this respect, but were not well referenced in the text. DOE might consider upgrading the text to include more references to these lists.

Cover Requirement Analysis. In various parts of Section 5 and Appendix A reference was made to the amount of cover needed to protect the tailings from water and water erosion and human disruption. Several tables, including those cited above in the "Benefits of Alternative 3" section of these comments, gave graphic explanations to the text. However, no mathematical calculations were given using the NRC's radon emanation formula in Appendix P of NUREG-0706 (NRC, 1980) for determination of cover requirements in either Secs. A.4.2.3 or A. 5.2.3 (stabilization in place and South Clive, respectively). Additionally,

the discussion on soil-moisture content in Sec. A.4.2.3 was not detailed enough to inform the public of the significance that the moisture content of soils plays in designing an adequate cover. The NRC has noted that research has identified "moisture content as the key quality governing radon attenuation" (NRC, 1980; page 9-25).

Radiation Dose Analysis. SRIC is supporting the most conservative preliminary design option for Alternative 3 (stabilization with a 4-foot clay liner, 2-foot clay cap and 4 additional feet of cover including compacted granular outer layer and possible riprapping) not only to guarantee that up to 1,000 years of protection will be assured following remedial action, but also to act as a buffer against what may be an underestimation of the health effects of exposure to radioactive materials in the tailings.

The health effects of the three proposed alternatives are presented in Tables 5.1 and 5.2, pages 108-109. These effects, especially those from chronic exposure to Alternative 1 (No Action), may have been underestimated because DOE considered only lung cancer deaths from exposure to radon-222 and
11.1 12.1 its progeny and other cancers from exposure to gamm radiation. DOE ignored other significant health effects known to be caused by radiation and computed dose commitments from various exposure sources only for healthy, adult members of the populations. These deficiencies are discussed briefly in the following paragraphs and in more detail in the Specific Comments section which follows these General Comments.

Uranium-decay series radiation (predominantly alpha particles) has been connected to a wide range of nonmalignant respiratory diseases (see, for example, Archer, 1976, and Wagoner, 1980). Some preliminary studies suggest that genetic effects have resulted in communities near active and inactive

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uranium activities (Weiss, 1981). A compilation of the known and suspected health hazards of uranium activities is presented in an SRIC draft report (Taylor, 1983), which is attached hereto as Appendix 1.

Potential radiation harm to humans historically has been calculated on the basis of models which assume that only adults are exposed. Children, and particularly the developing fetus, are known to be more suspectible to the effects of ionizing radiation. Consequently, any radiation dose models which do not take into account the greater suspectibility of certain members of the population may have underestimated the cumulative radiation effects on the local population. Table F-21 of Appendix F of the DEIS indicates that DOE only estimated doses before, during and after remedial action at Vitro to adult members of the local population. 12.3 11.1

In the FEIS, DOE should address these considerations. DOE also should discuss the potential genetic effects of the alternatives considered in the DEIS and the possibility that doses and health effects were underestimated by the use of radiation models which predict harm only to healthy adults. 11.3

SPECIFIC COMMENTS ON ALTERNATIVE 3

The following comments pertain to specific statements in the DEIS concerning Alternative 3 or generic matters which indirectly pertain to Alternative 3, relocation of the Vitro tailings to the South Clive site. These comments also why Alternative 2 should be rejected as the preferred method of disposing of the Vitro tailings. The comments are arranged in order of page number and are identified as such.

Sec. 3.1.4, page 23

DOE was correct in pointing out the uncertainty involved in predicting seepage from the design alternatives. Its plan to conduct a detailed, two-phase geohydrologic investigation of the Vitro site is prudent. However, the anticipated groundwater study, which is designed to determine "the effectiveness of the less-expensive seepage-control options," may significantly change the conceptual design of Alternative 2 making stabilization in place more attractive economically than any option under Alternative 3. Several matters arise from the undertaking of such a study. 6.1 6.2

First, DOE implies that cost is a statutory or regulatory objective in remedial action. SRIC is aware of DOE's intent to reduce costs of the UMTRA program, but contends that the agency has no authority to use cost as a justification for lesser environmental controls. Congress addressed this point in the Fiscal 1982-83 Nuclear Regulatory Commission Authorization Act. The conference committee report which accompanied the legislation said: 20.2

> The conferees are of the view that the economic and environmental costs associated with standards and requirements established by the agencies should bear a reasonable relationship to the benefits expected to be derived. This recognition is consistent with the accepted approach to establishing radiation protection standards, and reflects the view of the conferees that, in promulgating such general environmental standards and regulations, EPA and NRC should exercise their best independent technical judgment in making such a determination. At all times, the conferees fully intend that EPA and NRC recognize as their paramount responsibility protection of the public health and safety and the environment. (House Report No. 97-884, p. 47.) 20.7

DOE's authority under Title I of P.L. 95-604 extends only to implementing the general environmental standards set by EPA. DOE is under no authority to make the consideration of cost equal to or greater in importance than

protection of public health and the environment in chosing remedial action alternatives. To make such a determination, DOE would be overstepping its statutory authority and subverting EPA's standards to a second-class role.
20.7 Additionally, EPA noted in adopting its final standards that strict cost-benefit analyses are not possible to carry out with any degree of certainty (EPA, 1983; page 596).

Common sense dictates that DOE can implement a less expensive technological "fix" if it accomplishes the same level of protection as another more expensive remedy. However, DOE cannot base a technical/engineering decision exclusively on cost without regard to level of protection -- as it appears to be doing in Sec. 3.1.4 of the DEIS.

Second, the matter arises of the importance of the geohydrologic study. DOE implies that the study will be used to determine if a "less-expensive" seepage control method will satisfy the EPA standards. Presumably, one type of "less-expensive" seepage-control method would be no seepage control. If the study shows that seepage control is not necessary, DOE may decide to adopt Alternative 2 as the proposed action. In this event, members of the public who
1.3 supported any one of the three options for Alternative 3 must be given an opportunity to review and comment on the study. DOE may find it necessary to prepare a supplement to the DEIS on this issue. At the minimum, and regardless of DOE's decision on a preferred alternative, the department should make the study available before DOE commits to a particular remedial action at the Vitro site.

Sec. 3.3.2, page 47

2.4 Any consideration of active institutional controls, as suggested in the

third complete paragraph on this page, should be rejected. Such controls would
2.4 not satisfy the EPA standards and would do nothing to remove a serious radiological and hazardous waste site from a fast growing area of a major population center.

Sec. 4.6.1, page 64

In the discussion of surface water flows at the South Clive site (third paragraph), DOE states, "Streamflows from higher elevations are normally evaporated and infiltrate into the ground before they reach lower, flatter land." The northeast-to-southwest gradient of the ground surface at the site suggests that this is true. However, the groundwater contour map of Figure A-25 shows a southwest-to-northeast hydraulic gradient, that is, despite the rise in surface elevation toward the northeast portion of the site there is a perceptible decline in the water table in the same area.

This decline in water table elevation toward the Cedar Mountains suggests that a subsurface physical control prevents recharge of surface water to the
7.5 shallow site aquifer at the western periphery of the mountains, thus lowering the water table as it moves northeastward toward the mountains. Such a physical control may be a fault zone lying at the edge of the mountains at their interface with the valley fill -- a typical occurrence in basin and range physiological settings -- or, the subsurface dipping of the valley fill beds.

If seepage from the South Clive disposal site is permitted to go unchecked (that is, if clay lining of the proposed trenches is rejected), contaminated water may flow freely downgradient (northeastward) until a groundwater mound is formed at the periphery of the mountains. When this

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occurs, the hydraulic gradient may change directions causing contaminated water to move south, west and north back toward the disposal site. The result may be a rise in elevation of the piezometric surface under the site in which the water table would be in direct contact with tailings and contaminated material. Hence, the emplacement of a clay liner under the South Clive site appears essential to preventing contamination of offsite groundwater. 7.5

Sec. 4.6.1, page 69

The first full paragraph (last line) of this page illustrates one of the many disadvantages of stabilization in place at the Vitro site. Probable maximum flood (PMF) flows in the Jordan River would inundate the stabilized Vitro site up to 11 feet above ground surface. Alternative 2 would result in a mound approximately 25 feet (Sec. 5.8, page 129) above the existing grade. Consequently, PMF flows at Vitro would cover about 40 percent of the reclaimed tailings, contributing to a degradation of the cover material, which provides only 6 feet of protection between the tailings and their external environment. 6.4

Flood flows at the South Clive site, on the other hand, are predicted to be sheet flows which could pass over the hardened, granular cover without causing appreciable damage. DOE could add to this level of protection by encasing the 6-foot above-grade cover at South Clive with a layer of riprap (boulder-size rocks encased in wire). This would not add substantially to the cost of the cover in that DOE already is considering an armoring layer of riprap on the northern and eastern toes of the impoundment where a surface runoff collection ditch is proposed (Sec. 3.2.4.5, page 40; Figure 3-8, page 41).

Sec. 4.6.2, pages 71-74

Vitro Site Water Quality. DOE admits that contamination of shallow groundwater under the Vitro site already has been occurred (page 72: "the shallow ground-water system has been contaminated by the past milling and tailings disposal activities at Vitro site"). Water quality data in Appendix D documents this contamination. 11.5

Groundwater samples taken in April 1982 from eight shallow-aquifer monitoring wells at the Vitro site show extensive radiological contamination (App. D, Table D-6): gross alpha averaged 207.9 pCi/l, based on a range of 3.7 to 1,181 pCi/l; radium-226 averaged 18.1 pCi/l, based on a range of 1.0 to 114 pCi/l; and total uranium (as U_3O_8) averaged 126.1 pCi/l, based on a range of 3.4 to 744.7 pCi/l. Total dissolved solids concentrations in these same wells in April 1982 samples averaged 4,197.4 mg/l with a range of 310 to 9,473 mg/l (App. D, Table D-5). Table D-4 of Appendix D shows that the screened interval of these wells ranges from 13 feet (Well V-DS) to 45 feet (Well V-HS). An inspection of Figure D-2 shows that this contamination is most serious beneath the southwest and south tailings areas. The most serious contamination at depth in the shallow system was in well V-HS which is screened between 35 and 45 feet. 6.3

The shallow system begins at depths of 2 to 5 feet below the surface (page 72). More than 120 wells serving the domestic water needs of South Salt Lake range from 100 to 400 feet below the surface within a half mile of the site (page 73); one municipal well of 850 feet in depth was said to yield 1,100 gallons per minute (gpm) (page 72). Figure D-2 shows the shallow water table trending west-northwest, a gradient which jeopardizes water quality in the industrial and undeveloped area west and north of the tailings. These data

6.3 demonstrate that groundwater use for human purposes is extensive in the area of the Vitro site and that the presence of the tailings constitutes a very real threat to groundwater in areas which may be developed following stabilization.

South Clive Water Quality. Water quality in four shallow DOE monitoring wells at the South Clive site averaged 35,600 mg/l TDS for four sampling occasions between September 1981 and August 1982 (App. D, Table D-11). Some radiological parameters also were elevated, apparently by natural conditions.

9.2 Despite the poor quality of groundwater below the South Clive site, steps should be taken to prevent a worsening of the situation. Given that the preliminary design of the disposal trenches is 20 feet in depth and that the depth to the water table ranges from 25 feet to 35 feet below the ground surface, the shallow aquifer would range from 5 feet to 15 feet below the bottom of the tailings. Figure A-26 shows that a 4-foot liner would reduce the initial seepage rate to 30 gpm and a 2-foot liner would reduce seepage from the tailings to about 50 gpm. These discharge rates would decrease substantially with time as the moisture content of the tailings decreases. While it is apparent that a clay liner will not prevent seepage, lining of the disposal trenches will nonetheless inhibit further contamination of the shallow aquifer and slow the rate of rise in the water table relative to the increase in water table elevation that may result from uncontrolled seepage. To verify this potential, DOE should present calculations showing the rate of seepage from unlined trenches in Alternative 3 and compare those rates to the projected seepage through the two clay lining options.

Secs. 4.7.1 and 4.7.2, pages 75-76

9.2 Information in these sections on the ability of native vegetation at the South Clive site to resist erosion seems contradictory. In the first paragraph of page 76, DOE states, "The highly saline, slowly permeable soils in this extremely arid location are unsuitable for re-establishing a lasting, self-sustaining vegetation to protect the soil covering the disposed materials." Yet in the last paragraph on the same page, the local vegetation is said to form "an important ground cover and deterrent to soil erosion. . ." DOE should clarify this point, although the available data suggests that a vegetative cover will be difficult to maintain and sustain at the South Clive site. This would be another reason for adding a layer of riprap to the proposed 6-foot cover.

Sec. 4.8, page 79

19.8 The order of the second sentence of the introductory paragraph to this section should be changed. The sentence should read: "Radiological dose rates and exposure are presented in millirem/year and microroentgens/hour, respectively."

Sec. 4.8.1, page 80

The subsurface radium-226 concentrations around and beneath the Vitro site demonstrate why groundwater there has been contaminated. These elevated concentrations (up to 560 pCi/g at the 1-foot depth, compared to a background concentration of 1 to 2 pCi/g) also have implications for decontamination of the site for unrestricted use, if Alternative 3 is adopted.

It is not clear if EPA's radium-226 standard for cleanup of "open lands"

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applies to subsurface contamination beneath tailings piles (EPA, 1983; page 600). DOE did not address this issue in its discussion of the evacation of the Vitro site under either Alternative 2 (Sec. A-4.4.2, page A-43) or Alternative 3 (Sec. A-5.4.1, page A-73). However, the subsurface radium concentrations discussed on page 80 show clearly that decontamination must proceed deeper than 1 foot below the tailings. The water quality analyses discussed above and in Secs. 4.6.2 and Appendix D of the DEIS also suggest that elevated radium concentrations are present a depths much greater than 1 foot.

11.5 To resolve this problem, DOE should undertake a soil sampling program to determine radionuclide concentrations beneath the Vitro site at depths greater than 1 foot. The discussion of site preparation for lining (Sec. A-4.4, page A-40) indicates that the Vitro site will be excavated to an average depth of 7 feet (last paragraph, page A-40). Thus, soil investigations as suggested above should be carried out to at least 8 feet below the tailings to determine if elevated radium-226 concentrations are present at this depth. The 15-pCi/g "subsurface, open lands" standard adopted by EPA can be used as a guide for decontamination, although DOE should be aware that this level is 7.5 to 15 times greater than background radium-226 concentrations.

Additionally, the EPA standard provides a regulatory guidance of averaging radium-226 concentrations over 100 square meters (Table 3-1, page 20). DOE should devise a statistical method (with significance at, say, the
11.5 95-percent confidence interval) whereby enough soil samples are taken to gain a representative radium-226 average over the entire 128 acres of the Vitro site.

Sec. 5.1.3, page 106

12.3 Radiological Comments. DOE should discuss in greater detail why it selected the radon and external gamma radiation (EGR) risk factors presented on page 106. The two-sentence explanation at the bottom of the page says only that there is a wide difference in expert opinion on the matter of risk of cancer from exposure to ionizing radiation. These differences should be spelled out clearly. Appendix F shed no additional light on this matter; it only gave the technical methods for determining doses from various radiological source terms and how the MILDOS and AIRREL codes were used to relate the various dose-deliverying parameters. The discussion on page 106 and in Appendix F also fails to mention the quality factor (Q) DOE has chosen to assign to alpha radiation, the principle radiation emitted by uranium-decay series radionuclides, particularly radon and its progeny.

As mentioned in the General Comments section above, one of the main weaknesses of the DEIS was its failure to give much credence to nonmalignant
11.3 diseases caused by exposure to ionizing radiation and reliance on deaths from lung cancer (through exposure to radon and its progeny) in its estimation of the health effects caused by the three alternatives, including No Action. Appendix F provided valuable background data and important insights into the methods by which the dose commitments of Tables 5.1 and 5.2 (pages 108-109) were derived, but gave little information on how the expected number of excess deaths were derived. An inspection of Sec. 5.1.4 (page 107) shows that the number of excess deaths was obtained simply by multiplying the dose commitments of Tables 5.1 and 5.2 by the risk factors for radon and gamma exposure on page 106. No reference or other basis was given for using this formula.

In addition to these deficiencies, and as noted in the General Comments section, dose commitment projections were computed only for healthy, adult members of the population. Table F-21 in Appendix F (pages F-55 to F-56) attests to this problem. The time-weighted exposure data was valuable in that it showed decreasing doses over time following completion of remedial action (Table F-21), but no attempt was made to consider doses to the more sensitive members of the population: developing fetuses, children and elderly individuals. DOE must clarify why it chose not to consider these matters in its estimation of health effects. Until it does, we conclude that the number of health effects predicted in Table 5.1 may be underestimated, especially those resulting from chronic exposure to the No Action Alternative. 12.3

Worker Exposures. Appendix F predicted very large doses to remedial workers. External gamma exposure alone was calculated to be 3 rem/yr (whole body) for each of the three years of remedial action. Lung doses from radon inhalation was estimated to be 3.2 rem/yr for each of the three years. Thus, cumulative worker exposure from radon and EGR sources may approach the ICRP and worker limit of 5 rem/yr, whole body (CESC, 1978; page 49). The DEIS does not address the cumulative effects of exposure to both radon and EGR other than to multiply the dose commitments of Table 5.2 (page 109) with the risk factors of page 106. 11.3

Neither is there much discussion about exposure mitigation measures. Worker exposures during remedial action can be lessened by the wearing of respirators, frequent relocation to work areas not containing radioactive materials and other shielding measures. DOE should list what mitigation measures it plans to require for contractors employing remedial workers. .4

Sec. 5.3.2, page 115

Another advantage of Alternative 3 is that the necessary cover materials can be obtained from the local environs without large land disturbance. Material excavated from the trenches contains a high amount of clay and greater moisture content. Gravel for the granular outer cover layer and boulder-size rocks for possible riprap features can be obtained from the nearby mountains. The availability of clay materials at the site also facilitates installation of a clay liner. 7.7

Sec. 5.3.4, page 116

In the second full paragraph, a reference is made to "Choar, 1959." The reference table on page 141 lists "Chow, 1959," but nothing by "Choar". This should be corrected. 19.8

Sec. 5.4.2, page 120

The upward movement of groundwater may result not only from the hydraulic head of the deep aquifer, but also from capillary forces in the vadose zone above the shallow aquifer and in the unsaturated area above the deep aquifer (if, indeed, that area is unsaturated). Regardless of the cause, the potential for reversal of the vertical gradient appears very possible, especially if local groundwater use increases as the DEIS suggests it might. Stabilization in place might accelerate this process through discharge of seepage from the tailings, especially if a liner is not used. The fact that groundwater conditions are unsuitable for permanent tailings disposal (for example, high water table, pervasive contamination, etc.) at the Vitro site suggests that the tailings and contaminated material should be relocated and the entire 128- 6.2

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acre site decontaminated.

Sec. 5.4.3., page 120

This section discusses whether different types and thicknesses of liners, or no lining, will meet the EPA standards for groundwater protection (which, under the final standards, essentially are existing state and federal water quality criteria). Figures A-11, A-12, A-13 (pages A-28 through A-31)
9.4 demonstrate the seepage attenuation properties of a clay liner for radium-226.

However, if another regulated contaminant would have been used to predict seepage migration, the spread of that contaminant, in terms of its concentrations, certainly would be more widespread beneath the unlined tailings than Figure A-11 shows. Radium-226 is a notoriously slow mover. DOE should construct seepage migration models and graphics to compare the rate of migration of other more mobile contaminants under the various seepage-control (liner) options.

Sec. 5.6, page 125

10.2 The No Action Alternative and Alternative 2 would prohibit or inhibit, respectively, expansion of the CVWRF. Alternative 3, however, would permit the Board's expansion plans to proceed. The "permanent preemption" of the 200 acres at South Clive is a much less serious impact on land use than either Alternative 1 or Alternative 2.

Sec. 5.9, pages 130-131

10.8 DOE should discuss how it determined the number of individuals who would "immigrate" to Salt Lake City to take remedial action jobs. The number of jobs

10.8 that would be created by either Alternative 2 or Alternative 3 is small; it would seem more likely that these new, but limited employment opportunities would be taken by persons from the local communities seeking work. DOE should explain how its construction contractors will hire workers and under what conditions, if any, preference will be given to local workers.

Sec. 5.11, pages 134-135

It is clear from the data on these pages that Alternative 3 will create more new jobs and greater benefits to the local economies than Alternative 2.
10.5 These benefits will be small in comparison to existing employment and economic structures. However, they nonetheless will constitute a "return" on South Salt Lake's unfortunate "investment" of having to live with hazardous uranium mill tailings for so many years.

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Dr. Volney Wallace
April 1983

The original letter has been misplaced and is reproduced in part.

I consider the chance of an epidemic of lung cancer compelling reason for doing as I have just suggested and see no compelling reasons to the contrary. My views of the contrary reasons follows.

The proposed action terminates the pollution of underground water. The pollution wasn't particularly serious anyway. The shallow wells affected are or at least ought to be contrary to public policy for they are sensitive to contamination from filthy surface waters, leaking sewers, leakage from the Vitro site sewer plant, extract of road tar and so on. If, rather when for the water is already polluted, the pollution reaches these wells, the arsenic can be taken out with ion exchange resin.

6.2 The specter of Virto leachate contaminating the deep artesian water due to heavy usage of this water is unrealistic. That heavy of usage of the water will render it polluted by sewage, filthy runoff water, road tar extracts and so on, so the condition will be avoided.

As I pointed out in the Tooele hearing, a planting of desert shrubs on the stabilized pile will terminate penetration of meteoric water into the tailings.

9.5 The complaint of having to tend the pile for millenia is also unrealistic. Due to our inexhorable depletion of our resources, in several decades that pile will be a valuable mineral resource and will be mined for its mineral value. The reprocessing will be done by safe procedure, probably hydraulic and robotic equipment will be used in the actual handling of the tailings, and the tailings will be disposed of in a proper permanent way at no cost to the taxpayer. The reprocessing of the tailings at that time will be a boost to both the local and general economy.

10.1 I personally am opposed to taking a gamble if I cannot afford the consequences of losing or if I commit innocent other people to take consequences of my losing the gamble. I despise people who take such gambles, such as the person who will pass on a blind curve or the loser who tries to whine his way out of his predicament. That principle and my perception of the hazard of radioactive dust leads me to the opinion that the Vitro tailings should be stabilized in place with an absolute minimum of moving of the tailings. I would go along with the proposed cover of clay and gravel but would propose as I did at the Tooele hearing that the pile be planted with a desert plant. I tentatively propose that the present load of water in the tailings with its dissolved arsenic be removed by pumping.

13.4 The complaint of taking away of needed land from the sewer plant there is also unrealistic. Progress in sewage technology has and will continue to take the pressure of land off from sewer plants. The Japanese have already developed a small land area oxygenator. It is possible that land can be gained by reducing the inventory of sludge and it is possible that the tailings pile can be used for storage of dewatered sludge. I pointed these things out at the Tooele meeting.

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ABSTRACT

Radon daughters appear to have been overestimated and radioactive dust underestimated as causes of lung cancer. The advisability of disturbing the Vitro tailings, other than to cap them, is highly questionable.

EPA ESTIMATES OF CANCER CAUSED BY VITRO TAILINGS

The environmental impact statement on the Vitro tailings is characterized by exact, dogmatic statement on the amount of cancer that will be produced by the tailings under specified conditions. No confidence limits nor explanation is given nor is a distinction between the hazard of dust and gas made.

The EIS does mention that it is lung cancer that will be produced and that the daughters of radon are in particular the cause. This indicates that the EPA used mortality data for uranium miners, who suffer from a quite high incidence of lung cancer. The estimates given are not possible except one assumes a zero threshold of radiation effect, indicating that this assumption was also made.

RADIOACTIVE DUST VERSUS RADIOACTIVE GAS AS A CAUSE OF LUNG CANCER

12.4 Particles of dust larger than about 0.01 mm tend to lodge in the upper respiratory tract and are removed from the body by coughing, sneezing and blowing of the nose. Particles 0.001 to 0.01 mm in size tend to lodge in the lungs. Smaller particles tend to remain airborne and if inhaled are immediately exhaled. The particles that deposit in the lung are normally swept back up the respiratory tract by the cilia of the lungs. This action is not perfect, though, as indicated by the occurrence of silicosis and black lung among hard rock and coal miners respectively, and the problem of asbestos in the environment. If I recall news releases of a few decades ago correctly, the action of cilia in the lungs is weak or absent in smokers. It follows that if there is radioactive dust of a particular size in the air, there will be deposited in some peoples lungs, permanently, a number of radioactive particles.

Given a radioactive particle lodged in the lung, with an average radiation of one alpha particle per day. In the course of a year it will irradiate a dozen or so lung cells with a total of 365 alpha particles. This is more than enough to cause cancer, indicating danger from particles with as little radiation as one alpha particle per week or month.

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In the 1950's a retroactive study was made of causes of death among uranium miners and uranium mill workers. The miners, who are heavily exposed to radioactive dust, had a very high incidence of lung cancer and, not surprisingly, it was by far the highest among those that smoked. The uranium mill workers, in spite of their exposure to high levels of radon and radon daughters, had a normal incidence of lung cancer. This indicates that it was radioactive dust particles causing the lung cancer, not gaseous radon or its radioactive daughters. Surprisingly (not surprisingly if you are aware of the fallibility of science) this conclusion has been overlooked or ignored and in its place the theory that radioactive daughters of radon are responsible has been substituted. The reason for it I do not know. I suspect dominance of the radiation health scare and the mistaken understanding that radon decomposes to radioactive particulates. The latter may have arisen from handbook listing of the radioactive daughters as solids, coupled with lack of understanding of extreme low vapor pressures and metastable gases. It may have arisen instead with failure to appreciate the fact that reactive gases can be picked up by a filter by process of chemisorption.

I have no direct data on whether gaseous radioactive daughters of radon can deposit and stay in the lung long enough to cause lung cancer, other than the absence of excess lung cancer in uranium mill workers. From my professional understanding of molecular processes I find it unlikely. This involves the dynamics of gaseous diffusion and short duration sorption processes which I will not go into. Rather I shall use a close, familiar analogy.

12.4

He who takes an incautious whiff of concentrated hydrochloric acid, concentrated ammonia or glacial acetic acid is in for a rude surprise, an explosion of pain in the nose and sinuses. Gaseous diffusion processes are sufficiently fast that the upper respiratory tract filters out these vapors. The mucus and the mucous membrane dissolve these gases essentially irreversibly and stops them from getting into the lower respiratory region. If the gas or vapor is volatile and poorly soluble in water, it is absorbed just the same by the upper respiratory tract (molecules not soluble in water do not avoid impacting on mucus) but creates a thin layer of lower concentration, high saturation solution in the surface of the mucus from which the vapor or gas evaporates and continues its trip down the respiratory tract. The gaseous radioactive daughters of radon should be captured thus by the upper respiratory tract and, lacking particular volatility, should go no further. Not reaching the lungs, they cannot produced cancer of the lungs.

Let us suppose that we erred, that the radioactive daughters of radon do actually reach the lung and are taken from air suspension by the lungs. They are solitary atom by their species and so are in solution when picked up by the lungs. They would be expected to be carried off immediately by the bloodstream, not staying in the lung long enough to expose the lung to much radioactivity. Either way, it looks like radioactive particulates far exceed radioactive gas in ability to irradiate the lung with cancer causing radiation.

There is more to it than this. Some radioactive minerals are more radioactive than others, some are more radioactive because of greater particle size, some of the minerals dissolve quickly in body fluids and do not reside a long time in the lungs, other factors are involved in carcinogenesis as well, and so on. I rather suspect but its only a guess, that the culprit is a quartz particle with an inclusion of radioactive mineral.

VITRO DUST

One of the speakers at the Tooele hearing on the Vitro EIS complained that the tailings were 40% sub-200 sieve. Maximum particle size in that 40% fraction is about 70 microns. There should be a considerable amount of 1-10 micron size particles in that fraction, easily airborne materials (the mentioned speaker complained that the operations would be extremely dusty). I think it follows that under either option II or option III of the EIS that a lot of Salt Lakers would get a lung full of radioactive dust and that an epidemic of cancer of the lung would follow.

12.4

I cannot say absolutely that the lung cancer of the uranium miners_____by radioactive dust and that the Vitro tailings pile dust will have the same effect. I believe, though, that I have a better case for it than the present case for lung cancer from radon escaping the Vitro tailings pile. The decision of what to do with the Vitro tailings will have to be made under the cloud of uncertainty on this point.

Tooele County

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March 14, 1983

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Mr. James A. Morley
Project Manager
Uranium Mill Tailings Project Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Morley:

The Tooele County Board of County Commissioners appreciate the opportunity to voice our objections to the movement of the Vitro Tailings now located in South Salt Lake City to the location at Clive, Utah located in Tooele County.

15.1 Certainly Tooele County can sympathize with Salt Lake City, but Tooele County did not create the tailings pile neither did we receive tax money or the benefits of employment for some of our County citizens. It is the intention of the County Government and the concerned citizens to take every step available to us to prevent our County from becoming a nuclear dumping grounds.

Tooele County presently stores the free worlds supply of nerve gas at Tooele Army Depots South Area, including the much discussed wet-eye bombs. Many experiments using nerve gas and germ warfare materials have been conducted at Dugway Proving Grounds, Tooele County.

We are world reknown for killing a large nmber of sheep near Dugway Proving Grounds, and for sometime following the incident people from out of State and even some people in State were apprehensive about traveling Highway I-80 West between Salt Lake City and Wendover.

15.1 It is the Commissioners concern that to dump the Vitro Tailings in Tooele County would place a stigma on the County that would discourage industry, and especially those employees who follow the industry, from building and living in Tooele County.

15.1 Another concern is that once we allow the Vitro Tailings to be placed in Tooele County we will eventually become a dumping grounds for other low grade nuclear waste material.

We understand that under the present law this could not happen, however, laws and Government officials can be and are often changed.

11.2 The fact that there is no medical evidence and the State Board of Health can produce no records that the Vitro Tailings in their present location is a health hazard to people living in the close vicinity of the trailings pile.

20.1 It is, therefore, the recommendation of the Tooele County Commissioners that the Vitro Tailings pile be stabilized in place at a greatly reduced cost to both State and Federal Governments.

20.9

Sincerely,

BOARD OF COUNTY COMMISSIONERS

CHARLES STROMBERG, Chairman

REED RUSSELL

LEE V. BRACKEN

RR/pl

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SALT LAKE CITY-COUNTY HEALTH DEPARTMENT

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March 31, 1983

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Mr. James A. Morley, Project Manager
Uranium Mill Tailings Project Office
U.S. Department of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Morley:

Enclosed are the comments of the Salt Lake City-County Health Department on the Vitro tailings draft environmental impact statement. We would appreciate your full consideration of our remarks in the preparation of the final environmental impact statement.

Sincerely,

Harry L. Gibbons, M.D., M.P.H.

HLG:jt

Enc.

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Our office has carefully reviewed the latest available Draft Environmental Impact Statement on Vitro. This document sets forth three possible alternatives for the Vitro site: no action (alternative 1), stabilization in place (Alternative 2) or removal of the tailings and accompanying contaminated material to the South Clive site (Alternative 3). Alternative 1 is not an acceptable or viable option, and will not be discussed. For a number of reasons we believe that Alternative 2, the plan to stabilize the tailings in
20.1 place is "fatally flawed," and we are therefore opposed to this concept. We have no objection to the proposal to relocate the tailings, and believe that this is the course of action which should be followed. Regarding the stabilization in place alternative, our concerns are related not only to specific technical points discussed in the Draft Environmental Impact Statement (DEIS), but also to certain decisions and judgements which have been made in preparing the DEIS itself. These points will be discussed in this paper. There is no particular significance to the order in which they appear.

To begin, we are concerned by a number of statements given in the foreword of the Draft. These statements are disturbingly clear in explaining that the final parameters for the stabilization in place alternative not only may but likely will differ substantially from elements of this action described in the DEIS. Further, we believe that these and other statements which will be quoted shortly open the door for a lowering of the final standards to which the stabilization in place alternative would have to conform.

In the foreword an explanation is given that the final EPA Standards for Remedial Actions at Inactive Uranium Processing Sites were published just prior to the DEIS being sent to press. Quoting from the foreword:

> 2.4 "Because the final EPA Standards are somewhat less stringent than the (previously) proposed standards, all of the action alternatives described in this DEIS will satisfy the requirements of the final standards. Also, the designs finally adopted can be expected to result in somewhat lower construction impacts than are addressed in the DEIS. Expected changes include reduced cover thickness, reduced volumes of materials to be removed from open lands, and reduced transportation impacts for cover and fill material."

This paragraph is disturbing for a number of reasons. The final EPA Remedial Actions at Inactive Uranium Processing Sites Standard did remove reference to a specific table of contaminant concentrations, but by no means gave blanket endorsement to the type of plans proposed in the DEIS. In fact, the final standard may have provided a vehicle which will result in a more rigorous solution than if specific contaminant levels were given. To quote from Section 192.20 "Guidance for Implementation" of the final EPA Remedial Actions at Inactive Uranium Processing Sites Standard (40 CFR, Chapter I, Subchapter F, Part 192 issued December 15, 1982):

"Judgements on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's Hazardous Waste Management System (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization."

2.4 In other words, EPA's Hazardous Waste Management System and State regulations may be used to specify ground-water requirements, which could be even more restrictive than the initial ones the EPA proposed in their original Remedial Actions at Uranium Processing Sites standard.

Regardless of what standards the State might specify, a comment on page 19 of the Draft opens the door to the possibility that the DOE may be able to back away from the guidelines in the final EPA Remedial Actions at Inactive Uranium Processing Sites Standard itself.

"As indicated in table 3-2, under exceptional circumstances when the EPA standards cannot be fully met, the DOE may select and perform remedial actions that come as close to meeting the EPA standards to which the exception applies as is reasonable."

It must be remembered that the stabilization in place alternative described in the DEIS is not in its final form. The foreword makes a rather nebulous statement regarding "lower construction impacts than are addressed in the DEIS". Literal interpretation of the preceeding quote gives D.O.E., with N.R.C. concurrence, considerable latitude (for D.O.E. convenience) to declare that exceptional circumstances exist and vary the final design as they wish, as the stabilization in place alternative plan is not in its final form.

Even if the scope of the stabilization in place design is not changed from that proposed in the DEIS, the full design for stabilization in place as presented in the DEIS is not adequate. For example, considerable study is set forth in the DEIS related to the alternatives between a slurry wall and a clay liner for the encapsulation cell at the Vitro site. The DEIS makes clear that a committment to the clay liner concept has not been made and that a liner may
9.1 well be omitted. To quote from page 22:

"The clay liner may not be needed under the final EPA standards provided that it can be shown that other, less-expensive means of seepage control would meet the ground-water protection requirements of the final standards. The clay liner is nevertheless incorporated in the design for alternative 2 (stabilization in place) to provide a worse case design on which the analysis of construction impacts can be based."

Quoting further from page 23:

"If engineered protection is not needed (of the deep ground-water system)--that is, if the no control option will meet EPA standards--then the liner option will not be the preferred option in the final design for the stabilization in place remedial action."

It is logical to assume that if the clay liner is omitted, a slurry wall will then be used to confine contaminants. The slurry wall concept has a particularly striking weakness, however, as the DEIS itself admits. To quote from page A-32:

"The effectiveness of the slurry wall concept is related to the maintenance of the upward hydraulic gradient beneath the stabilization area. If extensive ground-water development and increased pumping
6.2 were to occur within the area of the Vitro site, the upward hydraulic gradient could be reduced or reversed. This would
9.1 result in a loss of hydraulic containment and an increase in the potential for downward migration of contaminants from the tailings."

An addtional paragraph on this page indicates:

"Because of the hydrogeologic and soil conditions at the Vitro site, the integrity of the slurry wall can be expected to last longer than that of the liner. Although the slurry wall alternative would present a greater contamination potential in case of failure after installation, the failure of the
9.4 slurry wall would be easier to detect and the remedial measures would be less costly."

This statement alone recognizes that stabilization in place is not a long term solution. Several places in the Draft speak of stabilization for a period of a thousand years. Yet these two paragraphs admit to the possible failure of the clay liner, possible failure of the slurry wall and dependence upon the upward hydraulic gradient to assist in the containment of contaminants. In
6.2 future years there will be substantially increased groundwater withdrawal in the vicinity of the Vitro site, as well as all across the Salt Lake Valley. In addition we cannot be sure that the aquifers will continue to be recharged at the rate they have been. There is no guarantee that the currently favorable upward hydraulic gradient will indefinitely continue.

An additional fact which makes the stabilization in place alternative so undesirable is that the potential hazard from the tailings will virtually never disappear. The half lives of the radioactive components of the tailings is many thousands of years, but there is even a longer lasting health hazard. Looking beyond the radionuclides, the heavy metals present in the tailings
14.2 will never "burn out". The leachability of the tailings has not been well examined, having taken a backseat to the radiation concerns, yet this may well be the most significant long term hazard of the tailings. The tailings have substantial concentrations of many potentially hazardous elements and compounds such as arsenic, selenium, chromium, lead and antimony to mention only a few of the dozens present. As a graphic example of this hazard, data collected between 1967 and 1971 showed that waters discharged from the Vitro tailings had hexavalent chromium levels as high as 58 ppm (that is 1160 times higher than the National Interim Primary Drinking Water Standards). This high value alone would be sufficient to classify this discharge as a hazardous waste stream.

Regarding hazardous waste sites, at the present time there are a number of problem areas within Salt Lake County being investigated by our office and by State and Federal agencies because of toxic contaminants. But none of them have as wide a diversity of or as high a total concentration of contaminants as is found within the Vitro tailings. Several of these sites may require substantial corrective action. To leave such a huge concentration of heavy metals and other contaminants permanently in any population center is not logical.

9.4 There is no guarantee that a clay liner of the type proposed in the DEIS has the capability of maintaining its integrity for a thousand plus years. Although there are theoretical arguments, there is no track record for such a system. Recent studies have indicated that clay liners are more permeable and subject to failure than previously thought.

Page 45 of the DEIS makes a statement, related to groundwater contamination which is alarming.

> "Alternatives 2 and 3 would not differ in their radiological and non-radiological impacts on ground- and surface-water quality. Either alternative would meet the EPA water standards. In any case, the ground- and surface-water systems involved do not contain potable water."

6.3 This statement is simply not true. Within one-half mile of the tailings there are currently 41 wells less than 120 feet in depth. Some of these are much more shallow that 120 feet and at least half of these are downstream from the pile in relation to the movement of the underground aquifers. Additionally, there are many other wells in the same area which are deeper than 120 feet. According to the DEIS itself, one local municipality, South Salt Lake, is considering using a portion of the deep water system under the Vitro site as part of its water supply. We live in a region of the country where water is very precious. Our valley has been inhabited for only 136 years. The tailings lie in the groundwater system in the heart of one of the fastest growing metropolitan areas within the United States. To leave the tailings potentially in contact with this groundwater system is totally unacceptable.

6.1 In several places the DEIS refers to the forthcoming groundwater study which is to address and resolve some of the issues related to groundwater just discussed. The timing of this study borders on the ridiculous. The study is to answer vital questions such as what would happen to the stabilized tailings if the upward hydraulic gradient were to be reversed. Our understanding is that this groundwater study started in mid-March of this year and that it will be completed within 6 to 10 weeks. In reviewing this proposed study we have spoken with a number of hydrology experts. The unwavering consensus is that while the data to be gathered will be interesting, it is far too brief a study to provide the necessary data needed on seasonal or cyclic changes within the underground aquifers. Also the current short term study is being conducted during a time when the soil is more saturated that it has been for many years. In light of this we must wonder if the hydrology study is nothing more than a "band-aid" attempt to pacify the local citizenry while continuing upon a pre-set course.

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16.1 Considering the alternatives for remedial action it is vital to remember the philosophy that Congress followed in passing the legislation for tailings remedial action. The Congressional Report accompanying P.L. 95-604 expressed the view that the methods used for remedial action could not be effective for only a short period of time. Quoting from the report:

> "The committee believes that the uranium mill tailings should be treated...in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms," and, "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p. 17, and Pt. II, p. 40 (1978)).

Even under the most favorable conditions of hydraulic gradient and liner integrity, continued active surveillance and monitoring of the pile will have to continue indefinitely if it is left in the heart of the Salt Lake Valley. If the pile does develop leakage problems years from now, what problems will this pose our decendents, and who would pay for the remedial work?

There is an additional reason we are concerned with the stabilization in place concept as presented in the DEIS. A great deal of time and effort went into studying alternative disposal sites, to insure that one having the proper configuration of groundwater, long term stability, and other favorable parameters was selected. It therefore appears to us that DOE is following a double standard in proposing long term stabilization in place at the Vitro site. The South Clive site was very carefully selected, as an alternate disposal site, after reviewing many areas. Would the Vitro site be considered for long term stabilization, if the tailings did not now reside at that location? Of course not, since the Vitro site fails to meet the rigid selection criteria as an alternative disposal site. We currently do not have a hazardous materials landfill within the county, nor are there plans or a desire to develop one. If we were seeking to develop a hazardous landfill site we certainly would not place it in the middle of a populated area. We would not place it in an area of high groundwater. Were the Vitro tailings not now there, it is doubtful that we could put comparably contaminated hazardous waste at that site no matter how badly we wanted to. Yet DOE is telling us in their DEIS that the Vitro site is a fine and acceptable location for long term stabilization. To leave the tailings there, as a final secure resting place flies in the face of the Congressional intent behind the Act, as well as railing against common sense.

20.7 We have been told repeatedly that DOE has not made a final selection, but that is is considering Alternatives 2 and 3 in an open minded fashion, not on the basis of economics alone. Yet DOE's direction is to perform remedial action, consistent with EPA standards, in the most cost effective manner. Their entire budget for remedial actions nationwide, at all tailings sites (not just Vitro) in 1983 is approximately 20 million dollars and in 1984, if their full appropriation request is granted, 27 million dollars. Considering the projected 61 million dollar cost of moving the tailings to the South Clive

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site, after deducting the State's 10% share, DOE would be left with an annual 3 year average price tag of approximately 18.3 million dollars for Vitro
20.7 alone. Their budget has obviously not been built to accommodate this. In light of this fact, we have to assume that DOE is under a great deal of pressure to propose and accept the stabilization in place alternative short of a "fatal flaw" which may be detected in the stabilization in place proposal.

By way of summary and conclusion, it is our belief that the proposed plan to leave the tailings in place is conclusively and ultimately "fatally flawed" for a number of reasons. The tailings pile is located within the groundwater system in the heart of one of the fastest growing metropolitan areas of the United States. Our valley has been inhabited for only 136 years, and will undoubtedly experience great growth and change in the coming years. In order for the stabilization in place concept to work successfully, stable hydrogeologic conditions must exist in the valley, including the present upward mobility of the under-ground aquifer, for a period of time exceeding up to 50 generations. Fifty generations--that's an awfully long time.
9.5 Additionally, there is no guarantee that the clay liner or slurry wall (or
9.4 less) containment systems proposed will last that long. Although there are theoretical arguments, there is no proven track record for such systems. As previously indicated, recent studies have proven that clay liners are more permeable and subject to failure than previously thought. And all the while the potential radiation hazard and the hazard of heavy metal poisoning of our water system will continue. If and when leakage, or other problems do develop in the future, as they well may, what costs and social problems will be incurred by remedial actions at this future time? And who will pay? Would the Vitro site be chosen as a final disposal site if it were not already there? Certainly not. We vigorously object to the federal fixation on cost which has forced DOE not only to propose but attempt to sell us an inadequate and short-sighted solution.

The uranium extracted at the old Vitro Site was done for the sake of national defense, for the good of all the citizens in the United States. It is a federally fouled nest in the heart of our city which both should and must not be a continuing burden to the residents of Salt Lake County. The only permanent, adequate, sure and acceptable solution to the problem lies in removal of the tailings. To do anything less is to leave our dependents a potentially terrible legacy.

000211

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 83/241

APR 5 1983

James A. Morley, Project Manager
Uranium Mill Tailings Project Office
Department of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Morley:

We have reviewed the draft environmental impact statement for Remedial Actions at the Former Vitro Chemical Company Site at South Salt Lake, Salt Lake County, Utah. The analysis indicates (p. C-13) that while reprocessing the tailings could recover 508,239 lbs of U_3O_8, 2,160,070 lbs of V_2O_5, and 283,753 lbs of Mo, having an estimated gross value in excess of $20 million, this would not be economical. We believe that the option of reprocessing this material should receive further examination before the opportunity to recover these mineral resources is foregone.

5.4 The preliminary studies were based on reprocessing of the tailings at a new process plant, using a heap-leaching process and we agree that this would not be economically feasible at today's prices. A similar alternative, however, involving reprocessing and disposal of the tailings at an existing uranium recovery plant (mill), apparently has not been considered. Although the cost to transport the tailings would be high, recovery of salable products at an existing plant, disposal of the tailings at a licensed facility, and the lack of costs for tailings disposal at the South Clive or Vitro sites might make this a feasible alternative.

5.3 Still another alternative that should be considered is burying the Vitro tailings below mine waste dumps generated by Kennecott Copper Corporation at their existing Bingham Canyon operation. These dumps already contain low concentrations of uranium which Kennecott has attempted to recover during ongoing, standard copper recovery operations. Economic and environmental advantages offered include:

(1) The Bingham Canyon leach dump area is close to the existing Vitro site, yet removed from population centers of the Salt Lake valley.

(2) The Vitro tailings could be effectively covered by large volumes of waste rock generated by existing operations at the Bingham Canyon mine.

(3) Potential recovery of residual uranium values could be incorporated into the existing copper cementation circuitry. Capital cost expenditures associated with recovering uranium and vanadium at a new plant site would be saved.

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(4) An existing waste site would be utilized, which probably would be at least as favorable environmentally as previous considerations (sec. 3.2.5.3) to dispose of the tailings by utilizing them in public construction projects, such as highway exchanges or airport runway extensions.

5.3 (5) Public goodwill would be gained by a private company in aiding the community to solve a long-standing problem.

Obviously, processing the tailings through either an existing uranium mill or a copper facility such as Kennecott's would require negotiations with and acceptance by the private operator. We do believe these alternatives are worth further examination before a final decision on remedial action is made. Moreover, we believe that these types of alternatives also should be considered during the course of studies for remedial action on uranium mill tailings at other sites designated under P.L. 95-604.

Specific comments are enclosed.

Sincerely,

Bruce Blanchard

Bruce Blanchard, Director
Environmental Project Review

Enclosure

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SPECIFIC COMMENTS

16.1 Page 8, Part 1.2.2 - This paragraph states that the Nuclear Regulatory Commission (NRC) will issue a license for the long-term maintenance and monitoring at the Vitro site (Alternative 2). Perhaps it would be appropriate that the statement include a specific commitment to develop a program to monitor the ground water, all seeps from the confinement area, and surface waters. This is very important and should not be left up to the NRC license process. The statement should also include commitments to provide security for the site as well as a program for proper maintenance of the confinement area.

6.3 Page 73, Part 4.6.2 - The statement indicates all the test wells at the Vitro site contain pollutants that violated the Environmental Protection Agency's safe drinking water standards. The statement also indicates that there are 121 domestic wells within 0.5 miles from the Vitro site. The statement did not indicate if the tailings contaminated any of these wells. If there is a pollution problem with any of these wells, removal would seem to be the wisest choice to make on the final disposal of the Vitro tailings. These wells should be tested and monitored for pollutants from the tailings.

6.2 Page 103, Part 5.1.1, 4th Paragraph - This paragraph states "...there is no evidence that the potable water drawn from deeper ground-water system under the Vitro site has been contaminated by tailings-derived materials." On page 72 (Part 4.6.2, 4th full paragraph), however, it states that some deep test wells contain gross alpha, radium - 226, and radium - 228. If these pollutants did not come from the tailings, what was the source?

Page 118, last paragraph - The long-term benefits of Alternative 2, stabilization-in-place, are mentioned but not those of Alternative 3, removal to South Clive. Apparently the stated benefits are only in relation to the No-Action Alternative. The long-term benefits of removal at the Vitro site would be greater than those of Alternative 2 since the potential of eroding the tailings in extreme floods would be eliminated.

6.2 The suggestion that a liner may not be worthwhile at the South Clive site seems to be borne out by the very poor quality of the underlying ground water (tables D-11, D-12). However, we believe that the concept that stabilization at the Vitro site might also be accomplished without a liner needs more extensive analysis. One of the deep Vitro wells is being considered for use as part of a public water-supply system (p. 73) and long-term withdrawals may locally reverse the present upward hydraulic gradient. The statement should analyze the potential for migration of pollutants already noted in the shallow ground water and of those which may continue to seep from the onsite tailings pile—both with and without a liner (tables D-5, D-6; p. 12). Physical-chemical properties of the soils that would underlie the Vitro site tailings and of any liner materials that might be considered should be included in the statement.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295-0699

APR 6 1983

Ref: 8AW-RC

Mr. James A. Morley, Project Manager
Uranium Mill Tailings Remedial Action Project
U.S. Department of Energy
5301 Central Avenue, N.E., Suite 1700
Albuquerque, New Mexico 87108

Dear Mr. Morley:

In fulfillment of our responsibilities under Section 309 of the Clean Air Act I am enclosing the comments by the Region VIII Office of the Environmental Protection Agency on the Draft Environmental Impact Statement (DEIS) for Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah (DOE/EIS-0099D).

According to the standard rating system we would rate this DEIS as ER-3, meaning that we have reservations concerning some aspects of the proposed study due to inadequate assessment of economic and certain environmental impacts. Specific comments or corrections are attached. In general, however, there are several significant points which may be cause for concern and which should be developed more completely in the final statement. These are the impacts on the Central Valley Water Reclamation Facility, the potential impacts of the action on groundwater at the Vitro site, and the often ambiguous or equivocal details of the various alternatives. Recalling that this site provided much of the impetus for passage of the Uranium Mill Tailings Radiation Control Act of 1978, it is surprising how many areas of the studies are still incomplete.

13.1 As you know, EPA Region VIII has had an involvement with the water quality needs of Salt Lake County which has paralleled the various radiological investigations at the Vitro site back to 1970, and even before. The plans leading to the decision to construct a regional wastewater treatment facility were not drawn in haste and involved the study and concurrence of a large number of municipalities and state agencies. Population growth along the Wasatch Front has strained the municipal facilities and led to serious water pollution problems. Further delays and uncertainties in the expansion of the Central Valley facility will only serve to exacerbate the problem. The stabilization-in-place alternative, as conceptually presented, may hamper current plant expansion to a capacity of 50 million gallons per day (mgd), and make it difficult to expand to 100 mgd without further land acquisition which is itself of questionable feasibility. The cost of the plant expansion
10.2 as presently conceived is estimated between 80 million and 100 million dollars. The economic impact of stabilization in place was given very

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superficial treatment, and the impact on the plant construction not stated at all. These important impacts require greater consideration, as it appears that stabilization in place may pose an economic and environmental burden on the people of Salt Lake County in the form of higher drinking water and waste
10.2 water treatment costs and/or degraded water quality. Futhermore, for a public works project of this magnitude, the EPA construction grants system would conduct a value engineering analysis of the project to identify the most cost effective alternatives and procedures to achieve a given set of goals. We would commend this approach to your attention as well.

The potential for contamination of groundwater at the Vitro site has been a long term concern as well, and, as noted in the DEIS (page 23), there is inadequate information upon which to project an impact. It is certainly clear that Salt Lake County in general will continue to grow at a rapid rate in the next decade or more, which will make additional demands on land and water resources. It is very likely that groundwater will be utilized more heavily
6.2 in the future than it is today, as witnessed by the proposal to use a Vitro site well in the community water supply system. Many private wells in proximately to the site are already drawing water from both the deep and shallow aquifers for domestic use. Additional information on this important issue should be made available as part of the NEPA process so it may be subject to the same critical review as the rest of the proposal. We understand that you are developing this information and we feel its inclusion in the final EIS is most important. The integrity of this groundwater data is also important, and we urge you to consider the EPA Quality Assurance guidelines for all sampling and analyses.

We are aware of the problems of trying to provide final disposal of this large volume of hazardous waste at either site noted in Alternatives 2 or 3. This material, even if it were not uranium mill tailings, would be classified as hazardous waste based on the extraction procedure (EP) test and the metals content. The EPA standards state, "Judgements on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the
2.4 stabilization. The decision on whether to institute remedial action, what specific action to take, and to what levels an aquifer should be protected or restored should be made on a case-by-case basis taking into account such factors as technical feasibility of improving the aquifer in its hydrogeologic setting, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water resource, the availability of alternative water supplies, and the degree to which human exposure is likely to occur". It does not appear that the provisions of these standards have been adequately addressed by the DEIS as they specifically apply to the Vitro site and the conceptual design for Alternative 2.

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9.1 There is a tone of uncertainty in the proposals which makes evaluation difficult for both Alternatives 2 and 3. For example, you note that a clay liner "may be required" at either the Vitro site or the South Clive site. Will this determination be made before the FEIS is issued? Since the final disposal/stabilization standards have been issued by EPA, many of these uncertainties should have been resolved by DOE prior to publication of this DEIS. Another question raised by Alternative 2 is the question of soil stability at the Vitro site. Construction at the wastewater treatment plant has necessitated preloading of building sites in order to achieve the required ground stability, and it seems reasonable that this would have to be done for
6.5 the stabilized pile as well. The effect of this huge mass on nearby buildings or roads is hinted at but never adequately explained. Present construction activities on the treatment plant have also demonstrated the need for constant dewatering, another uncertainty noted in the conceptual design.

We thank you for the opportunity to comment on this Draft Environmental Impact Statement. If you have any questions on any points of our review, please don't hesitate to contact Mr. John Giedt of our Radiation Programs Office at FTS 327-6008.

Sincerely yours,

Steven J. Durham
Regional Administrator

Attachment

Specific Comments by EPA Region VIII on the Draft Environmental Impact Statement on Remedial Actions at the Former Vitro Chemical Company Site...

8.5 1. p. 10 The maximum seismic acceleration estimated for both the Vitro site and the South Clive site is 0.2g. Since the Vitro site is so much closer to an active fault, this appears unreasonable. Futhermore the seismic potential is given a very cursory treatment for such an important issue.

9.1 2. p. 11 It is noted that the need for clay liners has not been demonstrated, yet elsewhere it is noted that available information on the groundwater situation (p.23) is incomplete. The decision on clay liners seems premature.

19.8 3. p. 22 paragraph 5, line 1 "affect" should be "affects"

6.1 4. p. 22-23 We assume the final EIS will include data from the studies described in part 3.1.4. We strongly recommend that DOE coordinate its hydrological studies with similar studies by Salt Lake County and USGS which are already in progress, as one of their sampling wells is located just west of the Vitro site. Any hydrologic studies should be done over a monitoring period sufficiently long to determine seasonal fluctuations.

14.3 5. p. 30 The construction impacts of Alternative 2 with the clay liner appear to exceed the impacts of other alternatives in terms of traffic and resultant accidents. This deserves additional attention.

17.3 6. p. 33 Any vegetation chosen for the stabilized pile should be selected with care so that the integrity of the cover material is not breached by deep-rooted plants. There are adapted grasses and forbs which may be useful in this regard to form a permanent sod. The material covering the clay cap should be of sufficient thickness that a saturated zone does not form above the clay, creating a zone which will encourage deep-rooted species. Deep-rooted vegetation can also encourage burrowing rodents. To maintain a healthy plant community, it should be cropped or grazed periodically. Temporary runoff and sediment control measures may be needed for up to three years before adequate plant cover is established.

6.2 7. p. 45 It is flatly stated that either Alternative 2 or 3 would meet the EPA water standards without any further explanation. It is further
6.3 stated that the ground water systems involved do not contain potable water, yet an on-site well has been proposed for municipal use and there are a number of domestic wells within a half-mile of the site. This should be clarified.

19.2 8. p. 48 "Dave Finerfrock" should be "Dane Finerfrock"

9.8 9. p. 71 Part 4.6.2 references a well "abandoned and capped in the early 1960's." If the statement is literally true, the well should be properly plugged to remove the potential for vertical cross-contamination in the future. The other wells which are not used should also be checked if Alternative 2 is chosen.

6.2 10. p. 72-73 Some deep wells are noted to contain high levels of gross alpha radioactivity, 226- and 228-Ra, and U_3O_8. What is the source of the contamination? Are contaminants present upgradient as well as downgradient?

11.5 11. p. 80 ORNL found "no contamination in Jordan River sediments," but there were studies by Dr. Robert Pendleton tracing contamination for some distance down the river in years past. Can you explain this? Also ORNL found the highest 226-Ra level on-site to be 560 pCi/g, which seems low compared to values measured by others. The exposure rate on the pile itself also seems low compared to past EPA measurements.

11.3 12. p. 106 DOE states that the factors used for the lung cancer incidence from radon daughter exposures overestimate the risk. EPA does not agree but rather contends the estimates used by DOE fall in the low to mid range of those by many groups. BEIR III states that for high LET radiations, the linear hypothesis is less likely to lead to overestimates of risk, and may in fact lead to underestimates. (See EPA's comments on the Canonsburg DEIS risk estimates.) We also disagree

12.1 (p. 107) that "all doses and health effects would occur within 10 kilometers of the Vitro site". While it is true that the radon from the pile diminishes rapidly with distance from the pile, the effect of that radon on the large population beyond the arbitrary 10 km distance can and should be assessed since even a small incremental dose to a large population will produce a definite population dose.

12.2 Since the BEIR III gamma risk estimates are based on misinterpretations of Japanese exposure data (which are now being reassessed), we recommend that until new risk factors are developed, BEIR I or other sources for gamma risk coefficients should be used.

19.2 13. p. 110 Table 5.3 is very confusing, mixing backgrounds and the limits from the EPA standards translated to dose. Furthermore it appears that the proposed, not the final, standards were used for inference.

6.2 14. p. 119 The possibility for the reversal of the present upward groundwater flow is mentioned, but it is simply stated that the effects are unknown. Can't this be modeled to obtain some tentative conclusions?

13.6 15. p. 128 The possibility of restrictions on the placement of building foundations near the stabilized mound is raised. Please explain the reason for this and its potential effect on the CVWRF expansion plans.

10.2 16. p. 129 The loss in lease income to the Central Valley board from the land which would be occupied by the stabilized pile could represent a substantial economic impact when projected over the years the pile will be there, yet this factor is hardly mentioned.

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6.2 17. p. A-24 The treatment of contaminant mobility seems unduly superficial, since it is likely that acidic, neutral, and basic environments can all exist depending on where in the system the contaminants might be.

9.4 18. p. A-32 Since the slurry wall depends heavily on the maintenace of an upward groundwater flow gradient for containment, the consideration of this option should include a careful review of the potential for flow reversal in the next 200-1000 years.

6.2 19. p. D-8 to 17 Tables D-4 to D-6 show differences between wells sampled at 15-40 feet depth and those at greater than 85 feet depth. Arsenic, boron, iron, magnesium, manganese, sodium, strontium, uranium, gross alpha and beta, thorium, lead, & polonium are present in elevated concentrations in the shallower wells. It should be determined if they are from the pile and if a plume can be defined, as suggested on page 122, before deciding what the impact is on groundwater.

10.2 20. p. E-6 to 10 The projected growth for Salt Lake County and the development of industrial land in South Salt Lake by the year 2000 would seem to make the economic cost of land withdrawal fairly high to the municipality.

9.8 21. p. F-11 "Pb-201" should be "Pb-210"

19.3 22. p. F-14 In common physics and chemistry parlance, "standard temperature" is 0°C, not 70°F.

19.4 23. p. F-19 to the end: Presumably the rest of the monitoring data from the TLD's, etc. will be presented in the final EIS.

19.8 24. p. F-41 "100 m" should be "100 um"

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RESOLUTION
83 - 11

A RESOLUTION OBJECTING TO DUMPING CONTAMINATED VITRO TAILING IN TOOELE COUNTY, UTAH

WHEREAS, the Federal Government through the Department of Energy is considering relocating the uranium tailings from the Vitro Plant located at 3300 South 300 West, Salt Lake City, to Clive, Utah, a location in Tooele County; and,

20.1 WHEREAS, the citizens of the City of Tooele do not favor said relocation of these tailings and further recognize the serious economic, environmental and physical harm which our City

10.5 and County may experience from this relocation and repository of this low level radioactive waste; and,

WHEREAS, by becoming the repository for this nuclear waste, Tooele County will, to a great extent, be limited and prohibited

13.7 from the future use of these remote lands for other taxable operations, such as, but not limited to, chemical plants; and,

WHEREAS, The Citizens of Tooele City deem it to be in their best interest to minimize this economic impact; and,

WHEREAS, in an attempt to minimize the negative economic impact which shall result from these tailings being relocated and redeposited in Tooele County, and to increase the employment rate within our County.

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Tooele, as follows: That the following minimum requirements and conditions shall be met by the Federal

17.1 Government in relocating the Vitro Tailing to Tooele County; and Congress shall inact as follows:

1. That in the bidding procedures for the facility to be constructed in Tooele County to house the tailing, the transportation of the tailing and any and all other construction related thereto, Utah Licensed contractors shall be given a 5% preferential treatment in all bidding procedures.

2. Further, in addition to the 5% incentive to Utah contractors as stated in No. 1 above, Tooele County Contractors shall be given an additional 5% incentive, in all bidding procedures for

construction on this project.

17.1

3. The Federal Government shall pay to Tooele County as payment in lieu of taxes for the use of the land for these tailings, as well as all land within our County which are impacted and either limited in future development or prohibited from future development, by the placement of these tailings in Tooele County.

4. Payment shall be made to Tooele County at the same or similar rate assessed for chemical plant locations and said sum shall compensate Tooele County for the loss of a potential chemical plant site, and the resulting economic loss to the County and the citizens thereof.

5. All moneys paid by the Federal Government to Tooele County pursuant to No. 3 and No. 4 above shall be distributed to the local governments which represent the citizens of Tooele County.

DATED THIS 6th day of April, 1983

Resolution 83-11: A Resolution Objecting to Dumping Contaminated Vitro Tailing in Tooele County, Utah

Page 3

TOOELE CITY COUNCIL

(For)	(Against)
[illegible]	
Harvey E Wright	
[illegible]	
Raymond Johnson	

TOOELE CITY MAYOR

(For)	(Against)
John K Luff	
ABSTAINING	

SEAL

Cynthia Baker

Cynthia Baker, Tooele City Recorder

Approved as to Form: [illegible]

Effective Date: 04-06-83

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The maximum impact of the project on regional employment would be 207 to 317 jobs depending on the transport option chosen. These figures include incremental employment in the supply industries of 20 jobs. The majority of these jobs would be created in Salt Lake County. The maximum effect of project-related employment on total County employment would be an increase of approximately 0.1 percent over current (1982) levels. If one-half of the new direct and indirect jobs were filled by Tooele County residents, Tooele County employment would increase by approximately 1.5 percent.

The creation of up to 317 jobs during the construction phase of the project, and 705 jobs in connection with the industrial park will not result in significant inmigration into the area in response to the employment opportunities. In addition to the reasons noted in connection with the discussion of Alternative 2, above, unemployment among warehousemen, shipping and receiving personnel and clerks is currently between 20 and 25 percent in the Salt Lake City area (State of Utah, Job Service, June 1983). These are the types of skills that employers in an industrial park which catered to warehousing and distribution activities would be seeking. In addition, unemployment in Tooele County is currently (May 1983) 9.9 percent. Unemployment during 1982 also was 9.9. percent (State of Utah, Job Service, 1983).

5.10 IMPACTS ON HOUSING, COMMUNITY SERVICES, AND SOCIAL STRUCTURES

Alternative 1

The no-action Alternative would not affect housing, community services, or social structures in either Salt Lake County or Tooele County, the county in which the South Clive site is located.

Alternative 2

Alternative 2 would not measurably affect housing, community services, or social structures in either Tooele County or Salt Lake County.

Any project related growth in Salt Lake County would be minuscule in comparison to the current (1980) growth rate, which is estimated to be 3.5 percent per year or about 22,000 persons per year.

Alternative 3

Alternative 3 would not measurably affect housing, community services, or social structures in Salt Lake County or Tooele County.

As explained in connection with Alternative 2, any project-related growth in Salt Lake County would be minimal compared to the current (1980) growth rate of 3.5 percent per year. This corresponds to approximately 22,000 persons per year. To the extent that construction-related employment opportunities result in an inmigration of workers into Tooele County, there could be a small and short-term impact on the availability of temporary

housing. However, for the reasons previously stated, it is anticipated that construction-related employment opportunities will be absorbed by the local labor force. This is due, in part, to the unemployment rate in Tooele County which is currently (May 1983) 9.9. percent, as well as the high unemployment rate among skilled construction workers in the region. In addition, it is estimated that 5.3 percent of the housing stock in Tooele County (8,566 units) is vacant. Therefore, to the extent that Alternative 3 results in inmigration into Tooele County, the impacts on housing and social structure are expected to be minimal.

As previously noted, the CVWRF has stated that it will develop a temporary industrial park on the 3300 South Street portion of the Vitro site if Alternative 3 is the adopted remedial action. Based on this assertion, it is estimated that development of the temporary industrial park will result in 271 direct jobs and 434 indirect jobs (Appendix H). This corresponds to less than 0.3 percent of total employment in Salt Lake County as of the second quarter of 1982 (273,848; Utah Department of Employment Security, 1982). It is anticipated that the majority of these employees would be drawn from the local work force. Unemployment among warehousemen, shipping and receiving personnel, and clerks in the Salt Lake City area is currently estimated at 20 to 25 percent (State of Utah, Job Service, 1983).

5.11 IMPACTS ON ECONOMIC STRUCTURE

Impacts on the economic structure of Tooele County, Salt Lake County, and South Salt Lake, arising from implementation of the two action alternatives would range from no impact to a very small impact.

Alternative 1

Economic conditions detailed in Sections 4.12.2 for the State, Tooele and Salt Lake Counties, the cities of South Salt Lake, Tooele, and Grantsville would be expected to continue under the no-action alternative.

Alternative 2

Alternative 2 would have no predictable impacts on the economy of Tooele County.

Impacts of Alternative 2 on the economy of Salt Lake County would result from wages and benefits paid to employees and the purchase of materials, supplies, and services from local vendors. The largest contribution to the economy would be wages and benefits.

Wages paid to project workers are projected to total $5.9 million up to completion of stabilization based on the employment schedule in Appendix A. Assuming benefits total 30 percent of wage costs, $1.77 million in benefits would also be paid during stabilization.

Assuming that the respending of income would result in total personal income of 2.0 times the original income derived from wage and benefit

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payments and an 18.8-percent-average tax rate for stabilization activities, personal income in Salt Lake County would rise by a total of approximately $13.1 million due to stabilization at the Vitro site. Because this income-multiplier effect occurs as income is respent, some time would elapse after wages are paid before the full effect would be realized.

The impact of this increase in personal income on the Salt Lake County economy would be negligible given the current size of personal income for the County. Even if the $13.1 million was realized in a single year, it would still represent approximately a 0.06 percent increase in the net Salt Lake County personal income (1980).

Purchase of materials, supplies, equipment, and minor services during Alternative 2 will amount to approximately $16 million. Monitoring equipment may cost an additional $500,000. Construction materials, supplies, and equipment would most likely be purchased or leased from local vendors. To the extent that major equipment purchases or leases are made out of state, the personal income associated with these purchases would accrue to out-of-state residents.

Wage payments for the project would increase state and Federal income tax receipts. Based on an estimated average net state income tax rate for stabilization activities of 3.7 percent, state income taxes would amount to $218,000 during stabilization. The Federal income tax rate is estimated to be 15.1 percent of the total wages paid during stabilization. Thus, Federal income tax payments would amount to $891,000 during stabilization. The respending of wage income would also result in increased state and Federal income taxes; however, this induced income would be realized in a number of forms (individual and corporation income, interest income) and is, therefore, not quantified in this analysis. Local purchases of supplies, equipment, and materials would also result in increased state, sales, use, and gasoline taxes.

Alternative 3

Stabilization south of Clive would result in wage payments to residents of both Salt Lake County and Tooele County, increasing personal income in both counties. This impact, while beneficial, would be very small given the present magnitude of personal income in the combined counties.

Wages paid to project workers are projected to be $7.2 to $11.7 million up to the completion of stabilization at South Clive depending on the transport option choosen. These estimates are based on the employment schedule in Appendix A. Assuming benefits total 30 percent of wage costs, benefits would total $2.16 to $3.51 million. Eighty percent of these wages are assumed to be paid to Salt Lake County residents and 20 percent to Tooele County residents.

Much of the personal income accruing to Tooele County residents is ultimately spent in Salt Lake County, which provides many of Tooele County's goods and services. Thus, the income multiplier is much lower in Tooele County than Salt Lake County because of income "leakage" to Salt Lake County.

If an income multiplier of 1.5 is assumed for Tooele County, the total personal income derived in the county from wage payments to Tooele County residents would be $2.4 to $3.9 million during stabilization at the South Clive site (assuming a tax rate of 18.8 percent). This would represent a maximum increase of approximately 2.2 percent in the current total county personal income.

Assuming that an income multiplier of 2.0 applies to wage and benefit payments to Salt Lake County residents and that a multiplier of 0.4 applies in Salt Lake County to wages paid to Tooele County residents, approximately $13.5 to $21.9 million in total personal income would accrue to Salt Lake County residents from wage payments during stabilization. This would represent a maximum increase in the total Salt Lake County personal income of approximately 0.1 percent.

In Alternative 3, purchases of materials supplies, equipment, and minor services would amount to approximately $52 million for the train transport option and $50 million for the truck transport option. These figures include all nonlabor and site acquisition costs. The majority of the materials, supplies, and equipment would be purchased or leased from local vendors. The income that would be realized in the local economy from these purchases/leases is included in the analyses in the preceding paragraphs. To the extent the major equipment purchases or leases are made out of state, the personal income associated with these purchases would accrue to out-of-state residents.

Based on an estimated average Utah state income tax rate for stabilization activities of 3.7 percent, state income tax receipts would amount to $266,000 to $433,000 during stabilization. The Federal income tax rate is estimated to be 15.1 percent of the total wages paid during stabilization. Thus, Federal income tax payments would amount to $1.1 to $1.8 million during stabilization. The respending of wage income would also result in increased state and Federal income taxes; however, this induced income would appear in a number of forms (individual and corporate income, interest income) and is, therefore, not quantified in this analysis. The State of Utah would also receive sales and use taxes from purchases of materials, supplies, and equipment for the project.

The South Clive site is in state ownership under the control of the Division of State Lands and Forestry. If lands are purchased from the State of Utah, the purchase price would be at the fair market value of the land (about $50 per acre). If a lease were used, the annual cost would be the prime interest rate times the fair market value of the land permitted for use. No other permit charges would be levied for use of the South Clive site.

5.12 IMPACTS ON TRANSPORTATION NETWORKS

Alternative 1

With the no-action alternative, transportation networks and their traffic loads would be as noted in Section 4.12.6.

Alternative 2

The impact on transportation networks of stabilization at the Vitro site would be limited to haul trucks, miscellaneous deliveries, and employee commuter traffic. Access to the site would be via a new entrance which would feed 900 West Street approximately 1200 feet north of 3300 South Street. Miscellaneous deliveries and commuter trips would be expected to impact the intersection of 3300 South Steet and 900 West Street. Haul trucks would not impact this intersection or any of 3300 South Street. The expected haul route would be north on 900 West Street to 21st West Street, then west on 21st South Street to 5600 West Street, then south on 5600 West Street to 5400 South Street, then west on 5400 South Street to 6000 West Street--a distance of approximately 13 miles. Although this is not the most direct haul route it avoids impacting 3300 South Street as well as residential areas. Hauling would avoid peak-hour traffic periods. Heavy construction equipment would be stored at the site. The primary source of project traffic would be commuting by workers and truck hauling of the estimated 1.865 million cubic yards of fill needed for stabilization and restoration. A maximum of about 210 daily trip-ends at the site is expected based on the manpower schedule in Appendix A. Assuming each haul truck carried 26.5 tons, about 200,000 trip-ends at the site would be necessary over an approximate 510 working-day period, for an average of about 395 trips per day. Assuming that miscellaneous trip-ends at the site would total about 50 per day, a total of 655 vehicle trip-ends at the site are projected.

Table 5-10 shows the expected impacts to the local roadway network as a result of Alternative 2. The maximum percentage increase along the affected network is estimated to be 8.5 percent. This maximum increase would be along 5400 South Street. However, this roadway, and all other roadway segments along the haul route, would be expected to show no signs of significant congestion as a result of the remedial action. The increase in roadway surface loading from the haul truck would be expected to require maintenance of portions of the haul route which are not designed to withstand these types of load cycles. This could include surface patching, complete resurfacing, or structural maintenance.

Table 5-10. Current, projected, and projected with remedial action average daily traffic (ADT) along the haul route. Alternative 2.

Roadway section	1982[a] ADT	Estimated 1986[b] ADT	1986 plus remedial action ADT
900 West between			
2100 S & 3300 S	9300	10,265	10,920[c]
2100 South between			
900 W & 1200 W	56,775	62,670	63,065
1700 W & 3200 W	40,285	44,470	44,865
3200 W & 3600 W	27,600	34,465	34,860
3600 W & 5600 W	25,325	27,950	28,345
5600 West between			
2100 S & 3500 S	10,725	11,840	12,235
3500 S & 3600 S	8350	9215	9610
4100 S & 5400 S	7225	7975	8370
5400 South between			
5600 S & West	4200	4635	5030

[a]UDOT, 1984.
[b]Assuming a 2.5% per year increase in traffic.
[c]Includes all commute and miscellaneous trips.

Alternative 3 - Train

Stabilization south of Clive would result in increased road traffic to the South Clive site and the Vitro site, as well as increased rail traffic on the Denver and Rio Grande Western and the Union Pacific rail lines between the Vitro and South Clive sites. The increase in road traffic (a maximum of 110 trip-ends per day) near the South Clive site would not be significant since traffic levels on I-80 are well below the highway's capacity and because of the low level of worker and heavy-equipment traffic projected for the site. Heavy equipment used at either site would be stored at the site. Workers commuting to and from the Vitro site would add an average of approximately 145 commute period trip-ends per day and a peak of approximately 160 commute period trip-ends per day to traffic volumes on access roads to the Vitro site, primarily 3300 South Street and 900 West Street. Assuming miscellaneous trips total 50 per day (ingress and egress), approximately 210 vehicle trips per day, or less than 1 percent of current traffic levels, would be added to 3300 South Street and 900 West Street. The impact of this level of traffic would be small.

Vitro site restoration would require the importation of approximately 1,040,000 cubic yards of material from the borrow site identified in

Alternative 2. It is anticipated that this would be accomplished using a fleet of seventeen, 18.5 cy-haul trucks. This fleet would increase the average workday traffic along the haul route by about 170 trips per day over the 625-workday period. Workers commuting to and from the Vitro site would be expected to add 50 trip-ends per day. These would be expected to occur during the morning and evening peak hours. Miscellaneous trips are assumed to add 50 nonpeak-hour trips per day to the local network. Therefore, the Vitro site restoration phase (train) would be expected to increase traffic by a maximum of 4 percent along the haul route and less than 1 percent to the local network.

Rail traffic between the Vitro and South Clive sites would be two unit-train trips per day. Discussions with representatives of the Union Pacific railroad indicated that no difficulties would be encountered in scheduling this level of rail traffic.

Alternative 3 - Truck

Stabilization at the South Clive site using 35-ton capacity trucks to transport the contaminated materials from the Vitro site to South Clive would increase road traffic between the two sites and along the commuting routes to these sites. This option would have no effect on the rail systems in the area. It is expected that this option would add a maximum of approximately 50 commute trips per day to the roadway network near Clive. This increase in road traffic near the South Clive site would not be significant since the traffic levels on I-80 are well below the highway's capacity. Heavy equipment used at either site would be stored at the sites. Worker commuting to the Vitro site would add an average of about 230 and a maximum of 260 commute period trips per day to the access roads to the Vitro site. Contaminated materials hauling is estimated to add 300 trips per day along the haul route to the South Clive site. Assuming miscellaneous trips to this site total 50 per day, approximately 610 vehicle trips per day would be added to the local roadway network near the Vitro site. All of the haul trips (300 per day) would be impacting 900 West Street to 2100 South Street, 2100 South Street, through Magna, to its intersection with I-80 and I-80 to the South Clive site. These roadway segments have sufficient traffic capacity to accept this level of increased traffic (UDOT, 1984). However, portions of 2100 South Street, in particular the older, two-lane sections, may not have sufficient structural capacity to withstand the loads of the haul truck without periodic maintenance to the surface or structural components of the roadway.

Vitro site restoration for this option could be the same as site restoration for the train option except that slightly more clean fill would be required to be imported. The truck fleet would be increased to produce approximately 190 trips per day. The additional 20 trips per day over the train option would not significantly change the consequences of the increased traffic along the haul route or local roadway network.

5.13 USE OF ENERGY AND OTHER RESOURCES

Each of the action alternatives would require the use of electricity, fuel, water, manpower, and construction materials. The use of water,

manpower, and soils would not be a commitment of nonrenewable resources, but the uses of electricity, engine fuel, concrete, and nonsalvageable steel would be. The amounts of electricity, engine fuel, and concrete used in Alternatives 2 and 3 are shown in Table 5-11.

Electricity would operate the lights and the dewatering pumps at the Vitro site. Electricity at the South Clive site could be provided by an on-site generator powered by engine fuel. Engine fuel would be required for the earthmoving equipment and construction-related machinery used in both alternatives; it would also be used to power the railroad engines that move railroad cars in Alternative 3. All of these electricity and fuel requirements are tabulated in Table 5-11. Engine fuel and electricity are in ample supply in the Salt Lake City area .

Minor amounts of concrete would be needed to construct the foundation for the railroad unloading equipment at the South Clive site.

Table 5-11. Energy and other resource requirements

Resource	Alternative		
	2	3 (train)	3 (truck)
Electricity (kwh)	400,000	800,000	800,000
Engine fuel (gal)	2,520,000	6,970,000	7,121,000
Concrete (cu yds)		400	0

5.14 NONRADIOLOGICAL IMPACTS OF ACCIDENTS

In the two action alternatives, the major potential hazards would be those typically associated with construction sites, i.e., equipment-related hazards and the hazards of falling into excavations. There would also be potential transportation hazards involving truck drivers and other highway users and railroad workers. The expected numbers of work-related accidents have been calculated for each action alternative; the results of the calculation are summarized in Table 5-12.

Table 5-12. Expected number of work-related accidents[a]

Type	Alternative 2	Alternative 3	
		Train	Truck
Accidental deaths among:			
Construction workers[b]	0.025[d]	0.066	0.045
Truck drivers	0.13	0.07	0.47
Railroad crews	--	0.004	--
Disabling injuries[c] among:			
Construction workers[b]	9.45	24.6	16.9
Truck drivers	2.16	1.25	8.04
Railroad crews	--	0.90	

[a]Calculated using manpower schedules in Appendix A, and incidence rates given in DOT, 1977; Ramana et al., 1982; and NSC, 1982).

[b]Construction workers do not include administrators, managers, aides, monitoring personnel, or secretaries.

[c]A "disabling injury" is an injury involving death or lost work days.

[d]The expected number of deaths can be related to the individual worker's chances of death in an accident if the size of the work force is known. For example, "0.025 expected accidental deaths" among a work force of about 58 workers (Alternative 2) means that each worker's chance of a fatal accident would be, on the average, 0.025/58 = 0.0004 or 0.04 percent.

5.15 RELATIONSHIP TO LAND USE PLANS, POLICIES, AND CONTROLS

Alternative 1

The entire Vitro site is owned by the Central Valley Water Reclamation Facility (CVWRF) Board. The current plans to establish a temporary industrial park, a regional waste-water treatment plant, a waste-recycling facility, and a municipal ground-water pumping facility at the site (all described in Subsection 4.9.1) might not be implemented under the no-action alternative. Expansion of the CVWRF facility to 100 million gallons per day (mgd) depends on the relocation of the tailings within the site by the Federal government. The CVWRF Board began construction in 1981 and the expansion of the facility to a capacity of 50 mgd is continuing.

The no-action alternative would not affect the zoning in the area of the Vitro site. The south portion of the Vitro site is currently zoned for business uses. However, the development of a temporary industrial park along the 3300 South Street corridor, which would require a zoning change, might have to be abandoned if the no-action alternative were implemented.

Alternative 2

Implementation of Alternative 2 would, in the short term, conflict with the CVWRF Board's proposed plans for leasing a 300-foot strip of the site along 3300 South Street to business interests. In the long term, implementation of Alternative 2 could force the CVWRF Board to revise plans for expanding the waste-water treatment plant to a capacity of 100 mgd. However, under Alternative 2 approximately 20 acres in the southwest portion of the site will be available for development. Potential uses include a temporary industrial park, a municipal solid waste-to-energy facility and a municipal ground-water facility (see Section 4.9.1).

Alternative 3

As stated above, the CVWRF Board's long-term plans for development of the 128-acre Vitro site apparently depend upon the decontamination of the site by the Federal government. Implementation of Alternative 3 would realize these expectations, and would be in accord with the CVWRF Board's planning.

Alternative 3 would not seriously conflict with land-use plans for the South Clive site. Although most of the land within a 10-mile radius of the South Clive site is public domain administered by Bureau of Land Management (BLM), the section on which the actual disposal area would be located is owned by the State of Utah. Sheep grazing, transportation, hunting, and recreational-vehicle driving are the only uses made of this section of land. The State derives some revenue from the section by issuing grazing and mineral exploration permits, but otherwise it has no plans for use of the South Clive site. Tooele County has no zoning designations within a 10-mile radius of the site.

5.16 UNAVOIDABLE ADVERSE IMPACTS

The major adverse impact of Alternative 1 would be the continued presence of above-background levels of radiation at and near the Vitro site and the continued exposure of workers and the public near the site to enhanced concentrations of Rn-222 and its daughter products. A second impact of Alternative 1 would be the inability of the CVWRF to expand its sewage-treatment plant to 100 mgd.

The major adverse impact of Alternative 2 would concern land use: the CVWRF Board would not be able to use 53 acres of the 128-acre site; however, Alternative 2 would permit most anticipated uses for the 75 acres of the land that would be decontaminated. Temporary but nevertheless unavoidable impacts of Alternative 2 would be construction noise, dust from construction activities, and some increase in the traffic on routes leading to the southern boundary of the site. Also, workers on the site would be unavoidably exposed to above-background levels of radiation during the 2.5-year term of the remedial actions.

As in Alternative 2, the major adverse impact of Alternative 3 would fall on plans for land use. But in this case, the impact would fall on the State

of Utah's plans for using the South Clive site as a revenue-producing property. The long-term impact of Alternative 3 on the Vitro site would be wholly beneficial in that all of the 128-acre tract would be decontaminated and used according to the CVWRF Board's current plans. Temporary but nevertheless unavoidable impacts of Alternative 3 would be similar to the ones in Alternative 2; there would be noise and dust from construction activities at the Vitro site, and construction workers, truck drivers, and railroad crews would be exposed to above-background levels of radiation during the 3-year term of remedial actions.

5.17 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Alternatives 2 and 3 would require the same types of resource inputs. These include electricity, engine fuel, backfill and cover material, manpower, water, and land. The only resources among this list that are irretrievably lost after use are electricity and engine fuel; the amounts of these resources that would be used in the two alternatives are detailed in Section 5.13. The use of water is not a permanent commitment of a resource. Even the use of backfill and cover material, and land in general, would not be completely permanent commitments; if permitted by law, either of the two alternative disposal sites could be reexcavated in the future and the materials and mineral values they contain could be salvaged.

5.18 RELATIONSHIP BETWEEN THE SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Under Alternative 1, no action, there would be no short-term use of the environment. Full development of the long-term productivity of the Vitro site lands would be precluded for an indefinite period of time since unstabilized tailings would remain on the site.

In Alternative 2 the Vitro site and its immediate surroundings would experience the inconveniences of construction activities for 2.5 years; there would be noise and dust from these activities, some increase in traffic congestion, and construction workers would be subject to above-background levels of radiation. This period of inconvenience would, however, lead to a substantial increase in the long-term productivity of the 128-acre tract. In fact, the amount of potentially productive lands on the site would increase from nearly zero acres to 75 acres.

Under Alternative 3 the Vitro site and the South Clive site would experience construction activities for 3 years. As in Alternative 2, there would undoubtedly be inconveniences to the owners and neighbors of the Vitro site from these activities. Potential inconvenience to persons near the South Clive site is considered to be negligible. But again, the 3-year period of inconvenience in Alternative 3 would lead to an even more substantial increase in the long-term productivity of the 128-acre tract; it would cause the entire site to be potentially useful land. The 60-acre (55 acres for the embankment, 5 acres for ancillary facilities) South Clive site would, on the other hand, be permanently removed from public or private use. Since the potential

productivity of the Vitro site is so much larger than that of the South Clive site, the net long-term productivity of lands would be enhanced by Alternative 3.

5.19. MITIGATION MEASURES DURING THE REMEDIAL ACTIONS

Several mitigation measures to be taken during the action alternatives have already been described in previous sections of this document. These measures are planned ones and would be adopted as part of the normal procedures during construction activities. Such planned mitigation measures are briefly recapitulated in this section. The major emphasis of this section will be upon those mitigation measures that are possible but to the implementation of which neither the DOE nor the State of Utah have committed themselves at this time.

5.19.1 Mitigation of impacts on land use

There are no planned actions for mitigating the impacts on land use in any of the three alternatives. Some possible mitigation measures are the following ones.

As stated before, the major impact on land use of Alternatives 1 and 2 derives from the inability of the CVWRF Board to expand its sewage-treatment facility to 100 million gallons per day if any tailings are left on the 128-acre site. To mitigate this impact, the State of Utah might acquire uncomtaminated, vacant lands adjacent to the site and exchange them with the CVWRF Board for all or part of the presently contaminated 128-acre tract, depending on whether Alternative 1 or 2 is implemented. The CVWRF Board would of course have to change their long-term development plans under either alternative, so this possible but-not-proposed land exchange may not totally mitigate the adverse impacts of Alternatives 1 and 2 on land use. It should also be noted that under Alternative 2, 20 acres in the southwest portion of the Vitro site will be available for development. To the extent that development consistent with the CVWRF's approved Master Plan is undertaken, it will be possible to partially mitigate the adverse impacts of Alternative 2.

As stated before, the impact on land use of Alternative 3 derives from the loss of the South Clive site by the State of Utah as revenue-producing lands. To mitigate this impact, the DOE might acquire an adjacent section of Federal lands and exchange it with the State of Utah for the section of State land that contains the South Clive site.

5.19.2 Mitigation of impacts of releases of radiation

Planned actions for mitigating exposure of construction workers to radiation during Alternatives 2 and 3 include dampening exposed contaminated material or covering it with sealants, tarps, and plastic sheeting to prevent dust blow off; stopping the handling of contaminated materials during periods of heavy wind; the provision on request of protective equipment such as masks to the remedial-action workers; and the use of lids and plug seals on the rail cars that carry the materials in Alternative 3. Contamination of the railroad

bed would be prevented by the washing down of the rail cars before they leave the construction sites. Public exposure to radiation during the construction phases would be limited by restricting access to the project's sites.

If Alternative 1 should be implemented, a possible action that would somewhat mitigate exposure to radiation would be the following: either the DOE or the State of Utah might fence the more-contaminated parts of the 128-acre site and suppress dust by wetting down those areas in periods of dry weather and heavy wind. This action might also include direct surveillance of the fenced site by security personnel, in order to prevent further removal of tailings from the site and the concomitant creation of new "vicinity" properties.

5.19.3 Mitigation of impacts on water

Planned actions for mitigating the impacts of construction activities on surface waters during Alternatives 2 and 3 include using evaporation ponds for the isolation of construction-process water that exceeds the permission-to-discharge standards; and constructing temporary dikes to contain potentially contaminated runoff waters that form during heavy rains.

5.19.4 Mitigation of impacts on noise

The construction-activity plans for Alternatives 2 and 3 would include some means for reducing the impacts of noise whenever and wherever it is necessary. Mufflers would be used on vehicles and equipment, and noisy activities at the Vitro site would be scheduled for daytime hours. The haul routes were selected to avoid sensitive receptors.

5.19.5 Mitigation of impacts on transportation networks

The commercial suppliers of cover and fill in Alternatives 2 and 3 would be required to use only those high-capacity roads that lead to the Vitro site as described in Section 5.12 and to avoid schedules and routes that could cause annoyance to the public and congestion of high-use intersections. If required, structural maintenance of the haul route would be incorporated into the project design plans.

In Alternative 3, the use of the railroads to transport materials between the two sites and the choice of the South Clive site are planned actions intended to mitigate impacts on transportation networks. The use of the railroad for transporting the material would avoid the additional congestion of heavily travelled public highways that would be caused by a fleet of 35-ton capacity trucks (it would take 77 such trucks making two round trips per day to carry the 5400 tons per day that the railroad would carry).

5.19.6 Mitigation of impacts from seismic events

Vitro

The results of a seismic risk study, as described by Sergent, Hauskins and Beckwith (1983), at the Vitro site are presented in Appendix H. The study

concluded that saturated zones within the tailings and zones of the native soils below the water table are susceptible to seismically induced liquefaction. If the Maximum Credible Earthquake (MCE) were to occur with the saturated conditions of the subsoils and tailings, the side slopes of the final embankment could slide. The remedial action as described in this document contains a mitigation for the seismically induced liquefaction. As explained in Appendix A, all of the tailings will be excavated, and compacted in the embankment. The movement and mixing of the tailings will desaturate the material. As the material is replaced it will be compacted in lifts to stabilize the base of the embankment for the placement of the remaining material and the cover. The desaturated tailings will no longer be subject to liquefaction. Should a major seismic event occur, liquefaction of the subsoils below the embankment is possible. However, the damage to the embankment would be reduced to minor surface cracking of a few inches. Any damage to the cover poses no hazard to the public and could be easily repaired.

South Clive

At the South Clive site, the potential for damage is much less since the chances of seismically induced liquefaction are much less than for the Vitro site. Additionally, the tailings would be dewatered, mixed, and compacted during placement so as to reduce the possibilites for within-embankment liquefaction to a very low level. An MCE would still probably cause some minor cover cracking, most of which would be self-healing; but this damage would pose no hazard and would be easily repairable.

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6 PUBLIC AND AGENCY COMMENTS

This chapter discusses the comments made by private citizens and government reviewers (Federal, state, and local) on the draft environmental impact statement (DEIS) for remedial actions at the former Vitro Chemical Company site in South Salt Lake, Utah.

Comments on the DEIS were obtained from the public, citizens groups, and government agencies during 2 days of public hearings and a 52-day* written-comment period. The public meetings were held in Tooele and South Salt Lake, Utah, on March 22 and 23, 1983. A total of 53 persons presented oral statements on the DEIS. Twenty-six letters, some longer than 20 pages, were received during the written-comment period. Table 6-1 lists the persons who presented oral statements at the public hearings, and Table 6-2 lists the persons, groups, and agencies that submitted written comments. (These tables may be found at the end of Section 6).

To put all the comments in an easily accessible form, each oral statement (recorded by a certified stenographer) and letter was analyzed in detail, and comments on specific issues were identified. A preliminary outline of this chapter was prepared, and each comment was categorized according to the subsections of this outline. Notebooks were prepared in which all comments on a specific topic (e.g., ground water at the Vitro site) were brought together in one place. This system allowed the preparers of this FEIS to consider all comments received on a topic while revising the parts of the document dealing with that topic.

To consolidate the discussion of the voluminous response to the DEIS, the comments have been grouped into 19 major topics that cover all the substantive comments received. Each of these topics deals with one or more issues, which are listed in this chapter as part of the discussions of the 19 topics. This chapter summarizes the topics and issues and the responses of the DOE to the comments. Where the responses required changes in the text of the DEIS, they appear in the main text of this FEIS. For example, the State of Utah disagreed with the cost estimates presented in the DEIS. In responding to this comment, the DOE has met with the state to compare details of its cost estimates with those of the state and has changed its estimates to those presented in Table 1-3 and Appendix A. Finally, a twentieth section was added to include those comments that did not directly comment on the DEIS, but which should be acknowledged and, in some instances, responded to.

Sections 6.1 through 6.5 discuss the legal basis of the proposed remedial action and the choice of alternatives. Sections 6.6 through 6.10 discuss sites (Vitro and South Clive), various matters related to the engineering designs of the alternatives, and the direct and indirect costs of the alternatives, including the requests for a more thorough economic analysis of the project.

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*The EPA notice of availability of the DEIS was published in the Federal Register on February 18, 1983 (Vol. 48, p. 2794-2796). This notice allowed a 52-day comment period, through April 11, 1983. However, all written comments received by the DOE were considered in this final environmental impact statement (FEIS).

Sections 6.11 through 6.15 discuss comments on the noneconomic impacts of the alternatives: the radiological and nonradiological impacts of routine portions of the remedial actions and of the accidents that may occur, as well as comments on land use and psychological impacts. Sections 6.16 through 6.18 discuss monitoring during and after the remedial action, mitigation of impacts, and archaeology. Section 6.19 discusses those comments which are editorial in nature.

Finally, Section 6.20 discusses the comments that dealt with topics considered to be outside the scope of this FEIS.

Table 6-3 at the end of Section 6 provides an extensive set of cross-references between the substantive issues and the letters and oral statements providing comments.

Section 6.21 of this FEIS reproduces in full the written comments received on the DEIS. Transcripts of the public hearing, are available for inspection at each of the public reading rooms and libraries listed at the beginning of Section 6.21.

6.1 COMPLIANCE WITH NEPA

The compliance of the Vitro DEIS with the National Environmental Policy Act (NEPA) and with the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA was commented on in 5 letters and 3 oral statements. The comments are summarized below. A response to each issue is also provided.

1. Comment.
   The DEIS does not comply with NEPA or the CEQ Regulations because it does not adequately address certain economic impacts of the remedial action. (15, 16, 23, 207, 209, 212, 213)

   - The Governor of Utah, the Central Valley Water Reclamation Facility Board, their economist, and a Salt Lake County commissioner said that the DEIS has grossly underemphasized the indirect and long-term costs of stabilization in place.

   - They also asserted more generally that the economic analysis of the project is not adequate.

   Response.
   Since the DEIS was published in February 1983, the DOE has made a further analysis of the costs and economic implications of alternatives 2 and 3 in order to better understand and comment on the state's and board's analyses. The several sets of analyses are compared and discussed in Section 6.10 below, and appropriate changes have been made in Sections 5.9 and 5.11 and Appendix E of this FEIS.

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2. Comment.
A DEIS should not be used to rationalize or support a decision already made by an agency required to complete a NEPA document. A DEIS should state a preferred alternative if one exists. It appeared to a number of commentors, including the Governor and a Salt Lake County commissioner, that the DEIS implicitly supported stabilization in place at the Vitro site. (16, 23, 209)

Response.
At the request of the state, the DOE did not identify a preferred alternative in the DEIS. Since then, the Secretary of Energy has agreed with the state that relocation is preferable and this has been identified as the preferred alternative in this FEIS.

3. Comment.
The DEIS indicates that additional ground-water data are being acquired. It also says that the design for stabilization in place may change as the result of these data and/or the fact that the final EPA standards are not as strict as the proposed EPA standards. NEPA regulations (40 CFR 1502.9) require the preparation of supplements within drafts or final environmental impact statements if "there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." It may be that a new or supplemental draft is in order with subsequent opportunity for public review and comment. (23, 110, 213)

Response.
Additional ground-water studies have been completed since the DEIS was issued and have been made available to state and local officials, the NRC, and the EPA. It is the DOE's decision, with which the state has expressed agreement that these data do not contribute significant new information and therefore do not warrant a supplement to the DEIS. These studies are included in Sections 4.6.2 and 5.4, and Appendix D of this FEIS.

6.2 EPA AND OTHER REGULATIONS

Comments on various regulatory aspects of the Vitro remedial actions were received in 6 letters and 6 oral statements. These comments are summarized below and a response to each issue is provided.

1. Comment.
The Sierra Club, other public interest groups, and the State of Colorado have entered a suit in Federal Court in Denver asserting that the EPA regulations the DOE is working under are inadequate. The Sierra Club's representative said that if more adequate regulations were in force, only moving to South Clive would be acceptable. Thus if the tailings are stabilized in place, the DOE may be forced to come back and dig the tailings up again. (51)

Response.
The DOE is aware of several suits filed against the EPA, and although it is not a defendant, it is following them closely because of their potential affect on the UMTRA project. However, the DOE must proceed with the project on the basis of the final EPA standards (issued January 5, 1983). These have been issued in final form, and the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA, PL95-604) establishes a deadline of March 1990 for completing the project. In any event, the DOE's preferred alternative identified in this FEIS is to move the Vitro tailings to the South Clive site.

2. Comment.
The Central Valley's economist and two private citizens said that the EPA regulations are certainly necessary, but they implied that they may not be sufficient to protect the public health. (16, 24, 39)

Response.
The UMTRCA directs the DOE only to perform remedial actions that will leave the tailings in a condition that will conform to the EPA standards. It puts the NRC in the role of judging whether the actions do in fact conform. The DOE is not authorized to spend government funds to exceed these standards.

The EPA standards themselves have been the subject of an EIS, and by the tiering principle (40 CFR 1502.20) they need not be addressed again in this FEIS.

3. Comment.
The CVWRF Board's general manager said that the Nuclear Regulatory Commission regulations for low-level waste (10 CFR 61) are applicable. These regulations require: 1) a design that will provide for long-term isolation avoiding the need for continuing active maintenance, 2) a buffer zone about the waste (he said of 30 meters width), and 3) that wastes not be in contact with standing water at its highest seasonal fluctuation. (15)

Response.
The NRC regulations for the land disposal of low-level radioactive waste (10 CFR 61) do not apply to the UMTRA project. The definition of low-level radioactive waste specifically excludes uranium or thorium tailings (10 CFR 61.2).

4. Comment.
There were a variety of comments relative to whether the alternatives, especially stabilization in place, adhere to the EPA standards.

- Comment a
  The critics referred to the statements in the standards that say that "judgments on the possible need for remedial or protective actions for ground-water aquifers should be guided by relevant considerations described in EPA's Hazardous Waste Management System (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the period of

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stabilization." This may in fact constitute a more restrictive set of requirements than the ones the EPA proposed initially. (18, 202, 204, 209, 212)

- Response a
  The DOE agrees that the statements in the final EPA standards referred to by the critics could in some cases prove to be more restrictive than the numerical standards appearing in the proposed version of the standards.

- Comment b
  The Foreward to the DEIS says that the designs finally adopted can be expected to be different because the final EPA standards are somewhat less stringent than the (previously) proposed standards. This statement was disturbing, especially since it is not true as regards ground-water protection. (18, 202)

- Response b
  It is agreed that the statement in the Foreword to the DEIS, "Because the final EPA Standards are somewhat less stringent than the proposed standards, all of the action alternatives . . . will satisfy . . . final standards," could prove to be logically false because of the new ground-water protection guidelines in the final EPA standards. The original thought behind this statement focused on the less stringent, radon-protection guidelines which certainly warrant changes in the design of covers and the requirements on removal of soil from open lands.

  In this FEIS, the analyses and designs have been modified to comply with the final EPA Standards. Additional ground-water studies (field studies, contaminant transport, and modeling) and cover design studies (erosion, infiltration, and radon attenuation modeling) have been conducted and the designs for Alternatives 2 and 3 modified accordingly.

- Comment c
  There was concern lest the DOE "back away from the guidelines" by taking advantage of the provision in the EPA standards for exceptional circumstances. (18, 202)

- Response c
  It is assumed that the comments in referring to the "provision in the EPA Standards for exceptional circumstances" meant the Sections 192.22, Supplemental Standards, and 192.21, Criteria for Applying Supplemental Standards, in the final EPA standards. The EPA criteria for applying supplemental standards clearly preclude application of any but the regular standards (Subparts A or B) to remedial actions at high-priority, former processing sites such as the Vitro site (FR 48, No.3, pg. 605, summary).

- Comment d
  The Governor said, "Major portions of the final EPA standards are not addressed, nor is Congressional intent noted. The Uranium Mill Tailings Radiation Control Act reflects (in Section 206) Congressional desire that EPA's standards be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act." (209)

- Response d
  A discussion of the final EPA standards, and the DOE's interpretation of those standards, including their consistency with Congressional intent, is contained in Section 3.1.1 of this FEIS. The alternatives described in Appendix A and elsewhere have been developed to comply with all of the provisions of the final standards.

- Comment e
  The EPA was quoted to the effect that an "optimized cost-benefit rather than a 'least cost' alternative... provides much greater protection of health at only a slight increase ((in cost))." The DOE should do likewise. (207)

- Response e
  Agreed.

- Comment f
  The EPA was also quoted to the effect that "the single most important goal of control ((is)) effective isolation and stabilization of tailings for as long a period of time as is reasonably feasible." The DOE would have great difficulty certifying the required longevity. (207)

- Response f
  The DOE believes that the EPA's ". . . single most important goal of control . . ." is achievable with either of the action alternatives in the FEIS; otherwise, these alternatives would not have been considered. The implementing agencies must provide "reasonable assurance" that the provisions of Subparts A and B of the final EPA standards are satisfied by the disposal scheme that is finally implemented.

- Comment g
  There is no mention of RCRA in the document. "Utah is <u>adamant</u> that RCRA requirements be carefully considered..." (212)

- Response g
  Except for ground-water protection, the Resource Conservation Recovery Act (RCRA) of 1977 does not apply to the UMTRA project.

- Comment h
  The Public Health Service of the U.S. Department of Health and Human Services said that they thought that either remedial action will meet EPA standards. (215)

- Response h
  Agreed.

- Comment i
  Active controls cannot be counted on to ensure the longevity called for in the EPA standards. (110, 207)

- Response i
  Agreed. Neither action alternative would require an active maintenance program to ensure their longevity.

6.3 NRC AND STATE CONCURRENCE

A number of persons (in 5 written and 2 oral statements) dealt with the need for state concurrence in any remedial action taken on the South Salt Lake tailings pile. There were no comments on the process of concurrence by the NRC.

Comment.

- The Governor and others pointed out that the UMTRCA anticipates a mutually satisfactory and acceptable course of action with respect to the Vitro tailings. The implicit preference seen in the DEIS for stabilization in place is not such a mutually satisfactory resolution of the problem. (1, 17, 109, 209, 211, 213)

- Going further, the state said it would not "undertake responsibility for actual acquisition of" the Vitro property, if stabilization in place were the alternative decided upon. (209, 212)

Response.
These issues are beyond the scope of this EIS, whose function is rather to set forth the environmental consequences of the several alternatives for the remediation of the Vitro tailings problem as one of several bases for the decision among them. These issues are discussed further in Section 6.20.

6.4 SCHEDULE

A number of persons (in 4 written and 9 oral statements) criticized the rate at which progress is being made towards actual physical remedial action on the Vitro tailings.

1. Comment.
   The general tenor of these criticisms was that there is too little progress being made towards actually "moving dirt." People used such phrases as, "haven't we studied this enough?" and "cycle of indecision." Congressman Marriott is "extremely upset with the length of time that has

elapsed ((since PL95-604 was passed))." The governor stated that "The relocation of these tailings must begin this year." (1, 17, 28, 34, 36, 41, 47, 48, 105, 109, 206, 209)

Response.
The UMTRA Project must be conducted according to the provisions of its enabling legislation, UMTRCA, and other broadly applicable laws, such as the National Environmental Policy Act of 1969, as amended. These laws in effect determine the UMTRA Project's schedule for conducting remedial actions by requiring an unusual degree of coordination and agreement between the different Federal agencies involved in the project, and also between the DOE and the affected states or tribes. The DOE believes that it has made an earnest effort to coordinate its UMTRA Project tasks with the EPA and NRC, and to obtain agreement with affected states, in particular the State of Utah. Indeed, the Vitro site in South Salt Lake has received special attention because of its location in a highly populated area: remediation of vicinity properties was begun in 1981 as soon as EPA's interim standards were promulgated; concurrence of Utah in specific proposals for cleanup of the Vitro site was sought by the DOE in numerous drafts of the Remedial Action Concept Paper that were submitted to the State in 1981-1982; and--in spite of the extra expense--the NEPA process leading to this EIS was initiated early, before receiving State agreement on a proposed action, in order to more fully develop the issues on which agreement would depend. Based upon this history and assuming satisfactory completion of the NEPA process, the proposed remedial action is scheduled to begin upon completion of the final design by the State of Utah.

2. Comment.
An owner of a business at the southwest edge of the Vitro pile said he needs to know what the DOE is going to do with his property. He cannot sell it, and the contamination in it prevents full use of the property. (29)

Response.
The design for Alternative 2, stabilization in place, in this FEIS differs from the Alternative-2 design in the DEIS in that the 5.4-acre industrial strip on the southwest corner of the Vitro site would not be part of the stabilization area. In other words, properties in the 5.4-acre strip would not be affected by the actions in this FEIS; however, they might be affected by the actions proposed for cleanup of vicinity properties. Thus, neither in that alternative nor in alternative 3, removal to South Clive, would this business be condemned or have to move. Regardless, in either case, it is a vicinity property. The owner of the property in question should consult with the Utah Department of Health concerning the effect on his land and business of being a vicinity property.

6.5 ALTERNATIVES

Many comments (in 5 written and 14 oral statements) were made on the alternatives analyzed in the DEIS. These covered a number of issues as identified below. The DOE's response to each of these comments follows the description of that issue. Suggestions for alternative designs are discussed in Section 6.9, Comment 8.

1. Comment.
Almost everyone who wrote or spoke had his or her opinion about what should be the preferred alternative. Few were neutral. Almost invariably Tooele County residents wanted the tailings left where they are and Salt Lake County residents wanted the tailings moved away. The Governor of Utah, the CVWRF Board, and many local boards and agencies in the valley are for moving the tailings. Tooele County boards and agencies prefer them to be left in place, or at least not moved to the South Clive site.

Response.
The DOE does care about local preferences among alternatives. These do not, however, change the technical facts that constitute one set of inputs to its choice. Rather, these preferences are all-important in forming the political input to its choice, have been considered in selecting the stated preference for removal in this FEIS, and will be reflected in the final record of decision on what to do about the Vitro tailings. Personal preferences are discussed further in Section 6.20.1.

2. Comment.
The State of Utah said that the DOE has vacillated in its preference among the alternatives. Early talk (and the CVWRF Board had understood this talk to be a promise) was in terms of moving the tailings, and the 1981 Remedial Action Concept Paper (RACP) expressed this opinion; however, the 1982 RACP proposed stabilizing the tailings in place. The DEIS expresses no preference. The early talk was purely in terms of what was needed for the health and safety of the people of Salt Lake County; only in 1982 was cost brought up as an important factor. (1, 18, 21, 38, 48, 107, 209, 211, 212)

Response.
There is merit in this comment. The first draft of the Remedial Action Concept Paper (RACP) for the Vitro site said, ". . . it appears that Option 2B, Disposal in the First Alternate Area, is the economically and environmentally preferable action." However, even then, that expression was qualified by the state- ment: "This (proposal of an action) does not imply a final selection of that option or less study or consideration of other options." There were few data or studies at that time that could technically support a definite preference for a stabilization in place alternative and--until further study might justify a change--the DOE made a tentative expression of preference for alternatives involving transfer of the wastes to a new location.

Studies to determine feasibility of stabilization in place were begun in early 1982. As the information developed in these studies became available, it became clear that stabilization in place would be technically feasible, could be accomplished in a way that would meet the proposed EPA standards, and would cost less than alternatives involving transport to new sites recommended by the state. The new information caused the DOE to shift its preferences, as expressed in the next-to-last draft of the RACP, to the stabilization in place option. At this point, the State of Utah objected to any expression of preference and suggested that the following language be inserted in the final draft of the RACP:

> "A proposed option for the Vitro site remedial actions has not been selected by the cooperating parties, the DOE and the State of Utah. Accordingly, Options 2 and 3 will be given equal depth of study in the draft environmental impact statement (DEIS) covering the proposed remedial actions. The information supplied in the DEIS plus additional data and analyses to be published in 1982 will be used by the cooperating parties to reach agreement on the proposed course of action in the final EIS. Important considerations in deciding upon a proposed option will be: whether the options meet the EPA standards, the degree to which each option protects the environment and reduces health risks, the relative cost-benefit ratios of the options, and the impacts of each option on land use, social factors, and the physical environment (DOE, 1982a)."

The DEIS did not identify a preferred alternative. This FEIS does identify a preferred alternative: the removal of the Vitro tailings to South Clive.

3. Comment.
There were some comments to the effect that the site selection and alternative selection process omitted alternative sites that should have been examined.

The Department of the Interior and others suggested looking into the possibility of disposing of the tailings at existing mine waste dumps, other possible sites including Moab and Monticello, and "taking them back to where they came from." (3, 4, 11, 13, 41, 42, 47, 50, 102, 203)

Response.
Prior to initiation of this FEIS, the DOE investigated the feasibility of disposing of the tailings at 15 sites (including those described in Appendixes B and C and the referenced mine waste dump). The DOE investigation ranked the suitability of each site based upon geological, hydrological, ecological, and economic factors. The three eastern sites were ranked 1 through 3; the waste dump was ranked fourteenth. Relocating the tailings to Moab, Monticello, or returning the tailings to the uranium-ore mines would be unreasonable alternatives for the same reasons as those given in Appendix C.

4. Comment.
Several sets of comments included some discussion of reprocessing as an alternative.

- Comment a
  The Department of the Interior pointed out that the studies reported in the DEIS considered reprocessing the tailings at a new process plant. The commenter thought that other processing options should be examined, such as in an existing uranium mill. (203)

- Response a
  Reprocessing the Vitro tailings at an existing uranium mill would not be economically practicable. The tailings would have to be shipped to the nearest mill in eastern Utah at a cost in excess of the $20 million in marketable value of the U_3O_8, V_2O_5, and Mo that could be extracted from the tailings, and of which the Federal government would receive only a part to offset its costs. After reprocessing, the residues would still be the responsibility of the DOE since most of the radioactive elements would remain; these residues would have to be stabilized at a new site in a manner that meets EPA standards within the time limits set by PL95-604.

- Comment b
  An engineer in private practice suggested that "there are many other marketable products (in the tailings besides uranium, vanadium, and molybdenum) that can be concentrated from the tailings." He went on to suggest using flotation and bacterial leach treatment, saying that after such processing the remaining material could be left in place. (35, 108)

- Response b
  Other than (possibly) uranium, vanadium, and molydenum, there are no economic minerals in the Vitro tailings that could be extracted and marketed at a net profit using currently available technology. Because of the currently depressed market, even the economic minerals that remain in the tailings, and for which the ore was originally mined, are not marketable at a profit. Flotation and bacterial leaches would not remove <u>all</u> these materials from the tailings.

- Comment c
  On the other hand, a state official said that "reprocessed residue tailings would remain with a high concentration of radium and other heavy metals that would result in the tailings still being classified as a radioactive hazardous waste." (211)

- Response c
  Agreed: the tailings residues would still require stabilization under the provisions of PL95-604.

- Comment d
  A private citizen felt that a cost effectiveness study should be done to find out what part of the tailings can be processed to concentrate them so that they might be useful. (12)

- Response d
  The DOE believes that such a study has been done; it is summarized in Section C.4, Appendix C, of this FEIS. A full report of the study's findings is available (DOE 1982b).

- Comment e
  Another private citizen referred to an article in the Proceedings of the 15th Annual Uranium Seminar, held in Albuquerque on September 20-23, 1981, which described "a novel approach to tailings disposal." He didn't say what this process is but said it should be looked into. (5)

- Response e
  The referenced article was inaccurate because the referenced meeting was not held. The "novel approach" cannot be addressed without additional information. The DOE, through its UMTRA Project, has identified and reviewed currently available methods for tailings disposal.

6.6 THE GEOLOGIC AND HYDROLOGIC SUITABILITY OF THE VITRO SITE.

There were 16 written statements and 8 oral ones that commented on the suitability of the Vitro site for stabilization of the tailings in place. The issues involved were numerous; they are listed below together with the DOE's responses to each.

1. Comment.
   The data base on which the analyses rely is inadequate. In particular, the hydrologic data are incomplete and the new studies planned are too short in duration to show seasonal or cyclic effects. Six to eight weeks is "far too brief to provide the necessary data on seasonal or cyclic changes." (6, 18, 19, 23, 39, 51, 107, 110, 202, 204, 209, 212)

   Response.
   The DOE believes that the additional hydrologic studies completed since publication of the DEIS and described in Appendix D of this FEIS are sufficient to characterize seasonal changes.

2. Comment.
   Many private citizens, the State Health Department, the CVWRF Board, and others spoke or wrote about ground-water problems.

- Comment a
  Ground-water contamination is probable or inevitable, regardless of design features intended to make it improbable. The need for public use of deep ground water may, some said, eventually reverse the present upward gradient of hydraulic head. (15, 18, 19, 39, 51, 105, 106, 107, 110, 202, 203, 204, 206, 207, 209, 211, 212)

- Response a
  This subissue is addressed in Appendix D, and in Section 5.4 of this FEIS.

- Comment b
  The City of South Salt Lake is considering the use of a well in the southeast corner of the site for general use. This would not be possible if the tailings remained at the Vitro site. (15, 203, 204)

- Response b
  It is agreed that implementation of Alternative 2 of this FEIS would preclude well development in the location indicated by the commenters.

- Comment c
  What is the source of the gross alpha, Ra-226, Ra-228, and U in the water samples from deep wells? What is the source of the heavy metals in the shallower wells (Tables D4, D5, D6)? Are contaminants present upgradient, as well as downgradient? (203, 204, 209)

- Response c
  Activities of gross alpha, Ra-226, Ra-228 and U in samples taken from deep wells are background levels and probably are not associated with the Vitro mill tailings. A comparison of samples from wells 1, 2, and 3, representing background, confined ground water with samples from wells V-AD, V-BD, V-CD, V-DD, and V-FD, representing confined ground water beneath the site and samples from wells 4 and 5, representing downgradient, confined ground water, suggests that the tailings pile has not contributed radioactivity to the confined ground water. No samples from monitoring wells beneath or downgradient of the pile showed Ra-228, gross alpha, or U above background levels. Analyses of samples from two wells beneath the site, V-BD and V-ED indicated Ra-226 levels above background. A sample from well V-BD had a Ra-226 activity of 9.1 pCi/l. A second sample from the same well measured activity of <1.0 pCi/l. A sample from well V-ED measured Ra-226 activity of 4.5 pCi/l. This value is well within the range of background activity given possible sampling and analytic errors.

The area encompassing the Vitro site is urban and industrial. There are many potential sources of heavy metals to the shallow ground-water system. The Vitro mill tailings probably contribute U and Fe and possibly Mo to the shallow ground water. The source of any other heavy metals is not known but probably is not associated with the mill tailings pile.

There is upgradient as well as downgradient contamination of the shallow ground water. The upgradient contamination probably is not associated with the Vitro mill tailings but associated with other sources in the urban/industrial area surrounding the Vitro site. For example, a sample from upgradient well 6C showed higher Cl than any samples from any downgradient well. This well is adjacent to Interstate 15. The sample was taken in the spring of 1983. It is likely the measured contamination was from infiltration of snow and rain containing road salts.

- Comment d
  The treatment of contaminant mobility is inadequate, as a variety of environments--acidic, neutral, and basic--are likely to be encountered at different locations in the system. (203, 204)

- Response d
  This issue has been addressed in Appendix D of this FEIS.

- Comment e
  On the other hand, one private citizen stated that pollution from the mill tailings is not a particularly serious problem. Heavy usage of the deep ground water would "render it polluted by sewage, filthy run-off water, road tar extracts and so on." (111)

- Response e
  Contamination of the confined aquifer by sewage and urban runoff is an issue beyond the scope of the FEIS. The contamination of the confined aquifer by brackish water in the unconfined system as a result of heavy pumping of the confined aquifer during mill operation is discussed in Appendix D of this FEIS.

3. Comment.
   The State Health Department, the EPA, and others wrote or spoke about shallow water problems.

- Comment a
  The DEIS states that "the ground- and surface-water systems involved do not contain potable water." This is wrong; there are now 41 wells within one-half mile of the site drawing household water from the shallow aquifer. It is only a matter of time before the surface-water system is contaminated. (1, 18, 110, 202, 203, 204, 209, 212)

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- Response a
  This statement does not appear in the DEIS without qualification. The on-site surface waters are certainly not potable according to Utah standards for domestic sources of water; neither are the ground waters in the unconfined aquifer at 2- to 45-ft depths below the site (see Appendix D). Regarding the "41 wells within one-half mile of the site": Data on these wells were requested from the Salt Lake City-County Health Department on March 31, 1983 (letter from Kelly M. Peil, Jacobs/ Weston Team, to City-County Health Department). The Health Department replied that "A search was made of our records with no chemical data found on any wells in that area. At the time those wells were drilled, no chemical information was required in this office." (letter from Jewel Snow, Bureau of Water Quality, to Kelly M. Peil, Jacobs/Weston Team, April 19, 1983.) A review of U.S. Geological Survey records indicated the existence of 2 wells, possibly within one-half mile of the Vitro site. The majority of the wells referenced by the state were at depths greater than 60 feet. These wells are in the artesian aquifer, not the shallow aquifer. The two wells identified by the USGS are upgradient of, and unaffected by, the Vitro site. Possible effects on wells within one-half mile of the site are discussed in Section 5.4.2 of this FEIS.

- Comment b
  Water-table depths are misleading, as they are based on just one season's observations. Other work has indicated a much broader fluctuation in water-table depth. Also, ground-water flow is toward the Jordan River and Mill Creek; a strong potential thus exists for migration of contaminants from the site to nearby surface waters. (209, 212)

- Response b
  It is agreed that fluctuations in the water-table depths could be wider than those indicated by DOE measurements; the important item is the consequence of foreseeable wide fluctuations in water-table depths; some of these consequences are discussed in Appendix D, and Section 5.4.2 of this FEIS. It was recognized in the DEIS that "groundwater flow (in the unconfined system) is toward the Jordan River and Mill Creek . . .", and that a potential exists for migration of contaminants to these water bodies.

4. Comment.
   The Vitro site is in an identified flood drainage basin with known general flooding from nearby drainage canals. The possibility of dam breaks has not been considered. Probable Maximum Flood (PMF) flows at the site would create an erosion hazard. (110, 214)

   Response.
   These effects are addressed both in the DEIS and in this FEIS in Subsection 5.3.4; see also the response to Issue 1 in Section 6.9.

5. Comment.
The State Health Department, the CVWRF Board, and others doubt the ability of the underlying soil to support the tailings either in the short or the long term.

- Comment a
  The soil will have little bearing strength unless it is precompacted by covering the site with a large mound of earth for at least three years. Otherwise uneven settling will cause the liner and cover to fail. There is also the possibility of mud waves (permanent ridges surrounding the site caused by underlying soil moving laterally out from under the pile), and there may be interference with normal ground-water flows in the area causing unpredicted surface and subsurface characteristics. (1, 15, 204, 206, 207, 209)

- Response a
  The potential does exist for the development of areal settlements (analyses indicate approximately 2 inches) immediately adjacent to the stabilized mound. Thus, it may be necessary to offset the mound a "safe" distance from the adjacent roadways and critical utility lines. This could require some slight modifications to the location and general configuration of the stabilized area as is shown on Figure A-16 of the DEIS and updated in Appendix A of this FEIS. However, these modifications should have essentially no effect upon the feasibility of the conceptual scheme.

  Analyses to date indicate that the majority of the settlement associated with the construction of the stabilized mound would occur during the three-year period predicted for the required earthwork operations. Thus, "long-term" settlement which could affect the integrity of any future facility should not be a problem.

  It is recognized that there are "margins of error" or "risks" associated with these analyses and that with additional field and laboratory analysis these "margins of error" or "risks" could be reduced. The State of Utah has indicated that differential settlement may indeed be more of a concern than indicated by the engineering analyses included in this EIS. If preloading were to be required, based upon engineering analyses and cost estimates prepared by the state, an additional 3.0 million cy of fill would be needed for about 2.5 years to preload the site prior to tailings placement (letter from State of Utah Department of Transportation to the Department of Health, December 19, 1983).

Preloading would result in an increase in short-term impacts beyond those identified in the EIS. Increases would occur primarily in traffic, combustion and particulate emissions, noise, and soil requirements. Employment (and economic factors) would be relatively similar in magnitude although impacts would occur over a longer time span.

- Comment b
  The statement on page A-35 ". . if a liquefaction incident were to occur in one of the discontinuous soil layers little evidence of liquefaction would be apparent and damage to the site would not be expected . . ." is inaccurate. (209, 214)

- Response b
  The quoted statement was based upon the results of preliminary field investigations which indicated only isolated, discontinuous zones of potentially liquifiable soils. Due to the minimal topographic relief within the site area, it is DOE's opinion that the liquefaction of these zones would not induce any significant lateral displacements which could have the potential to damage the subbase or protective cover. Further, the areal settlement resulting from the densification of these zones should be minimal.

6.7 THE GEOLOGIC AND HYDROLOGIC SUITABILITY OF THE SOUTH CLIVE SITE

There were 3 written statements and 5 oral ones that commented on the suitability of the South Clive site for final disposition of the tailings. The issues brought up are outlined below together with the DOE's responses to these concerns.

1. Comment.
   Several persons, including a representative of Tooele County, said that the data base on which the analysis of the site was made is inadequate. No weather data were taken at the site; instead the weather was inferred from records taken at stations many miles away. Nothing is known about the deep underlying geology. There are a number of ranches in the area not mentioned in the DEIS. (6, 11, 14, 209)

   Response.
   Before gathering the data that support this FEIS, DOE contractors reviewed Utah and NRC requirements that are applicable to air quality and meteorology. This review included discussions with the Utah State Health Department Bureau of Air Quality and the NRC. The Bureau of Air Quality agreed to the use of existing Salt Lake City meteorological information for the Vitro site and the use of Wendover Air Force Base meteorological data for the South Clive site. Regarding the deep, underlying geology of the South Clive site, it is known that the unconsolidated Quaternary deposits below the site are at least 500 feet thick. The properties of this layer

alone would thus determine the suitability of the South Clive area for uranium mill tailings disposal. Regarding ranches not mentioned in the DEIS: the DOE surveys in 1980 identified no permanent residences within 15 miles of the site; to the DOE's knowledge, no new residences have since been established.

2. Comment.
Several commenters stated that the site is hydrologically unsuitable. The DEIS says the depth to water varies from 20 to 35 feet; but during the time the hearings were being held, water was standing on the surface and this happens every year at this time. Also, long-term climatic variations, such as have occurred in the last 1000 years, might substantially raise the water table. (6, 214)

Response.
The surficial materials underlying the South Clive site consist of a three- to twelve-foot surface layer of sandy to clayey silt over lacustrine sands and silty clays. Because of the low permeability of the surface materials, ponding and the occurrence of standing water seasonally are expected. The ponding is due to surface runoff and is not a surface representation of the water table.

As described in Appendix A to the DEIS, and Appendix D of the FEIS, the depth to the ground water as observed in both cased monitoring wells and in open boreholes drilled during the geotechnical program at the South Clive site ranged from 20 feet in boring number SC-2 to more than 30 feet in boreholes SC-4, SC-9, and SC-10. Fluctuations in the depth to the water table in all monitoring wells and open boreholes were small, ranging from 0.3 feet in boreholes SC-6 and SC-13 to 2.9 feet in borehole SC-1. Boreholes SC-1, SC-6, and SC-13 were monitored over nine, five, and two months, respectively. The water levels in these wells were monitored by the state of Utah in 1983 and were found to be the same as reported in the DEIS.

It is agreed that long-term climatic variations, although unpredictable, might cause a substantial rise in the water table. The effect of such a rise on the stabilized tailings is unknown.

3. Comment.
The inevitable contamination of the ground water at the South Clive site will affect drinking water supplies at Tooele, Grantsville, and Cloverdale. (4)

Response.
The South Clive site is located in an area of regional ground-water discharge. As a result, the primary direction of flow is upward and toward the playas to the west of the site. The potential for any direct impact on drinking water supplies at Tooele, Grantsville, or Cloverdale is extremely remote. Further, analyses of the ground-water samples from the monitoring wells completed on the South Clive site indicate that the water does not meet either State of Utah or U.S. EPA primary and secondary drinking water standards

and is not suitable for domestic use without extensive treatment. For instance, total dissolved solids concentrations range from about 20,000 to more than 45,000 mg/l compared to the U.S. EPA secondary drinking water standard of 500 mg/l. The water is very high in sodium, chloride, sulfate, strontium, and other dissolved salts.

4. Comment.
A 100-year flood would wash the tailings away, if they are disposed of at South Clive. The absence of dry washes is not evidence against this possibility, because such washes are filled up again between these extreme events. (12)

Response.
This subissue was addressed in the DEIS and is addressed in this FEIS in Subsection 5.3.4 of the main text. In summary, analysis of a Probable Maximum Flood (a storm event far in excess of a 100-year flood) indicate that the erosion barrier will protect the disposal site.

5. Comment.
A group pointed out that the local hydraulic gradient is to the northeast, which may imply that the local shallow water is not supplied by recharge at the foot of the Cedar Mountains to the east. They inferred from this that seepage from the site, if unchecked, would cause a ground-water mound to form at the mountains, resulting in an undesirable change in the ground-water flow regime with a consequent rise of the water table at the site. (110)

Response.
The cause of the northeasterly hydraulic gradient in the unconfined aquifer at South Clive is unknown. However, even if the disposal site were to be a 200-acre lake instead of relatively dry materials, there is no possibility that it could "cause a ground-water mound to form at the mountains" more than 3 miles away to the northeast. The natural sources of recharge of the shallow aquifer would utterly dominate the small contribution from site seepage in determining changes in the ground-water/flow regime.

6. Comment.
A Utah state geologist said evapotransiration is unlikely with the water table at a depth of 25 to 35 feet. (214)

Response
The DOE agrees that evapotranspiration from the water table is not likely. However, evapotranspiration is an important process in the fate of local rainwater, some of which is transpired by the thin cover of vegetation.

7. Comment.
An advantage of the South Clive site is the local availability of cover material. (110)

Response.
Agreed.

6.8 THE SEISMIC SUITABILITY OF THE VITRO AND SOUTH CLIVE SITES

There were 6 written statements and 6 oral ones that commented on the seismic suitability of the Vitro site for the stabilization of the tailings in place or the South Clive site for final disposition of the tailings. The issues brought up are outlined below together with the DOE's responses to these concerns.

1. Comment.
The seismic data bases for both the Vitro and South Clive sites are inadequate. There have been no serious seismic studies. (1, 6, 206, 212)

Response.
Seismic analyses have been performed and the results included in this FEIS as Appendix H. The analyses of impacts of seismic events in Subsection 5.3.4 have been amplified.

2. Comment.
A seismic event near the Vitro site, probable because of the nearness of the Wasatch fault, could damage the tailings pile, the proposed liner, and the ground-water regime at that site. Increased seepage could then result in contamination of the ground water; the State Health Department envisions a possible "direct pathway from the tailings to the ground water." (1, 15, 20, 206, 207, 211)

Response.
The issue of seismic damage to the tailings pile through slope failure is addressed in Appendix H, and is summarized in Section 5.3.4 of the text. The DOE agrees that liner system failure could occur during extreme seismic events (Maximum Credible Earthquake, 1000-2000 years return period) in which liquefication of underlying sand lenses would induce differential movement of the liner system and embankment (a few inches). It is also agreed that extreme seismic events could change the ground-water regime at the site; but such changes would result in insignificant contamination of ground water from the tailings pile because of the design and existing water quality. (See Appendix D.3.2 for water-quality data).

3. Comment.
The locations of three earthquakes are incorrectly given. The governor said, "Serious miscalculations render the seismic analysis invalid." (209, 214)

000251

Response.
This issue arises from the following comment regarding material on page 58 and in Table 4-1 of the DEIS:

> The May 22, 1910 earthquake was probably at about 40°44.94' and 111°50.95', well south of Bountiful and about 5 km from the Vitro site. It had an estimated magnitude of 5.7. The November 10, 1884, earthquake was not in Bountiful, but near the Utah-Idaho border. The March 28, 1975, event was at Pocatello Valley, not Pocatello, Idaho. Damage reports clearly indicate that the December 1, 1958, earthquake was near Nephi. The errors in pinpointing the locations of the latter three events is around 100 km. These gross errors negate the validity of the seismic risk analysis.

The May 22, 1910, earthquake is listed in "Earthquake History of the United States" (Coffman and von Hake, 1973; NOAA, 1982a) as having its epicenter located at 40.8 degrees north latitude and 111.9 degrees west longitude, which is slightly more than 6 miles (9.7 kilometers) north of the Vitro site and about 7 miles (11.3 km) south of downtown Bountiful. The epicenter location is in the extreme northwest part of Salt Lake City.

The location and distance from the Vitro site of the epicenter for the November 10, 1884, earthquake was taken from the NOAA (1982a) computerized "Earthquake Data File." This listing is in error. The true epicenter location is near the Utah-Idaho border in Bear Lake Valley, about 95 miles north of Salt Lake City.

The word "Valley" was inadvertently left out of the location for the March 28, 1975, earthquake.

Again, the "Earthquake Data File" (NOAA, 1982a) lists the earthquake of December 1, 1958, as having its epicenter at 40.5 degrees north latitude and 112.5 degrees west longitude on the west side of the Tooele Army Depot. Cook and Smith (1967) also list this event as having its epicenter located in the St. John area, which is near the location listed by NOAA. Both of these locations are situated approximately 55 to 60 miles northwest of Nephi.

The historical seismic record is used to define regional seismicity as one portion of preparation of the input for a probabilistic seismic risk study. The model makes no direct use of any single historic event and, because of restraints in the development of the input parameter, the possible mislocation of a single event will have almost no influence on the results of the analysis.

4. Comment.
The Utah Geological and Mineral Survey believes that most of the earthquakes in Utah cannot be correlated with surface faults. They ask what reference indicates that "more than 90 percent of the earthquakes which occurred in Utah between 1950 and 1965 were located along or in association with known fault zones?" (209, 214)

Response.
It is agreed that the previous cited interpretation by Cook in 1970 is misleading. It is also true that if the total seismic record is considered, both small and large magnitude events, most earthquakes in Utah cannot be correlated with surface faults. It must be noted, however, that for most large, damaging earthquakes in the Basin and Range Province, such as the MCE considered for the Vitro site, it is common and predictable that surface faulting will result. It is also reasonable to conclude that it is common for this surface rupture to occur along fault systems which express geomorphic features of past, geologically young activity, such as the Wasatch frontal fault system.

5. Comment.
The EPA, the Governor, and the Utah Geological and Mineral Survey wrote about acceleration values.

- Comment a
  The 21 percent estimate for horizontal bedrock acceleration is invalid because the Vitro site is not located on rock. (209, 214)

- Response a
  The horizontal bedrock acceleration of 23 percent g (not 21 percent g) was based on a 90 percent chance of nonexceedance in 50 years at the Vitro site; it was calculated that the presence of deep, saturated alluvium between the site and bedrock would reduce this acceleration slightly, to about 20 percent g (see page 116, 4th paragraph, of the DEIS). Seed and others (1976) found that peak accelerations between 0.1 and 0.7 g at sites where rock is exposed at the ground surface tend to exceed peak accelerations at the ground surface where sites are underlain by more than 80 meters of soil. This is consistent with the recommendation presented on page 116, to utilize a design acceleration of 0.2 g for the Vitro site.

- Comment b
  The 50-year standard for horizontal bedrock acceleration is used for construction purposes but is not applicable to the Vitro disposal configuration. A more reasonable approach for the Vitro site is the use of the 250-year, 90 percent probability standard. "For bedrock the value would be 60 percent g." (209, 214)

- Response b
  The 50-year standard for horizontal acceleration (i.e., 90 percent probability of not exceeding 20 percent g in 50 years) was used in the DEIS for the conceptual design for Alternative 2 because it was believed that the stabilized pile would not be classified as a "critical" structure, such as a hospital, archives, or any other structure in which extreme seismic events could cause loss of life or damage to irreplaceable resources. It is possible that interpretations of final EPA Standards may require a design that meets the 250-year, 90 percent probability of nonexceedance of approximately 40 percent g; the implications of this are discussed in Appendix H of this FEIS.

000256

- Comment c
  The EPA questioned the maximum seismic acceleration being 0.2g at bc the Vitro and South Clive sites. Since the Vitro site is much close to an active fault, this appears unreasonable. (204)

- Response c
  Since publication of the DEIS, detailed seismicity studies have been completed and are included in Appendix H. These studies have found that the front of the Wasatch Range is apparently a still-active normal fault. Motion on it or its tributary faults could produce accelerations in rock of as much as 0.3 g to 0.55 g at the Vitro site. The South clive site is also located in a region which contains active faulting; however, maximum expected accelerations in bedrock would approximate 0.37 g.

- Comment d
  The USGS assigns a value for the Wasatch Front for horizontal bedrock acceleration with a 90 percent probability of not being exceeded in 50 years of 27 percent g. (214)

- Response d
  Algermissen and others (1982) have developed horizontal acceleration estimates in rock with a 90 percent probability of not being exceeded in 10, 50, and 250 years. Their estimates are 0.09, 0.22, and 0.55 percent of gravity, respectively, for the Salt Lake City area. The average return period for these accelerations are 232, 475 and 2,372 years, respectively.

  The use of different design earthquakes for different types of facilities has been actively discouraged (Newmark and Hall, 1973). Instead, higher factors of safety should be used for more critical facilities.

  The actual level of acceleration for the Vitro site should not be a major issue. Seed (1979) showed that well-engineered earth embankments designed using a lateral force coefficient of 0.10 to 0.15 are readily able to safely withstand ground motions that are produced in the near-field region of a magnitude 7 to 7.5 earthquake.

6. Comment.
   The Governor and the Utah Geological and Mineral Survey wrote about earthquake magnitudes and ground response.

- Comment a
  A statement is not true that refers to earthquakes in Nevada and Wyoming, "Each of these earthquakes was of a magnitude comparable with what might be expected to be the maximum event produced by the faulting along the front of the Wasatch Range." (209, 214)

- Response a
  This issue has been reevaluated and is discussed in Sections 4.5.4, 5.3.4, and Appendix H.

- Comment b
  A critical structure such as that proposed for the Vitro site should anticipate a magnitude 7.5 event occurring in the Salt Lake Valley. (209, 214)

- Response b
  In Appendix H of this FEIS, it is concluded that there is a reasonable possibility of a magnitude 7.0 or greater earthquake occurring along the Wasatch Front within the next 200 years. The consequences of such an earthquake for the integrity of the tailings-disposal structure proposed in Alternative 2 are also discussed in Appendix H and Section 5.3.4.

- Comment c
  Ground responses at sites on thick saturated alluvium such as exists beneath large parts of the Salt Lake City area can be ten times greater than at adjacent rock sites. (209, 214)

- Response c
  The "ground responses" are acceleration, speed, and displacement. In thick, saturated alluvium horizontal accelerations are likely to be slightly attenuated relative to adjacent locations on bedrock; on the other hand, displacements could be amplified relative to bedrock sites. Horizontal accelerations are the main cause of slope failure.

7. Comment.
   A private citizen, in reference to discussion of seismic activity of the Wasatch Fault during recent time, said, "This recent activity has been happening for the last ten thousand years. Okay? It hasn't been. . . recent as in twenty years." (5)

   Response.
   To geologists, "recent" means the Recent (Holocene) epoch, the 7 to 12 thousand-year period of time since the last ice age ended in North America.

8. Comment.
   Another private citizen felt that if the site is seismically suitable for buildings and sewage plants, then it should also be suitable for stabilization in place of the mill tailings. (26)

   Response.
   See paragraphs b and d of the response to Issue 5.

000258

6.9 ENGINEERING DESIGNS

There were 16 written and 21 oral statements that commented on various aspects of the engineering designs for the two action alternatives. These are summarized below, together with the DOE's responses to these comments.

1. Comment.
   Several comments focused on the design of Alternative 2, stabilization in place.

   - Comment a
     The design for stabilization in place at the Vitro site makes no allowance for soil settling under the pile and for consequent failure of the liner, damage to roads, and disruption of utilities. (19, 209, 212)

   - Response a
     The engineers who drafted the conceptual design for Alternative 2 calculate that up to 2.7 ft of soil settling under the center of the pile could be expected. Since the pile would be constructed in segments over a 2.5-year period, adjustments for differential settling of the liners under each segment could easily be made. There would be no damage of roads or disruption of utilities (the latter would be rerouted around the pile). Calculated settlements at the edge of the pile will only be on the order of 2 inches.

   - Comment b
     The governor and others pointed out that the DOE has made no commitment to a liner, but that since the tailings are now in contact with ground water, a liner is definitely needed. (6, 18, 202, 204, 209, 212)

   - Response b
     See the responses to Issues 4 and 5 in this section.

   - Comment c
     "Dam failure should be considered. If this factor is added to a probable maximum flood in progress, floodwater velocities could reach seven (7) feet per second, thereby creating an erosion hazard." (214)

   - Response c
     The two existing major structures whose failure may result in flooding conditions in the Jordan River Basin are the Deer Creek Reservoir on the Provo River and the outlet gates on Utah Lake at the headwaters of the Jordan River. Salient features of these two surface water bodies are given below:

Name	Stream	Approx. Location	Height (ft)	Storage Capacity (ac-ft)	Surface Area (acres)
Deer Creek Reservoir	Provo River	25 miles upstream of Utah Lake	150	161,000	---
Utah Lake	Jordan River	Headwaters	18 ft at Lake el. 4494.0	1,369,894	107,538
			13.34 ft at Lake el. 4489.34[a]	898,000	95,000

[a] 4489.34 ft is the compromise lake elevation at which the outlet gates are opened agreed upon by the affected landowners and water users.

In addition, two proposed reservoirs, the Lampton Reservoir and Jordanelle Reservoir, are at different stages of planning. The Lampton Reservoir is proposed to be located on the Jordan River at about 9800 South upstream of Salt Lake City and downstream (north) of Bluffdale with a storage capacity of 48,000 acre-ft, reservoir surface area of 2,310 acres, and maximum and mean water depths of 56 and 20.8 ft, respectively. According to the Dam Safety Branch of the Utah State, the probability of this dam being constructed is very low. The Jordanelle Reservoir is proposed to be located on the Provo River about ten miles upstream of the Deer Creek Reservoir, with a storage capacity of 325,000 acre-ft. According to current practice, the consequences of the failures of these proposed dams will be analyzed in detail well before the authorization of construction and the final designs of the respective dams will ensure that any significant adverse environmental impacts resulting from their failures are mitigated to acceptable levels. At the present time, the location, size, feasibility, and details of construction of these dams have not been finalized. Therefore, evaluation of the impacts of postulated dam-break scenarios for these nonexistent facilities is not considered necessary.

Based on analysis of similar dams (Fread, 1979), the floodwaters released by a complete breach in the Deer Creek Dam will be fully absorbed by the valley storage in the 25 mile-long floodplain of the Provo River between the dam and Utah Lake and will not result in a rise of more than 1.5 ft in the water surface elevation of Utah Lake. Therefore, it is concluded that the impact of the failure of Deer Creek Dam at the Vitro , which is approximately 25 miles downstream from Utah L will be insignificant.

A conservative estimate of the flood wave released by a complete failure of the outlet gates on Utah Lake indicates that the peak flow would be 128 cfs/ft on opening when the lake is at the maximum elevation of 4494.0 ft and 82 cfs/ft when the lake is at the compromise elevation of 4489.34 ft (US Army Corps of Engineers, 1977). Thus, a postulated opening of 100 ft, which is slightly more than the overall span of the outlet gates, will result in a peak flow of 12,800 cfs. This is only three percent of the PMF peak and will be greatly attenuated by the valley storage between Utah Lake and the Vitro site. Therefore, even if the occurrence of the PMF peak on the Jordan River coincides with the peak of the dam-break flood wave, the flow velocities and erosion potential at the Vitro site will be nearly the same as those for the PMF conditions alone. It must be emphasized that the above-mentioned coincidence is an event of extremely low probability. The outlet gates at Utah Lake would most likely be destroyed by the flood flows preceeding the PMF peak and the peak of the resulting dam-break flood wave would pass the Vitro site well before the PMF peak.

Regardless, the embankment as designed will withstand 14 fps without loss of the erosion barrier. Appendix A contains the details of this analysis.

2. Comment.
Several comments focused on the design proposed for Alternative 3.

- Comment a
  Burial at South Clive would not be deep enough. At Los Alamos, low-level waste is buried 40 feet deep. (11)

- Response a
  The low-level radioactive waste produced by Los Alamos National Laboratory is occasionally much "hotter" (i.e., greater specific activity than uranium mill tailings) and contains more mobile contaminants, such as tritium. These wastes warrant deeper burial, which is possible at Los Alamos because the water table under the Pajarito Plateau is several hundred feet below the surface. At the South Clive site ground water can be found within 25 to 35 feet of the surface, albeit of poor quality.

- Comment b
  Dewatering the site during construction will be necessary and should be considered. (6)

- Response b
  It is agreed that dewatering of the site will be necessary; this is included in the description for Alternative 3 in Appendix A and Section 3.2.4.

- Comment c
  A liner is needed to protect the ground water from contamination. (6, 110)

- Response c
  See responses to Issues 4 and 5 in this section.

- Comment d
  The DEIS says that the soils at the South Clive site are unsuitable for reestablishing a lasting, self-sustained vegetation. It also says that the local vegetation forms "an important ground cover and deterrent to soil erosion..." The DOE should clarify this apparent contradiction. (110)

- Response d
  The importance of the native vegetation's role in deterring soil erosion was perhaps overstated here. The relative flatness of the terrain is probably the major deterrent to soil erosion. Indeed, South Clive appears to be a depositional area (where soil is being deposited), rather than a degradational area (where soil is being removed). The South Clive soils are unsuitable for establishing a self-sustaining vegetation cover of any species but the native ones. A final cover layer of pit run rock will prevent erosion of the disposal embankment, without the need for a self-sustaining vegetative cover. Section A.6.2 has been revised to clarify this issue.

- Comment e
  On page 118, the statement "for transient loading conditions such as the ones imposed by earthquakes, acceptable factors of safety range from 1.0 to 1.3 is <u>incorrect</u> and in <u>conflict</u> with page A-69 which indicates that a factor of safety "well in excess of 1.5 is generally accepted as the recommended minimum to ensure stability." (209, 214)

- Response e
  In a review of pertinent geotechnical references and requirements set forth by regulatory agencies, the acceptable factors of safety for transient loading conditions, such as those imposed by earthquakes, appear to vary between 1.0 and 1.3. The most pertinent reference is that cited by the Nuclear Regulatory Commission in which a minimum seismic factor of safety of 1.0 is recommended for the design of uranium tailings disposal facilities. An additional pertinent reference is that cited by the US Mine Safety and Health Administration (MSHA) for the design of mine-related embankment systems. For these facilities a minimum seismic factor of safety of 1.2 is recommended.

  The above statement is not in conflict with page A-69 (of the DEIS) which indicates that a minimum factor of safety of 1.5, "is generally accepted as the recommended minimum to ensure stability." This latter statement is in reference to the overall stability of the slopes associated with the excavation at South Clive. The quoted factor of safety pertains to sustained or static loading conditions and does not consider the potential application of seismic loads.

3. Comment.
Salt Lake County would not have permitted a sanitary landfill to be constructed at a site with as shallow groundwater as the Vitro site or with as inadequate and uncertain a design as this. There is no commitment to a liner (and even then uncertainty as to its effectiveness) and no slurry wall surrounding the site. A sanitary landfill in the valley would be required to have a leachate control system; none is provided for in this design. (1, 15, 23)

Response.
The implications of this issue are that the engineering difficulties and hazards associated with a landfill are significantly less than those of a tailings disposal site. This is not necessarily true. For example, a landfill is particularly sensitive to settlement and leachate production because of the highly porous nature of the fill; this is not so for a stabilized pile. Regarding "a leachate control system," none was included in the design because it would require active maintenance which is contrary to EPA standards. These systems typically require an underdrain to collect leachate that flows to a sump; leachate is then pumped from beneath the source (i.e., pile) for treatment and discharge. Further, the design and ground-water analyses indicate that such a system would not be needed because of the very long time period (700+ years) before contaminants would reach the ground water in low concentrations. (see Appendixes A and D).

4. Comment.
There was some discussion about liners and slurry walls, mostly doubting their efficacy and longevity.

- Comment a
  A few officials said that if a liner is not used at the Vitro site, presumably a slurry wall would be; however, the efficacy of a slurry wall depends upon maintenance of an upward hydraulic gradient. (18, 202, 204)

- Response a
  The DOE has made a commitment to use a liner system in the design of Alternative 2 of this FEIS. Although a moot point, the fact that "the efficacy of a slurry wall depends upon maintenance of an upward hydraulic gradient" was stated in the DEIS; Subsection 5.4.3.

- Comment b
  Still and all, liners have not been tested enough with "materials of untested quality such as the Vitro tailings." (209, 212)

- Response b
  The DOE agrees that before using any material in a liner system, studies would have to be performed to determine the chemical and physical compatibility of available liner materials with the tailings.

- Comment c
  A liner cannot guarantee the integrity of the aquifers in perpetuity. (107, 211)

- Response c
  Agreed. However, worst-case analyses (Appendix D) indicate that arsenic, uranium, and molybdenum would cross the liner system in very low concentrations in 700+ years.

- Comment d
  One citizen felt that "the proposal to underlay the tailings (option 2) with clay is ridiculous." Water will penetrate both the surface and basement layers of clay and will not filter out arsenic or other pollutants. (2)

- Response d
  A liner system serves two purposes: 1) it retards water flow across it; and 2) by absorption it inhibits the transport of certain dissolved elements. Water flows less rapidly through a layer of clay than, say, a layer of sand in the presence of equal pressure heads; clay and rocks formed of clay (shales) are said to be relatively impermeable. In addition, some of the elements dissolved in the water are strongly adsorbed on the surface of the clay particles because of the enormous surface areas offered by the foliar clay granules. The net effect of a liner system is to greatly slow down the escape of contaminants from within the containment volume to adjacent soils. For example, dissolved arsenic is transported through typical clays at speeds that are 1/300 to 1/120 of the water speed.

- Comment e
  The DEIS demonstrated the seepage attenuation properties of a clay liner for Ra-226 (Figures A-11, A-12, A-13). "Ra-226 is a notoriously slow mover. DOE should construct seepage migration models and graphics to compare the rate of migration of other more mobile contaminants...." (110)

- Response e
  Agreed. See Appendix D of this FEIS.

5. <u>Comment.</u>
   Many commenters discussed the longevity of the proposed disposal facilities.

   - Comment a
     There is a need for a <u>permanent</u> solution. The radiation hazard will last for thousands of years, and the hazard from heavy metals will last forever. "The remedial action must be done right the first time." Past mistakes should not be repeated. (1, 10, 12, 18, 23, 24, 105, 110, 202, 206, 207, 208, 209, 211, 212)

000264

- Response a
  The DOE believes that compliance of remedial actions with EPA standards, as mandated by PL95-604, will effect as "permanent" a solution as is reasonably achievable, given limited Federal resources and the magnitude of the problem relative to other national problems.

- Comment b
  If the stabilization in place design is chosen, the liner will fail, either in the short term because of settling of the soil under it or in the long term because of seismic shock. (1, 15, 19, 28, 35, 107, 202, 206, 209, 212)

- Response b
  Some of the consequences of liner system failure are discussed in Appendix D of this FEIS.

- Comment c
  One of the design options for Alternative 3 (which calls for partial below-grade disposal, a 4-foot clay liner, a 6-foot cover including a 2-foot clay cap, and a riprap-lined diversion ditch) will provide protection for the recommended 1000 years. (110)

- Response c
  It is agreed that the referenced design option would provide reasonable assurance of protection for the 1000-year period required by final EPA standards.

- Comment d
  On the other hand, one citizen felt that concerns about longevity were unwarranted. "Due to our inexorable depletion of our resources, in several decades that pile will be a valuable mineral resource and will be mined for its mineral value." After this future reprocessing, the tailings would be disposed of in a proper permanent way. (111)

- Response d
  The possibility that resources in the stabilized Vitro tailings might be retrieved in the future was mentioned in Section 5.17 of the DEIS.

- Comment e
  A citizen with experience in these matters felt that reliability engineering was the appropriate method for determining the longevity of a proposed facility. (12)

- Response e
  The techniques of modern reliability engineering are difficult to apply to problems in waste disposal because of the many uncertain elements in the system of waste-and-emplacement structures (it is in part a natural system, not entirely engineered), and because of the chronic nature of certain of the system's "failure modes" (failure statistics of components are not measurable in reasonable amounts of time).

6. Comment.
There were several comments about the cover to be used.

- Comment a
  More detail was asked for on the calculations made on the thickness of cover needed to protect the tailings from water, water erosion, and human disruption. (110)

- Response a
  Details regarding cover thickness are included in Appendix A of this FEIS. The pit run rock layer on the cover will prevent erosion from runoff or during the unlikely flooding events. The cover design will prevent inadvertent human intrusion.

- Comment b
  Sand, gravel, and clay are in short supply along the Wasatch Front. (209, 212, 214)

- Response b
  The sand, gravel, and clay needed to complete Alternatives 2 or 3 would be obtained from identified commercial suppliers or, in Alternative 3, would be taken from on-site excavations at South Clive. Based upon field investigations conducted by the DOE and discussions with commercial vendors, the amount of these materials used would not tax supplies available in the Salt Lake Valley or Tooele County.

7. Comment.
There were several comments about transporting the tailings from the Vitro to the South Clive site.

- Comment a
  One private citizen noted that the DEIS called for a railway car with "a solid covering on the top and if at all possible a solid floor." In the FEIS he would like to see "this type of container transport by rail and not by road be reaffirmed." (22)

- Response a
  Tailings transport by truck and railroad for relocation to South Clive is evaluated in Appendix A and elsewhere in this FEIS.

- Comment b
  One private citizen asked, "Where will the railroad cars go to be washed down and where will this dangerous, contaminated water and material go -- on the ground?" (4)

- Response b
  The railroad cars and haul trucks would be washed down at washdown stations before leaving either site. The washdown water would be confined and recycled from tanks or lined lagoons. Any excess washdown water would be used as tailings compaction water or treated prior to discharge.

- Comment c
  Another citizen suggested that instead of moving the material by train or truck, the DOE "could slurry it out in the pipeline, a temporary pipeline." (50)

- Response c
  The DOE believes that moving the tailings to South Clive by slurry pipeline would be totally impracticable because of the uncertainty and costs of obtaining rights-of-way for such a pipeline, because the tailings would have to be dewatered at South Clive before they could be covered, and because of the additional cost to dispose of the pipeline.

8. Comment:
Several persons suggested variations in the design for Alternative 2. These are summarized below.

- Comment a
  Reduce the pile to grade; cover with successive layers of bentonite clay, sewage sludge, and soil; plant with the desired vegetation. (40, 102)

- Response a
  Except for reducing the pile to grade and the use of sewage sludge, this suggested variation is essentially the same as Alternative 2. Reducing the pile to grade is assumed here to mean complete burial. Besides being unnecessarily expensive, this would bring almost all of the tailings into contact with ground water--a situation that the design of Alternative 2 avoids. The DOE sees no benefits in using sewage sludge as part of a cover (see paragraph 3, response to this issue).

- Comment b
  Compact the material to 95 percent of its ultimate density; place a membrane of flexible materials on the base and top of each mixed and compacted layer; cover the pile with a 9-inch concrete topping. (32)

- Response b
  The DOE assumes that the purpose of the interlayered flexible membranes would be to reduce settlement and damage from seismic events. In essence, Alternative 2 incorporates similar measures; tailings will be desaturated and compacted in lifts on a liner system, and will be covered with natural materials. The layers in the liner system and cover will be composed of materials that will "flex" under material stresses. Natural soils were selected as cover rather than concrete because concrete will weather more easily over time (a 1000-year longevity standard is difficult to demonstrate).

- Comment c
  Relocate those tailings (if any) which are below the water table; dewater them; contour the pile to suit future users of the land; inject sewage sludge into the pile; cover the pile with successive layers of sewage sludge, clay, and black gravel; plant native desert plants on the pile. (2, 111)

- Response c
  Except for the use of sewage sludge, this suggested variation is really not different from Alternative 2. There are several reasons for not considering sewage sludge as a suitable cover material or as a useful stabilizer for the tailings. The use of unprocessed (raw) sludge would increase the moisture and contaminant loads of the pile, produce gas pressure in the pile, increase the mobility of certain contaminants, and would probably be contrary to state standards for sewage treatment. Processed sludge has been treated to destroy the microorganisms; however, the material is organic (much like humus). Therefore, the material would decompose over time increasing the likelihood of settlement of the cover, ponding, and radon escape. In addition, there would not be enough processed sludge produced in the required time for remedial action.

- Comment d
  Classify the tailings using a "dry airflow classifying process." (42)

- Response d
  The benefits to be achieved by the indicated procedure were not stated by the commenter. No response is possible.

- Comment e
  One individual specified a layered cover he thought proper: 9 feet of sand and crushed stone, but no liner. He also called for settlement gauges to control the rate of cover placement and to avoid embankment shear. (103)

- Response e
  The cover suggested by this individual would probably meet EPA standards but would be more expensive than the cover proposed in Alternative 2 because of the greater volumes of material it would require.

- Comment f
  The EPA noticed a reference to a well "abandoned and capped in the early 1960s (DEIS, page 72)," and commented that that well must be properly plugged. (204)

- Response f
  All wells to be covered by the stabilized tailings will be properly plugged pursuant to state regulations and procedures before the tailings are finally put in place.

- Comment g
  The Governor and his advisors said that partial burial is the state-of-the-art, not mounding as described in the DEIS for Alternative 2. They said further that liners should not be emplaced over areas where presumably contaminated water from sump pumps has been discharged. (209, 212)

- Response g
  Besides being more expensive than above-grade disposal, partial burial of tailings at the Vitro site would result in more of the tailings coming into contact with the saturated zone and, consequently, an increase in the leaching of contaminants. Above-grade disposal is the best engineering practice in the Salt Lake Valley.

  Regarding sump waters: It is proposed in the conceptual scheme that the installation of the liner system be closely coordinated with the required excavation and dewatering operations. In the operational sequence the contaminated materials are to be placed over the liner system prior to the abandonment of adjacent ground-water collection ditches and dewatering sumps. The projected weight of these materials will be more than sufficient to offset any potentially damaging uplift pressures resulting from the underlying ground-water conditions.

  It should be noted that in light of the projected excavation depth and the placement of the granular bed, any uplift forces acting on the base of the clay liner will be relatively minor. For this study it was assumed that the average excavation depth would be on the order of seven feet below the adjacent grade. Thus, the base of the excavation would be approximately two to five feet below the projected ground-water table as described on page A-14. With the placement of a three-foot granular base, the maximum projected uplift pressure is equivalent to a two-foot head of water. In fact, this pressure will be more than offset by the dead weight of the recommended three-foot clay liner.

  The return of sump waters to the ground would not increase the pre-remedial action contamination of the shallow aquifer under the site.

9. Comment.
   A group made suggestions about disposal at the South Clive site under Alternative 3. They called for stabilization below grade (yet above the regional water table), riprap over the whole surface, not just the uphill toes of the mound, a half-mile buffer zone, Federal ownership or control of all land within 10 miles, and no use of the land for recreational vehicles or grazing. (110)

   Response.
   With the exception of exclusion of recreational vehicles, none of these suggested features of the disposal at South Clive are necessary to meet EPA standards. Stabilization completely below grade above the ground water would require an unnecessarily large tract of land, a situation the

DOE has tried to avoid within the design for Alternative 3. The entire surface will be covered with an erosion barrier. There would be no purpose served by requiring Federal ownership of all lands within 10 miles of the site; most of that land is already managed by the Bureau of Land Management, Department of the Interior.

6.10 COSTS, DIRECT AND INDIRECT

The State of Utah and the CVWRF Board were particularly critical of the DOE's cost estimates; a few individuals also had comments on the matter. The state's and the board's basic concern was that the DOE would use the very great difference in the projected costs between stabilization in place and moving to South Clive (almost $40 million in the DEIS) to justify a choice of alternatives that is not desirable from the standpoint of health and safety. Altogether there were 15 written statements and 13 oral ones on this topic. These are summarized below, followed by the DOE's responses to the particular issues.

1. Comment.
Some commenters claimed that the cost differential of about $40 million between stabilization in place and moving to South Clive is wrong.

   - Important costs of leaving the tailings at the Vitro site have been left out. These include site dewatering costs, replacement of the Vitro ditch, relocation of utility systems, relocation of roads, land acquisition, leachate monitoring and control systems, and formal value engineering of the final design. In addition, unit costs, particularly for imported clay, have been underestimated. (1, 6, 15, 16, 23, 35, 108, 206, 209, 211, 212, 213)

   - The design does not take advantage of possible cost savings in the plan for moving the tailings to the South Clive site. These include the use of two unit trains instead of three, combined with an improved unloading capability, the use of a more common type of train car, the lease instead of purchase of the train cars, the omission of the clay liner at South Clive, and the use of a better system than conveyors for transporting tailings material. (1, 15, 206, 209, 211, 212)

   - On the other hand, several persons said that the cost estimates for moving the tailings to South Clive are low because they do not allow for dewatering the site, hauling some materials on roads, inflation, and other unforeseen costs and charges. (4, 6, 108)

   Response.
   The costs for each subissue have been reviewed and are addressed in the alternatives and are included in Appendix A.

2. Comment.
Commenters claimed that the economic analysis of stabilization in place is inadequate in that long-term costs are not evaluated. There are more costs than just the engineering or capital costs of cleanup. Life-cycle costing favors tailings removal.

- Comment a

The Central Valley Water Reclamation Facility will be economically affected in several ways. (15, 16, 21, 23, 107, 204, 206, 207, 211)

1. Central Valley may have to buy land to make up for land dedicated to tailings disposal.

2. The CVWRF Board will face increased costs of operation if the Vitro lands are only partially cleared of tailings. They will have to develop sludge disposal sites elsewhere or install expensive dewatering facilities.

3. The CVWRF Board will face the loss of resource recovery benefits. The present long-term plans for the use of the land include a Resource Recovery Facility, which is to say a garbage-burning incinerator to recover useful heat energy. The land presently planned to be used for this facility would remain open under the stabilization in place alternative, but would have to be devoted to uses with a higher value, namely sludge disposal.

4. The CVWRF Board will lose potential lease revenue. Their plan for the land includes a 20 to 25 acre industrial park for the southern end of the site. This land would be held for the eventual expansion of facilities and leased out in the meantime. If the site is only partially cleared, the Board would lose these revenues, which their economist estimates may be in the vicinity of $4.5 million.

- Response a

1. The CVWRF Board's approved Master Plan identifies intended land uses on the Vitro site as follows:

- Mechanical treatment plant: 100 acres
- Sludge lagoons: 23-32 acres
- Temporary industrial park: 20-25 acres
- County resource recovery facility: 16 acres
- City culinary waterwell site: 1 acre

Based on the above land uses, for stabilization in place, it is agreed that Central Valley may have to purchase land to make up for the acres dedicated to the disposal of the tailings.

2. Yes, to the extent that stabilization in place results in insufficient acreage being available to Central Valley for sludge disposal, the development of alternative disposal sites or the installation of sludge dewatering facilities may be required.

3. The operational start-up of the municipal solid waste-to-energy facility is currently estimated to be eight to ten years away (Dahl, 1983). Therefore, it has been excluded from the analysis of the economic impact of remedial action options for the Vitro tailings site. With regard to the economic benefits lost to Central Valley, revenue from the lease or sale of the site to be occupied by the facility appears to be the only direct economic benefit lost to Central Valley if the facility is not built on the Vitro site. In addition, the question of whether the facility is municipally or privately owned and operated must be resolved.

4. Based on a 1983 market value of $78,400 per acre, an annual lease rate equal to ten percent of the current market value and a 22.5 acre development, it is estimated that lost lease revenues would be approximately $176,000 per year. Assuming that the temporary industrial park had a useful life of approximately 13 years, this corresponds to approximately $2.3 million in lost lease revenues in 1983 dollars.

- Comment b

  The economic development of all property adjacent to the site would be inhibited or even prohibited because of health and safety risks. Potential benefits which would be lost include more than $697M within 30 years from capital investments, public revenues, and private sector income; more than $82.1M within 30 years from taxes, licenses, and user fees; and more than 900 jobs within 20 years. If the tailings are not removed, depressed property values will continue. (1, 16, 17, 21, 25, 46, 107, 109, 110, 206, 209, 210, 212)

  - Response b

    Stabilization in place will not preclude development of the properties adjacent to the Vitro site due to health and safety risks.

    In response to the following comments, the DOE commissioned an analysis of the economic impacts of alternative remedial actions. (See Economic Impact of Remedial Action Options, Vitro Tailings Site, City of South Salt Lake, Utah, FEIS, Appendix I.)

    - "The sum of capital investment, public revenues, and private sector income resulting from the economic development of the Vitro site will exceed $697 million within thirty years if not constrained by on-site stabilization."

    - "Total taxes, licenses, and user fees resulting from Vitro site development will exceed $82.1 million within thirty years."

    - "Total wages, land rents, and business profits resulting from Vitro site development will exceed $178 million within thirty years."

    - "Employment generated by site development will increase from 465 jobs initially to over 900 jobs within twenty years."

Stabilization in place would likely result in land use restrictions that would preclude the development of a temporary industrial park on the CVWRF Board's 3300 South Street frontage property. The estimate of annual economic benefits associated with the operation of an industrial park on the 3300 South Street frontage property is set forth below (thousands of 1983 dollars).

- Public revenues	$1,865
- After-tax wages	8,678
- After-tax corporate profits	315
- Rental income	176
Total	$11,034

These data exclude the estimated construction cost of the temporary industrial park ($11.0 million), as well as the estimate of additional economic activity due to the effect of the multiplier ($15.4 million). The direct and indirect employment impacts of the operation of the industrial park are estimated to be 271 jobs and 434 jobs, respectively. Finally, it should be noted that the estimated life expectancy of the temporary industrial park is 13 years based on the CVWRF Board's adopted Master Plan.

- Comment c
  The additional 740 to 850 cancer-induced deaths over the 1000-year planning cycle have economic costs which must be specifically addressed in the final EIS. (16, 209, 212)

- Response c
  The DOE feels that costs associated with medical treatment, income loss, and other "what might have been" costs from cancer-induced deaths over 1000 years cannot be estimated with any degree of confidence.

- Comment d
  After the remedial action is done, there will be some monitoring and maintenance of the site required by the Nuclear Regulatory Commission. It is likely that the requirements for monitoring tailings stabilized in place would be more stringent than those for monitoring tailings moved to the South Clive site, because of the very great differences in populations surrounding the two sites. This would increase the cost of disposal at the Vitro site relative to the cost of disposal at the South Clive site.

- Response d
  Agreed. However, the surveillance and maintenance requirements will not be established until a license has been issued by the NRC. Therefore, costs cannot be estimated with accuracy. Regardless, it is doubtful that these costs would ever approach the cost differential between Alternatives 2 and 3.

stabilizing the Vitro residual radioactive materials in place ($42 million). DOE will pay seventy-five percent (75%) and the state will pay twenty-five percent (25%) of allowable costs which exceed the amount of the SIP cost estimate for relocation to the South Clive site.

8. Comment.
In reference to DEIS Section 5.9 (pages 130-131), a commenter wrote "DOE should discuss how it determined the number of individuals who would 'immigrate' to Salt Lake City to take remedial action jobs." He thought it likely that the small number of new jobs would be taken by local residents. "DOE should explain how its construction contractors will hire workers and under what conditions, if any, preference will be given to local workers." (110)

Response.
The estimates of the number of workers who would be attracted to Salt Lake City by a project of this size are based on past experience with similar situations as well as the assumptions described in the referenced section. Admittedly, the national labor market and current economic conditions can change the validity of past experience as an estimator of labor immigration. The estimated number of immigrants is seen to be small, compared to overall labor needs. DOE contractor's policies for hiring workers will be explained in engineering-design documents that will follow the EIS.

6.11 RADIOLOGICAL EXPOSURES AND EFFECTS

There were 9 written and 16 oral statements that discussed some aspect of radiation effects. The issues involved are summarized below, followed by the DOE's responses.

1. Comment.
Most commenters expressed general concern about the radiation exposures to the nearby populace. (e.g., 21, 110, 206, 209)

Response.
This concern was the basis for the Uranium Mill Tailings Radiation Control Act of 1978 (PL95-604).

2. Comment.
On the other hand, some commenters thought the concern overdone.

- Two persons thought the levels very small. One spoke of them as "de minimis." The other said that "limited, intermittent contact with the pile would not constitute a major health hazard." (40, 102, 104)

- Several persons from Tooele doubted that it could be demonstrated that anyone had died from cancer because of the presence of the tailings. (4, 8, 13, 40, 201)

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Response.
The exposures to radon from the Vitro pile (Table 5.1) are indeed small compared to background (Table 5.3), but the radon release rates are well above the EPA standards and therefore the law mandates that there be remedial action.

3. Comment.
Several commenters found the presentation of expected impacts incomplete.

- Comment a
  The EPA disagreed with the statement in the DEIS that "all doses and health effects would occur within 10 kilometers of the Vitro pile." (204)

- Response a
  This statement was indeed incorrect. It has been corrected in Section 5.1.4 of this FEIS.

- Comment b
  Potential genetic effects should have been considered. (110)

- Response b
  The intelligent commenter can make his own or her own estimates of genetic defects using the whole-body population doses given in Tables 5.1 and 5.2 of the DEIS and whatever risk factor he finds acceptable. The EPA appears to accept the following risk factors (EPA, 1982; Section 4.4.2):

  0.04 to 0.6 serious genetic abnormalities per 1000 live births for the first generation.
  0.14 to 5 serious genetic abnormalities per 1000 live births for all succeeding generations.

  In each case, a lifetime exposure of the gonads to 100 mR/y (approximately background) is assumed. The International Commission on Radiation Protection (ICRP, 1977) estimated the genetic effects to be less than somatic effects for a given population dose, therefore, only risk of somatic effects must be considered.

- Comment c
  The DEIS failed "to give much credence to nonmalignant diseases caused by exposure to ionizing radiation." (110)

- Response c
  The DOE is unaware of risks of nonmalignant diseases caused by exposure to the relatively low levels of ionizing radiation that occur on the Vitro pile. Cataracts may be what is spoken of; but the minimum x-ray dose capable of causing a clinically significant cataract is thought to lie between 600 and 1000 rad in adults (Eisenbud, 1973:33).

- Comment d
  The DEIS should have addressed the cumulative effects on workers of exposures to radon and external gamma radiation. (110)

- Response d
  It is believed that "the cumulative effects on workers of exposure to radon and external gamma radiation" during construction were addressed in Section 5.1 and Appendix F of the DEIS. It is agreed that exposure of workers on the pile will have to be limited to 5 rem/yr. This point is discussed further in the section on mitigation, 5.19, of this FEIS.

4. Comment.
   There should be some discussion in the document of the consequences of the Vitro tailings having been present and unprotected for over a decade.

   - Several persons from the Salt Lake Valley said that there are already elevated levels of cancer among nearby residents and workers and are worried about their own health. (20, 27, 34, 36, 49)

   - Two persons pointed to studies said to demonstrate the link between the tailings and cancers. (34, 49) Several blamed their own or their relatives' cancers on the tailings. (3, 27, 33, 43, 52) Two persons offered lists of cancer victims. (27, 47)

   - Two people told of grotesquely deformed fish having been caught in Mill Creek and the Vitro ditch. (27, 47)

   Response.
   In 1981, the natural incidence was such that about one in six persons died of cancer. Section 5.1.4 of the main text of this FEIS indicates that the calculations predict an additional cancer death in Salt Lake Valley due to the tailings every 5 to 6 years. There is no way to tell which of the many cancers that do occur may be attributable to the tailings.

   In any case the decision has been made for remedial action. What the effects of the pile having been there in the past are, does not affect that decision except to emphasize that no action is not a satisfactory alternative.

5. Comment.
   There were several comments about the present radioactive state of the Vitro tailings and their environs.

   - Comment a
     The underlying soil is contaminated. (34) More data are needed on this contamination, as the evidence suggests that it is much deeper than stated in the DEIS. (110)

   - Response a
     Agreed. The depths of contamination stated in the DEIS were based on the evidence available at the time the DEIS was written. During remedial action the contamination will be removed until the Ra-226 standard is met. However, for purposes of this EIS, the DOE believes the information to be sufficient to ascertain, and bound, the impacts from the remedial actions.

- Comment b
  The ground water is contaminated, and there is the suggestion in the data that the deeper, partially confined ground-water system is already contaminated. (110, 209, 214)

- Response b
  This subissue is addressed in Appendix D, and in Section 5.4 of this FEIS.

- Comment c
  The DEIS says there is no contamination in the Jordan River sediments, but Dr. Pendleton "traced contamination for some distance down the river in years past." (204)

- Response c
  The DOE has inquired into the existence and availability of Dr. Pendleton's data regarding radiological contamination of water or sediments of the Jordan River. These data, available at the University of Utah, will be reviewed by the State of Utah prior to completion of the final design. Dr. Pendleton's radiological investigations regarding soil concentrations were reviewed in ORNL/TM-5251 and incorporated into Appendix F of the FEIS.

- Comment d
  "No measurements of ambient-air radon concentrations on the Vitro site itself were available for use in the impact statement." The commenter went on to say that the DEIS reports radon concentrations at 6 feet above the surface of the tailings, but does not point out whether the radon daughters are in equilibrium. (5)

- Response d
  Data from long-term radon concentration measurements on and around the site (40 locations) are presented and used in the revision of Section 4.8 and Appendix F. A dose conversion factor developed in Appendix F

$$7.3 \times 10^{-5} \frac{\text{rem}}{(\text{hr-pCi}/\ell)}$$

  was used to convert radon concentration to dose to the lungs from radon inhalation. Implicit in this dose-conversion factor is an assumption of 25 percent equilibrium between radon-daughter products and radon.

- Comment e
  There were two comments about techniques of measurement. One man said the DOE should use an apparatus recently perfected at the Idaho Falls laboratory to determine the isotope of uranium-226 (sic, he probably meant radium). (32) Another said the DOE should develop a statistically sound sampling scheme "to gain a representative Ra-226 average over the entire 128 acres of the Vitro site." (110)

o Response e
The techniques used by the DOE to measure Ra-226 concentrations are believed to be sound and generally acceptable. New data based on the statistically designed sampling by MSRD (1982) are presented for U-238, Ra-226, and Th-230 in the revision to Section 4.8 and Appendix F.

6. Comment.

The accident analyses in the DEIS (Section 5.1.5 and Appendix F.2.3) are an adequate assessment of the radiation exposure pathways and a reasonable estimate of doses due to a hypothetical accidental spill of material on land. (215)

Response.
Agreed.

6.12 HEALTH EFFECTS AND CONVERSION FACTORS

Several statements (3 written and 2 oral) had observations to make about the way health effects are inferred from radiological exposures.

1. Comment.
Several persons and organizations questioned the conversion factors used. The EPA questioned the statement in the DEIS that the factors used for lung cancer incidence from radon daughter exposures overestimate the risk. The estimates used fall in the low- to mid-range of those used by many groups. Moreover, according to BEIR-III for high LET radiations the linear hypothesis is less likely to lead to overestimates of risk, and may in fact lead to underestimates. (204)

Response.
The risk factors used in the DEIS are, in the DOE's opinion, realistic estimators of the true risk of lifetime cancer death. The text has changed "overestimate" to "estimate realistically". It should be pointed out, however, that literature values range from 13 to 102 lung cancer deaths per million man-rems of dose commitment due to inhalation of radon-daughter products, and from 50 to 621 cancer deaths per million man-rems of dose commitment due to gamma exposure (Cohen, 1981; Evans et al, 1981; Harley and Pasternack, 1982; National Academy of Science, 1980; National Academy of Science, 1972; United Nations, 1972; United Nations, 1977; United States Radiation Policy Council, 1980). Thus, the factors used in predicting cancer deaths in this FEIS are probably accurate to within a factor of 5. Since the same risk factors were used throughout this report, intercomparisons of radiological impacts between the two action alternatives are valid, regardless of the accuracy.

2. Comment.
The EPA also said that since "the BEIR III gamma risk factors are based on misinterpretations of Japanese exposure data (which are now being reassessed), we recommend that until new risk factors are developed, BEIR I or other sources for gamma risk coefficients be used." (204)

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Response.
In another context (DOE 1982c) the EPA recommended using 200 x 10^{-6} per man-rem instead of 120 x 10^{-6} per man-rem. The DOE thinks such a substitution premature and, in any case, a substitution that would not change the comparison between action alternatives.

3. Comment.
A group representative said the DOE should discuss in greater detail why it selected the radon and EGR risk factors it did. He also asserted that estimates were made only for healthy, adult members of the population. (110)

Response.
The conversion factors used are for a demographically based distribution of ages and sexes, and therefore implicitly included young and old people and people of less than perfect health. See also the responses above to the EPA and to Issue 4 below.

4. Comment.
One man said that the hazard attributed to radon is grossly exaggerated, saying that the usual conversion factors are wrong. (2, 111)

- He believed the inferences from the uranium miner data are false because they are inconsistent with data from uranium mill workers. The former breathed contaminated dust, the latter radon gas. Moreover, these epidemiological inferences are confounded by the prevalence of smoking among the miners.

- He said that the standard assumption of a linear, non-threshold response to radiation is not provable, and implied that health effects are therefore inevitably overestimated.

Response.
An excess lung cancer risk has been observed among several groups of underground miners exposed to Rn-222 and its daughters: uranium miners in Colorado, Czechoslovakia, and Ontario, fluorspar miners in Newfoundland, and several smaller groups of nonuranium miners working in hard rock mines in Sweden and England. The results of these epidemiological studies are discussed in detail in a report of the United Nations Scientific Committee on the Effects of Atomic Radiation, published in 1977.[a] These studies led the International Commission on Radiological Protection to estimate[b] a total lifetime risk for lung cancer of

$$1.5\text{-}4.5 \times 10^{-4} \text{ per WLM.}$$

[a] "Levels and Effects of Ionizing Radiation." UNSCEAR, 1981.
[b] "Limits for Inhalation of Radon Daughters by Workers." ICRP Publication 32, 1980.

The data have also been reviewed by the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR)[a] together with data from experimental studies with animals designed to elucidate the processes involved. The synergistic link with smoking is well known and continues as a matter of intense research interest; the experimental evidence, for instance, shows that the origin of tumors in animals is deep in the lungs, whereas human cancers induced by cigarette smoking or exposure to environmental agents nearly always arise high in the lungs.

The lifetime risk factor used in this FEIS is one suggested by an international group of experts[b] as modified by a changed definition of the WLM due to Harley and Pasternak[c], equivalent to

$$2 \times 10^{-4} \text{ per WLM.}$$

The BEIR report[c] also discusses at length the linear, non-threshold hypothesis for radiation exposure. It chooses to follow a linear-quadratic but still non-threshold response. This very likely does tend to over-estimate health effects somewhat.

The DOE and its contractors feel that they must follow the lead of these experts in documents such as this.

5. Comment.
One man said that the danger from radon is exaggerated, "I am afraid there has been some intentional fear-making ... we do not have a runaway nuclear pile sitting across the street." (22)

Response.
The DOE does not believe that fears have been deliberately incited; the fears expressed are real and a product of the times.

6.13 LAND USE

Several statements (12 written and 9 oral), especially those of the Central Valley Water Reclamation Facility Board, commented on the proper and best use, as well as the value, of the land at the Vitro and South Clive sites. These comments are summarized below together with the DOE's responses to them.

1. Comment.
The CVWRF Board purchased this large tract of land for the specific purpose of constructing a waste-water treatment plant and having adequate land available for long-term expansion. This site was specifically

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a "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980." NAS, 1980. See Especially Page 308 and Following.

b "Estimate of Risk From Environmental Exposure to Radon-222 and Its Decay Products." Nature 290, 98-100.

c "Environmental Radon Daughter Alpha Factors in a Five-lobed Human Lung." Health Physics 42, 789-800. See Especially Page 793.

000[illegible]

selected to accommodate a long-term need at the least long-term cost. Moreover, it was purchased with the promise from the Federal government that it would be immediately cleaned up and that all of this land would be available for their purposes. All of this land is needed. (15, 18, 107, 110, 204, 207, 209, 212)

Response.
It is agreed that the CVWRF Board purchased the "large tract of land" for the construction of a waste-water treatment plant and to facilitate long-term expansion (Final Report, 201, Facilities Plan, CVWRF Board). In addition, it is agreed that the land was purchased contingent on a promise by the Federal government to clean up the property and make it available for "Central Valley purposes." This is supported by their approved Master Plan, which identifies intended land uses in the Vitro site as follows:

- Mechanical treatment plant: 100 acres
- Sludge lagoons: 23-32 acres
- Temporary industrial park: 20-25 acres
- County resource recovery facility: 16 acres
- City culinary waterwell site: 1 acre

However, the DOE disagrees that ". . .it would be immediately cleaned up...." Remedial action is contingent upon many time-consuming processes required by law. Regardless, alternative 3 is DOE's preferred alternative and the land will be available to the CVWRF Board upon completion of the remedial action.

2. Comment.
The tailings are presently and will continue to be an eyesore and an aesthetic blight. If the tailings are stabilized on the site, it will mean a pile 45 feet high -- four and a half stories. This would be a very unaesthetic monument to a giant Federal mistake. (17, 20, 109, 209)

Response.
It is agreed that the unstabilized tailings are something of an eyesore. But the DOE disagrees that the tailings stabilized according to the plan of Alternative 2 would constitute an "aesthetic blight" on what is already a functional-appearing industrial warehousing neighborhood, not unpleasant to look at, but hardly a residential or commercial district that requires extremely pleasing surroundings in which to conduct daily business.

3. Comment.
Stabilization in place will prohibit development of the prime industrial land adjacent to the site, will constrain development of other nearby lands, and may discourage further development elsewhere in the Salt Lake Valley. At the present time there are vacant fields within one-half mile of the site; this vacant land is valued at from $100,000 to more than $193,000 per acre. (17, 21, 109, 206, 209, 210, 211). One person quoted a local planner as saying that "the Vitro site is the prime industrial property in the western United States." (211).

Response.
Stabilization in place will likely result in land use restrictions that will preclude development of the Vitro site's 3300 South Street frontage property as a temporary industrial park. However, the development of an alternate parcel as an industrial park is a possibility. In addition, it is not anticipated that stabilization in place would prohibit the development of adjacent properties or discourage development elsewhere in the Salt Lake Valley.

The estimate of $193,000 per acre for the market value of vacant fields within one-half mile of the Vitro site is noted. However, the DOE analysis of local land values does not support this estimate of the market value of vicinity properties. A 22.71-acre site at 3300 South Street and 900 West Street is currently (1983) being offered for sale by the Utah State Retirement Fund for $1,978,495 or approximately $87,120 per acre. A spokesperson for the Utah State Retirement Fund stated that a recent appraisal of the property did not mention the property's proximity to the Vitro site or the uranium mill tailings (Blackburn, 1983).

Based on the preceding, the difference between the aforementioned estimate of $193,000 per acre and the asking price for the Utah State Retirement Fund's adjacent property can not be attributed to the property's proximity to the Vitro site.

The following data were provided by the Chairman of the Board (Petersen, 1983) and the General Manager (Dahl, 1983) of the Central Valley Water Reclamation Facility. These data summarize transactions involving the Vitro site, as well as the site of the waste-water treatment facility.

Year	Parcel Size (acres)	Purchase Price (dollars/acre)	Description
1953	39.0	$ 3,500	District One's[a] purchase of the site for the treatment plant
1980	39.0	50,000	Sale of the site to Central Valley
1975	25.5 & 16.0	9,000	Tracts "B" and "C" north; purchased by District One
1980	25.5 & 16.0	10,000	Tracts "B" and "C" north; sold to Central Valley by District One
1981	12.5 & 14.3	62,500	Tracts "B" and "C" south; sold to Central Valley by Richards-Moench

[a] A predecessor organization, and now a member, of Central Valley.

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Finally, the current market value of Central Valley's 3300 South Street frontage property is estimated to be $78,400 per acre. These details are included in Appendix I of this FEIS.

4. Comment.
One private citizen questioned whether or not the Central Valley Water Reclamation Facility really needed all of its land. He suggested that because of advances in sewage technology, the sewage treatment plant will not need as much land as their plans indicate. He also suggested storing dewatered sludge on the tailings pile and making the pile deeper to decrease the area of land covered by the pile. (2, 111)

Response.
There is no doubt that the CVWRF Board could profitably use all of the 128-acre site; its plans for use of the land were outlined in Section 4.9 of the DEIS. The CVWRF management is presumably well aware of advances in sewage technology and how those advances might influence planning. Regarding the use of dewatered sludge, see responses to Issue 8, third response, Section 6.9. It is preferable to prevent the tailings from contacting ground water; thus, the final embankment cannot be completed below grade (deeper) or partially below grade because of the high water table.

5. Comment.
One citizen, referring to the Vitro site, asked, "How much an acre was the site sold for ((presumably to the CVWRF)) and what is the value of the property today?" She also asked if the 128-acre figure given on page one of the DEIS were correct. (4)

Response.
In 1979, the CVWRF Board bought the last 29 acres of the present, 128-acre site for about $62,000 per acre. The DOE's recent economic study shows that, if cleared of tailings, site land would be valued at $78,400 per acre in 1983. The 128-acre figure is believed to be accurate within a few tenths of an acre.

6. Comment.
The possibility of restrictions on the placement of building foundations near the stabilized mound (alternative 2) was raised. The DOE should explain the reason for this and its potential effect on the CVWRF expansion plans. (204)

Response.
The reasons for restrictions were presented in the DEIS, Section 5.6, Impacts on Land Use (page 124).

7. Comment.
A few comments focused on land use and value in Tooele County.

- Comment a
  Tooele County will be limited and prohibited from future use of these remote lands. Potential future use includes mining and chemical plants. (7, 12, 205)

- Response a
  It is agreed that any use of the South Clive site will be prohibited if Alternative 3 is implemented. The South Clive site, as well as most of the land within a 10-mile radius of the site, is characterized by poor soil conditions and sparse vegetation. Current land uses are limited to sheep grazing, jackrabbit hunting, and occasional recreational vehicle driving. The site is currently owned by the State of Utah, while most of the land within a 10-mile radius of the site is public domain administered by the Bureau of Land Management. Based on considerations of technology and raw materials requirements, the site has virtually no resource value. In addition, its remoteness from the urbanized areas of Tooele County makes it an improbable location for a chemical plant. Based on the preceding, it is incorrect to characterize potential future land uses as including mining and chemical plants. Therefore, it also is incorrect to value the site on the basis of it being a potential location for a chemical plant.

- Comment b
  If the County is reimbursed for this land, the "assessed valuation of this plot should be on a chemical plant basis, not on waste ground." (7)

- Response b
  This subissue is beyond the scope of this EIS. It has not been established that Tooele County must be reimbursed for this state-owned land or, should it be so established, what the basis of assessment of land value should be.

- Comment c
  The Governor said that if the DOE chooses to exchange some Federally-owned land for the state-owned South Clive site, the exchange should be made before construction begins. Otherwise, DOE will need to get a special-use permit from the Division of State Lands and Forestry. A right-of-way permit may also be needed to provide access across other state lands. (209)

- Response c
  The question of the ownership of the South Clive site will be resolved prior to construction. In addition, if a right-of-way permit is required to gain access to the South Clive site, it will be obtained prior to construction.

6.14 NONRADIOLOGICAL IMPACTS

There were 3 written and 9 oral statements that discussed nonradiological impacts. These and the DOE responses to them are given below.

1. Comment.
   Several persons spoke of the dust hazard. They apparently were not speaking so much of its radiological effects as of the problems associated

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with dust concentrations so high that those downwind sometimes have to wear eye coverings and cover their noses. Dust, they said, is inevitable, although it can be alleviated by keeping the working areas wet. (5, 20, 22, 31, 34, 50, 52)

Response.
Production of dust during the construction phases of Alternative 3 will be kept as low as is practicable; this may require the wetting down of the excavated materials during dry periods. The commenters should note that dusting from the present, 128-acre site will be substantially reduced upon completion of the remedial action.

2. Comment.
Several persons brought up the issue of heavy metals. (209, 212, and others)

- Comment a
  There was a complaint that "the technical document does not specifically deal with heavy metals or any of those constituents." The commentor specifically mentioned hexavalent chromium; he was talking about the presence of heavy metals in and their transport by ground water. (6)

- Response a
  The DEIS did address the problem of heavy metals. This was done in Section A.4.2.2 of Appendix A, where the transport rates of thorium, lead, uranium, arsenic, selenium, chromium, and silver were compared with the transport rate of radium in clays or silty clays typical of the Vitro-site (Table A-4). Of these, only chromium is transported more rapidly than radium (5 times as fast) and neither of these elements moves with the full ground-water speed. The DOE estimates a 0.026 percent site-weighted average for the chromium content of the tailings; this amounts to 264 grams per ton, or 2.6 times the average crustal abundance of chromium. The compounds formed of chromium in the tailings are unknown; but it appears that they are relatively insoluble compounds. Chromium concentrations in waters drawn from shallow wells drilled in the tailings are all less than 0.05 mg/ , which is the maximum concentration allowed in drinking water. Further discussion of the heavy metal problem can be found in Appendix D of this FEIS.

- Comment b
  "The heavy metals present in the tailings will never burn out." Hexavalent chrominum was again mentioned. (18, 202)

- Response b
  Agreed. See response in previous paragraph.

3. Comment.
A Tooele County official and EPA questioned the data in Section 5.14 of the DEIS which indicated there would be a higher incident of construction-related problems and disabling industrial accidents at the Salt Lake site than at the South Clive site. (6, 204)

Response.
The estimates of expected number of work-related accidents given in Table 5-12 of the FEIS have been recalculated to reflect changes in the alternative designs, manpower, and incidence rates of the Utah Department of Transportation and others. Table 5-12 indicates that disabling injuries (defined as a death or lost work days) among construction workers is more than twice as great for Alternative 3 than for Alternative 2.

6.15 PSYCHOLOGICAL IMPACTS

Many statements (3 written and 13 oral) included mention of the fear and worry that the tailings arouse among people.

1. Comment.
In Tooele County, the prospect of having these tailings in the same county as themselves causes people to expect their part of Utah to be stigmatized as a general dumping ground for the nation's wastes: (6, 7, 8, 11, 13, 201)

   - The military's nerve gas supply, including the Weteye missile, is already stored at the Tooele Army Depot.

   - It was near the Dugway Proving Ground in Tooele County that several years ago a number of sheep died from exposure to poison gas. This incident received wide coverage in the national press.

   - People from out of state, and even some Utah residents, are apprehensive about traveling along Interstate 80 west of Salt Lake City and only two miles north of the South Clive site.

   Response.
   The DOE appreciates Tooele County concern over being stigmatized as a general purpose dumping ground. The feeling is real, although in DOE's opinion based on an unjustified fear of low level radiation. The tailings are such a low-level source that unless one is right on top of or next to the tailings themselves, the amount of additional irradiation one receives is no more than the normal variation in background. When the tailings are moved to South Clive, they will be covered and isolated from ground water.

   These tailings must be cared for. The present situation of having bare tailings sitting uncontrolled in the middle of a major metropolitan area cannot be permitted to continue.

2. Comment.
In Salt Lake County, the presence of the tailings means that people wonder about their future health because of having lived, worked, or regularly driven near the Vitro site. (17, 21, 30, 33, 44, 46, 47, 53, 105, 109)

   Response.
   The DOE also appreciates the worries of the residents of Salt Lake Valley, and its message to them is the same as its message to the residents of the Tooele County.

GLOSSARY

absorbed dose, radiological	Radiation energy absorbed per unit mass, usually given in units of rads.
acceleration	In this report, the action of gravity in units of velocity per time squared.
alluvium	Unconsolidated detrital deposits resulting from operations of modern rivers.
alpha particle	A positively charged particle emitted from certain radionuclides. It is composed of two protons and two neutrons, and is identical to the helium nucleus.
animal-unit month	The amount of feed or forage required by one mature cow and calf for one month.
anticline	A fold in the underground rock structure that is convex upward. Its core contains the stratigraphically older rocks.
aquifer	A subsurface formation containing sufficient saturated permeable material to yield significant quantities of water.
aquitard	A confining bed that retards but does not prevent the flow of water to or from an aquifer.
atom	A unit of matter; the smallest unit of an element consisting of a dense, central, positively charged nucleus surrounded by a system of electrons, equal in number to the number of nuclear protons and characteristically remaining undivided in chemical reactions except for limited removal, transfer, or exchange of certain electrons.
A-weighted sound levels	A method of measuring sound intensity that simulates an individual's sound perception.
background radiation	Radiation arising from radioactive material other than that under consideration. Background radiation due to cosmic rays and natural radioactivity is always present, and there may also be background radiation due to the presence of radioactive substances in building materials, etc.
beta particle	Charged particle emitted from the nucleus of an atom, with mass and charge equal to those of an electron.
blow counts	The number of blows of a drop hammer to advance a soil penetrometer as detailed in the Standard Penetration Test (ASTM D1586).

boundary seismicity	Seismicity which is associated with the boundary between two structural and/or physiographic provinces; for example, seismic events along the Wasatch Front, the physiographic boundary between the Colorado Plateau and the Basin and Range Province.
colluvium	Rock fragments, sand, and soil that accumulate on steep slopes or at the foot of hills.
confined aquifer	An aquifer bounded above and below by relatively impermeable beds.
contamination	In this report, the presence of radioactive material in concentrations above natural levels.
curie (Ci)	A unit of radioactive disintegration; 3.7×10^{10} disintegrations per second.
Dames & Moore	An engineering and environmental consultant firm with an office in Golden, Colorado.
daughter product(s)	A nuclide resulting from radioactive disintegration of a radionuclide, formed either directly or as a result of successive transformations in a radioactive series; it may be either radioactive or stable.
decay, radioactive	Disintegration of the nucleus of an unstable nuclide by spontaneous emission of charged particles, photons, or both.
decibel (dB)	A unit used to express power or intensity ratios in electrical and acoustical technology.
decontamination	The reduction of radioactive contamination to a predetermined level set by a standards-setting body such as the EPA.
densification	The proccess of compacting loose soil materials.
disintegrations per minute or second	The number of radioactive decay events occurring per minute or second.
disposal	The planned safe permanent placement of radioactive waste.
dose	A general term denoting the quantity of radiation or energy absorbed; for special purposes, it must be qualified; if unqualified, it refers to absorbed dose.
dose, absorbed	The amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material at the point of interest; given in units of rads.
dose commitment	The cumulative dose equivalent that results and will result from exposure to radioactive materials over a discrete time period; given in units of rems.

dose equivalent	The quantity that expresses all kinds of radiation on a common scale for calculating the effective absorbed dose; defined as the product of the absorbed dose in rads and modifying factors, especially the qualifying factor; given in terms of rems. Often abbreviated "dose."
electron	A negatively charged particle found either free or surrounding the nucleus of an atom.
excess lifetime cancer deaths	The number of cancer deaths occurring in the lifetime of a particular population that is in excess of the number normally expected.
exposure	The presence of radiation that may deposit energy in an individual; given in units of roentgens.
external dose	The absorbed dose or dose commitment that is due to a radioactive source external to the individual as opposed to radiation emitted by inhaled or ingested sources.
fault	A surface or zone of rock fracture along which there has been movement.
flood plain	Lowland or relatively flat areas that are subject to a 1 percent or greater probability of flooding in any given year (i.e., a 100-year or more common flood).
flow slide	The rapid failure of soil due to rapid strength loss and the resulting translational movement of that mass. Flow slides are often caused by liquefaction within a soil mass resulting from dynamic loading such as from an earthquake.
flux, radon	The emission of radon gas from the earth, usually measured in units of picocuries per square meter per second.
g Units	A unit of acceleration equal to the standard acceleration of gravity.
gamma dose	Radiation dose caused by gamma radiation.
gamma ray or radiation	High energy electromagnetic radiation emitted from some radionuclides. The energy levels are specific for different radionuclides.
graben	A block of the earth's crust, generally with a length much greater than its width, that has dropped relative to the blocks on either side.
ground water	Water below the land surface, generally in a zone of saturation.
hopper	A railroad car that dumps its load from the bottom of the car.

horst	A block of the earth's crust uplifted along faults relative to the rocks on either side.
half-life	The time it takes for 50 percent of the quantity of a radionuclide to decay into its daughters.
hypocentral distance	The distance to an earthquake focus from a given point.
in situ	In the natural or original position.
internal dose	The absorbed dose or dose commitment resulting from inhaled or ingested radioactivity.
isotopes	Nuclides having the same number of protons in their nuclei, but differing in the number of neutrons: the chemical properties of isotopes of a particular element are almost identical.
lacustrian	Soil produced, or formed, in a lake.
lenticular	Generally a laterally discontinuous rock or soil unit or bed.
licensing	In this report, the process by which the NRC will, after the remedial actions are completed, approve the final disposition and controls over a disposal site. It will include a finding that the site does not and will not constitute a danger to the public health and safety.
lineament	Any line on the ground or on an aerial photograph, that is structurally controlled.
liquefaction	A change in the phase of a soil unit from a solid mass to a viscous mass due to increases in soil water pore pressure.
liquid limit	The minimum amount of water which has to be mixed with a sediment or soil so that, under standard conditions of test (ASTM D423), the material becomes capable of flowing like a liquid.
man-rem (person rem)	Unit of population exposure obtained by summing individual dose-equivalent values for all people in the population. Thus, the number of man-rems attributed to 1 person exposed to 100 rems is equal to that attributed to 100 people each exposed to 1 rem.
maximum credible earthquake	The earthquake of the greatest magnitude that is predicted to occur along a known fault system.
micro	A prefix meaning one millionth (x 1/1,000,000 or 10^{-6}).
microseismic	Seismic events of very low Richter magnitude.

milli	A prefix meaning one thousandth (x 1/1000 or 10^{-3}).
Modified Mercalli (scale)	A standard scale for the evaluation of the local intensity of earthquakes based on observed phenomena such as the resulting level of damage. Not to be confused with magnitude, such as measured by the Richter scale, which is a measure of the comparative strength of earthquakes at their sources.
normal faulting	A fault where the hanging wall moves downward relative to the footwall.
nucleus	The positively charged center of an atom.
nuclide	A kind of atom characterized by the constitution of its nucleus. It is specified by the number of protons and the number of neutrons in the nucleus.
off-site property	(See vicinity property)
ordinary method-of-slices analyses	A method to determine slope stability where the slopes are analyzed as a group of vertical slices. The driving and resisting forces of each slice are calculated using basic static equilibrium equations. The factor of safety is determined as the ratio of the resisting forces to the driving forces.
passive controls	Those controls which inhibit human contact with the waste and depend on a continuing social order. Examples include Federal ownership of a disposal site, monuments on the site, records with agencies, and physical barriers (e.g., riprap, covers, waste burial).
permeability	The ease with which liquids or gases penetrate or pass through a solid material. Technically, it is the volume of fluid that will flow through a unit area under a unit hydraulic gradient, measured in centimeters per second or equivalent units.
permissible dose	That dose of ionizing radiation that is considered acceptable by standards-setting bodies such as the EPA. Also, the dose of radiation that may be received by an individual within a specified period with the expectation of no substantially harmful result.
person-rem	Same as man-rem.
pico	A prefix meaning one trillionth (x 1/1,000,000,000,000 or 10^{-12}).
picocurie	A unit of radioactivity defined as 0.037 disintegrations per second.

population dose (exposure)	The sum of individual radiation doses received by all of those exposed to the source of interest.
pore water pressure	Stress or pressure within a soil or rock mass due to the pressure of interstitial fluid.
potentiometric surface	That surface represented by the static water-level in wells tapping a saturated geologic formation or aquifer.
probable maximum flood	The hypothetical flood (peak discharge, volume, and hydrograph shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of probable maximum precipitation (PMP) and other hydrologic factors favorable for maximum flood runoff such as sequential storms and snowmelt.
probable maximum precipitation	The estimated depth for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance.
proton	An electrically positive elementary particle found in the nucleus of an atom. Also, the nucleus of a hydrogen atom.
quality factor (QF)	The principal modifying factor by which absorbed doses are multiplied to obtain dose equivalents for radiation-protection purposes and thus express the effectiveness of absorbed doses on a common scale for all kinds of ionizing radiation. The quality factor depends on the type and the energy of the radiation being considered.
rad	A unit of measure for the absorbed dose of radiation. It is equivalent to 100 ergs per gram of material.
radioactivity (radioactive decay)	The property of some nuclides of spontaneously emitting particles or gamma radiation or of spontaneous fission.
radioisotope	A radioactive isotope of an element with which it shares almost identical chemical properties.
radionuclide	A radioactive nuclide.
radium-226	A radioactive daughter product of uranium-238. Radium is present in all uranium-bearing ores; it has a half-life of 1620 years.
radon-222	The gaseous radioactive daughter product of radium-226; it has a half-life of 3.8 days.
radon-daughter product	One of several short-lived radioactive daughter products of radon-222. All are solids.

rem	A unit of dose equivalent equal to the absorbed dose in rads times quality factor times any other necessary modifying factor. It represents the quantity of radiation that is equivalent in biological damage to 1 rad of x-rays.
Richter magnitude	A measure of the total energy released by an earthquake.
roentgen	A unit of measure of ionizing radiation in air; 1 roentgen in air is approximately equal to 1 rad and 1 rem in tissue.
safety factor	A classification of stability based on the ratio of resistant forces to driving forces where a ratio greater than 1 indicates non-failure.
sands	In this report, relatively coarse-grained waste products of uranium-ore processing.
secular equilibrium	The condition of a radionuclide decay chain in which the rate of decay of any radioactive product is just equal to its production from the previous member of the chain.
seismicity	Phenomena of earth movements.
seismogenic	Said of a geologic setting or structure which has been or could be the locus of seismic activity. For example, an active fault is considered the potential seismogenic source for future earthquakes.
seismotectonic	Adjective used to describe the relationship between seismicity and the geologic structural fabric of the earth.
shear resistance	Resistance to displacement by a shear stress.
shear stress	A stress causing or tending to cause two adjacent parts of a solid to slide past one another parallel to the plane of contact.
slimes	In this report, fine-grained waste materials from uranium-ore processing that are mixed with small amounts of water.
South Clive site	A site 3 miles south of a rail point called Clive on the eastern edge of the Great Salt Lake Desert and about 85 road miles west of Salt Lake City, Utah. It has been nominated by the State of Utah as a possible site for permanently disposing of the radioactive material from the Vitro site.
Standard penetration test	A test to determine the relative values of soil density based on the numbers of blows of a standard force necessary to drive a shaft a standard distance into the soils.
syncline	A fold in the rock structure that is concave upward.

tailings, uranium-mill	The wastes remaining after most of the uranium has been extracted from uranium ore.
tectonics	Study of the deformation of the major structural features of the Earth's crust or broad structure of a region.
tectonic stress	The force per unit area transmitted to strata during seismic or earthquake activity.
thorium-230	A radioactive-daughter product of uranium-238; it has a half-life of 80,000 years and is the parent of radium-226.
total overburden stress	The force per unit area caused by the weight of the overlying rock or soil.
transmissivity, hydraulic	A measure of the ability of an aquifer to transmit water equal to the product of the permeability and the thickness of the aquifer, expressed in gallons per day.
unconfined aquifer	An aquifer that is not confined by impermeable beds. The upper surface is called the water table.
Unified Soil Classification System	The generally accepted system for the classification of soils based on grain size, size distribution and plasticity properties adopted by the U.S. Army Corps of Engineers and the Bureau of Reclamation.
uranium-238	A naturally occurring radioisotope with a half-life of 4.5 billion years; it is the parent of uranium-234, thorium-230, radium-226, radon-222, and others.
vicinity property	A property in the vicinity of the Vitro site which is determined by the DOE, in consultation with the NRC, to be contaminated with residual radioactive material derived from the Vitro site, and which is determined by the DOE to require remedial action.
Vitro site	A site in South Salt Lake, Utah, containing radioactive residues left from operations of the Vitro Chemical Co. plant, which extracted uranium from various ores for the U.S. Atomic Energy Commission. It has been designated as requiring remedial action under UMTRCA.
water table	The potentiometric surface in an unconfined aquifer.
working level (WL)	A measure of radon-daughter-product concentrations. Technically, it is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of alpha particles with a total energy of 130,000 MeV.

working-level month (WLM)	Exposure resulting from inhalation of air with a concentration of 1 WL of radon daughters for 170 working hours. Continuous exposure of a member of the general public to 1 WL for one year results in approximately 50 WLM of exposure; 1 WLM is approximately equal to 5 rem.

ABBREVIATIONS AND ACRONYMS

AAR	American Association of Railroads
ADT	Average Daily Traffice (trips)
AEC	U.S. Atomic Energy Commission
ANL	Argonne National Laboratories
ANS	American Nuclear Society
AQCR	Air Quality Control Region
BAR	Basin and Range
BEIR	Advisory Committee on the Biological Effects of Ionizing Radiation of the National Academy of Sciences (also their report)
BLM	Bureau of Land Management, U.S. Department of Interior
BOD	Biological oxygen demand
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CO	Carbon monoxide
CVWRF	Central Valley Water Reclamation Facility, Salt Lake City, UT
dBA	Decibels on the A scale; a logarithmically based unit of sound intensity weighted to account for human auditory responses
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
EA	Environmental assessment
EGR	External gamma radiation
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
F&WS	U.S. Fish and Wildlife Service
FBDU	Ford, Bacon and Davis Utah Inc.
FEMA	Federal Emergency Management Agency
FR	Federal Register
g	Grams, a unit of weight = 0.035 ounce; also a measure of acceleration, 1 g = 32 feet per squared second
gpm	gallons per minute
HC	Hydrocarbon
HEC	Hydrologic Engineering Center
HELP	Hydrologic Evaluation of Landfill Performance
HEW	U.S. Department of Health, Education and Welfare
HUD	U.S. Department of Housing and Urban Development
kWh	Kilowatt hours
l	Liter; a unit of volume = 1.057 quarts
LASL	Los Alamos Scientific Laboratory
L_{dn}	Day-night sound level, measured in decibels

m	Meter; a unit of length = 3.28 feet; also milli, a prefix meaning one-thousandth (10^{-3})
MCE	Maximum Credible Earthquake
MeV	Million electron volts
mg	Milligrams; a thousandth of a gram
mgd	Million gallons per day
MILDOS	A computer code used to calculate both the spread of radon and particulates in the atmosphere and the consequent radiation doses
MMI	Modified Mercalli Intensity; a measure of earthquake intensity
MPC	Maximum permissible concentration
mR/hr	Milliroentgens per hour
MSRD	Mountain States Research & Development Company, Tucson, Arizona
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969 (PL 91-190)
NOAA	National Oceanic and Atmospheric Administration
NO^2	Nitrogen dioxide
NO^x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Agency
O^3	Ozone
ORNL	Oak Ridge National Laboratory, Oak Ridge, Tennessee
P	Pico, a prefix meaning one-trillionth (10^{-12})
Pb	Lead
pCi/g	Picocuries per gram
pCi/l	Picocuries per liter
pH	A logarithmic scale of hydrogen-ion concentration, and hence, an indication of acidity or alkalinity: pH = 7 is neutral; pH less than 7 is acidic; pH greater than 7 is alkaline
PERM	Passive environmental radon monitor
PL	Public Law
Po	Polonium
PMF	Probable maximum flood
PMP	Probable maximum precipitation
RA	Remedial action
RAECO	Rogus and Associates Engineering Company
Ra-226	Radium-226
RAC	Remedial Action Contractor
RDC	Radon-daughter concentration
Rn-222	Radon-222
Sandia	Sandia National Laboratories, Albuquerque, New Mexico
SCS	U.S. Soil Conservation Service
SH&B	Sergent, Hanskins & Beckwith
SMSA	Standard Metropolitan Statistical Area
SO^2	Sulfur dioxide
TAC	Technical Assistance Contractor
TDS	Total dissolved solids
Th	Thorium

TLDS	Thermoluminescent dosimeters; a device for measuring radiation
TOC	Total organic carbon
TSP	Total suspended particulates
TSS	Total suspended solids
UBC	Uniform Building Code
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238
U_3O_8	Uranium oxide, also called yellowcake
UMTRA	Uranium Mill Tailings Remedial Action Project
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978 (PL 95-604)
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
Vitro	Vitro Chemical Company, South Salt Lake, Utah
VTSSC	Vitro Tailings Site Selection Committee; a committee appointed by the Governor of Utah in 1980
WL	Working level (a measure of radon-daughter-product concentration)
WLM	Working-level month (exposure to 1 WL for 170 hours)
$\bar{X}$	Mean (average value of the variable)
μ	Micro; a prefix meaning one-millionth (10^{-6})

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Department of Energy officials have estimated the cost of stabilization in place at $22,548,000. Yet, they further indicate that this figure does not include the costs of utility relocation, land aquisition, and other costs associated with ground water control. Figures derived by the Utah Departments of Health and Transportation have placed a more accurate figure of stabilization on-site at
10.1 $43,315,000 ($20,827,000 more than the DOE figure).

10.2 Department of Energy officials have estimated the cost of stabilization at a remote site would be $61,014,000. The Utah Department of Transportation has looked closely at these figures and have assured me that, under current Utah construction costs, the relocation would cost $53,222,000 ($7,792,000 less than the DOE figure).

So we have a possible $10 million cost difference. Let's look at some other cost-impact data that have great relevance in our discussions here
10.2 today:

1. Economic development of the Vitro site. The Utah Department of Economic and Community Development conducted a March, 1983 study and determined that "the sum of capital investment, public revenues, and
10.3 private sector income resulting from the economic development of the Vitro site would far exceed $697 million within thirty years if not constrained by on-site stabilization."

2. Employment. This same study indicates that employment generated by site development will "increase from 465 jobs initially to over 900 jobs within 20 years.

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3. Private Sector Revenues. Again, quoting from the same March, 1983 study, "the differential cost of stabilization and decontamination ($38.5 million) will be recovered in public sector revenues alone within ten years; total decontamination costs ($61 million) will be recovered within eighteen years."

These figures cannot be negated. They are important not only to this discussion of the remedial action that will be taken by the Department of Energy, but by the economic impact on future Utahns. And, at a time when it is apparent that revenues are needed at the State level to compensate for the lack of dollars at the Federal level, this is a valid
10.3 argument.

10.2 Considering the negative impacts in a fast-growing metropolitan area, the higer operating costs for the Central Valley Water Reclamation Facility (with the condemned adjouring land and no expansion) and the costs which will be passed along in terms of higher sewage treatment plant costs and higher utility rates for users, the additional revenues from taxes on an industrial center, the cost factor should not be the primary concern. The health factor must be the concern. And looking at the social and health-related problems associated with the location of stabilized tailings in a high-concentration area, huge remedial action costs (both in terms of dollars and health) will be dumped on our future generations. This was not the original intent of the legislation I worked so hard for passage in the 95th Congress. The Federal Government wants the problem fixed right the first time around.

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In conclusion, I would like to thank the U.S. Department of Energy for holding these hearings this week. I know that this is a fact-finding mission and that the response from Utahns has been great. I know further that the DOE offices in both Washington and in Albuquerque, New Mexico will have a host of facts and figures acquired at these hearings which must be looked at in depth. These hearings are important.

My wish now is that the Department of Energy roll up its' shirtsleeves and look at the overall health perspective of this issue, taking into consideration, not the short-term health reduction, but the long-term health hazards. This data must be weighed with the nominal difference in costs between the two options being considered. I am sure that the decision reached by the Department will have to take into consideration the potentially legacy that we could be handing our decendents.

While this decision is being made, I want to assure the Department of Energy that I will work closely with them to let the Members of Congress, and in particular, the Members of the Appropriations Committees in both Houses, know of the importance of adequate funding at the present time so that generations from now will not have to go through this process looking to stop dangerous health hazards. During the first week of April, 1983 I will be testifying before the House Energy and Water Appropriations Committee urging that adequate funding be provided for initial action in 1983 and in 1984. I will continue by efforts to ensure that the proper dollars are appropriated to fund the only decision that is before us -- the decision to protect Utahns, both now and in the distant future, from any further health-related incidents from the uranium mill tailings.

We must do the job the first time around. As Governor Matheson indicated, "there may be no second chance...".

In my opening remarks, I expressed my concern with the delay in the implementation of remedial action. I will end my testimony by repeating my concerns and charging the the representatives of the Department of Energy to make a proper and quick decision to once and
for all end these consistent delays. The facts have been placed before
20.1 you. I will be looking forward to working with you for a decontamination
of the vitro site and a removal of the uranium mill tailings to a
remote area this year. It is the only humane decision.

When considering the health hazards, you must look at the gamma radiation, the radon gas and all of the subsidiary chemical by-products and wastes left from the milling process at the Vitro plant. These dangers have been recognized and they are known cancer-causing elements. Yet, the hazards are never completely eliminated -- the radiation hazards last and affect both the environment and the people living in
11.1 the vicinity of these toxic substances. They threaten the lives of people in Utah -- people who never knew of these hazards when they built their homes and established their businesses, or even selected schools for their children to attend.

I am particularly concerned with the physiological hazards caused by the inhalation of radon gas and the associated dust particles. This is directly linked (as supported by the U.S. Surgeon General) to cancer, and in particular, lung cancer. It is 100% fatal.

The EPA standards issued last December require remedial action at both vicinity properties and the tailings pile. But further, it states that "Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 LFR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization."

Now, posing the question of the reduction of health hazards, it is clearly an unwise choice to stabilize the tailings at the Vitro plant site.

And, while it is possible to drastically reduce the radiation eminating from the pile; Utahns believe that other environmental concerns are not easily solved and in fact may not be quantifiable. Therefore, unresolved

health and environmental issues will remain should the pile be stabilized in place.

Remember, the radiation hazard from tailings lasts for many thousands of years, and some nonradioactive toxic chemicals persist indefinitely. While we must look at the immediate health threat, and I applaud both the EPA and the Department of Energy for doing so, the long-range picture must also be considered. The tailings are vulnerable to human misuse and to dispersal by natural forces for an indefinite period. This will lead to possible contamination overshadows that present dangers to the
9.5 public health.

We must also remember what the original legislation, P.L. 95-604 stated: "uranium mill tailings should be treated...in accordance with the substantial hazard they will present until LONG AFTER EXISTING INSTITUTIONS CAN BE EXPECTED TO LAST IN THEIR PRESENT FORMS." Further, the legislation indicated that the drafters "did not want to visit this problem again with additional aid. The remedial action must be done right the first time."

And so, I repeat. Let's do it right the first time -- let's not look at only the somewhat less price tag of stabilization on-site to make a
20.7 determination -- let's not give our grandchildren's grandchildren a more costly problem, both in terms of dollars, but more importantly, in terms of health hazards to their community. And, these are hazards that we can fix properly the first time around.

The Vitro mill tailings pile in Salt Lake is the only abandoned uranium tailings site located in the center of a large metropolitan area! Clearly, the impact on the density of the population cannot be discounted when looking at the questions before us today.

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GROUNDWATER

I am also concerned about the future contamination of the groundwater. Studies have been completed which address the groundwater situation and I believe that they must be looked at further. The Central Valley Water Reclamation Facility is presenting testimony at these hearings by the General Manager, Rodney L. Dahl along with their consulting
10.1 economist James Weaver. I believe that this testimony goes into depth on the potential hazards for the residents of Salt Lake. And, in their report they indicated that the draft Environmental Impact Statement obviously underemphasized these potential hazards to win favor of on-site stabilization at the Vitro site.

I implore that the Department of Energy fully reconsider this important
6.2 aspect prior to the release of the Final Environmental Impact Statement making the determination for a metropolitan stabilization, or one in a remote vacinity.

The statement by the water authorities is valid and I support their assessment of the faulty findings of the original environmental impact statement.

EARTHQUAKES

The Draft EIS does state that the Clive site is geologically superior to the present Vitro plant cite in the event of an earthquake. If a major seismic occurence were to occur at the Vitro site (and the odds of this happening at Vitro is much greater than at Clive), there would be major detrimental effects. Even a minor seismic event could change the ground water regime to the detriment of a stabilized pile with or without a liner

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The Draft Environmental Impact Statement proposes a clay liner beneath the tailings if stabilization were to occur on site in an attempt to reduce contamination to the underlying aquifers. Scientists at Utah's Geologic and Mineral Survey and the Utah Department of Health
3.1 have indicated that the long-term integrity of a liner is faulty. The earthquake analysis reported in the draft statement is inadequate, raising questions concerning liner stability during severe ground motions. And then, the ground at the Vitro site would be transforming rapidly and at varying degress with the placement of large embankments at the site. This could be combated with the covering of an extremely large mound of
6.5 earth for three consecutive years to assure a uniform ground settling. Bu these costs were not figured into the Draft Impact Statement -- they would increase the project costs tremendously. And I have been informed by the State authorities that Utah requires more restrictive siting and design criteria for a sanitary landfill than the proposal does for stabilizing the Vitro tailings in-place.

Once again, we must ask that question of what is best for the health of our future generations?

After reviewing the above health hazards, it is easy to see that the determination to stabilize on-site would be a decision based on dollars rather than potential health concerns. Unfortunately, the Draft
10.1 Environmental Impact Statement did not fully figure-in the dollar-impact of on-site stabilization which, in the long run, would raise the cost of this option substantially.

DAN MARRIOTT
2nd District, Utah

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Congress of the United States
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Washington, D.C. 20515

April 7, 1983

Mr. James A. Morley
Project Manager
Uranium Mill Tailings Project Office
U.S. Department of Energy
Post Office Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Morley:

It was with great regret that Congressional business in Washington, D.C. prevented me from appearing at the Public Hearings held in Salt Lake, Utah on March 22 & 23. As the site selection for the stabilization of the Uranium Mill Tailings at the old Vitro Chemical Plant is of extreme concern to me, I would appreciate having my testimony included for the official record.

Further, it would be appropriate to note that after hearing of the testimony that was presented during these hearings, I am convinced that the third option presented in the DEIS, the removal of the tailings from the Salt Lake City site and transport to South Clive is of vital importance. This is the only decision which will carry out the intent of the Congressional legislation passed in 1978, P.L. 95-604.

Thank you for your cooperation in this matter.

Sincerely,

Dan Marriott

Dan Marriott
Member of Congress

DM:bb

Testimony of

The Honorable Dan Marriott, MC

Second District -- Utah

regarding

Remedial Actions at the Former Vitro Chemical Company Site

South Salt Lake, Utah

March, 1983

While I regret that Congressional duties will not permit me to attend the series of Public Hearings held by the Department of Energy March 22nd and 23rd, 1983 regarding the Department of Energy's Uranium Mill Tailings remedial Actions in Salt Lake County, Utah, I am pleased to submit testimony for the Environmental Impact Statement studies.

As the record stands, the uranium mill tailings at the old Vitro site has been a problem of concern to me for many, many years. I am extremely upset with the length of time that has elapsed since I was successful in having the Congress pass legislation authorizing the Department of Energy to enter into cooperative agreements with the
4.1 affected states and Indian tribes in order to establish assessment and remedial action programs at inactive uranium mill tailing sites. This law, Public Law 95-604, "Uranium Mill Tailings Radiation Control Act of 1978" recognized that uranium mill tailings pose a potential health hazard to the public, and charged the U.S. Government, namely the Department of Energy and the Environmental Protection Agency, with the responsibility for promulgating radiological and nonradiological standards for remedial action at inactive millsites and to enter into agreements with states to

perform remedial actions to bring the radiation levels at sites under their jurisdiction within the EPA standards.

It was in November, 1979 that the Department of Energy designated this
4.1 particular site, the Vitro site, as eligible for remedial action under this public law. And, it took until January 30, 1981 for the DOE and State of Utah to enter into the necessary agreement to perform remedial action on the tailings.

During the discussions between the DOE and the State of Utah, a number of potential offsite disposal areas were proposed to allow the Vitro site to be cleaned up and contaminated materials moved elsewhere. The alternative site, proposed by the DOE and State of Utah is 85 miles west of the Vitro site on the eastern edge of the Great Salt Lake Desert, owned by the State of Utah and called South Clive.

The questions before us today are not only on the need to see remedial action begun in 1983, but are on the need for a permanent, long-term
9.5 solution, reducing all potential health hazards for the residents of Utah.

After reading the Draft Environmental Impact Statement issued by the
20.7 U.S. Department of Energy, February, 1983, I am convinced that while it is possible to stabilize the tailings in place at the old Vitro site, it is NOT possible to stabilize the tailings in place AND protect the environment and public health in perpetuity. Further, the continued
13.0 presence of the Vitro tailings pile within the Salt Lake metropolitan area represents a blight that will discourage further development and revenues

in Salt Lake. And, I am not alone in my convictions. The State Department of Health, under the direction of Dr. James O. Mason, and the Governor of Utah, Scott M. Matheson, have made this same determination. Together, we hope that you will understand that the intent of the original legislation passed by the United States Congress was for the Federal Government to reach an agreement with the State Government for proper remedial action for ELIMINATION of the recognized health hazards of the inactive uranium mill tailings. The law never intended for the Congress to turn its' back on the issue of States' rights. And this is very much an issue in the debate before us today.

I urge the Department of Energy's support in having the tailings stabilized
20.1 at a remote site in the western Utah desert.

At this time, I would now like to back-up my convictions with facts. It was only after consideration of these facts, and asking, repeatedly, the question of the need to protect the environment and public health in perpetuity when looking at each fact, that I reached the conclusion that the tailings have to be moved to an environmentally acceptable remote site, and moved this year.

HEALTH HAZARDS

Over the past 25 years, not only elected officials, but the citizenry of Utah, have expressed grave doubts that the continued location of the uranium mill tailings in a metropolitan area would not only jeopardize potential growth and revenues for the State, but would affect the health of the residents of this metropolitan area, an area with one-third the population of the entire state of Utah.

Based on my most recent discussions with the Technical Assistance Contractor, if the tailings were to be stabilized on site, the taking of land would be some nine acres less than proposed in the Draft Statement. To some degree, that's good; but on the other hand, imagine yourself standing on 900 West Street and viewing a permanent mill tailings pile some 45 feet high--4 1/2 stories. Now that's some monument to a giant federal mistake. How long would you imagine it will take to get the Golden Fleece Award?

Those good folks in Tooele County are very concerned about getting the tailings as far away from them as possible and yet to keep the tailings as environmentally safe as possible. We agree with that concept. The move to Clive serves both purposes and adds the additional safety factor of one additional mountain range between Tooele's population centers and the stabilized pile. For them, the distance to Clive is greater than the distance to South Salt Lake.

It's interesting to me to note that those who have the responsibility for preparing this Draft Statement and, for that matter, those who will make the decision as to how these tailings are to be stabilized are all from out of the Salt Lake area and are not very familiar with the seismic timebomb that we in this Valley live with every day. If you lived here and were really familiar with the Wasatch Fault threat, the decision to move the tailings would be easy. If there is a major earthquake in this valley and it does breach the pile on the Vitro site, it would probably be months before it is recognized that one of our major culinary water sources is irreparably damaged--likely to the point where who knows how many people have been contaminated.

We have had the opportunity to discuss the various issues that are clearly not well enumerated in the Draft Statement before this hearing today. The Central Valley master plan and surrounding land use intentions are in conflict with stabilization in place. There are some severe technical inadequacies that are reviewed here as well as by others. Life-cycle costing of alternatives must be an important element in the decisions to remove the tailings from the Vitro site. The economic evaluations show clearly that it is in the best interest of the public to return the Vitro site to its highest and best use, again to remove the tailings to an environmentally sound desirable location.

The congressional report which accompanied the federal law for this remedial action program states clearly that "the Committee believes that the uranium mill tailings should be treated. . .in accordance with the substantial hazard that they will represent until long after existing institutions can be expected to last in the present form. . . ." Note that this mandate cannot possibly be met with the tailings in an urbanizing area. This alone says move the tailings regardless of the costs.

It cannot be emphasized enough that the primary intended use of the total Vitro site is to accommodate a worthwhile public purpose. A decision to stabilize the tailings in place would be an unfortunate one in that it would jeopardize the true foresight and the public trusteeship of local elected officials.

Thank you.

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Table 1

Health Risk Factor Analysis

	Vitro	Clive
Potential Seismic Activity Affecting the Stabilized Pile	High	Low
Groundwater Flows in Proximity to Stabilized Pile	Extreme	None
Underground Culinary Water Sources in Proximity to Stabilized Pile	Extreme	None
Nearby Groundwater Ability to be Used for Municipal and Industrial Purposes	Extreme	None
Stabilized Pile in Proximity to Known-Municipal and Private Culinary Wells	Extreme	None
Known General Flooding of Site from Nearby Drainage Channels	High	None
Stabilized Pile Located in Identified Flood Drainage Basin	Moderate	None
Ability to Protect Against Stabilized Pile Becoming a Health Hazard to the Community in which it Resides	Perhaps	Yes

Table 2

Site Development Analysis

	Vitro	Clive
Stabilized Pile Located on Land Previously Identified for Development		
Public Works Project	Yes	No
Commercial/Industrial	Yes	No
Grazing/Recreation	No	Yes
Site Can Contribute to the Economic Well-Being of the Community	Yes	No
Stabilized Pile to be Maintenance Free on a Long-Term Basis (that is, no close monitoring because of close proximity to culinary water sources or other health-risk factors)	No	Yes
Geologically Superior in the Event of Earthquake	No	Yes
Site in Close Proximity to Existing and Future Utility Systems	Yes	No
Necessity of a Long-term Leachate-Monitoring System to Adequately Protect the Potential Community Water Supply	Yes	No

up regulations seldom require their inclusion. However, to the great credit of EIS regulations, such external costs and damages are to be included in the evaluation of alternatives. In the analysis provided in this Draft EIS, they have been treated much too cursorily or not at all.

Let me review some of the most obvious oversights.

1. Increased Costs of Operation

The Central Valley Water Reclamation Facility Board (CVWRFB) will face certain increases in operating costs if Vitro lands are partially cleared and stabilized. Since land is required as a means for disposing sludge, any lost land area will mean additional outlays will be made to either develop sludge disposal sites elsewhere and/or install extensive sludge dewatering facilities. Inasmuch as CVWRFB purchased the Vitro land with full expectation that the tailings would be cleared by DOE, this amounts to a "taking" of beneficial land value, the cost of which will ultimately be passed on to Central Valley customers in the form of higher fees or special assessments.

10.2 2. Loss of Resource Recovery Benefits

Under the partial clearing alternative, a Resource Recovery Facility will not be built because cleared land will have to be devoted to uses with higher value to CVWRFB, namely sludge disposal. The loss of benefits resulting from this cancellation amounts to a further loss to CVWRFB. Since these benefits would have been available to offset operating costs, their loss will also be felt by Central Valley rate payers.

3. Forgone Lease Revenue

The prevailing and forecasted use of land in the vicinity of Vitro is light commercial. CVWRFB has planned a 20 - 25 acre industrial park

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development for part of the Vitro Site which would be prevented if the Vitro Site were only partially cleared. If the present worth of all future returns to land is reflected by current selling prices for otherwise equivalently "endowed" land, then CVWRFB's forgone lease benefit in present worth terms could be in the vicinity of $200,000/acre or $4,500,000. If the Vitro indiustrial park were developed, there would be additional economic returns to its developers, and the suppliers of goods and services who either directly or indirectly serve these industries.

4. Other Property Losses

Both the real and perceived health risks of being close to the
10.2 Vitro mill tailings have caused fear among those who live and work near the Vitro Site. It is likely that these concerns have depressed property values in the vicinity of Vitro. The Draft EIS should more adequately assess the range of possible impact for this effect. Econometric regression techniques have been used widely for this purpose, using data concerning property characteristics and selling price which are typically recorded for property transactions.

It is easy to see that such impacts may be large. Let me state a hypothetical case which may clarify this point. Assuming an affected area of 500 acres and a cost impact distribution such that annual land values were depressed 5 percent in 80 percent of the area, 10 percent in 15 percent of the area, and 50 percent in 5 percent of the area, and average land values were $100,000/acre, then the total present worth impact would be as large as $4,000,000. This value is, of course, entirely speculative but is plausible enough that it should compel a far more serious analysis to be provided in the Draft EIS.

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5. Health Damages

The value of life is the least tractable of all economic issues surrounding the Vitro issue. Is there a finite range to human life value? Are all lives worth the same? Who says how much each is worth? Although economists have been able to find imputed values of human lives by examining the amount governments are willing to spend to save lives (for example by outlays for highway improvements with known mortality prevention rates), or by calculating the present value of lifetime earnings, few believe seriously that such estimates capture all the value of an individual in any social context. Further complicating this issue is the inclusion of future generations in the evaluation. In this issue, the welfare of the next 10 to 50 generations is a stake. Should the value of future generations be discounted?

Whatever the values used, they are clearly great. Yet treating them only "subjectively" (that is unquantified), as does the Draft, has resulted in too little consideration in the review of alternatives. The Draft asserts that 0.8 new cancers would occur per year with no remedial action, and implementation of either on-site or off-site stabilization apparently results in a near-zero cancer rate. Too easily assumed is that there will be 100 percent certainty of stabilization systems working throughout the 200 - 1000 year period and that there is 100 percent certainty that no future findings about mill tailing epidemiology that will alter cancer risk assessments. It is relevant to note in the 30 years or so since limits have been set for occupational radiation exposure, nearly every time limits were reviewed for adequacy, they were lowered. It would appear a very questionable, although plausible, assumption to make that in 200 - 1000 years, no new discoveries will made about mine tailing health impacts which would cause us to revise our expectations about public health damage.

Conclusions

I believe that the sum of these costs, namely the sum of

- *Increased Operating Costs for CVWRFB,
- *Lost Benefits from the Resource Recovery Facility
- *Forgone Revenues from a planned industrial park
- *Property Losses in the Vitro vicinity, and
- *Health Damage Risks,

is very high. A preliminary estimate for only two of these five cost categories already approaches 10 million dollars. When combined with a $25-million estimate for engineering cost oversights, it is apparent that the alleged cost advantage of the "stabilization-in-place" alternative is already eliminated.

1.1 It is my conclusion that the economic analysis provided in the EIS is totally inadequate for making the important social decision of how best to manage Vitro mine tailing waste. The cost categories described above should be carefully analyzed in revising the Draft EIS.

CONCLUSIONS

For the transcript record, I am Rodney Dahl.

10.2 In summary, we have presented here, today, enough evidence on the real economics of the tailings removed and the inherent risks of leaving the tailings in place that it should not be difficult to make the decision to move the tailings to a remote site for stabilization. I have prepared two tables for review that will conclusively illustrate how easy it is to make the decision to move.

(Slide - Table 1, "Health Risk Factor Analysis")
(Slide - Table 2, "Site Development Analysis")

Statement by CVWRF
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We concur in the Salt Lake County position which states that the attempted modeling of the groundwater aquifiers will not show us anything that good old common sense will not show. Some day there's going
6.2 to be a negative hydraulic pressure in the aquifers under the Vitro site based on the growth of the valley and the demand made for municipal water. All of us in this hearing may not see that day, but our progeny will.

Sanitary landfills in Utah are required to have active leachate control systems designed to protect groundwater including impervious clay liners (permeability less than 10^{-6} centimeters per second), and leachate collection/treatment systems. Should not the same degree of protection be provided for a nuclear waste repository located in the middle of Salt Lake Valley?

Based on personal experiences during the on-going construction of the Central Valley wastewater treatment plant, it is evident that the subsurface soil conditions that are expected to be encountered to support a large 3,000,000 ton stabilized pile are quite different than what one would anticipate to find on that site. The soils are much more variable than predicted. Three distinct and maybe simultaneous events may occur under severe soil loading conditions. First, adjacent prop-
6.5 erty subsidence which may affect 3300 South Street, 900 West Street, along with the underground utilities. Secondly, a mud wave on adjacent properties having the same effect as the first mentioned. And, third, interference with normal groundwater flows in the area thereby causing unpredicted surface and subsurface flow characterisics. All of these would have severe and detrimental effects on Central Valley as well as adjacent environs.

The Draft Statement is clear when it states that the Clive site is geologically superior in the event of an earthquake. We agree. We are

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Statement by CVWRF
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also not aware of any means available to mitigate the detrimental effect of a major seismic occurence on the Vitro site. It is well understood that the odds of a seismic event happening at Vitro is much greater than at Clive. It must also be remembered that even a minor seismic event
8.2 could change the groundwater regime to the detriment of a stabilized pile with or without a liner. There are over 100 culinary wells within one-half mile of this site, and the largest user is the municpal system which supports the working force of one-eighth of the population of the state.

Section 5.11 of the Draft Statement, "Impacts on Economic Structure," clearly does not meet the federal law for preparation of a Draft
1.1 Statement. This issue will be discussed in some detail later inasmuch as it is one of the three major issues in the evaluation of the stabilization alternatives.

LIFE-CYCLE COSTING OF RECOMMENDED ALTERNATIVES

One of the significant areas of shortcomings thus far in the decision-making process is that of implementing the value engineering (V.E.) concept into the conceptual, preliminary, and final design processes. My preliminary discussions with DOE personnel indicate that
10.2 there will not be a V.E. or life-cycle costing analysis completed prior to the record of decision being made. I don't know how the DOE does business, but the EPA will not allow a large construction project to move ahead without at least two very detailed value engineering analyses being completed during the course of the project design. I know. I am in the process of constructing a $100 million wastewater treatment plant on the Vitro site. The three V.E. sessions conducted on my project have saved many millions of dollars to the public.

In some instances, what has been identified as the most expensive
2.4 alternative to construct becomes the least cost alternative in the long

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term during the value engineering analysis. Some of the many factors that would have an influence on this analysis would be:

- Cost of operation and maintenance
- Replacement costs
- Inherent risks and probabilities of failures
- Dollars lost to the public through misplacement of the structure

In the case of stabilization of mill tailings on the Vitro site, the least capital cost alternative, it is apparent that this alternative is the most costly using a value engineering analysis.

2.4 Over the past months, I have been quoting the results of an in-
10.2 house value engineering analysis which needs to be reiterated here. Using standard government value engineering or life-cycle costing techniques, the payback of the cost to move tailings to Tooele County will occur somewhere between nine and ten years. Now it is recognized that the site cleared is a good decision even though it is initially the most expensive.

We have now had the opportunity to relook at this question of the potential economic impacts of the Vitro site if the tailings were not stabilized in place which can accrue to Salt Lake County using a cost-benefit perspective.

(Introduction of Jim Weaver)

ECONOMIC EVALUATIONS

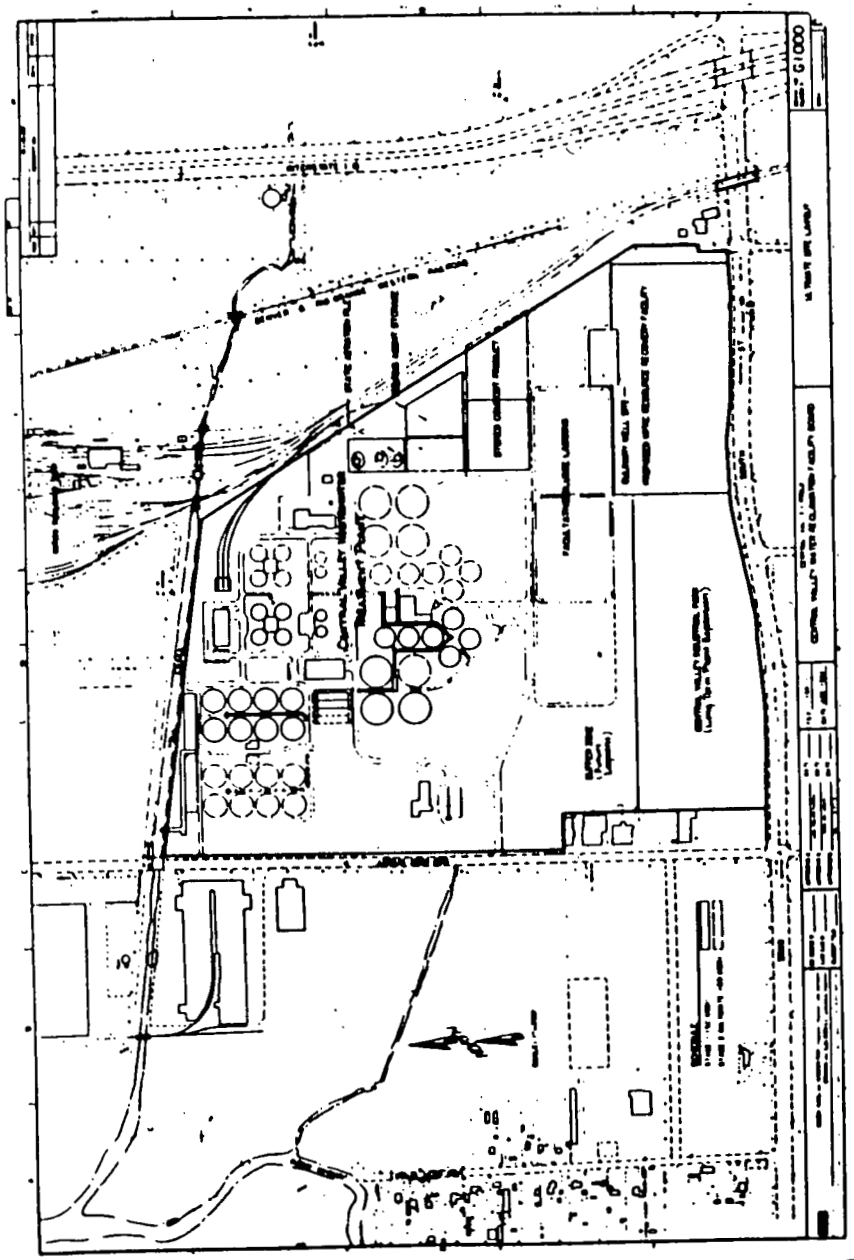
My name is Jim Weaver. I am Chief Economist for Engineering Science, a worldwide firm of scientists and engineers engaged in a wide variety of environmental engineering projects for Government and Industry. I have been retained by the Central Valley Water Reclamation Facility Board

(CVWRFB) to review the Draft Environmental Impact Statement, which is the subject of these hearings today. The principal goal of this review was to provide CVWRFB with an objective appraisal of the economic evaluation of alternatives set forth in the Draft EIS. The remarks I will make today represent the preliminary findings of my review.

The Draft EIS sets forth an evaluation of alternatives for correcting public health hazards associated with uranium mine tailings at the Vitro Site. The DOE authors assert, at least implicitly, that compliance with recent EPA regulations concerning clean up of open lands and buildings provides the appropriate basis for determining how much cleanup it would jointly undertake with the State of Utah, as provided for by UMTRCA (PL95-604). The comparison of alternatives in the Draft EIS is performed using the cost effectiveness principle which states that the
1.1 alternative which attains compliance cheapest is the most preferred.

Without commenting on the legal question of whether meeting the EPA regulations amounts to the appropriate definition of responsibility, I will argue that the cost effectiveness analysis presented in the Draft EIS is seriously deficient. I would like to review a broad list of excluded costs which both undermine the conclusions reached in the Draft EIS and which further call into the question for the usefulness cost effectiveness principle employed therein.

As is nearly always the case in matters relating to health and environmental protection, the costs to society are much greater than "engineering" costs of cleanup. In the Vitro case, the cost of doing nothing about the tailings is not zero, but the sum of a long list of public and private damages resulting from the real or perceived dangers associated with living in close proximity to the wastes. The analyst who uses a cost effectiveness criteria for determining how to meet specified cleanup levels seldom evaluates such damages because the clean-



Statement by CVWRF
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TOTAL LAND owned by the Central Valley Board	168 Acres
Land covered by Mill Tailings	128 Acres

Dedicated Land Uses	
*Mechanical Treatment Plant	100 Acres
*Sludge Lagoons (long term)	23-32 Acres
*Temporary Industrial Park (long-term expansion property)	20-25 Acres
*County Resource Recovery Facility	16 Acres
*City Culinary Water Well Site	1 Acre
	160 Acres minimum
	174 Acres maximum

With these figures in mind, it is then easy to visualize that the planned and intended purpose of this land is for the public benefit and that the Central Valley Board made the correct decision years ago to purchase this specific parcel for this specific purpose. It's also easy to visualize that there just plain isn't any property available for stabilization of mill tailings on site.

TECHNICAL ADEQUACY OF THE DRAFT STATEMENT

There are a number of specific areas of shortcomings in the technical adequacy of the Draft Statement. I will not attempt to enumerate all of them during this presentation, as others will have sufficiently covered these items in some detail during this hearing process. But I do have some areas of great concern that should be mentioned.

20.7 There are a number of items left out of the stabilization-in-place estimates which severely skew the decision-making processes into concluding that it is clear that the tailings must remain on site based on large dollar differences between alternative solutions. Specifically, those things identified as not being included in the analysis of alternatives are:

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- *Site dewatering costs
- *Replacement of the Vitro Ditch
- *Utility systems relocation
- *Low unit costs of imported clay
- *Road relocation costs
- *Land acquisition costs
- *Leachate monitoring/control systems
- *Life-cycle costing of alternatives
- *Economic evaluation of alternatives
- *No provision for formal value engineering of the final design

Without looking at the economics and life-cycle questions, the above represents in the neighborhood of $25 million addition to the cost of stabilization in place.

There are also a number of things that could be accomplished to reduce costs which pertain primarily to the stabilization at the Clive Site. Specifically:

- *The use of two unit trains with improved Clive unloading capability instead of three trains.
- *The use of a more common type of train car rather than a specialized car with a car lease rather than purchase.
- *Not installing a clay liner at Clive because the tailings would not be in near proximity to the ground water regime.
- *Abandoning the conveyor system of transporting tailings material which would not work (based on experience on site).

Based on these suggestions, it is fairly apparent that the cost estimate for stabilizing the tailings at Clive can be reduced by many millions of dollars. These are essentially value engineering cost reducing suggestions.

2.4 The United States Nuclear Regulatory Commission is very specific in its technical requirements for near-surface disposal of nuclear

waste site design. Part 61 says "site design features must be directed toward long-term isolation and avoidance of the need for continuing active maintenance after site closure." Look carefully at that word "isolation" and the statement "need for continuing maintenance." Based on my personal experience and others in the scientific community, there is not a liner available that will guarantee that these mill tailings will remain isolated for 100 years, let alone 1,000 years. This being the case, why not include in the Vitro cost estimate the cost of replacing or major repairs of a liner every fifty years or so? And who's going to pay the bill for repairs and replacements? If the DOE is going to meet the isolation requirement, there's a necessity for a liner on the Vitro site.

2.4 It is the NRC staff's published position "that at a minimum, a 30 meter buffer zone should be maintained on all sides (of the entire area containing waste disposal units)." That requirement would add another 13-15 acres to be purchased for the stabilization on site cost estimate, which also creates additional unresolvable land use deficiencies for the Central Valley Organization.

20 CFR Part 61 also mandates that wastes not be in contact with standing water in the disposal trenches and to be be well above maximum seasonal fluctuations in the water table and the zone of capillary rise. Adherence to this rule cannot be met by stabilization on the Vitro Site but can be met at Clive.

6.2 The recent long-range water supply plan by Salt Lake County water management agencies envisions greater dependence on local groundwater to meet the water supply needs in the next five to ten years. Also, South Salt Lake City fully intends to make full use of their recently acquired well field at the Vitro site. To assume that an upward hydraulic gradient beneath the site will exist over the 1,000 year-design life is unrealistic.

STATEMENT of RODNEY L. DAHL

General Manager

CENTRAL VALLEY WATER RECLAMATION FACILITY

on behalf of himself

and the CENTRAL VALLEY WATER RECLAMATION FACILITY BOARD

supplemented by

STATEMENT of JAMES WEAVER

Consulting Economist
Washington, D.C.

March 23, 1983

Public Hearing to Receive Comments on

Draft Environmental Impact Statement

for Remedial Actions at the

Former Vitro Chemical Company Site

in Salt Lake County, Utah

INTRODUCTION

My name is Rodney Dahl and I am the General Manager of the Central Valley Water Reclamation Facility. I am here today to enter into the official record of this hearing the comments and position of the Central Valley Board, a local governmental entity, who is the owner of record of the total Vitro Site. My remarks will address the needs of the Central Valley Organization relative to the land development needs of a very large public works facility as well as the long-term uses of the site in the interest of general public in the State of Utah. My remarks will also be supplemented by James Weaver, a consulting economist.

As can be imagined, much review of the Draft Environmental Impact Statement has been conducted, not only by the staff of Central Valley but by outside specialized consultants which have specific expertise in these matters. The Draft Statement review process has not been taken lightly. The serious consequences to the public at large by leaving the mill tailings in place is of considerable concern to those of us who have been given that trusteeship of working in the best interest of the public. There is little question that it is in the best interest of all of the people of the state to remove this health hazard to a remote site where it will have no human health effects or for that matter, no adverse economic effects on the community in which the tailings reside.

20.1

I make the comment very often that the Great Salt Lake Valley has only been inhabited for the relatively short period of 135 years. We're now talking about stabilizing a health hazard in the very center of a highly urbanizing valley for 1,000 years if we can imagine that far in advance--that's 50 generations. There are very few, if any, engineered structures in this valley remnant of the pioneer times. As a professional engineer, I submit that any structured stabilization of radio active material located directly adjacent to an existing culinary water supply is doomed to be a long-term health hazard.

9.5

20.7 1.1 The Draft Statement generally complies with Federal National Environmental Policy Act (NEPA) 1970 guidelines in terms of the content

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20.7 1.1 required for environmental impact statements except that the required "discussion of how socioeconomic activities and land use changes related to the proposed action conform or conflict with the goals and objectives of approved or proposed Federal, regional, State and local land use plans, policies, and controls for the project area..." (from NEPA 1980) was obviously underemphasized in the Draft Statement to win favor of on-site stabilization at the Vitro site. This will be discussed in some detail.

CENTRAL VALLEY MASTER PLAN OF THE VITRO SITE

13.1 The Draft Statement is good to acknowledge that if the mill tailings are stabilized on site that the Central Valley Board will need to alter its long-term plans for the property owned by the Board. In turn, no long-term alternative solutions are offered. When the Board purchased this property some years ago, it was with the promise from the federal government that it would be immediately cleaned up and that all of this land would be available for Central Valley purposes. The record needs to reflect that the Board purchased this large tract for the specific purpose of constructing a wastewater treatment plant and having adequate land available for long-term expansion. Based on the regionalization concept of construction and the mandate given to us by the United States Environmental Protection Agency, it is expected that these facilities will be the final location for this plant, which serves one-half of the state's most populous county and twenty-two percent of the state's population. Again, the Central Valley Board, serving in a public trusteeship role, purchased this large parcel of land for the specific purpose of serving the public interest. It must be recognized that this land is the last parcel in the center of the valley able to accommodate this specific purpose at the least long-term cost to the public. Let me emphasize that this site was specifically selected to accommodate a long-term need at the least long-term cost. To be required to purchase--which

13.1 problaby means condemnation procedures--adjacent lands to accommodate Central Valley purposes, means to incur additional long-term costs that would not otherwise have to be incurred.

(Slide)

The total Vitro site has been master planned for very specific public uses, both on a short-term and a long-term basis. As previously mentioned, the total site is intended to be utilized in the interest of the public. The ultimate use of the property is three-fold: First and foremost, as a wastewater treatment plant; secondly, to accommodate a resource recovery facility (a garbage burning incinerator); and third, a culinary water well site for the community of South Salt Lake. On the short-term, a portion of the site will be utilized as what I call, a temporary industrial park where the Central Valley Board retains ownership of the land which ultimately becomes long-term treatment plant expansion property many years from now. A side benefit of this industrial park concept is that during its existence, it generates a limited income to the Central Valley Board, which is used to offset the costs of operating and maintaining the treatment plant.

(Slide)

For the record, the following are the intended land uses according to the Board's approved master plan:

April 8, 1983

Memo to: Mr. James A. Morley, Project Manager

From: Salt Lake City-County Board of Health

Re: Vitro Resolution

Attached, for your information, is a copy of a resolution passed April 7, 1983 by the Salt Lake City-County Board of Health. It is our position that stabilization in place, as presented in the DEIS is "fatally flawed", and that such a solution is unacceptable.

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RESOLUTION

WHEREAS, the Salt Lake City-County Board of Health has studied the health effects of the Vitro tailings, and

WHEREAS, the Salt Lake City-County Board of Health has studied the proposed remedial action alternatives set forth in the Draft Environmental Impact Statement (DEIS) issued by the U.S. Department of Energy, and

WHEREAS, it is recognized that radiation from inhaled radon daughter particles, as are released from the Vitro tailings, has been established as a cause of lung cancer in both man and animals, and

WHEREAS, the tailings constitute a substantial quantity of a low level radioactive material, exposure to which is unnecessary and not in the interest of public health, and

WHEREAS, the numerous heavy metals and related compounds in the tailings constitute a significant and permanent threat to the surrounding groundwater systems, and

9.5

WHEREAS, (1) The tailings constitute a hazardous waste, and (2) were the tailings not now at the Vitro site, the Vitro site would not have been suggested as a permanent hazardous waste site as it fails the rigid selection criteria for such sites, and

WHEREAS, Congress clearly required that permanent solutions be implemented in funding remedial actions, and

WHEREAS, the concepts and designs set forth in the DEIS for on-site stabilization at Vitro, in all suggested variations, do not provide an adequate, permanent, or certain solution to the problem.

NOW THEREFORE BE IT RESOLVED that the Salt Lake City-County Board of Health does hereby adopt the position that on-site stabilization as proposed by the Department of Energy is "fatally flawed", and that such a solution is unacceptable. We are opposed to the permanent establishment of a 3,400,000 ton hazardous waste site within Salt Lake County. Furthermore, the only adequate and acceptable solution to the problem is removal of and proper stabilization of the tailings at a suitable location, such as is proposed in the third DEIS alternative of relocating the tailings to the South Clive Site.

20.1

Dated this 7th day of April, 1983

SALT LAKE CITY-COUNTY BOARD OF HEALTH

by _____

WAYNE I. BAER, CHAIRMAN

9.5 "The committee belives that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions can be expected to last in their present forms. ...The committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time."(emphasis added).

Page 16, paragraphs 2 and 3

Health effects are estimated in the statement, "... calculations suggest that the Vitro site contamination might produce 0.7 to 0.8 fatal cancers ...". The additional 740 to 850 additional cancer induced deaths over the 1000 year planning cycle have economic costs which must be specifically addressed in the final EIS.

Page 16, paragraph 4

6.2 Here, as well as throughout the draft EIS, the potential health effects of the other toxic substances remaining in the Vitro tailings are ignored. The state of Utah believes that these heavy metals represent at least as great a health hazard to the underlying aquifers as the radionuclides.

Pages 19, 20 and 21 - 3.1.1 - Tables 3-1 and 3-2

The presence of significant levels of nonradioactive toxic substances in the wastes dictates that an appropriate site be found. The Vitro site would not qualify under state and federal standards as a hazardous waste site. In fact, the site fails to meet even state and federal standards for the disposal of common solid wastes.

Page 30 - 3.2.3.1, paragraph 1

9.8 The method, as described by the statement, "[t]he water produced during emplacement could be temporarily stored in sumps near the excavations and pumped back into the excavated area after the granular working base is in place.", should not be employed in the preparation of the lined stabilization area. Any attempt to place a clay liner over a working base in which excess groundwater has been pumped will fail. Also, the groundwater will be further contaminated by the tailings.

Page 45, paragraph 4

6.3 The statements, "Alternatives 2 and 3 would not differ in their radiological and nonradiological impact on ground- and surface-water quality. Either alternative would meet the EPA standards. In any case, the ground- and surface-water systems involved do not contain potable water." are inaccurate. Within a one-half mile radius of the Vitro site there are 120 wells. Forty of these wells are less than 120 feet deep and are being used for irrigation and stock watering. Many of the contaminants present in the tailings could enter the food chain through these sources.

Page 58 and Table 4-1

8.3 The May 22, 1910 earthquake was probably at about 40°44.94' and 111°50.95', well south of Bountiful and about 5 km from the Vitro site. It had an estimated magnitude of 5.7. The November 10, 1884 earthquake was not in Bountiful, but near the Utah-Idaho border. The March 28, 1975 event was in Pocatello Valley, not Pocatello, Idaho. Damage reports clearly indicate that the December 1, 1958 earthquake was near Nephi. The errors in pinpointing the locations of the latter three events is around 100 km. These gross errors negate the validity of the seismic risk analysis.

Page 59

8.6 A critical structure such as that proposed for the Vitro site should anticipate a magnitude 7.5 event occuring in the Salt Lake Valley.

8.4 It is the opinion of the Utah Geological and Mineral Survey that most of the earthquakes in Utah cannot be correlated with surface faults. The reference that maintains that "...90 percent of the earthquakes which occured in Utah between 1950 and 1965 were located along or in association with known fault zones." should verified.

19.9 The figure for horizontal acceleration is 21% g or 0.21 g, but cannot be 0.21% g, as indicated in the text.

8.5 The Vitro site is <u>not</u> located on rock, which invalidates the 21% g estimate.

The USGS assigns a value of 27% g for Wasatch Front horizontal bedrock acceleration, which has a 90 percent probability of not being exceeded during a 50-year period. However, the 50-year standard used for construction purposes is not applicable to the Vitro disposal configuration. A more reasonable approach for the Vitro site is use of the 250-year standard. For bedrock, the value would be 60% g. This comment is also applicable to page 116.

Page 63

8.6 The statement, "[e]ach of these earthquakes was of a magnitude comparable with what might be expected to be the maximum event produced by the faulting along the front of the Wasatch Range." is inaccurate according to the Utah Geological Mineral Survey.

Page 64

It is unlikely that evapotranspiration will occur, since the water table lies between 25 and 35 feet in depth.

Page 64

Recreational use of the Jordan River should be considered "beneficial".

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The state of Utah feels that the draft EIS has failed to meet the CEQ guidelines as outlined below.

Furthermore, the draft EIS fails to satisfy the spirit and intent of the Uranium Mill Tailings Radiation Control Act of 1978. This occurs in two key areas. First, it is clear that Congress intended remedial actions to consist of a one-time solution to problems. On-site stabilization (as implicitly recomended by the DOE) would not accomplish this, but rather, leaves the ultimate solution to the future, after sustained generation of adverse socioeconomic impacts has occurred and funding for remedial action is no longer available. Second, the Act anticipates a mutually satisfactory course of action through the implementation of a cooperative agreement. The implicit
3.1 preference found in the draft EIS does not accomplish a mutually satisfactory resolution of the problem.

20.7 Finally, in keeping with the cooperative agreement, the state should be fully involved in the development of the final EIS.

SPECIFIC COMMENTS

Forward, paragraph 3

Change in designs may be needed to conform to changes in the final EPA standards for remedial action at inactive uranium mill tailings sites. The final EIS should stipulate that such changes will be reviewed and approved under the provisions of NEPA.

6.1 A lack of adequate data to predict either the probabily of future grounwater contamination or groundwater use patterns is mentioned. The referenced additional groundwater investigations are inadequate in design and of too short duration to fill in the existing gaps in the data base.

Page 5. - 1.2.2

20.9 DOE is responsible for actual acquisition of the 69 acres. The state of Utah recognizes its responsibility to pay 10 percent of all agreed upon costs, but will not undertake responsibility for actual acquisition of the realty in question.

Page 6 - Table 1-1

10.1 The total cost of Alternative 2 is underestimated by as much as $20.5 million (see also p. 54 - Table A-17 comments).

The total cost of Alternative 3 is overestimated by $8 million (see also pp. A-90 & A-91).

Pages 5 and 8

Because the DOE analysis considered different stabilization regimes at the Vitro site (stabilized mound) and the South Clive site (partial burial), a direct cost-benefit comparison is not appropriate. The state of Utah

9.8 believes that partial burial represents state of the art technology and offers superior benefits in terms of public health and safety. This further increases the attractiveness of the South Clive alternative.

Page 9 - paragraph 2

5.2 It should be noted that a building moritorium for several years halted development in the vicinity of the Vitro site. This moritorium was relaxed by Salt Lake County only after assurances by the DOE that the wastes would be removed.

Page 11 - 1.4

9.1 The draft EIS states that "[t]he need for clay liners has not been demonstrated." This issue must be addressed before any siting decisions are made. The state believes that clay is an essential component of a stabilization structure. In fact, with the tailings presently in contact with the groundwater, Utah believes that on-site stabilization cannot be seriously considered as an option which will suffice for even the 200-year minimum period, as specified in the EPA standards. However, even with the addition of a clay liner at the Vitro site will not guarantee the integrity of the stabilization structure due to the sheering effect of the soils. (See also comments p. A-35, para. 2.) Since natural clay goes to a depth of 20-25 feet at the South Clive site, an additional lining of clay may not be necessary.

Pages 12 and 13 - Table 1-3

The alternative project costs presented in Table 1-3 are not realistic. In developing these cost projections, the DOE has not applied the same criteria or regiment to stabilization on-site (Alternative 2) and stabilization at the South Clive site (Alternative 3). Furthermore, the radiological effects are not correctly expressed in cumulative terms for
19.7 Alternative 1. Mathematical discrepansies exist between Tables 1-1, 1-2 and 1-3 for Alternatives 2 and 3.

Page 14, last paragraph

10.2 The cost estimates presented for the alternatives are incomplete. No attempt has been made to estimate life-cycle costs, which would show the true societal cost over the 1000 year planning cycle. Even when a 30-year social-cost estimating model is employed, the lost opportunity costs associated with industrial and commercial development at the Vitro site is greater than the difference in cost between Alternative 2 and Alternative 3. This holds true for both the DOE's and the State of Utah's cost difference estimates in implementing the two alternatives.

Page 15, last paragraph

The following portion of the Congressional report accompanying the Uranium Mill Tailings Radiation Control Act of 1978 should augment the explanation of the Act in the Final EIS, since it more clearly reflects the intent of the Congress in the legislation:

APR 25 1 43 PM '83

STATE OF UTAH

SCOTT M. MATHESON
GOVERNOR

OFFICE OF THE GOVERNOR
SALT LAKE CITY
84114

April 8, 1983

The Honorable Donald P. Hodel
Secretary of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Secretary:

The residents of Utah, perhaps as much as those of any other state, have participated in the tremendous scientific and technological advances fostered by the federal government in the nuclear arena. The Vitro Chemical Company plant was one of those ventures. For 14 years, the federal government and the citizens of the state of Utah shared the industrial output and economic benefits of the Vitro plant.

However, since the termination of operations at the plant in 1968, the tailings and other toxic contaminants left at the site have posed an increasing threat to the health and safety of residents of the Salt Lake valley where nearly one-half of the total population of our state resides. In addition, the resulting aesthetic blight and building restrictions imposed by the presence of the waste have prevented the development of prime industrial property. In 1978 Congress provided a means for solving these problems when it passed the Uranium Mill Tailings Remedial Action Act

The Draft Environmental Impact Statement on the Remedial Actions at the Former Vitro Chemical Company Site was prepared for the purpose of taking a hard look at environmental consequences of alternatives proposed for implementing this act. The two key solutions are removal to a remote area and stabilization on-site, both of which I have carefully reviewed. My conclusion is that the state of Utah cannot concur with on-site stabilization as an
20.1 acceptable means of dealing with the contamination at the Vitro site. The only acceptable alternative under consideration is the removal of the tailings to a remote, environmentally safe site.

The Department of Energy appears, however, to implicitly identify stabilization on the Vitro site as the preferred alternative, a complete reversal of the previous DOE position. This change of direction is apparently based upon the economic conclusion that stabilization on-site provides a cheaper alternative. Our attached technical comments challenge not only the health and safety conclusions of the DOE, but also the data and methods used to arrive at cost estimates. It is our opinion that serious miscalculations have occurred regarding the current and future threats the wastes pose to the

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human environment and the one-time costs of implementing the various alternatives. Furthermore, the long term costs to society over the thousand year planning cycle are not even considered in the DEIS.

The application of theoretically sound technology oftentimes has unanticipated and imperfect results. We in Utah have repeatedly relied upon the judgment of the federal government as to the safety of various nuclear related activities, only to realize later the error in judgment. The latent problems which are surfacing with the Vitro tailings pile is one example, but with a difference: we have the opportunity to remedy the problem before further errors in judgment have serious human impact.

The opportunity for assuring the greatest safety for the Utah public lies in implementation of the alternative of removal to a safe, remote site. The cooperative agreement between the DOE and the state of Utah requires state concurrence in the alternative selected. The only alternative with which the state can concur is that which provides the safest and surest remedy to the problem at hand.

In the spirit of the cooperative agreement, and the need for immediate resolution of the Vitro tailings question, I urge you to select removal as the course of remedial action. We have shared the economic and social benefits brought about by this development. We must now begin the immediate relocation of the tailings before we are faced with sharing the responsibility for potentially tragic impacts to Utah residents.

Sincerely,

Governor

SM: jc

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COMMENTS OF THE STATE OF UTAH

on the

DRAFT ENVIRONMENTAL IMPACT STATEMENT:
REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE
SOUTH SALT LAKE, SALT LAKE COUNTY, UTAH

April 6, 1983

I. GENERAL COMMENTS

20.1 The state of Utah maintains that both the tailings and the other contaminated materials located at the Vitro site must be moved to a remote area. It is not possible to stabilize the tailings in place and protect the environment and public health into perpetuity. In addition, the aesthetic blight and zoning restrictions which would result from on-site stabilization would preclude realization of the full economic potential from development of the Vitro site and the surrounding properties. For these and other reasons listed below, Alternative 3 -- Stabilization at the South Clive site, as described in the Draft Environmental Impact Statement: Remedial Actions at the Former Vitro Chemical Company Site, is the prefered alternative of the state of Utah. This policy is in keeping with the position previously taken by the state of Utah.

13.2
13.3

In the draft EIS, the U.S. Department of Energy consistently underestimates the potential threat to public health and safety. Errors occur in several areas. Serious miscalculations render the seismic analysis invalid. The extent of current and potential groundwater contamination is also significantly underestimated. The hazardous effects of various heavy metals and other nonradioactive contaminants are not considered. Finally, the economic evaluations which were performed consistently overestimate the costs associated with removal of the tailings and other contaminants to the South Clive site, and underestimate the cost of on-site stabilization.

8.3
14.2
1.1

20.2 Furthermore, by failing to consider the full-range of economic costs and benefits accruing during the entire 1000 year planning cycle, the DOE underestimates the costs of stabilizing the tailings at the Vitro site. Such costs will accrue due to the loss of public revenues and associated opportunity costs if the wastes are stabilized at the Vitro site. Consideration of these lost opportunity costs indicates that both the federal government and the state of Utah will recover a major portion of their tailings removal costs within 30 years.

10.2

The failure of the DOE to utilize a long-term economic model has also resulted in a lack of consideration of the private sector income and job opportunities which could be realized if the wastes were moved to a remote site, allowing the full economic potential of the Vitro site and the surrounding properties to be developed. An analysis of these and other economic factors is offered in Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, a Utah Division of Community Development report which accompanies these comments.

5.2 Another major concern of the state of Utah is the implicit change in direction the DOE has taken from the concept paper generated during early consideration of the Vitro issue. In the June 1981 Remedial Action Concept Paper, the department agreed with the state that removal of the tailings to a remote locale was the preferred alternative. Less than a year later in a revised document, the DOE reversed its position, maintaining that on-site stabilization was its preferred alternative. This sudden reversal has caused serious problems for local government, especially planning and zoning activities. It is the state's position that this change is unjustified and unsupported in the draft EIS.

1.2

The Council on Enviromental Quality's regulations for implementing the National Environmental Policy Act state that the purpose of an EIS is to "...provide full and fair discussion of significant environmental impacts."

current Utah construction costs, the relocation would cost $53,222,000 or $7,792,000 less than DOE figures. The actual cost differential between stabilization in Salt Lake Valley and a permanent solution in the remote western desert is likely to be less than $10 million.

This cost difference could be realized through increased economic development in a few years after removal of the tailings. The Utah Department of Economic and Community Development conducted an economic study in March 1983 based on DOE figures. This critical issue is not addressed in the DEIS. Using DOE's own figures (which we now find to be inaccurate) this study notes among other things:

- "The sum of capital investment, public revenues, and private sector income resulting from the economic development of the Vitro site will exceed $697 million within thirty years if not constrained by on-site stabilization."
- "Employment generated by site development will increase from 465 jobs initially to over 900 jobs within twenty years."
- "The differential cost of stabilization and decontamination ($38.5 million) will be recovered in public sector revenues alone within ten years; total decontamination costs ($61 million) will be recovered within eighteen years."

Environmentally, economically, and for the health of men, women and children now and for generations to come, stabilization in-place cannot be justified.

The Congressional report accompanying Public Law 95-604, The Uranium Mill Tailings Remedial Action Act of 1978, expressed the

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view that the methods used for remedial actions should not have short-lived effectiveness. It states, "The Committee believes that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions can be expected to last in their present forms." It continues, "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time."

I concur with that reasoning. I do not want future generations to be faced with a Salt Lake City Love Canal or Times Beach environmental disaster because we did not do the job right the first time. There will be no second chance. The only acceptable option for remedial action at the Vitro uranium mill tailings site is the immediate relocation to a remote, environmentally suitable location. There has been too much delay already. We must begin the relocation of these tailings this year.

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As a matter of fact, the State requires more restrictive siting and design criteria for a sanitary landfill than the proposal does for stabilizing the Vitro tailings in-place.

The second option for remedial action at the Vitro tailings pile is to move them to a remote area. This proposed site is further away from any population site in Salt Lake or Tooele Counties than the current Vitro site in the middle of the Salt Lake Valley. The DEIS indicates that the geotechnical considerations that make stabilization in-place a poor choice in the Salt Lake Valley are not problems at the remote site. Ground water, earthquake, and population density are not problems at the remote site; in fact, not a single environmental issue has been identified at this location.

Why then are we examining two proposed options? This question must be asked after reading the DEIS. It is clearly pointed out in this document that relocation of the tailings to a remote area is the environmentally superior solution to the problem and that this relocation can be carried out safely and without great risk to our citizens. Every precaution will be taken to assure a safe transportation process.

The answer is money. DOE indicates there is a great disparity in cost of the two options. They value the cost of stabilization in-place at $22,548,000, but admit this low figure does not include the costs of utility relocations, land aquisition, and other costs associated with ground water control. The Utah Department of Health and the Utah Department

of Transportation estimate a more accurate cost of stabilization in-place at $43,315,000 or $20,827,000 more than the DOE figures.

REMEDIAL ACTION COST ESTIMATES
STABILIZATION IN-PLACE

	UTAH	DOE
Construction, Engineering and Inspection	$25,415,000	$22,548,000
Land Aquisition costs, utility relocation, and ground water control	$17,960,000	not included
TOTAL	$43,375,000	$22,548,000
DIFFERENCE	+20,827,000	

RELOCATION TO A REMOTE SITE

	UTAH	DOE
Construction, Engineering and Inspection	$53,222,000	$61,014,000
TOTAL	53,222,000	$61,014,000
DIFFERENCE	-$7,792,000	
TOTAL COST DIFFERENCE BETWEEN ON-SITE STABILIZATION AND RE-LOCATION	+$9,847,000	+$38,466,000

DOE indicates that it will cost $61,014,000 to relocate the Vitro tailings to a remote site. Our estimates indicate that at

In fact, as late as June, 1981, even the U.S. Department of Energy (DOE) advocated tailings removal in a Remedial Action Concept Paper for the Vitro uranium mill tailings pile. I quote from page 15, "It appears that option 2B, Disposal at the First Alternative Area [a remote area] is the economically and environmentally preferrable action." One year later in April, 1982, a draft of a second version of the Remedial Action Concept Paper was produced by DOE. On page 13, in an abrupt change of direction, this draft listed stabilization in-place as the preferred option, giving stabilization cost as the overriding issue. Last year was the first time any consideration other than health, safety, and technical aspects were even considered by DOE. Now, however, cost of stabilization has taken precedence over any other professional considerations.

Up until April, 1982, there was only the option of moving the tailings. Now, in March, 1983, DOE is asking us to review a Draft Environmental Impact Statement (DEIS) for Remedial Actions at the Vitro Site. This statement identifies two proposals for remedial action. The first alternative is stabilization in-place. I am sure the Vitro site would never have been purposefully considered as a siting option, because of its many geotechnical shortcomings, had not the tailings already been located there. If this alternative were to be exercised, the tailings would pose a continuing threat to the underlying aquifers.

Data in the DEIS suggest that the shallow aquifer is now contaminated and that as many as 120 wells located within a half-mile radius of the site may be drawing domestic water from that source. Our own research indicates that 41 wells are using the shallow aquifer for domestic purposes; however, Department of Health data do not presently show contaminstion of these wells. That potential for contamination will linger as long as the tailings remain on the Vitro site. It is just a matter of time before those wells no longer meet health standards.

The DEIS proposes a clay liner beneath the tailings in an attempt to reduce contamination to the underlying aquifers. Scientists at Utah's Geologic and Minerial Survey and Department of Health indicate the long-term integrity of a liner is seriously questioned for two reasons. First, the earthquake analysis reported in the DEIS is gravely inadequate, raising questions concerning liner stability during severe ground motions.

Secondly, the soil under the proposed stabilization areas has little structural integrity. Placement of large embankments at the Vitro site will lead to the ground settling at different rates and varying degrees unless the site is covered with an extremely large mound of earth for three years to assure uniform ground settling. This would tremendously increase costs to the project. (This has not been considered in the DEIS.) Without this precaution, uneven settling would breach the liner, damage roads and disrupt utilities.

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STATEMENT ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE SOUTH SALT LAKE, SALT LAKE COUNTY, UTAH

I am James O. Mason, Executive Director of the Utah Department of Health. Previous commitments prevent Governor Scott M. Matheson's attendance, but he has asked me to represent him at the public hearing today and to deliver the oral comments of the State of Utah on the Draft Environmental Impact Statement prepared by the Department of Energy. Governor Matheson is extremely concerned about the ultimate fate of the uranium mill tailings at the old Vitro site in the Salt Lake Valley and has consistently said that the tailings must be moved to an environmentally acceptable remote site.

These comments will give a broad overview of our concerns and differences with the DEIS. The State of Utah will submit formal written comments which will cover all the technical and other differences we have with the DEIS by April 11, 1983.

Over the past 25 years, Utah citizens and elected officials have expressed a growing concern with the location of the Vitro uranium mill tailings pile within the metropolitan area of the Salt Lake Valley.

The recognized health hazards associated with the tailings are gamma radiation, radon gas and its daughter products and those metals and chemical wastes left from the milling

process. The adverse biological effects of radiation exposure are well known. Gamma radiation and radon daughter products have been linked to cancer. The radiation hazard from tailings lasts for many thousands of years, and some non-radioactive toxic chemicals persist forever.

The hazard from uranium tailings pose an immediate threat to the environment and to men, women and children who live and work in the Salt Lake Valley. Beyond this clear and present danger, the tailings are vulnerable to human misuse and to dispersal by natural forces for thousands of years. This threat of expanded, indefinite contamination overshadows the present dangers to the public.

For the past quarter century, Utah's consistent policy has been that the tailings must be moved to a remote area. The following list is indicative of the broad-based support to remove the tailings to a remote area.

1. Former Governor Calvin Rampton
2. Governor Scott M. Matheson
3. Utah's Congressional Delegation
4. Utah State Legislature, 1979, S.B. 335
5. Utah Department of Health
6. South Salt Lake City, April 1982, Resolution
7. West Valley City, June 1982, Resolution
8. Salt Lake County, 1982, Resolution
9. Various civic and community groups

In prepared remarks by Governor Scott M. Matheson, (see attached) mention was made of the lack of a hazardous materials analysis of the Vitro uranium mill tailings. Because the tailings fail the EPA's EP toxicity test, the impacts to public health and to the environment caused by leachates from the tailings impoundment must be considered.

The Utah's Geologic and Mineral Survey has grave concerns about the seismic analysis included in the draft EIS. Their report, closely examining the seismic studies, is also included in Utah's written response to the draft EIS.

11.1 Finally environmentally, economically and medically, for the generations of men, women and children, now and to come, on-site stabilization cannot be justified.

9.5 The Congressional report accompanying P.L. 95-604 expressed the view that the methods used for remedial actions should not have short-lived effectiveness. The report states, "[t]he committee believes that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions can be expected to last in their present forms...The Committee does not want to visit this problem again with additional aid. The remedial action must be done the first time."

The state of Utah concurs with this reasoning. It does not want future generations to be faced with a Salt Lake City equivalent of the Love Canal or Times Beach environmental disasters because the job was not done right

20.1 the first time. There will be no second chance. The only acceptable option for remedial action at the Vitro uranium mill tailings site is immediate relocation to a remote, environmentally acceptable location.

4.1 There has been too much delay already. The relocation of these tailings must begin this year.

13.2 In a position paper developed by the Department of Health in January 1983 (attached copy), the Vitro tailings are characterized as "a blight that will discourage development."

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STATEMENT ON THE DEPARTMENT OF ENERGY
DRAFT ENVIRONMENTAL IMPACT STATEMENT

for

REMEDIAL ACTION AT THE FORMER
VITRO CHEMICAL COMPANY

Scott M. Matheson
Governor, State of Utah

Presented at Public Hearings
March 22, 1983, Tooele, Utah
March 23, 1983, South Salt Lake City, Utah

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Page 141

13.7 The Board of State Lands and Forestry has expressed its willingness to accommodate the DOE on whichever option (lease, sale or exchange) the DOE chooses to pursue regarding the South Clive site. Since the NRC will ultimately assume ownership of the property, it is the Board of State Lands and Forestry's preference that the entire section be exchanged and that the exchange be completed prior to any construction at the South Clive site.

If an exchange cannot be completed before construction begins, a special use lease from the Division of State Lands and Forestry will be required. A right-of-way permit will also be required if access is needed across state land which is not included in the special use lease acreage.

Page A-10 - paragraph 1, 2, and Table A-3

2.4 A discussion of applicable EPA standards for remedial action at contaminated sites is given.

Major portions of the final EPA standards are not addressed, nor is Congressional intent noted. The Uranium Mill Tailings Radiation Control Act reflects (in Section 206) Congressional desire that EPA's standards be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act.

Subpart C -- Implementation of the Final EPA Standard 192.20, requires "...[j]udgments on the possible need for remedial actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 CFR 32274, July 26, 1982) and by relevant state and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization."

Page A-14, A.4.1.3

6.3 "Two principal groundwater systems have been identified within the area of the Vitro site; a shallow water table system and a deeper partially-confined system (see Section 4.6.2). The water table in the upper, unconfined system ranges seasonally from about 2 to 5 feet below the existing ground surface and is locally above the base of the tailings throughout the year." This statement is misleading since it only represents a single season observation. Actually, watertable measurements taken during CVWRF design and construction (1980-1982) indicate a much broader groundwater surface fluctuation; elevations as low as 4223 have been reported on the CVWRF site in the vicinity of the existing secondary sedimentation tanks. Also, since the primary direction of groundwater flow is northwest (i.e., toward Mill Creek and the Jordan River), a strong potential exists for migration of any contaminant from the site to nearby surface waters if a total containment barrier is not provided.

Page A-33, paragraph 3

"In the analyses, consideration was given to the placement of a thin layer of the imported clay soils (Type 4) directly on top of the contaminated materials." The DOE has not identified the source of type 4 clay soils in Utah. Costs of importing from out of state could be prohibitive.

A-35 paragraph 2

6.5 Site stability of the Vitro site is examined. Nowhere in the test is reference made to the problems associated with differential settlement of the proposed embankment.

Tests have been conducted at the site by the construction management firm for the CVWFR Board. They have determined that there is considerable danger of differential settlement from the proposed stabilization loads. Their concerns are:

> Estimated settlement at the CVWRF site from a stabilized load 29 feet high would be 15 inches maximum.
>
> Estimated settlement at the CVWRF site from a stabilized load 37 feet high would be 22 inches maximum.
>
> Settlement or consolidation might extend for a period of up to three years.
>
> The underlying soil has lenses of sand, silt, clay and various mixtures. Shear strengths vary widely, and their estimated settlement rates are based on empirical data from reload piles at the site.
>
> It is estimated that considerable damage to adjacent roadways (3300 South and 900 West), could occur from soil settlement if the tailings were piled and stabilized in place. This settlement could also damage utilities and other properties in the immediate area (within 150 feet). In addition, such differential settlement would jeopardize the integrity of any clay liner use for on-site stabilization.

Page A-40

9.1 The failure of a clay liner due to differential settlement was not discussed. How can the clay liner's integrity be assured under these conditions?

Appendix D - Hydrologic and Water Quality Information

6.1 Appendix D is incomplete, lacking data from the newly proposed and currently implemented groundwater study at the present Vitro site. Criteria specifying a limited time frame study (six to eight weeks) will provide questionable data for modeling future groundwater conditions at the Vitro site.

Appendix E - Socioeconomic Information

This appendix, as well as Section 5.11, "Impacts on Economic Structure," overlook many potential economic impacts of on-site stabilization. Consequently, Utah's Division of Community Development prepared a report, entitled Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, that examines the economic concerns not covered in the draft EIS. A copy of this report is attached

9.4 use of clay liners to preclude leachate migration has not been tested enough over materials of untested quality such as the Vitro tailings. The effectiveness of liners is suspect under conditions which exist at the Vitro site (see also page 11 comments).

Page 119, last paragraph

6.1 Reports indicate that the groundwater within and under the tailings is contaminated. Reference is made to a two-three month groundwater study designed and implemented in February 1983 to produce data adequate to predict long-term groundwater movement and contamination. A six to eight week study cannot collect data reliable enough to predict present groundwater patterns, let alone hundreds of years into the future.

Page 124, 5.6 - Impact on Land Use

Alternative 2

5.2 The DOE has apparently forgotten that as early as 1975 decisions were made to move the Vitro tailings and allow other use of the land. The draft EIS does not give adequate attention to the long-range land use planning done by Salt Lake County for the Vitro area. The draft EIS glosses over the long-range Master Plan by the CVWRF Board, although acknowledging that the Board must change its plans in mid-construction. It does not attempt to quantify the dollar magnitude of this change, if made. It may also be that such a change is not possible.

13.1

Page 130, 5.9 - Impacts on Populations and Employment

Alternative 2

The draft EIS makes no attempt to analyze the forgone job opportunities by removing 69 acres of prime industrial property from use. An Economic Impact Report prepared by Utah's Division of Community Development indicates a potential for on-site employment of 465 persons initially and over 900 within 20 years should this land become useful by removal of the Vitro tailings.

10.2

Page 133, 5.11 - Impacts on Economic Structure

This section is too brief and poorly done. It has completely ignored economic issues vital to the appropriate assessment of economic impacts.

An economic study conducted by Utah's Division of Community Development reports:

> According to the Utah Department of Health, health and safety risks will prohibit the economic development of all property adjacent to the on-site stabilization areas, thereby constraining economic development of surrounding properties. Therefore, potential benefits to be realized from site development must be defined as the costs that society will incur if on-site stabilization is adopted.

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> The sum of capital investment, public revenues and private sector income resulting from the economic development of the Vitro site will exceed $697 million within 30 years if not constrained by on-site stabilization.
>
> Total taxes, licenses, and user fees resulting from Vitro site development will exceed $82.1 million within 30 years.
>
> Total wages, land rents, and business profits resulting from Vitro site development will exceed $178 million within 30 years.
>
> Employment generated by site development will increase from 465 jobs initially to over 900 jobs within 20 years.

10.2

> The differential cost of stablization and decontamination ($38.5 million) will be recovered in public sector revenues alone within ten years; total decontamination costs ($61.0 million) will be recovered within 18 years (Note: This estimate uses the DOE cost estimates. The state's own cost estimates certainly reduce the differential and allow for recovery within a much shorter timeframe.) The state's share of site decontamination costs ($61.0 million) will be recovered in state income and sales taxes within 19 years. Local public revenues will exceed $53.7 million within 30 years.

10.3

Page 136

9.6 Sand gravel and clay are in sufficiently short supply along the Wasatch Front to be considered "significant resources."

Page A-20 and A-21

9.1 Dam failure should be considered. If this factor is added to a probable maximum flood in progress, floodwater velocities could reach seven feet per second, thereby creating an erosion hazard.

Page A-35

The sensitivity of the clay types to be used, to various on-site factors, should be addressed.

The statement, "[i]f a liquification incident were to occur in one of the discontinuous soil layers little evidence of liquefaction would be apparent and damage to the site would not be expected.", is inaccurate.

Page 138, Alternative 2

..."By some revision of plans, the other uses proposed for the 128-acre tract could <u>probably</u> be accommodated;..."(emphasis added). It is extraordinarily expensive to change plans in mid-construction. This proposal would lead to construction delays, increased engineering costs and bid price changes.

Other uses for the tract could not be accommodated since the lands that are to be leased would not be available for that use. The NRC would have the land under control, seemingly forever.

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Page 72

6.2 The high levels of radium-226 and radium-228 in the deep, partially-confined groundwater system may be due to the earlier mining and milling activities at the Vitro site. If so, leaving the wastes at the site could further increase these above-standard radium levels.

6.2 "The piezometric levels in March and April 1982, as measured in monitoring wells drilled to a depth of approximately 60 feet, ranged from 1.0 to 12.0 feet above the existing ground surface. As a result, deep wells within the Vitro area are artesian and flow at the surface." When the city of South Salt Lake begins pumping their deep, 830-foot well at the Vitro site, the artesian conditions will change a great deal. With the deep aquifer being only "partially-confined" (as indicated in the draft EIS), a serious contamination potential will exist.

Page 73

Several issues raised on this page warrant further investigation before any decisions are made. For example, have any of the 121 domestic wells located within a one-half mile radius of the Vitro site been tested for

11.5 evidence of contamination? If the upper groundwater system (and possibly the deeper system) are contaminated, to what extent has the contamination plume migrated offsite, and what are its potential health affects?

The DOE's current studies are not adequately designed to address the remaining hydrologic concerns. For example, the South Clive site is described as being hydrologically similar to the Vitro site, but only one groundwater system is mentioned. Is there also a deeper, partially-confined groundwater system at the South Clive site, and if so, what are its characteristics?

Page 74

19.5 "May" should be changed to will in the statement, "[t]he high salinity of the ground water in the South Clive area may limit its use...".

Page 114. 5.3.1, paragraph 2

The text mentions acquisition of "[a] 5.4 acre strip adjacent to the southwest side...". However, the draft EIS fails to mention the need to acquire 63.6 acres of property from the CVWRF Board.

Page 116 (see also page 59 comments)

19.6 A discrepancy exists between the 23% g acceleration value found on page 116 and the 21% g value given on page 59. Would the final acceleration estimate then be 18% g?

The Proceedings of Conference Ten, Earthquake Hazards Along the Wasatch and Sierra-Nevada Frontal Fault Zones, convened under the auspices of the National Earthquake Hazards Reduction Program (1979), concluded: "If data from the complete earthquake catalogue (1850-1978) are used, they indicate return periods for the Wasatch Front area (92,810 sq. km) of 22 to 25 years for events of 6.0 on the scale, 111 to 115 years for 7.0 events and

232 to 263 years for 7.5 events." The conclusion to these proceedings adds: "Comparison of ratios of velocity spectra between rock and alluvium, in the period ranges of most interest in risk analysis, suggests that ground response at sites on thick saturated alluvium such as exists beneath large parts of the Salt Lake city area can be ten times greater than at adjacent rock sites." This comment should be referenced with the Page 59 comment regarding structure design at the Vitro site.

Page 118

9.2 The statement, "[f]or transient loading conditions, such as the ones imposed by earthquakes, acceptable factors of safety range from 1.0 to 1.3." is incorrect. It is also in conflict with p. A-69, which indicates that a factor of safety "of 1.5, ... is generally accepted as the recommended minimum to insure stability."

Page 119, 5.4.2 - Impacts on groundwater

This aspect is not adequately addressed in the draft EIS. The Vitro site is underlaid by a thick sequence of unconsolidated Quaternary deposits. Bedrock below the site (which is buried under a thick sequence of alluvial deposits to at least 500 feet) consists of semiconsolidated clay, sand and gravel, interspersed with lava and cemented layers of sand and gravel. Within the unconsolidated section, two interrelated (but separate) groundwater flow systems have been identified. There is a shallow watertable system which occurs within the upper 10-30 feet of the unconsolidated alluvial materials. At the site, the watertable is shallow and typically two to five feet below the existing grade, and in places the tailings are in groundwater.

The primary direction of groundwater flow in both the shallow and deeper groundwater systems is to the west and northwest. The principal recharge of the deeper groundwater system is through infiltration of precipitation and streamflow along the flank of the Wasatch Mountains. There is also an upward component of flow from the deeper to the shallow system due to the artesian pressure on the deeper system.

6.2 Under the no action alternative, the degradation of goundwater quality would continue to exist. This potential is limited to the hydrogeologic setting. Upward gradient and migration precludes the deep downward migration of leachate and contaminants. If this upward gradient flow which currently exists was reversed, then degradation of the deeper aquifer would occur through leaching and infiltration. Increased pumping and groundwater withdrawals could cause a migration reversal which could result in serious groundwater contamination.

Another potential exists for lateral migration of leachate and contaminants within the shallow groundwater system beneath the site. Leachate generation would continue, and metals, dissolved salts and radionuclides will exceed the EPA primary and secondary drinking water standards.

Under the on-site stabilization alternative, deep groundwater contamination is minimized, provided that increased deep groundwater withdrawals in the Vitro area do not revise the upward hydraulic gradient or significantly reduce the artesian pressure.

Table 13
Total Private Sector Incomes

Year	Number of Developed Acres	Gross Wages	Total Rents	Total Profits Before Taxes	Gross Private Sector Income	Cumulative Discounted Income
1	35.0	$6,655,545	$1,812,440	$399,010	$8,916,995	$8,916,995
2	36.7	6,970,431	1,812,440	418,392	9,251,263	17,644,602
3	38.4	7,299,630	1,812,440	437,771	9,599,841	26,188,426
4	40.1	7,614,516	1,812,440	457,152	9,934,108	34,529,295
5	41.8	7,943,715	1,812,440	476,533	10,282,688	42,674,147
6	43.5	8,258,601	1,812,440	495,913	10,616,954	50,357,969
7	45.2	8,587,800	1,812,440	515,294	10,965,534	58,088,238
8	46.9	8,901,686	1,812,440	534,675	11,299,801	65,603,251
9	48.6	9,231,885	1,812,440	554,054	11,648,379	72,911,588
10	50.3	9,561,084	1,812,440	573,435	11,996,959	80,012,570
11	52.0	9,875,970	1,812,440	592,817	12,331,227	86,898,262
12	53.7	10,205,169	1,812,440	612,196	12,679,805	93,577,826
13	55.4	10,520,055	1,812,440	631,577	13,014,072	100,045,421
14	57.1	10,849,254	1,812,440	650,958	13,362,652	106,310,353
15	58.8	11,178,453	1,812,440	670,338	13,711,231	112,374,844
16	60.5	11,493,339	1,812,440	689,719	14,045,498	118,235,540
17	62.2	11,822,538	1,812,440	709,098	14,394,076	123,501,714
18	63.9	12,137,414	1,812,440	728,479	14,728,343	129,371,297
19	65.6	12,466,623	1,812,440	747,860	15,076,923	134,653,403
20	67.3	12,781,509	1,812,440	767,240	15,411,189	139,747,002
21	69.0	13,110,708	1,812,440	786,621	15,759,769	144,660,972
22	69.0	13,110,708	1,812,440	786,621	15,759,769	149,296,793
23	69.0	13,110,708	1,812,440	786,621	15,759,769	153,670,209
24	69.0	13,110,708	1,812,440	786,621	15,759,769	147,796,074
25	69.0	13,110,708	1,812,440	786,621	15,759,769	161,688,399
26	69.0	13,110,708	1,812,440	786,621	15,759,769	165,360,403
27	69.0	13,110,708	1,812,440	786,621	15,759,769	168,824,559
28	69.0	13,110,708	1,812,440	786,621	15,759,769	172,092,630
29	69.0	13,110,708	1,812,440	786,621	15,759,769	175,175,715
30	69.0	13,110,708	1,812,440	786,621	15,759,769	178,084,287

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Table 14
Total Public and Private Sector Impacts

Year	Number of Developed Acres	Total Public Sector Revenues	After Tax Private Sector Income	Total Capital Investment	Total Impact	Cumulative Discounted Impact
1	35.0	$4,567,436	$7,794,445	$415,101,696	$427,463,577	$427,463,577
2	36.7	4,673,832	8,074,189	3,480,562	16,228,583	442,773,561
3	38.4	4,778,932	8,368,244	3,549,859	16,697,035	457,633,863
4	40.1	4,885,401	8,647,987	3,621,304	17,154,692	472,037,272
5	41.8	4,992,351	8,942,741	3,693,816	17,628,909	486,001,020
6	43.5	5,105,299	9,221,785	3,767,393	18,094,477	499,522,264
7	45.2	5,207,740	9,515,841	3,843,104	18,566,685	512,611,044
8	46.9	5,316,198	9,795,584	3,919,881	19,031,663	525,268,187
9	48.6	5,425,181	10,089,639	3,998,791	19,513,611	537,511,268
10	50.3	5,434,699	10,383,694	4,078,766	19,997,159	549,347,555
11	52.0	5,644,762	10,663,438	4,159,808	20,468,008	560,776,784
12	53.7	5,755,378	10,957,493	4,242,982	20,955,853	571,816,066
13	55.4	5,866,564	11,237,236	4,328,290	21,432,092	582,230,483
14	57.1	5,978,326	11,531,291	4,414,664	21,924,281	592,509,442
15	58.8	6,090,676	11,605,347	4,503,171	21,849,758	602,206,572
16	60.5	6,203,630	12,105,091	4,592,743	22,901,464	611,762,553
17	62.2	6,317,194	12,399,145	4,684,449	23,400,787	620,974,186
18	63.9	6,431,386	12,678,887	4,778,287	23,888,560	629,664,405
19	65.6	6,546,217	12,972,943	4,874,258	24,393,416	638,210,488
20	67.3	6,661,686	13,251,988	4,972,363	24,886,037	646,435,647
21	69.0	6,777,818	13,546,742	5,071,532	25,396,092	654,354,262
22	69.0	6,777,818	13,546,742	5,071,532	20,324,560	660,332,648
23	69.0	6,777,818	13,546,742	5,071,532	20,324,560	665,973,017
24	69.0	6,777,818	13,546,742	5,071,532	20,324,560	671,293,931
25	69.0	6,777,818	13,546,742	5,071,532	20,324,560	676,313,661
26	69.0	6,777,818	13,546,742	5,071,532	20,324,560	681,049,256
27	69.0	6,777,818	13,546,742	5,071,532	20,324,560	685,516,793
28	69.0	6,777,818	13,546,742	5,071,532	20,324,560	689,731,460
29	69.0	6,777,818	13,546,742	5,071,532	20,324,560	693,707,557
30	69.0	6,777,818	13,546,742	5,071,532	20,324,560	697,458,591

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Table 11

Land Rental Values

Year	Total Rents	Cumulative Disconted Rents
1	$1,862,440	$ 1,862,440
2	1,862,440	3,619,458
3	1,862,440	5,277,024
4	1,862,440	6,840,764
5	1,862,440	8,315,991
6	1,862,440	9,707,715
7	1,862,440	11,020,662
8	1,862,440	12,259,290
9	1,862,440	13,427,808
10	1,862,440	14,530,184
11	1,862,440	15,570,161
12	1,862,440	16,551,271
13	1,862,440	17,476,846
14	1,862,440	18,350,031
15	1,862,440	19,173,790
16	1,862,440	19,950,921
17	1,862,440	20,684,064
18	1,862,440	21,375,708
19	1,862,440	22,028,202
20	1,862,440	22,643,781
21	1,862,440	23,224,499
22	1,862,440	23,772,346
23	1,862,440	24,289,182
24	1,862,440	24,776,764
25	1,862,440	25,236,747
26	1,862,440	25,670,093
27	1,862,440	26,080,076
28	1,862,440	26,466,286
29	1,862,440	26,830,636
30	1,862,440	27,174,361

Table 12

Business Profits

Year	No. of Developed Acres	Total Profits	Cumulative Discounted Profits
1	35.0	$399,010	$ 399,010
2	36.7	418,392	793,719
3	38.4	437,771	1,183,334
4	40.1	457,152	1,567,167
5	41.8	476,533	1,944,626
6	43.5	495,913	2,315,201
7	45.2	515,294	2,678,463
8	46.9	534,675	3,034,052
9	48.6	554,054	3,381,673
10	50.3	573,435	3,721,088
11	52.0	592,817	4,071,975
12	53.7	612,196	4,394,473
13	55.4	631,577	4,708,347
14	57.1	650,958	5,031,853
15	58.8	670,338	5,328,344
16	60.5	689,719	5,616,140
17	62.2	709,098	5,895,274
18	63.9	728,479	6,165,805
19	65.6	747,860	6,427,613
20	67.3	767,240	6,681,413
21	69.0	786,621	6,926,996
22	69.0	786,621	8,595,262
23	69.0	786,621	8,813,553
24	69.0	786,621	9,019,489
25	69.0	786,621	9,213,767
26	69.0	786,621	9,397,049
27	69.0	786,621	9,569,956
28	69.0	786,621	9,773,076
29	69.0	786,621	9,886,963
30	69.0	786,621	10,032,139

Table 9

Capital Investment

Year	Number of Developed Acres	Capital Invest.	Additional Econ Activ Generated	Gross Invest Impact	Cumulative Discnt Econ Impact
1	35.0	$172,959,040	$242,142,656	$415,101,696	$415,101,696
2	36.7	1,450,234	2,030,328	3,480,562	418,385,245
3	38.4	2.072,751	3,549,859	3,549,859	421,444,607
4	40.1	1,508,877	2,112,427	3,621,304	424,485,124
5	41.8	1,539,090	2,154,726	3,693,816	427,410,972
6	43.5	1,569,747	2,197,646	3,767,393	430,226,187
7	45.2	1,601,293	2,241,811	3,843,104	432,935,423
8	46.9	1,633,284	2,286,597	3,919,881	435,542,368
9	48.6	1,666,163	2,332,628	3,998,791	438,051,259
10	50.3	1,699,486	2,379,280	4,078,766	440,465,474
11	52.0	1,733,253	2,426,555	4,159,808	442,788,259
12	53.7	1,767,909	2,475,073	4,242,982	445,023,439
13	55.4	1,803,454	2,524,836	4,328,290	447,174,467
14	57.1	1,839,443	2,575,221	4,414,664	449,244,234
15	58.8	1,876,321	2,626,850	4,503,171	451,235,991
16	60.5	1,913,643	2,679,100	4,592,743	453,152,382
17	62.2	1,915,854	2,732,595	4,684,449	455,107,039
18	63.9	1,990,953	2,787,334	4,778,287	456,881,525
19	65.6	2,030,941	2,843,317	4,874,258	458,589,191
20	67.3	2,071,818	2,900,[illegible]45	4,972,363	460,232,622
21	69.0	2,113,138	2,958,394	5,071,532	461,813,950

Table 10
Employment and Wage Income

Year	No of Develop Acres	Direct Employees	Indirect Employees	Total Employees	Total Wage Income	Cumulative Discnted Wage Income
1	35.0	174	291	465	$6,655,545	$6,655,545
2	36,7	185	304	487	6,970,431	13,231,423
3	38.4	191	319	510	7,299,630	19,728,068
4	40.1	200	332	532	7,614,516	26,121,362
5	41.8	208	347	555	7,943,715	32,413,528
6	43.5	217	360	577	8,258,601	38,584,835
7	45.2	225	375	600	8,587,800	44,638,895
8	46.9	233	389	622	8,902,688	50,559,690
9	48.6	242	403	645	9,231,885	56,351,689
10	50.3	250	418	668	9,561,084	62,011,085
11	52.0	259	431	690	9,875,970	67,525,770
12	53.7	267	446	713	10,205,169	72,90[illegible],726
13	55.4	276	459	735	10,520,055	78,129,871
14	57.1	284	474	758	10,849,254	83,216,425
15	58.8	293	488	781	11,178,453	88,160,666
16	60,5	301	502	803	11,493,339	92,956,435
17	62.2	310	516	826	11,822,538	97,610,330
18	63.9	318	530	848	12,137,424	102,117,737
19	65.6	327	544	871	12,466,623	106,485,361
20	67.3	335	558	893	12,781,509	110,709,796
21	69.0	343	573	916	13,110,708	114,797,777
22	69.0	343	573	916	13,110,708	118,654,363
23	69.0	343	573	916	13,110,708	122,292,65[illegible]
24	69.0	343	573	916	13,110,708	125,724,998
25	69.0	343	573	916	13,110,708	128,963,062
26	69.0	343	573	916	13,110,708	132,017,839
27	69.0	343	573	916	13,110,708	134,899,704
28	69.0	343	573	916	13,110,708	137,618,445
29	69.0	343	573	916	13,110,708	140,183,39[illegible]
30	69.0	343	573	916	13,110,708	142,602,9[illegible]

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Table 7

State Tax Revenues

Year	Income Taxes	Sales Taxes	Gross Revenues	Cum Discnted Revenues
1	$199,505	$180,000	$379,505	$ 379,505
2	209,196	191,700	400,896	757,709
3	218,886	203,400	422,286	1,133,542
4	228,576	215,100	443,366	1,505,801
5	238,266	226,800	465,066	1,874,177
6	247,957	238,500	486,457	2,237,686
7	257,647	250,200	507,847	2,595,698
8	267,337	261,900	529,237	2,947,671
9	227,027	273,600	550,627	3,293,141
10	286,718	285,300	572,018	3,631,718
11	296,408	297,000	593,408	3,963,074
12	306,098	308,700	614,798	4,286,942
13	315,788	320,400	636,188	4,603,108
14	325,479	332,100	657,579	4,911,407
15	335,169	343,800	678,969	5,211,716
16	344,859	355,500	700,359	5,503,951
17	354,549	367,200	721,749	5,788,065
18	364,240	378,900	743,140	6,064,041
19	373,930	390,600	764,530	6,331,889
20	383,620	402,300	785,920	6,591,646
21	393,311	414,000	807,311	6,843,369
22	393,311	425,700	819,011	7,084,286
23	393,311	437,400	830,711	7,314,813
24	393,311	449,100	842,411	7,535,354
25	393,311	460,800	854,111	7,746,301
26	393,311	472,500	865,811	7,948,034
27	393,311	484,200	877,511	8,140,920
28	393,311	495,900	889,211	8,325,314
29	393,311	507,600	900,911	8,501,559
30	393,311	519,300	912,611	8,669,988

Table 8

Federal Tax Revenues

Year	Number of Developed Acres	Indv. Income Taxes	Corporated Income Taxes	Total Federal Revenues	Cumulative Discounted (6%)Rvnues
1	35.0	$ 731,520	$191,525	$ 923,045	$ 923,045
2	36.7	767,050	200,828	967,878	1,836,137
3	38.4	802,581	210,130	1,012,711	2,737,446
4	40.1	838,112	219,433	1,057,545	3,625,381
5	41.8	873,643	228,736	1,102,379	4,498,568
6	43.5	909,174	238,038	1,147,212	5,355,831
7	45.2	944,705	247,341	1,192,046	6,196,176
8	46.9	980,236	256,644	1,236,880	7,016,772
9	48.6	1,015,767	265,946	1,281,713	7,822,935
10	50.3	1,051,298	275,249	1,326,547	8,609,116
11	52.0	1,086,829	284,552	1,371,381	9,373,888
12	53.7	1,122,360	293,854	1,416,214	10,119,932
13	55.4	1,157,891	303,157	1,461,048	10,832,747
14	57.1	1,193,422	312,460	1,505,882	11,538,763
15	58.8	1,228,953	321,762	1,550,715	12,224,646
16	60.5	1,264,483	331,065	1,595,548	12,890,412
17	62.2	1,300,015	340,367	1,640,382	13,536,142
18	63.9	1,335,546	349,670	1,685,216	14,126,547
19	65.6	1,371,077	358,973	1,730,050	14,732,659
20	67.3	1,406,608	368,275	1,774,883	15,354,478
21	69.0	1,442,139	377,578	1,819,717	15,921,874
22	69.0	1,442,139	377,578	1,819,717	16,457,154
23	69.0	1,442,139	377,578	1,819,717	16,962,135
24	69.0	1,442,139	377,578	1,819,717	17,438,532
25	69.0	1,442,139	377,578	1,819,717	17,887,963
26	69.0	1,442,139	377,578	1,819,717	18,311,955
27	69.0	1,442,139	377,578	1,819,717	18,771,947
28	69.0	1,442,139	377,578	1,819,717	19,089,297
29	69.0	1,442,139	377,578	1,819,717	19,445,289
30	69.0	1,442,139	377,578	1,819,717	19,781,130

Table 5
Total Public Revenues

Year	Number of Developed Acres	Property Taxes	Sales Taxes	Income Taxes	Licences User, Fees	Gross Public Revenues	Cumulative Discounted Revenues
1	35.0	$2,946,802	$213,750	$,1,122,550	$284,334	$4,567,436	$4,567,436
2	36.7	2,970,871	227,644	1,177,074	298,243	4,673,832	8,976,711
3	38.4	2,993,645	241,538	1,231,597	312,152	4,778,932	13,229,943
4	40.1	3,017,782	255,432	1,286,121	326,061	4,885,401	17,331,820
5	41.8	3,042,410	269,326	1,339,947	339,970	4,992,351	21,286,230
6	43.5	3,067,525	281,026	1,395,169	353,879	5,105,299	25,101,206
7	45.2	3,093,145	296,914	1,449,693	367,788	5,207,740	28,772,457
8	46.9	3,119,276	311,008	1,504,217	381,697	5,316,198	32,308,032
9	48.6	3,145,933	324,902	1,558,740	395,606	5,425,181	35,711,858
10	50.3	3,173,123	338,796	1,613,265	409,515	5,534,699	38,987,838
11	52.0	3,200,859	352,690	1,667,789	423,424	5,644,762	42,139,844
12	53.7	3,229,149	364,584	1,722,312	437,333	5,755,378	45,171,705
13	55.4	3,258,008	380,478	1,776,836	451,242	5,866,564	48,087,208
14	57.1	3,287,442	394,372	1,831,361	465,151	5,978,326	50,890,081
15	58.8	3,317,466	408,266	1,905,884	479,060	6,090,676	53,583,153
16	60.5	3,348,094	422,160	1,940,407	492,969	6,203,630	56,171,751
17	62.2	3,379,331	436,054	1,994,931	506,878	6,317,194	58,658,491
18	63.9	3,411,195	449,948	2,049,456	520,787	6,431,386	61,046,879
19	65.6	3,443,699	463,842	2,103,980	534,696	6,546,217	63,340,305
20	67.3	3,476,842	477,736	2,159,201	548,605	6,661,686	65,542,079
21	69.0	3,510,646	491,630	2,213,027	562,514	6,777,818	67,655,435
22	69.0	3,510,646	505,524	2,213,027	562,514	6,777,816	69,653,245
23	69.0	3,510,646	519,418	2,213,027	562,514	6,777,818	71,541,844
24	69.0	3,510,646	533,312	2,213,027	562,514	6,777,818	73,327,170
25	69.0	3,510,646	547,206	2,213,027	562,514	6,777,818	75,014,872
26	69.0	3,510,646	561,100	2,213,027	562,514	6,777,818	76,610,281
27	69.0	3,510,646	574,994	2,213,027	562,514	6,777,818	78,118,438
28	69.0	3,510,646	588,888	2,213,027	562,514	6,777,818	79,544,108
29	69.0	3,510,646	602,782	2,213,027	562,514	6,777,818	80,891,796
30	69.0	3,510,646	616,676	2,213,027	562,514	6,777,818	82,165,768

Table 6

Local Revenues

Year	No of Develop Acres	Property Taxes	So SL Sales Taxes	Licenses & User Fees	Total Local Revenues	Cumulative Discnted Revenues
1	35.0	$2,946,802	$33,750	$284,334	$3,264,886	$3,264,886
2	36.7	2,970,871	35,944	298,243	3,305,508	6,382,865
3	38.4	2,993,645	38,138	312,152	3,343,935	9,358,555
4	40.1	3,017,782	40,332	326,061	3,384,175	12,200,633
5	41.8	3,042,410	42,556	339,970	3,424,936	14,913,485
6	43.5	3,067,525	44,720	353,879	3,466,124	17,507,689
7	45.2	3,093,145	46,914	367,788	3,507,847	19,980,583
8	46.9	3,119,276	49,108	381,697	3,550,081	22,341,589
9	48.6	3,145,933	51,302	395,606	3,592,841	24,595,782
10	50.3	3,173,123	53,496	409,515	3,636,134	26,748,004
11	52.0	3,200,859	55,690	423,424	3,679,973	28,802,882
12	53.7	3,229,149	57,884	437,333	3,724,366	30,764,931
13	55.4	3,258,008	60,078	451,242	3,769,328	32,651,353
14	57.1	3,287,442	62,272	465,151	3,814,865	34,440,911
15	58.8	3,317,466	64,466	479,060	3,860,992	36,146,831
16	60.5	3,348,094	66,660	492,969	3,906,723	37,777,388
17	62.2	3,379,331	68,854	506,878	3,955,063	39,334,234
18	63.9	3,411,195	71,048	520,787	4,003,030	40,856,291
19	65.6	3,443,699	73,242	534,696	4,051,637	42,275,757
20	67.3	3,476,842	75,436	548,605	4,100,883	43,595,955
21	69.0	3,510,646	77,630	562,514	4,150,790	45,141,915
22	69.0	3,510,646	79,824	563,014	4,153,484	46,111,805
23	69.0	3,510,646	82,018	563,514	4,153,984	47,264,896
24	69.0	3,510,646	84,212	564,014	4,154,481	48,353,284
25	69.0	3,510,646	86,406	564,514	4,154,981	49,380,603
26	69.0	3,510,646	88,600	565,014	4,155,481	50,350,292
27	69.0	3,510,646	90,794	565,514	4,166,954	51,335,571
28	69.0	3,510,645	92,988	566,014	4,169,648	52,129,457
29	69.0	3,510,646	95,182	566,514	4,172,342	52,944,955
30	69.0	3,510,646	97,376	567,014	4,175,036	53,714,650

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Table 3
Income Tax Revenues

Year Revenues	Number of Developed Areas	State of Utah	Federal Taxes Individual	Federal Taxes Corporate	Gross Revenues	Cumulative Discounted
1	35.0	$199,505	$731,520	$191,525	$1,122,550	$1,122,550
2	36.7	209,196	767,050	200,828	1,177,074	2,232,997
3	38.4	218,886	802,581	210,130	1,231,597	3,329,114
4	40.1	228,576	838,112	219,433	1,286,121	4,408,966
5	41.8	238,266	873,643	228,736	1,339,947	5,470,330
6	43.5	247,957	909,174	238,038	1,395,169	6,512,881
7	45.2	257,647	944,705	247,341	1,449,693	7,534,857
8	46.9	267,337	980,236	256,644	1,504,217	8,535,247
9	48.6	277,027	1,015,767	265,946	1,558,740	9,513,220
10	50.3	286,718	1,051,298	275,249	1,613,265	10,468,109
11	52.0	296,408	1,086,829	284,552	1,667,789	11,399,394
12	53.7	306,098	1,122,360	293,854	1,722,312	12,306,666
13	55.4	315,788	1,157,891	303,157	1,776,836	13,189,719
14	57.1	325,479	1,193,422	312,460	1,831,361	14,048,333
15	58.8	335,169	1,228,953	321,762	1,905,884	14,891,307
16	60.5	344,859	1,264,483	331,065	1,940,407	15,700,971
17	62.2	354,549	1,300,015	340,367	1,994,931	16,466,268
18	63.9	364,240	1,335,546	349,670	2,049,456	17,247,363
19	65.6	373,930	1,371,077	358,973	2,103,980	17,984,479
20	67.3	383,620	1,406,608	368,973	2,159,201	18,698,123
21	69.0	393,311	1,442,138	377,578	2,213,027	19,385,155
22	69.0	393,311	1,442,138	377,578	2,213,027	20,039,129
23	69.0	393,311	1,442,138	377,578	2,213,027	20,653,255
24	69.0	393,311	1,442,138	377,578	2,213,027	21,232,619
25	69.0	393,311	1,442,138	377,578	2,213,027	21,779,189
26	69.0	393,311	1,442,138	377,578	2,213,027	22,294,821
27	69.0	393,311	1,442,138	377,578	2,213,027	22,781,267
28	69.0	393,311	1,442,138	377,578	2,213,027	23,240,178
29	69.0	393,311	1,442,138	377,578	2,213,027	23,673,113
30	69.0	393,311	1,442,138	377,578	2,213,027	24,081,542

Table 4

Licenses and User Fees

Year	No of Develop Acres	Business Licenses	Water User Fees	Sewer Service Fees	Gross Revenues	Cumulative Discnted Revenues
1	35.0	$ 8,250	$162,720	$113,364	$284,334	$ 284,334
2	36.7	8,750	170,623	118,870	298,243	565,695
3	38.4	9,250	178,526	124,376	312,152	843,509
4	40.1	9,750	186,429	129,882	326,061	1,117,276
5	41.8	10,250	194,332	135,388	339,970	1,386,654
6	43.5	10,750	202,235	140,894	353,879	1,651,003
7	45.2	11,250	210,138	146,400	367,788	1,910,279
8	46.9	11,750	218,041	151,906	381,697	2,164,129
9	48.6	12,250	225,944	157,412	395,606	2,412,337
10	50.3	12,750	233,847	162,918	409,515	2,654,728
11	52.0	13,250	241,750	168,424	423,424	2,891,166
12	53.7	13,750	249,653	173,930	437,333	3,121,548
13	55.4	14,250	257,556	179,436	451,242	3,345,801
14	57.1	14,750	265,459	184,942	465,151	3,563,882
15	58.8	15,250	273,362	190,448	479,060	3,775,771
16	60.5	15,750	281,265	195,954	492,969	3,981,470
17	62.2	16,250	289,168	201,460	506,878	4,181,031
18	63.9	16,750	297,071	206,966	520,787	4,374,403
19	65.6	17,250	304,974	212,472	534,696	4,561,730
20	67.3	17,750	312,877	217,978	548,605	4,743,051
21	69.0	18,250	320,780	223,484	562,514	4,918,446
22	69.0	18,750	320,780	223,484	563,014	5,084,060
23	69.0	19,250	320,780	223,484	563,514	5,240,438
24	69.0	19,750	320,780	223,484	564,014	5,388,015
25	69.0	20,250	320,780	223,484	564,514	5,527,518
26	69.0	20,750	320,780	223,484	565,014	5,659,165
27	69.0	21,250	320,780	223,484	565,514	5,783,471
28	69.0	21,750	320,780	223,484	566,014	5,900,844
29	69.0	22,250	320,780	223,484	566,514	6,011,671
30	69.0	22,750	320,780	223,484	567,014	6,116,317

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o Local public revenues will exceed $53.7 million within thirty years.

I. OVERVIEW.

The VITRO site is a 128-acre property four miles south-southwest of the center of Salt Lake City, in South Salt Lake City. The entire site is owned by the Central Valley Water Reclamation Facility Board, which operates a sewage treatment plant on adjacent property north of the central portion of the VITRO site.

From 1951 to 1964 the Vitro Chemical Company of America processed uranium ore for sale to the U.S. Atomic Energy Commission at a mill in the southeast corner of the site. When the plant was dismantled in 1970, the radioactively contaminated materials from the processing operations (approximately 3 million tons) remained on the site.

The U.S. Department of Energy, in its draft environmental impact statement of February 1983, has identified three alternatives for remedial action on the VITRO site. These include the following:

1. No action. Does not meet EPA standards. Considered an unacceptable alternative.

2. Stabilization of contaminated materials on-site. Mitigates environmental and health hazards; EPA standards satisfied. Stabilization area (69 acres) not suitable for any other use; remainder of site capable of supporting economic development. Estimated cost: $22.5 million.

3. Decontamination of VITRO site and disposal of contaminated material at South Clive site in Tooele County. Eliminates environmental and health hazards. Economic development of entire VITRO site feasible. Estimated cost: $61.0 million.

DOE will become responsible for 90% of the costs of any remedial action, with the State of Utah incurring the remaining 10%.

Although no 'preferred alternative' has been specified in the Draft EIS, DOE's estimated costs of the proposed remedial alternatives imply that on-site stabilization (Alternative 2) would be the least costly and most environmentally acceptable action. Consequently, it may well be the eventual preferred action. DOE's assessment of the costs of on-site stabilization, however, can be subjected to two major criticisms:

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1. As determined by the State Department of Health, on-site stabilization will not adequately protect the health and safety of Utah residents; accordingly,

2. Health and safety risks will prohibit the economic development of all properties adjacent to the "stabilization area" and constrain economic development of surrounding properties.

If a 'least-cost' criterion is employed by DOE in formulating its preferred remedial action, then the total costs of on-site stabilization should be accurately assessed. The omission of opportunity costs incurred as the result of unduly constrained economic growth of the site and surrounding properties, as well as those intangible, yet more catastrophic costs to the health and safety of local residents, raises serious concerns that DOE's implicitly preferred remedial action may not be the less costly alternative.

In this report, we investigate the public and private sector costs of adopting on-site stabilization as the VITRO remedial action. The proposition has been advanced throughout the VITRO debates, that the potential economic benefits of VITRO site development, apart from health and safety considerations, would serve to eliminate all but site decontamination (Alternative 3) as the most economically viable remedial alternative. The following analysis confirms this hypothesis.

II. ASSUMPTIONS EMPLOYED IN THE ANALYSIS.

Site description. The property in question is located in the incorporated area of South Salt Lake City and consists of a total of 128 acres.[1] We assume that 69 acres in the southern portion of the property will be developed to support commercial and industrial enterprises. This tract is presently zoned for business and industrial activities.[2] The remaining 59 acres will be available for any future expansion of the Central Valley sewer treatment facility.

Distribution type industrial parks and high technology oriented operations are predominant in the area. Established industrial parks enjoy prime tenants and a high rate of occupancy.[3]

Tract development. Commercial development of the 69 acre tract is assumed to occur in the following fashion:

ECONOMIC IMPACTS OF ALTERNATIVE REMEDIAL ACTIONS FOR THE VITRO TAILINGS

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March 21, 1983

Prepared by

Nile Eatmon
Division of Community Development

EXECUTIVE SUMMARY

This report analyzes the economic opportunity costs that will be incurred by the public and private sectors of the State and local economies if on-site stabilization is adopted by DOE as the VITRO site remedial action. Data and analysis developed in this report may equally be considered to reflect the benefits that will accrue to the public and private sectors if site decontamination is undertaken. The analysis has been limited to economic considerations, and do not include health and safety risks, or costs resulting from these risks.

This study results in the following conclusions:

o According to the Utah Department of Health, health and safety risks will prohibit the economic development of all property adjacent to the on-site stabilization area, thereby constraining economic development of surrounding properties. Therefore potential benefits to be realized from site development must be defined as the costs that society will incur if on-site stabilization is adopted.

o The sum of capital investment, public revenues, and private sector income resulting from the economic development of the VITRO site will exceed $697 million within thirty years if not constrained by on-site stabilization.

o Total taxes, licenses, and user fees resulting from VITRO site development will exceed $82.1 million within thirty years.

o Total wages, land rents, and business profits resulting from VITRO site development will exceed $178 million within thirty years.

o Employment generated by site development will increase from 465 jobs initially to over 900 jobs within twenty years.

o The differential cost of stabilization and decontamination ($38.5 million) will be recovered in public sector revenues alone within ten years; total decontamination costs ($61.0 million) will be recovered within eighteen years.

o The State's share of site decontamination costs ($6.1 million) will be recovered in State income and sales taxes within nineteen years.

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necessary to draw water from the artesian aquifer; the upward pressure would be eliminated and contamination could seep into the strata should an impermeable layer not be placed under the tailings. Even placement of a synthetic impermeable layer cannot guarantee the integrity of the aquifer in perpetuity. Consideration of EPA's final standards for remedial action at tailings piles, specifically the section requiring stabilization as described in 47 CFR 32274, July 26, 1982, causes great concern over the feasibility of stabilization in place.

The continued presence of the Vitro tailings pile within the Salt Lake metropolitan area represents a blight that will discourage development, cause continuing public concerns and detract from the asthetic values of the valley.

6.2 Position

These relationships represent the basis for the decision of the Utah Department of Health to recommend the relocation of the Vitro
3.1 uranium mill tailings to a remote area. This will continue to be Health
20.1 Department policy unless it can be demonstrated that other options are not only more cost effective, but will also absolutely protect the environment and the public health for millenia into the future.

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Utah's share of this projected cost is $8,[illegible] of which $295,000 is now available in a nonlapsing fund for use during F.Y. 83. Utah furnished matching funds during FY80 to 82 in the amount of $279,42[illegible].

5.3 Life Cycle Costing Study

Preliminary Life Cycle Costing studies conducted on the Vitro site by the Central Valley Water Reclamation Facility indicated that placement
10.2 of a small, non-specialized industrial park on the 20 acres fronting 33rd
10.3 South would produce taxes and fees of about four million dollars per year. This results in "pay-back" of the increased cost of the tailings relocation within ten years, and production of over one billion dollars of useable funds over the next 100 years. A high technology park would produce funding at an accelerated rate. It should be stressed that this study is preliminary in nature and should only be considered an estimate until varified by independent review.

13.3 Greg Goodwin, Salt Lake County Planner, reports that the Vitro site is the prime industrial property in the Western United States.

6.0 Conclusions and Position

6.1 Conclusions

Protection of the public health for millenniums by the EPA standards cannot be assured in the Salt Lake metropolitan area with as much confidence as can be provided in a geophysically suitable remote rural area. In the urban area there would be a vastly greater problem with security (trespass, illegal off-site use of tailings, etc.) and a greater temptation to local government to modify the designated use of land as happened in the past. In addition, Salt Lake City lies in one of the most active seismic belts in the United Staets, with most of the activity being centered along the many individual faults of the Wasatch fault zone. One of these, the East Bench Fault, trends north and south
along a line only 4 km east of the sites. In addition, an earthquake
6.2 could result in catastrophic damage to the underlying artesian aquifer such as changing the piezometric (water pressure gradient) level,
8.2 tailings liquifaction, or creating a direct pathway from the tailings to the groundwater. This possibility is greatly reduced by transporting the tailings away from the Wasatch Fault to an area of better geophysical stability. It is also almost certain that within fifty years it will be

post-World War II era, where an increase in nuclear weapons production was called for in the United States. At that time technological efforts were concentrated on the development of ore refining facilities and economic refining processes with little attention being given to the materials which remained in the waste effluents from the mills; effective waste treatment or proper containment was lacking.

In perspective, the Vitro tailings pile represents an environmental problem which originated within a federally sponsored program. The U_3O_8 product was purchased solely by the federal government and the price of the product set by the government did not have built into it a sufficient amount for adequate reclamation, nor did the federal government recommend or provide funds for adequate reclamation following their abandonment of the Vitro site.

The federal government in sponsoring this raw materials program acted for and in behalf of the American people from whom it derives its purchasing power. The monetary costs were shared by the total populace and all of us also shared in the intended benefits derived from the program. Investigations now show the environmental risks have not been equally distributed and those in the Salt Lake Valley are experiencing a disproportionate share of the risks, especially the people who live or work in the immediate vicinity of the pile. The Vitro pile is the only abandoned uranium tailings site located in the center of a large metropolitan area!

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5.2 Cost Estimates

Cost estimates for vicinity property cleanup and relocation of the Vitro tailings are presented below. The estimates include consideration of the remote site location, the special handling of contaminated material, the capabilities of local earthwork contractors, the site-specific subsurface conditions at the Vitro and South Clive sites and remedial action at vicinity properties. Anticipated resale value of purchased equipment, such as conveyor units, trackmobiles, railroad cars, etc. are also considered in the cost estimate.

10.1 The total construction cost plus engineering design (in 1981 dollars) and a 15 percent contingency is estimated to be $87,381,000 including $15,000,000 for vicinity property cleanup. The projected resale value of the purchased equipment is estimated to be about $6,460,000 resulting in a total estimated projected cost of $80,921,000.

Total Expenditures Federal & State in Millions of Dollars

FY	Vicinity Sites $	Vitro $	Cumulative Total $
80-82	2.800	0	2.800
83	1.916	0	4.716
84	8.869	19.131	32.716
85	3.952	24.048	60.716
86	0	10.103	70.819
87	0	10.102	80.921

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abandoned uranium mill sites. This bill evolved into the Uranium Mill Tailings Radiation Control; Act of 1978. A bill that passed the Congress and was signed into law by the President. This law, Public Law 95-604, provides for remedial actions to be taken at Vitro and 23 other sites within the United States. Representative Dan Marriott has steadfastly supported decontamination of the Vitro site and transfer of wastes to a remote site.

Public Law 95-604 requires that each state nominate sites for tailings relocation should that be necessary. Utah, in May 1980, selected a primary site and two alternate sites. These sites were selected by the Vitro Tailings Site Selection Committee, a committee made up of professionals from pertinent Bureaus in the Division of Environmental Health and the Utah Geological and Mineral Survey Office.

The Committee using a complex numerical evluation system rated over 24 different siting proposals. Siting options in western, central and southeastern Utah were considered. This process resulted in the selection of Great Depression as the primary site; alternate #1, 1 mile south of Clive; alternate #2, south of Delle.

These sites were submitted to DOE as Utah's preferred relocation site. Further evaluation by DOE resulted in the identification of the "South Clive" site as being geophysically superior for tailings placement.

4.5 Local Government and Organization Support for Tailings Relocation

Beginning in March, 1975, when the Women's State Legislative Council of Utah passed a resolution in support of relocation of the Vitro tailings to a remote site and continuing through 1982 when the Salt Lake City Commission, Salt Lake County Commission, West Valley City, Utah State Legislature, and others all passed resolutions in support of relocation of the Vitro tailings to an isolated, permanent site. The Utah position has historically been that the tailings must be relocated.

Governor Rampton met with Tooele County officials in September, 1976, and reviewed with them the possibility of placing the Vitro tailing pile in Tooele County. They agreed with the Governor that placing the tailings in the Great Depression area of Tooele County would have the least environmental impact. Several meeting have been held with the Tooele County Commission since them. Currently the Commission is not supportive of relocation of the tailings to Tooele County.

5.0 Federal Participation Needed

5.1 Benefits vs. Risks

The Vitro tailings pile in Salt Lake County is one of those tailings piles which resulted from the sudden demand for uranium during the

5.2 One year later in April, 1982 a second version of the RACP was
20.9 produced. This version listed as the preferred option stabilization in-place, listing economic considerations as the overriding issue.

4.4 Utah's Position on Vitro Remedial Actions

As early as 1959 Utah's Health Agency began expressing concern over the public health and environmental impacts of the Vitro tailings pile.

By 1967 a position was already evolving with Lynn Thatcher, Deputy Director of Health, suggesting the only sound solution to the tailings issues was to avoid scattering of the tailings and to finally remove the pile to a remote area.

In September, 1973, Lyman J. Olsen, M.D., Director of Health was requesting studies to explore "...the feasibility of removing the tailings to a remote location."

October, 1973 saw the introduction of S.2566 by Senator Frank E. Moss, Utah, authorizing a cooperative agreement to solve Utah's Vitro tailings problem. By November, 1973 a moratorium on building was proposed for the area within a one-half mile radius of the tailings.

Testimony by Lyman J. Olsen, M.D., Director of Health before the Subcommittee on Raw Materials in March, 1974, advocated moving of the tailings pile. By July, 1974 policy was firmly established with Dr. Olsen stating, "...the appropriate action is removal of the tailings from this site for disposal in a remote area. Any other considerations are not acceptable to the State of Utah."

In a letter to the Nuclear Regulatory Commission (NRC) in January, 1975, Senator Moss requested immediate action that would result in removal of the radioactive tailings.

Since his election in November, 1975, Governor Scott M. Matheson has firmly supported the removal of the Vitro tailings to a remote location. A site for this relocation was selected by Utah in May, 1980.

After his election, Congressman Dan Marriott, Utah, began exploring the need for legislation at the Federal level dealing with the uranium mill tailings problem. By March, 1978, Marriott was holding Congressional Hearings on the subject and in April 1973 he introduced H.R. 12229, a bill to provide grants in aid to states for restoration of

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There are, however, several alternative actions which could be taken for solving the problem in a quasi-permanent manner such as pile stabilization or removal from the current high-density population center to an area which could be forecasted to be remote for a number of years.

4.2. Vicinity Property Cleanup Begins 1981

Remedial actions in Salt Lake City began in 1981 with decontamination of the county fire station. This work continued during 1982 during which time 8 more contaminated properties were cleaned up. An estimated 90 vicinity sites remain for remedial action. Should the projected Federal timetable for vicinity property remedial action hold up, 14 properties will be decontaminated during Federal FY83 at a cost of approximately $2 million. Vicinity sites will be cleaned during FY84 at a cost of $6 million. The remainder will be accomplished during FY85 at an estimated cost of $6 million. Utah's share of the remedial action costs will be 10 percent.

4.3 Federal Recommendations for Long Term Maintenance of the Vitro Tailings

Over the years a number of options have been discussed as being appropriate remedial measures to solve the tailings issue. These options have ranged from stabilization in-place to removal to a remote location.

Following the enactment of P.L. 95-604, the Uranium Mill Tailings Radiation Control Act of 1978, U.S. Department of Energy (DOE) advocated removal of the Vitro tailings to a remote site. In support of this position DOE prepared a Remedial Action Concept Paper (RACP) in June, 1981. The paper evaluated the following options:

1. Stabilization in place at the Vitro site;

2. Decontamination of the Vitro site and transfer of wastes to a new location;

5.2 Suboption 2A, Disposal in the prime area - The Great Depression,

20.9 Suboption 2B, Disposal in the first alternative area - south Clive,

Suboption 2C, Disposal in the second alternative area - South of Delle.

After considering the pros and cons of these options conclusions were reached on p. 14 ... "It appears that option 2B, Disposal at the First Alternative Area, is the economically and environmentally preferable action."

1. exceed an average release rate of 20 pci/M^2 sec, or
2. increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half pci/liter.

These requirements clearly require remedial action at both vicinity properties and the tailings pile. Quoting further from these standards, "Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 CFR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization."

20.1 These requirements make it extremely difficult if not impossible to stabilize the tailings on-site.

3.6 Engineering Radiation Control

While it is clear that engineering controls may be developed to drastically reduce the radiation eminating from the pile; Utah believes that other environmental concerns are not easily solved and in fact may not be quantifiable. Therefore, unresolved environmental issues will remain should the pile be stabilized in place.

4.0 Solutions for the Vitro Tailings Problems

4.1 A Permanent Solution is Needed

The radiation hazard from tailings lasts for many thousands of years, and some nonradioactive toxic chemicals persist indefinitely. The hazard from uranium tailings must therefore be viewed in two ways. In themselves, the tailings pose a present hazard to the environment and to human health. Beyond this immediate, but generally limited, health threat, the tailings are vulnerable to human misuse and to dispersal by
9.5 natural forces for an indefinite period. In the long run, this threat of expanded indefinite contamination overshadows the present dangers to public health. The Congressional report accompanying P.L. 95-604 expressed the view that the methods used for remedial actions should not be effective for only a short period of time. It stated: "The Committee believes that uranium mill tailings should be treated...in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms," and, that "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p.17, and Pt.II, p.40 [1978]).

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be 100 percent fatal. It is, therefore, unfortunate that there is only a limited amount of experimental evidence or clinical documentation available regarding the consequence of chronic low-level exposures. There is a synergistic effect between radon and other cancer causing health hazards such as cigarette smoking and exposure to airborne asbestos. The inference is that, cigarette smoking coupled with radon exposure results in a 10 fold increased risk of lung cancer. This result is of current interest because of the marked synergism for lung cancer reported recently between cigarette smoking and exposure of the lungs to asbestos. Because of this, on February 18, 1970, the Department of Interior published standards for mandatory radiation limits to underground uranium mines under title 30, CFR 57. Smoking was prohibited underground, effective August 1, 1970.

3.4 Radon Equilibrium - A Function of Air Movement

Radon gas consisting of radon-222 and three short lived daughters is a hazard to health when the daughters become entrapped in the lungs. Their short half life means they will probably decay while in the respiratory tract. When air containing radon gas is allowed to stagnate, the daughters will approach equilibrium with radon-222. However, when there is air movement, such as exists out of doors, the daughters become less abundant with respect to radon and a lower percentage of equilibrium is reached.

The health hazard along with the measuring unit working level (WL), is dependent upon the percentage of equilibrium; therefore, as equilibrium is increased so is the health hazard and measured WL. The outside measurement is the minimum potential hazard. Whenever any building or enclosure is restricting the natural air movement, both the radon's equilibrium value and resulting health hazard will increase. A good example of the problem is the difference in the measured level (0.0075 WL) outside one of the buildings adjacent to the pile (the Non-Door building), and the measured level inside the building (0.469 WL), an increase of 6,000 percent! Just because the outside measurement is below the allowable level, there is no assurance that an enclosure built on the same site would also enjoy the same safe level. In fact, if the above case were to be used as a reference, the enclosure would have a level 60 times greater than the outside level.

The average radon release rate from the Vitro tailings pile is 670 pci/M^2 per second. This value exceeds the Final EPA standards for radon control (20 pci/M^2 sec) by 33 times, obviously requiring remedial action.

3.5 EPA Requirements

Radon control shall be designed to:

a. be effective for up to 1000 years, to the extent reasonably achievable, and in any case, for at least 200 years, and,

b. provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

reprocessing the tailings at the disposal site, a firm would incur a net loss of $26 million at present day uranium and vanadium prices. This loss would be in addition to the cost of stabilizing residues from reprocessing.

5.4 Reprocessed residue tailings would remain with a high concentration of radium and other heavy metals that would result in the tailings still being classified as a radioactive hazardous waste.

3.0 Health Hazard from the Tailings Pile

3.1 Radiation Health Hazards

Two radiation health hazards exist at the site and vicinity properties. Gamma radiation and radon gas have both been associated with adverse health effects.

3.2 Gamma Radiation

The external health hazard is caused by the gamma radiation which is given off by radium-226 and its daughter products and reaches levels up to 3 mr. per hour immediately above the pile. It should be noted here

that the maximum allowable accumulated dose of external radiation to the whole body in unrestricted areas is 500 mr per year. The tailings pile is an unrestricted area in as much as the area is not suitably posted or fenced. It should also be mentioned that gamma levels up to .5 mr per hour (1,000 mr per working year) have been detected in vicinity properties. Levels outside of these buildings range from 14 μr/hr all the way to 2.3 mr per hour. Early recommendations by the U.S. Surgeon General required remedial action wherever external gamma radiation levels exceed 0.1 mr./hr. Recently promulgated EPA Standards for Remedial Actions at Inactive Uranium Processing Sites require remedial action when gamma levels exceed 20 μr/hr. above background. These standards would require that remedial action be taken at vicinity properties as well as at the Vitro Tailings pile.

3.3 Radon Gas

The most severe hazard to human health is the internal physiological hazard, caused by inhalation of radon gas, its daughter products, and associated dust particles. One of the biological effects of excess exposure to radon daughters can be lung cancer, considered to

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Junction, Colorado, area. As mentioned above the mill tailings contain radium and its daughter products from which radiation is released in the form of gamma rays and radon gas.

As a part of the record of the above mentioned hearing held in Washington, correspondence has been documented dealing with the disposal of mill tailings. An example is a letter from the Vitro Corporation of America, dated August 7, 1959, to the U.S. Atomic Energy Commission, in which Vitro requested approval of waste disposal procedures covering mill tailings from their site in Salt Lake City, Utah. In their August 7 letter they asked for permission from the AEC to let the Tolboe and Harlin Construction Company of Salt Lake City use tailings for fill material around the Salt Lake Suburban Sewer District facilities located just north of the plant. On September 1, 1959 the AEC issued the Vitro Corporation authorization pursuant to Sections 20.302, Part 20, Title 10, Code of Federal Regulations, to dispose of waste in the form of tailings from the Salt Lake City mill, in accordance with the procedures described in their letter of August 7, and as supplemented by other correspondence. The AEC stated that "...in as much as the waste in the form of tailings containing 0.029 percent uranium and trace quantities of thorium, it does not constitute source material, no license to receive this material need be obtained by either the Tolboe and Harlin Construction Company or the Salt Lake Suburban Sewer District."

Therefore, the AEC in 1959 apparently was not concerned at all about the presence of radium or its daughter products in these tailings! Two years later, in early, 1961, Utah health personnel began expressing concerns relating to groundwater contamination and occupational exposures.

By July of that year a strong position had been taken by the Utah Health Department. Dr. James D. Wharton, Interim Director of Public Health in correspondence with Luther L. Terry, M.D., U.S. Surgeon General remarked, "It has been proposed that this material be used as highway fill ... while this argument has certain elements of validity, we are seriously concerned about the future. In view of this problem, and in view of the recent information received by us that the AEC is planning to sell its refining plant at Monticello, Utah, it begins to become obvious that present and future generations are going to be faced with a very serious problem unless competent authority and decision can be established by State and Federal governments to regulate this problem area."

2.6 Potential for Economic Reprocessing

Preliminary DOE studies show that reprocessing of the Vitro tailings is not economical at present-day prices for uranium. Using what would currently be the most economical process (heap leaching) and

2.3 Radioactive Materials in Tailings

The radioactive materials present in the tailings are made up principally of radium and its daughter products, along with traces of uranium, as well as thorium.

The Vitro Corporation in correspondence with the AEC on August 7 and 11, 1959, disclosed that Vitro's measurement from two random samples showed the radium concentration to be 290 picocuries of radium per gram (290×10^{-12} gram of radium per gram of tailings). Vitro also indicated that the average uranium concentration of the tailings deposited in the collection area over the period from 1955 to 1959 averaged 0.029 percent U_3O_8. Recent analyses suggest that various definable fractions exist in the tailings. Each fraction having a differing activity. Activity ranges from 200 pci/gr for sands to in excess of 2000 pci/gr for slimes have been reported.

E.C. Tsivoglou and R. L. O'Connell from the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio conducted a series of intensive and detailed in-plant surveys of six United States uranium mills for the specific purpose of characterizing the waste products of

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the industry. They also have reported that in an acid leach/solvent extraction process (the process used by Vitro) that the major portion (98% to 99.5%) of the radium-226 input to the mill remains undissolved and in the tailings following the milling process. The slimes produced by this process have been found to contain a much higher concentration of radium-226 than that of the waste sand. Tsivoglou and O'Connell reported that, "...in general, the slimes, which comprise about a third of the waste solids, will contain 70% to 80% of the total radium originally present in the ore". This might explain why Vitro's northwest tailings exhibit a comparatively high gamma radiation level.

2.4 Volume of Tailings and Contaminated Soils

In as much as most of the ore processed ends up as tailings, there are approximately 1.8 million tons of waste material spread over 125 acres. An estimated one million tons of contaminated soil underlying the tailings must also be removed as will the estimated 340,000 tons of contaminated materials located at the 100 plus vicinity sites (off-site locations contaminated with tailings re: the Salt Lake County fire station.)

2.5 AEC Approved Use of Vitro Tailings for Construction

On October 28, 1971, the Subcommittee on Raw Materials of the Joint Committee on Atomic Energy met to discuss the use of uranium mill tailings for construction purposes. Emphasis was placed on tailings being used as land fill or in mortar mix particularly in the Grand

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1.2 Vanadium Processing During 1964 - 1968

During the years 1964 to 1968, Vitro treated ferrophos from the Idaho phospate industry to recover vanadium. The tailings from this operation were placed on the uranium tailings over a relatively limited area. Over 106,000 dry tons of ferrophos was treated during the time period.

1.3 Shutdown - 1968

During the summer of 1967, Vitro arranged with the adjacent sewage treatment plant to pump sludge onto the largest pile closest to the mill. This was necessary because the sewage treatment plant lacked technology and space to deal with the rapidly increasing volume of sludge coming from plant operations. Early in June, 1968, Vitro shut down the plant entirely.

2.0 Radioactive Tailings From Vitro's Mill Operation

2.1 Acid Leach/Solvent Extraction Method

Vitro's Salt Lake City plant used what is called an acid leach/solvent extraction method of extracting yellow cake (U_3O_8) from the uranium ores. Both mechanical and chemical processes were involved

in the milling operation. Initially the ore was crushed and ground, after which it was treated with a sulfuric acid leaching solution to extract the uranium. The leach liquor was purified and concentrated by solvent extraction and the uranium was recovered by chemical precipitation with the solid product calcined, pulverized and drummed for shipment as "yellow cake".

2.2 Tailings From Vitro's Mill Operation

The Vitro tailings represent liquid and solid chemical, radiological, and sandy wastes which have been discharged from the uranium mill. About 1.8 million tons of tailings are spread at varying depths over a 125 acre tract located immediately north of 3300 South and to the west of Interstate 15 in Salt Lake City. Some of the tailings have been used as fill-dirt in the construction of homes and businesses in Salt Lake Valley. In addition to small amounts of uranium and radium, the tailings contain significant concentrations of base metals. Arsenic, barium, chromium, vanadium, copper, iron, lead, manganese, silver, zinc, and cobalt have been detected in the tailings. Included in the volume of materials to be given remedial treatment are the uranium and vanadium tailings, soils underneath the tailings which have been contaminated through groundwater radionuclide migration, material excavated from off-site locations where tailings were used as fill-dirt, and contaminated sludges from the Central Valley Water Reclamation Facility's sewage treatment plant.

Cost estimates for cleanup of uranium mill processing related problems exceed $80 million 1981 dollars. Utah's share of this expense is 10 percent.

20.1 It is concluded that it is not possible to stabilize the tailings in place and protect the environment and public health in perpetuity. In addition, the continued presence of the Vitro tailings pile within the Salt Lake metropolitan area represents a blight that will discourage development.

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DEPARTMENT OF HEALTH

Position Paper for the Vitro Uranium Mill Tailings

1.0 Background Vitro Corporation of America, Salt Lake City Plant

1.1 Early Western Uranium Mills

The Salt Lake City plant of Vitro Chemical Corporation began processing uranium ore during 1951. It was one of the first western plants to begin production. The plant operated from 1951 through January, 1964 milling approximately 1.7 million tons of uranium ore. In mid 1965 the Atomic Energy Commission (AEC) announced that the AEC - Vitro Uranium Purchase Contract was terminated. The mill had not processed uranium ore since January, 1964. Vitro subsequently processed vanadium ore until 1968. Independent producers of uranium concentrates arranged to have their production shipped to the Atlas mill in Moab, Utah, after Vitro shutdown.

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January 17, 1983

Executive Summary

The Vitro plant processed uranium ores by acid leach/solvent extraction from 1951 to 1964. During this period, the plant processed 1.7 million dry tons of ore. In 1965, the mill was converted to the production of vanadium. Vanadium production ceased in 1968.

The tailings are made up of extremely fine sands, clays, and slimes. Quantities of tailings, contaminated materials, and miscellaneous debris are listed in this paper. Mention is made of Atomic Energy Commission permission to use tailings for construction purposes.

The recognized health hazards associated with the tailings are gamma radiation, radon gas and its daughter products, and base metals and chemical wastes left from the milling process. The biological effects of radiation exposure at low dose rates is not well know, however, higher dose rates of gamma radiation or radon daughter products have been linked to cancer.

The radiation hazard from tailings lasts for many thousands of years, and some nonradioactive toxic chemicals persist indefinitely. The hazard from uranium tailings must be viewed in two ways. In themselves, the tailings pose a threat to the environment and to public health. Beyond this immediate, but generally limited, health threat, the tailings are vulnerable to human misuse and to dispersal by natural forces for an indefinite period. In the long run, this threat of expanded indefinite contamination overshadows the present dangers to public health. The Congressional report accompanying PL 95-604 expressed the view that the methods used for remedial actions should not be effective for only a short period of time. It states: "The Committee believes that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions are expected to last in their present forms," and that, "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time."

Utah has historially supported the relocation of the tailings to a remote area. Former Governor Rampton and Governor Matheson have supported the relocation effort as have the Utah State Department of Health, Utah's Congressional Delegation, local governmental entities, and other civic groups.

DEPARTMENT OF HEALTH
Position Paper for the Vitro Uranium Mill Tailings
January 17, 1983.

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Scott M. Matheson
Governor

James O. Mason M.D. Dr.P.H.
Executive Director
801 533-6111

DIVISIONS
Community Health Services
Environmental Health
Family Health Services
Health Care Financing

OFFICES
Administrative Services
Community Health Nursing
Management Planning
Vitals Examiner
Vital Health Laboratories

STATE OF UTAH
DEPARTMENT OF HEALTH
150 West North Temple P.O. Box 2500 Salt Lake City, Utah 84110-2500

January 19, 1983

Honorable Scott M. Matheson
Governor of Utah
State Capitol
Salt Lake City, Utah 84114

Dear Governor Matheson:

Attached is the Department's position paper on remedial action for the Vitro uranium mill tailings.

Highlighted in the document is the importance of moving the tailings to a remote site away from Utah's major population centers. Although stabilization at its present urban location will prevent some hazards, this approach only addresses a part of the problem.

Long-term protection of the environment and mitigation of a serious urban blight can best be accomplished by removal of the tailings.

Sincerely,

James O. Mason, M.D., Dr.P.H.
Executive Director

Attachment

Vitro Uranium Mill Tailings
Remedial Action
Position Paper

UTAH DEPARTMENT OF HEALTH
January 17, 1983

James O. Mason, M.D., Dr.P.H.
Executive Director
Utah Department of Health

Marvin H. Maxell, Ph.D.
Acting Director, Division of
Environmental Health

Larry F. Anderson, M.P.A., C.I.H.
Assistant Director, Bureau of
Radiation Control

Page 54 - Table A-17

Utah believes these costs to be severley underestimated. Table A-17 can be more accurately shown as:

Work or material	Quantity	Unit	Unit Price	Total
Mobilization	job	lump sum	5% const. cost	$ 962,000
Relocation of South Vitro Ditch	2,600	lineal ft	$ 130	338,000
Excavation of contaminated material within stabilization area	1,533,000	cubic yds	3.50	5,366,000
Seepage-control lining				
Granular working base	335,000	cubic yds	4.50	1,508,000
Clay	335,000	cubic yds	6.00	2,010,000
Move other on-site tailings & contaminated material to stabilization area	1,000,000	cubic yds	3.50	3,500,000
On-site material transportation				
Portable conveyor units	25	each	30,000	750,000
Maintenance & operation	--	--	--	225,000
Restoration grading (imported material)	438,000	cubic yds	4.50	1,971,000
Cover stabilization area	670,000	cubic yds	4.50	3,015,000
Site security fence	7,300	lineal ft	8.00	58,000
Environmental Monitoring Equipment & installation	N/A	lump sum	--	500,000
Land Acquisition	69	acres	200,000	13,800,000
Buildings on 900 West	5	--		2,160,000
Dewatering				670,000
Relocation of Utilities				887,000
Relocation of unknown utilities				402,000

	Total construction cost[d]	13,122,000
	Contingencies @ 15%	5,718,300
	Subtotal	43,840,300
Design-6.5% Inspection-4.5%	Engineering and design @11%	4,822,433
	Total Estimated Costs[e]	48,662,733
	Resale of conveyors	375,000
	Net Cost	48,287,733

[a]Includes demolition of buildings on industrial tract along 900 West.

[b]Includes $0.50 per cubic yard for environmental and health requirements associated with working on exposed tailings materials.

[c]See footnote c to Table A-16.

[d]Does not include costs associated with construction dewatering, if required.

[e]Cost estimate is exclusive of land and right-of-way costs, legal and administrative costs, finance and interest costs, and vicinity-property cleanup.

Page A-90 & A-91 - Table A-26

Utah believes these cost estimates are too high. Utah's estimates place remedial action costs for Table A-26 as follows:

Work or material	Quantity	Unit	Unit Price	Total
VITRO SITE				
Mobilization of equipment	job	lump sum	5% const. cost	832,000
Earthwork excavation of on-site contaminated materials and loading conveyor	2,533,000	cubic yds	$4.00	10,132,000
Restoration grading (imported material)	1,068,000	cubic yds	$4.50	4,806,000
On-site material transportation				
Portable conveyor units	35	units	$30,000	1,050,000
Stacking conveyor	1	units	$150,000	150,000
Rail car loaders with feed hoppers	2	units	$50,000	100,000
Maintenance and operation[c,d]				400,000
				$17,470,000

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No discussion, design criteria, or any other indication of consideration of RCRA appears in the DEIS.

2.4 Utah is adamant that RCRA requirements be carefully considered and applicable criteria be considered and implemented for any remedial action selected to stabilize the Vitro uranium mill tailings site.

Page A-11, A.3.1.2.

No reference is made to Utah's Bureau of Solid and Hazardous Waste Management, The State agency that administers RCRA. This agency has stringent requirements protecting the underlying aquifers at the Vitro or Clive sites.

Page A-14, A.4.1.3

"Two principal groundwater systems have been identified within the area of the Vitro site; a shallow water table system and a deeper partially-confined system (see Section 4.6.2). The water table in the upper, unconfined system ranges seasonally from about 2 to 5 feet below the existing ground surface and is locally above the base of the tailings throughout the year."

This statement is misleading since it only represents a single season observation. Actually, water table measurements taken during CWRF design and construction (1980-1982) indicate a much broader groundwater surface fluctuation; elevations as low as 4,223 have been reported on the CWRF site in the vicinity of the existing secondary sedimentation tanks. Also, since the primary direction of groundwater flow is northwest (i.e., toward Millcreek and the Jordan River), a strong potential exists for migration of any contaminant from the site to nearby surface waters if a total containment barrier is not provided.

Page A-33, paragraph 3

9.6 "In the analyses, consideration was given to the placement of a thin layer of the imported clay soils (Type 4) directly on top of the contaminated materials." DOE has not identified the source of Type 4 clay soils in Utah. Costs of importing from out of state could be prohibitive.

A-35 paragraph 2

9.1 Site stability of the Vitro site is examined. Nowhere in the presentation is reference made to problems associated with differential settlement of the proposed embankment.

Tests have been run at the site by the construction management firm for Central Valley Water Reclamation Facility Board. They have determined that there is considerable danger of differential settlement from the proposed stabilization loads. Their concerns are expressed below:

Estimated settlement @ CWRFB site from stabilized load 29' high would be 15" maximum

Estimated settlement @ CWRFB site from stabilized load 37' high would be 22" maximum

Settlement or consolidation could extend to a period of up to three years.

9.1 Underlying soil has lenses of sand, silt and clay and various mixtures. Shear strengths vary widely and the estimated settlements are based on empirical datas from preload piles at site.

It is estimated that considerable damage to adjacent roadways, 33rd South and 900 West, could occur from soil settlement if the tailings were piled and stabilized in-place. This settlement could also damage utilities and other properties in the immediate area (within 150'). In addition, such differential settlement would jeopardize the integrity of any clay liner use for on-site stabilization.

Page A-40

The failure of a clay liner due to differential settlement was not discussed. How can the clay liner integrity be assured under these conditions?

-2-

Page 130, 5.9 - Impacts on Populations and Employment

Alternative 2

No attempt is made to analyze lost job opportunities by removing 69 acres of prime industrial property from use. An Economic Impacts Report prepared by Utah's Division of Community Development indicates a potential for employment on-site of 465 persons initially and over 900 within 20 years should this land become useful by removal of the Vitro tailings (attached).

Page 133, 5.11 - Impacts on Economic Structure

1.1 This section is too brief and poorly done. It has completely ignored economic issues vital to the appropriate assessment of economic impacts.

An economic study conducted by Utah's Division of Community Development reports:

According to the Utah Department of Health, health and safety risks will prohibit the economic development of all property adjacent to the on-site stabilization area, thereby constraining economic development of surrounding properties. Therefore, potential benefits to be realized from site development must be defined as the costs that society will incur if on-site stabilization is adopted.

10.2 The sum of capital investment, public revenues, and private sector income resulting from the economic development of the Vitro site will exceed $697 million within 30 years if not constrained by on-site stabilization.

Total taxes, licenses, and user fees resulting from Vitro site development will exceed $82.1 million within 30 years.

Total wages, land rents, and business profits resulting from Vitro site development will exceed $178 million within 30 years.

Employment generated by site development will increase from 465 jobs initially to over 900 jobs within 20 years.

10.3 The differential cost of stabilization and decontamination ($38.5 million) will be recovered in public sector revenues alone within ten years; total decontamination costs ($61.0 million) will be recovered within 18 years (Note: This estimate uses DOE cost estimates. The State's own cost estimates certainly reduce the differential and allow for recovery within a much shorter time frame.)

The state's share of site decontamination costs ($61.0 million) will be recovered in state income and sales taxes within 19 years.

Local public revenues will exceed $53.7 million within 30 years.

Page 138, Alternative 2

..."By some revision of plans, the other uses proposed for the 128 acre tract could probably be accommodated;..." emphasis added.

It is extraordinarily expensive to change plans during construction. This proposal would lead to construction delays, increased engineering costs, and bid price changes.

Other uses for the tract could not be accommodated since the lands that are to be leased would not be available for that use. NRC would have the land under control for a seeming eternity.

Page A-10 - paragraph 1, 2, and Table A-3

A discussion of applicable EPA standards for remedial action at contaminated sites is given.

Major portions of the Final EPA Standard are not addressed nor is Congressional intent noted. The Uranium Mill Tailings Radiation Control Act reflects the desire of Congress (in Section 206) that EPA's standards be consistent, to the maximum intent practicable, with the Solid Waste Disposal Act.

2.4 Subpart C -- Implementation of the Final EPA Standard 192.20, requires ..." Judgments on the possible need for remedial actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 CFR 32274, July 26, 1982) and by relevant state and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the stabilization."

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Page 72, paragraph 2

"The piezometric levels in March and April 1982 as measured in monitoring wells completed at a depth of approximately 60 feet, ranged from 1.0 to 12.0 feet above the existing ground surface. As a result, deep wells within the Vitro area are artesian and flow at the surface."

6.2 When the City of South Salt Lake begins pumping their deep well (830 foot) at the Vitro site, the artesian conditions will change a great deal. With the deep aquifer being only "partially-confined" (as indicated in the DEIS) a serious contamination potential will exist.

Page 114, 5.3.1, paragraph 2 - "A 5.4 acre strip adjacent to the southwest side...

The DEIS fails to mention the need to acquire 63.6 acres of property from CVWRB.

Page 119, 5.4.2. - Impacts on groundwater

This aspect is not adequately addressed in the DEIS. The Vitro site is underlaid by a thick sequence of unconsolidated Quaternary deposits. Bedrock below the site (which is buried under a thick sequence of alluvial deposits to at least 500 feet) consists of semiconsolidated clay, sand and gravel, interspersed with lava and cemented layers of sand and gravel. Within the unconsolidated section, two interrelated (but separate) groundwater flow systems have been identified. There is a shallow watertable system which occurs within the upper 10-30 feet of the unconsolidated alluvial materials. At the site the water table is shallow and typically 2-5 feet below the existing area grade and in places the tailings are in groundwater.

The primary direction of groundwater flow in both the shallow and deeper groundwater systems is to the west and northwest. The principal recharge mechanism to the deeper groundwater system is infiltration of precipitation and streamflow along the flank of the Wasatch Mountains. There is also an upward component of flow from the deeper to the shallow system because of the artesian pressure on the deeper system.

6.2 Under the no action alternative, the degradation of groundwater quality would continue to exist. This potential is limited to the hydrogeologic setting. Upward gradient and migration precludes the deep downward migration of leachate and contaminants. If this upward

6.2 gradient flow which currently exists was reversed, then degradation of the deeper aquifer would occur through leaching and infiltration. Increased pumping and groundwater withdrawals could cause a migration reversal which could result in serious groundwater contamination.

Another potential exists for lateral migration of leachate and contaminants within the shallow groundwater system beneath the site. Leachate generation would continue and metals, dissolved salts and radionuclides will exceed the EPA primary and secondary drinking water standards.

6.2 Under the on-site stabilization alternative, deep groundwater contamination is minimized provided that increased deep groundwater withdrawals in the Vitro area do not reverse the upward hydraulic gradient or significantly reduce the artesian pressure.

9.4 Use of clay liners to preclude leachate migration has not been tested enough over materials of untested quality such as the Vitro Tailings. The effectiveness of liners is suspect under conditions which exist on the Vitro site.

Page 119, last paragraph

6.1 Reports indicate that the groundwater within and under the tailings is contaminated. Reference is made to a 2-3 month groundwater study designed and implemented in February 1983 to produce data adequate to predict long term goundwater movement and contamination. This study is too little too late. It is ludicrous to believe that a six to eight week study can produce data reliable enough to predict groundwater patterns during the present, let alone for hundreds of years into the future.

Page 124, 5.6 - Impacts on Land Use

Alternative 2

5.2 13.1 DOE has apparently forgotten that as early as 1975 decisions to move the Vitro tailings and allow other use of the land were made. The DEIS does not give adequate attention to long range planning by Salt Lake County for land use in the Vitro area. The DEIS glosses over the long range Master Plan of the CVWRF Board and acknowledges that the Board must change its plans in mid-construction but does not attempt to place a dollar value on this change if made. It may be that such a change is not possible, but certainly if possible the change would be costly.

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9.4 9.1 Utah believes that the DEIS should address the need for a liner. If a liner is not used, the credibility of the design to last 1000 years is seriously questioned. In fact, with the tailings resting presently in the groundwater, Utah believes that stabilization in-place cannot confidently be addressed as an option lasting for the 200 year minimum specified period in the EPA standards. Since clay goes to a depth of 20-25' at the South Clive site, a clay liner there may not appear necessary. However, a clay liner is definitely necessary to protect groundwater at the Vitro site.

Pages 12-13 - Table 1-3

10.1 Utah believes that project costs presented in Table 1-3 are not realistic. In developing the estimated cost projects DOE has not applied the same criteria to stabilization on-site (Alternative 2) and stabilization at South Clive (Alternative 3).

Page 14, last paragraph

10.1 Costs of alternative options are presented. These costs are questioned by Utah. No attempt has been made at life-cycle costing which would show the true cost to society during the 1000 year planning cycle. The loss of the use of land in the Salt Lake Valley has a greater economic impact than the actual (not DOE's) difference in cost between Alternative 2 and Alternative 3.

Page 15, Last paragraph continued on Page 16

A quote indicative of Congressional intent is used, "uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health problem to the public...". This quote does not go far enough to establish the intent of Congress.

9.5 Utah believes that the Congressional report accompanying the Uranium Mill Tailings Act of 1978 (P.L. 95-604) should also be quoted because it more clearly defines the mood of Congress. "The Committee believes that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions can be expected to last in their present forms." It continues, "The committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." Emphasis added.

Page 16, paragraph 2, 3

10.2 Discusses potential health effects ... "calculations suggest that the Vitro site contamination might produce 0.7 to 0.8 fatal cancers..."

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10.2 Utah suggests the potential 740 to 850 additional cancer-linked deaths must have some economic value - an issue totally ignored by the DEIS.

Page 16, paragraph 4, quoting Chairman J. M. Hendrie concerning health effects

14.2 Here as well as throughout the DEIS the only health effects considered come from exposure to radionuclides. Potential health effects from other toxic species left in the tailings are totally ignored. The several heavy metals represent a far greater hazard to the underlying aquifers.

Page 19 3.1.1 EPA standards - Including Tables 3-1 and 3-2

The DEIS attempts to address the final EPA standards. However, the DEIS fails to address the RCRA requirements found in the final EPA standards. RCRA requirements for siting and impoundment design have been totally ignored.

Page 30, 3.2.3.1, paragraph 1

"...The water produced during emplacement could be temporarily stored in sumps near the excavations and pumped back into the excavated area after the granular working base is in place."

9.8 Utah believes that any attempt to place a clay liner over a working base into which the excess groundwater has been pumped will fail. Also the groundwater will most certainly be contaminated by the tailings.

Page 45, paragraph 4

Discusses impacts on ground and surface water ..."Alternatives 2 and 3 would not differ in their radiological and nonradiological impact on ground and surface water quality. Either alternative would meet the EPA standards. In any case, the ground and surface water systems involved do not contain potable water."

6.3 This statement is not supported by fact. Within a one-half mile radius there are 120 wells. Forty one of these wells are less than 120 feet deep and are being used for domestic purposes, irrigation and stock watering.

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March 29, 1983

DRAFT EIS FOR REMEDIAL ACTIONS AT THE FORMER
VITRO CHEMICAL COMPANY SITE
SOUTH SALT LAKE, SALT LAKE COUNTY, UTAH

Written Comments

Foreword

Paragraph #3

Mention is made of expected design changes reflecting criteria contained in the final EPA standards for Remedial Action at Inactive Uranium Mill Tailings Sites and the lack of adequate data to predict future groundwater contamination probability and use patterns.

6.1 Utah believes that any construction design changes indicated to meet EPA standards must be reviewed and approved. Additionally, the proposed "additional groundwater investigations" are inadequate in design and too short term to provide the needed data.

Page 5 - 1.2.2

3.1 Discussion is made concerning the need to acquire "the industrial strip on 900 West Street." It will also be necessary to buy approximately 63.6 acres of property from the Central Valley Water
20.9 Reclamation Facility Board (CVWRFB) at significant cost. Utah will not acquire the 69 acres necessary if stabilization on site is the preferred alternative or final decision made by DOE.

Page 6 - Table 1-1

Alternative 2, #7, estimated total cost (with clay liner for seepage control): $22.5 million. Utah believes this cost to be under-estimated by as much as $20.5 million.

Alternative 3, #9, estimated total cost

-On-site (Vitro Costs)
$14.6 million
-Transportation to South Clive
$23.8 million
-South Clive Stabilization
$14.9 million
-Total
$61.0 million

Utah believes these costs to be over-estimated by $8 million.

-On-site
$17.470 million
-Transportation
$22.176 million
-South Clive
$ 8.407 million
-Total
$53.222 million

Page 5 - 1.2.2 continued on Page 8 (Reference Table 1-1, pg. 6)

DOE presents a general description of the stabilization in-place option at the Vitro site. For cost comparison purposes an attempt has been made to examine identical stabilization criteria at both sites. A
9.8 glaring error exists, however, in that at the Clive site partial burial (state of the art technology for uranium mill tailings) is used. This technology was not examined at the Vitro site apparently because of the great difficulty involved in construction and the associated high construction costs.

Page 9, - 1.3, paragraph 2

It should be noted that a building moritorium prevented development for several years in this area. The moratorium was relaxed recently by Salt Lake County after DOE assurances that the tailings would be removed.

Page 11, - 1.4, paragraph 5

"In both Alternative 2 and Alternative 3, groundwater systems might have to be protected by use of a clay liner that would reduce seepage ... the need for clay liners has not been demonstrated."

Appendix D - Hydrologic and Water Quality Information

6.1 Appendix D is incomplete, lacking data from the newly proposed and currently implemented groundwater study at the present Vitro site. Criteria specifying a limited time frame study (6-8 weeks) will provide questionable data for modeling the future groundwater condition at the Vitro site.

Appendix E - Socioeconomic Information

1.1 This appendix as well as Section 5.11, "Impacts on Economic Structure," do not meet NEPA requirements in that many potential economic impacts of stabilization on-site have been overlooked. Consequently, Utah's Division of Community Development prepared Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, a report that closely examines economic concerns not examined in the DEIS. A copy of this report is attached.

In prepared remarks by Governor Scott M. Matheson, (see attached) mention was made of the lack of a hazardous materials analysis of the Vitro uranium mill tailings. Because the tailings fail the EPA's EP toxicity test, we must consider impacts to public health and to the environment caused by leachates from the tailings impoundment. This exclusion must be resolved.

8.1 We are also aware of grave concerns Utah's Geologic and Mineral Survey has concerning the seismic analysis included in the DEIS. This report, closely examining seismic studies, will also be included in Utah's written response to the DEIS.

Finally, environmentally, economically, and for the health of men, women and children now and for generations to come, stabilization in-place cannot be justified.

9.5 The Congressional report accompanying P.L. 95-604, expressed the view that the methods used for remedial actions should not have short-lived effectiveness. The report states, "The committee believes that uranium mill tailings should be treated ... in accordance with the substantial hazard they will represent until long after existing institutions can be expected to last in their present forms." Continuing, "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time."

20.1 We concur with that reasoning. We do not want future generations to be faced with a Salt Lake City Love Canal or Times Beach environmental disaster because we did not do the job right the first time. There will be no second chance. The only acceptable option for remedial action at the Vitro uranium mill tailings site is the immediate relocation to a remote, environmentally suitable location. There has been too much delay already. We must begin the relocation of these tailings this year.

In a position paper developed by the Department of Health in January 1983 (attached copy), the Vitro tailings are characterized as "a blight that will discourage development."

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TRANSPORTATION TO SOUTH CLIVE SITE

Rail construction at Vitro and South Clive				
Track	20,000	feet	$52.00	1,040,000
Switches	6	units	$15,000	90,000
Train costs				
Rail cars	165	units	$42,000	6,930,000
Lids	165	units	$9,000	1,485,000
Maintenance[c]				400,000
Rail transportation[e]	660	50-car train	$16,115	10,636,000
Truck transportation of oversized contaminated material (concrete rubble)	118,000	tons	$2.50	295,000
Wash down facilities equipment and construction	2		$200,000	400,000
Well construction at South Clive	1		$50,000	50,000
Maintenance and operation[c]				50,000
On-site rail car handling				
Track mobile	4	units	$100,000	400,000
Maintenance and operation[c,d]				400,000
				$22,176,000

SOUTH CLIVE SITE

Mobilization of equipment	job	lump sum	5% const. cost	400,000
Rotary dump equipment and construction	1	unit	$1,115,000	1,115,000
Operation and maintenance[c,d]				200,000
On-site material transportation				
Portable conveyor units	35	units	30,000	1,050,000
Stationary stacker and feed hopper	1	unit	200,000	200,000
Mobile stacking conveyor	1	unit	400,000	400,000
Maintenance and operation[c,d]				600,000
Earthwork				
Excavation of pits & and placement of cover and liner	2,533,000	cubic yds	1.50	3,800,000
Stabilization cover	225,000	cubic yds	2.50	562,000
Security fence	10,000	lineal ft	8.00	80,000
		Total construction cost		48,053,000
		Contingencies @ 15%		7,208,000
Design	6.5%	Subtotal		55,261,000
Inspection	1.5%	Engineering design @ 8%		4,421,000
		Total estimated cost		59,682,000
		Equipment resale		6,460,000
				$53,222,000

[a]Includes $0.50 per cubic yard for environmental and health requirement associated with working on exposed tailings materials.

[b]Unit cost is based on cost for select materials purchased from commercial quarry. Cost may be more or less at the time of construction depending on construction market and material availability.

[c]Maintenance and operation projected for three-year operational period.

[d]Includes personnel salary for three-year period.

[e]Cost estimate from Western Pacific Railroad.

[f]Assume 50 percent resale value on rail cars and conveyors units.

000366

Dr. James Mason
Page 3
March 21, 1983

DOE adequately deals with those deficiencies will have to be addressed after issuance of the final EIS.

3.1 The State is in a difficult position with respect to the Vitro EIS. Usually, a legal challenge to an EIS is for the purpose of delay or to defeat a project. In this instance, delay is not in the State's interest. The State has the ability to veto any DOE proposal per the cooperative agreement, so a State challenge to the EIS would be meaningless. It should be remembered that a challenge to the EIS cannot force selection of one alternative over another except indirectly. The issue before the Court would be the adequacy of the statement, not which alternative should be selected. It would appear to be in the State's interest to help DOE prepare an adequate statement and apply whatever pressure it can to insure that the selected "preferred alternative" is acceptable to the State.

FGN/gh

LANGUAGE FOR STATE COMMENT -
DEIS VITRO TAILINGS

3.1 1. No "preferred alternative" is outlined in the draft. To adequately comment on environmental considerations it is necessary to understand the basis and rationale for a preferred alternative. It is imperative that the State participate in selection of the preferred alternative. Selection of the preferred alternative must be a coordinated effort between DOE and the State per the Cooperative Agreement which requires concurrence by the State on any selected remedial action plan. The public should then be allowed to comment on the "preferred alternative" and rationale underlying its selection before issuance of the Final EIS.

1.3 2. The DEIS identifies that a groundwater monitoring program review is presently being undertaken. NEPA regulations, 40 C.F.R. 1502.9, require the preparation of supplements to either draft or final environmental impact statements if "there is significant new circumstances or information relevant to environmental concern and bearing on the proposed action or its impacts." It may be that the information acquired from the groundwater studies will require preparation of a new or supplemental draft with subsequent opportunity for public review and comment.

10.1 3. The method of costing of alternatives appears to be deficient in many aspects, one of which is that land costs are not included. This omission and others results in a misleading costs comparison. (Needs to be expanded.)

000368

THE ATTORNEY GENERAL
STATE OF UTAH

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Tax & Business Regulation Division

M E M O R A N D U M

CONFIDENTIAL

TO: DR. JAMES MASON
LARRY ANDERSON
DEPARTMENT OF HEALTH

FROM: FRED NELSON
Assistant Attorney General

RE: Vitro Tailings Draft EIS Issues

DATE: March 21, 1983

The following comments are provided on the Draft Environmental Impact Statement (DEIS) for Remedial Actions at the Vitro Site:

1. What is the consequence of not identifying a "preferred alternative" in the DEIS?

40 C.F.R. Section 1502.14(e) provides that the agency is required to "identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement...." DOE is not therefore required to identify the preferred alternative in the draft if one does not exist. It must, however, do so in the final EIS. When the final
1.1 EIS is issued, it may be commented upon but no hearings need be scheduled.

The cooperative agreement between DOE and the State requires State concurrence on the selected remedial action plan. It would seem to be imperative for the State to either through administrative channels within DOE or through the political process attempt to insure that the preferred
3.1 action selected by DOE is acceptable to the State. Neither DOE nor the State can afford selection of an alternative that the State would veto.

2. Who will make the decision on the "preferred alternative?"

DOE. The State must concur in the remedial action plan per the cooperative agreement.

The President's Council on Environmental Quality may be
20.7 asked to review the NEPA process, but it does not make the decision. It should be remembered that NEPA does not require the decisionmaker to select the most environmentally acceptable alternative. It simply requires that he take a "hard look" at environmental consequences through use of a management tool, the EIS. If the EIS presents the alternatives and fairly represents the consequences of each, the legal requirements have been met.

3. Does the availability of new information require preparation and circulation of a new draft?

The DEIS identifies that a groundwater monitoring program review is presently being undertaken. NEPA regulations, 40 C.F.R. 1502.9, require the preparation of
1.3 1.1 supplements to either draft or final environmental impact statements if "there is significant new circumstances or information relevant to environmental concern and bearing on the proposed action or its impacts." It may be that the information acquired from the groundwater studies will require preparation of a new or supplemental draft with subsequent opportunity for public review and comment.

4. Is the draft EIS "legally adequate?"

This question was posed in the Central Valley Water Reclamation Facility Board list of issues. I am not sure what is meant by a "legally adequate draft." If reference is being made to whether procedural requirements have been met in issuance of the draft, no deficiencies have been brought to my attention. The purpose of the draft is to receive comment for purposes of correcting deficiencies in preparation of the final EIS. Based on my conversations with technical personnel, it would appear there are clearly some technical deficiencies in the draft. It is important that the State point out any known deficiencies. Whether

STATE OF UTAH
NATURAL RESOURCES & ENERGY
Utah Geological & Mineral Survey

606 Black Hawk Way · Salt Lake City, UT 84108 · 801-581-6831

Scott M. Matheson, Governor
Temple A. Reynolds, Executive Director
Genevieve Atwood, State Geologist

March 25, 1983

RECEIVED
DOCUMENT MANAGEMENT
12 MAY 1983

MEMORANDUM

TO: Hunter Weiler, State Planning Coordinator's Office

FROM: William R. Lund, Utah Geological and Mineral Survey

SUBJECT: Comments on Draft Environmental Impact Statement "Remedial Action at the Former Virto Chemical Company Site, South Salt Lake, Salt Lake County, Utah (February, 1983).

COMMENTS PREPARED BY DON R. MABEY

8.3 Page 58 and Table 4-1. The 1884, November 10, earthquake was not in Bountiful but near the Utah-Idaho border at least 100 km north of Bountiful. The 1910, May 22, earthquake was probably at about 40°44.94' and 111°50.95' well south of Bountiful and about 5 kms from the Vitro site. It had an estimated magnitude of 5.7. The 1975, March 28, event was in Pocatello Valley not at Pocatello, Idaho (another 100 km error). Damage reports clearly indicate that the 1958, December 1, event was near Nephi (another 100 km error).

These gross errors related to key seismic events negate much of the seismic risk analysis.

8.6 Page 59. A critical structure designed for the Vitro site should anticipate a magnitude 7.5 event anywhere in the Salt Lake Valley.

8.4 Page 59. Most of the earthquakes in Utah cannot be correlated with surface faults.

Page 64. Recreational use of the Jordan River should be considered "beneficial."

7.2 Page 73. Long-term variations in the climate such as have occurred in last 1000 years might substantially raise the water table at the South Clive site.

Board: Kenneth R. Poulson, Chairman
Lawrence H. Lofthouse
Peter E. Matthews
Robert W. Berrick · Benton Boyd
Natalie A. Mainwaring
Leon Rich
an equal opportunity employer · please recycle paper

8.6 Page 116. The Proceedings of Conference X Earthquake Hazards Along the Wasatch and Sierra-Nevada Frontal Fault Zones convened under the auspices of the National Earthquake Hazards Reduction Program (1979) concluded: "If data from the complete earthquake catalogue (1850-1978) are used, they indicate return periods for the Wasatch Front area (92,810 km^2) of 22 to 25 years for M_L _ 6.0, 111 to 115 years for M_L _ 7.0, and 232-263 years for M_L _ 7.5." The conclusion adds: "Comparison of ratios of velocity spectra between rock and alluvium in the period ranges of most interest in risk analysis suggests that ground response at sites on thick saturated alluvium such as exists beneath large parts of the Salt Lake city area can be ten times greater than at adjacent rock sites." See comment relative to page 59.

Page 122. See comment relative to page 73.

9.6 Page 136. The sand, gravel and clay to be used at the Vitro site is a significant resource.

COMMENTS PREPARED BY BRUCE N. KALISER

8.6 Page 59. A critical structure designed for the Vitro site should withstand a design earthquake of 7.5 in the Salt Lake Valley.

8.4 Page 59. What reference indicates that " 90% of the earthquakes which occurred in Utah between 1950 and 1965 were located along or in association with known fault zones"?

8.5 Page 59. It should be pointed out that the Vitro site is not on rock, relevant to the 0.21 g.

8.1 Page 59. It should read 21% g. or 0.21 g, not "0.21% g."

8.5 Page 59 and 116. The USGS assigns a value for the Wasatch Front for horizontal bedrock acceleration with a 90% probability of not being exceeded in 50 years of 27% g.

8.5 Page 59 and 116. A more reasonable approach for Vitro would be a more conservative one, using a 250 year, 90% probability acceleration. For bedrock the value would be 60% g.

8.6 Page 63. The statement "Each of these earthquakes was of a magnitude comparable with what might be expected to be the maximum event produced by the faulting along the front of the Wasatch Range" is not true.

Page 64. I am unable to address the question of flooding potential of the South Clive site without a firsthand knowledge of the on site and vicinity terrain - maps and other data may be inadequate to address this item.

7.6 Page 73. With the water table at a depth of 25 to 35 feet how does one get ground-water discharge by evapotranspiration? - most unlikely!

19.5 Page 74. "The high salinity of the ground water in the South Clive area may limit its use...." Change "may" to "will."

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19.6 Page 116 is in conflict with page 59 with respect to value of g assigned to Vitro site for horiz. acceleration in bedrock: 23 vs 21%. P. 116 reduces the value of g to 20% because of the valley fill section - would they now want to reduce it to 18%?

9.2 Page 118. The statement, "for transient loading conditions such as the ones imposed by earthquakes, acceptable factors of safety range from 1.0 to 1.3" is incorrect and in conflict with P. A-69 which indicates that a F.S. "well in excess of 1.5 is generally accepted as the recommended minimum to ensure stability."

6.4 9.1 Page A-20 and A-21. The possibility of dam breaks has not been considered; nevertheless, adding dam break discharge to a PMF in progress would not be an added factor because the cover elevation of 4260 feet would still exceed the most conservative flood elevation (4255'). The one new relevant factor is that flood water velocities (with dam break discharges) could reach 7 feet per second, thereby creating an erosion hazard.

Page A-35. Sensitive clays, whether present or not on site, are not addressed.

6.5 Page A-35. The last sentence of the second paragraph, "If a liquefaction incident were to occur in one of the discontinuous soil layers little evidence of liquefaction would be apparent and damage to the site would not be expected" is incorrect in my opinion.

COMMENTS PREPARED BY WILLIAM LUND

Section 4.6.2 Ground Water

11.5 Page 72, paragraph 4. Radium-226 and radium-228 are reported in concentrations that exceed EPA-recommended drinking water standards from the deeper, partially-confined ground-water system. Does this indicate that the deeper system has been contaminated by past milling and tailings disposal activities at the Virto site?

11.5 Page 73, paragraph 2. Have any of the 121 domestic wells located within 0.5 mile of the Virto site been tested for evidence of contamination? If the upper ground-water system and possibly the deeper system are contaminated (page 72 paragraphs 4 and 5), to what extent has the contamination plume migrated offsite and what are its potential health affects?

7.2 Page 73, paragraph 3. The South Clive site is described as being similar to the Vitro site "from a hydrological point of view," but only one ground-water system is mentioned in the EIS. Is there a deeper, partially-confined ground-water system also present beneath the South Clive site, and if so what are its characteristics?

cc: Genevieve Atwood

000370

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

APR 26 6 36 AM '83

APR 22 1983

Project Manager
UMTRA Project Office
U.S. Department of Energy
Albuquerque Operations Office
5301 Central Avenue, N.E., Suite 1700
Albuquerque, New Mexico 87108

Dear Sir:

The National Center for Devices and Radiological Health staff has reviewed the Draft Environmental Impact Statement (DEIS) related to the remedial actions at the former Vitro Chemical Company site, South Salt Lake County, Utah, DOE/EIS-0099-D, dated February 1983. Our assessment has been limited to the health and safety impacts associated with the proposed alternative remedial actions. We have the following comments to offer:

2.4 1. It appears the proposed remedial action will meet EPA standards for such actions at inactive uranium processing sites by consolidation of the tailings and stabilization of the newly created pile at the Vitro site (Alternative 1) or by moving and stabilization of the tailings material at a location south of Clive, Utah, and decontamination of the Vitro site (Alternative 2). Either alternative will reduce the normal average radonflux from the bare undisturbed Vitro tailings of about 670 pCi per square meter per second to less than the 20 pCi per square meter per second on top of the stabilized tailings as required by the EPA standard.

11.6 2. The environmental pathways identified in Section 5.1 and depicted in Figure 5-1 and Appendix F.2 cover all possible emission pathways that could impact on the population and remedial action workers during the 3-year period required to complete the remedial action. The source term data, computer codes (MILDOS and AIRREL) and methodology as described in related Appendixes have provided the means to make reasonable estimates of the radiological impact resulting from each of the alternatives. Results of these calculations are shown in Table 5.1 as estimates of 3-year excess population dose commitments and expected excess cancer deaths caused by the remedial action, and in Table 5.2 as estimates of 3-year excess population dose commitment to the remedial action worker and expected excess cancer deaths caused by the remedial action. It is considered appropriate to relate the excess population dose commitment and expected excess cancer deaths to those that are likely to result from the background radiation levels as presented in Table 5.3. From this comparison, it would appear that the radiological impact of the remedial action over the 3-year period is an acceptable risk. Furthermore, the data presented in Table F-21, Figures 9 and 10 show the reduction in whole body and organ dose in 10 receptor-directions for a 10-year period. The data in Figure 10 appear to indicate that the dose to the bronchial epithelium would be reduced from over 1000 mrem/to less than 10 mrem/year by the fourth and succeeding years.

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3. The radiological monitoring for the South Clive site is presented in Appendix F.1.2, and summarized in Table 4. The location of the environmental sampling programs is shown in Figure F-3. It appears that this program provides adequate sampling frequency and analyses for specific radionuclides to document the background radiation levels should Alternative 3 be selected for the remedial action. Section 3.1.2 states that the UMTRA requires NRC to license the final tailings disposal site following completion of the remedial action. Further, the NRC may require the DOE or other Federal agency having custody of such property and minerals to undertake such monitoring, maintenance, and emergency measures as necessary to protect public health and safety, and other actions as the NRC deems necessary. We believe a monitoring program should be conducted for a period of time following completion of the remedial action at the selected site
16.1 to document that the releases from the sites meet the EPA standards. Therefore, it would be helpful to add a section in Appendix F that would indicate the programs that would be extended to the post remedial action period. We recognize that radiological monitoring after disposal is not required to demonstrate compliance as stated in Subpart A, Section 192.02, footnote 4 of 40 CFR 192.

4. Discussions in Section 5.1.5, Appendix F.2.3, on the radiological consequences in the event of accident during the transport of tailings to the South Clive site as described in Alternative 3, are considered to be (1) an adequate assessment of the radiation exposure pathways, and (2) a reasonable estimate of doses due to a hypothetical accidental spill of material on land (Table 20).

17.4 5. The mitigating measures during remedial actions as presented in Section 5.19.2 are considered to be important for radiation protection action in reducing the potential exposure of construction workers and to limiting public exposure. Experience from similar type activities involving radioactive material has demonstrated that this action is beneficial and should be fully implemented.

6. The protection of ground water from seepage of radioactive material is necessary to meet the EPA standard. Potential ground water contamination requires detailed examination as described in Section 3.1.4 to assure that adequately engineered barriers are provided to prevent seepage from the disposal site. We believe the discussions in Section 5.4.3 and Appendixes A.4.2.2 and A.5.2.2 have adequately addressed this in the conceptual design, and that it provides assurance that such design will provide protection of the public health and the environment.

Thank you for providing the NCDRH the opportunity to review and comment on this Draft Environmental Impact Statement.

Sincerely yours,

John C. Villforth
Director
National Center for Devices
and Radiological Health

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APPENDIX

DOE/EIS-0099-F

6442

Final Environmental Impact Statement

REMEDIAL ACTIONS AT THE FORMER VITRO CHEMICAL COMPANY SITE SOUTH SALT LAKE, SALT LAKE COUNTY UTAH

VOLUME II - APPENDICES

July, 1984

U.S. DEPARTMENT OF ENERGY

000372

Appendix A

Site Conceptual Design

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A.1 INTRODUCTION

A.1.1 Purpose

This appendix provides the information needed to understand the conceptual designs for the remedial action alternatives addressed in this FEIS. This appendix is intended to provide sufficient detail for the reader to understand the remedial action alternatives and the anticipated environmental impacts. This appendix is not intended to provide the detailed engineering necessary to implement the alternatives. Additional details of the proposed remedial action (i.e., Alternative 3--relocation to South Clive) can be found in the Draft Remedial Action Plan (DOE, 1984). Details of stabilization on the Vitro site (i.e., Alternative 2) are available in the DOE UMTRA Project Office in Albuquerque, NM.

A.1.2 Design objectives

The purpose of the remedial action is to dispose of the uranium mill tailings and other contaminated material in a manner which complies with EPA standards (40 CFR 192). Consistent with these standards, and project objectives, the following major design objectives have been established for both action alternatives:

- Reduce the average radon flux from the disposal site to 20 picocuries per square meter per second.
- Design controls to be effective for up to 1000 years with minimum maintenance and a minimum design life of 200 years.
- Prevent inadvertent human intrusion through the use of passive techniques.
- Ensure that existing or anticipated beneficial uses of ground and surface waters are not adversely affected.
- Reduce contaminant levels on areas released for unrestricted use to levels which do not exceed 5 picocuries per gram (Ra-226) above background in the top 15 centimeters of soil and do not exceed 15 picocuries per gram above background in any 15-centimeter layer below that depth.
- Protect against releases of contaminants from the site during construction.
- Provide flood protection, runoff and sediment control, and treatment of waste water as required.
- Minimize areas disturbed during construction and minimize worker and public exposure to contaminated materials.

A.2 STABILIZATION ON THE VITRO SITE (ALTERNATIVE 2)

A.2.1 Major elements of the design

The principal feature of this design concept is the consolidation of the tailings and other contaminated materials into an embankment on the southcentral and southeast portions of the Vitro site (Figure A-1). This design would require the following major construction activities:

- Preparation of the site, including erection of a security fence, and construction of waste-water sedimentation basins to protect against inadvertent release of contaminants from the site during construction.
- Construction of drainage control measures to direct waste-water and storm-water runoff to sedimentation basins during construction activities.
- Removal, relocation, or abandonment of surface and subsurface utilities within the embankment area to prevent the need for human access on the site.
- Excavation and handling of tailings and other contaminated materials.
- Installation of measures to control erosion and sedimentation from disturbed areas during construction.
- Installation and operation of a waste-water treatment facility to protect against release of contamination to surface waters during construction.
- Construction of a liner system to isolate the tailings and other contaminated materials from the ground water.
- Construction of the embankment to isolate tailings and other contaminated material.
- Demolition and disposal of structural foundations and rubble on the site.
- Decontamination of existing surface waterways and placement of material in the embankment.
- Construction of the final cover system over the tailings to inhibit water infiltration and radon exhalation.

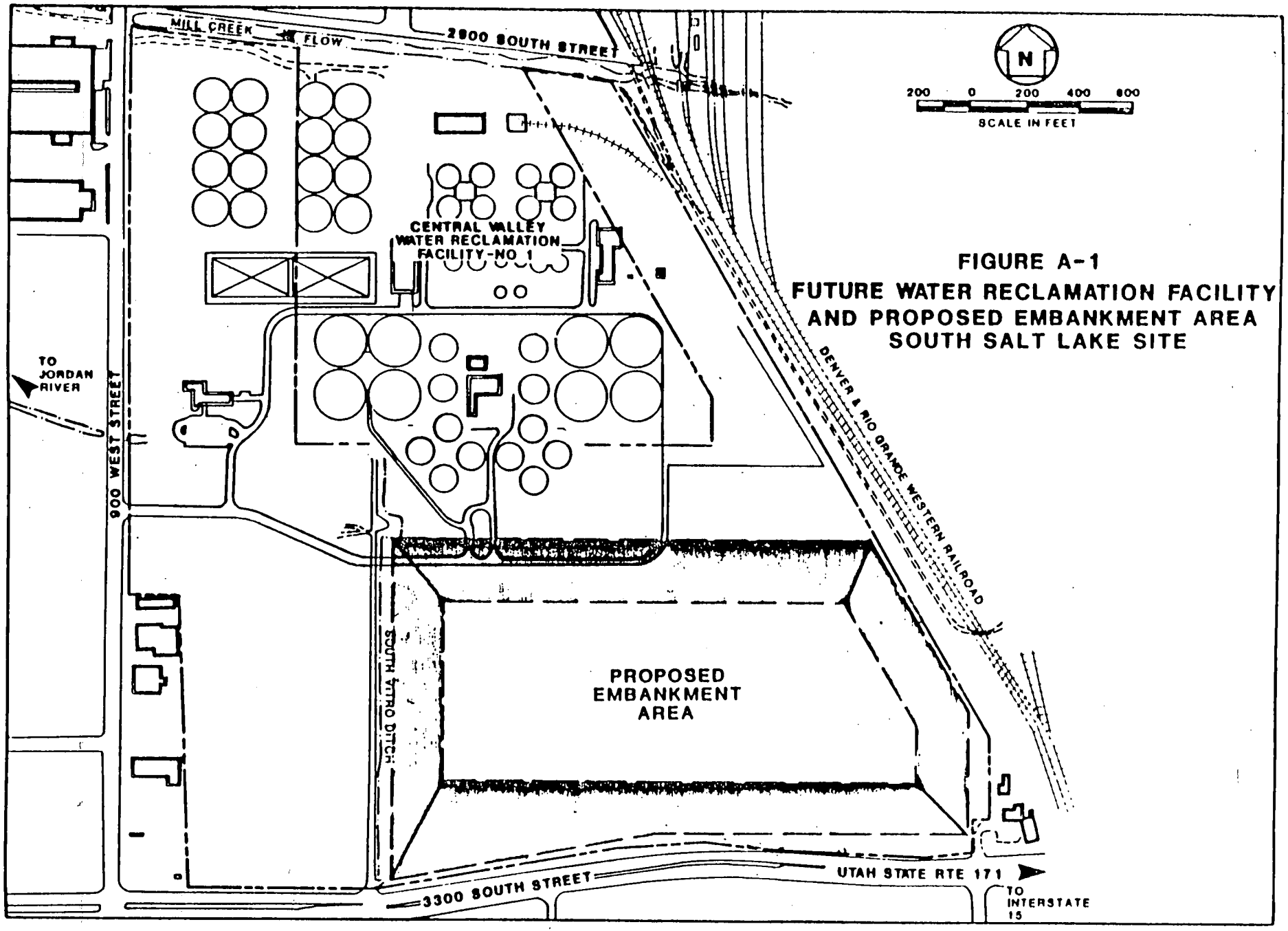

FIGURE A-1
FUTURE WATER RECLAMATION FACILITY
AND PROPOSED EMBANKMENT AREA
SOUTH SALT LAKE SITE

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- Restoration of all excavated areas of the site to at or near natural contours with imported fill and final grading to provide suitable drainage control.
- Emplacement of erosion protection on the embankment.
- Revegetation of all disturbed areas to mitigate erosion.
- Installation of temporary and permanent fencing to discourage human intrusion.

A.2.2 Description of final condition

The completed site would be an embankment situated on the southcentral and southeast portions of the present site and would occupy approximately 53 acres. The completed site would be bounded on the west by the existing South Vitro Ditch, on the south by Utah Highway 171 (3300 South Street), on the east by the railroad right-of-way (R.O.W.), and on the north by the CVWRF property (Figure A-1). The embankment boundary would extend north from Utah Highway 171 and along the east side of the South Vitro Ditch for approximately 1250 feet and thence east to the railroad R.O.W.

The top of the embankment would cover about 25 acres. Side slopes of the embankment would have a slope of 1 vertical to 5 horizontal and the top would be slightly convex (2 percent), reaching a maximum elevation of approximately 50 feet above the surrounding terrain. The top and sides would be covered with pit run rock for erosion protection.

An unpaved access road, tied into the pit run rock, would loop the bottom of the embankment. A security fence with warning signs would enclose the embankment and roadway. Channels adjacent to the embankment would provide drainage and divert surface runoff around and away from the embankment.

The remaining areas of the present site would be restored with clean soil, contoured for surface drainage, and revegetated. Approximately 75 acres of the present site would be released and available for uses permitted by local zoning ordinances.

A.3 DESIGN FEATURES - VITRO SITE (ALTERNATIVE 2)

A.3.1 Introduction

Included in this section is a description of the major features of the design. Table A-1 summarizes earthwork volumes described in the following sections. Figure A-2 illustrates the site concept.

Table A-1. Earthwork volume summary--stabilization on the Vitro site

Item description	Estimated volume (cubic yards)
1. CONTAMINATED MATERIAL RELOCATION:	
Excavation outside embankment area	1,370,000
Relocation in embankment area	850,000
Windblown and vicinity properties (spread and compact)	150,000
Rubble	80,000
2. (PRELOAD SYSTEM):*	(3,000,000)
3. LINER SYSTEM:	
Subbase (random fill)	220,000
Base (granular soil)	300,000
Liner (fine grained soil)	190,000
4. EMBANKMENT COVER:	
Radon barrier (silty sand)	290,000
Erosion barrier (pit run rock)	155,000
5. RESTORATION (select fill)	710,000

*The designs included in this EIS are based upon available information and supporting engineering analyses. It is recognized that there are "margins of error" or "risks" associated with these analyses and that with additional field and laboratory analysis these "margins of error" or "risks" could be reduced. For example, the design for Alternative 2 does not include provisions for preloading (to reduce excessive differential settlement) based upon the analyses to date; however, the State of Utah has indicated that differential settlement may indeed be more of a concern than indicated by the

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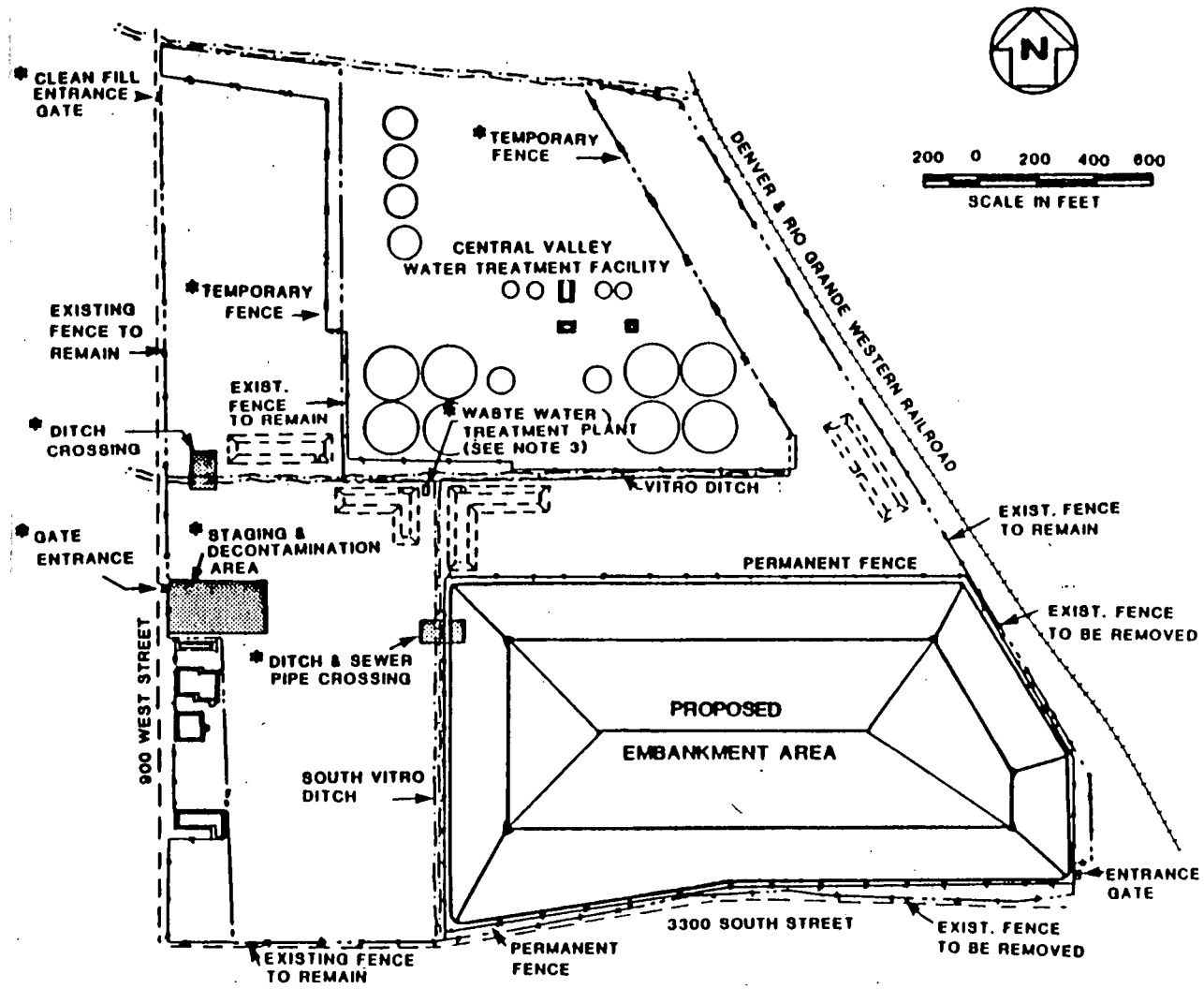

NOTES

1. FOR BOUNDARY SURVEY AND BASIS OF BEARINGS SEE "VITRO PLANT SITE SURVEY" DATED NOVEMBER 2, 1982 PREPARED BY WESTERN DESIGN CONSULTANTS FOR FORD, BACON & DAVIS UTAH INC
2. AERIAL TOPOGRAPHY BY OLYMPIS AERIAL SURVEY INC., SALT LAKE CITY, UTAH DATED SEPTEMBER 18, 1982
3. WASTE WATER TREATMENT PLANT TO BE LOCATED AS REQUIRED DURING CONSTRUCTION SEQUENCE

LEGEND

- SLOPE
- INDICATES INTERIM CONSTRUCTION
- PERMANENT FENCE
- TEMPORARY FENCE
- PROPERTY BOUNDARY
- SEDIMENTATION POND
- EMERGENCY SPILLWAY

FIGURE A-2
PLOT PLAN SHOWING THE STABILIZED PILE
SOUTH SALT LAKE SITE

engineering analyses included in this EIS. If preloading were to be required, based upon engineering analyses and cost estimates prepared by the state, an additional 3.0 million cy of fill would be needed for about 2.5 years to preload the site prior to tailings placement. This would increase the cost of Alternative 2 by $10.8 million to $42.0 million (letter from State of Utah Department of Transportation to the Department of Health, December 19, 1983.)

A.3.2 Design considerations

The remedial action was designed to ensure that the disposal site would withstand the forces of nature for a long period of time (1000 years), and provide radon control and required ground-water protection consistent with the EPA standards.

Several factors were investigated and are discussed below.

A.3.2.1 Cover Design

The cover would be constructed of two basic layers: a lower compacted earthen layer to act as a radon and water infiltration barrier and an upper rock layer for surface stability (Figure A-3). The cover would also:

- Act as a barrier against inadvertent human intrusion.
- Act as a barrier to discourage intrusion by burrowing animals.
- Act as a barrier to discourage root intrusion.

Radon control

Control of radon emissions from the stabilized embankment would be accomplished through a combination of techniques including the following:

- Sequencing of excavation and construction in order to place lesser contaminated "sands" over higher contaminated "slimes."
- Placing lesser contaminated foundation soils and windblown soils over the tailings.
- Placing a compacted soil cover over the tailings and other contaminated materials.

Data on the distribution of radium in the tailings, on the properties of the borrow material, and on the anticipated depth of excavation in areas to be restored were analyzed in order to develop an estimate of cover thickness.

Radon emissions before and after the remedial action were calculated using the RAECO model (Rogers et al., 1981). Four parameters for each layer of the cover and tailings are required to compute the exit flux from the pile using the RAECO model. The first input is the source term of the tailings; this is the available radon per unit volume of tailings that can be released into the atmosphere each second. The second input is the effective diffusion

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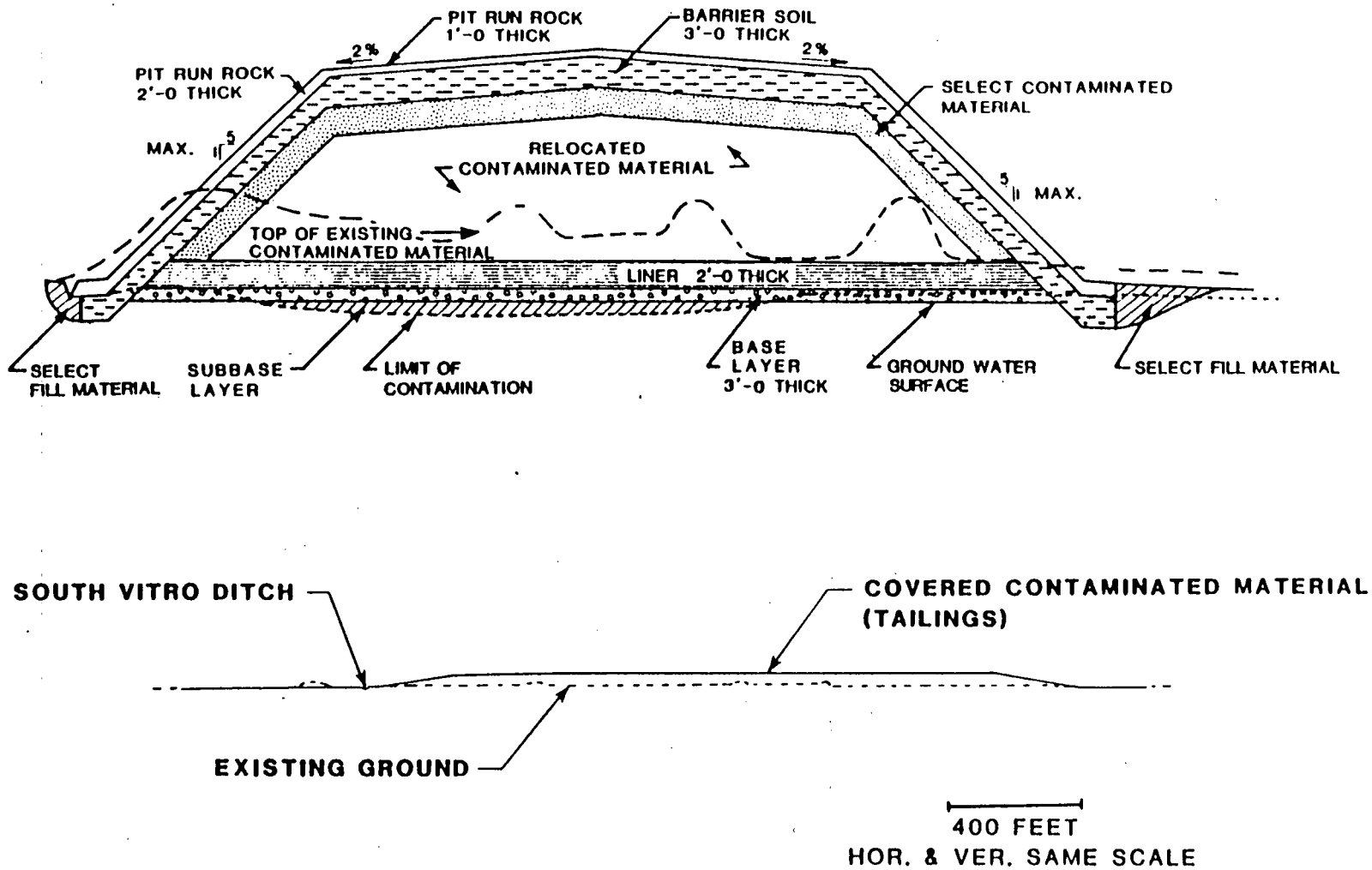

FIGURE A-3
TYPICAL LINER AND EMBANKMENT SECTION
SOUTH SALT LAKE SITE

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coefficient of each layer which is based on the porosity and level of moisture saturation in the layer. The diffusion coefficient defines how well a layer confines the radon gas as it migrates through that layer. If confined long enough, the radon will decay to radon daughters, which are particles and will be trapped in the cover layer. The third input is the porosity of a layer. A low porosity soil will better attenuate the diffusion of the radon gas. The fourth input variable is the thickness of each layer which defines the path length the radon gas must take to be released to the atmosphere. A thicker layer confines the radon gas longer allowing time for it to decay to its daughters. These four inputs, adjusted for long-term cover thickness and moisture retention of the tailings and cover, allow the model to conservatively calculate the radon flux through the cover compared to the background radon concentration of the atmosphere which is 0.59 pCi for Salt Lake City.

Based upon these data and analyses, the radon barrier required to meet the EPA standard would be constructed of approximately 3 feet of locally available borrow. Radon emissions after remedial action, including the additional erosion barrier are calculated to be about 17 pCi/m^2 sec. These data and analyses are available in the DOE UMTRA Project Office, Albuquerque, New Mexico.

Ground-water protection

Ground-water contamination at the Vitro site currently is generated by two processes: by water infiltrating into and through the contaminated material, and by ground water flowing laterally through the base of the tailings. After remedial action, ground-water protection would be provided by the embankment cover, which would reduce infiltration through the tailings, and by the liner system, which would raise the embankment out of the ground water.

The cover, including the rock erosion barrier, was analyzed for infiltration using the modified HELP model (Walski et al., 1982). Daily and monthly climatologic data for Salt Lake City (1974-1978) were used as model inputs. Five years of simulation showed that the post-remedial action net average annual infiltration through the cover system would be 1.3 inches. This reduction to about 8 percent of the average annual rainfall in the Salt Lake City area will substantially reduce the volume of leachate entering the ground water. The modelling runs, inputs, and other supporting data are available in the DOE UMTRA Project Office, Albuquerque, New Mexico.

The liner system is designed to raise the embankment out of the ground water. The granular base layer will prevent capillary water from rising into the embankment. The liner will also filter the water that percolates through the tailings, reducing the downward migration of contaminants. The liner system, by preventing contact between the ground water and the contaminated material, will substantially reduce the volume and concentration of leachate.

Ground-water protection will also be provided by sealing the existing monitoring wells during remedial action. This is especially important for the wells completed in the confined aquifer. These wells represent a potential

avenue for loss of water from the confined system; or even for contamination of the confined aquifer if a local reversal of the vertical head gradient were to allow downward movement of water from the unconfined aquifer. Additionally, the location of a suspected artesian well at the head of Vitro ditch (see Section D.3.1.2) will be excavated during remedial action. If the remnants of a well are found, it will be plugged and sealed.

A.3.2.2 Long-term stability

Water erosion

To protect the embankment from the effects of water erosion, the embankment slopes would be limited to 1 vertical to 5 horizontal (20 percent). The top of the embankment would be convex with gentle (2 percent or less) slopes to promote drainage.

To ensure that the remedial action would withstand water erosion during the design life, the surfaces of the radon barrier cover would be graded and the corners rounded, and the entire radon barrier would be covered with a rock erosion barrier.

Over its design life, the embankment cover may be subjected to severe rainfall events. The most severe potential rainfall event is a Probable Maximum Precipitation (PMP), which would have a peak 5-minute intensity of 30 inches/hour on the embankment. To protect against the erosive effects of a PMP, the side slopes of the embankment would be covered with a 2-foot-thick layer of 6-inch mean diameter pit run rock; the top of the embankment, which has much gentler slopes, would be covered with a 1-foot thick layer of 2-inch mean diameter pit run rock.

Wind erosion

Due to the height of the embankment above the surrounding terrain, wind velocities at the site, and the long reach, the embankment is subject to erosion from wind. The rock layer used to protect against water erosion would protect the embankment against wind erosion.

Flood protection

The embankment is located in the wide, relatively flat alluvial valley of the Jordan River. The river, at its nearest point, is approximately 2500 feet from the embankment. Mill Creek, a tributary of the Jordan River, flows across the valley and joins the river northwest of the proposed embankment. Mill Creek, at its nearest point, is approximately 1500 feet from the embankment.

HEC-2 was used to model Probable Maximum Flood (PMF) flows for the Jordan River and Mill Creek using cross sections obtained from the Sacramento District Corps of Engineers and extended using USGS quadrangle maps. The results of this analysis indicated that the bottom of the embankment is above the 100-year flood level. During a 500-year flood, standing water would rise about 2 to 3 feet above the base of the embankment. Although the base of the

embankment would be inundated (6 to 10 feet) under PMF flood conditions, the embankment would not be subject to erosive water velocities (estimated at 4 to 5 fps).

Geomorphology (stream meander)

As discussed above, the embankment is located in the alluvial valley of the Jordan River and Mill Creek. The Jordan River, in particular, would normally be classified as a meandering river. The location of the embankment in relation to the water bodies, combined with the present and future human intervention between the water bodies and the embankment, makes the likelihood of encroachment very remote.

Seismicity

The Vitro site is located along the Wasatch Front in an active seismotectonic area, and the embankment would be subject to future seismic hazard. A seismic evaluation of the embankment has been performed (SH&B, 1983; Appendix H).

In the event of a Maximum Credible Earthquake (MCE), with a return period of 1,000 to 2,000 years, the subsurface sands would be susceptible to liquefaction. This could result in minor cracking (a few inches in width). It would not result in flow slides of the tailings. However, minor repair of the slopes would be required.

Earthquake-induced ground motions of lesser intensity, which would be expected to occur on the average of once every 50 to 400 years, would cause no significant damage to the embankment. Minor cracking may occur. Damage of this nature would require minor repair.

A.4 CONSTRUCTION SEQUENCE - VITRO SITE (ALTERNATIVE 2)

A.4.1 Site preparation

A.4.1.1 Mobilization

To provide for a construction staging area, tailings and other contaminated material would be removed and temporarily stockpiled on the remainder of the site. The staging area would be constructed immediately north of the industrial tract located along 900 West Street north of Utah Highway 171 (Figure A-2).

A.4.1.2 Clearing

To ensure that disposal of the small amounts of organic material does not interfere with the integrity of the embankment and cover, it is proposed to cut grasses, weeds, and low shrubs close to the ground, shred or chip these and other minimum amounts of contaminated organics, and mix them evenly throughout the lower portions of the tailings. No open burning would be conducted during shredding and chipping operations.

A.4.1.3 Storm drainage

All earth disturbing activities would be conducted in such a way as to prevent accelerated erosion and sedimentation during construction. Hay bales, fabric filter fences, fabric sheets, and the like will be used to further minimize erosion and sedimentation. Areas would be reclaimed as soon as feasible after tailings are removed.

A.4.1.4 Sedimentation basins

Sedimentation basins would be the primary means to collect contaminated waste water prior to treatment. Waste waters would result from:

- Decontamination activities including equipment washing and truck washdown.
- Dewatering of contaminated material.
- Runoff from contaminated materials.
- Laundry waste from washing protective clothing.
- Shower and wash basin waste water.

Basins and channels would be sized to retain the 10-year 24-hour storm event of the area tributary to the basins plus other waste waters. Retention would be for at least 24 hours. Embankments, dikes, and inlet/outlet structures would be designed and located to minimize short-circuiting within the basins and to avoid retarding circulation. Basins would be designed with sufficient freeboard and spillway systems to allow discharge of peak flow rates from larger storm events.

A.4.1.5 Waste-water treatment

Waste water from the sources mentioned above would flow to the sedimentation basins which would provide primary settling and flow and contaminant equalization. Some of this flow would be utilized for road and pile wetdown for dust and radon control. The remainder would be treated to acceptable limits and discharged to either Mill Creek or Vitro Ditch.

The principal dry-weather flow at the site will be the ground water from excavation. This flow may be as high as 300 gpm. An additional treatment capacity of 300 gpm will be available for storm-water runoff. The flow from the other sources will be insignificant, totaling only a few thousand gallons per day.

Unit processes which have been selected for treatment of the settled and equalized flow include:

- Multi-media filtration for removal of suspended solids.
- Uranium- and radium-selective ion exchange for control of radium and gross alpha.

Suspended solids which are captured by the filter and later backwashed will be placed in an excavation for solids containment. Solutions from resin regeneration and the ultimate spent resins will be buried on the site for contaminant containment. Neutralizing chemicals (e.g., NaOH or H_2SO_4) and flocculent aids (e.g., polymer) may be mixed with the sedimentation basin inflow, if necessary, for pH and solids control.

The performance specifications for the treatment unit will be detailed in the final design for construction by an experienced manufacturer. The system will include automatic controls for minimal operator attention and be weather-proof, requiring no enclosure. After completion of the remedial action, the treatment system will be decontaminated and salvaged or buried on the site.

A.4.2 Fugitive dust control

Dust generated by excavation, earth movement, vehicle use, stockpiling, seeding, and similar activities would be controlled and minimized by the use of a water-based surfactant sprayed under moderately high pressure (from trucks and hoses). The source for dust suppression water would be potable water. In addition, hoses would be available for areas of excavation.

A.4.3 Demolition

No complete structures remain on the site with the exception of the water tower and tank. Numerous foundations remain on the site in the former mill area. Since this area would become part of the embankment, those portions of the foundations that would interfere with the construction or integrity of the embankment would be demolished and incorporated, without nesting, into the internal portions of the embankment. Tailings would be distributed and compacted between and against the rubble to prevent settlement.

A.4.4 Preloading (see note to Table A-1)

After excavation and stockpiling of tailings and contaminated materials, 3,000,000 cy of non-contaminated material would be trucked in to cover the 53-acre disposal site for preloading. The preload would stay in place for approximately 2.5 years (determination of the time would be based on field measurements of settlement to determine the amount and rate of settlement). Once settlement has slowed and the amount of settlement that would take place due to the construction of the embankment has taken place, 2,000,000 cy of the preload material would be hauled away for disposal. The remaining material would be used in the construction of the liner system and for fill around the site.

A.4.5 Liner system construction

The embankment liner system would isolate the contaminated materials from the ground water. It would be constructed of three layers: a subbase layer, a base layer, and a liner (Figure A-3). The subbase is designed to raise the embankment out of the ground water. Prior to subbase emplacement, residual radioactive materials would be excavated. The base layer (about 3 feet thick) would provide a capillary break between the subbase and the liner. It would also serve as a solid base for the compaction of the liner. The liner (2 feet thick) would reduce the transport of contaminants from the embankment into the ground water. Water which has infiltrated through the embankment cover would be filtered by the liner. The liner would have a greater permeability than the cover to prevent water build-up within the embankment.

A.4.6 Embankment construction

The embankment would be constructed in the southcentral and southeast portions of the present site. All residual radioactive material from the existing site and material from vicinity properties remedial action would be consolidated into the embankment.

Tailings would be dewatered as required for material handling. This would be accomplished in layers by scraping, trenching and drying, excavating the dewatered material until a new level is reached which is too wet for handling, and repeating the process. The dewatering water would be pumped or allowed to gravity flow to the sedimentation basins.

Pockets of slimes would be mixed with drier sandy tailings during placement in the embankment to provide a stable working surface for construction equipment and to help reduce the effects of differential settlement in the tailings. For purposes of reducing radon emissions and providing a capillary break, sandy tailings would be identified and incorporated into the upper portion of the embankment.

The purpose of the upper capillary break would be to limit or eliminate upward migration of moisture-transported contaminants. The benefits of placement of sandy tailings in the upper portion of the embankment would outweigh the disadvantage of the slight increase of net infiltration into the tailings.

A.4.7 Restoration

During the relocation of tailings into the embankment, large portions of the existing site would be excavated to below ground level. These areas would be restored with uncontaminated borrow to the approximate elevation of the surrounding terrain and contoured to provide surface drainage.

A.4.8 Existing utilities

Numerous utilities, including an overhead power line, a buried telephone cable, water lines, gas lines, and a sewer drain exist adjacent to or under 3300 South Street. These lines would be left in place. A 42-inch sewer line traverses the present site along the west side of the South Vitro Ditch and access road. This line would be protected during construction and left in service. The artesian wells, which are located in the embankment area, would be plugged and abandoned. All wells or holes to be abandoned would be sealed so as to prevent future contamination of ground water.

A.4.9 Revegetation

All areas of the site disturbed by the remedial action except for the embankment cover would be prepared and seeded with native grasses.

A.4.10 Fencing

After remedial action, permanent fencing would be placed around the embankment. The fence would be 6-foot chain link with barbed wire topworks. A gate would be installed for access from 3300 South Street.

A.4.11 Temporary facilities

During construction operations, temporary facilities would be required for construction workers and supervisory, engineering, administrative, security, and monitoring personnel. The facilities would consist of office space, showers and change facilities for all personnel working on the site, and facilities for laundering contaminated clothing.

A.4.11.1 Security

Fencing is required to ensure site security during the construction period. Portions of the existing fencing would be used during construction if possible. All other existing fencing would be removed and replaced with a new fence surrounding the entire site. No vehicle would be allowed to exit the site without monitoring at the decontamination station located at or near the staging area.

A.4.11.2 Water supply

An 8-inch water line runs along 900 West Street. This would supply showers, laundry, vehicle wash when needed, and drinking water.

A.4.11.3 Waste water

Portable construction toilets would be used. Waste water from showers, wash basins, and laundry would gravity flow to a holding tank. Wash water from the vehicle wash area would be held in a pit. These waters would be used for dust suppression or would be pumped to the sedimentation basin for treatment and discharge.

A.4.11.4 Transportation

To ease traffic congestion due to the remedial action along 900 West Street and 3300 South Street, mitigations such as upgrading intersections, traffic signals, and flagmen would be employed as required.

A.4.12 Borrow area

A local borrow area for embankment cover and restoration material has been identified within about 10 miles of the Vitro site. It is located along 5400 South Street in the southwest Salt Lake County area and is locally operated by Moulton Excavating, Inc.

A.5 RELOCATION TO SOUTH CLIVE (ALTERNATIVE 3)--PROPOSED ACTION

A.5.1 Major elements of the design

The principal feature of this design concept is the relocation of the tailings and other contaminated material to a disposal site located near Clive, Utah (Figure A-4).

This alternative considers two modes for transporting (train, truck) tailings and other contaminated materials from the Vitro site to the South Clive site. The major construction activities for the proposed action are listed separately below for the train and truck transportation modes.

A.5.1.1 Train Transportation

- Preparation of both sites, and construction of waste-water sedimentation basins to protect against release of contaminants. Security fencing would be installed at the Vitro site.
- Construction of drainage control measures to direct generated waste-water and storm-water runoff to the waste-water sedimentation basins during construction activities.
- Installation of measures to control erosion and sediment from disturbed areas during construction.
- Installation and operation of a waste-water treatment facility at the Vitro site to protect against inadvertent contaminant release during construction.
- Protection of surface and subsurface utilities at the Vitro site during construction.
- Construction of a railroad loadout spur on the Vitro site.
- Construction of a railroad spur and offloading facility at the South Clive site.
- Upgrading of the existing frontage road from the Aragonite exit of I-80 to the Clive overpass and construction of an access road from the I-80 overpass to the disposal site.
- Demolition and disposal of structures and rubble.
- Excavation and loading of tailings and other contaminated material into train cars.
- Excavation and construction of the embankment at the South Clive site.
- Relocation of the tailings from the offloading facility to the embankment.

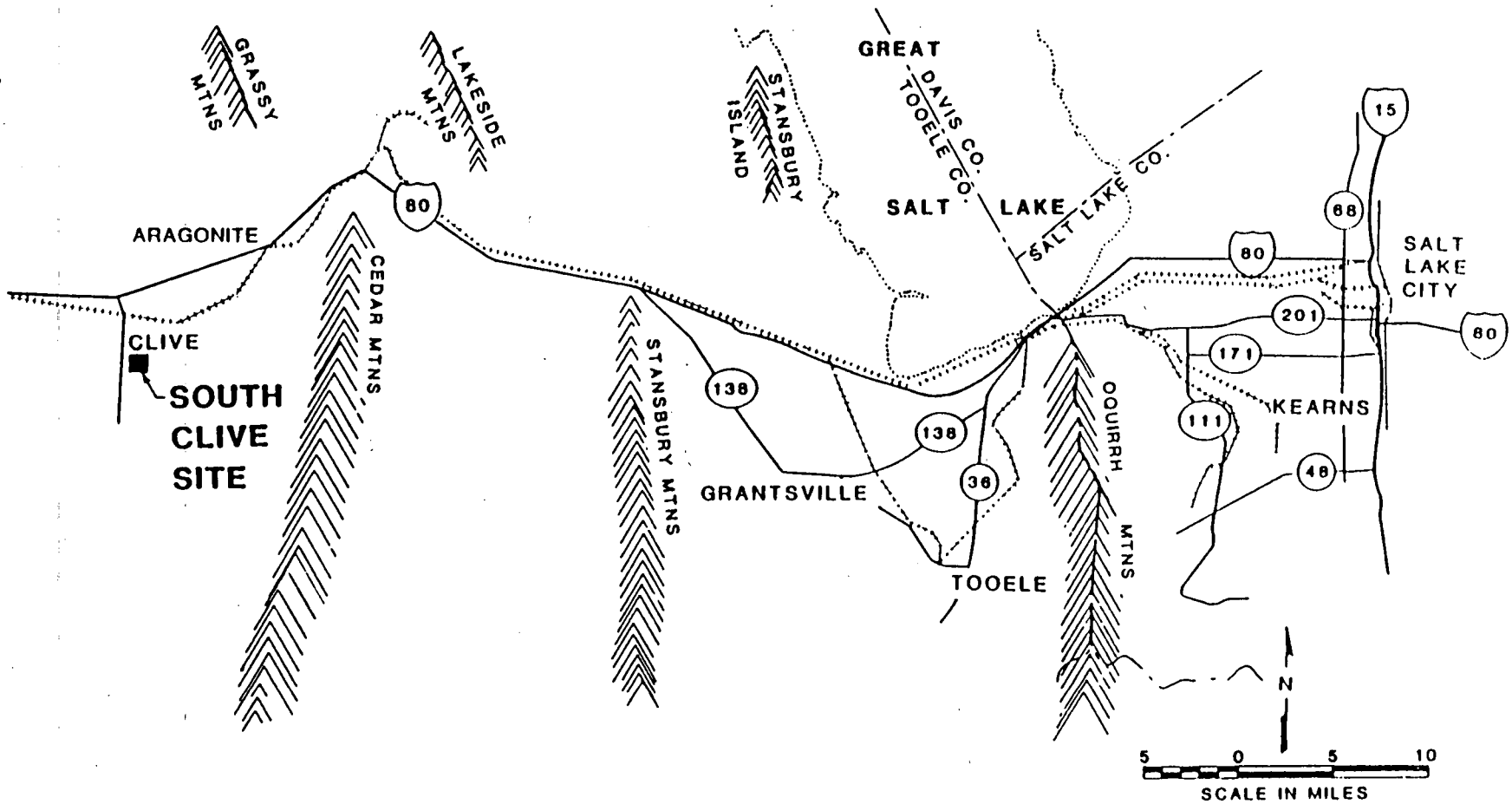

FIGURE A-4
SOUTH CLIVE VICINITY MAP

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- Construction of the cover system over the tailings to inhibit water infiltration and radon exhalation.
- Emplacement of erosion protection on the embankment.
- Installation of a permanent fence around the disposal site.
- Demolition of railroad spurs at both sites.
- Restoration of the excavated areas at the Vitro site with backfill and vegetation.

A.5.1.2 Truck Transportation

- Preparation of both sites, and construction of waste-water sedimentation basins to protect against release of contaminants. Security fencing would be installed at the Vitro site.
- Construction of drainage control measures to direct generated waste-water and storm-water runoff to the sedimentation basins during construction activities.
- Installation of measures to control erosion and sedimentation from disturbed areas during construction.
- Installation and operation of a waste-water treatment facility at the Vitro site to protect against inadvertent contaminant release during construction.
- Protection of surface and subsurface utilities at the Vitro site during construction.
- Upgrading of the existing frontage road from the Aragonite exit of I-80 to the Clive overpass and construction of an access road from the I-80 overpass to the disposal site.
- Demolition and disposal of structures and rubble.
- Excavation and loading of tailings and other contaminated material into trucks.
- Excavation and construction of the embankment at the South Clive site.
- Construction of the final cover system over the tailings to inhibit water infiltration and radon exhalation.
- Emplacement of erosion protection on the embankment.
- Installation of a permanent fence around the disposal site.
- Restoration of the excavated areas at the Vitro site with backfill and vegetation.

A.5.2 Description of final condition

The disposal site is located about 85 road miles west of Salt Lake City and about 1.5 miles south of the Clive siding of the Union Pacific System. The total available site, which is one full section or 640 acres, is a relatively flat area at about 4,300 feet above sea level along the eastern edge of the Great Salt Lake Desert. The site is sparsely vegetated with grasses and small bushes. Site access is by a frontage road from the Aragonite exit of I-80 about 7 miles east of Clive.

The completed embankment would be partially below grade, extending approximately 1100 feet by 2200 feet (Figure A-5). The tailings would extend from approximately 6 feet below grade to approximately 27 feet above grade. Material excavated for partial below grade disposal would be used for cover. The final covered embankment would be 34 feet above the surrounding terrain. The embankment would have maximum side slopes of 20 percent and a slightly convex top. The top and sides would be covered with pit run rock for erosion protection. The unpaved access road from I-80 would remain. A chain link fence with warning signs would enclose the site.

The excavated areas at the Vitro site would be restored with clean soil to the original approximate ground level, contoured for surface drainage, and revegetated (Figure A-6). The Vitro site would be available for uses permitted by local zoning ordinances.

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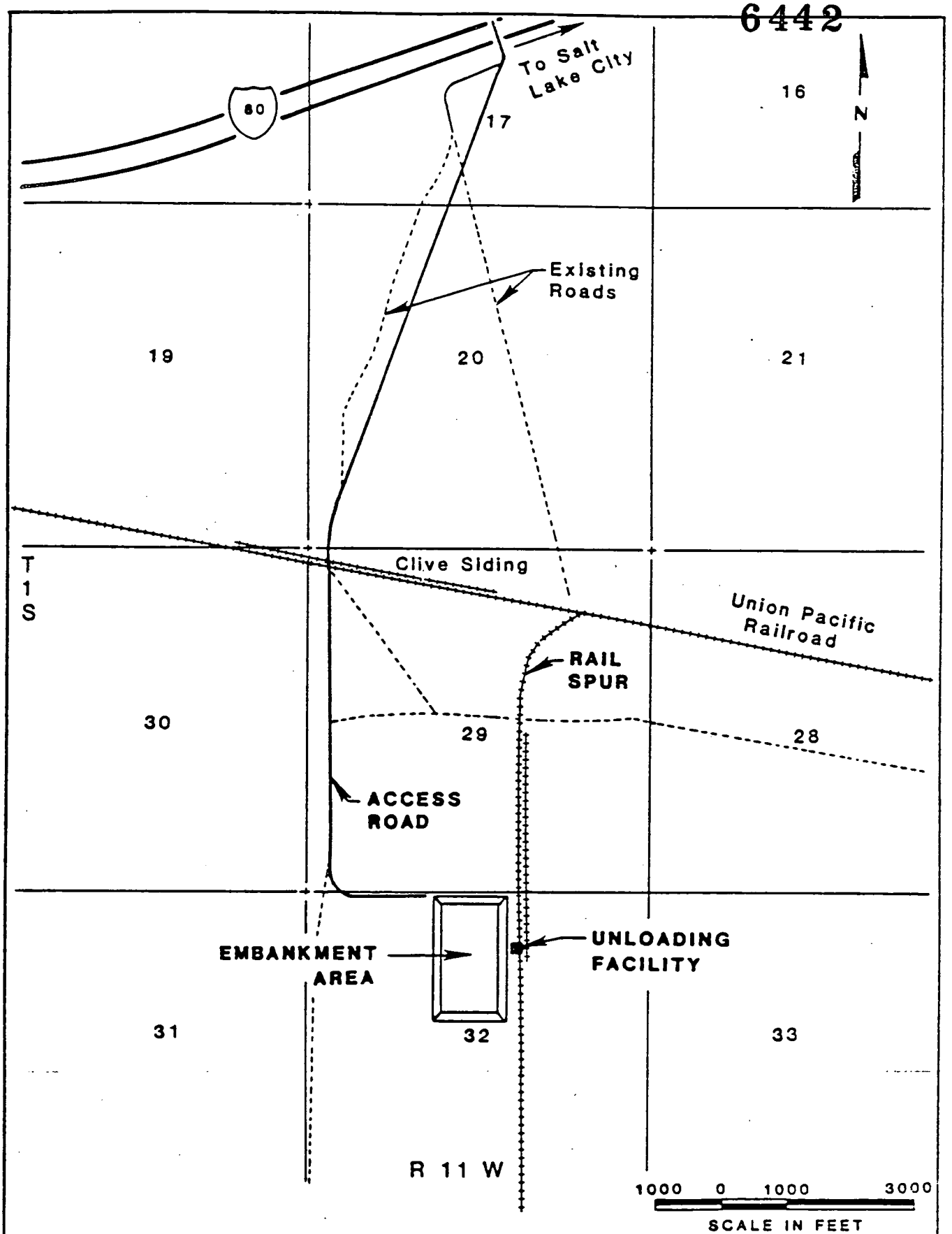

FIGURE A-5
PLOT PLAN FOR SOUTH CLIVE

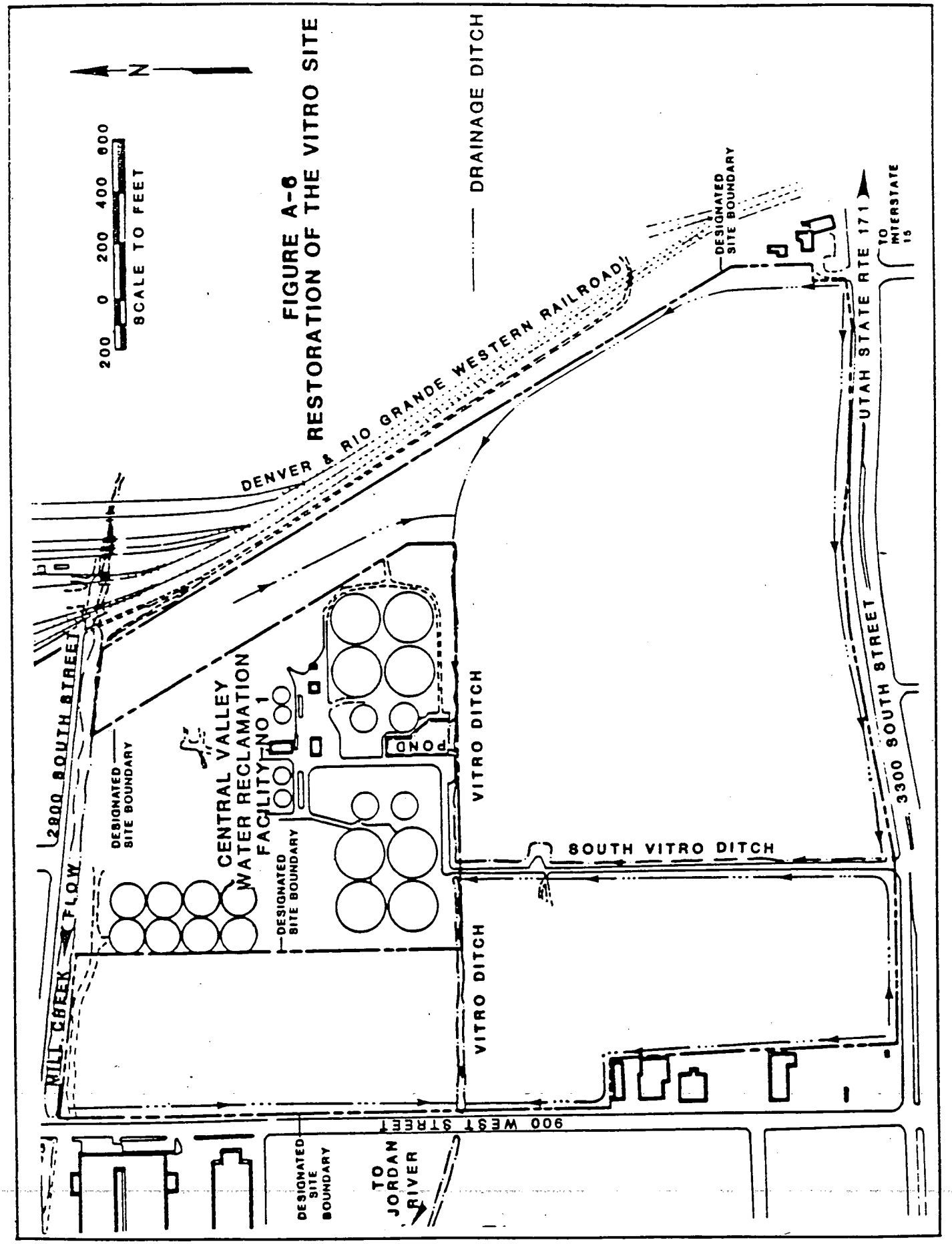

FIGURE A-6
RESTORATION OF THE VITRO SITE

A.6 DESIGN FEATURES - SOUTH CLIVE (ALTERNATIVE 3)

A.6.1 Introduction

Included in this section is a description of the major features of the conceptual design for the proposed action. The details of the conceptual design can be found in the Remedial Action Plan (DOE, 1984).

Tables A-2 and A-3 summarize earthwork volumes described in the following sections. Figure A-5 illustrates the site concept.

A.6.2 Design Considerations

The remedial action was designed to withstand the forces of nature for a long period of time (1000 years), and provide radon control and required ground-water protection consistent with the EPA standards. Several factors that could affect the effectiveness of the embankment were investigated and are discussed below.

A.6.2.1 Cover

The cover would be constructed of two basic layers: a lower compacted earthen layer to act as a radon and water infiltration barrier and an upper rock layer for erosion protection. The cover would also:

- Act as a barrier against inadvertent human intrustion.
- Act as a barrier to discourage intrusion by burrowing animals.
- Act as a barrier to discourage root intrusion.

A typical cross section through the embankment is shown in Figure A-7. Additional details are available in the Remedial Action Plan (DOE, 1984).

Radon control

Control of radon emissions from the embankment would be accomplished by the placement of a compacted soil cover over the tailings and other contaminated material. In addition, the relocation of the tailings would promote natural mixing of slimes and sands which results in a more even distribution of tailings. However, the major factor in the reduction of emissions would be the clean cover material.

Data on the distribution of radium in the tailings, on the properties of the cover material, and on the anticipated depth of excavation in areas to be restored were analyzed in order to develop an estimate of cover thickness. Radon emissions before and after the remedial action were calculated using the RAECO model (see Section A.3.2.1 for an explanation of RAECO). Based upon these data and analyses, the radon and water infiltration barrier would be constructed of approximately 5 feet of soil from the embankment excavation. Radon emissions after remedial action are calculated to be 20 pCi/m^2 sec.

Table A-2. Earthwork volume summary--train relocation to South Clive

Item description	Estimated volume (cubic yards)
Vitro site:	
Rail spur construction	
Excavation of contaminated materials	180,000
Subgrade and subballast (select fill)	94,000
Contaminated materials	
Tailings and contaminated subsoils	2,220,000
Windblown and vicinity properties	150,000
Rubble	80,000
Restoration (select fill)	945,000
South Clive site:	
Access road construction	
Road subgrade (compacted fill)	27,000
Gravel surface	31,000
Rail spur construction	
Subgrade (compacted fill)	98,000
Subballast (select compacted fill)	10,000
Embankment construction	2,450,000
Cover	
Radon barrier	460,000
Erosion barrier, ditches, and perimeter roads (pit run rock)	202,000

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Table A-3. Earthwork volume summary--truck relocation to South Clive

Item description	Estimated volume (cubic yards)
Vitro site:	
Contaminated materials	
Tailings and contaminated subsoils	2,220,000
Windblown and vicinity properties	150,000
Rubble	80,000
Restoration (select fill)	1,040,000
South Clive site:	
Access road construction	
Road subgrade (compacted fill)	27,000
Gravel surface	44,000
Embankment construction	2,450,000
Cover	
Radon barrier (excavated from embankment)	460,000
Erosion barrier, ditches, and perimeter roads (imported pit run rock)	202,000

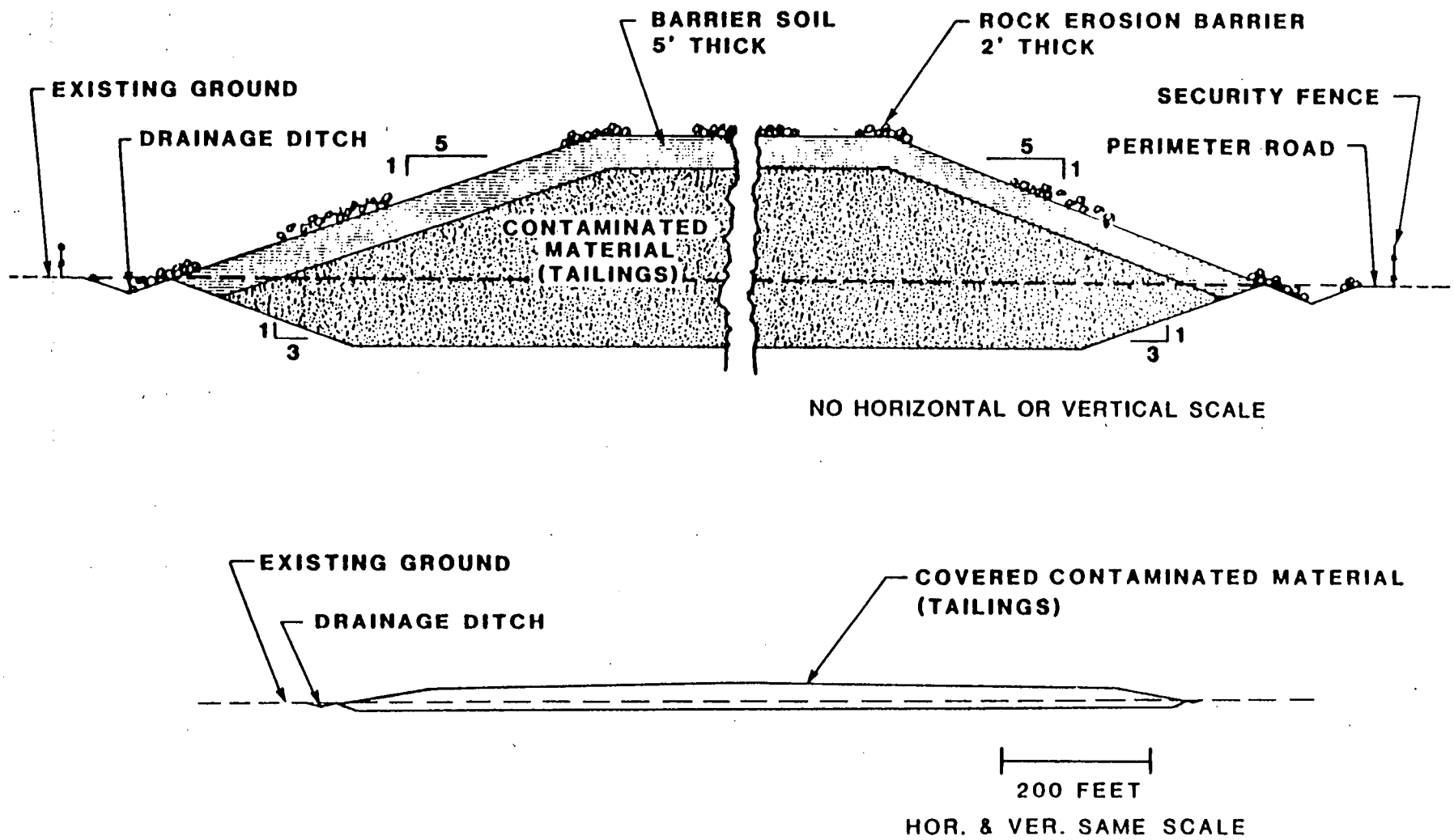

FIGURE A-7
TYPICAL SECTION OF THE EMBANKMENT
SOUTH CLIVE SITE

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Ground-water protection

Stabilizing and covering the tailings and other contaminated materials at a minimum of 15 feet above the water table would reduce the potential for leaching of soluble contaminants and subsequent migration via the ground-water regime. Further, the embankment cover includes a low permeability soil, and coupled with low precipitation (i.e., no leachate or driving force for leachate production), would result in essentially no infiltration into the tailings.

Some seepage from the embankment would be expected as a result of the redistribution of moisture within the tailings. The existing ground-water conditions would limit the impact of this seepage because of the extremely poor quality of the water (Appendix D), and the absence of any uses (current or anticipated) of the ground water near the site. Additionally, the volume of seepage would be small, also limiting the potential for degradation of the ground water.

A.6.2.2 Long-term stability

Water erosion

To protect the embankment from the effects of water erosion, the embankment slopes would be limited to 20 percent. The top of the embankment would be convex with gentle (2 percent or less) slopes to promote drainage.

To ensure that the remedial action would withstand water erosion during the design life, the surfaces of the radon barrier cover would be graded and the corners rounded, and the entire embankment radon barrier would be covered with a rock erosion barrier.

Over its design life, the embankment cover may be subjected to severe rainfall events. The most severe potential rainfall event is a PMP which would have a peak 5-minute intensity of approximately 30 inches/hour on the embankment. To protect against the erosive effects of a PMP, the side slopes of the embankment would be covered with a 2-foot-thick layer of 5-inch mean diameter pit run rock; the top of the embankment, which has much gentler slopes, would be covered with a 2-foot-thick layer of 1.5-inch mean diameter pit run rock.

Wind erosion

Because of the long open reach in the Clive area, wind velocities at the site must be considered. The rock layer used to protect against water erosion would also provide protection against wind erosion.

Flood protection

Flooding at the South Clive site would result from the collection of runoff (sheet flow) due to precipitation on the Cedar Mountains east of the site. There are no bodies of water in the area. The PMF peak flow past the embankment resulting from a 6-hour Probable Maximum Precipitation estimated (PMP) of 9.7 inches over the 46-square-mile drainage area was calculated

Hansen et al., 1977) and USGS topographic maps. The 1-hour PMP was used in calculating the PMP because the 6-hour general PMP for the 46-square-mile drainage area is of lesser intensity (2.45 vs 3.66 inches) (USDOI, 1977). The peak flood depths and velocities were found using flood control channel hydraulic design methods (COE, 1970). The results of the analysis indicate that the PMF would have a peak flow of 83,000 cfs and maximum depth adjacent to the embankment of approximately 5.5 feet. The velocity of the overland flow would be approximately 2 fps and the peak velocity (at the toe of the embankment slope) would be approximately 10 fps.

Rip rap design methods (Simons and Senturk, 1976) were then used to determine the stability of the erosion barrier during passage of the PMF. The pit run rock layer on the embankment would provide protection from the flood waters.

Other stability concerns

No perennial rivers or streams occur near the South Clive site. Therefore, stream encroachment into the stabilized embankment is of no concern.

Seismically induced liquefaction of the subsoils and resultant effects to the embankment are also of little concern. First, the ground water is at least 20 feet below the surface and below several layers of unsaturated silty sands. Second, these sand layers are of medium to high density. These factors, combined with the relatively high static overburden pressure to the saturated soil layers, indicate that significant liquefaction due to an MCE (3,000-15,000 years recurrence interval) is improbable; at most, self-healing "cracks" may result. Additional details are available in Appendix H of this FEIS.

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A.7 CONSTRUCTION SEQUENCE - SOUTH CLIVE (ALTERNATIVE 3)

A.7.1 Vitro site work

A.7.1.1 Mobilization

To provide for a construction staging area, tailings and other contaminated material would be removed and temporarily stockpiled. The staging area would be constructed adjacent to the industrial buildings along 900 West Street (Figure A-8).

A.7.1.2 Clearing

To ensure that disposal of small amounts of organic material does not interfere with the embankment and cover at the disposal site, it is proposed to cut grasses, weeds, and low shrubs close to the ground, shred or chip these and other minimum amounts of contaminated organics, and mix them evenly with the tailings. There would be no open burning and care would be taken to prevent material from becoming airborne.

A.7.1.3 Erosion and sediment controls

All earth-disturbing activities would be conducted in such a way as to prevent accelerated erosion and sedimentation during construction. Areas would be reclaimed as soon as feasible after tailings are removed.

A.7.1.4 Storm drainage and waste-water sedimentation basins

Basins and channels would be sized to retain runoff from the 10-year 24-hour storm event plus other waste waters. Retention would be for at least 24 hours. Embankments, dikes, and inlet/outlet structures would be designed and located to minimize short-circuiting within the basins and to avoid retarding circulation. Basins would be designed with sufficient freeboard and spillway systems to allow discharge of peak flow rates from larger storm events.

Sedimentation basins would be the primary means to collect contaminated waste water prior to treatment. Waste waters would result from:

- Decontamination activities including equipment washing and truck/train washdown.
- Dewatering of contaminated material.
- Runoff from contaminated materials.
- Laundry waste from washing protective clothing.
- Shower and wash basin waste water.

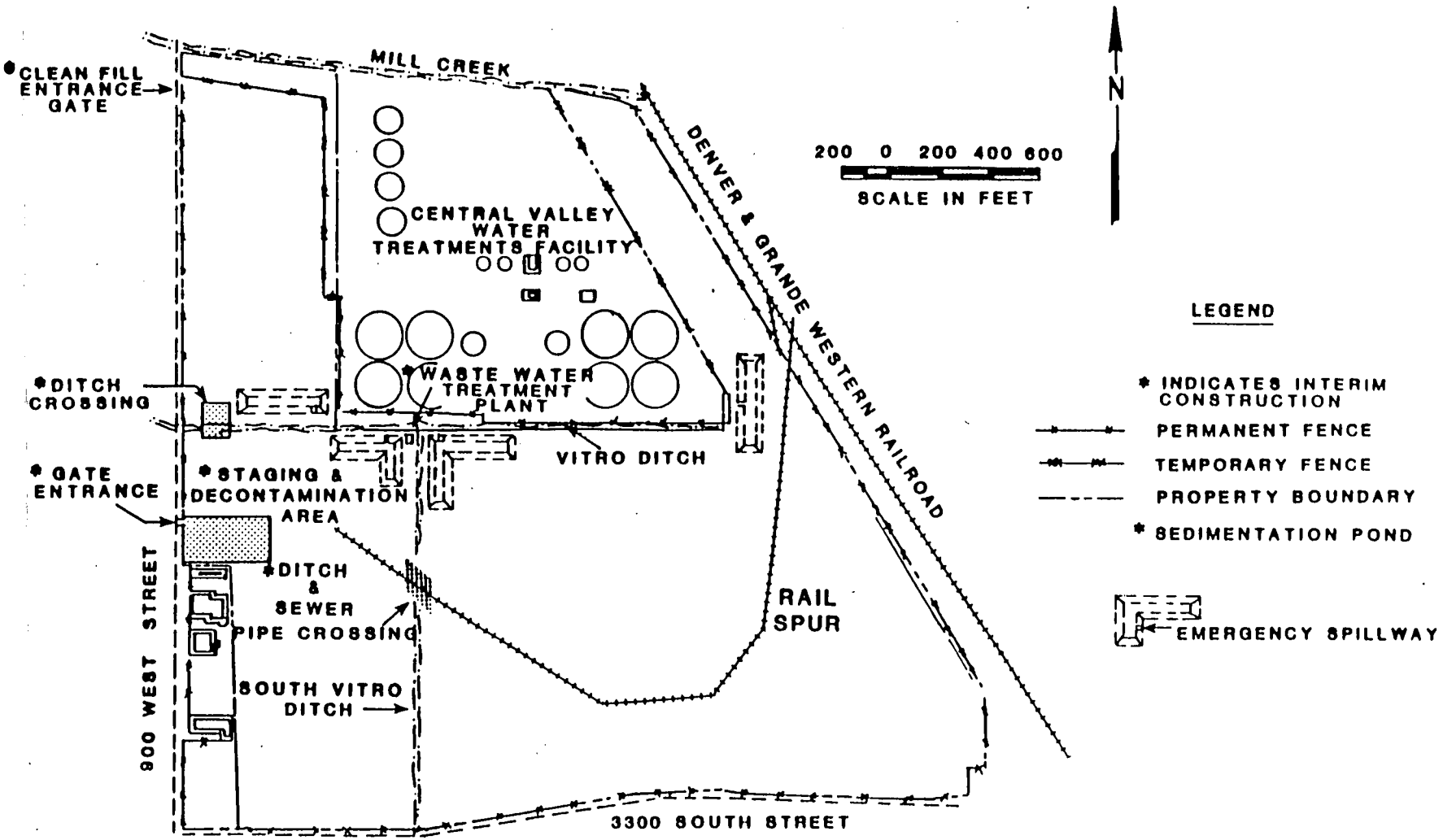

FIGURE A-8
PLOT PLAN VITRO SITE

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A.7.1.5 Dewatering

Ground water at the Vitro site is near the surface and at times rises into the tailings. To facilitate handling, the tailings would require dewatering.

Dewatering would be accomplished in layers by plowing or trenching and drying (by evaporation), excavating the dewatered material until a new level is reached which is too wet for handling, and repeating the process. Water would be pumped or gravity flow to the sedimentation basins.

A.7.1.6 Waste-water treatment

Waste water from the sources mentioned above would flow to the sedimentation basins which would provide primary settling and flow and contaminant equalization. Some of this flow would be utilized for road and pile wetdown for dust and radon control. The remainder would be treated to acceptable limits and discharged to either Mill Creek or Vitro Ditch. The flows and treatment scheme would be the same as discussed for Alternative 2 (Section A.4.1.5). The contaminants from the treatment plant would be transported to the South Clive site for final disposal.

A.7.1.7 Fugitive dust control

Dust generated by excavation, earth movement, vehicle use, stockpiling, seeding, and similar activities would be controlled and minimized by the use of a water-based surfactant sprayed under moderately high pressure (from trucks and hoses). The source for dust suppression water would be potable water. In addition, hoses would be available for areas of excavation.

A.7.1.8 Demolition

Existing foundations on the Vitro site would be demolished and combined with the rubble from vicinity properties for disposal in the embankment at South Clive. Rubble would be placed in the lower levels of the disposal embankment. Pieces would not be nested. Tailings would be spread and tamped between and against the rubble so that voids would not occur presently or in the future.

A.7.1.9 Railroad construction (train transport mode)

Transport of the tailings and other contaminated material to the South Clive site by railroad would require the construction of approximately 3800 feet of railroad spur on the Vitro site. The spur would originate at an existing spur at the Roper rail yard, follow the existing railbed to the mill site, turn about 120°, and angle through the site (Figure A-8).

To prepare for the railroad bed, tailings and any contaminated subbase would be removed from the railroad route and stockpiled. Since it is proposed to load the cars directly with a front-end loader, the railroad route through the tailings would be excavated to a width sufficient for the railroad plus a working area for loading from both sides of the train.

A.7.1.10 Excavation and loading

Train

Material within easy working distance of the railroad would be excavated and loaded with front-end loaders. Material beyond a reasonable working distance would be dewatered as necessary, excavated with scrapers or other standard earth moving equipment, transported to the railroad spur, and spread along both sides of the spur for the full length of the train and at an optimum working distance from the train. From there it would be loaded with front-end loader(s).

Truck

The material would be dewatered as necessary, excavated, and loaded with front-end loaders and backhoes into trucks.

A.7.1.11 Transportation

Train

Tailings and other contaminated material would be hauled from the Vitro site to the South Clive site by train. The concept is based on transporting 5400 tons per day (TPD).

Tailings would be transported with one train per day. Two trains of 54, 100-ton capacity cars would be required. One would be loaded at the Vitro site daily while the other is being unloaded at the South Clive site. The loaded train would be covered, decontaminated, and hauled to the South Clive site in the evening. The locomotive engines would leave the loaded train at the South Clive site and return to the Vitro site with the unloaded train by morning.

Fifty of the railroad cars (per unit train) would be rotary-coupled gondola cars which would be water and sand tight. Large pieces of rubble or other contaminated material which cannot be handled by the offloading system at the South Clive site would be transported in four side-dump railcars fitted with door seals to prevent release of contaminated materials.

To prevent windblown contamination during transport, railcars would be covered with a tarpaulin or canopy, or with a sprayed latex seal.

Truck

Tailings and other contaminated materials would be hauled to the South Clive site by truck. The concept is based on hauling 5400 tons per day. Seventy-seven, 35-ton capacity trucks would be required. The trucks would make two round trips per day. They would be loaded, covered, and decontaminated at the Vitro site in the morning, driven to the South Clive site, unloaded and decontaminated, and returned to the Vitro site in the afternoon to obtain a second load for disposal at South Clive. Each round trip would take 4.5 to 5 hours.

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The trucks would be 35-ton capacity trucks and trailers fitted with door seals to prevent leakage. To prevent windblown contamination during transport, the trucks would be covered with a sprayed latex seal, tarpaulin, or canopy.

A.7.1.12 Restoration

After removal of the contaminated material from the Vitro site, all areas of excavation would be restored to the approximate original contours (in concurrence with CVWRF) and released for unrestricted use (Figure A-6). The site would be restored by importing, spreading, and compacting clean fill material (see Section A.4.11 for source of fill).

A.7.1.13 Existing utilities

Since the Vitro site would be decontaminated and released for unrestricted use, the existing 42-inch sewer line and all other surface and underground utilities would be protected in place during construction or temporarily removed and replaced in kind.

A.7.1.14 Temporary facilities

During construction operations, temporary facilities would be required for construction workers and supervisors, engineering, administrative, security and monitoring personnel, and equipment maintenance and repair. The facilities would consist of office space, showers and change facilities for all personnel working on the site, as well as facilities for laundering clothing.

Security

The entire site would be fenced during construction. Access would be controlled and no parking would be permitted on the site. Construction vehicles would remain on the site. Trucks bringing construction materials from off the site would be monitored and decontaminated as required prior to exit. A security staff would be on the site 24 hours per day.

Water supply

An 8-inch water line runs along 900 West Street. This would supply showers, laundry, vehicle wash when needed, and drinking water.

Waste water

Portable construction toilets would be used. Waste water from showers, hand basins, and laundry would gravity flow to a holding tank. Wash water from the vehicle wash area would be held in a pit. These waters would be disposed of on the site by a mobile irrigation system, or treated.

A.7.2 South Clive site work

A.7.2.1 Mobilization

A construction staging area would be constructed at the South Clive site and temporary facilities installed (Figure A-5).

A.7.2.2 Clearing

Low brush would be cleared only from areas to receive embankment materials. If burning is not allowed, brush would be mulched and added to the topsoil.

A.7.2.3 Erosion and sediment controls

All earth disturbing activities would be conducted in such a way as to prevent accelerated erosion and sedimentation during construction.

A.7.2.4 Storm drainage and waste-water retention basins

Basins and channels would be sized to retain runoff from the 10-year 24-hour storm event of the area tributary to the basins plus other waste waters. Retention would be for at least 24 hours.

Retention basins would be the primary means to collect contaminated waste water for evaporation. Waste waters would result from:

- Decontamination activities including equipment washing and truck/train washdown.
- Dewatering of contaminated material.
- Runoff from contaminated materials.
- Laundry waste from washing protective clothing.
- Shower and wash basin waste water.

A.7.2.5 Fugitive dust control

Dust generated by excavation, earth movement, vehicle use, stockpiling, seeding, and similar activities would be controlled and minimized by the use of a water-based surfactant sprayed under moderately high pressure (from trucks and hoses). The source for dust suppression water would be ground water.

A.7.2.6 Roads

Road access to the site would be via the Aragonite exit off I-80, along the north frontage road west alongside I-80 for about 7 miles, to the overpass across I-80, and thence by about 3 miles of new access road (Figure A-5).

The existing frontage road between the Aragonite exit and the Clive overpass is a graded, graveled, county road and would require upgrading to carry the increased weight and frequency of traffic.

From the Clive overpass, approximately 3 miles of new access road would be constructed to the disposal site.

A.7.2.7 Rail car unloading (train transport mode)

Approximately 13,800 feet of railroad spur would be constructed to provide rail access to the offloading facility (Figure A-5).

The offloading facility would consist of a car positioner, rotary dump, receiving hopper, and stacking conveyor system. The car positioner would advance a car over the rotary dump mechanism, rotate the car about the axis of its end couplers, and dump the contents into a receiving hopper.

The conveyor system would remove tailings from the hopper beneath the rotary dump for deposition in stockpiles. The system would consist of feeders, an incline conveyor, and a radial stacker. The radial stacker would discharge into two 5000-ton stockpiles, one being deposited while the other is being transported to the embankment. Rubble and other materials that arrive at the South Clive site in side-dump cars would be dumped alongside the track. After unloading, the train would be checked for contamination, decontaminated as necessary, and returned to the Vitro site for loading.

A.7.2.8 Embankment construction

The tailings and other contaminated materials would be placed in an embankment constructed largely above grade. Materials for the radon barrier would be excavated, the contaminated material placed and compacted, and the radon barrier cover and erosion cover placed over the tailings and other contaminated materials.

Tailings would be placed about 15 feet above the ground-water table and the cover would be contoured and compacted to minimize water infiltration. Tailings and other contaminated material would be placed in and over the excavated area. For the transport by train option, tailings would be removed from the stockpiles created by the radial stacker with dozers and scrapers, transported to the excavation, spread, and compacted. For the transport by truck option, trucks would drive into the excavation and spread their load for compaction.

A.7.2.9 Cover construction

The cover would be constructed of two basic layers: A lower compacted earthen layer, and an upper rock layer. The earthen layer would be excavated with scrapers from the portion of the embankment area under construction and compacted over already completed portions of the embankment in a continuous cut and cover operation. The rock layer, for erosion protection, would be brought in by truck, spread, and compacted.

A.7.2.10 Restoration

The site would be returned to its approximate natural condition. Excess excavated material would be wasted around the disposal area. A site access road and drainage ditch would surround the embankment. The railroad and offloading facility would be dismantled, decontaminated, and salvaged.

A.7.2.11 Fencing

The embankment area would be secured by a 6-foot-high chain link fence with barbed wire topworks. A locked gate would be installed for access to the site.

A.7.2.12 Temporary facilities

During construction operations, temporary facilities would be required for construction workers and supervisors, engineering, administrative, security and monitoring personnel, and maintenance and repair services. The facilities would consist of office space and showers and change facilities for all personnel working on the site, as well as facilities for laundering clothing.

Access would be controlled and construction vehicles would remain on the site. Trucks bringing construction materials from off the site would be monitored and decontaminated as required prior to exit. All vehicles leaving the site would be checked for any contaminated material which is subject to release on public thoroughfares. A paved washdown area would be provided to remove all such contamination. Wash water would be collected and treated. A security staff would be on the site 24 hours per day.

There is no developed water supply at the disposal site. Brackish water, adequate for equipment decontamination, compaction, and dust control on the site would be developed from an on-site well. A holding pond would be constructed for storage of developed water. Potable water would be hauled from the nearest source.

Portable construction toilets would be used. Waste water from showers, hand basins, and laundry would gravity flow to a holding tank. Wash water from the vehicle wash area would be held in a pit. These waters would be used for dust suppression or disposed of on the site by a mobile irrigation system.

No electricity, gas, or other utilities are available at the disposal site. Electricity would be supplied by portable generators. Telephone service would be by radio telephone.

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A.8 EQUIPMENT, PERSONNEL, ENERGY CONSUMPTION, AND FUEL ESTIMATES, ALTERNATIVES 2 AND 3

A.8.1 Vitro site--introduction

As discussed in Sections A.2 through A.4, stabilization on the Vitro site (Alternative 2) consists of relocating all of the tailings and contaminated material into an embankment on the southcentral and southeast areas of the existing site. The embankment would occupy approximately 53 acres. The remainder of the site would be decontaminated, restored to approximate grade, and released for unrestricted use.

The construction activities are divided into phases. Each of the phases are described in the following subsections.

A.8.1.1 Site preparation

Tailings, rubble, and other contaminated material presently exist on portions of the area which would be utilized for the embankment. To provide a stable foundation for the tailings embankment, it would be necessary to relocate and recompact tailings presently in the embankment area, and to demolish and relocate foundations and other rubble in this area. The proposed construction staging area is presently covered with tailings and these would be removed and relocated as part of the site preparation.

The site preparation activity would require about 20 working days to complete and would utilize the following equipment.

Type of equipment	Number
D-8 dozer	3
Mobile crane	1
Truck	1
Grader	1
Front end loader	1

A.8.1.2 Tailings relocation

To install a liner system, tailings and contaminated material in the embankment area would be removed, a liner system installed, and the contaminated material replaced and recompacted on the liner system. Although the tailings and contaminated material relocation and liner placement would be two separate operations, they would progress concurrently and thus some of the equipment would be utilized for both activities.

This activity includes relocation of all of the tailings and contaminated material presently located in the embankment area. These materials are subdivided into three general categories depending upon degree of saturation.

Dry material	80,000 cy
Damp material	505,000 cy
Wet material	265,000 cy
Total	850,000 cy

Dry material is defined as loose tailings that can be relocated with heavy earth-moving equipment without special preparation. Damp material is defined as loose material that would require furrowing and dewatering prior to relocation with heavy earth-moving equipment. Wet material would require dewatering prior to excavation with a dragline or backhoe for relocation.

This activity would require approximately 50 working days (10 weeks) and the following equipment.

Type of equipment	Number
D-8 dozer	6
Scraper (20 cy capacity)	6
Backhoe (4 cy capacity)	2
Water truck	2
Compactor	2

A.8.1.3 Liner system placement

This activity includes placement of a base layer, subbase layer, and the liner. Material would be hauled from an off-site borrow location, placed, and compacted. This activity would require the placement of 710,000 cy of subbase and liner material. Liner system placement would require 220 working days (44 weeks) and the following equipment.

Type of equipment	Number
D-8 dozer	4
Backhoe (4 cy capacity)	1
Trucks (18.5 cy capacity)	35
Compactor	2
Grader	2
Water truck	2

A.8.1.4 Tailings consolidation

This activity includes relocation of tailings from the remainder of the site to the embankment area. These tailings are subdivided into three categories.

Dry material	90,000 cy
Damp material	875,000 cy
Wet material	405,000 cy
Total	1,370,000 cy

This activity would require 200 working days (40 weeks) and require the following equipment.

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Type of equipment	Number
D-8 dozer	6
Scraper (20 cy capacity)	7
Truck (12 cy capacity)	6
Backhoe (4 cy capacity)	2
Grader	2
Compactor	2
Water truck	2

A.8.1.5 Cover installation

This activity includes the placement of the cover over the finished embankment. The cover material is divided into two categories: a radon barrier and an erosion barrier. All cover materials would be acquired from an off-site borrow location, hauled to the site, spread, and compacted.

Radon barrier cover	290,000 cy
Erosion barrier cover	155,000 cy

This activity would require 140 working days (28 weeks) to complete and the following equipment.

Type of equipment	Number
Trucks (18.5 cy capacity)	35
D-8 dozer	4
Grader	2
Compactor	2
Water truck	2

A.8.1.6 Site restoration

This activity includes the placement of restoration material. During the relocation, tailings and contaminated material would be excavated to depths below the elevation of the surrounding terrain. This excavated material would be replaced with clean fill to restore the area and to provide drainage. The restoration material would be acquired from an off-site borrow location, hauled to the site, spread, and compacted. The area would be revegetated. The quantity of fill required for restoration and revegetation is estimated to be 640,000 cy of random fill and 70,000 cy of select fill.

This activity would require 220 working days (44 weeks) to complete and the following equipment.

Type of equipment	Number
Trucks (18.5 cy capacity)	35
Water trucks	2
D-8 dozer	4
Compactors	2
Grader	1

A.8.1.7 Summary of personnel, energy consumption, and fuel estimates

Tables A-4 through A-6 contain a summary of personnel requirements, and energy and water consumption.

A.8.2 South Clive site--introduction

As discussed in Sections A.5 through A.7, the proposed action (Alternative 3) consists of relocating the tailings and other contaminated material from the Vitro site to the South Clive site. The embankment would occupy about 55 acres. The Vitro site would be decontaminated, restored to approximate grade, and released for unrestricted use.

Construction activities are divided into phases. Each phase is described below by mode of transportation.

A.8.2.1 Site preparation--train option

Vitro site

A construction staging area, site drainage system, waste-water retention basins, and a rail spur would be constructed during the site preparation phase. The staging and rail spur area would be cleared of 180,000 cy of contaminated materials and filled with 95,000 cy of compacted clean soils from an off-site borrow location. A rail spur 3,800 feet long, and a turn out and switch would be installed.

The site preparation activity on the Vitro site would require about 35 working days to complete and would utilize the following equipment.

Type of equipment	Number
D-8 dozer	4
Backhoe (4 cy capacity)	1
Trucks (18.5 cy capacity)	32
Grader	1
Compactor	1
Water truck	1

South Clive Site

A construction staging area, site drainage system, waste-water sedimentation basin, rail spur, rail unloading system, and access road would be constructed during the site preparation phase. The 7-mile frontage road along I-80 would be upgraded by adding 41,000 cy of gravel. A 2.3-mile access road from I-80 to the site and a 2.6-mile rail spur with four switches would be built of 125,000 cy of compacted adjacent soils, geotextile fabric, and

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Table A-4. Personnel requirements and exposure type - stabilization in place.

	Number of days	Hours per day	No exposure[1] Number people	No exposure[1] Hrs (000s) exposure	On-site exposure[2] Number people	On-site exposure[2] Hrs (000s) exposure	Total Number people	Total Hrs (000s) exposure
Site preparation								
Equipment operators	20	8			6	1		
Truck drivers	20	8			1			
Maintenance personnel	20	8			1			
Miscellaneous personnel	20	8			4	1		
Supervisor/foremen	20	8			2			
TOTAL PERSONNEL			0		14		14	
TOTAL EXPOSURE HOURS (000s)						2		2
Tailings relocation								
Equipment operators	50	8			16	6		
Truck drivers	50	8			2	1		
Maintenance personnel	50	8			2	1		
Miscellaneous personnel	50	8						
Supervisor/foremen	50	8			3	1		
TOTAL PERSONNEL			0		23		23	
TOTAL EXPOSURE HOURS (000s)						9		9
Liner system placement								
Equipment operators	220	8			9	16		
Truck drivers	220	8	35	62				
Maintenance personnel	220	8			4	7		
Miscellaneous personnel	220	8						
Supervisor/foremen	220	8			3	5		
TOTAL PERSONNEL			35		16		51	
TOTAL EXPOSURE HOURS (000s)				62		28		90
Tailings consolidation								
Equipment operators	200	8			19	30		
Truck drivers	200	8			8	13		
Maintenance personnel	200	8			3	5		
Miscellaneous personnel	200	8				0		
Supervisor/foremen	200	3			3	5		
TOTAL PERSONNEL			0		33		33	
TOTAL EXPOSURE HOURS (000s)						53		53
Cover installation								
Equipment operators	140	8			8	9		
Truck drivers	140	8	35	39				
Maintenance personnel	140	8			4	4		
Miscellaneous personnel	140	8						
Supervisor/foremen	140	8			3	3		
TOTAL PERSONNEL			35		15		50	
TOTAL EXPOSURE HOURS (000s)				39		17		56
Site restoration								
Equipment operators	220	8			7	12		
Truck drivers	220	8	35	62				
Maintenance personnel	220	8			4	7		
Miscellaneous personnel	220	8						
Supervisor/foremen	220	8			3	5		
TOTAL PERSONNEL			35		14		49	
TOTAL EXPOSURE HOURS (000s)				62		25		86
General Supervision								
Equipment operators	600	8			1	5		
Field service personnel	600	8			7	34		
Security personnel	600	8			4	19		
Office personnel	600	8			2	10		
Monitoring personnel	600	8			6	29		
TOTAL PERSONNEL			0		20		20	
TOTAL EXPOSURE HOURS (000s)						58		96
TOTAL EXPOSURE HOURS (000s)			162			231		393

[1]Limited exposure to remedial action workers transporting uncontaminated fill.
[2]Exposure to remedial action workers on the site.

Table A-5. Energy consumption - stabilization in place

Construction phase	Fuel (gal)	Electricity Kwh.
Site preparation	20,000	-0-
Tailings relocation	150,000	-0-
Liner system placement	450,000	-0-
Tailings consolidation	500,000	-0-
Cover installation	500,000	-0-
Restoration	800,000	-0-
General supervision	100,000	400,000
Total	2,520,000	400,000

Table A-6. Water consumption - stabilization in place

Construction Phase	gallons
Site work (general)	1,000,000
Tailings relocation	400,000
Tailings consolidation	1,200,000
Liner system placement	3,000,000
Cover installation	2,700,000
Restoration	1,600,000
Miscellaneous	1,100,000
Total	11,000,000

20,000 cy of gravel. The components of the rotary dump, hopper, and stacking conveyor unloading facility would be prefabricated off the site and assembled on the site.

The site preparation activity would require about 35 working days to complete and would utilize the following equipment.

Type of equipment	Number
D-8 dozer w/scarifyer	1
Scraper	2
Compactor	1
Trucks (18.5 cy capacity)	8
Grader	1
Water truck	1

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A.8.2.2 Site preparation--truck option

Vitro site

Site preparation would be the same as for the rail option without the rail spur construction. Approximately 10 working days and the following equipment would be required.

Type of equipment	Number
D-8 dozer	1
Backhoe (4 cy capacity)	1
Trucks (18.5 cy capacity)	8
Grader	1
Compactor	1
Water truck	1

South Clive site

Site preparation would be the same as for the rail option, without the rail spur and offloading facility construction. Approximately 25 working days and the following equipment would be required.

Type of equipment	Number
D-8 dozer w/scarifyer	1
Scraper	1
Compactor	1
Trucks (18.5 cy capacity)	12
Grader	1
Water Truck	1

A.8.2.3 Tailings relocation--train option

This activity includes relocation of all of the tailings and contaminated material presently located at the Vitro site, 100,000 cy of contaminated vicinity properties, and 50,000 cy of windblown contaminated soils to the South Clive site. Tailings are subdivided into three general categories depending upon degree of saturation.

Dry material	170,000 cy
Damp material	1,380,000 cy
Wet material	670,000 cy
Total	2,220,000 cy

Dry material is defined as loose tailings that can be relocated with scrapers without special preparation. Damp material is defined as loose material that would require furrowing and dewatering prior to relocation with scrapers. Wet material would require dewatering prior to excavation with a dragline or backhoe for relocation with haul trucks. The windblown contaminated soils are generally dry. These materials would be excavated,

transported, and deposited beside the rail spur. Front end loaders would then place the tailings and fine-grained contaminated materials in the gondola cars. Rubble and vicinity property materials (180,000 cy) would be reduced in size, as necessary, with a mobile crane and wrecker ball, excavated with a dozer, and loaded into the side-dump cars with front end loaders.

This activity would require approximately 635 working days (127 weeks) and the following equipment.

Type of equipment	Number
Mobile crane (20 days only)	1
D-8 dozer	2
Scraper (20 cy capacity)	3
Backhoe (4 cy capacity)	1
On-site haul trucks (12 cy cap)	3
Water truck	1
Front end loaders	2
Rail cars (100 ton capacity)	108
Grader	1

A.8.2.4 Tailings relocation--truck option

The activity would be the same as the train option except that the contaminated materials would be loaded directly into 35-ton capacity trucks with front end loaders. Each truck would make two trips per day (9-10 hours per day). This activity would require approximately 635 working days (127 weeks) and the following equipment.

Type of equipment	Number
Mobile crane (20 days only)	1
Front end loader	2
Backhoe (4 cy capacity)	1
D-8 dozer	1
Trucks (35-ton capacity)	77
Grader	1
Water truck	1

A.8.2.5 Embankment and cover construction--train option

The embankment would be constructed in a continuous cut and cover operation. The existing soils would be excavated for use in covering already completed portions of the embankment. The bottom of the excavation would be compacted in preparation for placement of the contaminated materials which would then be compacted in lifts to the design elevation. Approximately 2,270,000 cy of contaminated materials would be transported from the rail stockpile to the embankment with scrapers and 180,000 cy of rubble by trucks. The radon barrier would require 460,000 cy of compacted soil and the erosion barrier would require 202,000 cy of rock from an off-site borrow area.

The embankment and cover construction would be concurrent with the tailings relocation and would require 640 working days (128 weeks) and the following equipment.

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Type of equipment	Numbers
Scraper	6
D-8 dozer	2
Front end loader	1
Compactor	1
Water truck	1
On-site trucks (12 cy capacity)	1
Off-site trucks (18.5 cy capacity)	3
Grader	1

A.8.2.6 Embankment and cover construction--truck option

The activity would be the same as in the train option except all of the contaminated materials would be deposited directly on the embankment.

The embankment and cover construction would require 640 working days (128 weeks) and the following equipment.

Type of equipment	Number
Scraper	1
D-8 dozer	2
Compactor	1
Water truck	1
Off-site trucks (18.5 cy capacity)	3
Grader	1

A.8.2.7 Site restoration--train option

Vitro site

This activity includes the placement of restoration material (select fill). During the relocation, tailings and contaminated material would be excavated to depths below the elevation of the surrounding terrain. This excavated material would be replaced with clean fill to restore the area and to provide drainage. The restoration material would be acquired from an off-site borrow location, hauled to the site, spread, and compacted. The area would be revegetated. The quantity of fill required for restoration and revegetation is estimated to be 1,040,000 cy of select fill. Approximately 95,000 cy of clean fill would have been brought in for the rail spur and staging area, thus 945,000 cy would be brought in the restoration phase.

This activity would require 625 working days (125 weeks) to complete and the following equipment.

Type of equipment	Number
Trucks (18.5 cy capacity)	17
Water truck	1
D-8 dozer	1
Compactors	1
Grader	1

South Clive Site

After all of the tailings and contaminated materials have been relocated from the Vitro site to the South Clive site the rail spur track and offloading facility would be decontaminated and salvaged. The rail spur subbase would be recontoured to approximately the original grade. The embankment construction equipment would be used a short time in this task. The access road would remain.

A.8.2.8 Site restoration--truck option

Vitro Site

The activity would be the same as in the train option except that restoration fill required would be greater than the amount for the rail spur.

The site restoration would require 615 working days (123 weeks) and the following equipment.

Type of equipment	Number
Trucks (18.5 cy capacity)	19
Water truck	1
D-8 dozer	1
Compactor	1
Grader	1

South Clive Site

No restoration activities would be required at the South Clive site.

A.8.2.9 Summary of personnel, energy consumption, and fuel estimates

Tables A-7 through A-11 contain a summary of personnel requirements, and energy and water consumption for Alternative 3.

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Table A-7. Personnel requirements and exposure - train option - relocation to South Clive.

	Number of Days	Hours Per Day	No Exposure[1] Number People	No Exposure[1] Hrs (000s) Exposure	On Site Exposure[2] Number People	On Site Exposure[2] Hrs (000s) Exposure	Exposure During Haul[3] Number People	Exposure During Haul[3] Hrs (000s) Exposure	Total Number People	Total Hrs (000s) Exposure
Site preparation - Vitro										
Equipment operators	35	9			11	3				
Truck drivers	35	8	32	9						
Maintenance personnel	35	8			2	1				
Miscellaneous personnel	20	8			22	4				
Supervisor/foremen	35	8			8	2				
TOTAL PERSONNEL			32		43				75	
TOTAL EXPOSURE HOURS (000s)				9		9				18
Site preparation - Clive										
Equipment operators	35	8	9	3						
Truck drivers	35	8	8	2						
Maintenance personnel	35	8	2	1						
Miscellaneous personnel	20	8	28	4						
Supervisor/foremen	35	8	8	2						
TOTAL PERSONNEL			55						55	
TOTAL EXPOSURE HOURS (000s)				12						12
Tailings relocation - Vitro										
Equipment Operators	635	8			9	46	5			
Equipment operators	20	8			1			25		
Truck drivers	635	8			3	15				
Maintenance personnel	635	8			2	10				
Miscellaneous personnel	635	8			11	56				
Supervisor/foremen	635	8			4	20				
TOTAL PERSONNEL					30		5		35	
TOTAL EXPOSURE HOURS (000s)						147		25		173
Embankment construction - Clive										
Equipment operators	640	8			13	67				
Truck drivers	640	8	3	15	1	5				
Maintenance personnel	640	8			2	10				
Miscellaneous personnel	640	8			8	41				
Supervisor/foremen	640	8			4	20				
TOTAL PERSONNEL			3		28				31	
TOTAL EXPOSURE HOURS (000s)				15		143				159
Site restoration - Vitro										
Equipment operators	625	8			4	20				
Truck drivers	625	8	17	85						
Maintenance personnel	625	8			1	5				
Miscellaneous personnel	625	8								
Supervisor/foremen	625	8			2	10				
TOTAL PERSONNEL			17		7				24	
TOTAL EXPOSURE HOURS (000s)				85		35				120
TOTAL EXPOSURE HOURS (000s)				121		335		25		482

[1]Limited exposure to remedial action workers transporting uncontaminated fill.
[2]Exposure to remedial action workers on the site.
[3]Exposure to remedial action workers transporting tailings.

Talbe A-8. Personnel requirements and exposure - truck option - relocation to South Clive.

	Number of Days	Hours Per Day	No Exposure[1] Number People	No Exposure[1] Hrs (000s) Exposure	On Site Exposure[2] Number People	On Site Exposure[2] Hrs (000s) Exposure	Exposure During Haul[3] Number People	Exposure During Haul[3] Hrs (000s) Exposure	Total Number People	Total Hrs (000s) Exposure
Site preparation - Vitro										
Equipment operators	10	8			5					
Truck drivers	10	8	8	1						
Maintenance personnel	10	8			1					
Miscellaneous personnel	10	8			9	2				
Supervisor/foremen	10	8			4					
TOTAL PERSONNEL			8		19				27	
TOTAL EXPOSURE HOURS (000s)				1		2				2
Site preparation - Clive										
Equipment operators	25	8	5	1						
Truck drivers	25	8	12	2						
Maintenance personnel	25	8	1	1						
Miscellaneous personnel	25	8	6	1						
Supervisor/foremen	25	8	4	1						
TOTAL PERSONNEL			28						28	
TOTAL EXPOSURE HOURS (000s)				6						6
Tailings relocation - Vitro										
Equipment operators	635	8			6	30				
Equipment operators	20	8			1					
Truck drivers	635	8					77	489		
Maintenance personnel	635	8			2	10				
Miscellaneous personnel	635	8			15	76				
Supervisor/foremen	635	8			4	20				
TOTAL PERSONNEL					28		77		105	
TOTAL EXPOSURE HOURS (000s)						137		489		626
Embankment construction - Clive										
Equipment operators	640	8			5	26				
Truck drivers	640	8	3	15		0				
Maintenance personnel	640	8			1	5				
Miscellaneous personnel	640	8			9	46				
Supervisor/foremen	640	8			4	20				
TOTAL PERSONNEL			3		19				22	
TOTAL EXPOSURE HOURS (000s)				15		97				113
Site restoration - Vitro										
Equipment operators	615	8			4	20				
Truck drivers	615	8	19	93						
Maintenance personnel	615	8			1	5				
Miscellaneous personnel	615	8								
Supervisor/foremen	615	8			2	10				
TOTAL PERSONNEL			19		7				26	
TOTAL EXPOSURE HOURS (000s)				93		35				128
TOTAL EXPOSURE HOURS (000s)				115		271		489		875

[1] Limited exposure to remedial action workers transporting uncontaminated fill.
[2] Exposure to remedial action workers on the site.
[3] Exposure to remedial action workers transporting tailings.

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Table A-9. Energy consumption--train option

Construction phase	Fuel (gal)	Electricity (Kwh)
Site preparation	180,000	--
Tailings relocation	3,420,000	--
Embankment construction	2,000,000	--
Restoration	1,070,000	--
General supervision	300,000	800,000
Total	6,970,000	800,000

Table A-10. Energy consumption--truck option

Construction phase	Fuel (gal)	Electricity (Kwh)
Site preparation	51,000	
Tailings relocation	4,940,000	
Embankment construction	690,000	
Restoration	1,140,000	
General supervision	300,000	800,000
Total	7,121,000	800,000

Table A-11. Summary of water use--gallons

Activity	Train		Truck	
	Vitro	Clive	Vitro	Clive
Site prep	2,600,000	1,400,000	--	300,000
Relocation	400,000	400,000	1,500,000	1,500,000
Embankment		4,700,000		4,700,000
Restoration	6,100,000		6,700,000	
Dust control	2,700,000	2,700,000	2,700,000	2,700,000
Total	11,800,000	9,200,000	10,900,000	9,200,000
Total Option	21,000,000		20,100,000	

A.9 CAPITAL COST ESTIMATES

A.9.1 Vitro site--Alternative 2

A cost estimate has been prepared, based upon the conceptual design described in this Appendix. The conceptual design cost estimate is $31.24 million and is summarized in Table A-12. This represents the preliminary cost estimate for cost-sharing purposes. A detailed breakdown of the remedial action construction costs is presented in Table A-13. These costs do not include the vicinity property work.

Table A-12. Site cost estimate summary (1983 - $000)
Alternative 2

Item		Costs
Site acquisition		
Mineral value	0	
Land value	5,000	
TOTAL SITE ACQUISITION		5,000
Remedial Action (RA)		
Processing site		
Site preparation	1,550	
Liner system	4,230	
Site grading	8,370	
Cover	1,370	
Erosion protection	930	
Decontamination facilities	60	
Restoration	3,960	
Fencing	80	
Supervisory & field services	3,600	
TOTAL REMEDIAL ACTION		24,150
Engineering/construction management		
Engineering	630	
Construction management	1,110	
TOTAL ENGINEERING/CONSTRUCTION MANAGEMENT		1,740
MAINTENANCE AND SURVEILLANCE		350
TOTAL COST ESTIMATE		$31,240*

*Based upon the State of Utah engineering analyses and cost estimates for the preload system, the cost for Alternative 2 would increase to $42.0 million.

Table A-13. Cost estimate--detailed
Alternative 2

Item		Cost ($000)
SITE PREPARATION		
1. Mobilization (lump sum)		60
2. Staging area (lump sum)		20
• Laydown and parking facilities		
3. Roads		80
• Construct and maintain temporary roads		
• Concrete protection pads over utilities		
4. Clearing and grubbing (lump sum)		10
5. Dewatering		140
• Temporary ditches, gravel liners		
• Sump pumps and lines		
• Retention ponds		
• Permanent ditches		
6. Waste-water treatment facility		860
7. Demolition		380
• Stack, concrete foundations		
• Telephone and power lines (relocate)		
• Water and gas lines (relocate)		
Total site preparation		$1,550
TAILINGS PILE		8,370
1. Relocate, grade, and compact (on-site materials)		
• Dry	(170,000 cy)	
• Dewatered	(1,380,000 cy)	
• Wet	(670,000 cy)	
• Rubble	(80,000 cy)	
• Off-site materials	(150,000 cy)	
2. Liner system		4,230
• Subbase preparation	(220,000 cy)	
• Base preparation	(300,000 cy)	
• Liner preparation	(190,000 cy)	

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Table A-13. (continued)

Item		Cost ($000)
RADON COVER		1,370
1. Compacted borrow • Purchase, haul, spread, and compact	(290,000 cy)	
EROSION COVER		930
1. Pit run rock • Purchase, haul, spread, and compact	(155,000 cy)	
DECONTAMINATION (lump sum)		60
1. Driveway washdown facility		
SITE RESTORATION		3,960
1. Fill material • Purchase, haul, spread, and compact	(640,000 cy)	
Select fill material • Purchase, haul, spread, and compact	(70,000 cy)	
2. Seeding	(75 Ac)	
FENCING (lump sum)	(7,000 LF)	80
SUPERVISORY AND FIELD SERVICES		
1. Field staff • Project manager • Project engineer • Construction engineer • Safety engineer • Schedules/cost engineer • Secretary		1,000
2. Field services • Additional labor • Security • Survey crew • Quality control		1,060

Table A-13. (continued)

Item	Cost ($000)
3. Field health services • Health physics manager • Access control technician • Truck monitor • Laboratory services • Equipment and miscellaneous	1,070
4. Temporary facilities • Field office • Field office expenses • Change and shower unit • Temporary utilities • Temporary sanitary facilities • Insurance • Consumable supplies • Laundry and operation • Mobile equipment • Fencing, barricades, signs, and miscellaneous	470
Supervisory and Field Services Total:	3,600
Total Preliminary Cost Estimate	$24,150

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A.9.2 South Clive site--Alternative 3 (proposed action)

A cost estimate has been prepared, based upon the conceptual design described in this Appendix. The conceptual design cost estimate is $63.78 (train) or 67.68 (truck) million and is summarized in Tables A-14 and A-15. This represents the preliminary cost estimate for cost-sharing purposes. A detailed breakdown of the remedial action construction costs is presented in Tables A-16 (train) and A-17 (truck). These costs do not include the vicinity property work.

Table A-14. Site cost estimate summary (1983 - $000)
Alternative 3 - train transportation

Item		Costs
Site acquisition		
Mineral value	0	
Land value	80	
TOTAL SITE ACQUISITION	80	
Remedial action (RA)		
Work at Salt Lake City		
Site preparation	2,520	
Decontamination	330	
Site relocation	33,400	
Site restoration	5,270	
Supervisory and field services	3,980	
		45,500
Work at Clive		
Site preparation	2,820	
Cover	1,250	
Erosion protection	1,430	
Decontamination	330	
Site relocation	6,460	
Fencing	90	
Supervisory and field services	3,020	
		15,400
TOTAL REMEDIAL ACTION		60,900
Engineering/construction management		
Engineering	1,150	
Construction management	1,560	
TOTAL ENGINEERING/CONSTRUCTION MANAGEMENT		2,710
MAINTENANCE AND SURVEILLANCE		90
TOTAL COST ESTIMATE		$63,780

Table A-15. Site cost estimate summary (1983 - $000)
Alternative 3 - truck transportation

Item		Costs
Site acquistion		
Mineral value	0	
Land value	80	
TOTAL SITE ACQUISITION	80	
Remedial action (RA)		
Work at Salt Lake City		
Site preparation	1,490	
Decontamination	120	
Site relocation	41,300	
Site restoration	5,270	
Supervisory and field services	4,320	
		52,500
Work at Clive		
Site preparation	3,510	
Cover	1,250	
Erosion protection	1,430	
Decontamination	120	
Site relocation	2,680	
Fencing	90	
Supervisory and field services	3,220	
		12,300
TOTAL REMEDIAL ACTION		64,800
Engineering/construction management		
Engineering	1,150	
Construction management	1,560	
TOTAL ENGINEERING/CONSTRUCTION MANAGEMENT		2,710
MAINTENANCE AND SURVEILLANCE		90
TOTAL COST ESTIMATE		$67,680

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Table A-16. Cost estimate--detailed
Alternative 3 - train transportation

Item	Cost ($000)
WORK AT SALT LAKE CITY	
SITE PREPARATION	
1. Mobilization (lump sum)	60
2. Staging area (lump sum) • Laydown and parking facilities	20
3. Utility protection • Concrete protection pads over utilities	20
4. Clearing and grubbing (lump sum)	10
5. Dewatering • Temporary ditches, gravel liners • Sump pumps and lines • Retention ponds • Permanent ditches	140
6. Waste-water treatment facility	860
7. Demolition • Stack, concrete foundations • Telephone and power lines (relocate) • Water and gas lines (relocate)	380
8. Temporary railroad spur • Construct base, install new and used track, maintenance and salvage	1,030
Total site preparation	$2,520
DECONTAMINATION (lump sum)	330
1. Equipment and truck wash-down facility	
2. Train wash-down facility	
SITE RELOCATION	
1. Excavate and load contaminated material (2,450,000 cy)	8,810
2. Transportation: cars, maintenance, hauling, covers	24,590

Table A-16. (continued)

Item		Cost ($000)
SITE RESTORATION		
1. Fill material	(825,000 cy)	5,270
• Purchase, haul, spread, and compact		
Select fill material	(120,000 cy)	
• Purchase, haul, spread, and compact		
2. Seeding	(128 Ac)	
SUPERVISORY AND FIELD SERVICES		
1. Field staff		1,190
• Project manager		
• Project engineer		
• Construction engineer		
• Safety engineer		
• Schedules/cost engineer		
• Secretary		
2. Field services		1,090
• Additional labor		
• Security		
• Survey crew		
• Quality control		
3. Field health services		1,140
• Health physics manager		
• Access control technician		
• Laboratory services		
• Equipment and miscellaneous		
4. Temporary facilities		560
• Field office		
• Field office expenses		
• Change and shower unit		
• Temporary utilities		
• Temporary sanitary facilities		
• Insurance		
• Consumable supplies		
• Laundry and operation		
• Mobile equipment		
• Fencing, barricades, signs and miscellaneous		
Supervisory and field services total:		3,980

Table A-16. (continued)

Item	Cost ($000)
WORK AT CLIVE	
SITE PREPARATION	
1. Mobilization (lump sum)	60
2. Staging area (lump sum) • Laydown and parking facilities	20
3. Roads • Construct and maintain temporary roads • Construct permanent roads	1,070
4. Dewatering • Temporary ditches, gravel liners • Retention ponds • Permanent ditches	190
5. Water well	120
6. Temporary railroad spur	1,360
Total site preparation	$2,820
RADON COVER	1,250
1. Compacted on site soils (570,000 cy) • Excavate, spread, and compact	
EROSION COVER	1,430
1. Pit run rock (190,000 cy) • Excavate, haul, spread	
DECONTAMINATION (lump sum)	330
1. Equipment and truck wash-down facility	
2. Train wash-down facility	
SITE RELOCATION	
1. Haul tailings from radial stacker; spread and compact (2,450,000 cy)	4,290
2. Off-loading facility	2,170

Table A-16. (continued)

Item	Cost ($000)
FENCING (7,500 LF)	90
SUPERVISORY AND FIELD SERVICES	
1. Field staff • Construction engineer	260
2. Field services • Additional labor • Security • Survey crew • Quality control	1,260
3. Field health services • Health physics manager • Access control technician • Laboratory services • Equipment and miscellaneous	810
4. Temporary facilities • Field office • Field office expenses • Change and shower unit • Temporary utilities • Temporary sanitary facilities • Insurance • Consumable supplies • Laundry and operation • Mobile equipment • Fencing, barricades, signs and miscellaneous	690
Supervisory and field services total:	3,020
Total preliminary cost estimate	$60,900

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Table A-17. Cost estimate--detailed
Alternative 3 - truck transportation

Item	Cost ($000)
WORK AT SALT LAKE CITY	
SITE PREPARATION	
1. Mobilization (lump sum)	60
2. Staging area (lump sum) • Laydown and parking facilities	20
3. Utility protection • Concrete protection pads over utilities	20
4. Clearing and grubbing (lump sum)	10
5. Dewatering • Temporary ditches, gravel liners • Sump pumps and lines • Retention ponds • Permanent ditches	140
6. Waste-water treatment facility	860
7. Demolition • Stack, concrete foundations • Telephone and power lines (relocate) • Water and gas lines (relocate)	380
Total site preparation	$1,490
DECONTAMINATION (lump sum)	120
1. Equipment and truck wash-down facility	
SITE RELOCATION	
1. Excavate and load contaminated material (2,450,000 cy)	4,510
2. Transportation: trucks, maintenance, hauling, covers	36,790

Table A-17. (continued)

Item		Cost ($000)
SITE RESTORATION		
1. Fill material • Purchase, haul, spread, and compact	(825,000 cy)	5,270
Select fill material • Purchase, haul, spread, and compact	(120,000 cy)	
2. Seeding	(128 Ac)	
SUPERVISORY AND FIELD SERVICES		
1. Field staff • Project manager • Project engineer • Construction engineer • Safety engineer • Schedules/cost engineer • Secretary		1,190
2. Field services • Additional labor • Security • Survey crew • Quality control		1,090
3. Field health services • Health physics manager • Access control technician • Truck monitor • Laboratory services • Equipment and miscellaneous		1,500
4. Temporary facilities • Field office • Field office expenses • Change and shower unit • Temporary utilities • Temporary sanitary facilities • Insurance • Consumable supplies • Laundry and operation • Mobile equipment • Fencing, barricades, signs and miscellaneous		540
Supervisory and field services total:		4,320

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Table A-17. (continued)

Item		Cost ($000)
WORK AT CLIVE		
SITE PREPARATION		
1. Mobilization (lump sum)		60
2. Staging area (lump sum) • Laydown and parking facilities		20
3. Roads • Construct and maintain temporary roads • Construct permanent roads		3,120
4. Water well		120
5. Dewatering • Temporary ditches, gravel liners • Retention ponds • Permanent ditches		190
Total site preparation		$3,510
RADON COVER		1,250
1. Compacted on-site soils • Excavate, spread, and compact	(570,000 cy)	
EROSION COVER		1,430
1. Pit run rock • Excavate, haul, spread	(190,000 cy)	
DECONTAMINATION (lump sum)		120
1. Equipment and truck wash-down facility		
SITE RELOCATION		
1. Haul tailings to embankment area	(2,450,000 cy)	2,680
FENCING	(7,500 LF)	90

Table A-17. (continued

Item	Cost ($000)
SUPERVISORY AND FIELD SERVICES	
1. Field staff • Construction engineer	260
2. Field services • Additional labor • Security • Survey crew • Quality control	1,260
3. Field health services • Health physics manager • Access control technician • Truck monitor • Laboratory services • Equipment and miscellaneous	1,010
4. Temporary facilities • Field office • Field office expenses • Change and shower unit • Temporary utilities • Temporary sanitary facilities • Insurance • Consumable supplies • Laundry and operation • Mobile equipment • Fencing, barricades, signs and miscellaneous	690
Supervisory and field services total:	3,220
Total preliminary cost estimate	$64,800

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Appendix B

THE SELECTION OF AN OFF-SITE DISPOSAL SITE

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Appendix B

THE SELECTION OF AN OFF-SITE DISPOSAL SITE

The impacts of transporting the Vitro tailings and other contaminated material to an off-site location are described in this document in terms of a new disposal site approximately 1 mile south of Clive, Utah. This appendix provides a background for and history of the events that led to the choice of the South Clive site as the off-site alternative.

B.1 BACKGROUND

On March 12, 1974, the subcommittee on Raw Materials of the Joint Committee on Atomic Energy (JCAE), Congress of the United States, held hearings on two identical bills submitted by Senator Frank E. Moss and Representative Wayne Owens of Utah. The bills, S. 2566 and H.R. 11378, provided for the assessment of an appropriate remedial action to limit the exposure of individuals to radiation from uranium mill tailings at the Vitro site in Salt Lake City, Utah. These bills also provided for a cooperative arrangement between the Atomic Energy Commission (AEC) and the State of Utah in making the assessment.

During the JCAE hearings, Dr. William D. Rowe of the U.S. Environmental Protection Agency (EPA) pointed out that there were other inactive uranium mill sites that shared the problems of the Vitro site; he recommended a generic approach to the problem of abandoned uranium mill tailings, with first priority being given to addressing the most critical tailings sites. Similar recommendations were made by Dr. James L. Liverman who testified for the AEC: he proposed that a comprehensive study should be made of all abandoned tailings piles, rather than treating potential problems on a piece-meal basis. This comprehensive study would be a cooperative two-phase undertaking by the concerned states and appropriate Federal agencies such as the AEC and EPA. Phase I of this undertaking would involve identifications of sites that might require remedial action, and determination of the need for corrective action through observations of each site's condition, ownership, proximity to populated areas, and prospects for increased population near the site. A preliminary report of Phase-I work would serve as a basis for determining if a detailed engineering assessment (Phase-II) was necessary for each mill site. The Phase-II engineering, if necessary, would include evaluation of the problems, examination of alternative solutions, preparation of cost estimates and of detailed plans, and specifications for alternative remedial-action measures.

The Phase-I assessment began in May 1974, with teams consisting of representatives of the AEC, the EPA, and the affected states visiting 21 of the known inactive millsites. A Phase-I report was presented to the JCAE in October 1974 (AEC, 1974). Based on the findings of that report, a decision was made by the AEC to proceed with the Phase-II engineering assessments at 17 sites, including the Vitro site at Salt Lake City.

B.2 HISTORY

B.2.1 The FBDU engineering assessments

An active search for alternate disposal sites for the Vitro mill tailings began in 1975. On May 5, 1975, the U.S. Energy Research and Development Administration (ERDA), formed by the Energy Reorganization Act of 1974 which abolished the AEC, selected Ford, Bacon & Davis Utah Inc. (FBDU) of Salt Lake City to provide architect-engineering services for Phase-II assessments of the 17 mill sites mentioned in the Phase-I report (AEC, 1974). FBDU began work on June 23, 1975, giving first consideration to the Vitro site. The architect-engineering services contract specified, among other things, that FBDU would determine the adequacy and the environmental suitability of sites at which mill tailings could be disposed.

The original Phase-II report on the Vitro site in Salt Lake City was published in April 1976 (FBDU, 1976). Altogether 29 potential disposal sites or areas were mentioned in this report; these sites are listed in Table B-1. The 29 sites were either nominated by state agencies, Federal agencies, private individuals, or were chosen by FBDU on the basis of their knowledge of suitable areas in the vicinity of Salt Lake City. Because of transportation costs, only those locations within 150 miles of Salt Lake City were initially considered.

Very early in their work on the engineering assessments, FBDU developed 29 criteria for determining the suitability of sites proposed for storage of mill tailings (personal communication, Mr. Robert Overmyer, FBDU, October 5, 1981). These 29 criteria, listed in Table B-2 in their original form as a field "score sheet," were logically developed from general principles of radiation protection that had been adopted by ERDA. It should be emphasized that in 1975 there were no Federal standards or guidelines specifically directed towards the cleanup of uranium mill sites or disposal of uranium mill tailings. Some guidelines for cleanup of habitable structures contaminated with tailings had been published by the U.S. Surgeon General for use in the Grand Junction, Colorado remedial program (10 CFR 12), but these guidelines did not directly apply to the problems of mill tailings disposal. Consequently, ERDA and FBDU had to create their own guidelines in order to proceed with the engineering assessments. In brief, these ad-hoc guidelines had three objectives: (1) to reduce residual gamma radiation to levels which would be as low as practicable; (2) where cleanup was necessary, to reduce the radium content of the soil to no more than twice the radium background in the area; (3) to meet applicable state and Federal standards for the radium-226 content of ground or surface waters. Other desirable goals, such as preservation of local ecosystems, the minimization of project costs, and making best use of lands, were factored into the development of the 29 site-selection criteria.

The site-selection criteria were used to score and rank the 29 sites shown in Table B-1; the highest-scoring site was ranked first, the next-highest-scoring site was ranked second, and so on. In obtaining a total score for each site, the scores for each criterion (a number in the range 1 to 10) were simply added, and equal weights were given to the 29 criteria. The results of this ranking are specified in Table B-1 for the top-ranking 15

Table B-1. Twenty-nine sites evaluated as repositories for the Vitro tailings in Phase II-Title I Engineering Assessment

Salt Lake Valley sites	FBDU site identification number	FBDU rank[a]
Salt Lake International Airport Fill for proposed runway expansion Township 1 North, Range 1 West	4[c]	7[b]
Freeway Interchange (I-80:40th W) South of Salt Lake International Airport #1 Township 1 South, Range 2 West	5[c]	8[b]
Kennecott Tailings Area 2 miles north of Magna, Utah Township 1 South, Range 2 West	6	-
Butterfield Canyon 5 miles south, southwest of Lark, Utah Township 1/2 South, Range 1 West	14	14
Magna Lake Bed North and east of Kennecott Tailings Pond Township 1 South, Range 2 West	28[c]	-
Magna Area State Land 2 miles east of Magna, Utah Township 1 South, Range 2 WEst	24[c]	12
Lark Copper Tailings Site 1/2 mile east of Lark, Utah Township 3 South, Range 2 West	25	15
Oquirrh Foothills 12 miles west of Midvale, Utah Township 3 South, Range 2 West	29[c]	-
<u>Great Salt Lake Desert sites</u>		
1 mile south of Clive, Utah Township 1-1/2 South, Range 11 West	1[c]	2
Natural Depression 8 miles north of Clive, Utah Township 1/2 North, Range 12 West	2[c]	1
Natural Depression Township 1 North, Range 15 West	11	-
Newfoundland Range Basin Township 5-1/2 North, Range 14 West	12	-

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Table B-1 (continued)

Great Salt Lake Desert sites	FBDU site identification number	FBDU rank[a]
Dugway Proving Grounds 5 miles west of Camels Back Ridge Township 8 South, Range 11 West	17	-
6 miles northwest of Knolls, Utah Salt Lake Baseline, Range 12 West	22	-
12 miles northwest of Knolls, Utah Township 1 North, Range 13 West	23	-
1 mile south of Low, Utah	27	-
Other locations		
North Skull Valley 3 miles west of Delle, Utah Salt Lake Baseline, Range 9 West	3[c]	3
Rush Valley 20 miles south of Tooele Army Depot Township 7 South, Range 5 West	7	6
Ripple Valley 5 miles southeast of Porter Well, Utah Salt Lake Baseline, Range 10 West	8	-
Cedar Mountain Foothills 10 miles east of Clive, Utah Township 1-1/2 South, Range 10 West	9	-
Cedar Mountain Foothills 10 miles west of Delle, Utah Salt Lake Baseline, Range 9 West	10	5
Black Mountain Lakeside Mining District 7 miles north of Delle, Utah Township 1/2 North, Range 8 West	20	10
Point of the Mountain 3 miles north of Lehi, Utah Township 2 North, Range 10 West	26	13
Puddle Valley 5 miles east of Grassy Mountain Well Township 2 North, Range 10 West	13	-

Table B-1 (continued)

Other locations	FBDU site identification number	FBDU rank[a]
Puddle Valley Northwest of Delle, Utah Township 1 North, Range 9 West	21	9
Hell's Kitchen Ranch 40 acre natural basin Township 17 South, Range 1/2 West	16	-
Rush Valley 4 miles south of Tooele Army Depot Township 7 South, Range 4 West	18	4
Camp Williams State Military Reservation Tickville Gulch, 8 miles west of Lehi Township 3 South, Range 3 West	19	11
Ripple Valley 7 miles southwest of Porter Well, Utah Township 1/2 South, Range 11 West	15	-

[a]Ranks are specified for only the top-ranking 15 sites.
[b]No longer available as of 1981, since developments are already underway or are completed.
[c]Alternative disposal sites selected for cost studies (FBDU, 1976).

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Table B-2. FBDU site selection criteria

Criteria	Point values 1	2	3	4	5	6	7	8	9	10
					HYDROLOGY & GEOLOGICAL CONSIDERATIONS					
Rainfall	More than 30"ann.	<27"ann.	<24"ann.	<21"ann.	<18"ann.	<15"ann.	<12"ann.	<9"ann.	<6"ann.	Less than 3"ann.
Evidence of flooding	Common occur.				50% Chance					Negligible
Run-off characteristics	Gully erosion		Sheet erosion			Rills evident				No erosional features
Drainage distance from site to rivers, lakes & lower elev.	Within 1 mile	>2	>3	>4	>5	>6	>7	>8	>9	Over 10 miles
Wells or springs in area	Within 1 mile	>2	>3	>4	>5	>6	>7	>8	>9	Over 10 miles
Water table location	Water table >20'	>40'	>60'	>80'	>100'	>120'	>140'	>160'	>180'	Water table over 200'
Possibility of mud or rock slides, faults, avalanches	Common occur.									Negligible
Potential for agriculture & grazing, soil charc.	Good topsoil									No topsoil, rocky
Density of vegetative cover	100%	90%	70%	50%	30%	20%	15%	10%	5%	No vegetation
Type of underlying unconsolid. strata	Sand & gravel									Heavy clay
Wind erosion	Flat and windy									Protected from wind
Ability to isolate the site	Impossible				Good					Presently isolated

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Table B-2 (continued)

Criteria	Point values 1	2	3	4	5	6	7	8	9	10
Stabilization potential	Impossible				Good					Excellent
Dip of underlying strata	Folded	20°	10°	8°	6°	4°	3°	2°	1°	Flat
Extent of faulting	Evident offsets			Evident Fracturing			Occasional joints			Undisturbed
Type of bedrock	Limestone			Sandstone			Shales			Granite
Ground water quality	Potable		Suitable for livestock		Suitable for industry					Very poor quality
ECOLOGICAL CONSIDERATIONS										
Wildlife population	Yearlong habitat		Seasonal use		Shelter area					Negligible
Proximity to population	>2 miles	>4	>6	>8	>10	>12	>14	>16	>18	Over 20 miles
Current use of land	Rangeland									Wasteland
Aesthetic consideration	Naturally beaut.									Nondescript
Probable future land use	Human habitat				Agricultural					None
ECONOMIC CONSIDERATIONS										
Natural resources in area	Abundant									Negligible
Highway accessibility	Less than 10 mi	>9 miles	>8 miles	>7 miles	>6 miles	>5 miles	>4 miles	>3 miles	>2 miles	>1 mile

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Table B-2 (continued)

Criteria	Point values 1	2	3	4	5	6	7	8	9	10
Proximity to railroad	less than 20 mi	>18 miles	>16 miles	>14 miles	>12 miles	>10 miles	>8 miles	>6 miles	>4 miles	>2 miles
Miles from tailings site	Over 150 miles	<135	<120	<105	<90	<75	<60	<45	<30	30 miles
Estimated current value/acre	$360	$360	$320	$280	$240	$200	$160	$120	$80	Less than $40
Maintenance required for tailings in this area	Semi-annual	Annual	Every 2 years	Every 3 years	4	5	6	7	8	None
Source of fill for SLC site	None									Unlimited

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sites. It is seen that areas in the Great Salt Lake Desert, or in the series of valleys west of the Salt Lake Valley, rank the highest. The highest-ranking sites in the Salt Lake Valley, such as the runway expansion at Salt Lake Airport and the Interstate-80 Exchange, would also be acceptable; but the latter are no longer at a stage of development where joint utilization for tailings disposal is practicable (FBDU, 1981).

B.2.2 Site selection by the State of Utah

In November of 1978, Congress passed PL95-604, "The Uranium Mill Tailings Radiation Control Act of 1978" (UMTRCA). Title I of PL95-604 authorized the U.S. Department of Energy (DOE), successor to ERDA, to enter into cooperative agreements with affected states and Indian tribes in order to establish assessment and remedial action programs at inactive uranium mill tailings sites; the Federal government would pay 90 percent of remedial-action costs and the affected state would pay the remainder. The UMTRCA also stipulated that the affected state would acquire mill tailings disposal sites during remedial-action operations, but that ownership of these sites would revert to the Federal government after completion of the remedial action.

In November 1979, 25 former uranium-milling sites including the Vitro site in Salt Lake City, Utah, were designated for remedial action under PL95-604. In early 1980, Utah's governor directed the State Division of Environmental Health to recommend a final disposal site for the Vitro tailings. A committee of eight members, representing all pertinent Bureaus in the Division of Environmental Health and the Utah Geological and Mineral Office, was established to make the requisite studies and recommendations. The committee, called the "Vitro Tailings Site Selection Committee" (VTSSC) began work with the consideration of sites proposed in previous studies. The 29 sites mentioned in the 1976 engineering assessment (FBDU, 1976, and Table B-1) were studied, and all but the 3 top-ranking candidates were eliminated. Eight new candidates were added to obtain the 11 sites listed on Table B-3. All of the sites in the Salt Lake Valley were eliminated in this first round of site screening.

The VTSSC adopted the following rules for conducting its second and final round of screening: (1) each committee member would evaluate only those aspects of the site representative of his particular expertise; (2) the technical criteria used by FBDU (see Table B-2) would be used with possible changes in relative weighting of these criteria; (3) each committee member would submit a report to the Chairman who would summarize the committee recommendations; (4) only physical acceptability of the sites would be evaluated on the basis of direct observations and a review of information from reports of previous investigations; and (5) each committee member was to consider three separate options. The three options were: Option-I sites, the use of which was judged to entail no economic or political complications; Option-II sites, those sites requiring further evaluations to determine if transport of the tailings to them would be economical; and Option-III sites at which reprocessing of the tailings might be possible, subject to favorable outcomes of evaluations of the political and economic factors involved with reprocessing. The VTSSC eventually declined evaluation of Option-II and Option-III sites (VTSSC, 1980), pending an economic evaluation by the DOE (see Section C.2, Appendix C).

Table B-3. Sites considered by Vitro tailings site selection committee (VTSSC)

VTSSC site no.	Location	FBDU site no.[a]
Option-I sites[b]		
1	One mile south of Clive, Tooele County	1
2	Eight miles north of Clive, (Natural Depression), Tooele County	2
3	Three miles west of Delle, Tooele County	3
4	Boulder Creek, Tooele County	
Option-II sites[b]		
5	Three miles north of Woodside, Carbon County	
6	Nine miles south of Crescent Junction, Grand County	
Option-III sites[b]		
A	North of Crescent Junction, Grand County	
B	Sager's Flat, Grand County	
C	Northwest of Whitehouse, Grand County	
D	West of Cisco, Grand County	
E	North of Cisco, Grand County	

[a]See Table B-1.

[b]Option-I sites: Use of these would entail no economic or political complications.

Option-II sites: Use of these might require economic evaluations to determine if costs are competitive with Option-I sites.

Option-III sites: Use of these might include reprocessing to recover the uranium and other mineral values. In addition to economic evaluations, agreements with the DOE, the State of Utah, and property owners would be required.

A report by the VTSSC was submitted to the Governor of Utah on June 20, 1980 (VTSSC, 1980). The Committee recommended the FBDU site No. 2, a natural depression 8 miles north of Clive in Tooele County, as a primary site for final disposal of the tailings at the Vitro site. As secondary sites, the committee recommended FBDU site No. 1, one mile south of Clive, Tooele County, and FBDU site No. 3, 3 miles west of Delle, Tooele County. The Governor of Utah endorsed these recommendations in a letter to the DOE on January 6, 1981.

After the VTSSC report had been submitted, the Utah Department of Health recommended consideration of a fourth area not previously included in the State's site-selection process. In a letter to the DOE dated July 23, 1981, the Utah Department of Health requested that DOE evaluate an area on the extreme northeast corner of the Wendover Bombing and Gunnery Range, about 3 miles south of FBDU site No. 1. The DOE notified the U.S. Department of Defense (DOD) that it would consider part of the Wendover Bombing Range as a location for disposal of uranium mill tailings, and requested permission to perform studies and tests on the land in question. Officials of the DOD declined approving use of the Wendover Bombing Range lands on September 4, 1981, stating that the lands would be needed to support operational requirements and that they believed the lands would in any case be environmentally unsuited for the proposed use.

B.2.3 Site evaluations by the DOE

In April 1981, a DOE contractor made an independent analysis of the three Option-I sites recommended by the State of Utah. At the conclusion of this evaluation, the DOE determined that the area 1 mile south of Clive, Tooele County (FBDU site No. 1) was the superior of the three areas proposed by the State. The relative rankings of the three sites according to 7 environmental and geotechnical disciplines are shown in Table B-4.

Table B-4. Relative rankings of state-nominated areas

Discipline	FBDU Site No. 1	FBDU Site No. 2	FBDU Site No. 3
Vegetation	2	1	3
Wildlife	1	2	3
Soils & reclamation	2	3	1
Hydrology & water quality	1	2	3
Meteorology & air quality	1	2	3
Human resources	1	3	2
Geotechnical engineering	1	3	2
Composite score	9	16	17

A summary of the evaluation of the three state-nominated areas, and reasons for rejecting FBDU sites Nos. 2 and 3, are provided in Appendix C where considered-but-rejected alternatives are discussed.

The Option-II and Option-III sites proposed by the State's site-selection committee were evaluated by the DOE and then rejected because of their distance being at least 150 miles by road or rail from the Vitro site; evaluations of these options and reasons for rejecting them are also contained in Appendix C.

The possibility that there are technically suitable disposal areas nearer to the Vitro site than the three state-nominated areas was also considered. At the request of the DOE, Sandia National Laboratories (SNL) reviewed all the sites that had so far been proposed as alternative disposal sites, and in September 1981 the DOE determined that (1) there are presently no more-isolated locations for disposal of the Vitro tailings within 17 road-miles of the Vitro site other than the former Vitro site itself, and (2) there may be technically suitable disposal areas west of the Salt Lake Valley other than the three state-nominated areas, but the use of such areas would offer little or no environmental or economic advantages beyond the advantages to be realized in the use of one of the state-nominated areas. Therefore, the DOE determined that it was not reasonable to examine these Salt Lake Valley areas further. The bases for these conclusions are outlined in Appendix C.

B.3 CONCLUSIONS

The DOE has chosen the area approximately one mile south of Clive, Utah as the candidate for use as an alternative disposal site for the Vitro tailings and other contaminated material. This choice is in accord with site nominations made by the State of Utah, and can be justified by the results of over 7 years of study directed towards finding suitable alternate areas for long-term storage of the Vitro site wastes. The impacts of a remedial action at the Vitro site that would include the transportation of mill tailings and wastes to the area south of Clive, Utah, are assessed in the body of this document.

REFERENCES FOR APPENDIX B

AEC (U.S. Atomic Energy Commission), 1974. Phase-I Summary Report, October 1974.

FBDU (Ford, Bacon & Davis Utah Inc.), 1976. Phase-II - Title I Engineering Assessment of Inactive Uranium Mill Tailings, Vitro Site, Salt Lake City, Utah, GJT-1, prepared for U.S. Energy Research and Development Administration, Grand Junction, Colorado.

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VTSSC (Vitro Tailings Site Selection Committee), 1980. "Vitro Tailings Site Selection Committee Report," dated June 20; signed by Blaine N. Howard (Chairman), Earl Peirce, Fitzhugh Davis, Dan Blake, Robert Cunliffe, and Dane Finerfrock; copies available on request to Uranium Mill Tailings Remedial Actions Project Office, DOE Albuquerque Operations Office, Albuquerque, New Mexico.

Appendix C

ALTERNATIVES THAT WERE CONSIDERED BUT REJECTED

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Appendix C

ALTERNATIVES THAT WERE CONSIDERED BUT REJECTED

The alternatives for remedial actions at the Vitro site that were considered during the development of this EIS but were determined to be unreasonable are described in this appendix, and reasons given for their rejection. The considered-but-rejected alternatives can be divided into four classes: (1) alternatives involving disposal of the Vitro wastes at other locations considered by the State of Utah (excluding the South Clive site); (2) alternatives involving disposal at sites in Carbon County; (3) alternatives involving disposal of the Vitro wastes at locations within or near the Salt Lake Valley; (4) alternatives that would involve the reprocessing of the Vitro mill tailings to extract residual mineral values.

C.1 STATE-RECOMMENDED ALTERNATE DISPOSAL AREAS

The State of Utah found three areas acceptable for long-term disposal of the mill tailings and other residues from the Vitro site (see Section B.2.2, Appendix B). They are named and located as follows.

- The Prime Area is the so-called great depression located approximately 8 miles north of Clive, Tooele County, Utah. This area consists of three sections of public domain: Sections 8, 17, and 20 of T1N, R12W.

- The First Alternate Area is a parcel of state land located approximately one mile south of Clive, Tooele County, Utah within Section 32 of T1S, R11W. This area is referred to throughout this EIS as the "South Clive site."

- The Second Alternate Area is a section of state land located approximately 3 miles west of Delle, Tooele County, Utah: Section 2 of T1S, R9W.

The firm of Dames & Moore was contracted by the DOE to perform an independent evaluation of the suitability of the three areas for disposal of uranium mill tailings; the evaluation was made in April of 1981 by specialists in geohydrology, surface-water hydrology, soils and reclamation, plant ecology, wildlife ecology, meteorology and air quality, human resources, and geotechnical engineering. Evaluations were based on available literature, knowledge of the region, site reconnaissance, and professional judgement. It was assumed that the disposal of the mill tailings would be, according to current practice, subgrade in lined trenches or cells. Factors considered by the specialists were oriented toward achieving the standards then proposed by the EPA for disposal of mill tailings under Title I of UMTRCA (46 FR 2556-2563). Specific factors considered included the following:

- Potential for geologic hazards, erosion potential, or subsidence.

- Economics of the transport and stabilization of contaminated materials, including transportation distance, access to existing rail and highway systems, construction of the retention system, and availability of cover materials.

- Geohydrology, including general depth to ground water and potential for impacts on ground-water quality.

- Surface-water hydrology, including proximity to and potential for impacts on intermittent and perennial drainages, drainage basin characteristics, and flood potential.

- Local meteorological conditions and potential for impacts on air quality.

- Topography as related to transportation, engineering, and long-term stabilization (erosional versus depositional environment).

- Present and potential land use, general productivity.
- Existing and potential vegetation, value as wildlife habitat and/or rangeland.
- Importance of area to plant and wildlife species of concern (endangered, threatened, ecologically important).
- Potential for reclamation.
- Proximity and potential for visual impacts to human residences and public use areas.
- Engineering restrictions and construction problems imposed by geotechnical conditions.

The evaluation led to the elimination by the DOE of two of the three areas that the State had found to be acceptable--the Prime Area and the Second Alternate Area. The DOE found that these are not reasonable alternative areas (see Appendix B). A description of each of these areas and reasons for their elimination are given below.

C.1.1 The Prime Area

The Prime Area is an elongated natural depression in the Great Salt Lake desert. The depression is up to about 10 feet in depth, approximately 1 mile in width, and extends both north and south beyond the three sections of concern. The depression is bounded to the east and west by what appear to be old sand dune ridges that are sparsely covered with shadscale, winterfat, nuttall saltbush, koschia, and other salt-tolerant species of plants.

Geohydrology and surface waters. During the site reconnaissance, (April 1981), the ground-water table was within 3 feet of the depression's floor, which is a mud flat composed of salt-encrusted silt and clay underlain by Lake Bonneville lakebed depositions. Periodically there is standing water in the depression and there would thus be a very high potential for impact on ground-water quality if the disposal site were located there. Otherwise, this depression has no clear-cut disadvantages from a surface hydrology standpoint. It would not be subject to erosion from runoff and would have a very low potential for flood damage.

Soils and reclamation. The general lack of an on-site source of rock and gravel to protect the reclaimed surface from wind erosion coupled with an anticipated difficulty in establishing a vegetative cover would increase the cost of reclamation; the latter would make reclamation success questionable. The depression is a depositional environment since it receives run-in from the adjacent ridge slopes. Upon drying, however, the deposition of material carried in by water would be countered by wind erosion. The net effect of these two opposing actions would be most influenced by moisture conditions which, in turn, will reflect precipitation patterns and fluctuations in Great Salt Lake water levels.

Wildlife and plants. The depression floor is nearly devoid of vegetation. As evidenced by the presence of several desiccated individuals on the depression floor the day after heavy precipitation, the mud flat contains a population of Great Basin Spadefoot Toads; otherwise, very limited wildlife habitat exists on this area. No endangered or threatened species are known from this vicinity.

Meteorology and air quality. The depression is the farthest from Interstate 80 of the three areas (about 5 miles). Since about 40 percent of all winds greater than 12 mph are from the south, emissions would be blown away from the highway. However, soil erosion and drifting in the vicinity of the depression indicate that blow dust and wind erosion could be serious local problems; use of the area would involve about 10 miles of unpaved haul roads (compared to approximately 2.5 and 0.8 miles at the other two areas).

The railroad line lies 0.5 mile south of I-80. If contaminated material were transported by rail, a transfer point for transport to the depression would be required which could produce emissions that would impact highway traffic.

The nearest Class I air quality area (Capital Reef National Park) is approximately 200 miles south of the area.

Human resources. The issues that are of consequence to the choice of the best among the three nominated areas are transportation costs (construction of new rail or roads, total cost of transportation) and visual impacts to travelers on I-80 and/or nearby residents. The Prime Area would involve the longest (rail or highway) distance from Salt Lake City and the greatest transportation cost for haulage from the rail or highway to the disposal area. Visual impacts would be concentrated near Clive where material would be transloaded from the existing rail or highway to the connecting rail spur or haul road. The depression is sufficiently far from the existing railroad and I-80 (8-10 miles) to prevent on-site activities being visible to travelers. Of historical interest, the Donner Trail passes to the north of this depression.

Geotechnical engineering. Use of the depression would present major construction problems relative to excavation of pits or trenches in the soft silty clays and transport of contaminated materials from the adjacent alluvial ridges onto the mud flat. Periodic inundation of the site and the shallow water table would further complicate engineering design and construction. Excavated clay from the depression would be suitable for use as an impermeable cover over the disposal trenches or pits. A bottom liner would be unnecessary to control vertical seepage. The nearest gravels for cover are about 5 miles away in the Grayback Hills to the east.

Reasons for elimination. The Prime Area was ranked second after the South Clive Area owing mainly to its disadvantages in terms of reclamation, transportation, and geotechnical engineering, all of which would lead to increased costs of implementation with no increase in environmental benefits over those offered by use of the South Clive Area. Another major problem with use of the Prime Area would be the necessity for transporting the tailings

from a railhead near Clive, across Interstate 80, and into the Prime Area. The most economical means of carrying the material over this path would be truck transport. A direct truck route that crossed Interstate 80 would lead to serious and frequent traffic interruptions; on the other hand, use of an existing overpass west of Clive would necessitate the upgrading or construction of frontage roads and an extra transport distance of about 15 miles.

For these reasons, and the fact that an alternative involving the Prime Area would be too close on the spectrum of alternatives to one involving the South Clive site, the DOE has determined that the Prime Area alternative is unreasonable.

C.1.2 The Second Alternate Area

This area, about 3 miles west of Delle, is in the Skull Valley portion of the old lakebed deposits of Lake Bonneville. The topsoil is poorly developed and varies from sandy to clayey silt. There is some topographic relief in the area and defined runoff channels are present, particularly on the eastern portion of the section. The area is used for recreation (hunting and target shooting, motorcycle riding) and is traversed by an access road to the Cedar Mountains, which are also used for recreation.

Geohydrology and surface waters. Based upon the literature, the upper water table is approximately 150 feet beneath the ground surface. However, the area is clearly the worst from the viewpoint of surface hydrology. Because of its location relative to surrounding terrain and the size of the drainage basin, it is susceptible to sufficient velocity and volume of runoff to be hazardous to a disposal system. This is evidenced by the existence of defined drainage channels. A relatively large depression in the eastern part of this area is not enclosed but, rather, is a portion of a major drainage system through Skull Valley. Thus, there would be a serious potential for contamination of down-gradient water quality.

Soils and reclamation. Because of its proximity to the Cedar Mountains, this area is exposed to lower wind velocities than the other two areas. There is consequently less potential for wind erosion. As on the other areas, the soils are highly alkaline; the soil texture is less than 18 percent clay. Of the three areas, soils on this area offer the greatest potential for development of winter sheep range through proper management. As elsewhere, rock and gravel would have to be imported for cover material. Because of the relatively favorable soils and availability of suitable plant materials for revegetation, this area would be the easiest to reclaim of the three evaluated.

Wildlife and plants. Because ecological conditions on this area are the most diverse of those evaluated, it is rated as being the most valuable as wild-life habitat. In addition, the presence of prairie dogs is not only academically of interest (since they were not known to occur in this vicinity) but represents potential habitat for endangered species. (However, no endangered or threatened species are known from this vicinity.) The area is used for recreational hunting more than are the other two. No wetlands are present.

Vegetation on the area varies from what is essentially a greasewood flat on the northwestern portion of the section to a sparse grassland to the east; the existing vegetation is similar to that on the South Clive site but is more diverse and includes less of the noxious weed Halogeton.

Meteorology and air quality. Assuming transportation emissions would be proportional to distance, this area is most favorable in being the closest to the Vitro site. However, the nearest residences are within 2 miles of the area and would potentially be impacted by fugitive emissions. In addition, the access road to the Cedar Mountains passes along and through this area; travelers on this would be impacted by fugitive emissions. Finally, the area is both south of and the closest to I-80 (less than 1 mile); because about 40 percent of the winds stronger than 12 mph blow from southerly directions, fugitive emissions would be carried across the highway.

Human resources. Because the existing railroad is on the opposite side (north) of I-80, transloading material from the railroad would require a crossing, increasing transportation costs. This would be partially offset by the fact that this area is about 25 miles closer to the Vitro site than the others. The overall cost advantage of the Delle area would be minimal. Because of its proximity to I-80 and to Delle, the use of this area would be more visible than at the other two areas.

Geotechnical engineering. From an engineering viewpoint, this area is similar to the South Clive site except for access problems imposed by the railroad being north of I-80; the latter problem is common to this area and the Prime Area.

Based upon the literature, the upper water table is deeper than at the First Alternate Area but the difference is not that significant relative to construction and operation of a disposal site. Construction problems would be minimal. Clay capping material could be obtained through excavation of trenches; a bottom liner would not be necessary. A gravel source is less than 1 mile from the area.

Reasons for elimination. The Second Alternate Area was ranked only slightly below the Prime Area, and, hence, third after the South Clive site, owing mainly to its value as wildlife habitat, its proximity to the highway and the settlement of Delle, and its unfavorable surface hydrology. As stated above, the Second Alternate Area shares the same kind of access problem with the Prime Area--the tailings would have to be transported from the rail head across I-80 to reach the disposal site. Thus, the DOE has concluded that an alternative involving the Second Alternative Area would be unreasonable for the same reasons that an alternative involving the Prime Area was determined to be unreasonable.

C.2 ALTERNATE DISPOSAL AREAS IN CARBON AND GRAND COUNTIES, UTAH

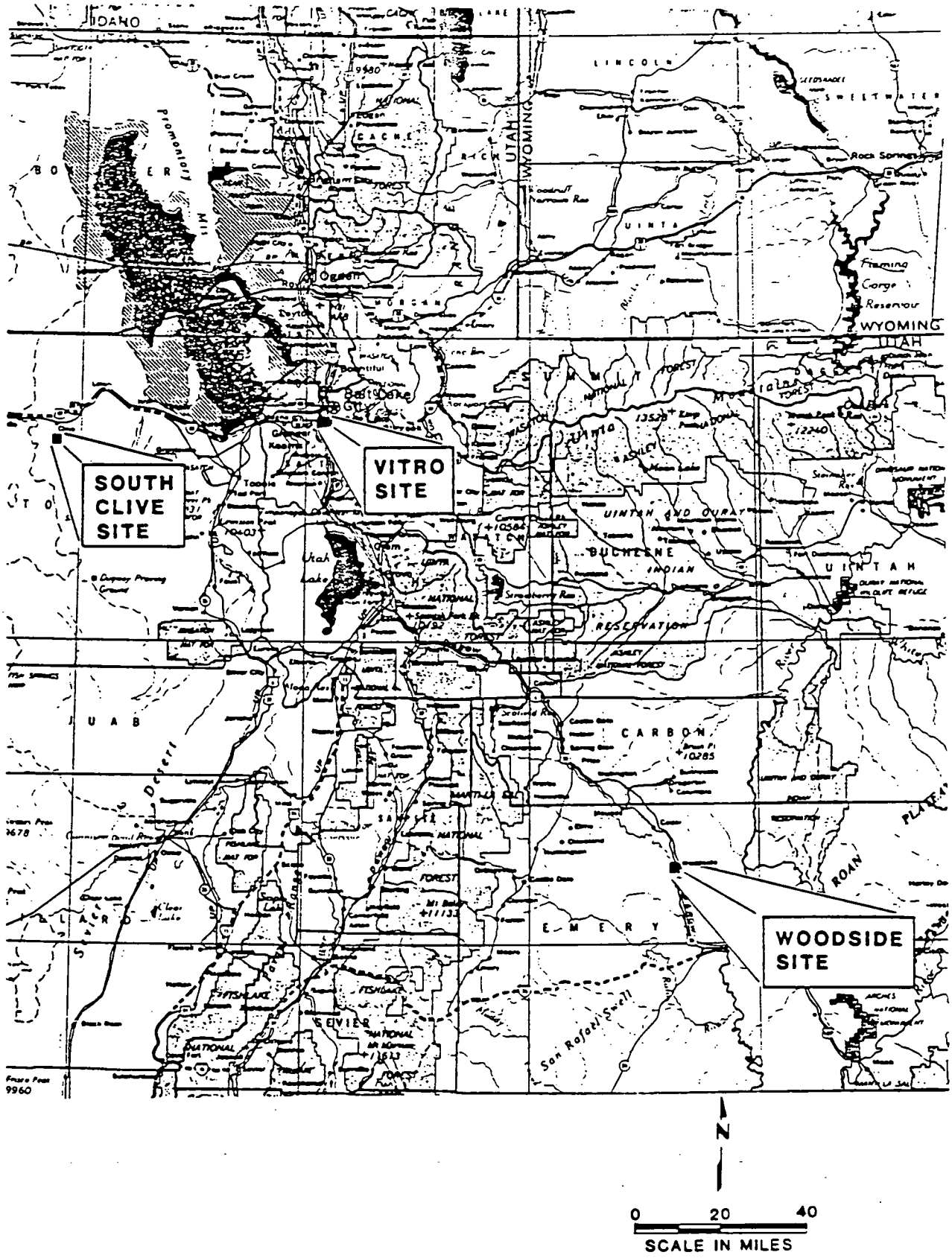
The State of Utah's site-selection team considered two disposal areas in Carbon and Grand Counties, respectively, but declined to evaluate them in detail (VTSSC, 1980). These areas were (1) an area 3 miles north of Woodside, Carbon County, Utah, and (2) an area 9 miles south of Crescent Junction, Grand County, Utah. The following is a brief discussion of these alternate disposal areas and the major environmental and economic factors that caused them to be rejected as reasonable alternate areas for the disposal of Vitro mill tailings and residues.

C.2.1 Stabilization north of Woodside

The Woodside site that was considered is located approximately 156 road miles southeast of Salt Lake City in Emery County, Utah, as shown on Figure C-1. Consideration was given to this area in response to a proposal submitted to the State of Utah that recommended the use of an existing fleet of trucks that were currently (1980) hauling coal from the Emery and Carbon County areas to the Kennecott copper mill near Salt Lake City. After the State of Utah had suggested this site, a preliminary analysis was made by DOE contractors of environmental and economic factors affecting its suitability. From this evaluation, it was concluded by the DOE that the Woodside site could not be considered a reasonable alternative disposal site.

General description of the area. The Woodside site, approximately 6.5 square miles in size, is located on a level, sparsely vegetated pediment near the base of the Book Cliffs. The site area itself appears to be suitable for the deposition of the Vitro tailings according to preliminary evaluations in which the geologic, hydrologic, and environmental setting of the site were considered (FBDU, 1981). The site is isolated from major population centers and is easily accessible by highway. It is public domain administered by the U.S. Bureau of Land Management. The stabilization alternatives proposed in the conceptual plan and engineering evaluation for the South Clive site (see Section 3.2.4 and Appendix A) would be suitable for the Woodside site.

Reasons for rejection. Although the Woodside site appears to be physically suitable for the stabilization of tailings, the primary concern associated with using this site involves the transportation of materials. One transportation proposal presented to the State consisted of using coal hauling trucks to transport the Vitro tailings to the Woodside site (VTSSC, 1980). The trucks currently haul coal from mines in Carbon and Emery Counties to the Kennecott mill near Salt Lake City. It was recommended in the proposal that, once unloaded, the trucks would be diverted to the Vitro site and loaded with tailings for their return trip. After discussions with local trucking contractors, a preliminary cost estimate was prepared. The estimate was prepared assuming a 9-year transporting period (250 working days per year) requiring an average of 39 truckloads per day. The estimated cost of transportation for this period was $14.09 per ton which included the cost of fitting trucks with the required seals and covers. This cost is well in excess of the $8.50 per ton ($0.10 per ton mile) estimated for truck transportation to the South Clive site and, thus, from the economic standpoint alone does not represent a reasonable alternative. Furthermore, the



VICINITY MAP, WOODSIDE AREA

9-year transporting period would exceed the 7 years (after publication of final EPA standards) allowed for remedial actions by PL95-604, Title I.

An additional concern that decreases the practicality of this alternative is the increased transport distance and the consequent increased potential for the occurrence of a traffic accident involving a truck filled with contaminated tailings. The transport distance estimated for the Woodside site is approximately 156 miles compared to a distance of about 85 miles for the South Clive site. Further, as shown on Figure C-1, the shortest route between the Vitro site and Woodside is via Highway 6, which crosses the Wasatch Mountain Range at Soldier Pass. During the winter months this pass is periodically snow packed and slippery, thus significantly increasing general trucking hazards.

C.2.2 Stabilization south of Crescent Junction

The Crescent Junction area is 9 miles south of Crescent Junction, Grand County, Utah. It is about 11 square miles of pediment near the base of the Booker Cliffs, and is similar to the Woodside area except that it lies approximately 215 road miles from Salt Lake City. Though the State ranked the Crescent Junction area higher than the Woodside area in terms of technical suitability for uranium mill tailings disposal, the State also disqualified the area. Apparently, use of the area for uranium mill tailings disposal would conflict with a proposed land exchange between the Division of State Lands and the Bureau of Land Management (VTSSC, 1980).

The DOE did not perform cost estimates for transportation to the Crescent Junction area, but since the area is some 60 miles farther from Salt Lake City than the Woodside area the reasons for rejecting the Woodside area would also apply with increased force to the rejection of the Crescent Junction area. Therefore, transport of the tailings and other contaminated material to the Crescent Junction area would not be a reasonable alternative.

C.3 ALTERNATIVE DISPOSAL AREAS IN THE SALT LAKE VALLEY

The State of Utah did not recommend any areas within the Salt Lake Valley for alternative disposal sites for the Vitro mill tailings and other residues. The possibility that suitable areas exist in the Salt Lake Valley or on its periphery was briefly studied in September 1981 by the DOE's contractor, Sandia National Laboratories, and based on results of that study, the DOE concluded that (1) there are presently no suitable locations for disposal of the Vitro tailings within the Salt Lake Valley more isolated than the Vitro site itself, and (2) there may be technically suitable disposal areas west of the Salt Lake Valley other than the three state-nominated areas, but use of such areas would offer little or no environmental or economic benefit beyond the benefits to be realized in the use of one of the state-nominated areas. This section briefly documents the bases for these two conclusions.

C.3.1 Lack of isolated areas within the Salt Lake Valley

The Salt Lake Valley is assumed to be that region bounded on the east by the foothills of the Wasatch Mountains, on the north by the Great Salt Lake, on the west by the Great Salt Lake and the foothills of the Oquirrh Mountains, and on the south by the foothills of the Traverse Mountains. The Vitro site is located in the northwest quadrant of this valley, and straight-line distances from it to other points in the valley vary up to about 17 miles; road mileage between any two points is usually larger than the straight-line mileage. Railroads connecting to the Vitro site are limited to a narrow north-to-south corridor that roughly bisects the region and lies on the western side of its most urbanized parts. An east-to-west railroad corridor joins the north-to-south corridor at a point just north of metropolitan Salt Lake City and runs westward along the southern margin of the Great Salt Lake. No railroads cross the Wasatch mountains east of the Salt Lake Valley; I-80 is the main route crossing the Wasatch range east of the city.

The lands east of the north-south railroad corridor are, in general, heavily populated and privately owned; no areas there could be construed as being isolated or would be acceptable to the Salt Lake Valley residents as a site for the disposal of uranium mill tailings. The lands west of the north-south railroad corridor are less densely populated, although most of these are in various stages of development. The immediate vicinity of the Vitro site is fairly typical of the type and degree of development of this western half of the region: land is used for businesses (retail, manufacturing, light industry) and residences or, in the extreme west of the region, for agriculture and mining (gravel pits, copper mine facilities). It is thus possible that locations as isolated and as technically suitable for tailings disposal as the Vitro site could be found in this western half of the valley. From the standpoint of the major physical factors that determine disposal site suitability (topography, geology, hydrology, and climate) all locations in the western half would be roughly equivalent.

The equivalence of the physical factors that determine site suitability, however, suggests that there would be no environmental benefit in moving the tailings from their present location to a new one in the western half of the valley unless the new location afforded unique opportunities for stabilization

of the tailings at reasonable costs and with minimum interference with planned land use. A few such locations have been considered in the past in connection with public construction projects such as interstate highway exchanges or airport runway extensions; but as of September 1981 these projects were no longer available and further projects of this kind are not foreseen to occur within the time span allowed for completion of remedial actions under the UMTRCA. For these reasons, the DOE determined that an alternative involving disposal at a location in the Salt Lake Valley other than the Vitro site would be unreasonable.

C.3.2 Lack of technically suitable areas in the mountains

Suitably isolated sites for disposal of the Vitro tailings might be found in the Wasatch Mountains bordering the Salt Lake Valley on the east or in the Oquirrh Mountains to the west. However, these mountains are of high relief, and there are few roads leading into them that could support a safe and efficient transport of the large amounts of material that would be moved during remedial action at the Vitro site. Railroad access to locations within the Wasatch Range is possible only by a long and roundabout route through Provo, Utah. Rail access to the Oquirrhs is apparently limited to routes owned by the Kennecott Corporation.

It would be difficult and expensive to construct an engineered waste containment in these mountains that would meet the EPA disposal standards. The large relief combined with relatively high precipitation make erosion a problem; there is also the risk of long-term contamination of useful ground waters, since both mountain ranges are recharge areas for the deeper ground waters of the Salt Lake Valley. Thus, the cost of placing the Vitro tailings in these mountains would probably be excessive because of the additional engineering required to build a waste depository under these adverse conditions. In short, the DOE sees neither environmental nor economic advantages in placing an alternative disposal site within the Wasatch or Oquirrh Mountains, and has determined that such alternatives are not reasonable.

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C.4 ALTERNATIVES INVOLVING REPROCESSING OF THE VITRO MILL TAILINGS

In alternatives of this kind, the higher-grade tailings at the Vitro site would first be reprocessed to recover residual minerals of economic value; then the residues (still retaining most of the original radioactive elements) would be placed in an engineered structure for long-term disposal. In principle, at least two basic alternatives are practicable: (A) on-site reprocessing of the Vitro tailings followed by on-site stabilization of the residues; (B) transfer of the wastes to a new site and decontamination of the Vitro site, followed by the reprocessing of the wastes and stabilization of the residues at the new site.

These alternatives involving reprocessing cannot be entirely rejected until all procedures for determining the practicability of reprocessing have been completed. By law (PL95-604, Title I, Section 108(b)), the DOE must solicit expressions of interest regarding the remilling of residual radioactive materials at designated inactive processing sites and, upon receipt of any expressions of interest, must determine whether the proposals are practicable. The determination of practicability includes an assay of the tailings to determine their residual mineral contents. The DOE has complied with these requirements by publishing a request for expressions of interest in the Federal Register, "Commerce and Business Daily," and in local newspapers. Several expressions of general interest were received; and an assay program was begun in 1981. The Vitro tailings pile was sampled for assay in May 1981. The results of the assay program are available in DOE (1982).

<u>Summary of investigations at Vitro site, Salt Lake City, Utah</u>

Project Description:

The primary objectives of these investigations were to:

- Determine the total quantity of uranium bearing material at the site.
- Determine the total quantity of uranium, vanadium, and molybdenum present in the material at the site.
- Determine the extractability of uranium, vanadium, and molybdenum by leaching methods.
- Evaluate the economics of reprocessing the tailings for recovery of any or all of these three metals.
- Obtain data on the concentration of various trace metals normally associated with uranium mill tailings, including Ra-226.

In order to accomplish these objectives it was necessary to drill and sample the entire tailings deposit at the site. A sufficient number of samples was required to assure a statistical accuracy of 90 percent with a minimum 12 percent confidence interval. A total of 104 holes (samples) were taken at the site. Samples of each 2.5-foot interval were taken to provide moisture determinations throughout the pile. Where possible, each hole was drilled a minimum of 5 feet into the subbase material to investigate the amount of uranium migration into the substrate.

All samples were transported to the Tucson laboratories of Mountain States Research and Development (MSRD) where they were dried, analyzed, and prepared into composite charges for leach testing. Approximately 10 percent of the samples were taken with Shelby tube samplers so that bulk density determinations could be made on the tailings.

Using survey data for the drill holes, hole depths, moisture data, bulk density data, and chemical analyses, the volume, tonnage, and metal content of the tailings and subbase material were calculated.

Laboratory leach testing was conducted on composite test charges to determine optimum conditions and methods for leaching of the uranium, vanadium, and molybdenum. These data were then used to develop process flowsheets and major equipment lists, from which the capital cost could be estimated for a treatment plant.

Based upon total recoverable value of the three metals, the capital cost of the plant, and the estimated cost of operating the plant, a final evaluation as to the profitability of reprocessing the tails was made.

Site Description:

The Vitro site is located in the Salt Lake City Metropolitan area and is bordered on the south by 33rd South Street and on the west by 9th West. The immediate vicinity is zoned for light industry.

The tailings were deposited in five separate and distinct areas covering approximately 75 acres. Section A, located in the northwest portion of the area is surrounded by berms and during recent years has been used for discard and storage of sewage plant effluent. A major part of the section is extremely soft and has a high water content.

Section E is located on the eastern portion of the site and is low-lying with no distinct boundaries. This section had some of the highest grade material found, probably due to its proximity to the mill and discharges of higher grade material during emergency situations as well as use for ore storage.

The other three sections are easily distinguishable and, with the exception of the heavy rubble cover on Section C, present no particular handling problem.

The tailings are typical of beneficiated ore, being sandy in nature and relatively fine. Screen analyses indicate they are 100 percent minus 10 mesh and over 50 percent minus 200-mesh.

A drilling and sampling program was conducted at the site to provide the physical and analytical data required to determine the total quantity of tailings and uranium-bearing subbase material at the site and the total content of uranium, vanadium, and molybdenum. From these data the following statistics were developed:

Tailings, wet tons	2,755,711
Water, %	20.21
Tailings, dry tons	2,198,668
U_3O_8, %	.0150
pounds	659,452
V_2O_5, %	.0955
pounds	4,198,565
Mo, %	.0173
pounds	62,458
Subbase, wet tons	739,047
Water, %	3.39
Subbase, dry tons	566,157
U_3O_8, %	.0116
pounds	131,440
Total material, wet tons	3,494,758
Water, %	20.89
Total material, dry tons	2,764,825
U_3O_8, %	.0143
pounds	790,892

Amenability Testing:

Laboratory testing was conducted at MSRD's laboratories on composited samples from the site. Testing was conducted on samples representing each section and for the entire site. Testing procedures included:

- o Agitation leach with sulfuric acid.
- o Agitation leach with carbonate solution.
- o Extended acid agitation leach.
- o Column leach with acid.

The tailings were generally unresponsive to alkaline leaching with low extractions of uranium and vanadium.

Agitation leaching with acid indicated uranium extractions in the 55 percent range could be expected. Hence, column leach testing was conducted with acid only. The best overall results were obtained with the column acid leach process, which is indicative of what can be attained in the heap leach process. Analysis of the test results indicated that extraction for uranium, vanadium, and molybdenum, respectively, of 75 percent, 30 percent, and 55 percent could be expected in a heap leach operation on this material.

Accordingly, flowsheets were developed for a process plant to treat the pregnant leach solutions from heap leaching to recover uranium, vanadium, and molybdenum as marketable products.

Economic Evaluation:

Although a total of 2,764,825 dry short tons (DST) of uranium-bearing material was identified at the site, only 1,192,940 DST were considered to be

acceptable feed for processing by reason of its grade and/or response to treatment. The material considered not acceptable is located such that it could be either left in place or bypass the plant during mining operations.

The process plant was sized to treat the 1,992,940 DST of tailings plus subbase material at a rate of 750,000 dry short tons per year with a project life of apporoximately 2.7 years. During this period the production would be as tabulated below:

Product	Total lbs	Unit Price	Total
U_3O_8	567,968	$23.00	$13,063,264
V_2O_5	1,168,831	3.00	3,506,493
Mo	390,161	8.50	3,316,369
TOTAL VALUE			$19,886,126

Evidently, reprocessing of the Vitro site tailings is not economic at present-day prices (unit prices given above) as shown by the following estimates:

Plant Capital Cost	$16,060,000
Operating Cost	27,419,000
Total Project Cost	$43,479,000
Less Salvage Value	782,000
Total Direct Cost	$42,697,000
Marketable Production	$19,886,126
Profit or (Loss)	($22,810,900)

The $23 million loss would be added to the costs of stabilizing the residues that remain after reprocessing is completed. Therefore, reprocessing does not represent a reasonable alternative at this time.

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Appendix D

Hydrological and Water Quality Information

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D.1 INTRODUCTION

D.1.1 Vitro site

In this appendix the hydrodynamics, geochemistry, and solute transport affecting the ground water underlying the Vitro site and the surrounding area are analyzed. The hydrodynamic analysis includes:

- Assessment of historic conditions.
- Assessment of present conditions.
- Prediction of post-remedial action conditions.

Static water-level measurements, aquifer tests, and numerical methods were used for the analysis of the hydrodynamic characteristics of the unconfined aquifer, the confining layer, and the confined aquifer.

The geochemical analysis includes supporting data and descriptions and explanations for the chemical changes between:

- Layer 1 (tailings and tailings water) and Layer 2 (tailings, soil, water, and ground water) of the pile.
- Layer 2 and the underlying ground water.
- The underlying ground water and downgradient unconfined ground water.
- Upgradient unconfined ground water and downgradient unconfined ground water.
- Upgradient confined ground water and downgradient confined ground water.
- Uncontaminated surface water and contaminated surface water.

The solute transport analyses were used to:

- Support the explanations for measured downgradient concentrations of uranium and sulfate.
- Predict the time of entry into the ground water and the concentrations of sulfate, uranium, arsenic, and molybdenum following remedial action.

D.1.2 South Clive site

Starting in section D.5 of this Appendix, the ground-water regime of the South Clive site and the surrounding area are analyzed. The analysis includes:

- Assessment of hydrologic setting.
- Assessment of existing water quality.
- Assessment of potential for recharge on site.
- Assessment of existing and potential water uses.

D.2 EXISTING CONDITIONS, PROBLEM STATEMENT, AND METHODS OF CALCULATION - VITRO SITE

D.2.1 Existing conditions

The Vitro site is located within the Jordan River Valley in South Salt Lake, Utah. The ground-water regime is generally characterized by two aquifer systems, a near-surface unconfined system and a deeper confined system. The unconfined system is principally recharged by upward flow from the confined aquifer and surface infiltration (Figure D-1). The confined system is recharged by infiltration into porous materials on the flanks of the Wasatch Mountains to the east and the Oquirrh Mountains to the west. Near the site, both aquifers flow generally toward the west-northwest (Figures D-2 and D-3). The unconfined aquifer discharges into surface-water courses such as Mill Creek, the Jordan River, and the Great Salt Lake.

The background water quality (chemistry) in the vicinity of the Vitro site is substantially different for each of the two aquifer systems. The upper unconfined aquifer water is characterized by a brackish quality with high total dissolved solids, generally 2000 ppm or greater, and sulfates on the order of 800 ppm or greater. [The unconfined water quality generally improves with depth and approaches the quality of the confined ground water.] Due to its [marginal] quality and minimal yields to wells, this water has very limited use for domestic or agricultural purposes. The confined aquifer water generally has dissolved solids values of about 300 ppm and a sulfate content of about 20 ppm. The confined aquifer is an important source of domestic, agricultural, and industrial water supply in the Salt Lake Valley. (Table D-1, EPA National Interim Drinking Water Standards).

Elevated levels of sodium, sulfate, chloride, total dissolved solids, and uranium have been found in the unconfined aquifer ground water downgradient (west-northwest) and beneath the tailings pile, as compared to the upgradient conditions of the same aquifer. No elevated levels of molybdenum (Mo), selenium (Se), radium (Ra-226 and Ra-228), vanadium (V), thorium (Th-230), and lead 210 (Pb-210) have been found downgradient of the pile boundary. Samples from upgradient wells contained higher concentrations of arsenic (As) than samples from downgradient wells. Elevated levels of molybdenum have been found in discharge water from the excavation at the Central Valley Water Reclamation Facility (CVWRF).

None of the radioactive constituents and metals listed above, which would be associated with the tailings pile, were found in levels above background in the confined aquifer water. However, higher levels of sulfate and chloride were found in samples of the confined aquifer beneath and downgradient of the pile boundary than were found in samples taken from upgradient wells.

D.2.2 Problem statement

The purpose of this study is to evaluate the present and projected characteristics of the ground-water flow regime. From this evaluation, a determination will be made of the projected changes in the water levels, and present and future rates and concentrations of contaminant migration. The following items have been analyzed:

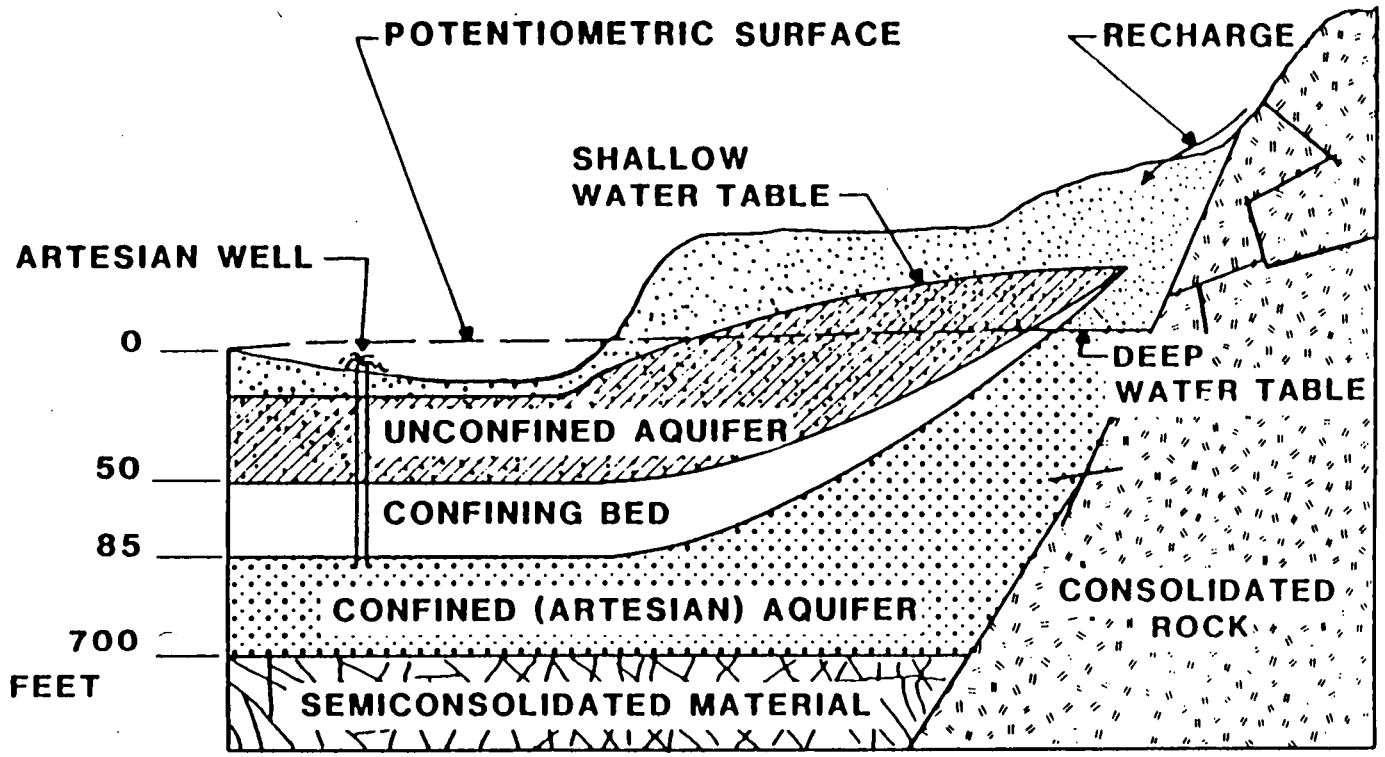

FIGURE D-1
GENERALIZED GROUNDWATER HYDROGEOLOGY
FOR THE SOUTHERN SALT LAKE CITY AREA

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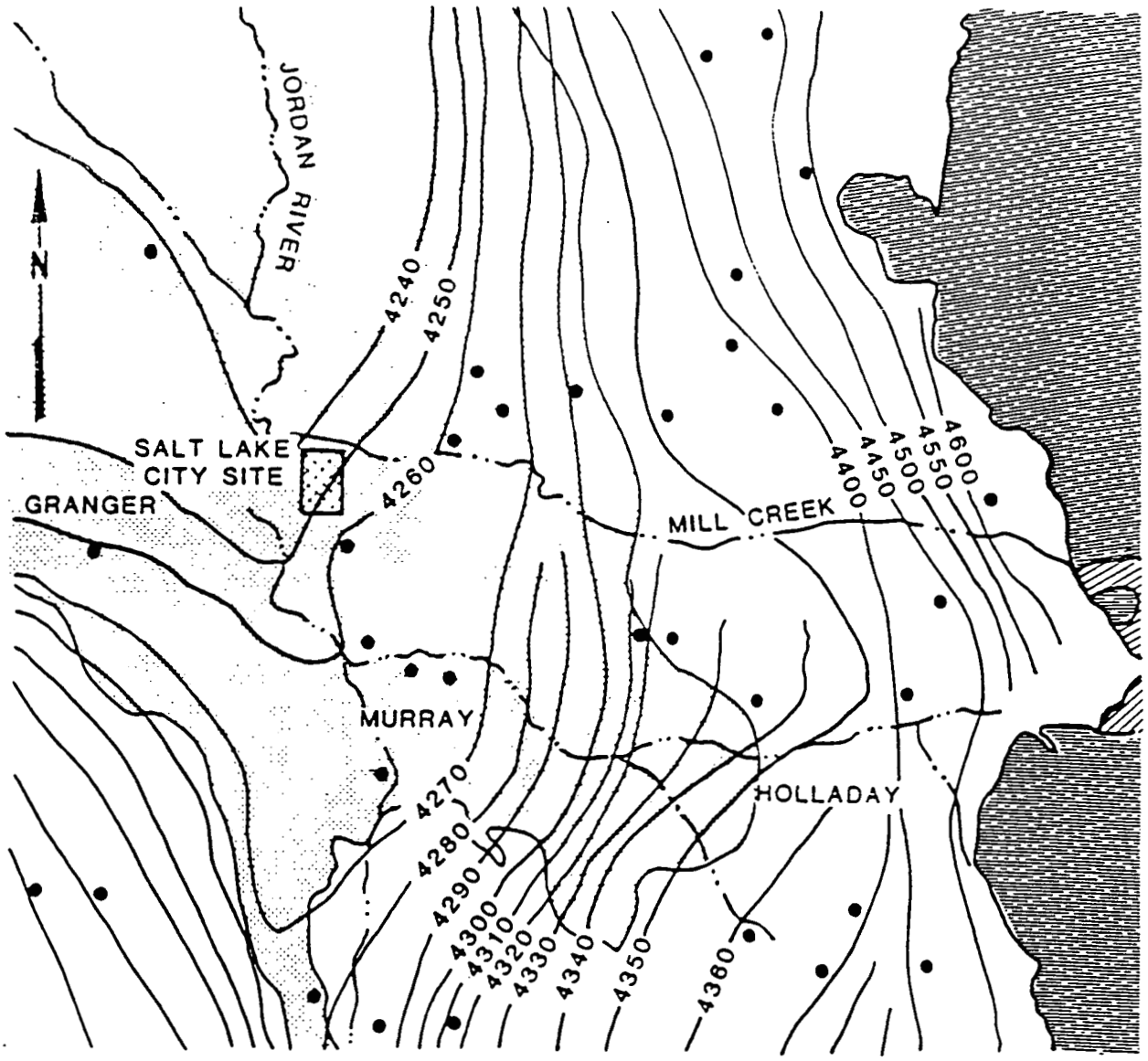


VALLEY FILL PERMEABILITY VARIABLE

ROCKS OF MODERATELY HIGH AND HIGHEST PERMEABILITY

ROCKS OF MODERATELY LOW AND LOWEST PERMEABILITY

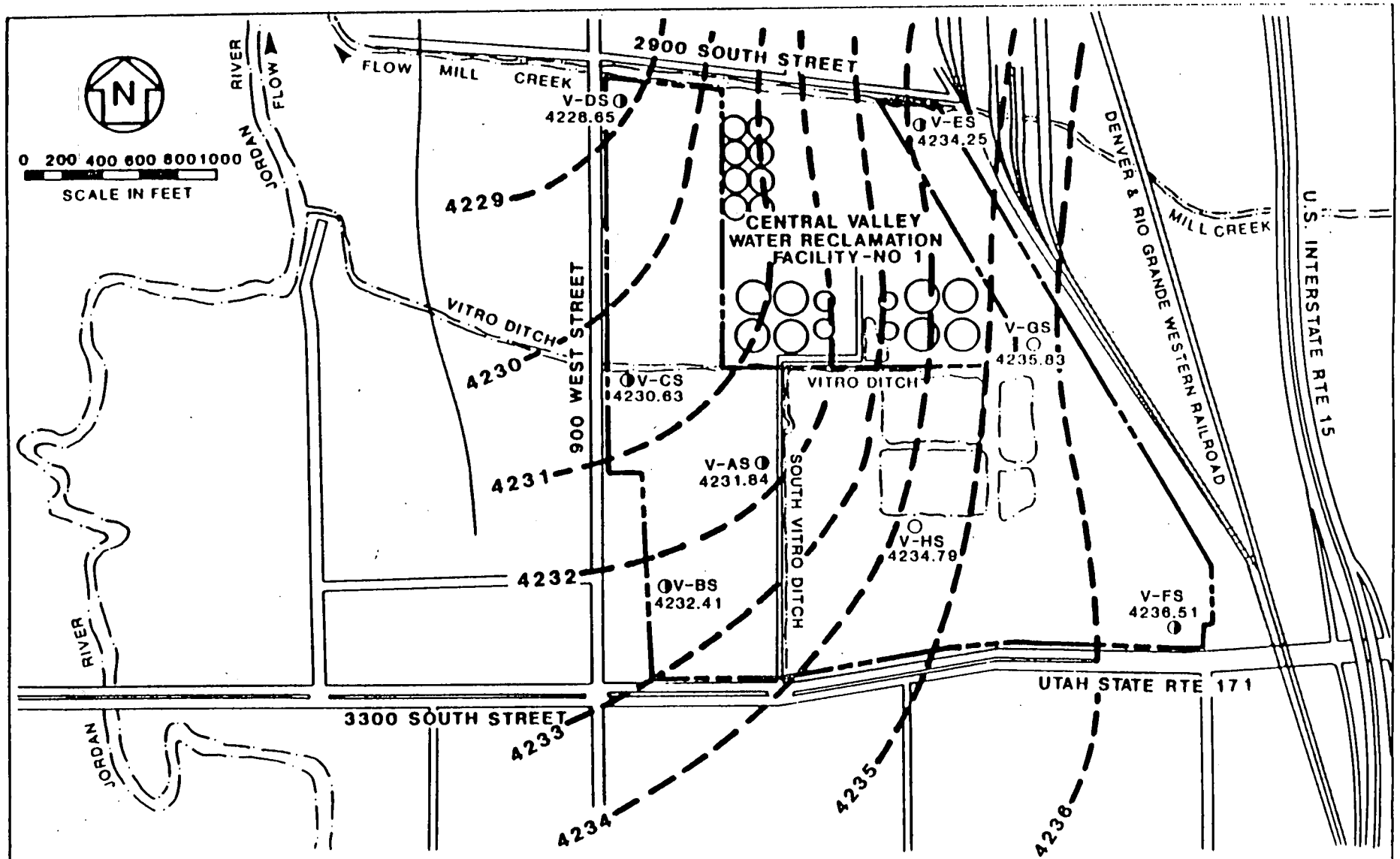
AREA OF ARTESIAN FLOW-FEBRUARY, 1969

4250 WATER-LEVEL CONTOUR

NOTE

ADAPED FROM HELY, MOWER, AND HARR, 1971.

FIGURE D-2
POTENTIOMETRIC SURFACE MAP OF THE CONFINED (ARTESIAN) AQUIFER FOR THE SOUTHERN SALT LAKE AREA



LEGEND

- ○ Shallow Well Location
- ◑ Deep and Shallow Well Location
- — — — Water Table Surface Contour

FIGURE D-3
HISTORIC WATER LEVELS IN THE UNCONFINED AQUIFER
SOUTH SALT LAKE SITE
MEASURED APRIL 1982

000487

Table D-1. EPA National Interim Drinking Water Standards (40 CFR 141, 143)

Parameter	Drinking water standards[a] primary	secondary
Arsenic	0.05	--
Barium	1.0	--
Cadmium	0.01	--
Chromium	0.05	--
Copper	--	1.0
Fluoride	1.4-2.4	--
Lead	0.05	--
Mercury	0.002	--
Nitrate	10.0	--
Selenium	0.01	--
Silver	0.05	--
Zinc	--	5.0
Chloride	--	250.0
Iron	--	0.3
Manganese	--	0.05
pH	--	6.5-8.5
Sulfate	--	250
TDS	--	500
Uranium (Health Advisory level) (in picocuries per liter)	10.0	--
Radium 226-228 combined (in picocuries per liter)	5.0	--
Gross alpha (in picocuries per liter)	15.0	--
Gross beta (in picocuries per liter)	50.0	--

[a]All values in mg/l unless otherwise noted.

- Numerical simulation of the steady-state water levels as compared to measured water levels (both aquifer systems).

- Calibration of present and historic rates and concentrations of contaminant migration, using total uranium and sulfate (i.e. the most representative mobile contaminants) as the key indicators in both systems.

- Prediction of post-remedial action, steady-state water level elevations for the unconfined aquifer.

- Prediction of post-remedial action rates and concentrations of contaminant migration (total uranium, sulfate, arsenic, and molybdenum).

D.2.3 Methods of calculation

- Detailed field investigations involving water-level monitoring, pump testing, and water sampling of both the unconfined system and the confined system were carried out by the TAC (1983) and Dames and Moore (1982). The data were analyzed for aquifer parameters such as hydraulic conductivity, transmissivity, storativity, and vertical and lateral hydraulic gradients[].

- The Illinois State Water Survey finite difference hydrodynamic flow model was used to simulate the hydrodynamic setting and predict the changes in the ground-water regime after remedial action (Prickett and Lonnquist, 1971). Input, output, calculation of the error tolerance, and several other parts of the program were modified or enhanced. The details of the modeling effort are presented in Sections D.3.4 and D.3.5.

- Contaminant migration was analyzed using the existing data base (TAC, 1983; Dames and Moore, 1982; and Markos and Bush, 1982) and the Prakash (1982) equations. The existing data were used to determine the lateral and vertical contaminant migration parameters, which were subsequently used to predict post-remedial action conditions.

- The ground-water chemistry was analyzed on the basis of chemical equilbria relations. The existing data were used to predict the migration from the tailings pile and subsequent precipitation of these constituents. The PHREEQE geochemical model (Parkhurst et al., 1980) was used to determine speciation.

000489

D.3 HYDROLOGY AND GROUND-WATER CHEMISTRY - VITRO SITE

D.3.1 Description of existing subsurface and ground-water setting

D.3.1.1 Data sources.

Subsurface explorations, monitoring well installation, hydrologic investigations involving pump testing of both aquifers, water-level monitoring, and sampling for water-quality testing have been carried out by various investigators at and near the Vitro site and in the Jordan River Valley. These investigators include Hely, Mower, and Harr (1971), Markos and Bush (1982), Dames and Moore (1982), and the TAC (1983). In addition, several studies using published data have been presented for the Salt Lake area in other references.

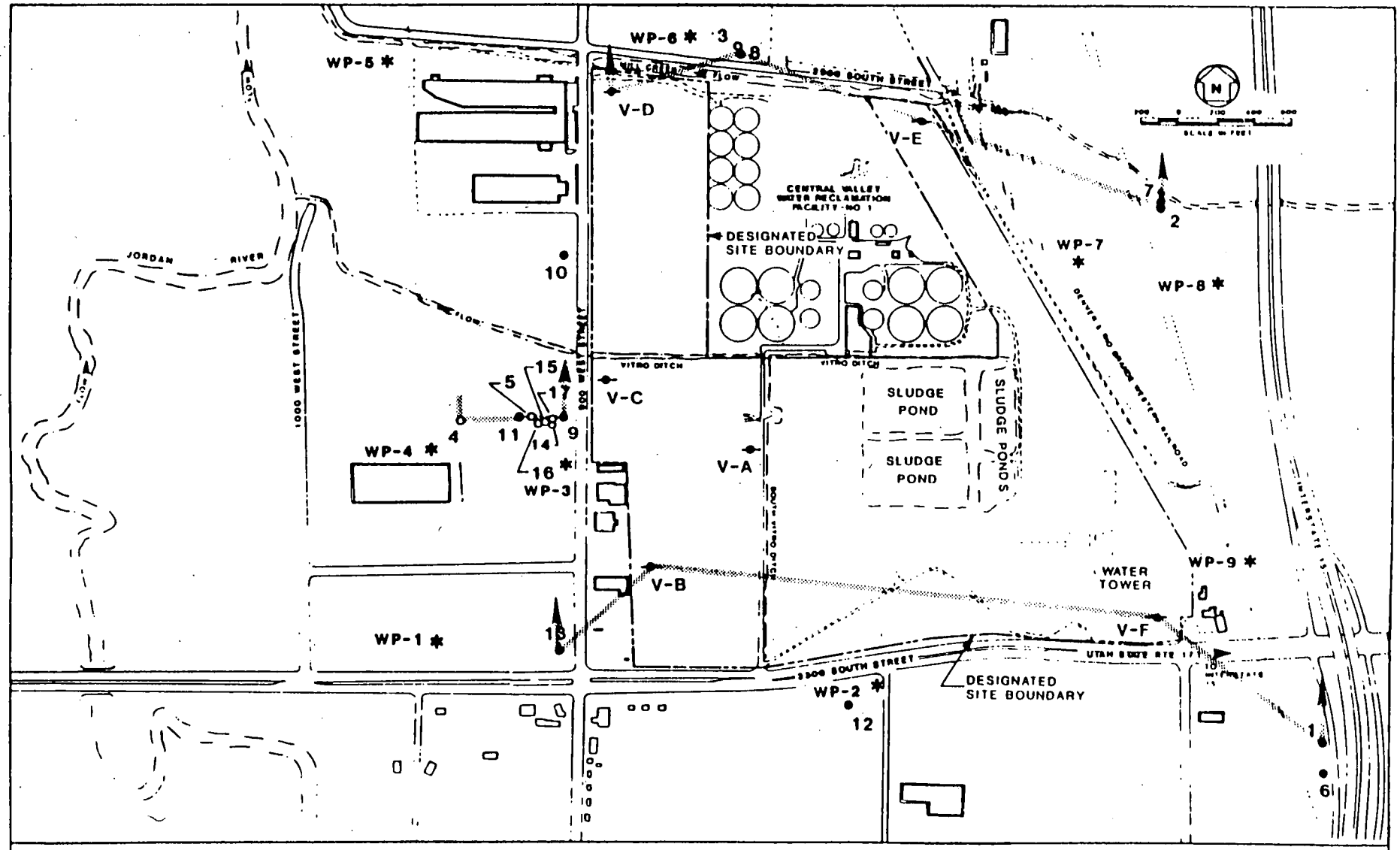
Several monitoring wells have been drilled (in 1982 and 1983) on and around the site both in the unconfined aquifer and the confined aquifer. During the first drilling program, 12 wells were completed in the shallow system (completion depths 50-60 feet) and 7 wells were completed in the deep system (completion depths 70-80 feet), (DOE, 1983). These wells are located within the Vitro site boundary, roughly defined as the quadrangle formed by 3300 South Street, 900 West Street, Mill Creek, and the Denver and Rio Grande Western Railroad.

During the second drilling program, 10 well points, 24 monitor wells, and 1 pump well were completed in the unconfined system. The 24 monitor wells are grouped in 8 nests with 3 wells per nest. Five monitor wells and one pump well were completed in the confined aquifer system. Also, two wells were completed to depths of 65.7 feet to 67.7 feet and 53.6 feet to 55.6 feet. These wells were used to isolate the confining layer between the unconfined and confined systems. Figure D-4 shows the location of the wells drilled in 1982 and in 1983 (TAC 1983), and Tables D-2 and D-3 describe the installation details for each well.

The first field testing program, in 1982, included a pump test on shallow, on-site well V-CS1 and 2 slug tests on well V-BS, 2 slug tests on well V-BD, 3 slug tests on well V-DS and 1 slug test each on wells V-ES, V-ED, V-FS, V-GS, and V-HS (Dames and Moore, 1982). The second field testing program, in 1983, included a pump test on deep, off-site well No. 15, and another pump test on shallow, off-site well No. 14.

The first water-quality sampling program, in 1978 and 1979, included 7 surface-water samples, 2 from the Jordan River, 2 from Mill Creek and 1 each from Vitro Ditch, South Vitro Ditch, and the marsh east of the site. Also, 14 borehole water-samples were taken from the tailings pile (Markos and Bush, 1982).

The second water-quality sampling program, in 1982, included 17 samples, taken on various dates, from a total of 15 on-site wells. This program included 11 samples from 9 shallow wells and 6 samples from 6 deep wells. Each of the 17 samples was analyzed for 70 different constituents or parameters (DOE, 1983) (Table D-4).



LEGEND

- ✱ WELL POINT (WATER LEVELS ONLY)
- ○ DEEP WELL
- ●—○ PAIRED WELL (SHALLOW & DEEP) -DAMES & MOORE
- ● SHALLOW WELL
- ▲ ▲ LOCATION OF GEOLOGIC CROSS-SECTIONS SEE FIGURES D-5, D-6, AND D-7

FIGURE D-4
LOCATION MAP OF SAMPLING WELLS ON OR NEAR SOUTH SALT LAKE SITE

000491

Table D-2. Well completion data, Vitro site, TAC (1983) wells

TAC well No.	Total[a] depth Ft.	Screened[a] interval Ft.	Blank[a] interval Ft.	Ground elev. Ft.	Collar elev. Ft.	Location[b]
1	115	100-110	0-100	4244.96	4246.47	U
2	135	119-129	0-119	4238.07	4239.07	U
3	125	110-120	0-110	4234.13	4235.74	C
4	137	105-115	0-105	4234.37	4235.62	D
5	132	115.5-125.5	0-115.5	4234.92	4237.41	D
6A	31.5	26-28	0-26	4244.61	4246.42	U
6B	20	17-19	0-17	4244.68	4246.51	U
6C	10	7-9	0-7	4244.71	4246.46	U
7A	35	26-28	0-26	4237.97	4240.30	U
7B	25	15-17	0-15	4238.02	4240.53	U
7C	15	8-10	0-8	4237.98	4239.81	U
8A	40	26-28	0-26	4233.13	4236.20	C
8B	35	19-21	0-19	4233.13	4235.40	C
8C	10	6-8	0-6	4233.13	4235.53	C
9A	35	27-29	0-27	4233.17	4234.80	D
9B	25	16-18	0-16	4232.97	4235.05	D
9C	15	6-8	0-6	4233.02	4235.73	D
10A	36.5	26-28	0-26	4234.60	4236.95	D
10B	20	14.5-16.5	0-14.5	4234.65	4236.67	D
10C	10	6-8	0-6	4234.55	4236.80	D
11A	31.5	24-26	0-24	4234.52	4236.54	D
11B	20	17-19	0-17	4234.62	4236.34	D
11C	15	6-8	0-6	4234.82	4236.54	D
12A	31.5	26-28	0-26	4235.90	4238.04	C
12B	20	17-19	0-17	4236.06	4237.87	C
12C	10	6.5-8.5	0-6.5	4235.95	4237.96	C
13A	31.5	26-28	0-26	4235.70	4238.41	D
13B	20	16-18	0-16	4235.75	4238.23	D
13C	10	6-8	0-6	4235.75	4237.95	D
14	41.5	18-38	0-18	4233.27	4235.40	D
15	133	102-112	0-102	4233.73	4235.20	D
16	71	66-68	0-66	4234.47	4236.80	D
17	60	54-57	0-54	4233.40	4235.80	D
WP-1	9	7-9	0-7	4235.52	4237.42	C
WP-2	6	4-6	0-4	4233.87	4236.20	D
WP-3	8.5	6.5-8.5	0-6.5	4233.37	4235.79	D
WP-4	7	5-7	0-5	4233.35	4235.70	D
WP-5	8.5	6.5-8.5	0-6.5	4232.09	4234.29	D
WP-6	9.5	7.5-9.5	0-7.5	4231.18	4233.31	D
WP-7	10	8-10	0-8	4236.68	4238.47	C
WP-8	7	5-7	0-5	4236.62	4237.71	U
WP-9	10	8-10	0-8	4238.02	4239.29	U
WP-10	10	8-10	0-8	4236.25	4237.90	U

[a]All depths from ground surface.
[b]Where: U = upgradient
C = crossgradient
D = downgradient

Table D-3. Well construction details, Vitro site

Well number[a]	Blank interval (ft)[b]	Screened interval (ft)	Sand pack interval (ft)	Grout seal interval (ft)	Bentonite seal interval (ft)
V-Ad1 obs. N	+2.0 - 98.0	98.0 - 128.0	65.0		
s. N	+2.5 - 97.5	97.5 - 127.5	92.0 - 137.0	0.0 - 90.0	90.0 - 92.0
	127.5 - 130.5				
V-AD3 pumping	+2.0 - 98.0	98.0 - 128.0	96.0 - 130.0	0.0 - 91.0	91.0 - 96.0
V-AS1 obs. N	+1.5 - 13.4	13.4 - 18.7	12.5 - 19.7	0.0 - 11.0	11.0 - 12.5
	18.7 - 19.7				
V-AS2 pumping	+2.0 - 13.0	13.0 - 19.0	12.0 - 22.0	0.0 - 11.0	11.0 - 12.0
	19.0 - 22.0				
V-AS3 obs. S	+2.0 - 10.0	10.0 - 20.0	9.0 - 22.0	0.0 - 8.5	8.5 - 9.0
	20.0 - 22.0				
V-BD	+3.0 - 85.0	85.0 - 95.0	82.0 - 97.0	0.0 - 80.0	80.0 - 82.0
	95.0 - 98.0				
V-BS	+2.0 - 15.0	15.0 - 20.0	14.5 - 25.0	0.0 - 13.5	13.5 - 14.5
	20.0 - 25.0				
V-CD	+2.0 - 105.0	105.0 - 115.0	80.0 - 118.0	0.0 - 80.0	None
	115.0 - 118.0				
V-CS pumping	0.0 - 14.5	14.5 - 37.5	Unknown	Unknown	Unknown
	37.5 - 39.5				
V-CS obs. N	0.0 - 17.0	17.0 - 27.0	None	Unknown	Unknown
	27.0 - 29.0	29.0 - 39.0			
	39.0 - 42.0				
V-CS obs. S	0.0 - 11.5	11.5 - 26.5	Unknown	Unknown	Unknown
	26.5 - 28.5	28.5 - 38.5			
	38.5 - 41.5				
V-DD	+1.5 - 80.0	80.0 - 90.0	75.0 - 90.0	0.0 - 73.0	73.0 - 75.0
V-DS	1.3 - 13.0	13.0 - 23.0	12.0 - 27.0	0.0 - 11.5	11.5 - 12.0
	23.0 - 25.0				
V-ED	+2.6 - 74.0	74.0 - 89.0	70.0 - 92.0	0.0 - 63.0	63.0 - 70.0
	89.0 - 92.0				
V-ES	+1.6 - 14.5	14.5 - 29.5	13.0 - 30.0	0.0 - 11.0	11.0 - 13.0
	29.5 - 31.0				

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Table D-3. (Continued)

Well number[a]	Blank interval (ft)[b]	Screened interval (ft)	Sand pack interval (ft)	Grout seal interval (ft)	Bentonite seal interval (ft)
V-FS	0.0 - 30.0	30.0 - 40.0	27.0 - 40.0	0.0 - 25.0	25.0 - 27.0
V-FD	0.0 - 81.5	81.5 - 91.5	63.0 - 91.5	0.0 - 63.0	
V-GS	+1.5 - 25.0 35.0 - 36.5	25.0 - 35.0	23.0 - 35.0	0.0 - 21.0	21.0 - 23.0
V-HS	+3.0 - 35.0	35.0 - 45.0	Unknown	Unknown	Unknown

[a]For well locations, see Figure D-4 (all wells located on the site).
[b]"+" denotes portion of well above ground surface.

Ref. DOE 1983

000494

6442

Table D-4. Ground-water quality, 1982

Parameter[b]	Well number[a]						
	V-HS	V-CD	V-ED	V-DD	V-CS	V-DS	V-ES
Date sampled	2/9/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	0.02	<0.01	0.02	<0.01	0.05	0.10	<0.01
Arsenic - total (As)	0.02	<0.01	0.02	<0.01	0.05	0.10	0.02
Barium (Ba)	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Barium - total (Ba)	0.5	0.3	<0.1	<0.1	<0.1	<0.1	<0.1
Boron (B)	0.68	0.21	0.35	0.20	0.98	1.31	0.92
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (Cr)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium - total (Cr)	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (Co)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Cu)	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper - total (Cu)	0.16	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe)	0.11	0.51	0.45	0.12	21.0	54.0	<0.05
Iron - total (Fe)	44.0	0.56	0.92	0.52	23.00	58.00	0.24
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead - total (Pb)	0.3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium (Mg)	320	50.0	23.0	22.0	210	390	290
Manganese (Mn)	0.64	0.31	0.15	0.06	1.43	3.88	0.12
Manganese - total (Mn)	1.85	0.29	0.13	0.06	1.37	4.02	0.14
Mercury - total (Hg)	0.5	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
(in micrograms per liter)							
Molybdenum (Mo)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel (Ni)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Potassium (K)	140	13.0	25.0	12.0	38.0	24.0	44.0
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	2,000	27.0	76.0	30.0	340	240	420
Sodium - total (Na)	2,000	27.00	76.0	30.0	340	240	420
Strontium (Sr)	1.79	0.90	0.23	0.33	2.11	5.50	3.16
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	0.02	0.01	<0.01	0.02	0.01	0.05	0.02
Zinc - total (Zn)	0.25	0.01	0.01	0.02	0.01	0.05	0.02

000495

Table D-4. (continued)

Parameter[b]	Well number[a]							
	V-HS	V-AD	V-AS	V-GS	V-FD	V-BS	V-FS	V-BD
Date sampled	4/14/82	4/15/82	4/15/82	4/15/82	4/15/82	4/21/82	4/21/82	4/21/82
Aluminum (Al)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic (As)	0.05	< 0.01	0.09	0.05	< 0.01	< 0.05	0.09	0.01
Arsenic - total (As)	0.05	< 0.01	0.09	0.05	< 0.01	0.05	0.09	0.01
Barium (Ba)	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Barium - total (Ba)	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1
Boron (B)	0.84	0.14	2.09	0.41	0.10	1.96	0.26	0.18
Cadmium (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium - total (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium - total (Cr)	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05	< 0.01
Cobalt (Co)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Copper (Cu)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Copper - total (Cu)	0.09	< 0.01	< 0.01	0.06	< 0.01	0.04	0.30	< 0.01
Iron (Fe)	0.19	0.58	< 0.05	0.46	0.18	12.0	0.18	0.61
Iron - total (Fe)	20.20	< 0.70	0.33	15.10	0.20	18.00	70.00	0.90
Lead (Pb)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Lead - total (Pb)	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.14	0.05
Magnesium (Mg)	260	23.0	670	39.0	21.0	530	35.0	33.0
Manganese (Mn)	0.36	0.13	0.07	0.07	0.03	1.77	0.17	0.18
Manganese - total (Mn)	0.91	0.13	0.07	0.37	0.04	1.85	1.60	0.16
Mercury - total (Hg) (in micrograms per liter)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.3	< 0.3	< 0.3
Molybdenum (Mo)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel (Ni)	< 0.05	0.05	0.10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Potassium (K)	110	9.10	110	34.0	5.70	130	26.0	11.0
Selenium (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Selenium - total (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver - total (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium (Na)	1,500	19.0	1,470	72.0	15.0	820	22.0	24.0
Sodium - total (Na)	1,500	19.0	1,470	72.0	15.0	820	22.0	24.0
Strontium (Sr)	1.65	0.27	11.10	0.19	0.30	8.60	0.13	0.46
Vanadium (V)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc (Zn)	0.11	0.04	0.32	0.10	0.15	0.05	0.01	0.02
Zinc - total (Zn)	0.19	0.04	0.35	0.16	0.15	0.05	0.37	0.02

000496

6442

Table D-4. (continued)

Parameter[b]	Well number[a]						
	V-HS	V-CD	V-ED	V-DD	V-CS	V-DS	V-ES
Date sampled	2/9/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82
Ammonia (NH_3-N) (un-ionized)	0.10	0.11	0.18	0.13	0.05	0.05	0.05
Bicarbonate (HCO_3)	586	225	443	352	604	1,186	377
Carbonate (CO_3)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Calcium (Ca)	150	120	28.0	48.0	220	550	210
Chloride (Cl)	2,686	156	21.7	11.7	332	319	501
Chloride - total (Cl)	2,853	158	24.9	12.8	354	323	507
Conductivity - field (in micromhos per centimeter)	22,000	1,200	640	500	4,100	5,200	5,000
Cyanide - total (CN)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoride (F)	1.36	0.22	0.35	0.27	3.33	0.79	0.62
Fluoride - total (F)	1.36	0.23	0.36	0.29	3.34	0.79	0.63
Hydroxide (OH)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nitrate (NO_3-N)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	15.3
Nitrate - total (NO_3)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	15.3
pH - field	7.8	7.8	7.8	8.0	6.9	6.6	7.6
pH - lab @25°C	8.30	8.00	8.01	8.20	7.50	7.25	8.08
Phenol	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Phosphate - total (PO_4-P)	0.38	0.38	0.69	0.48	1.69	0.49	0.32
Redox potential (EH) (in millivolts)	102	178	210	218	149	121	131
Salinity - field (0/00)	-	-	-	-	-	-	-
Sulfate (SO_4)	1,822	205	5	5	1,272	2,210	1,598
Sulfate - total (SO_4)	1,914	206	5.4	5	1,340	2,212	1,639
Sulfide (H_2S)	< 0.05	< 0.05	0.09	0.07	0.08	< 0.05	< 0.05
Temperature - field (°C)	10.3	12.2	13.3	11.7	13.3	12.2	12.2
Total alkalinity (as $CaCO_3$)	501	202	384	303	521	1,017	328
Total dissolved solids as calcium)	7,449	750	406	320	2,876	4,304	3,470
Total hardness (as $CaCO_3$)	1,691	505	164	210	1,413	2,978	1,718
Total organic carbon	9	10	17	11	16	27	14

000492

Table D-4. (continued)

Parameter[b]	Well number[a] V-AS-2	V-AS-2
Date sampled	7/18/82	11/8/82
Ammonia (NH_3-N) (un-ionized)	0.14	1.44
Bicorbonate (HCO_3)	1,525	1,144
Carbonate (CO_3)	1	1
Calcium (Ca)	470	410
Chloride (Cl)	122	721.3
Chloride - total (Cl)	128.6	720.1
Conductivity - field (in micromhos per centimeter)	2,000	9,200
Cyanide - total (CN)	0.005	0.05
Fluoride (F)	2.90	3.5
Fluoride - total (F)	2.9	3.7
Hydroxide (OH)	0.5	0.5
Nitrate (NO_3-N)	0.1	0.1
Nitrate - total (NO_3)	0.1	0.5
pH - field	7.1	7.14
pH - lab @25°C	7.43	7.63
Phenol	0.005	0.005
Phosphate - total (PO_4-P)	0.38	0.17
Redox potential (EH) (in millivolts)	117	189
Salinity - field (0/00)	-	-
Sulfate (SO_4)	6,008	3,917
Sulfate - total (SO_4)	6,016.0	3,950
Sulfide (H_2S)	0.05	0.06
Temperature - field (°C)	15.0	13.5
Total alkalinity (as $CaCO_3$)	1,293	962
Total dissolved solids (as calcium)	10,592	8,096
Total hardness (as $CaCO_3$)	4,178	3,247
Total organic carbon	11	7

000498

6442

Table D-4. (continued)

Parameter[b]	Well number[a]							
	V-HS	V-AD	V-AS	V-GS	V-FD	V-BS	V-FS	V-BD
Date sampled	4/14/82	4/15/82	4/15/82	4/15/82	4/15/82	4/21/82	4/21/82	4/21/82
Ammonia (HH_3-N) (un-ionized)	0.33	0.14	< 0.05	0.31	0.13	< 0.05	0.11	0.12
Bicarbonate (HCO_3)	556	309	1,507	385	290	1,229	354	279
Carbonate (CO_3)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Calcium (Ca)	95.0	55.0	390	30.0	62.0	410	28.0	90.0
Chloride (Cl)	2,245	29.6	918	110	16.1	736	13.9	90.1
Chloride - total (Cl)	1,508	29.6	918	110	16.1	747	15.0	91.2
Conductivity - field (in micromhos per centimeter)	18,000	620	17,000	1,050	570	8,000	630	1,000
Cyanide - total (CN)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoride (F)	0.62	0.11	2.09	0.45	0.12	6.01	0.59	0.26
Fluoride - total (F)	0.47	0.11	2.10	0.45	0.14	6.10	0.60	0.26
Hydroxide (OH)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nitrate (NO_3-N)	0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.1
Nitrate - total (NO_3)	0.2	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.2	0.1
pH - field	7.8	7.9	7.1	8.0	8.2	6.7	7.8	7.9
pH - lab @25°C	7.72	7.80	7.20	8.12	8.20	6.60	7.80	7.70
Phenol	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Phosphate - total (PO_4-P)	1.77	0.44	0.30	1.84	0.38	0.34	0.17	0.58
Redox potential (EH) (in millivolts)	114	209	130	182	228	122	224	181
Salinity - field (0/00)	-	-	-	-	-	-	-	-
Sulfate (SO_4)	1,236	< 5	4,612	23.0	44.4	3,008	< 5	96.3
Sulfate - total (SO_4)	567	8.2	4,642	41.2	46.9	3,020	< 5	96.7
Sulfide (H_2S)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Temperature - field (°C)	13.3	12.2	11.7	11.7	12.2	12.8	11.7	13.1
Total alkalinity (as $CaCO_3$)	485	273	1,275	335	253	1,047	369	248
Total dissolved solids (as calcium)	6,002	316	9,473	544	323	6,600	310	510
Total hardness (as $CaCo_3$)	1,307	232	3,731	235	241	3,205	213	360
Total organic carbon	26	10	14	14	30	25	10	12

000439

Table D-4. (continued)

Parameter[b]	Well number[a] V-AS	V-AS
Date sampled	7/18/82	11/8/82
Aluminum (Al)	< 0.01	< 0.1
Arsenic (As)	0.08	0.034
Arsenic - total (As)	0.10	0.048
Barium (Ba)	< 0.1	< 0.1
Barium - total (Ba)	< 0.1	< 0.1
Boron (B)	1.75	1.28
Cadmium (Cd)	< 0.01	< 0.01
Cadmium - total (Cd)	< 0.01	< 0.01
Chromium (Cr)	< 0.01	< 0.01
Chromium - total (Cr)	< 0.01	< 0.01
Cobalt (Co)	0.1	< 0.05
Copper (Cu)	< 0.01	< 0.01
Copper - total (Cu)	< 0.01	< 0.01
Iron (Fe)	0.13	0.13
Iron - total (Fe)	0.24	2.18
Lead (Pb)	< 0.05	< 0.01
Lead - total (Pb)	< 0.05	< 0.01
Magnesium (Mg)	730	540
Manganese (Mn)	0.06	0.05
Manganese - total (Mn)	0.07	0.11
Mercury - total (Hg) (in micrograms per liter)	< 0.3	< 0.3
Molybdenum (Mo)	0.2	0.1
Nickel (Ni)	< 0.05	< 0.05
Potassium (K)	120	110
Selenium (Se)	< 0.01	< 0.01
Selenium - total (Se)	< 0.01	< 0.01
Silver (Ag)	< 0.01	< 0.01
Silver - total (Ag)	< 0.01	< 0.01
Sodium (Na)	1,600	1,120
Sodium - total (Na)	1,600	1,090
Strontium (Sr)	10.00	9.5
Vanadium (V)	< 0.5	< 0.1
Zinc (Zn)	< 0.01	0.01
Zinc - total (Zn)	< 0.01	0.01

Table D-4. (continued)

Parameter[c]	Well number[a]						
	V-HS	V-CD	V-ED	V-DD	V-CS	V-DS	V-ES
Date sampled	2/9/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82	4/22/82
Gross alpha, total	0.0±39.7	0.7±5.6	11.8±6.5	0.0±3.0	77.0±35.0	3.7±30.0	21.0±28.0
Gross beta, total	71.4±173	10.6±6.7	25.6±5.0	10.6±4.2	39.0±39.0	36.0±38.0	52.0±39.0
Radium-226, total	3.8±0.4	0.9±0.2	4.5±0.4	0.5±0.1	7.4±0.5	1.1±0.2	1.0±0.2
Radium-228, total	8.7±3.3	0.0±2.3	0.6±2.6	0.0±2.7	2.0±2.4	0.0±2.4	0.7±2.7
Thorium-230, total	1.5±1.4	0.4±0.8	1.8±1.4	0.1±0.7	6.7±2.1	0.0±0.5	0.0±0.5
Lead-210, total	0.9±1.3	0.0±1.3	4.2±1.4	0.0±1.1	2.4±1.2	1.2±1.2	1.6±1.2
Polonium-210, total	1.7±1.7	0.7±0.5	2.0±0.6	0.3±0.4	2.0±0.7	2.1±0.7	0.5±0.3
Uranium (U_3O_8), dissolved	16.9	<0.7	0.7	<0.7	93.4	10.2	26.4
Uranium (U_3O_8), total	26.4	<0.7	0.7	<0.7	115.1	16.2	31.1

000501

Table D-4. (continued)

Parameter[c]	Well number[a]							
	V-HS	V-AD	V-AS	V-GS	V-FD	V-BS	V-FS	V-BD
Date sampled	4/14/82	4/15/82	4/15/82	4/15/82	4/15/82	4/21/82	4/21/82	4/21/82
Gross alpha, total	24.3±2.7	0.0±3.2	232±113	85.2±28.7	0.0±2.7	1,181±167	39.0±21.0	23.0±9.0
Gross beta, total	128±83.2	5.0±4.1	79.4±83.8	78.5±12.1	2.8±4.0	370.0±82.0	70.0±22.0	11.0±6.0
Radium-226, total	8.0±0.6	0.5±0.1	1.6±0.3	7.2±0.7	0.3±0.1	114±2.1	4.6±0.4	9.1±0.6
Radium-228, total	1.2±3.6	0.0±2.1	0.0±4.0	2.5±3.7	2.0±2.2	0.0±2.7	0.2±2.6	0.0±2.4
Thorium-230, total	2.7±1.6	0.2±0.3	0.9±0.8	4.7±1.8	0.2±0.3	28.9±2.5	1.8±1.4	0.0±1.1
Lead-210, total	19.9±2.0	0.3±1.2	6.6±1.5	6.7±1.6	0.5±1.4	161±4.5	7.0±1.3	3.2±1.1
Polonium-210, total	7.7±1.1	0.4±0.4	2.8±1.1	11.8±2.3	0.5±0.4	76.9±5.2	3.7±0.9	1.6±0.7
Uranium (U_3O_8), dissolved	2.7	< 0.7	83.9	4.1	< 0.7	249.1	2.7	< 0.7
Uranium (U_3O_8), total	3.4	< 0.7	83.9	10.2	< 0.7	744.7	6.1	< 0.7

000502

6442

Table D-4. (continued)

Parameter[c]	Well number[a] V-AS	V-AS
Date sampled	7/18/82	11/8/82
Gross alpha, total	183±114	281.8±78.9
Gross beta, total	84.1±72.8	117.9±54.1
Radium-226, total	1.9±0.3	7.3±0.5
Radium-228, total	0.4±2.1	3.9±3.1
Thorium-230, total	4.8±1.0	8.3±2.8
Lead-210, total	1.2±1.0	4.7±2.5
Polonium-210, total	0.8±0.7	10.3±2.0
Uranium (U_3O_8) dissolved	254.6	160.8
Uranium (U_3O_8), total	278.1	191.0

[a]For well locations, see Figure D-4.
[b]All values in mg/l on a dissolved basis, unless otherwise noted.
[c]Values in pCi/l.
Ref. DOE 1983

000503

Although Eh was measured in the field and reported on Table D-4, these values were not used in the geochemical modeling with PHREEQE (see Section D.3.5). The measured values may not be accurate because dissolved oxygen may have been greater than 0.01 mg/l. Dissolved oxygen was not measured. For the geochemical modeling, discussed in Section D.3.5, redox potential was estimated on the basis of a general understanding of the geochemical system.

The third sampling program, through September, 1983, included a total of 52 samples, taken on various dates, from 33 different wells and the CVWRF excavation. It was comprised of 33 samples from 22 shallow wells, 15 samples from 9 deep wells, 2 samples from 2 wells completed in or adjacent to the aquitard between the confined and unconfined systems, and 2 samples from the excavation. Five to 34 constituents were analyzed per sample (TAC, 1983). The sampled wells, the dates of sampling, and the analyses are shown in Table D-5. The State of Utah (1983) obtained 32 sample splits with samples collected during the 1983 program. These samples were analyzed for 13 to 18 parameters (Table D-6).

A set of standardized procedures was used for gathering, preserving, shipping, handling within the laboratory, and analyzing samples. Details of these procedures are available at the DOE Uranium Mill Tailings Remedial Action (UMTRA) Project office in Albuquerque, New Mexico. The determination of the concentration of most of the chemical constituents was done according to the analytical procedures of the United States Environmental Protection Agency (1979).

The following discussion summarizes the current understanding and interpretation of the stratigraphy, geohydrology, and ground-water chemistry in the general vicinity of the Vitro site.

D.3.1.2 Stratigraphic and hydrologic setting.

The general stratigraphy of the Jordan River Valley in the vicinity of the site consists of several hundred feet of unconsolidated to poorly consolidated alluvial and lacustrine deposits of interbedded and highly lenticular sands, silty sands, silts, and clays. The fine-grained deposits were laid down in the lake environment of the prehistoric Lake Bonneville. The coarser-grained soils were deposited as alluvium, probably along the margins of this prehistoric lake as the levels fluctuated and lowered to its present condition, the Great Salt Lake.

The field investigations in the vicinity of the Vitro site indicate that approximately the upper 85 feet of subsoil consists of interbedded fine sand, silty sand, clay, and silt. These beds are often laterally discontinuous and vary in thickness from a few inches to several feet. Generally, the upper 50 to 70 feet of this complex profile form the unconfined aquifer system. This unconfined aquifer generally overlies a stratum of interbedded layers of low-permeability clays and silts. Because materials of the unconfined aquifer are very similar to the underlying aquitard, the thickness of the unconfined aquifer varies and can only be estimated. Potentiometers installed between 10 and 60 feet below the ground surface revealed water levels at, slightly below,

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Table D-5. Ground-water quality, 1983

Parameter[b]	Well number[a]									
	6A	6B(split)	6C	7C	10C	9A	9B(split)	9C	13C	Excavation
NO_3	<1.0	1.0/1.7	1.0	1.0	110	1.0	1.0/1.9	1.0	3.0	2.0
Al	0.024	0.054/1.68	0.036	0.02	0.056	0.025	0.038/9.26	0.019	0.021	0.026
As	0.12	0.052/0.1	0.05	0.065	0.05	0.05	0.05/ 0.01	0.05	0.5	0.05
Ba	<0.5	0.5/ 0.01	0.5	0.5	0.5	0.5	0.5/ 0.01	0.5	0.5	0.5
Cd	<0.01	0.01/ 0.001	0.01	0.01	0.01	0.01	0.01/ 0.001	0.01	0.01	0.01
Cr	<0.05	0.05/ 0.05	0.05	0.05	0.05	0.05	0.05/ 0.05	0.05	0.05	0.05
Cu	<0.02	0.02/0.46	0.02	0.02	0.02	0.02	0.02/ 0.01	0.02	0.02	0.02
Fe	.028	0.066/0.70	0.036	3.7	0.042	8.9	33/41	0.1	0.012	1.6
Pb	<0.5	0.05/ 0.001	0.05	0.05	0.05	0.05	0.05/ 0.05	0.05	0.05	0.05
Hg	<0.002	0.002/ 0.002	0.002	0.002	0.002	0.002	0.003/0.1	0.002	0.002	0.002
Mo	<0.01	0.01/ 0.01	0.01	0.012	0.018	0.01	0.01/ 0.01	0.012	0.045	1.2
Ni	<0.5	0.5/ 0.1	0.05	0.5	0.5	0.5	0.5/ 0.1	0.5	0.5	0.5
Ca	31	140/0.13	560	290	620	230	440/504	430	23	330
Se	<0.01	0.01/ 0.01	0.01	0.01	0.01	0.01	0.01/ 0.01	0.01	0.01	0.01
Ag	<0.05	0.05/ 0.05	0.05	0.05	0.05	0.05	0.05/ 0.01	0.05	0.05	0.05
Zn	<0.5	0.5/ 0.1	0.5	0.5	0.5	0.5	0.5/ 0.01	0.5	0.5	0.5
Cl	230	1200. 1.0	4900	630	1200	4300	4200/880	2800	590	460
TDS	930	4010/3768	16100	4250	12300	14500	18300/17950	15800	2320	4340
SO_4	21	980/865	4300	1400	5200	4800	6600/7050	6600	250	1600
Na	180	1100/450	3000	450	920	3100	3200/1357	2400	760	550
Mg	76	160/178	700	330	1000	880	1300/233	1200	14	280
K	52	49/40	67	22	51	160	190/435	200	97	50
V	<0.01	0.01/ 0.1	0.01	0.01	0.01	0.01	0.01/5.56	0.01	0.04	0.01
Th-230 (pCi/l)	<1.0	1.0/ 1±1.0	1.0	1.0	1.0	1.0	1.0/ 1±1.0	1.0	1.0	1.0
Pb-210 (pCi/l)	<1.5	1.5/ 1.5±1.5	1.5	1.5	1.5	1.5	1.5/ 1/5±1/5	1.5	1.5	1.5
U(NAT)	0.003	0.0045/ 0.1	0.04	0.022	0.11	0.038	0.092/ 0.1	2.24	0.021	0.248
Gross A (pCi/l)	<80	200/ 5±2.5	600	200	400	600	600/ 5±2.5	800	200	200
Gross B (pCi/l)	<20	500/ 5±2.5	2000	500	1000	2000	2000/ 5±2.5	2000	500	500
Ra-226 (pCi/l)	<1.0	1.0/ 1±1.0	1.0	1.2	1.0	1.2	1.4/ 1±1.0	13.0	1.0	1.2
Ra-228 (pCi/l)	<2	2 / 1±1.0	2	2	2	2	2 / 1±1.0	2	2	2
Alkalinity	550	580/383	580	400	720	900	965/798	780	680	--
pH (s.u.)	7.48	7.35	7.01	7.26	6.92	6.97	6.58	6.85	7.98	6.85
temp (°C)	12	11	9	17	11	11.5	11.5	10	8	13
Cond (μmhos/cm)[e]	1200	4050	12500	4150	7800	12500	13500	10500	2375	3950
date sampled	4/13	4/13	4/13	3/30	3/29	4/10	4/10	4/10	4/5	3/30

Note: right-hand halves of split samples represent analyses done by a laboratory which was later found to report inconsistent results.

Table D-5. (continued)

Parameter[b]	14[c]	Well number[a] 14[d]	16	17	4	V-BD	V-BS(split)	V-DS	V-DD
NO_3	--	--	--	--	--	--	--/ 0.2	--	--
Al	<0.01	<0.01	--	--	--	<0.01	0.07/ 9.94	<0.01	<0.01
As	<0.01	<0.01	--	--	--	<0.01	0.05/<0.002	0.04	<0.01
Ba	0.02	0.02	--	--	--	0.34	0.02/ 0.08	0.02	0.12
Cd	<0.01	<0.01	--	--	--	<0.01	<0.01/ 0.04	<0.01	<0.01
Cr	<0.01	<0.01	--	--	--	<0.01	<0.01/ 0.13	<0.01	<0.01
Cu	<0.01	<0.01	--	--	--	<0.01	0.01/ 0.85	<0.01	<0.01
Fe	10.3	25	1.3	0.6	4.6	0.2	<21/<6.11	6.5	0.13
Pb	0.01	<0.01	--	--	--	<0.01	<0.01/<0.001	<0.01	<0.01
Hg	<0.002	<0.002	--	--	--	<0.002	0.002/<0.002	<0.002	<0.002
Mo	<0.02	<0.02	--	--	--	<0.01	0.08/<0.005	<0.01	<0.01
Ni	<0.05	<0.05	--	--	--	<0.05	<0.05/ 0.39	0.05	<0.05
Ca	400	<400	41	44	250	75	470/ 460	390	47
Se	<0.01	<0.01	--	--	--	<0.01	<0.01/<0.002	<0.01	<0.01
Ag	<0.01	0.01	--	--	--	<0.01	<0.01/<0.76	<0.01	<0.01
Zn	0.1	0.15	--	--	--	<1	<1/<0.01	<1	<1
Cl	3600	3800	11	13	410	76	560/11.4	160	13
TDS	20000	20000	350	420	1800	510	6900/2904	2900	125
SO_4	7500	7800	5	7	590	73	3200/750	1300	<15
Na	3400	4000	26	29	86	20	700/ 45	200	30
Mg	1320	1325	25	28	100	30	525/ 160	186	23
K	166	167	19	20	22	12	121/ 31	17	13
V	0.02	<0.01	--	--	--	<0.01	<0.01/ 0.31	<0.01	<0.01
Th 230 (pCi/l)	<1.0	<1.0	--	--	--	<1.0	<1.0/<1±1.0	<1.0	<1.0
Pb 210 (pCi/l)	<1.5	<1.5	--	--	--	<1.5	<1.5/<1.5±1.5	<1.5	<1.5
U (ppm)	0.12	0.12	<0.003	<0.003	0.003	<0.003	0.33/<0.1	0.54	<0.003
Gross A (pCi/l)	<200	<200	--	--	--	<15	290/<5±2.5	350	<15
Gross B (pCi/l)	<600	<600	--	--	--	<50	370/<5±2.5	210	<50
Ra-226 (pCi/l)	<1.0	<1.0	--	--	--	<1.0	14/<1±1.0	<1.0	2.8
Ra-228 (pCi/)	--	--	--	--	--	--	--/<1±1.0	--	--
Alkalinity	1000	1080	310	294	280	240	1090/ 674	594	280
Sr 8.4	8.4	--	--	--	0.76	8.4/ --	4.5	0.44	
pH (s.u.)	6.66	6.66	7.68	7.85	6.68	7.65	6.51	6.78	7.7
temp (°C)	11.5	11.5	14	21	12.5	12.5	13.2	14	12.0
cond (mhos/ cm)[e]	14500	14800	420	550	1680	580	5300	2450	398
date sampled	6/2	6/2	6/30	6/30	6/29	6/6	6/10	6/7	6/6

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Table D-5. (continued)

Parameter[b]	Well number[a]								
	BB	12C	5	1(split)	3	2	V-CD	15***	15****
NO_3	<1	2	<1	<1/3.32	1	1	8	--	--
Al	<0.01	<0.01	<0.01	<0.01/0.52	0.01	0.01	0.01	0.01	0.01
As	<0.01	0.02	<0.01	0.03/0.57	0.01	0.01	0.01	0.01	0.01
Ba	<1.0	<1.0	<1.0	<1.0/0.14	1.0	1.0	1.0	1.0	1.0
Cd	<0.01	<0.01	<0.01	<0.01/<0.01	0.01	0.01	0.01	0.01	0.01
Cr	<0.01	<0.01	<0.01	<0.01/<0.05	0.01	0.01	0.01	0.01	0.01
Cu	0.02	<0.01	<0.01	<0.01/<0.02	0.01	0.01	0.01	0.01	0.01
Fe	14	0.02	0.62	0.21	0.32	0.61	0.22	1.3	0.04
Pb	<0.05	<0.05	<0.05	<0.05/<0.05	0.05	0.05	0.05	0.05	0.05
Hg	<0.002	<0.002	<0.002	0.002	0.002	0.002	0.002	0.002	0.002
Mo	0.02	0.02	<0.01	<0.01/<0.01	0.01	0.01	0.01	0.01	0.01
Ni	<1	<1	<1	<1/0.1	1	1	1	1	1
Ca	480	160	80	80/49.14	50	50	140	180	180
Se	<0.01	<0.01	<0.01	0.01/ 0.01	0.01	0.01	0.01	0.01	0.01
Ag	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zn	<1.0	<1.0	<1.0	0.1/ 0.1	1.0	1.0	1.0	1.0	1.0
Cl	1200	320	85	10	13	10	220	310	310
TDS	5800	1654	580	330/388	300	288	864	1242	1343
SO_4	2000	410	110	10/4.0	20	10	230	340	340
Na	650	140	26	14/6.57	19	30	24	42	43
Mg	300	130	40	23/23.0	20	20	62	80	80
K	15	39	13	8.4/0.01	5.6	10	14	15	15
V	<0.01	0.01	<0.01	0.02/ 0.06	0.01	0.01	0.01	0.01	0.01
Th-230(pCi/l)	<1.0	<1.0	<1.0	1.0/1.0±1.0	1.0	1.0	1.0	1.0	1.0
Pb-210(pCi/l)	<1.5	<1.5	3	1.5/1.5±1.5	2	2	1.5	1.5	1.5
U(ppm)	0.013	0.017	<0.003	0.011/ 0.1	0.003	0.003	0.003	0.003	0.003
Gross A (pCi/l)	<300	<45	<45	30/5.0±2.5	30	30	20	100	100
Gross B (pCi/l)	<300	<50	<50	50/5.0±2.5	50	50	50	100	100
Ra-226 (pCi/l)	2.1	<1	<1.0	1.0/1.0±1.0	2.0	1.0	1	1	1
Ra-228 (pCi/l)	--	--	2	2/1.0±1.0	--	--	--	--	--
Alkalinity	--	520	--	--	--	--	195	200	200
pH (s.u.)	6.85	7.08	7.21	7.73	7.78	7.25	7.35	7.49	7.46
temp (°C)	9	10	13	15	12	12	130	17	14
cond (mhos/ cm)[e]	4350	1650	700	385	352	370	1000	1210	1600
date sampled	5/11	5/17	5/5	5/5	5/11	5/12	5/17	5/21	5/23

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Table D-5. (continued)

Parameter[b]	Well number[a]														
	6A	6B	6C	7A	7B	7C	9A	9B	9C	10A	10B	10C	11A	11B	11C
NO_3	--	--	--	--	--	--	--	--	--	--	0.9	--	--	--	--
Al	--	--	--	<0.01	0.03	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
As	--	--	--	0.06	0.07	0.06	--	--	--	<0.01	<0.01	<0.01	--	--	--
Ba	--	--	--	0.07	0.05	0.05	--	--	--	0.03	0.03	0.03	--	--	--
Cd	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
Cr	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
Cu	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	0.01	--	--	--
Fe	--	--	--	0.04	1.4	3.2	--	--	--	6.4	17.5	<0.01	12	16	0.28
Pb	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
Hg	--	--	--	<0.002	<0.002	<0.002	--	--	--	<0.002	<0.002	<0.002	--	--	--
Mo	--	--	--	0.02	0.01	0.02	--	--	--	<0.01	<0.01	<0.01	--	--	--
Ni	--	--	--	<0.05	<0.05	<0.05	--	--	--	<0.05	<0.05	<0.05	--	--	--
Ca	--	--	--	30	165	315	--	--	--	350	625	800	--	--	--
Se	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
Ag	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	<0.01	--	--	--
Zn	--	--	--	<1	<1	<1	--	--	--	<1	<1	<1	--	--	--
Cl	--	--	--	78	330	860	--	--	--	2400	520	1400	5400	4900	3300
TDS	1000	5800	16000	810	2200	4600	8900	19000	17000	18000	7500	7700	21000	20000	20000
SO_4	--	--	--	110	820	2000	--	--	--	7100	3300	6600	7500	7500	6300
Na	--	--	--	170	300	500	--	--	--	2800	500	1100	--	--	--
Mg	--	--	--	46	182	385	--	--	--	1325	535	1130	--	--	--
K	--	--	--	28	27	20	--	--	--	123	42	52	--	--	--
V	--	--	--	<0.01	<0.01	<0.01	--	--	--	<0.01	<0.01	0.01	--	--	--
Th 230 (pCi/l)	--	--	--	<1.0	<1.0	<1.0	--	--	--	<1.0	<1.0	<1.0	--	--	--
Pb 210 (pCi/l)	--	--	--	2	<1.5	<1.5	--	--	--	3	<1.5	2	--	--	--
U (ppm)	--	--	--	<0.003	0.012	0.02	0.025	0.13	2.12	0.01	0.014	0.11	0.14	0.57	1.87
Gross A (pCi/l)	--	--	--	<20	<120	<100	--	--	--	<200	<200	<200	--	--	--
Gross B (pCi/l)	--	--	--	<60	<350	<300	--	--	--	<600	<600	<600	--	--	--
Ra-226 (pCi/l)	--	--	--	3.2	<1.0	14	--	--	--	1.5	<1.0	<1.0	2.0	2.1	3.2
Ra-228 (pCi/l)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sr	--	--	--	0.43	1.9	8.4	--	--	--	6.9	7.6	11	--	--	--
Alkalinity	530	510	560	456	400	400	650	1400	900	1000	870	770	840	870	840
pH (s.u.)	7.6	7.41	7.2	7.55	7.47	7.47	7.46	6.77	6.79	7.05	6.60	6.88	6.96	6.93	6.90
temp (°C)	16	16	17	14	21	20.5	18.	18.3	15.0	12	13	12	13.0	12.0	13
cond (mhos/cm)[e]	1380	6500	16000	950	2500	5000	9500	15900	12700	12000	5400	8800	17300	15900	13500
date sampled	6/10	6/10	560	6/9	6/9	6/9	6/9	6/9	6/9	6/8	6/7	6/7	6/9	6/9	6/9

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Table D-5. (continued)

Parameter[b]	Excavation drain	V-FS	4	5	15	private well
As	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fe	4.4	0.22	2.4	0.12	2.1	4.2
Mo	0.87	<0.01	<0.01	<0.01	<0.01	<0.01
Ca	300	26	220	80	180	81
cl	560	11	310	100	270	410
TDS	4722	340	1513	628	1120	2038
SO_4	2100	<5	510	140	390	680
Mg	310	35	94	42	79	240
K	55	30	28	16	18	23
Mn	1.1	0.05	0.60	0.35	0.45	0.75
Pb-210 (PCi/l)			<1.5	<1.5	1.8	
u (ppm)	0.240	0.003	<0.003	<0.003	<0.003	<0.003
Alkalinity	640	290	260	250	200	245
pH (s.u.)	6.95	7.38	7.25	7.34	7.38	7.25
temp (°C)	18	15	14.0	13.5	13.2	15.0
Cond (mhos/ cm)[e]	4150	425	1610	700	1230	2090
date sampled (1983)	8/22	8/24	8/22	8/22	8/23	8/26

Note: private artesian well located at 3181 So. 1100 W. St.

[a]For well locations see Figure D-4.
[b] All values in milligrams per liter on a dissolved basis, except as noted.
[c]Middle of pump test.
[d]End of pump test.
[e]Not corrected to 25°C.

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Table D-6. Ground-water quality, State of Utah samples, 1983

Parameter[b,c]	Excavation drain	15	15	14	14	13C	12C	11C	11B	11A	9C	9B	10C
	Well number[a]												
As	0.007	<0.0005	<0.0005	0.003	0.003	0.525	0.020	0.012	0.035	0.013	0.003	0.001	0.011
Ba		0.37	0.30	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Cd		<0.001	<0.001	0.005	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
Cr	<0.005	<0.005	<0.006	0.005	<0.005	0.005	<0.005	0.015	0.030	0.030	<0.005	0.005	0.006
Cu	<0.010	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.10	<0.010	<0.010	0.010	0.015
Fe	2.30	0.08	1.50	14.80	<0.03	<0.03	<0.03	0.40	21.40	18.40	0.49	0.03	0.36
Pb	<0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	<0.005	0.006	<0.005	0.005	0.005
Hg	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	0.0001
Mo		<0.200	<0.200										
Ni	0.037	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.185	0.385	0.430	0.077	0.074	0.044
Se	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0005
Zn	0.015	0.005	0.005	0.005	110.	0.005	0.020	0.010	0.015	0.015	0.050	0.020	0.005
Mn	0.725	0.420	0.415	1.670	1.740	0.010	0.700	0.815	1.655	1.285	1.180	3.145	0.360
Ag	0.002	0.002	0.002	0.004		0.002	0.002	0.005	0.006	0.006	0.002	0.003	0.002
Gr. Alpha (pCi/l)	109.	7.	7.	124.	362.		6.	303.	142.	63.	819.	63.	59.
Gr. Beta (pCi/l)	---	11.	36.	42.	127.		10.	763.	1093.	770.	513.	10.	---
Ra-226 (pCi/l)	<0.5	<0.5	1.	<0.5	<0.5		<0.5	1.	<0.5	<0.5	<0.5	1.	<0.5
U (pCi/l)	193.	0.	1.	112.	78.		16.	693.	110.	78.	1150.	59.	84.
Date (1983)	5/30	5/23	5/21	6/2	6/2	4/6	5/17	6/9	6/9	6/9	4/8	4/8	3/29

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Table D-6. (continued)

Parameter[b,c]	Well number[a]											
	10C	10B	10A	8B	7C	7A	7C	7B	6A	6A	5	3
As	0.021	0.014	0.004	0.003	0.070	0.245	0.162	0.245	0.014	0.133	0.0015	0.001
Ba	<0.05	<0.05	<0.05	<0.05	0.05	0.07	0.06	<0.05	<0.05	0.28	0.22	0.10
Cd	0.002	0.002	0.004	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cr	0.014	0.011	0.013	<0.005	<0.005	0.006	0.006	0.007	0.005	<0.005	<0.005	<0.005
Cu	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fe	<0.03	18.50	2.65	14.00	5.00	0.03	3.40	1.30	8.90	0.20	0.54	0.24
Pb	0.008	0.005	0.006	<0.005	<0.005	<0.005	<0.007	<0.005	0.005	<0.005	<0.005	<0.005
Hg	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mo												
Ni	0.086	0.053	<0.010	0.019	0.053	<0.010	<0.010	0.10	0.086	<0.010	<0.010	<0.010
Se	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Zn	0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.005	0.005	0.040	<0.005	<0.005	<0.005
Mn	0.590	2.590	0.865	0.515	0.600	0.060	<0.415	0.275	1.010	0.160	0.335	0.065
Ag	0.004	<0.002	0.006	<0.002	<0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Gr. Alphs (pCi/l)	0.42	21.	19.	5.			25.	56.				
Gr. Beta (pCi/l)	156.	56.	420.	<10.			298.	308.				
Ra-226 (pCi/l)	<0.5	<0.5	1.	0.			<0.5	0.				
U (pCi/l)	68.	15.	2.	9.			4.	14.				
Date (1983)	6/7	6/7	6/8	5/11	3/30	6/9	6/8	6/8	4/9	4/13	5/9	5/11

[a]For well locations see Figure D-4.

[b]All values in mg/l on a dissolved basis except as noted.

[c]All samples represent splits from samples of same date and well shown in Table D-5.

or slightly above the ground surface. Thus, in the vicinity of the tailings pile, the unconfined aquifer appears to be about 60 feet thick. The interbedded strata of this aquifer system produce water at variable rates. Results of water-sample collection for quality testing and a pump test indicate that water yields can be much less than 1 gpm for the silts and clays and greater than 10 gpm for the fine sands and silty sands. (Detailed well logs of the recent investigation by the TAC (1983) for the shallow wells are available at the UMTRA Project office in Albuquerque, New Mexico).

The major sources of recharge to the unconfined aquifer are infiltration of precipitation and upward leakage from the confined aquifer. This aquifer generally discharges into the surface-water drainages such as the Jordan River, Mill Creek, and the Great Salt Lake. However, dewatering of a temporary excavation near the CVWRF treatment plant has temporarily modified the discharge patterns of the unconfined aquifer (see Section D.3.4.1 for details). A highway drain below the Denver & Rio Grande Western Railroad overpass of 3300 South Street locally influences flow in the unconfined aquifer. The ground water which enters the drain is pumped out of a sump into a culvert which discharges into the head of South Vitro Ditch. Ground-water levels in the area indicate that there is a ground-water divide (Bear, 1979) between the site and the highway drain. The presence of the ground-water divide means that there is little or no potential for the migration of contaminants from the site to the drain.

Water levels in the unconfined aquifer range from 10 feet or more below the ground surface (where affected by the CVWRF excavation or highway drain) to 1 foot or more above ground surface. Topographic depressions and drainages allow surface expressions of the water table. Topographic "lows" to the east of the site are perennial marshy areas.

The stratigraphy below a depth of about 85 feet also consists of interbedded silts, clays, and sands. The sand layers are generally coarser-grained than the overlying beds described above. In some instances the sand layers contain considerable amounts of gravel.

Recent work by Dames and Moore (1982) and the TAC (1983) included monitoring and pump wells to a maximum depth of about 130 feet below the ground surface. The wells that penetrated to a depth of about 70 feet or greater, below the ground surface, encountered ground water under significant artesian pressure. The hydraulic head levels ranged from about 7.5 feet above land surface for the well at 70 feet to 15 feet above land surface for the wells at a depth of about 130 feet. Near the Jordan River, it is reported that this artesian aquifer system extends to depths of 500 to 800 feet below the ground surface (Hely et al., 1971).

Flow rates from 2-inch open piezometers in the confined aquifer ranged from a few gpm to several tens of gpm (TAC, 1983). Pump testing of an 8-inch well produced a sustained quantity of about 300 gpm, of which about 150 gpm was artesian flow. Even though the producing sand layers of the confined aquifer are separated by clay and silt layers, monitoring of potentiometers at various depths in the aquifer during a long-term pump test indicated that the sand layers are hydraulically connected. (Detailed well logs of the recent investigation by the TAC (1983) for the deeper wells are also available at the UMTRA Project office.)

The major source of recharge to the confined aquifer is infiltration of precipitation and snowmelt in the flanks of the Wasatch and Oquirrh Mountains. Beneath the site, the water in this aquifer flows toward the northwest. Natural discharge is upwards to the unconfined aquifer system. Artificial discharge occurs with pumping of wells completed in the confined aquifer system.

Based on the well logs, simplified subsurface cross-sections, Figures D-5, D-6, and D-7 were constructed to illustrate the conditions described above. It should be noted that the subsurface strata consist of numerous laterally discontinuous layers of silt, clay, and sand of variable thickness.

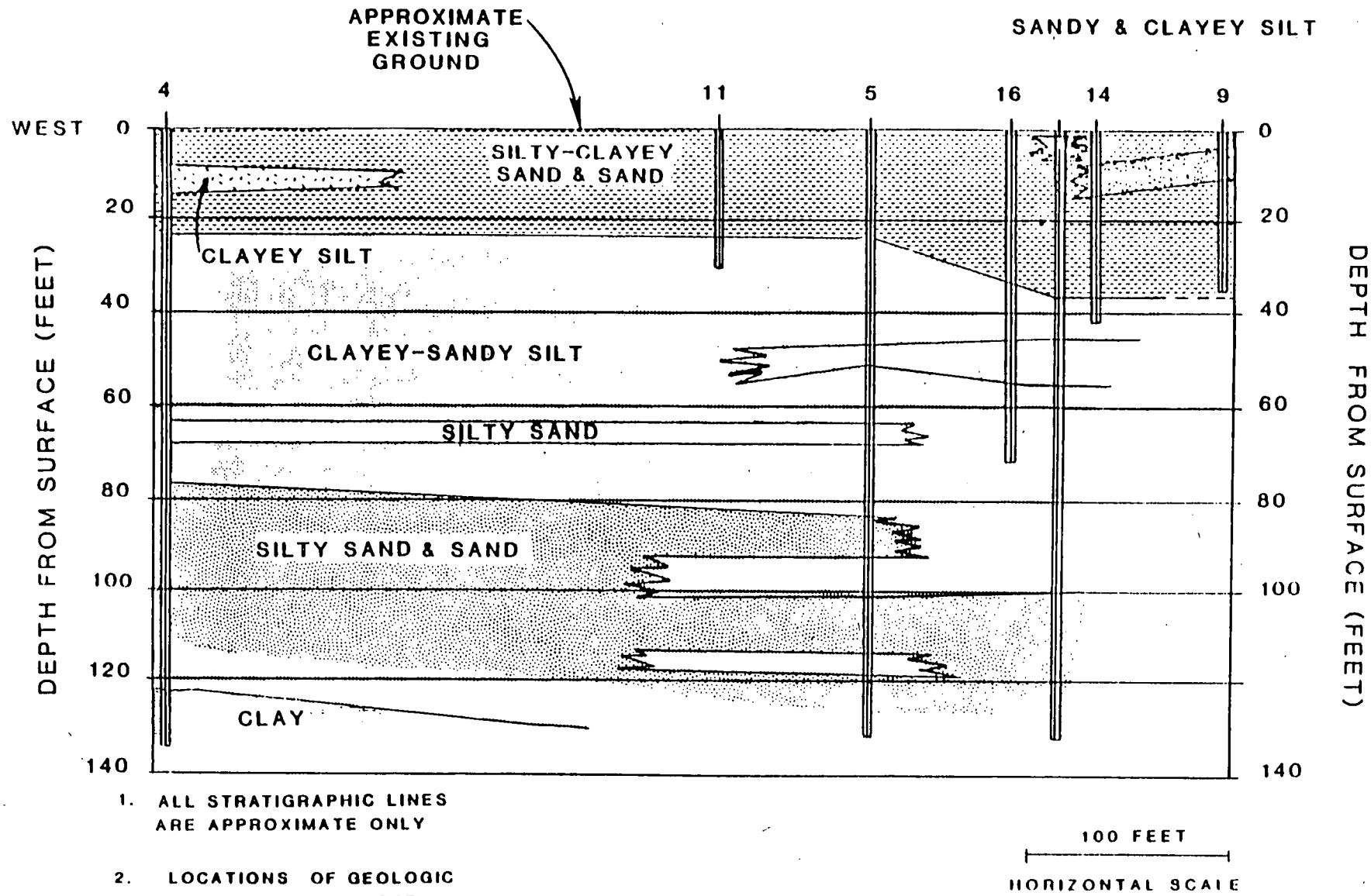
The relationship of the two aquifer systems with regard to recharge, discharge, and movement of ground water, as determined by a recent pump test by the TAC (1983) and a previous study by Hely et al., (1971) are described in detail in a subsequent section of this appendix.

Available records indicate that eight wells were drilled on the Vitro site in the period 1943-1961 (State of Utah). The wells were screened between 500 and 800 feet below ground surface. All but one of the wells were constructed as flowing wells; the remaining well was equipped with a pump. Five of the flowing wells can still be found on the site, with shut-off valves in working condition.

A small pool at the head of the Vitro ditch may be the site of another well. Water flows from the pool through a culvert to Vitro Ditch at a rate of about 1 cubic foot per second (Weber, 1983). Such high volume, localized discharge would not be expected from spring flow through the fluvial-pluvial sediments at the site. A possible explanation for the discharge would be artesian flow through a partially destroyed well completed in the confined aquifer. During remedial action, this area should be excavated and, if present, the well or wells would be sealed properly.

The existing monitoring wells in the confined aquifer represent a potential pathway for communication between the two aquifers. This communication could mean either loss of usable water from the confined aquifer or, in the event of a reversal of the upward hydraulic head gradient, downward migration of contaminants. During the remedial action these wells, and the remaining wells for the mill would be plugged and sealed.

000513



1. ALL STRATIGRAPHIC LINES ARE APPROXIMATE ONLY

2. LOCATIONS OF GEOLOGIC CROSS-SECTIONS SEE FIGURE D-4

FIGURE D-5

GENERALIZED GEOLOGIC CROSS-SECTION FOR THE AREA WEST OF THE TAILINGS PILE, SOUTH SALT LAKE SITE

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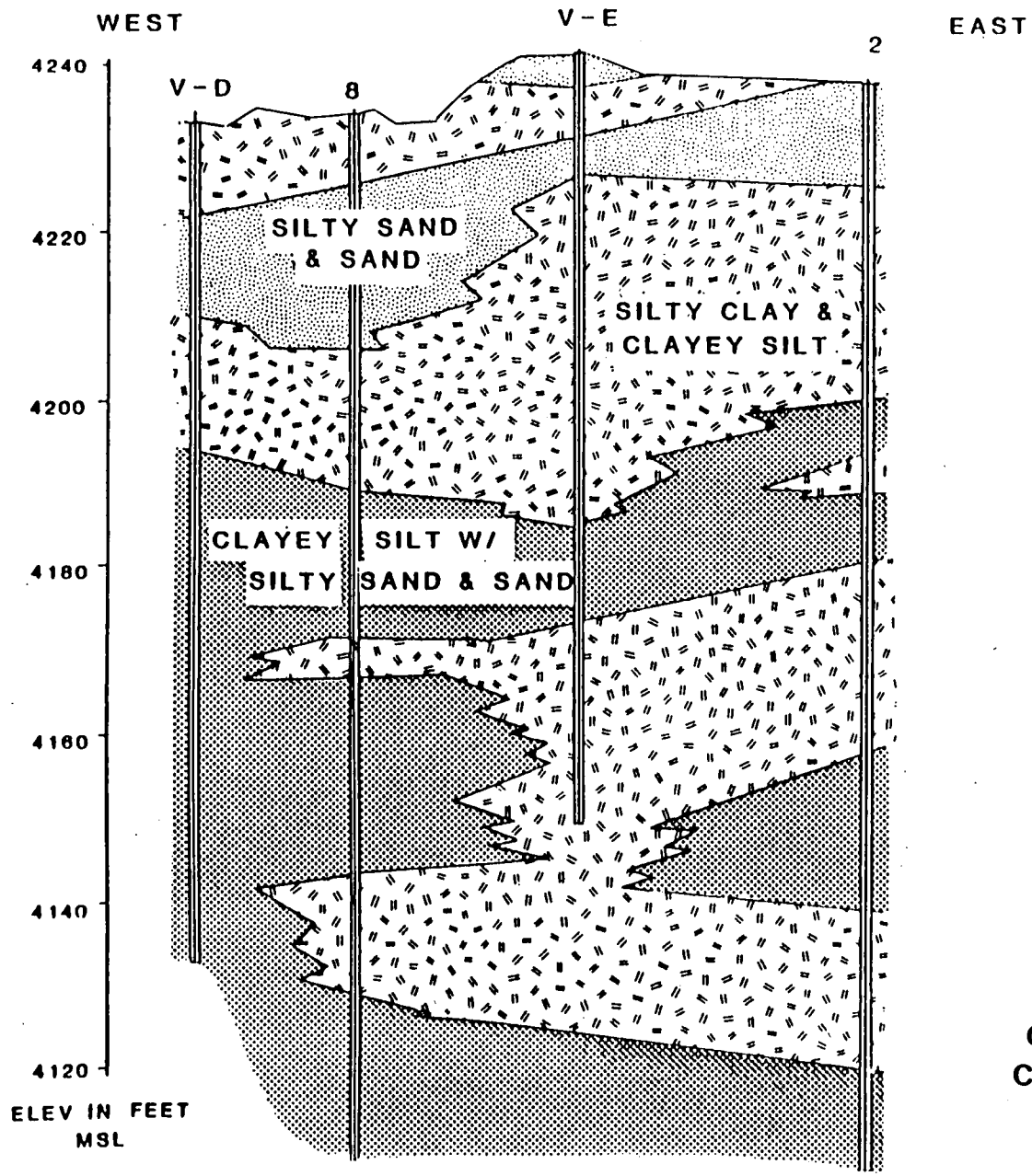

1. ALL STRATIGRAPHIC LINES ARE APPROXIMATE ONLY

2. LOCATIONS OF GEOLOGIC CROSS-SECTIONS SEE FIGURE D-4

700 FEET
HORIZONTAL SCALE

FIGURE D-6

GENERALIZED STRATIGRAPHIC CROSS SECTION ALONG NORTH SIDE OF THE TAILINGS PILE, SOUTH SALT LAKE SITE

000515

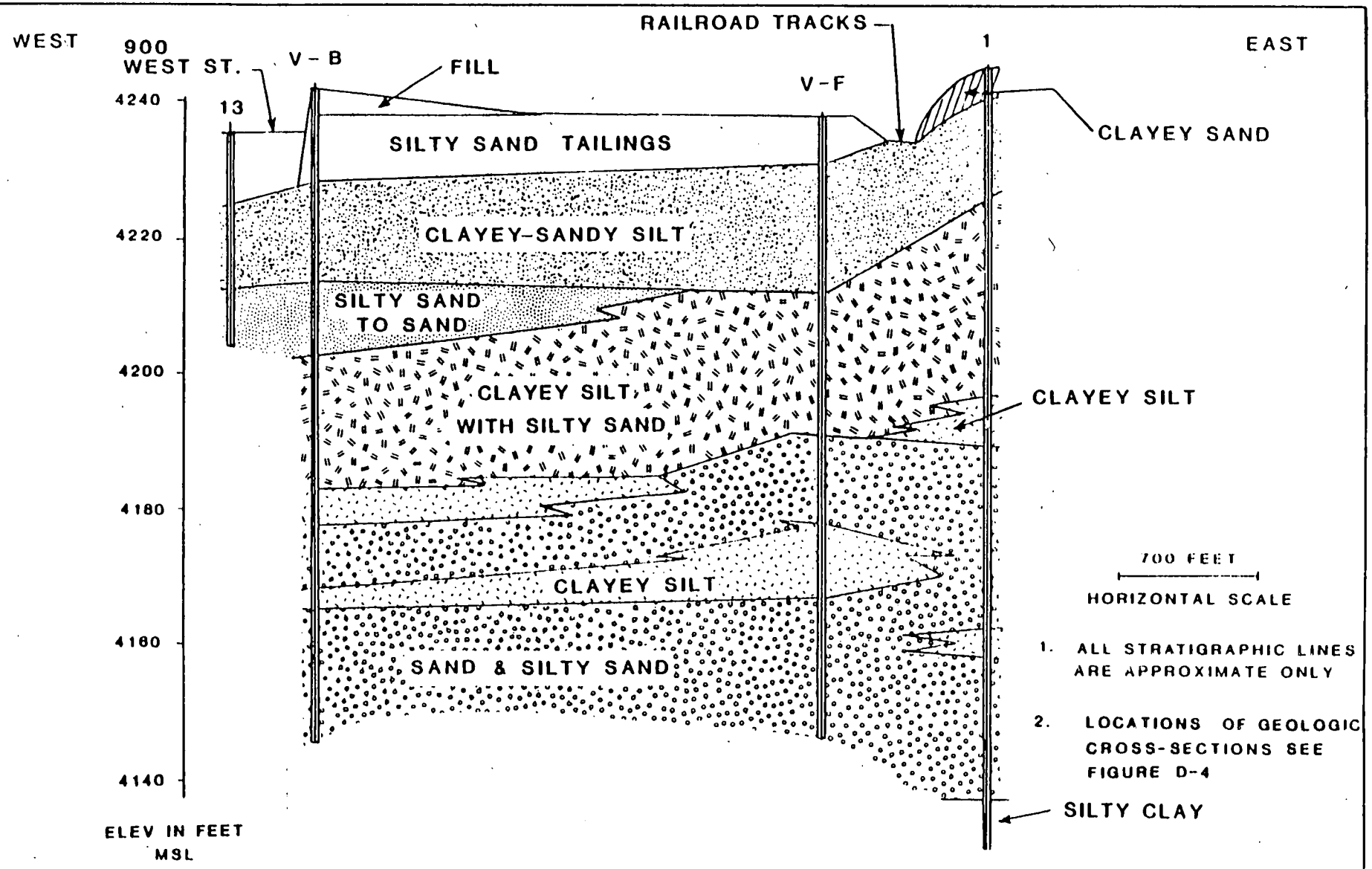

FIGURE D-7
GENERALIZED STRATIGRAPHIC CROSS-SECTION ALONG SOUTH SIDE OF THE TAILINGS PILE, SOUTH SALT LAKE SITE

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D.3.2 Description of existing ground-water chemistry

D.3.2.1 Field sampling of ground water.

Water from the shallow and artesian wells was obtained with a small diameter electric peristaltic pump. The samples were filtered through an in-line system having disposable 0.45 micron filter membranes. The water was then placed in several containers, preserved as per specifications provided by the testing laboratories (Bendix Field Engineering Corporation, Grand Junction, Colorado; and AnaCor Laboratories, Albuquerque, New Mexico) and placed in shipping containers with ice. Field testing of the samples included: alkalinity, pH, Ec (specific conductance), and temperature. Sufficient water was withdrawn from each well until the Ec and temperature values were stable.

D.3.2.2 Field test results.

Field determined Ec values (µmhos per cm) reflect the general water quality with regard to dissolved solids. The field Ec values for upgradient wells in the unconfined aquifer generally ranged from about 1000 to 4000 µmhos/cm with one anomalously high value of about 12,500 µmhos/cm at the 10-foot depth in well No. 6, located southeast and upgradient of the pile (Table D-5). Ec values for the shallow wells downgradient were consistently about 11,000 to 13,000 µmhos/cm. This increase in Ec values reflects an increase in dissolved solids downgradient (west and northwest) of the tailings pile as compared to the shallow wells upgradient.

The field alkalinity values, a measure of dissolved carbonates and bicarbonates, are lower upgradient than downgradient from the pile boundary. Upgradient alkalinity values range from 400 to 580 mg/l. Downgradient alkalinity values range from 680 to 1400 mg/l.

Field Ec values for the artesian wells were typically about 350 upgradient and 2,000 µmhos/cm downgradient of the pile and the alkalinity values were about 300 mg/l both upgradient and downgradient of the site (Table D-5). These conditions indicate a much lower level of dissolved solids as compared to the overlying unconfined aquifer water and an increase downgradient in the confined aquifer.

D.3.2.3 Laboratory testing and unconfined aquifer results.

Water samples were tested for several chemical constituents including major cations, anions, trace metals, total dissolved solids, Th-230, Pb-210, U, V, gross alpha, and gross beta. The results of the chemical analyses are shown in Tables D-4, D-5, D-6.

Standardized procedures were used for each of the steps in the water-quality sample program as detailed in Section D.3.1.1.

For this Appendix, the discussion of ground-water quality and contaminant migration is divided according to location with respect to the tailings, and according to the type of contaminant. Separate discussions are provided for the water quality upgradient, downgradient, and beneath the tailings. Contaminants are discussed according to classification as major constituents

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(predominantly SO_4 and TDS), minor constituents (As, Cd, Se, Cr, Mo), or radionuclides (U, Ra-226, Th-230, Pb-210).

Background water quality. The background water quality was established from wells upgradient and cross gradient to the site. The shallow wells revealed the following typical background values for the parameters listed above (not including well No. 6C at 10-foot depth). To further screen the upgradient samples to better represent unconfined, background water quality, only those wells with TDS between 1000 and 2000 mg/l are considered (Table D-7).

Table D-7. Summary of background data - unconfined aquifer

Constituent	Measured concentrations (upgradient and cross-gradient wells) (mg/l)	Background measured concentration (wells 7A, 6A, and 12C) (mg/l)
As	<0.05 to 0.245	0.02 to 0.12
Mo	<0.01 to 0.02	<0.01 to 0.02
U	0.003 to 0.022	<0.003 to 0.017
Ra-226	<1.0 to 1.2 pCi/l	<1.0 to 3.2 pCi/l
Gross a	<80 to 200 pCi/l	<20 to <80 pCi/l
Cl	13.9 to 1200	78 to 320
SO_4	<5 to 2000	21 to 410
TDS	310 to 4250	810 to 1654
Cd	<0.01 to 0.01	<0.01
Fe	0.02 to 14.0	0.02 to 0.04
Se	<0.01	<0.01
V	<0.01	<0.01
Th-230	<1.0 pCi/l	<1.0 pCi/l
Pb-210	<1.5 pCi/l	<1.5 pCi/l

As noted earlier, the 10-foot-deep sample from well No. 6 is anomalously high as compared to the other background sample concentrations and previous work by Hely, Mower, and Harr (1971). The source of the very high TDS and certain anions and cations in this upgradient well is not certain, but is not considered to be associated with the tailings.

On-site water quality. The water quality below the pile is characterized by high concentrations of chlorides, iron, sulfates, TDS, molybdenum, uranium, Ra-226, Th-230, and other major constituents (see Table D-8 for classification of constituents). The concentration of arsenic remains within the background range, and vanadium is not found in elevated levels. Water quality under the site is summarized in Table D-9.

Downgradient water quality. The water-quality of the unconfined aquifer downgradient (northwest to west) of the pile is characterized by elevated levels of sulfates, chlorides, iron, TDS, and total uranium as compared to the background water-quality data. Radium, arsenic, vanadium and thorium are not found in concentrations above background levels, except one analysis for well

Table D-8. Classification of dissolved solids, based on abundance in potable water[a]

Major Constituents	
Sodium	Bicarbonate
Calcium	Sulfate
Magnesium	Chloride
Silica	
Secondary Constituents	
Iron	Carbonate
Strontium	Nitrate
Potassium	Fluoride
Boron	
Minor Constituents	
Aluminum	Manganese
Arsenic	Molybdenum
Barium	Nickel
Cadmium	Selenium
Chromium	Uranium
Copper	Vanadium
Lead	Zinc
Trace Constituents	
Mercury	Thorium
Radium	Silver

[a]After Davis and DeWiest (1965)

Table D-9. Summary of on-site data, unconfined aquifer

Parameter (dissolved)	Measured concentrations
As	<0.01 to 0.19 mg/l
Cd	<0.01 to 0.003 mg/l
Cl	13.9 to 2686 mg/l
Fe	<0.05 to 54.0 mg/l
Mo	<0.1 to 0.2 mg/l
Se	<0.01 mg/l
SO_4	23.0 to 6008 mg/l
TDS	544 to 10,592 mg/l
U	0.004 to 0.61 mg/l
V	<0.5 mg/l
Ra-226	1.0±0.2 to 114 ±2.1 pCi/l
Th-230	0.0±0.5 to 28.9±2.5 pCi/l
Pb-210	0.9±1.3 to 161±4.5 pCi/l
Gross alpha	0.0±39.7 to 1181±167 pCi/l

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No. 13C with a vanadium concentration of 0.04 mg/l and an arsenic concentration of 0.5 mg/l.

The downgradient water quality in the unconfined aquifer is summarized in Table D-10.

Table D-10. Summary of downgradient data, unconfined aquifer

Parameter (dissolved)	Measured concentrations
As	0.05 to 0.525[a] mg/l
Cd	0.005 to <0.01 mg/l
Cl	590 to 4,200 mg/l
Fe	0.012 to 33 mg/l
Mo	0.01 to 0.045 mg/l
Se	0.01 mg/l
SO_4	250 to 7,000 mg/l
TDS	2,300 to 21,000 mg/l
U	0.02 to 4.05 mg/l
V	0.01 to 0.04 mg/l
Ra-226	1.0 to 1.4 pCi/l
Th-230	1.0 pCi/l
Pb-210	1.5 pCi/l
Gross alpha	200 to <400 pCi/l

[a]Anomalously high concentration from Well No. 13C

Well No. 13 is located southwest of the Vitro site. Water-quality from this well was included in the above table because it is located west of the pile area. However, the ground-water flow direction in the southwest corner of the pile is generally toward the northwest and thus the ground-water quality at well No. 13 was probably not measurably influenced by the pile. This is reflected in the water-quality data for well No. 13, which are very similar to the background quality summarized in Table D-10.

Summary of results. As shown above, the major influence of the tailings pile on the unconfined aquifer west of the site has been the past contribution of measurable amounts of TDS, chloride, sulfate, iron, and uranium. The background water quality of the unconfined aquifer is characteristically brackish with high levels of TDS, chloride, sulfate, and other nonradioactive constituents that make the water from this system nonpotable. Because the water of this aquifer throughout much of the Jordan River Valley is unsuitable for potable use without extensive treatment, the impacts of very limited quantities of additional dissolved solids and uranium after remedial action, immediately downgradient of the pile, are expected to be minimal.

D.3.2.4 Laboratory testing and confined aquifer results.

The water quality of the confined system contains elevated levels of chloride, sulfate and iron downgradient and beneath the tailings pile as compared to the upgradient, background samples (Table D-8).

The following is representative of typical water-quality data for wells penetrating the artesian aquifer upgradient, downgradient, and beneath the tailings pile.

Table D-11. Summary of confined aquifer data

Parameter (dissolved)	Upgradient (well No. 1)	Downgradient (well No. 5)	Beneath pile (well CD)
As	0.03 mg/l	0.0015 mg/l	<0.01 mg/l
Cd	0.01 mg/l	<0.001 mg/l	<0.01 mg/l
Cl	10 mg/l	85 mg/l	220 mg/l
Fe	0.21 mg/l	0.62 mg/l	0.22 mg/l
Mo	0.01 mg/l	<0.01 mg/l	<0.01 mg/l
Se	0.01 mg/l	<0.01 mg/l	<0.01 mg/l
SO_4	10 mg/l	110 mg/l	230 mg/l
TDS	330 mg/l	580 mg/l	864 mg/l
U	0.01 mg/l	<0.003 mg/l	<0.003 mg/l
V	0.06 mg/l	0.01 mg/l	0.01 mg/l
Ra-226	1.0 pCi/l	<1.0 pCi/l	<1.0 pCi/l
Th-230	1.0 pCi/l	<1.0 pCi/l	<1.0 pCi/l
Pb-210	1.5 pCi/l	3.0 pCi/l	1.5 pCi/l
Gross alpha	30 pCi/l	<45 pCi/l	20 pCi/l
Ec (field)	385 μmhos/cm	700 μmhos/cm	1080 μmhos/cm

The three wells listed above were sampled as part of the TAC (1983) study. Complete data summaries are shown in Tables D-4, D-5, D-6.

D.3.2.5 Confined aquifer hydrodynamics and ground-water quality impacts.

The relatively good water quality of the artesian (confined) aquifer is maintained by the upward gradient of the aquifer which prevents downward migration of the brackish unconfined aquifer water. Current utilization (pumping) of the confined aquifer in the Salt Lake City area has not significantly reduced the areal extent of the flowing artesian conditions which are present in the valley or the head levels of the aquifer as compared to levels measured in the early 1900's (Hintze and Miller, 1975). Thus, this upward gradient has been and is currently maintained in the Salt Lake area. Much heavier utilization of the artesian aquifer would reduce the head levels and possibly reverse the upward gradient. This condition would then cause downward flow of the brackish unconfined aquifer waters. The presence of the several feet of confining clay and silt layers would retard flow to very low velocities if the vertical gradient were reversed; however, the downward driving force would be present.

The location and volume of pumpage necessary to reverse the upward gradient near the Vitro site can be estimated by examining present pumpage of the artesian aquifer. Available data from the U.S. Geological Survey (1983) indicate that pumpage within two miles of the Vitro site averaged 462 gallons per minute in 1982 (Table D-12). Data of the TAC (1983) and the DOE (1983) indicate that an upward gradient is present and has been maintained in recent years. These data indicate that heavy pumpage in close proximity, probably less than 1/2 mile radial distance, of the Vitro site would be necessary to locally reverse the upward gradient.

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Table D-12. Major pumpage of the artesian aquifer in the vicinity of the Vitro site

Well Number[a]	Owner	Approx. distance from site (In feet)
(C-1-1)25caa	Public supply well	1600-2400
(C-1-1)25abc	Public supply well	2400-3300
(C-1-1)35add	Salt Lake County Water Conservation Dis.	5700-6400
(C-1-1)35dab	City of South Salt Lake	3700-4400
(C-1-1)35ddc	City of South Salt Lake	5700-6400

Annual Pumpage in acre-feet/yr (gpm)	Well Number 25caa	25abc	35cdd	35dab	35ddc	Total	Year
						325(201)	1970
			56(35)	985(611)		1366(847)	1971
			83(51)	1135(704)		1543(957)	1972
			73(45)	1057(655)		1455(902)	1973
	320(198)		48(30)	785(487)		1478(916)	1974
	678(420)		0	1026(636)		2029(1258)	1975
	527(327)		2.3(1.4)	1233(764)		2087(1294)	1976
	280(174)		53(33)	905(561)		1563(969)	1977
	272(169)		0	985(611)		1582(981)	1978
	52(32)		0	1329(824)		138(856)	1979
	77(48)		0	1454(901)		1531(949)	1980
	41(25)		0	821(509)		862(534)	1981
	178(110)			568(352)		746(462)	1982

[a]Wells numbered according to location as explained in Hely, Mower, and Harr (1971)

The migration of the unconfined aquifer water to the lower confined aquifer would increase the total dissolved solids levels in localized and downgradient portions of the confined aquifer. This condition would degrade the artesian water and it could eventually make the artesian water nonpotable. This scenario should restrict the long-term, heavy utilization of the confined aquifer, irrespective of the contamination noted in the upper aquifer system associated with the tailings pile.

The evidence of elevated iron, chlorides, and sulfates in the confined aquifer beneath and downgradient of the pile may reflect past utilization of the confined aquifer. Past heavy pumping of this aquifer at one or more locations near or upgradient of the tailings pile and mill site may have lowered the head levels of the artesian system and allowed downgradient migration of unconfined ground water.

Based on recent pump test results (TAC, 1983), the influence of this industrial pumping probably extended several hundreds of feet from the production wells. The vertical gradient was reversed most noticeably at the production wells, providing a driving mechanism for movement of mobile constituents such as sulfates and chlorides. These constituents are present in high levels in the unconfined aquifer both in background water samples and in the vicinity of the pile. Water-quality of samples collected during the pump test (TAC, 1983) of the confined aquifer revealed increased levels of iron, sulfates, chlorides, and TDS when compared to an artesian water sample taken at a nearby well prior to the pump test (Table D-5, wells No. 15 and 5).

In summary, data indicate that contamination from the brackish unconfined aquifer will occur if the underlying confined system is depressurized by sustained pumping at volumes large enough to depress the head levels below the head levels of the unconfined ground-water system. It should be noted that no significant evidence of levels above background for heavy metals and radionuclides were found in the confined aquifer beneath or downgradient of the tailings pile. These constituents are less mobile than the sulfates and chlorides and probably were adsorbed or precipitated in the clay and silt layers of the unconfined aquifer and aquitard.

D.3.3 Geohydrologic data analysis

D.3.3.1 Hydrodynamic data collection.

Subsurface explorations, monitoring well installation, hydrologic investigations involving pump testing of both aquifers, water-level monitoring, and sampling for water-quality analyses have been carried out by various investigators at and near the Vitro site and in the Jordan River Valley area. These investigators include Hely, Mower, and Harr (1971), Markos and Bush (1982), Dames and Moore (1982), and the TAC (1983). Details of these programs are presented in Section D.3.1.1. The well locations are shown in Figure D-4. The pump tests were all constant discharge, wherein declines in water level are measured periodically at various observation wells. Slug tests were performed by instantaneous removal of a slug of water from a well, followed by the measurement of the recovery of the water level in the well. Results of hydrodynamic testing are discussed below.

D.3.3.2 Hydrodynamic data analysis and results.

Pump Test Unconfined Aquifer. The pump test on shallow well V-CS1 was run for about 4.5 hours at a pumping rate of about 11 gpm (Dames and Moore, 1982). The total drawdowns at the observation wells were slight:

- 0.58 feet at the pumped well.
- 0.20 feet at observation well V-CS2 which is 9.6 feet from the pumped well.
- 0.14 feet at observation well V-CS3 which is 20.0 feet from the pumped well.

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The drawdown and recovery data at well V-CS2 were analyzed to supply values of transmissivity and storativity of the unconfined aquifer and saturated tailings material at the site. Using the Theis' Recovery method (Davis and DeWiest, 1965), a value of transmissivity = 6684 ft^2/day was calculated. Using the Jacob's method (Davis and DeWiest, 1965) on the drawdown data yielded a value of transmissivity = 7455 ft^2/day. Using the Jacob's method with a transmissivity value of 7059 ft^2/day (the geometric mean of the results for the drawdown and recovery data) yielded a value of storativity = 0.026. No corrections of drawdowns for water table conditions were needed because the total drawdown was much less than the saturated thickness of the aquifer. A check on the value of (u), the well function, showed that the Jacob's method was valid at times greater than 10 minutes. These results may be inaccurate due to the low pumping rate, approximately 11 gpm, and short duration of the test, about 270 minutes, resulting in relatively slight total drawdowns.

The on-site slug test data were analyzed with 3 methods; the Hvorslev, the Cooper, Bredehoeft and Papadopulos, and the Ferris and Knowles (Table D-13). The calculated values of hydraulic conductivity range from 0.0 to 6.4 x 10^{-3} cm/sec. Assuming a saturated thickness of 38 feet, the transmissivity value of 7059 ft^2/day from the pump test analysis indicates a hydraulic conductivity of 6.5 x 10^{-2}cm/sec.

Table D-13. Results of on-site slug tests (cm/sec.)

Well	Hydraulic conductivity [a]method 1	Hydraulic conductivity [b]method 2	Hydraulic conductivity [c]method 3
V-BS	4.0×10^{-4}	1.8×10^{-3}	1.9×10^{-4}
V-BS	3.5×10^{-4}	1.3×10^{-3}	1.0×10^{-4}
V-BD	1.6×10^{-3}	6.4×10^{-3}	7.0×10^{-5}
V-BD	1.2×10^{-3}	4.8×10^{-3}	1.6×10^{-3}
V-DS	0.	0.	1.3×10^{-3}
V-DS	0.	0.	1.3×10^{-3}
V-DS	0.	0.	1.4×10^{-3}
V-ES	8.8×10^{-5}	1.2×10^{-4}	2.3×10^{-5}
V-ED	5.4×10^{-5}	7.7×10^{-5}	2.6×10^{-5}
V-FS	3.3×10^{-5}	3.5×10^{-5}	9.3×10^{-6}
V-GS	2.6×10^{-5}	2.4×10^{-5}	1.1×10^{-5}
V-HS	1.6×10^{-5}	5.2×10^{-5}	8.4×10^{-6}

[a]Method 1 is Hvorslev (1951).
[b]Method 2 is Cooper, Bredehoeft, and Papadopulos (1967).
[c]Method 3 is Ferris and Knowles (1963).

The pump test on shallow, off-site well No. 14 was run for about 24 hours at a pumping rate of about 11 gpm. No drawdown was recorded at any of the observation wells (TAC, 1983). The lack of drawdown was probably caused by recharge from surface flooding (May, 1983) of the area and the relatively low pumping rate. A total drawdown of about 15.98 feet was recorded at the pump well. Pump well recovery data were analyzed to obtain values of transmissivity and hydraulic conductivity. Actual residual drawdowns were corrected for dewatering. The calculated value of transmissivity from this analysis was 768 ft^2/day. Assuming a saturated thickness of 38 feet, the saturated thickness above the bottom of the well screen, the hydraulic conductivity is 20.1 ft/day or 7.1×10^{-3}cm/sec.

The United States Geological Survey published values of transmissivity and specific yields for the shallow aquifer, estimated from lithologic logs (Hely et al., 1971). The transmissivity values range from 1300 to 4000 ft^2/day. At the area around the Vitro site, transmissivity is estimated as 2700 ft^2/day. The specific yield of the unconfined aquifer ranges from 0.10 to 0.20.

Pump test - confined aquifer. The pump test on deep, off-site well No. 15 was run for about 91 hours at a pump rate of approximately 300 gpm. Water levels were measured at the pump well, 6 other deep wells, 24 shallow wells, and 2 intermediate wells during the pump test and recovery period (TAC, 1983). Table D-14 lists the completion intervals, radial distances from the pump well, drawdowns at the time the well was shut down and the land surface elevation for all 33 observation wells.

In the analysis of drawdown data, no corrections were needed for barometric response of the aquifer, aquifer recharge-discharge trends, aquifer boundaries, and off-site water use. During the pump test, barometric pressure varied from a low of 30.00 inches of mercury at 4:00 a.m. on May 21 to high of 30.14 inches of mercury at 6:00 p.m. on May 20, 1983. At the beginning of the test, 2:30 p.m. on May 19, the barometric pressure was 30.08 inches of mercury and at the end of the pumping period, 9:45 a.m. on May 23, the barometric pressure was 30.07 inches of mercury. These values were abstracted from a barometric chart recording station at the United States Geological Survey's office at 1700 South, 1745 West in Salt Lake City.

The maximum change in barometric pressure was 0.14 inches of mercury which converts to 0.16 feet of water. The change from the beginning to the end of the pump test was 0.01 inches of mercury or 0.01 feet of water. Assuming an aquifer barometric efficiency of 100 percent, these values would represent the change in measured water level due to the change in atmospheric pressure. These small corrections were considered insignificant in the analyses of drawdown data. Static water levels were measured for up to one and a half months at the deep wells prior to the pump test. The maximum change through this period was +0.3 feet at well No. 3 from May 6 to May 19, 1983. Due to this minimal rise, corrections of drawdown data for aquifer recharge-discharge trends, aquifer boundaries, and off-site water use were not needed.

Table D-14. Results of pump test on deep well #15
South Salt Lake site

Well identification	Depth of completion interval (ft.)	Radial distance from well #15 (ft.)	Drawdown at well shutdown (ft.)	Land surface elevation (ft. msl)
CD	105.0-115.0	550	3.40	--
1	99.8-109.8	4440	1.04	4245.0
2	119.0-129.0	3420	1.87	4238.1
3	110.2-120.2	2000	2.15	4234.1
4	105.1-115.1	500	4.08	4234.4
5	115.5-125.5	100	3.42	4234.9
6A	26.4-28.4	4510	0.26	4244.6
6B	16.7-18.7	4510	0.70	4244.7
6C	6.7-8.7	4510	0.84	4244.7
7A	26.2-28.2	3420	-0.01	4238.0
7B	15.3-17.3	3420	0.17	4238.0
7C	7.6-9.6	3420	0.17	4238.0
8A	26.4-28.4	2220	-0.07	4233.1
8B	18.7-20.7	2220	-0.05	4233.0
8C	6.8-8.1	2220	Dry	4233.1
9A	216.9-28.9	70	0.12	4233.2
9B	15.7-17.7	70	0.18	4233.0
9C	5.8-7.8	70	0.19	4233.0
10A	26.1-28.1	870	0.08	4234.6
10B	14.5-16.5	870	0.03	4234.7
10C	6.3-8.3	870	0.08	4234.6
11A	24.3-26.3	150	0.27	4234.5
11B	16.8-18.8	150	0.27	4234.6
11C	6.1-8.1	150	0.26	4234.8
12A	26.4-28.4	2200	-0.05	4235.9
12B	16.7-18.7	2200	-0.25	4236.1
12C	6.5-8.5	2200	1.31	4236.0
13A	25.7-27.7	1220	0.39	4235.7
13B	16.2-18.2	1220	0.34	4235.8
13C	6.2-8.2	1220	0.01	4235.7
15	102.1-112.1	0	58.69	4233.7
16	65.7-67.7	20	0.51	4234.5
17	53.6-55.6	20	-1.04	4233.4

Qualitative information can be gained from the response of various wells to the pump test. Most of the shallow wells (wells Nos. 6A to 13C) show drawdown through the pumping period, but 6 shallow wells show a recovery (negative values on Table D-14). Generally, the A series shallow wells show less drawdown than the B series and the B series wells show less drawdown than the C series. Because the A wells are the deepest and the C wells are the shallowest, it would normally be expected that the deeper A wells would show more drawdown. It is difficult to determine if the non-normal shallow well response is due only to the pumping of well No. 15 or if the response is due to the combination of the pumping and some other unknown local stress or stresses attributable to environmental influences (Todd, 1980).

Well No. 17 is screened at a depth of about 54 to 56 feet, in the top of a clayey silt layer. This silt layer appears to be approximately 15 feet thick with sand partings. Well No. 16 is screened at a depth of about 66 to 68 feet near the base of the clayey silt layer. Because the hydraulic head differential across this layer is approximately 8 feet, this layer is believed to be the confining layer separating the unconfined and confined systems.

The hydraulic heads at wells No. 16 and No. 17 responded oppositely to the pumping of well No. 15. Well No. 17 showed a rise of 1.04 feet during the 91- hour pump test. This response was probably due to compaction of the underlying confining layer and aquifer. The hydraulic head at well No. 16 rose about 0.10 feet at the onset of the test, but eventually dropped 0.51 feet. The data from wells No. 16 and 17 were somewhat compromised because the sand filter packs extended from the screened intervals in the clayey silt layer into the overlying sand layer. Nonetheless, the hydraulic head measured in well No. 16 is substantially greater than that measured in well No. 17. Therefore, it is concluded that the changes of water level at well No. 16 represent the response of the confining layer. This response was used to calculate a value of vertical hydraulic conductivity of the aquitard.

All the deep observation wells showed definite drawdown in response to the pump test. The heterogeneity and layering of the materials composing the confined aquifer system are exhibited by the various responses of the deep wells. For instance, the final drawdown at well No. 5 was 3.42 feet, while the final drawdown at well No. 4 was 4.08 feet, even though well No. 5 is 100 feet from the pump well, while well No. 4 is 500 feet from the pump well. Both wells are located west of the pump well. Well No. 4 is completed at approximately the same depth as the pump well, while well No. 5 is 10 feet deeper. The response at well No. 2 also exhibits the effects of heterogeneity or layering. The logarithmic plot of drawdown versus time used to analyze the test results (Lohman, 1972) shows an abrupt increase in the rate of drawdown about 200 minutes into the pump test. Well No. 2 is completed about 12 feet deeper than well No. 15.

Values of transmissivity and storativity of the confined aquifer and values of vertical hydraulic conductivity for the overlying aquitard were calculated from the response to pumping at deep observation wells Nos. 1 through 5 and CD using the Hantush Modified method (Lohman, 1972). Also, values of vertical hydraulic conductivity through the confining layer were calculated using the "Ratio Method" (Neuman and Witherspoon, 1972). The values of vertical hydraulic conductivity were obtained by assuming a specific storage for the confining layer of 0.0125 ft^{-1}. Without assuming a specific storage, the "Ratio Method" and the geometric mean values from the Hantush Modified method were solved simultaneously. The results were a specific storage of 6.6×10^{-4} ft^{-1} and vertical hydraulic conductivity of 3.1×10^{-3} ft/day. Table D-15 lists these calculated values and values for the same parameters that were published by the United States Geological Survey (Hely et al., 1971). The field data, assumptions, and calculations that were summarized in this section are available at the UMTRA Project Office in Albuquerque, New Mexico.

D.3.4 Description of Illinois State Water Survey model modifications and additions

The Illinois State Water Survey finite difference hydrodynamic model (Prickett and Lonnquist, 1971) has a wide range of applications and has been pre-qualified for use on low-level waste disposal sites by the United States Nuclear Regulatory Commission. The code solves the partial differential equation governing the transient, two-dimensional flow of ground water in a confined, heterogeneous aquifer with axidirectional anisotropy. This equation is

$$\partial/\partial x\ [T(x)\ \partial h/\partial x] + \partial/\partial y\ [T(y)\ \partial h/\partial y] = S\ \partial h/\partial t + Q, \text{ where}$$

$T(x)$ = transmissivity in x direction (L^2/T)
$T(y)$ = transmissivity in y direction (L^2/T)
h = hydraulic head (L)
t = time (T)
S = storage coefficient
Q = net ground-water withdrawal rate per unit area (L/T)
x,y = rectangular coordinates. The code has been augmented and can also simulate:

- Unconfined conditions
- Conversion from unconfined to confined conditions
- Conversion from confined to unconfined conditions
- Leaky confined conditions
- Induced infiltration from a stream or pond
- Ground-water evapotranspiration
- Variable pumping rates

The code is applicable to the simulations of two-dimesional, heterogeneous, isotropic, steady-state ground-water flow as applied to the Vitro site and surrounding area.

Table D-15. Values calculated from pump test results on deep well #15 west of South Salt Lake site

Observation well identification	Method used	Transmissivity (ft^2/day)	Storativity	Vertical hydraulic conductivity (ft/day)
1	Modified Hantush	867	$2.7x10^{-6}$	$1.5x10^{-5}$
2	Modified Hantush	1482	$4.8x10^{-5}$	$1.7x10^{-5}$
3	Modified Hantush	2298	$1.8x10^{-4}$	$6.5x10^{-5}$
4	Modified Hantush	7660	$3.8x10^{-4}$	$1.5x10^{-6}$
5	Modified Hantush	3535	$2.4x10^{-4}$	0.98
CD	Modified Hantush	4596	$1.6x10^{-4}$	$7.8x10^{-4}$
16	Ratio	----	----------	$5.8x10^{-2}$
All Above Wells	Ratio and Modified Hantush	----	----------	$3.1x10^{-3}$
Geometric Mean	--	2676	$8.4x10^{-5}$	--
N/A	U.S.G.S Estimate	9000	$1.0x10^{-4}$	$1.6x10^{-2}$ and $4.9x10^{-2}$

For the Vitro site, the model is used to predict the past, present, and future hydrodynamics of the site and vicinity. To facilitate its use on this project, modifications and additions have been made to the code. These include:

- Renumbering of statement labels to make the program more readable.
- Increased flexibility for input and output procedures.
- Variably-spaced grid option.
- Redefinition of convergence criteria.
- Calculation of global mass balance and mass fluxes.
- Added statements to avoid infinite value errors.
- Slight reorganization to allow more efficient compilation.

The modifications to the input and output procedures have no effect on the numerical calculations of the code. The new input procedures allow for the reading of a complete data file of nodal parameters. The file contains a line for each node which includes the I and J coordinates (column and row designations) followed by the 13 hydraulic parameters. These parameters, in the order that they appear on each line, are:

1. T2 - Transmissivity in X direction, in L^2/T.
2. T1 - Transmissivity in Y direction (for isotropic case T2 = T1).
3. SF1--Artesian storage factor (storativity multiplied by the area represented by the node), in L^2.
4. H-Initial estimate of hydraulic head at the node, in L.
5. Q-Constant rate of vertical recharge or withdrawal for the area represented by the node, in L^3/T; for nodes along the boundary this may also represent constant lateral flux.
6. R-Vertical permeability factor between the modeled aquifer and a stream bed, vadose zone, or contiguous aquitard (the vertical hydraulic conductivity divided by the thickness of the stream bed, vadose zone, or contiguous aquitard multiplied by the area represented by the node), in L^3/T.
7. RH-Elevation of land or stream surface for problems involving seepage from a stream or evapotranspiration; or hydraulic head in adjacent aquifer for problems involving leakage through an aquitard, in L.
8. RD-Elevation of bottom of stream or water level below which evapotranspiration ceases, in L.
9. SF2-Water table storage factor (specific yield multiplied by the area represented by the node), in L^2.
10. CH-Elevation of the top of the principle aquifer, in L.
11. P2-Hydraulic conductivity in the X direction, in L/T.
12. P1-Hydraulic conductivity in the Y direction, in L/T (for isotropic problems P2=P1).
13. BOT-Bottom of the principle aquifer, in L.

Data manipulation is made more efficient for a heterogeneous setting by allowing explicit reading of all parameter values in the data file. Computer codes to manipulate these data can be written and executed easily. The only modification to the output is creation of a data file with all the calculated hydraulic head values in a format that can be input to a contouring program, thus allowing computer-generated potentiometric surface and water-table maps. These modifications to the input and output capabilities of the code do not affect the calculations in any way.

The variably-spaced grid option was necessary for an accurate representation of the unconfined flow regime at the Vitro site without using an excessive number of nodes. A detailed discussion of the finite-difference grid representations is presented in section D.3.4.1. The subroutine for this option, VARGRID, was verified on a transient problem with a pumping well in the center of an area. Also, computer codes were developed to interpolate nodal parameters from a variable-spaced grid to an equally-spaced grid and vice-versa. These codes, the subroutine VARGRID, and the input and output for the test case are available at the UMTRA Project Office in Albuquerque, New Mexico.

The modification to the convergence criteria does not affect the calculations of the computer code. Originally, the absolute differences between calculated hydraulic head at each node were computed and summed at the midpoint and end of each iteration. The modification was made to calculate and sum only the absolute differences at the end of each iteration. It was found that in most cases with a large grid, heterogeneous material properties, and inclusion of vertical leakage, the error criterion would converge asymptotically to some value greater than zero. The choice of the value to set the convergence criteria is subjective and should ensure that an adequate number of iterations have been executed to reach a relatively smooth solution. The modified convergence criteria allowed convergence to a more consistent asymptote for a given problem than did the original convergence criteria. In addition to modifying the computation of the convergence criteria, a parameter to end the computations after a given number of iterations was added to limit computer time and costs while executing a nonconvergent or slowly converging problem.

For each hydrodynamic situation simulated, a subroutine was added to calculate global mass balance and each flux into or out of the principle aquifer. These subroutines were added to ensure mass balance and to assess the relative significance of the various sources of inflow and outflow to the aquifer being modeled. These subroutines are discussed in detail in section D.3.4.1. Anotated versions of these subroutines and all modifications to the original code are available at the UMTRA Project office in Albuquerque, New Mexico.

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D.3.4.1 Calibration of the hydrodynamic model

The Illinois State Water Survey hydrodynamic code was used to calibrate two steady-state hydrogeologic settings for the unconfined aquifer and one setting for the confined aquifer. For each setting, the model of the Vitro site and adjacent areas was calibrated in two ways. First, calculated hydraulic heads were compared to field measured water levels. A residual (measured head minus calculated head at a given point) of ± 4 feet was adequate because this represents the range of annual water-level fluctuations. Second, the mass balance of the system was calculated and calibrated, i.e., inflows balanced against outflows. The calibration techniques and results are discussed in detail for each of the three calibrated cases.

Calibration of unconfined aquifer--present case. Recent water level measurements in the unconfined aquifer on and adjacent to the Vitro site reveal that:

- The present water table is below Mill Creek, Vitro Ditch, and South Vitro Ditch. These surface water courses are presently recharging the ground water.
- Shallow ground water flows radially toward the CVWRF excavation.

Prior to dewatering of the CVWRF excavation, shallow ground water discharged into Mill Creek, Vitro Ditch, and South Vitro Ditch. They were surface expressions of the water table. These shallow ground-water flows were toward the Jordan River and Mill Creek (Figure D-8).

To enhance calibration of the unconfined aquifer system, a subroutine to the Illinois State Water Survey code was written to calculate the various fluxes of water into and out of the area being modeled. This subroutine allowed calculation of the global mass balance. The fluxes calculated include:

- Infiltration from the surface.
- Upward leakage from the underlying artesian aquifer.
- Vertical seepage from Mill Creek, Vitro Ditch, and South Vitro Ditch.
- Lateral flow to or from the Jordan River.
- Lateral flow to the CVWRF excavation.
- Lateral flow into and out of the area being modeled.

Infiltration and upward leakage were summed and modeled as a constant rate across the entire modeled area. The constant recharge parameter, Q, for each node not along the boundary of the grid was assigned a value representing the sum of infiltration and upward vertical leakage in terms of ft^3/day. This was implemented by assigning an identical flux to each internal node, in terms of ft/day and allowing the subroutine VARGRID to multiply the flux by

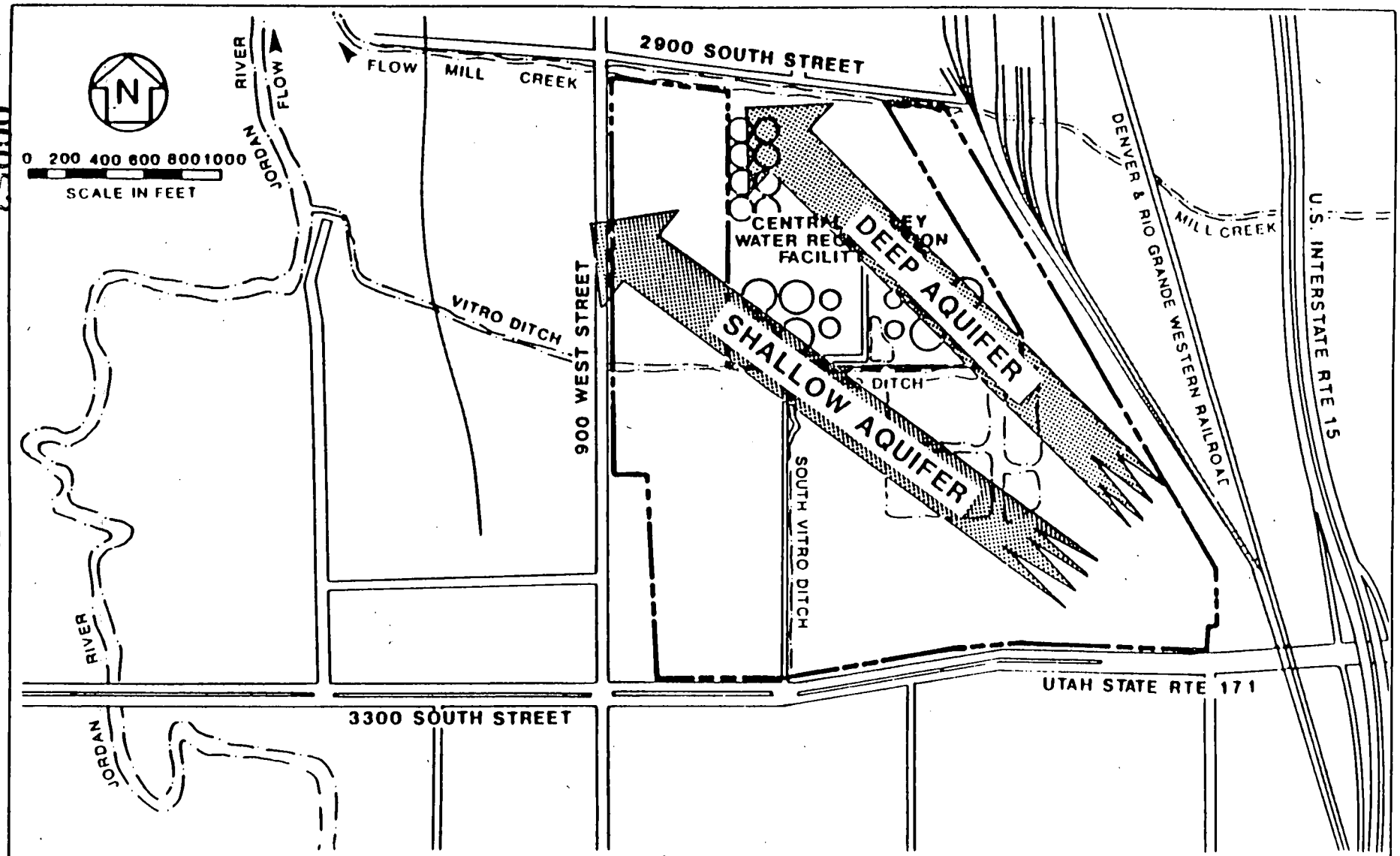


FIGURE D-8
GROUNDWATER FLOW DIRECTION
SOUTH SALT LAKE SITE

the area represented by the node. The value of flux from infiltration was 2.4 in/year (5.5×10^{-4} ft/day) (from Hely et al., 1971). Upward, vertical leakage was adjusted and a value of 2.25 in/yr (5.1×10^{-4} ft/day) provided the best calibration.

Seepage from Mill Creek and the Vitro Ditches was modeled with the use of the R, RH and RD nodal parameters (see Prickett and Lonnquist, 1971). The R values represent the vertical hydraulic conductivity of the material between the surface water body and the water table multiplied by the width of the stream channel multiplied by the length represented by the node in the direction of the stream. For Mill Creek, the width of the stream channel was estimated as 15 feet and the calibrated hydraulic conductivity was 1.5 ft/day. For the Vitro Ditches, the width of the stream channel was estimated as 10 feet and the calibrated hydraulic conductivity was 0.8 ft/day. The values of RD, (the bottom elevation of the streams) were derived from topographic maps and interpolated between assigned points. The values of RH, (the elevation of the stream surface) were assigned values of RD plus 2.0 ft. for Mill Creek and RD plus 1.5 ft. for the Vitro Ditches.

The flows to the Jordan River and to the CVWRF excavation were calculated with Darcy's Law. For each node representing the Jordan River or the boundary of the CVWRF excavation, the flow was approximated by (Figures D-9 and D-10):

$$Q = \frac{(h_n - h_o)}{r} K_{no} db \text{ where:}$$

Q = Volumetric flow rate (ft^3/day).

h_n = Calculated hydraulic head at the node (n) adjacent to the river or excavation (ft).

h_o = Calculated hydraulic head at the node (o) representing the river or excavation boundary.

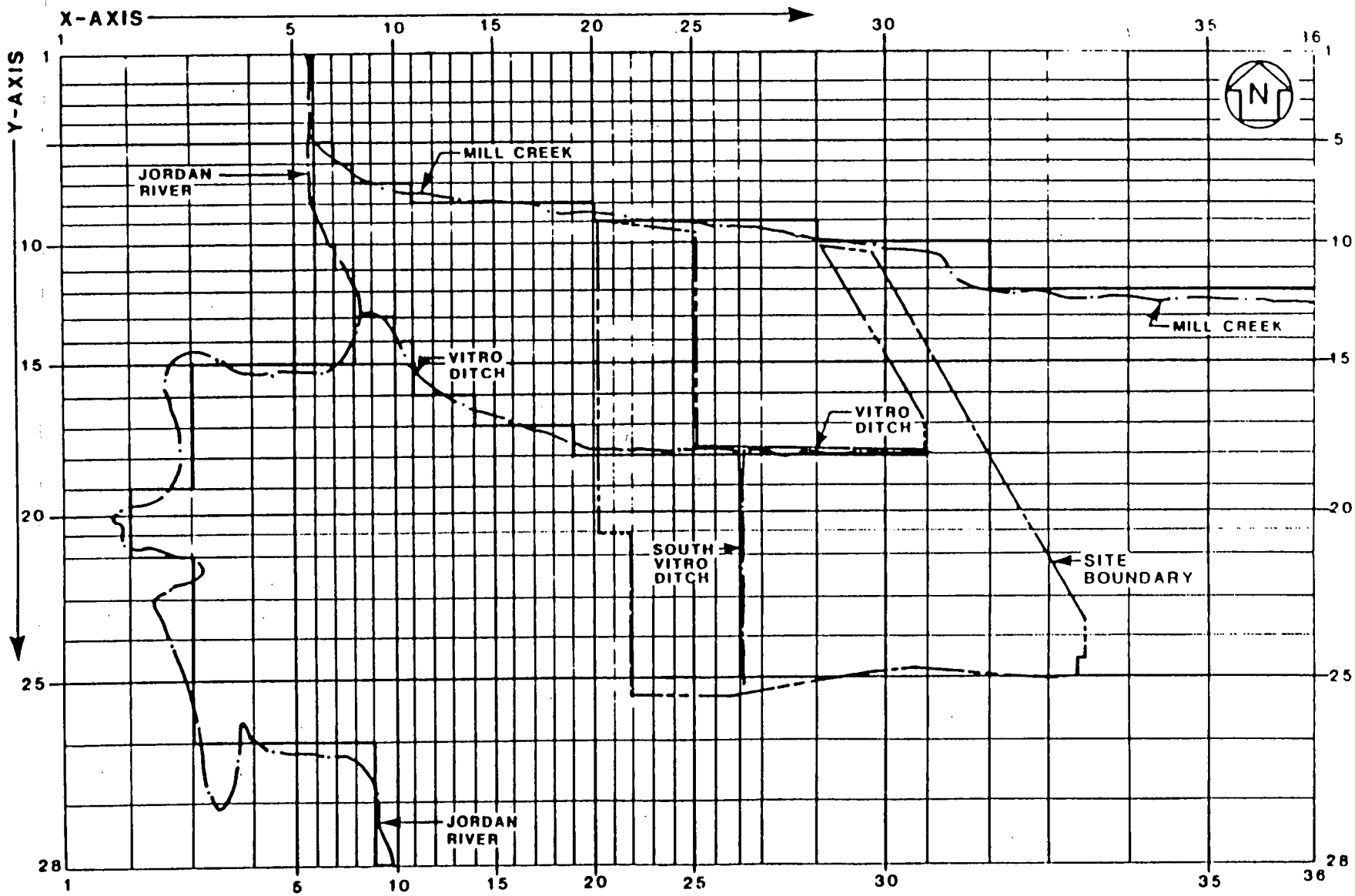
r = The distance between nodes N and O.

K_{no} = The value of hydraulic conductivity for flow between nodes N and O.

d = The width represented by nodes N and O.

b = The difference between average hydraulic heads and the average bottom of the aquifer at nodes N and O.

The computer code automatically sets the boundaries of the grid as impermeable. To model the boundaries as constant flux with a flux other than zero, the constant flux values are assigned in the recharge/withdrawal array, Q. The calibrated value of volumetric flux into the area being modeled was 52,062 ft^3/day.



ACTUAL WATERWAY ALIGNMENT

COMPUTER REPRESENTATION OF WATERWAY

FIGURE D-9
FINITE-DIFFERENCE GRID REPRESENTING THE SOUTH SALT LAKE SITE VICINITY

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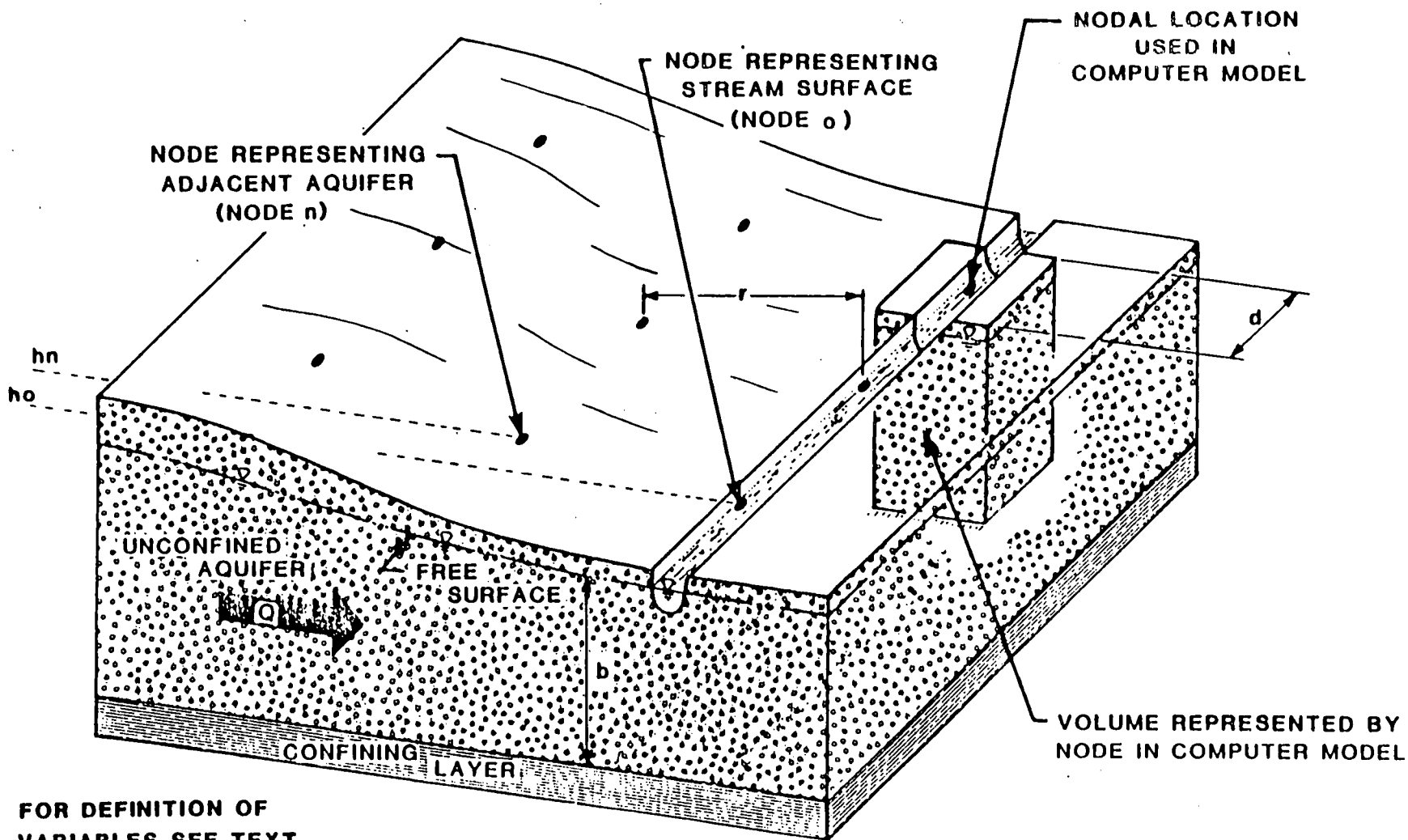

NOTE: FOR DEFINITION OF VARIABLES SEE TEXT.

FIGURE D-10
CROSS-SECTIONAL REPRESENTATION OF CALCULATION OF FLUX TO STREAM SOUTH SALT LAKE SITE

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The unconfined aquifer at the Vitro site and adjacent area, present case, was modeled initially on a variably-spaced grid with 36 columns and 28 rows of nodes (Table D-16). The storage factors (SF2) for the nodes representing the Jordan River and the CVWRF excavation were set to $1x10^{200}$. The extremely high values allowed these nodes to have a large enough storage capacity so that the hydraulic heads would remain constant. The storage factors at the other nodes were set to low values, on the order of $1x10^{-20}$, to allow steady-state calculations. These low values caused the finite-difference analog of $S \frac{dh}{dt}$ to be inconsequential in the results of the iterative, finite-difference calculations.

Table D-16. Variable grid spacing (36 x 28 nodes)

Column designation[a]	Width (in feet)	Row designation[b]	Width (in feet)
1-3[c]	390.6	1	182.3
4	260.4	2-9	130.2
5-26	130.2	10-13	162.8
27	162.8	14	130.2
28	312.5	15	221.4
29	481.8	16-18	195.3
30	260.4	19-21	156.3
31	377.6	22-24	260.4
32	390.6	25-27	390.6
33-34	520.8		
35	722.8		

[a]Column N is space between nodes (N-1,J) and (N,J).
[b]Row M is space between nodes (I,M-1) and (I,M).
[c]Column designation 1-3 means columns 1 through 3.

Because the unconfined system was modeled as isotropic and heterogeneous, for each node, the hydraulic conductivity in the x direction was set equal to the hydraulic conductivity in the y direction but the values from node to node varied.

The most representative field determination of hydraulic conductivity for the unconfined aquifer was the pump test performed and analyzed by the TAC (see Section D.3.3.2). The value of hydraulic conductivity obtained from this test was 20.1 ft/day. The calibration was most successful by assigning hydraulic conductivities of 15 ft/day to nodes representing the Jordan River meander belt, 30 ft/day to 50 ft/day along Mill Creek, and 20 ft/day to 35 ft/day for all other nodes with lower values near the Jordan River increasing to higher values to the east. Although these values were chosen to enhance calibration, their spatial distribution is also consistent with the depositional history of the shallow alluvial materials. As the materials were deposited in the lacustrine environments of Lake Bonneville and the Great Salt

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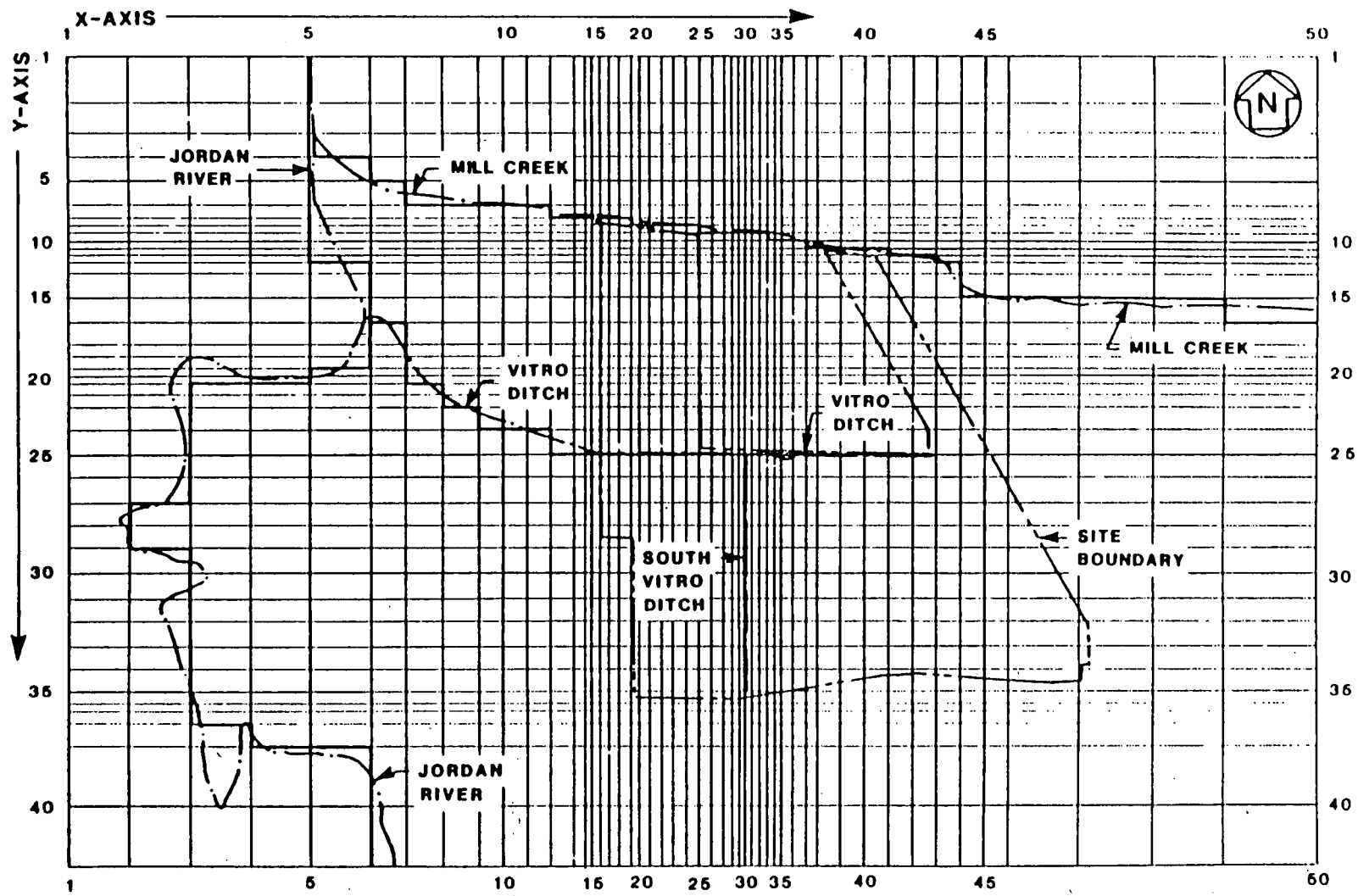
Lake, the heavier, coarser-gained particles probably settled further away from the center of the basin, while finer-grained particles would settle closer to the center of the basin. Coarser-grained, more permeable material probably underlies Mill Creek and the high hydraulic conductivities were necessary to attain a mass balance and calculated hydraulic head that matched the measured values. The values of CH, top of aquifer, were set to approximate land surface elevation and the values of BOT, bottom of aquifer, were set to about 60 feet below land surface.

After numerous runs with the 36 by 28 nodal grid, it was found that this spacing of nodes did not provide sufficient detail in the areas with steep hydraulic gradients to adequately calibrate the model. The major inflow and outflow occurs in a relatively small area, bounded by Mill Creek and the Vitro Ditches, which includes the CVWRF excavation. The major area of concern was around the excavation, particularly the Mill Creek side. It was found that to accurately calculate flux using Darcy's Law, the nodes adjacent to the excavation must be close to the nodes representing the excavation boundary, otherwise the linear approximation of the hydraulic gradient is not accurate. The second grid has more nodes located in the critical area around the excavation. This grid contains 50 columns and 41 rows of nodes, approximately doubling the number of nodes contained in the first grid (Table D-17, Figure D-11).

Table D-17. Variable grid spacing (50 x 41 nodes)

Column designation[a]	Width (in feet)	Row designation[b]	Width (in feet)
1-5[c]	390.6	1	312.5
6-8	234.4	2	187.5
9-12	156.3	3-5	156.3
13	78.1	6	78.1
14-16	46.9	7-12	46.9
17-18	78.1	13	78.1
19	46.9	14-16	156.3
20-26	78.1	17-18	78.1
27-34	46.9	19-20	46.9
35-37	78.1	21-22	78.1
38-45	156.3	23-34	156.3
46-48	468.75	35	78.1
49	625.	36	46.9
		37	78.1
		38	156.3
		39-40	390.6

[a]Column N is space between nodes (N-1,J) and (N,J)
[b]Row M is space between nodes (I,M-1) and (I,M)
[c]Column designation 1-5 means columns 1 through 5.



ACTUAL WATERWAY ALIGNMENT

COMPUTER REPRESENTATION OF WATERWAY

FIGURE D-11
REVISED 50 x 41 FINITE-DIFFERENCE GRID REPRESENTING THE SOUTH SALT LAKE SITE VICINITY

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During the calibration process, it was found that the hydraulic head distribution was more sensitive to changes in lateral hydraulic conductivity than to changes in infiltration, upward leakage, and seepage from the surface water bodies. The mass balance was relatively insensitive to changes in infiltration and upward leakage but was sensitive to changes in seepage from the creek and ditches. Table D-18 contains the results of the calibration of the unconfined system for present, steady-state conditions. The excavation has been and is currently being dewatered. The calculated value of flow rate to the CVWRF excavation is 54,718 ft^3/day or 284 gpm. The measured flow rate from the excavation discharge pipe is approximately 300 gpm. The relative error in the mass balance is about -1 percent computed with a relative error of (inflow-outflow)/(inflow+outflow). The calibration of residual hydraulic heads, measured hydraulic head minus calculated hydraulic head, had absolute values of less than 3.1 feet.

Table D-18. Calibration of unconfined system, present case

Well designation	ISWS nodal location X	ISWS nodal location Y	Measured[a] water levels (ft)	Calculated water levels (ft)	Difference (ft)[b]
7	47	18	4235.55	4232.45	+3.10
13	13	38	4233.79	4231.64	+2.15
9	13	28	4231.68	4230.53	+1.15
11	11	28	4231.61	4230.85	+0.76
6	49	40	4243.44	4242.79	+0.65
10	13	22	4230.01	4229.41	+0.60
12	38	39	4233.53	4233.56	-0.03
8	27	9	4226.42	4228.48	-2.06

Fluxes[b] (in ft^3/day)	
Sum of infiltration and upward leakage	+35,192.
Seepage to Mill Creek	+ 4,765.
Seepage from Vitro Ditches	+ 1,195.
Flow to Jordan River	-40,587.
Flow across boundaries	+52,062.
Flow to CVWRF excavation	-54,718.
Net mass balance error	+ 2,091.
% Percent relative error: (inflow-outflow)/ (inflow + outflow)	-1%

[a]average of well triplet completed to different intervals
[b]plus is flow into modeled aquifer; minus is flow out of modeled aquifer

Calibration of unconfined system--historic case. The historic case refers to the unconfined hydrodynamics prior to the existence of the CVWRF excavation. The same values of infiltration, upward leakage, and hydraulic conductivity used for the present case were used also for the historic case. The differences between the two simulations were in boundary conditions. In the historic case, Mill Creek and the Vitro Ditches were designated constant head boundaries ($SF2=1x10^{200}$). In the present case they were modeled as contributors of seepage to the unconfined system. Water levels measured (Dames and Moore, 1982) before the excavation at wells close to the creek and ditches, confirm that the surface water bodies are surface representations of the water table. The fluxes to Mill Creek and the ditches were calculated with Darcy's Law in the same manner as described in the previous section of this document. The constant head designation of the CVWRF excavation was eliminated, i.e., the values of SF2 where changed from $1x10^{200}$ to $1x10^{-20}$. The fluxes (values of Q) for nodes on the grid boundary were adjusted to properly calibrate the mass balance. Results of the calibration are shown on Table D-19. The relative mass balance error is 1.5 percent and the maximum absolute difference of measured head minus calculated head at a given point is 2.7 feet. The total calculated flux through the system is about 64,000 ft^3/day, (calculated by summing the flux in or out) while in the present case with the CVWRF excavation causing steep hydraulic gradients, the total calculated flux is about 94,000 ft^3/day. In the historic case, much of the ground-water discharge from the site is to Mill Creek.

Table D-19. Calibration of unconfined system-historic case

Well designation	ISWS nodal location X	ISWS nodal location Y	Measured[a] water levels (ft)	Calculated water levels (ft)	Difference (ft)[a]
V-CS	15	26	4230.63	4230.69	-0.06
V-AS	26	28	4231.84	4231.66	+0.18
V-GS	43	24	4235.83	4235.26	+0.57
V-ES	40	14	4234.25	4233.56	+0.69
V-BS	21	32	4232.41	4230.66	+2.15
V-HS	37	31	4234.79	4232.41	+2.38
V-FS	47	34	4236.51	4233.82	+2.69

Fluxes[a] (in ft^3/day)

Sum of infiltration and upward leakage	+35,192.
Seepage to Mill Creek	-57,841.
Seepage from Vitro Ditches	+13,196.
Flow to Jordan River	- 4,853.
Flow across boundaries	+16,252.
Net mass balance error	+1,945.
Percent Relative Error (inflow-outflow)/ (inflow + outflow)	1.5%

[a]plus is flow into modeled aquifer; minus is flow out of modeled aquifer

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Prediction of unconfined system--post-remedial action. Two minor changes were made to the unconfined system, historic case, to predict the post-remedial action water levels in the unconfined system. First, the rate of infiltration for the area of the covered embankment was reduced from 2.4 inches/year to 1.3 inches/year. Second, the lateral flow into the modeled area was raised about 2 percent to account for more inflow due to steeper hydraulic gradients caused by less infiltration. Table D-20 lists the various calculated fluxes. The calculated hydraulic heads were slightly lower than those calculated for the historic case. There was no calculated water level rise anywhere on the modeled area.

Table D-20. Fluxes in unconfined system after remedial action

Fluxes[a] (in ft^3/day)	
Sum of infiltration and upward leakage	+33,819.
Seepage to Mill Creek	-57,711.
Seepage from Vitro Ditches	+13,643.
Flow to Jordan River	- 4,874.
Flow across boundaries	+15,683.
Net mass balance error	+ 560.
Percent Relative Error (inflow - outflow)/ (inflow + outflow)	0.4%

[a]plus is flow into modeled aquifer; minus is flow out of modeled aquifer

Calibration of confined system--present case. The confined system was modeled on the second unconfined system grid (50x41 grid). The following parameter values were used:

1. SF1=Artesian Storage Factor--8.4×10^{-5} x area represented by the node. The storativity of 8.4×10^{-5} was derived from the pump test analysis (see Section D.3.3.2).

2. Q = Constant leakage or constant flux across boundary of grid--This value was set to 0.0 for internal nodes. It was set to negative values on the south and east borders of the grid and positive values on the north and west borders of the grid. Negative values indicate flow into the aquifer; positive values indicate flow out of the aquifer. These values were chosen to simulate the potentiometric surface configuration and fluxes observed in the field.

3. Perm = The hydraulic conductivity in the X and Y directions for each node were set to the same value to simulate isotropic conditions. The values varied from 6.5 ft/day in the southeast portion of the grid to 21.7 ft/day on the northwest portion of the grid with an arithmetic mean of 13.3 ft/day and a geometric mean of 14.1 ft/day. These values corresponded to the lower values calculated with the pump test analysis (see Section D.3.3.2). These values were chosen and varied as described to enhance calibration of measured to computed hydraulic head. The recharge factor R chosen was 3.4×10^{-5} day^{-1} which equals a vertical hydraulic conductivity of 3.4×10^{-4} ft/day through the aquitard divided by the 10-foot thickness of the aquitard. This value of vertical hydraulic conductivity is within the range calculated from the pump test results. The values of hydraulic head in the overlying aquifer, RH, were those values from the calibrated, unconfined system, present case. The aquifer thickness, CH-BOT, was set to a value of 70 feet.

Table D-21 shows the results of the calibration of the confined system. The relative mass balance error is about 0.1 percent. The largest difference between calculated and observed hydraulic heads is 4.8 feet. All the calculated values are lower than the corresponding measured values, but the measured values in 1981 by Dames and Moore were about 3 feet lower than the values measured in 1983. The calculated upward leakage is about 15,000 ft^3/day which equals 1.5 inches/year. The value calculated with the calibration of the unconfined system was 2.25 inches/year. These two values confirm that the upward leakage is about equal to the recharge from infiltration, which was estimated as 2.4 inches/year.

Table D-21. Calibration of confined system, present case

Well designation	ISWS nodal location X	ISWS nodal location Y	Measured water levels (ft)	Calculated water levels (ft)	Difference (ft)[a]
2	47	17	4248.9	4244.1	+4.8
4	8	27	4246.8	4242.7	+4.1
5	11	27	4247.2	4243.2	+4.0
3	26	5	4246.8	4243.7	+3.2
1	49	40	4249.1	4248.8	+0.3

Fluxes[a] (in ft^3/day)

Upward leakage	-15,236.
Flow across boundaries	+15,218.
Net mass balance error	- 18.
Percent relative error (inflow - outflow)/ (inflow + outflow)	0.1%

[a]plus is flow into modeled aquifer; minus is flow out of modeled aquifer

D.3.5 Analysis of water quality, geochemistry, and solute transport

Chemical data representing the tailings pile water and unconfined ground water were analyzed using the geochemical model PHREEQE (Parkhurst et al., 1980). This model uses thermodynamic relationships to determine aqueous and solid speciation. PHREEQE allows calculation of the form(s) in which a metal exists while in solution and the mineral which co-exists with the solute and controls its concentrations.

The equations used by PHREEQE are as follows:

1. Electrical neutrality (one equation).

$$\sum_{i=1}^{I} z_i \cdot m_i = 0$$

2. Conservation of electrons (one equation). The sum of the OPV of aqueous species equals initial total plus contribution from phases other than aqueous. This equation is only used in determining the speciation in reaction solutions, not initial solutions.

$$\sum_{i=1}^{I} v_i \cdot m_i = OPV + \sum_{p=1}^{P} u_p \cdot MIN_p$$

3. Mass balance (one equation for each element except H and O). The sum of aqueous species equals initial total plus contribution from phases other than aqueous.

$$\sum_{i=1}^{I} c_{i,j} \cdot m_i = TOT_j + \sum_{p=1}^{P} b_{p,j} \cdot MIN_p \quad \text{for each } j$$

4. Mineral equilibrium (one equation for each mineral phase).

$$\sum_{i=1}^{J} b_{p,j} \cdot \log(a_j) = \log(K_p) \quad \text{for each } p$$

5. Mass action equations for aqueous species (one for each aqueous species other than master species; written as association reactions).

$$\log(a_i) = \log(K_i) + \sum_{j=1}^{J} c_{i,j} \cdot \log(a_j)$$

where

a_i activity of the ith ion pair.

a_j activitiy of the jth master species.

$b_{p,j}$ stoichiometric coefficient of the jth master species in the pth mineral (zero if master species is not present in mass action equation for the ith species).

$c_{i,j}$ stoichiometric coefficient of the jth master species in the ith aqueous species (zero if master species is not present in mass action equation for the ith species).

I number of aqueous species.

J number of master species.

K_i equilibrium constant for the mass action equation for the ith aqueous species.

K_p equilibrium constant for the mass action equation for the pth phase.

m_i molality of the ith aqueous species.

MIN_p moles of the pth mineral transferred into (+) or out of (-) in the aqueous phase.

OPV $\sum_{i=1}^{I} v_i \cdot m_i$, calculated from the speciation of the initial solution or the mixture of two initial solutions.

P number of mineral phases.

TOT_j Total concentration of the element corresponding to the jth master species preceding any mineral dissolution or precipitation.

u_p sum of the OPV's of the constituents in the pth mineral.]
EX. $\mu_{FeS_2} = 0$ and $\mu_{Fe(OH)_3} = +3$

v_i Operational valence (OPV) of the ith aqueous species. The numerical values are assigned arbitrarily for bookkeeping convenience; they are self-consistent in terms of correctly defining electron transfer in redox reactions, but may or may not correspond to the true chemical valence for the entities involved.

v_i = 0 for "non-redox" species (those whose valence does not change within the stability range for water).

= 0 for H ,

= 0 for OH ,

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= -2 for H (aq) ,

= +4 for O (aq),

= the formal elemental valence for aqueous redox species (or the sum of the formal valences of the constituents of an aqueous complex, excluding H and O). Ex. v_{Fe2+} = +2, v_{SO4}^{2-} = +6, and v_{FeSO4}^{o} = +8.

z_i charge on the ith species.

PHREEQE solves a set of nonlinear equations using a combination of two techniques:

- o a continued fraction approach, as in Wigley (1977), is used for mass balance equations
- o a modified Newton-Raphson technique is used for all other equations

PHREEQE is an equilibrium model and does not account for reaction kinetics. Solute transport was simulated with steady-state unidirectional solutions to the advection-dispersion equations found in Prakash, 1982.

D.3.5.1 The Present Condition

Surface and ground waters on and near the Vitro site have been contaminated by the tailings pile. A sample was defined as being contaminated if it satisfied any of the following criteria:

- It contained metals associated with the tailings pile in concentrations higher than the highest concentration found in uncontaminated (background) samples.
- The pH of the sample was lower than the lowest found in background samples.
- It contained higher concentrations of calcium (Ca^{+2}) or bicarbonate (HCO_3^-) than the highest concentrations found in background samples.

These criteria are broad and may encompass samples which have not been contaminated by water derived from the tailings pile.

As far as its effect upon water quality is concerned, the tailings pile is composed of two geochemically distinct layers. The top layer is composed of tailings and pile water (Layer 1). It rests upon a mixture of tailings, soil, and ground water (Layer 2). These layers are about 10 feet and 3 feet thick, respectively. Layer 2 contains bands of iron (Fe) and sulfate ($SO_4^=$) precipitates which are the result of tailings water moving into the chemical environment of the ground-water system (Markos and Bush, 1982).

Determination of speciation in Layer 1 using PHREEQE can be found in Table D-23. Chemical data from both tailings layers are presented in Table D-24. These data illustrate that ground water in contact with tailings contains higher concentrations of As, Cd, Mo, Pb and U than does the tailings water. It follows that the chemical mechanisms occurring in Layer 2 are different from those in Layer 1 and are responsible for the greatest portion of aqueous contamination found in the site area. An explanation of the higher concentrations in Layer 2 follows.

When tailings water is mixed with ground water, the chemical environment changes drastically. Acidity decreases by a factor of several hundred and Eh (oxidation-reduction potential) decreases by several hundred millivolts (Markos and Bush, 1982). The acidic tailings water dissolves soil calcium carbonate ($CaCO_3$). This causes Fe and SO_4 compounds to precipitate which in turn causes metal-bearing minerals in the tailings to dissolve more rapidly than they do in tailings Layer 1. An example of this process is the dissolution of the arsenic mineral, scorodite:

$$FeAsO_3 \cdot 2H_2O \text{ (Scorodite)} = Fe^{+3} + AsO_4 + 2H_2O \quad (1)$$

$$Fe^{+3} + 3OH^- = Fe(OH)_3 \text{ (Amorphous Iron Precipitate)} \quad (2)$$

Reaction (2) causes Reaction (1) to be driven to the right, resulting in increased concentrations of dissolved arsenic. Amorphous iron has the ability to retard the movement of arsenic and other metals by sorbtion, co-precipitation, and occlusion (Markos and Bush, 1982). The concentration of arsenic depends upon which mechanism is faster, dissolution or retardation. In the water of Layer 2, dissolution is the faster. The implication is that if the tailings are placed above the water table, levels of contamination will be greatly reduced because the dissolution will not occur at appreciable rates.

On the other hand, concentrations of barium and chromium are lower in Layer 2 than in Layer 1. The movement of these metals may be highly retarded in tailings Layer 1, or, they may be rapidly sorbed in Layer 2. Recent research indicates that both mechanisms are operating (PNL, 1983). This is supported by the speciation information presented in Table D-22. Both barium and chromium exist as multi-valent cations in Layer 1. They remain cations as pH is increased. Therefore, their movement is retarded.

Surface Water and CVWRF Excavation

Data from samples of surface water are presented in Table D-22. The Jordan River and Mill Creek are considered to represent background conditions. The CVWRF excavation, Vitro Ditch, South Vitro Ditch, and the marsh east of the site are contaminated due to tailings sliding or blowing into these waters, or shallow ground-water flow beneath the pile to the surface water. The excavation and the ditches are bordered by tailings. The marsh is within the area identified as containing wind blown tailings (Douglas and Hans, 1975). As with the tailings water of Layer 2, some surface water samples have concentrations higher than the concentrations in Layer 1. These metals are cadmium (Cd), molybdenum (Mo) and uranium (U). Tables D-23 and D-24 show that mixtures of tailings and background waters contain high

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Table D-22. Analyses of surface water samples

	Background (4 samples)[a]	Excavation (2 samples)	Vitro Ditch (3 samples)	South Vitro Ditch (4 samples)	Marsh
pH	7.9	6.8	7.2	7.6	8.8
As	0.01	0.007	0.01	0.03	0.07
Ba	NA	ND	0.074	NA	0.021
Cd	ND	ND	ND	ND	0.36
Cr	0.01	ND	0.02	0.02	0.05
Mo	0.01	1.2	0.84	0.37	0.62
Pb	0.08	0.006	0.12	0.08	0.14
U	0.0042	0.58	1.0	0.10	0.0014
[b]Se	ND	ND	ND	ND	0.43

NA = Not Analyzed
ND = Not Detected

[a]Where more than one sample has been taken, the highest concentration found is reported

[b]No Se has been detected in any water sample from the tailings pile.

Note: All data reported as mg/l except pH.

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Table D-23. Speciation of metals as determined by PHREEQE

	Tailings pile (upper level)		Shallow ground water (contaminated)		Shallow ground water (Background)		Deep ground water (Background)	
	Aqueous	Solid)	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
As	H_3AsO_4	$FeAsO_4$ $2H_2O$	AsO_4 , H_3AsO_4	$Mn_3(AsO_4)$ $8H_2O$, $NaUO_2AsO_4$ $4H_2O$, $AlAsO_4$ $2H_2O$	AsO_4	$Mn_3(AsO_4)_2$ $8H_2$	AsO_4	$Mn_3(AsO_4)$ $8H_2O$
Ba	Ba^{+2}		Ba^{+2}	$BaSO_4$	Ba^{+2}	$BaSO_4$	Ba^{+2}	$BaSO_4$
Cd	$CdSO_4$	$CdSO_4$ H_2O	Cd^{+2}	$CdCO_3$	Cd^{+2}	$CdCO_3$	Cd^{+2}	$CdCO_3$
Cr	Cr^{+3}	Cr_2O_3	$CrOH^{+2}$, $Cr(OH)_2$	$Cr(OH)_3$	$Cr(OH)_2$	$Cr(OH)_3$	$Cr(OH)_2$	$Cr(OH)_3$
Mo	$HMoO_4$	$PBMoO_4$	MoO_4	$PbMoO_4$	MoO_4	$PbMoO_4$	MoO_4	$PbMoO_4$
Pb	$PbSo_4$	$PbMoO_4$	$PbHCO_3$ -2	$PbmoO_4$	$PbHCO_3$ -2	$PbMoO_4$	$PbHCO_3$ -2	$PbMoO_4$
U	UO_2	$NaUO_2AsO$ $4H_2$	$UO_2(CO_3)_2$	$NaUO_2As)_4$ $4H_2O$	$UO_2(CO_3)$	$NaUO_2AsO_4$ $4H_2O$	$UO_2(CO_3)_2$	

[a]Most abundant aqueous species reported; where data from more than one well were analyzed, most abundant species in each well is reported. The solid phase believed to control aqueous concentrations is reported.

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Table D-24. Analysis of tailings pile water

	Layer 1 (1 sample)	Layer 2 (Highest concentration found in 14 samples)	Average
Eh (Mv)	560	(-25) - (330)	
pH (s.u.)	3.3	(4.9) - (7.1)	
As (mg/l)	0.36	6.14	0.94
Ba (mg/l)	27.0	0.078	0.047
Cd (mg/l)	0.0069	0.22	0.020
Cr (mg/l)	0.06	0.05	0.030
Mo (mg/l)	0.05	7.90	1.14
Pb (mg/l)	0.26	0.28	0.17
U (mg/l)	0.45	75.0	7.61

Note: All data reported as mg/l except as indicated

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concentrations of Mo. This is in contrast to contaminated ground waters (Tables D-4, D-5, and D-6) which contain concentrations of Mo at near background levels. This indicates that two different mechanisms are operating. One controls concentrations of Mo in the presence of tailings, the other in the absence of tailings.

Since the opening of the CVWRF excavation, ground-water flow paths in the vicinity of the mill site have been altered towards the excavation (Figure D-12). The results of the calibrated hydrodynamic model of the present condition show that about one-third of the water flowing into the excavation comes from north of the excavation, while about two-thirds of the water is flowing from the existing tailings areas. The uranium concentration in the excavation drainage water was measured at 0.25 mg/l. Assuming a background concentration of 0.02 mg/l in the uncontaminated water and assuming that the uranium concentration in the shallow ground water entering the excavation is accurately represented by the excavation discharge sample, the average uranium concentration of water in the tailings can be calculated as 0.35 mg/l.

The TDS measured in the CVWRF excavation was 4340 mg/l. Assuming a background concentration of 2,500 mg/l, the calculated average TDS of ground water under the tailings is 5260 mg/l. These calculated concentrations of uranium and TDS may accurately represent present average source concentrations from the tailings pile to the shallow unconfined ground water.

Unconfined Ground Water. Samples from the following wells fit the definition of contamination: 8, 9, 10, 11, 13, 14, VBS, and VDS (Tables D-4, D-5, and D-6). These samples define a plume of contamination at least 3600 ft wide which has advanced at least 400 ft west of the site boundary. Wells 12 and 7 represent background concentrations.

Examination of Tables D-4, D-5, and D-6 yields the following information. In no sample is Ba found in concentrations significantly above background levels, including beneath the pile. This strongly suggests that transport of Ba is highly retarded. Arsenic is found in concentrations above background in only one well, suggesting that transport of arsenic is also quite retarded. Cadmium, chromium, molybdenum, and lead are found in concentrations slightly above background levels in a few cases, indicating that their movement through the aquifer is retarded to some degree. Uranium is found in concentrations above background levels in all but one instance. It is the most mobile of the metals considered.

Retardation of the transport of Ba, Cd, Cr, and Pb is expected because these metals exist as cationic species in the unconfined aquifer (see Tables D-4, D-5, and D-6). As and Mo exist as anions but recent research indicates that both species may be sorbed by Fe and aluminum compounds (PNL, 1983; Markos & Bush, 1982; LeGrendre & Runnels, 1975). It has also been suggested that Mo may form long chains of snowflake-like structures (polymers) which are more easily sorbed than MoO_4^{-2} (Bohn, 1975). Whatever the explanation, As and Mo are present in concentrations significantly lower than can be attributed to dilution alone (see Tables D-4, D-5, and D-6).

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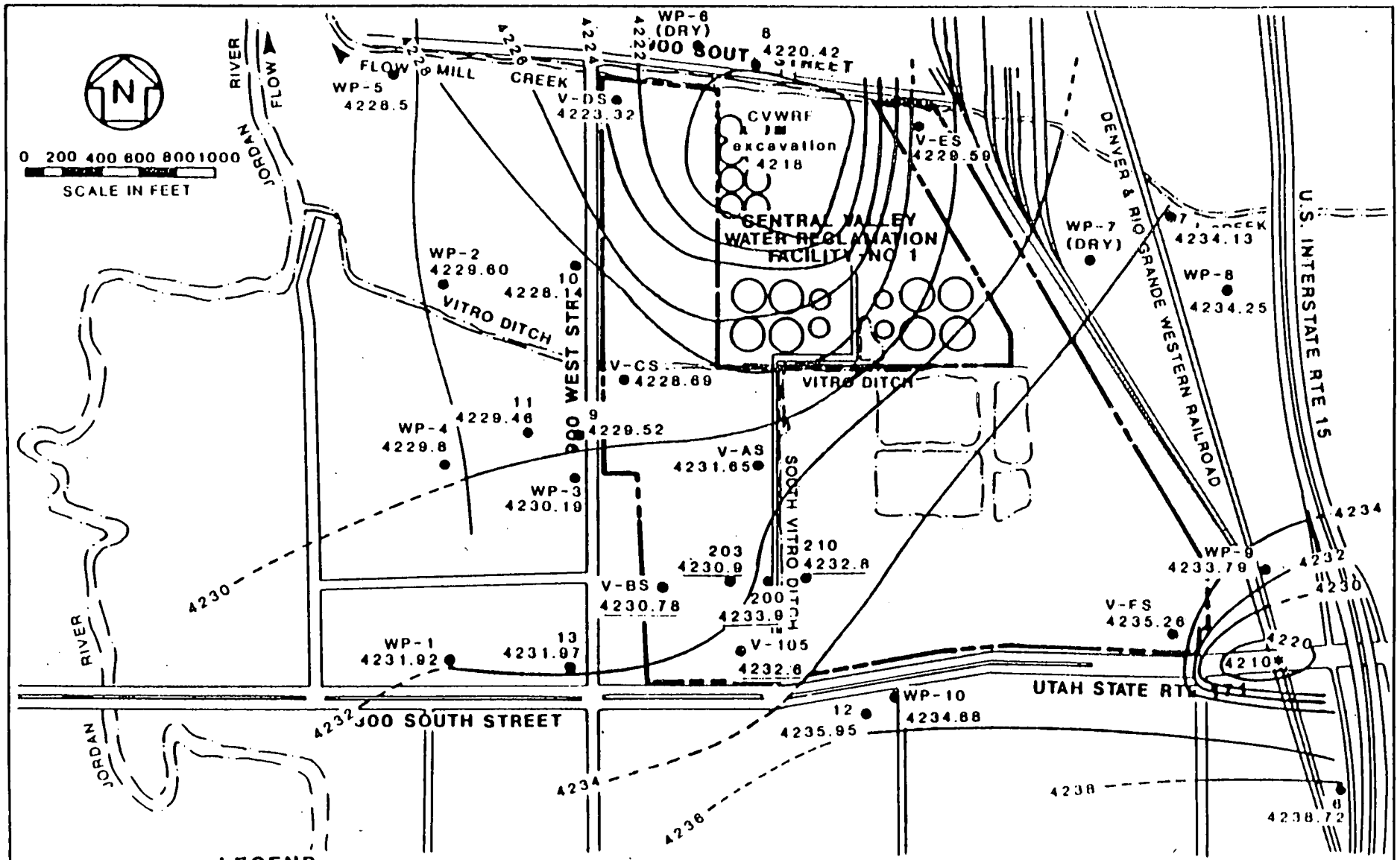

LEGEND

- ● WELLS SHOWING MEASURED WATER LEVEL (UNDERLINED WHERE VERTICAL CONTROL IS LACKING)
- ✱ HIGHWAY DRAIN
- - - — WATER TABLE SURFACE CONTOUR (DASHED WHERE EXTRAPOLATED)

FIGURE D-12
WATER LEVELS IN THE UNCONFINED AQUIFER
SOUTH SALT LAKE SITE,
MEASURED SEPT. 1983

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Uranium is mobile in the ground water beneath the tailings in the form of $UO_2(CO_3)_2^{=}$. Prior to the excavation, unconfined ground water flowed roughly southeast to northwest through the tailings, and discharged into the Jordan River and Mill Creek. In the downgradient area, the uranium concentrations in water samples from well triplets 9A, 9B, 9C and 11A, 11B, 11C, indicate evidence of a relic contaminant plume. Uranium concentrations at wells 9C and 11C are higher than any uranium concentrations of ground-water samples beneath the tailings pile. Using hydraulic parameters for the calibrated historic hydrogeologic model and the solute transport equations of Prakash (1982), uranium concentrations were calculated and compared to values measured in the wells. The strength and location of the source was varied until results of the simulation agreed with the measured values (Table D-25).

Table D-25. Comparison of measured and calculated uranium concentrations

Well ID	Approximate depth of well screen (ft)	Measured concentration (mg/l)	Calculated concentration (mg/l)
9A	6	0.025	0.013
9B	16	0.13	0.23
9C	26	2.12	2.24
11A	4	0.14	0.053
11B	15	0.57	0.39
11C	24	1.87	1.86

The following input values were used in this calibration of the solute transport equations:

- A point source 700 feet east of 900 West Street, directly east of well series 9 and 11.
- An effluent concentration of 7.76 mg/l released at a constant rate of 1 ft^3/day.
- A ground-water velocity of 0.3 ft/day.
- Lateral and vertical dispersivities of 0.00001 ft^2/day and 0.007 ft^2/day, respectively.

The uranium concentration at downgradient well No. 13 is 0.02 mg/l, about background level, while downgradient well No. 10C has a slightly elevated concentration of 0.11 mg/l. The concentrations at wells Nos. 10 and 13 show that there is selective transport with little spreading of the plume, confirming the low dispersivity of the system in the vicinity of wells 11 and 9. Calibration of the movement of sulfate (see below) showed that the dispersivity of the system as a whole is higher than in the area of wells No. 9 and 11.

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The concentration of sulfate downgradient was also modeled using the Prakash equations. The source was modeled as 2 lines, 900 feet long, perpendicular to the direction of flow. The concentrations were set at 6000 mg/l above background concentration representing the highest sulfate level of any sample. This simulation resulted in calculated maximum concentrations of sulfate of 3750 mg/l above background at a distance of 1500 feet west of the pile, 57.4 mg/l above background 4150 feet west of the pile, and 1.2 mg/l above background 4200 feet west of the pile (adjacent to the Jordan River). The Jordan River is considered as an infinite sink for contaminants through the application of image well theory in the Prakash equations. For these line sources, a lateral dispersivity of 4.0 ft^2/day and a vertical dispersivity of 0.25 ft^2/day were used. The value at 1500 feet west of the pile was close to values measured in that area.

Confined system. Comparing the water quality at upgradient wells Nos. 1 and 2 to downgradient wells Nos. 4 and 5 shows that the downgradient artesian water has elevated TDS but no elevation in the concentrations of radionuclides or trace metals. The average TDS at wells Nos. 1, 2, and 3 is about 300 ppm while the average at wells Nos. 4 and 5 is 1200 ppm. The high concentrations downgradient must represent relic contamination because the natural vertical hydraulic gradient in the area is upward, precluding the downward flow of water from the unconfined to the confined system. The downgradient contamination in the confined system is probably due to downward leakage caused by pumping at the mill site during processing. To obtain process water at the Vitro site, it is estimated that it was necessary to pump from the confined system at an average continuous rate of 190 gpm for 13 years.

It is difficult to determine whether or not water originating in the tailings pile has entered the confined system because the pathway is complicated. First, tailings pile water must enter the unconfined system. All metals will be diluted and immobilized to some degree. Next, the mixture of tailings pile--unconfined ground water must pass through the clay confining layer. Further immobilization will occur because clays have high sorbtive capacities (Garrels & Christ, 1965). Finally, the contaminated water enters the confined system where it is diluted once again. The plume of contamination, which is at least 2600 feet wide and has advanced at least 1900 feet west of the site boundary, may be due to downward migration of water from both the unconfined aquifer and the tailings pile or may be due to downward migration from the unconfined aquifer only.

Although these wells contain Ba and Cr in concentrations above background levels, it is unlikely that these metals came from the tailings pile. In the first place, Ba is not found in concentrations above background levels in the unconfined aquifer. Secondly, both metals are sorbed more strongly than U which is not found in concentrations above background levels. Lead-210 has been detected in one of two samples taken from well 5 and one sample from well 15. The concentrations were not significant because they were only slightly above the detection limit of 1.5 pCi/l.

It is difficult to accurately determine the concentration of TDS or individual chemical constituents of the water leaking from the unconfined to the confined aquifer; and the mixing of the natural, confined ground water with the water derived from leakage once the natural hydraulic gradients were restored. To determine the possibility of the downgradient water quality in the confined system being a result of pumpage during milling, the following calculation was performed:

1. Background TDS = 300 mg/l in the confined system.

2. Unconfined ground water leaking into confined system may have contained TDS from 4000 to 40,000 mg/l. The lower values would represent primarily water natural in the unconfined system while the higher values would represent water contaminated with tailings liquor.

3. Downgradient, unconfined ground-water samples contain approximately 600 and 1800 mg/l TDS.

4. Calculate mixing of the two sources of water, unconfined and confined, to produce the measured downgradient contamination, assuming no precipitation/dissolution reactions.

Table D-26 shows that mixing of ground water from the unconfined system with the confined system is a reasonable explanation of the elevated concentrations of dissolved solids found downgradient in the confined system at a depth of 110 to 130 feet below the ground surface.

Table D-26. Possible mixing of ground waters during pumping

Confined ground water TDS (mg/l)	Leaking unconfined ground water TDS (mg/l)	Resultant TDS (mg/l)	Fraction from confined water	Fraction from unconfined water
300	4000	600	0.92	0.08
300	4000	1200	0.76	0.24
300	4000	1800	0.59	0.41
300	20000	600	0.98	0.02
300	20000	1200	0.95	0.05
300	20000	1800	0.92	0.08
300	60000	600	0.99	0.01
300	60000	1200	0.98	0.02
300	60000	1800	0.97	0.03

D.3.5.2 Post-remedial action

Contaminant migration in the unconfined system after remedial action is dependent upon two items: fluid flow after remedial action, and the source of contamination after remedial action. The source of contamination will vary depending upon the location of the tailings with respect to the level of the water table.

Hydrodynamics. The calibrated hydrodynamic model shows that the water levels in the unconfined system will be approximately the same after remedial action and after the CVWRF excavation is closed as historic levels (before the excavation) (Tables D-19 and D-20). The levels will drop slightly under the Vitro site in response to the reduced infiltration in that area (Table D-20). Significantly, there will be no rise in water levels in the area of the tailings, so that the water table will remain about 3 feet below the contaminated material. The restoration of historic ground-water levels means that historic flow patterns will be restored, and the unconfined ground water will again flow southeast to northwest to discharge into the Jordan River and Mill Creek.

The remedial action requires that the tailings material be encapsulated with a cap that will reduce infiltration through the tailings to a maximum of 0.11 feet/year, assuming no vegetation, and a liner that will guarantee that the tailings are a minimum of 3 feet above the water table. The time necessary for contamination to travel from the encapsulation to the ground water can be calculated with equations from Gilbert et al., (1983). The input parameters for uranium are:

- N_e = effective porosity = 0.10 (assumed value)
- K_d = partitioning coefficient = 15 cm^3/g (a value of 30 cm^3/g for low pH was reported in Gilbert et al., 1983)
- I = infiltration rate = 0.11 ft/yr
- ρ_s = density of liner material = 1.7 g/cm^3 (assumed value)
- D = the distance from the encapsulated tailings to the water table = 3 feet

The delay time, $Td = DX(N_e + \rho_s Kd)/I =$

$3 \text{ ft. } (0.10 + 1.7 \text{ g/cm}^3 \times 15 \text{ cm}^3/\text{g})/0.11 \text{ ft/yr.} = 700 \text{ years}$

This analysis (700 years) is a worst case assessment for uranium migration, using highly conservative parameter values.

A probable case delay time can be calculated with more likely parameter values.

$N_e = 0.10$
$K_d = 30 \text{ cm}^3/\text{g}$
$I = 0.33$ ft/yr (value calculated assuming sparse vegetation)
$\rho_s = 1.7 \text{ g/cm}^3$
$D = 5$ ft (the design thickness of the liner)
$Td = DX(Ne + \rho_s Kd)/I = 5 \text{ ft } (0.10 + 1.7 \text{ g/cm}^3 \times 30 \text{ cm}^3/\text{g})/$
$0.033 \text{ ft/yr} = 7700 \text{ yrs}$

Partitioning coefficients for the dissolved metals under unmixed tailings pile conditions are available only for uranium (Gilbert et al., 1983). Only qualitative estimates of the effects of retardation can be made for the other metals. Recent research (PNL, 1983) and the information presented in this section indicates that Ba and Cr are highly retarded under tailings piles conditions. This same research indicates that As and Pb will also be highly retarded, while Cd, U, and Mo will be relatively mobile.

The proposed remedial action should cause significant delay (a minimum of 700 years) for trace metal contaminants to enter the ground-water system. Downgradient concentrations were predicted for U, Mo, and As following the 700+ year delay time, using the following assumptions:

- Tailings Layer 1 concentrations were used as source concentrations.
- Effluent release rate = predicted conservative percolation rate of 1.3 inches/year.
- Ground-water seepage velocity = 0.3 ft/day.
- Vertical dispersivity = 0.25 ft^2/day.
- Lateral dispersivity = 4.0 ft^2/day.
- The source can be defined as 2 horizontal lines perpendicular to the direction of flow. These lines bound the proposed encapsulation to the east and west and run the length of the proposed encapsulation, north to south.
- The constituents are mobile, i.e., move with the ground water.
- The Jordan River acts as a constant concentration discharge boundary.
- The depth of mixing in the aquifer is 45 feet.

See Table D-27 for the post-remedial action concentrations calculated for U, As and Mo, using the equation from Prakash (1982).

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Table D-27. Predicted maximum downgradient contaminant concentration in the unconfined aquifer, post-remedial action, with a liner

Contaminant	Location	Concentration (mg/l)
As	At Source	0.36
As	900 W.	0.008
As	900' west of 900 W.	0.005
As	2100' west of 900 W.	0.002
Mo	At source	0.05
Mo	900 W.	0.001
Mo	900' west of 900W.	0.0007
Mo	2100' west of 900 W.	0.0003
U	At source	0.45
U	900 W.	0.01
U	900' west of 900 W.	0.006
U	2100' west of 900 W.	0.002
SO_4 = Above background	At source	6600
SO_4 = Above background	900 W.	144
SO_4 = Above background	900' west of 900 W.	87
SO_4 = Above background	2100' west of 900 W.	34

Time necessary for contaminants to travel from base of encapsulation to water table:

SO_4 = >28 Years
U, Mo, As >700 Years

D.3.6 Aquifer Restoration Analysis

D.3.6.1 Boundaries of contamination

A contaminant plume exists in the unconfined aquifer downgradient of the Vitro site (see Section D.3.2 for description of existing ground-water quality). Contamination was detected in samples from well triplets 9, 10, and 11 (see Figure D.13 for well locations). Samples from these wells contained concentrations of total dissolved solids (TDS), uranium (U), sulfate ($SO_4^{=}$), sodium (Na^+), chloride (Cl^1), calcium (Ca^{++}), and magnesium (Mg^{++}) significantly higher than samples from upgradient, unconfined wells. A sample from well 13C did not contain these constituents in concentrations higher than upgradient or cross-gradient "C" wells (see Table D.5). A sample from well 17, completed in the top of the confining layer separating the unconfined and confined aquifers, also contained uncontaminated ground water. The natural flow in the unconfined aquifer is to the northwest (Figure D-8). Therefore, the Jordan River and Mill Creek are considered discharge boundaries of the shallow ground water flowing beneath the Vitro site. Based upon the data presented above, the assumed maximum boundaries of contamination have the following dimensions (Figure D-13):

- Plume width of 3,100 feet -- The distance, north-to-south, from well triplet 13 to Mill Creek. A sample from well 13C showed no contamination and Mill Creek is a discharge boundary for shallow ground water.

- Plume length of 1500 to 2600 feet -- The distance from the site boundary to the discharge at the Jordan River.

- Plume thickness of 50 feet -- The depth distance from the water table to the bottom of the unconfined aquifer. Water at the base of the unconfined system is uncontaminated as evidenced by the sample from well 17.

- The maximum area of contaminated, unconfined ground water is 7×10^6 ft^2 (Figure D-13). The maximum thickness is 50 feet. Assuming a conservatively high value of porosity of 0.30 (Hely, et al., 1971), the maximum volume of off-site contaminated, unconfined ground water is 1×10^8 ft^3.

Also, to ensure a worst-case analysis, the assumption was made that the quality of all the water contained within the contaminated volume is equal to the poorest quality found in the downgradient, unconfined ground-water samples (Table D-28).

D.3.6.2 Potentially affected water supplies

There are three potentially affected available water supplies (discounting quality or need for treatment):

- Surface water (Jordan River and Mill Creek).

- Unconfined aquifer water.

- Confined aquifer water.

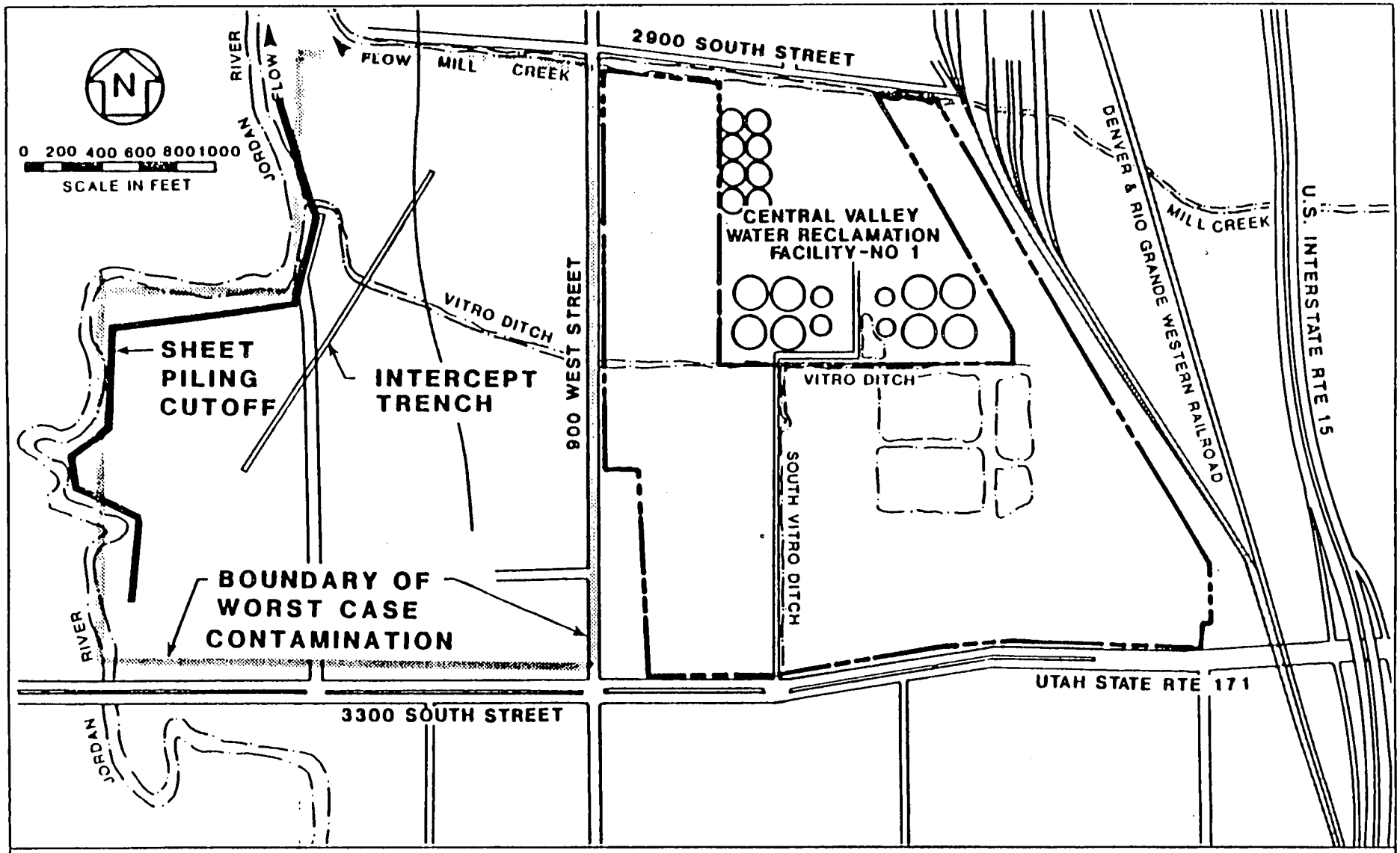

FIGURE D-13

AQUIFER RESTORATION DESCRIPTIVE MAP SOUTH SALT LAKE SITE

Table D-28 Calculated worst-case change of water quality in Jordan River

Parameter	Jordan River current concentration (mg/l)	Unconfined aquifer maximum concentration (mg/l)	Jordan River[a] plus plume concentration (mg/l)	Resultant change in river concentration (mg/l)
TDS	1180	20,000	1270	+90
U	0.7	2.0	0.7	0
SO_4	368	7,000	400	+32
Na	186	3,100	200	+14
Cl	271	2,500	282	+11
Ca	127	1,000	131	+ 4
Mg	60	1,000	64	+ 4

[a] $\frac{\text{(Concentration in River)} \times \text{(68,000 gpm)} + \text{(Concentration from Aquifer)} \times \text{(325 gpm)}}{\text{68,325 gpm}}$

In this section the benefits of aquifer restoration are described and calculated for each of the three water supplies by considering the loss of use and potential use, given no aquifer restoration. The loss of benefit would extend through the time needed for the contaminated water to travel and discharge to the Jordan River or Mill Creek (period of natural purging). Geochemical retardation was not considered because the contaminants are mobile in the ground water. To bound this time, two methods of calculation were used. First, for a lower bound, a shallow ground-water flux to Mill Creek and the Jordan River of 62,600 ft^3/day was considered (see Section D.3.4.1, Table D-20). Given a flux of 62,600 ft^3/day (325 gpm), it would require 4.4 years for the entire contaminated volume of 1×10^8 ft^3 to discharge to the surface water streams. For an upper bound, a seepage velocity of 0.3 ft/day was considered (see Section D.3.5.1). Given a maximum travel distance of 2,600 feet, the calculated travel time was 23.7 years. The average discharge through this period would be 11,500 ft^3/day (60 gpm).

Effect upon the Jordan River

The worst-case loss of benefit to surface water would occur if all the contaminated unconfined ground-water discharged to the Jordan River. For the reach from the Vitro site to the Great Salt Lake, the Jordan River is

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classified for aquatic wildlife (Class 3B) and agricultural beneficial uses (State of Utah, 1978). The 3B classification requires protection for warm water species of game fish and other equatic life, including the necessary aquatic organisms in their food chain. The agricultural uses include irrigation of crops and stock watering. Generally, warm water fish do not suffer stress from dissolved solids until concentrations reach 2,500 to 3,000 mg/l TDS (USEPA, 1973). Dissolved solids have been determined to be detrimental for irrigation and stock watering only at concentrations greater than 3,000 mg/l.

The average flow of the Jordan River near the Vitro site is 68,000 gpm (State of Utah, 1943-1968). The degradation of the river was calculated with a ground-water discharge of 325 gpm. This maximum discharge rate was used to calculate the maximum degradation of river quality. The river water concentrations displayed on Table D-28 were found in the State of Utah, 1943-1968. The quality of the discharge from the unconfined aquifer to the Jordan River is assumed to be equal to the poorest quality found in the aquifer to determine the worst-case degradation of river quality.

The results of the worst-case degradation calculations are presented on Table D-28. The increase in TDS, $SO_4^{=}$, Na^+, Cl^-, Ca^{++}, and Mg^{++} would not change the beneficial uses of the river. The change in river water quality would be insignificant and there would be no loss of benefit because there would be no effect on the river's beneficial uses.

Effect upon the unconfined aquifer

The upper portion of the unconfined aquifer is naturally brackish (see Section D.3.2 and Hely et al., 1971). The water quality improves with depth and approaches the good quality of the underlying confined system. Within a one-half mile radius of the site, there are two wells known to be completed to the unconfined system. These wells are believed to be used for irrigation only. There are no known wells other than monitor wells completed to the unconfined aquifer and within the boundaries of contamination. A maximum loss of benefit could be calculated by assuming all the water within the boundary of contamination in the unconfined aquifer would have been of drinking water quality and the entire volume of water could be used before discharging to Mill Creek or the Jordan River.

The maximum volume of contaminated ground water was calculated as 1×10^8 ft^3, (2,300 acre-feet). The State of Utah states that the cost of water in the Salt Lake area is approximately $105 per acre-foot (State of Utah, 1983). Therefore, the maximum loss of benefit to the unconfined ground water is $240,000.

The change in use of the unconfined aquifer due to contamination from the Vitro site would be from marginal irrigation and stock watering to industrial use only in the upper portions and from potable water to industrial use only in the lower portion. It should also be noted that yields from monitoring wells completed in the unconfined system are low (approximately 10 gpm).

Effect upon the confined aquifer

The confined aquifer is an important source of domestic, agricultural, and industrial water supply in the Salt Lake Valley (see Section D.2.1). The State of Utah indicated that within a half-mile radial distance from the Vitro site, there are 7,790 acre-feet per year of total water rights (State of Utah, 1983). Within the areal boundary of contamination in the unconfined system, only two wells are known to be completed to the confined system other than wells associated with the Vitro site. Both of these wells are not being used presently.

An upward, vertical hydraulic gradient protects the confined aquifer from the downward migration of lesser-quality, unconfined ground water. This upward gradient occurs naturally but could be reversed by localized heavy pumping (see Section D.3.2.5). Several samples downgradient of the Vitro site indicate that the confined ground water may have been contaminated. Samples from four wells averaged 1,140 mg/l of TDS; background is about 300 mg/l of TDS.

Although future degradation of the confined aquifer would occur only with localized, heavy pumping, the potential loss is considered. The areal extent of potential contamination in the confined system would be the same as in the unconfined system. The depth of contamination would be dependent on the magnitude of the downward vertical gradient induced by the localized pumping. Because this pumping is hypothetical, the depth of mixing is impossible to predict. A reasonably conservative estimate would be mixing to 160 feet below the ground surface or to the 100 foot depth of the aquifer. This estimate assumes that pumping-induced drawdowns will be less than 170 feet. For this hypothetical case, the volume of contaminated ground water would be $2x10^8$ ft^3, assuming a porosity of 0.30. This volume is 4,600 acre-feet and, at a value of $105 per acre-foot (State of Utah, 1983), the loss of resource would be $480,000.

Spatial apportionment method

A second method of calculating the loss of benefit due to the volume of contamination is to assume that a portion of the water rights claimed within a half-mile radius of the Vitro site is not available during the natural purging of the unconfined aquifer. Contaminated, unconfined ground water cannot be used during the 4.4 to 23.7 year purging period due to contamination. Also, for a worst-case assessment, it is assumed that ground water beneath the contaminated area cannot be used for the full purging period. The ground water upgradient or lying outside of the contaminated boundary is not affected and may be used to fulfill water rights. Apportionment is made as to the percentage of the surrounding water rights that will be reduced or not available. Even though a greater density of water rights are in the area outside the contaminated area, for conservatism it is assumed that water rights are equally distributed throughout the half-mile radius circle.

A circle with a half-mile radius has an area of 2.2×10^7 ft^2. The maximum area of the plume is 6.7×10^6 ft^2 (see Figure D-13). The contaminated area is approximately 30 percent of the area of the circle. There are 7,790 acre-feet per year of total water rights within the area of the circle (State of Utah, 1983). Thirty percent of this would be 2,340 acre-feet. At a value of $105 per acre-foot, the annual loss of ground water use would be a maximum of $245,000 per year.

D.3.6.3 Aquifer restoration techniques

There are several methods to remove the contaminants contained within the plume. These include:

- Intercept trench with recharge control.
- Barrier walls and removal by pumping.
- Pumping of contaminated water and recharging of fresh water using a series of wells.

All of these methods would lead to treatment and disposal of discharge.

Using EPA 1982 as a guideline, the intercept trench with recharge control appears to be the least expensive and most efficient method for the hydrogeologic setting by the Vitro site. The barrier walls with pumping would require a greater capital investment, take more time for cleanup, and cause greater mixing of uncontaminated and contaminated water. The pumping/recharge system is more expensive, would take considerably more time, and may cause differential settlement or fail completely in the highly stratified, unconsolidated unconfined aquifer.

Plume capture methodology

The intercept trench would be placed across the plume, between the Jordan River and 1000 West Street (see Figure D-13). Another intercept trench may be required between the northern end of 100 West Street and well number 4. The location of the trench(es) would be dependent on the result of a site investigation conducted at the beginning of installation of a remedial action program to define and quantify the plume in the area west and north of well number 4. For the purpose of this analysis, it was assumed there would be 1900 lineal feet of trench, four feet wide and to a depth of 50 feet. A trench of this nature would intercept the contaminant plume and passively collect it at a rate of about 500 to 1000 gpm. These values were calculated using the line sink method in Lohman (1972), with transmissivity = 1000 ft^3 /day, storativity = 0.3, change in drain state of 50 ft and time = 100 days and 365 days. The trench would be sloped to one end where a sump would collect the captured liquid and the liquid would be pumped to a treatment plant. The bottom of the trench would be sealed with clay.

Recharge from the Jordan River would be controlled by the use of a barrier to prevent Jordan River water from entering the treatment collection system and diluting the effectiveness of the collection and treatment system (Figure D-13). For this analysis, the barrier would be an interlocking steel barrier pile driven into the ground between the intercept trench and the river. This barrier, although not a complete control method, should control a sufficient quantity of recharge to prevent significant dilution in the trench (EPA, 1982).

Plume treatment

The goal of the treatment plant would be to generate an effluent of sufficient quality to discharge to the surface waters of the State of Utah. In addition to the effluent, the treatment plant would generate a sludge that would contain uranium and possibly other radioactive contaminants. (For the purposes of this analysis, it has been assumed that the sludge will require disposal at a low-level hazardous waste disposal site.)

The treatment plant will involve the following processes (Sherwood, 1983):

1. Neutralization to a pH of 8.0 to 9.0 to precipitate most metals and neutralize the residual acid. Sulfate ($SO_4^{=}$), would remain in solution. The operating costs of the neutralization facilities are based on lime as a neutralization agent.

2. Fixation -- The sludge generated in the neutralization step would be settled and then stabilized by a stabilizing agent, such as CHEMFIX, after dewatering so that it could be handled by normal construction equipment for disposal.

3. Reverse osmosis -- In order to obtain a discharge permit, the treatment plant effluent would be required to meet nondegradation standards (State of Utah, 1978) for the receiving stream (Jordan River). The primary contaminant not meeting the nondegradation standards after treatment would be TDS and sulfate. Reverse osmosis would be used to remove TDS and sulfate to meet the effluent discharge standards.

The capital costs for installation of the ground-water removal system and treatment plant are summarized in Table D-29. This estimate of capital costs does not include:

- Financing costs of the project.
- Right of ways and land acquisition.
- Removal or rerouting of utilities.
- Rerouting and reconstruction of roadways crossed by intercept trench.
- Drainage control of irrigation ditches and canals during construction and operation.

Table D.29 Estimated capital costs, ground-water removal and treatment, Vitro site

Task description	Basis	Unit cost	Task cost ($) for 500 gpm system	Task cost ($) for 1000 gpm system
Ground-water investigation to define aquifer	------	350,000	350,000	350,000
Sheet piling of intercept trench	3800 LF x 50 cy	13.75/sq ft	2,612,500	2,612,500
Excavation of intercept trench	14,000 cy	2.50/cy	35,000	35,000
Clay baseliner	2,000 cy	25.00/cy (in-place)	50,000	50,000
Select washed gravel trench fill	12,000 cy	8.50/cy	102,000	102,000
Recover sheet piling	3800 LF x 50 ft	1.33/sq ft	252,700	252,700
Redrive sheet piles at river	3800 LF x 50 ft	2.72/sq ft	516,800	516,800
Additional sheet piling required at river	400 LF x 50 ft	13.75/sq ft	275,000	275,000
Removal system	Includes pumps & piping to move water 2,500 ft to treatment plant	75,000	75,000	150,000
Neutralization facility	Reaction tank, controller, dewatering, sludge handling	600,000	600,000	1,200,000
Fixation	Mixing tank, dewatering and settling ponds, water control	750,000	750,000	1,500,000
Reverse osmosis	-------	3,200,000	3,200,000	6,400,000
Discharge system	-------	300,000	300,000	600,000
TOTAL CAPITAL COST			8,774,000	14,044,000
[a]Salvage value			2,612,000	3,670,000
Net Capital Cost			6,162,000	10,374,000

[a]Based on 20% recovery for treatment system and 50% recovery for sheet piling.

The ground water would be captured at a rate of approximately 500 to 1000 gpm and it is estimated that approximately 250 to 500 gpm would be from the plume while the remainder would be ambient, unconfined ground water. At this collection rate, it is estimated that the remedial action will require approximately three to six years to completely remove the $1x10^6$ ft^3 plume. The annual operating costs are shown in Table D-30. Estimates are given for treatment of discharges of 500 gpm and 1000 gpm on Table D.30.

Table D-30 Estimated annual operating costs for ground-water removal and treatment, Vitro site

System	Operation	Cost ($) 500 gpm - Discharge	- 1000 gpm
Collection and Removal	Labor	40,000	70,000
	Maintenance materials	50,000	100,000
Treatment and Disposal	Labor	125,000	225,000
	Maintenance materials	115,000	230,000
	Reagents	1,150,000	2,300,000
	Disposal	200,000	350,000
Monitoring and Analytical	Labor	50,000	50,000
	Chemistry	200,000	200,000
Annual Operating Costs		1,930,000	3,525,000

D.3.6.4 Comparison of benefits and costs

Benefits were calculated using two different methods:

- Maximum lost value of degraded or potentially degraded water resource on a volumetric basis.
- Lost value according to spatial apportionment of water rights.

In addition, a range of time required for natural purging of the contamination was considered. This range is 4.4 to 23.7 years. Also, two periods and rates of discharges, 500 gpm discharge for six years and 1000 gpm discharge for three years with trenching are considered. Table D-31 contains the cost-benefit ratios calculated for the eight possibilities.

The total cost is calculated as the capital cost plus the annual cost multiplied by the number of years of required treatment. The benefit using the maximum lost value is the sum of lost value to the unconfined and confined systems ($240,000 + $480,000 = $720,000). The benefit using the spatial

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apportionment approach is the difference between the time required for natural purging and the time required for treatment multiplied by the annual loss of benefit ($245,000). No benefit is considered for the Jordan River because, with dilution, the ground-water contamination does not restrict its use. As shown on Table D-31, the boundary cost-benefit ratios are 4.1 and infinity. Given the conservatism of the analysis, i.e., maximum possible benefits and costs discounted, aquifer restoration seems unwarranted.

Table D-31 Summary of cost-benefit analysis

Lost value volumetric or spatial apportionment	Range in possible time for natural purging	Range in treatment discharges	Total benefit ($-000)	Total cost ($-000)	Cost: Benefit ratio
Lost value calculated by volume of contaminated and potentially contaminated water resource	4.4 year natural purging	3-year treatment	720	20900	29
		6-year treatment	720	17700	25
	23.7 year natural purging	3-year treatment	720	20900	29
		6-year treatment	720	17700	25
Lost value calculated by spatial apportionment	4.4 year natural purging	3-year treatment	340	20900	61
		6-year treatment	0.0	20900	infinite
	23.7 year natural purging	3-year treatment	5070	20900	4.2
		6-year treatment	4340	17700	4.1

D.3.6.5 Potential use of the unconfined aquifer after remedial action

The highest level of uranium detected in water off the site is 2.24 ppm in shallow well 9C. An individual drinking this water exclusively over a period of years would have an increased risk of developing cancer. (Direct consumption of such water would represent the most significant exposure pathway.) This is considered very unlikely, because the area is not residential, public water supplies are available, and the preferred ground-water source is the deep aquifer. Even if an individual should drink such water, the high level of TDS and sulfates would result in ill effects such as diarrhea and dehydration; such water would not be consumed on a long-term basis. Nonetheless, DOE will review with NRC and the State of Utah the desirability of mitigation measures to limit use of the shallow ground-water system downgradient of the Vitro site.

D.4 CONCLUSIONS AND SUMMARY - VITRO SITE

- Downgradient contamination in the unconfined system represents a relic source and relic plume. The source of the uranium was modeled as a point source of concentration 7.76 mg/l at a distance 700 feet east of the site boundary. Significant contaminant migration appears to have been along a narrow band defined by wells Nos. 9 and 11.

- Present concentrations of contaminant migration from the tailings in the unconfined ground water are best defined by the water sample taken from the CVWRF excavation and consideration of the source of this water. This water sample shows no elevation of concentrations of nitrate, aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc, vanadium, thorium-230, lead-210, chloride, sulfate, or total dissolved solids. Uranium and molybdenum do show elevated concentrations.

- The unconfined aquifer has limited use due to poor water quality and low yield.

- Downgradient contamination in the confined system can best be explained by vertical hydraulic gradient reversal during active milling at the Vitro site. No further contamination will occur unless the vertical hydraulic gradient is reversed again.

- Percolation from the surface to the unconfined aquifer is (approximately) equal to the present upward leakage from the confined aquifer to the unconfined aquifer.

- If the saturated soils underlying the embankment are as permeable or more permeable than laterally adjacent soils, then a ground-water mound will not form beneath the embankment.

- With a liner system beneath the embankment, uranium and trace metals will not enter the ground water from the embankment under the worst conditions for at least 700 years.

- With a liner system beneath the embankment, off-site contaminant concentrations due to solute transport from the tailings will be less than any present or proposed drinking water standards.

- Aquifer restoration does not seem warranted given the range of calculated cost:benefit ratios (4.1 to infinity) and the current and predicted future absence of use in the maximum area of possible contamination.

- Although the likelihood of human health impacts from uncontrolled use of the unconfined aquifer downgradient of the Vitro site is considered very small, DOE will review with NRC and the State of Utah the desirability of mitigation measures to limit the use of this ground water.

D.5 GEOHYDROLOGY - SOUTH CLIVE SITE

The South Clive site lies near the periphery of the northern Great Salt Lake Desert. Two ground-water systems are in the vicinity of the site. The largest consists of unconsolidated to partly consolidated valley fill which ranges to more than 1600 feet in thickness. An idealized stratigraphic relationship is shown in Figure D-14. The valley fill aquifer does not transmit water uniformly, exhibiting a wide range in transmissivity. The water quality in the valley fill is generally characterized as briny.

The other ground-water system in the vicinity of the South Clive site is the alluvial fan aquifer which borders much of the floor of the northern Great Salt Lake Desert. The alluvial fan aquifer consists of both surficial deposits and underlying unconsolidated to well-cemented older alluvium. Water in the alluvial fan aquifer is derived from recharge above the desert floor (e.g., the Cedar Mountains to the east of the site) and discharges into the valley fill aquifer. The locally fresh to slightly saline water in the alluvial fan aquifer comprises much of the usable ground water in the northern Great Salt Lake Desert.

D.5.1 Existing geohydrology

The water table at the South Clive site ranges from about 25 to 35 feet below the ground surface, with saturated conditions extending to at least 230 feet deep. The apparent hydraulic gradient is about 2.8 feet per mile, sloping gradually to the north-northeast (Figure D-15). The magnitude and direction was determined from static water levels measured in wells. Given that ground-water recharge occurs from the east and the surface slope is to the southwest, the expected hydraulic gradient should be generally to the west-southwest. There are several possible explanations for the discrepancy between the apparent, measured hydraulic gradient and the expected hydraulic gradient:

- The gradient is shallow and possible surveying errors could cause an apparent reversal of the hydraulic gradient. A new survey has just been completed.

- Wells were completed in different stratigraphic units and the vertical hydraulic gradient may have a great enough magnitude to cause an apparent reversal of the hydraulic gradient (see Figures D-16 through D-19). For example, on Figure D-18, the measured water levels are lower at well SC-4 than SC-10 but SC-4 is completed in the clayey silt as well as an underlying sand with fines while SC-10 is completed in the clayey silt only.

- A localized recharge from precipitation and snowmelt may affect water levels at some wells differently than at other wells.

Measured fluctuations in ground-water elevations over time are generally less than 1 foot (Table D-32).

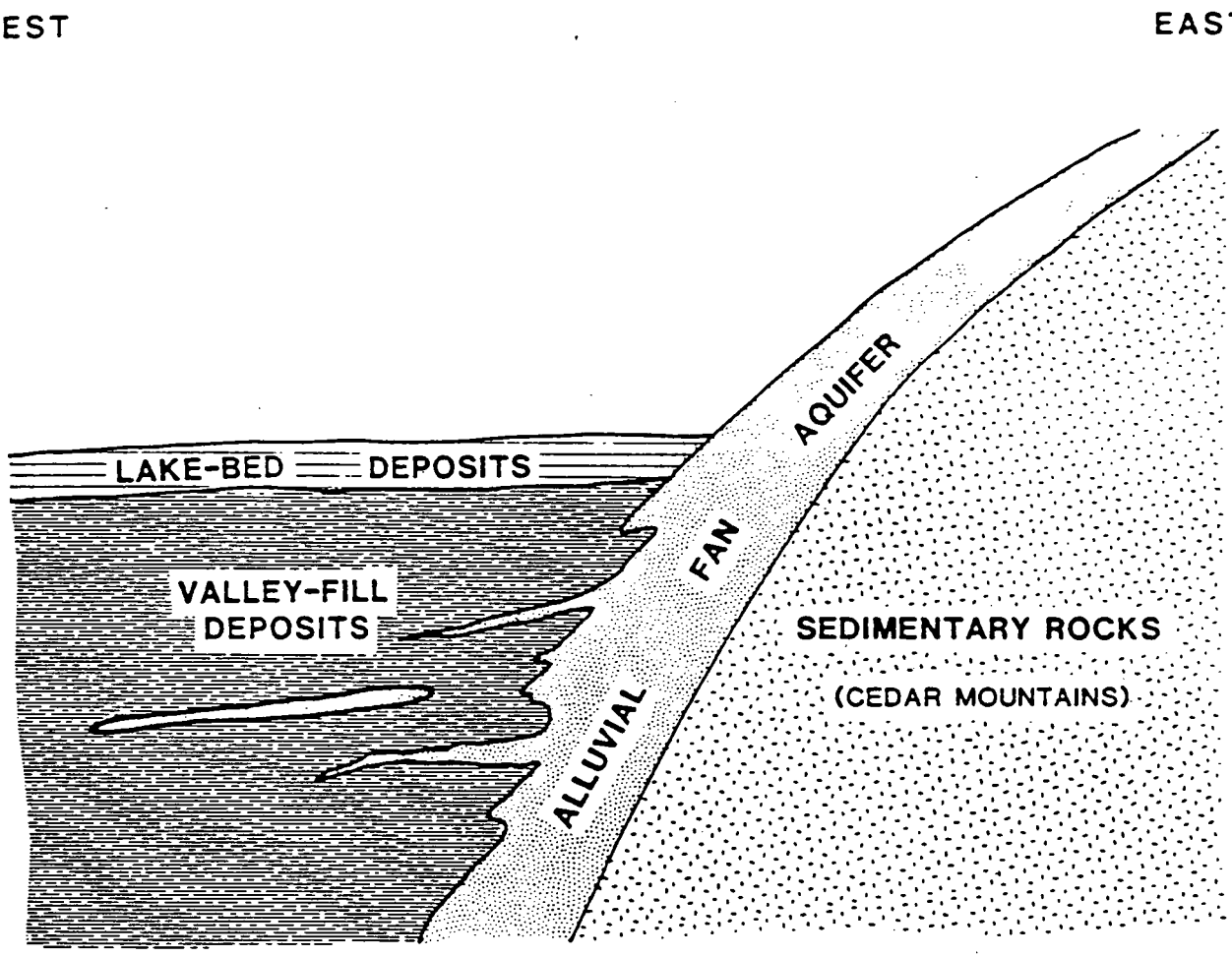

FIGURE 2.16

IDEALIZED STRATIGRAPHIC RELATIONSHIP
NEAR SOUTH CLIVE SITE

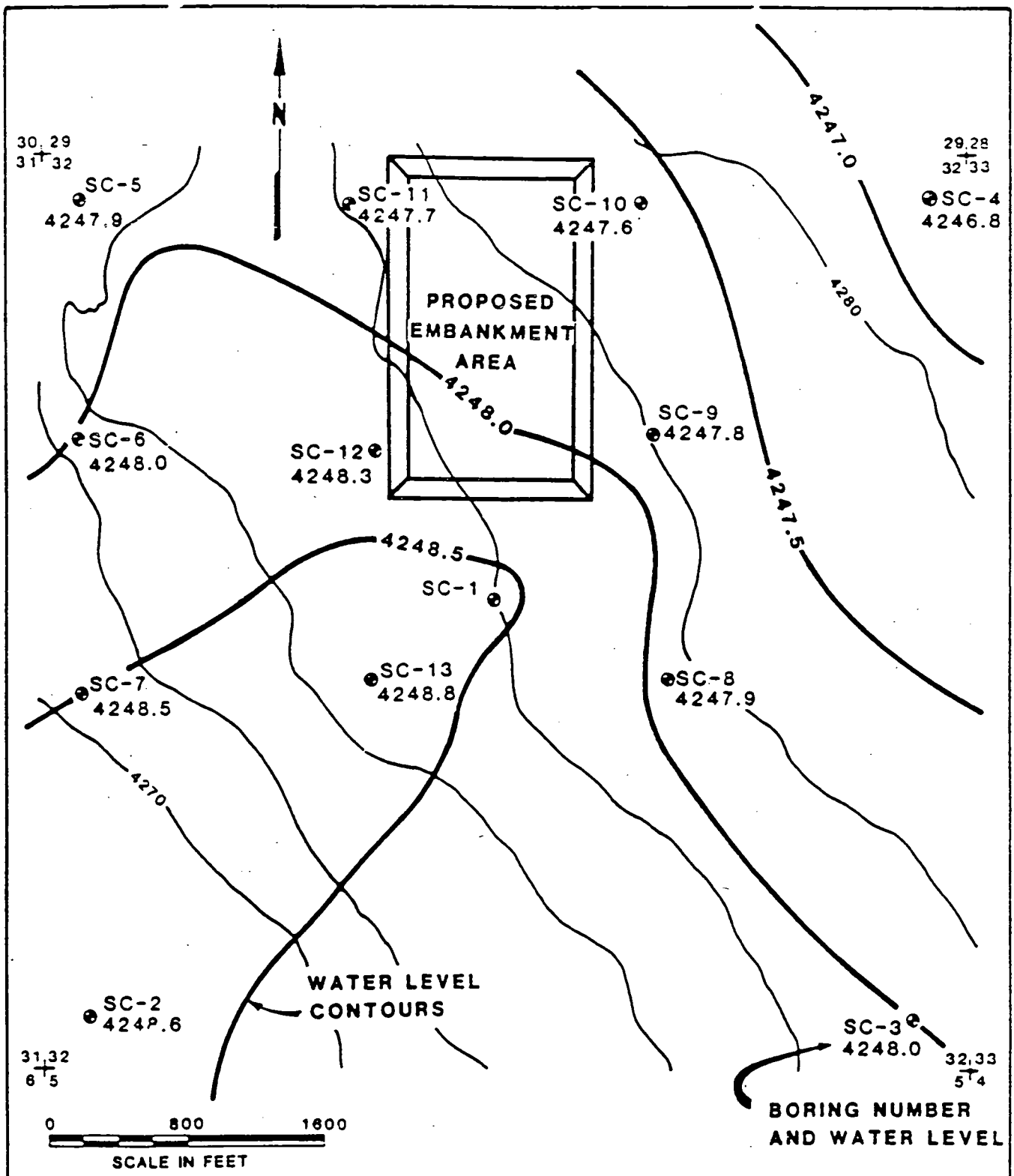

FIGURE D-15
WATER TABLE CONTOUR MAP AT
THE SOUTH CLIVE SITE
APRIL 2, 1982

Table D-32. Ground-water elevations at the South Clive site

Boring number	Ground surface elevation[a] (feet)	Elevation top of casing (feet)	Ground-water elevations in feet above MSL[a]													
			Date of measurement													
			9-22-81	9-23-81	9-24-81	9-29-81	9-30-82	2-12-82	2-26-82	3-8-82	3-17-82	4-2-82	7-14-8	9-26-83	10-13-83	1-18-84
SC-1	4276.1	4279.4					4250.1	4247.2	4248.3	4248.2	4248.5	4248.6	4248.3		4248.6	
SC-2	4269.2	4276.6	4248.4					4248.4	4249.1	4248.6	4248.6	4248.6		4248.2	4248.2	4250.2
SC-3	4277.3	4280.5			4248.0			4247.8	4248.0	4248.0	4248.1	4248.0	4247.2		4248.3	
SC-4	4280.7	4284.8				4246.6		4245.8	4246.6	4246.6	4246.0	4246.8	4246.4		4246.7	
SC-5	4273.5	4276.3		4247.4	4247.5			4247.5	4247.4	4247.4	4247.8	4247.9	4247.6	4247.0	4248.0	4248.5
SC-6	4272.6	4276.5							4248.0	4247.8	4248.1	4248.0	4248.0		4248.6	4247.6
SC-7	4270.1	4274.7							4248.6	4248.4	4248.5	4248.5	4248.1		4249.6	4249.1
SC-8	4277.8	4282.9							4247.9	4247.9	4248.0	4247.9	4247.5	4247.8	4248.3	
SC-9	4278.8	4283.2							4247.7	4247.6	4247.7	4247.8	4247.3	4248.3	4247.8	
SC-10	4280.0	4284.1							4247.4	4247.6	4247.6	4247.6	4247.2	4248.0	4248.0	
SC-11	4276.0	4280.8							4247.6	4247.5	4247.1	4247.7	4247.2		4248.0	
SC-12	4274.9	4277.5							4247.5	4247.5	4247.6	4248.3	4248.1		4249.9	
SC-13	4274.4	4279.5							4248.5		4248.6	4248.8			4249.4	

[a]Mean sea level datum.

000573

Studies of the hydrology of nearby areas indicate that there is minimal potential for significant ground-water recharge on the site. The low annual precipitation and fine-grained lake deposits below about 4600 feet tend to limit infiltration to the underlying ground water (Price and Bolke, 1970). Recharge may be concentrated on the more permeable alluvial fan deposits, and averages only 6 to 10 percent of the total precipitation on the drainage basin (Hood and Waddell, 1968). It is believed that ground water from the alluvial fan deposits recharges the valley fill deposits. The South Clive site is on the periphery of the northern Great Salt Lake Desert hydrologic province, where it is reported that precipitation contributes little, if any, recharge to the shallow system (Stephens, 1974).

D.5.2 Data Sources

Information about subsurface conditions at the site is based on 13 borings in the vicinity of the site (DOE, 1983). The boring locations are the same as the well locations shown in Figure D-15. The borings extended to between 43 and 251 feet below the ground surface. All of the borings were used to install observation wells (Table D-33). Four additional wells were constructed for use during pump tests. Four soil profiles across the site were constructed from well logs (see Figures D-16, D-17, D-18, and D-19).

Table D-33. Well construction details - South Clive site

Well[a] number	Well dia (in)	Blank interval (ft)	Screened interval (ft)	Sand pack interval (ft)	Grout seal interval (ft)	Bentonite seal interval (ft)	Back fill interval
SC-1	2	+3.17 - 219.8	219.8 - 229.8	100.0 - 229.8	0.0 - 68.0	68.0 - 73.0	73.0 - 100.0
SC-2	2	+3.25 - 18.5	18.5 - 48.5	16.0 - 48.5	0.0 - 5.5	none	5.5 - 16.0
SC-3	2	+3.25 - 30.5	30.5 - 50.5	23.0 - 50.5	0.0 - 5.0	none	5.0 - 23.0
SC-4	2	+4.25 - 31.5	31.5 - 51.5	29.5 - 51.5	0.0 - 4.0	none	4.0 - 29.5
SC-5	2	+2.67 - 31.5	31.5 - 51.5	29.0 - 51.5	0.0 - 4.0	none	4.0 - 29.0
SC-6	1.5	+3.85 - 30.0	30.0 - 45.0	30.0 - 46.0	0.0 - 5.0	none	5.0 - 30.0
SC-7	6	+3.80 - 41.0	41.0 - 56.0	32.0 - 56.0	0.0 - 5.0 10.0 - 31.0	31.0 - 32.0	5.0 - 10.0
SC-7A	1.5	+4.65 - 28.5	28.5 - 43.5	28.0 - 43.5	0.0 - 5.0	none	5.0 - 28.0
SC-7B	1.5	+3.00 - 45.0	46.0 - 55.0	38.0 - 55.0	0.0 - 5.0 17.0 - 37.0	37.0 - 38.0	5.0 - 17.0
SC-8	6	+3.00 - 40.0	40.0 - 55.0	35.0 - 55.0	0.0 - 5.0 14.0 - 34.0	34.0 - 35.0	5.0 - 14.0
SC-8A	1.5	+2.70 - 34.3	34.3 - 49.3	33.0 - 49.3	0.0 - 5.0	none	5.0 - 33.0
SC-8B	1.5	+3.00 - 45.0	45.0 - 55.0	40.0 - 55.0	0.0 - 5.0 12.0 - 39.0	39.0 - 40.0	5.0 - 12.0
SC-9	1.5	+4.35 - 30.0	30.0 - 45.0	28.5 - 45.0	0.0 - 4.0	none	4.0 - 20.5
SC-10	1.5	+3.95 - 33.0	33.0 - 48.0	32.5 - 48.0	0.0 - 4.0	none	4.0 - 32.5
SC-11	1.5	+4.70 - 30.0	30.0 - 45.0	29.0 - 45.0	0.0 - 3.5	none	3.5 - 29.0
SC-12	1.5	+3.25 - 63.0	53.0 - 58.0	47.5 - 58.0	0.0 - 46.5	46.5 - 47.5	-
SC-13	1.5	+5.07 - 52.0	52.0 - 55.0	45.5 - 55.0	-	43.0 - 45.5	0.0 - 43.0

[a]For well locations see Figure D-15.

000525

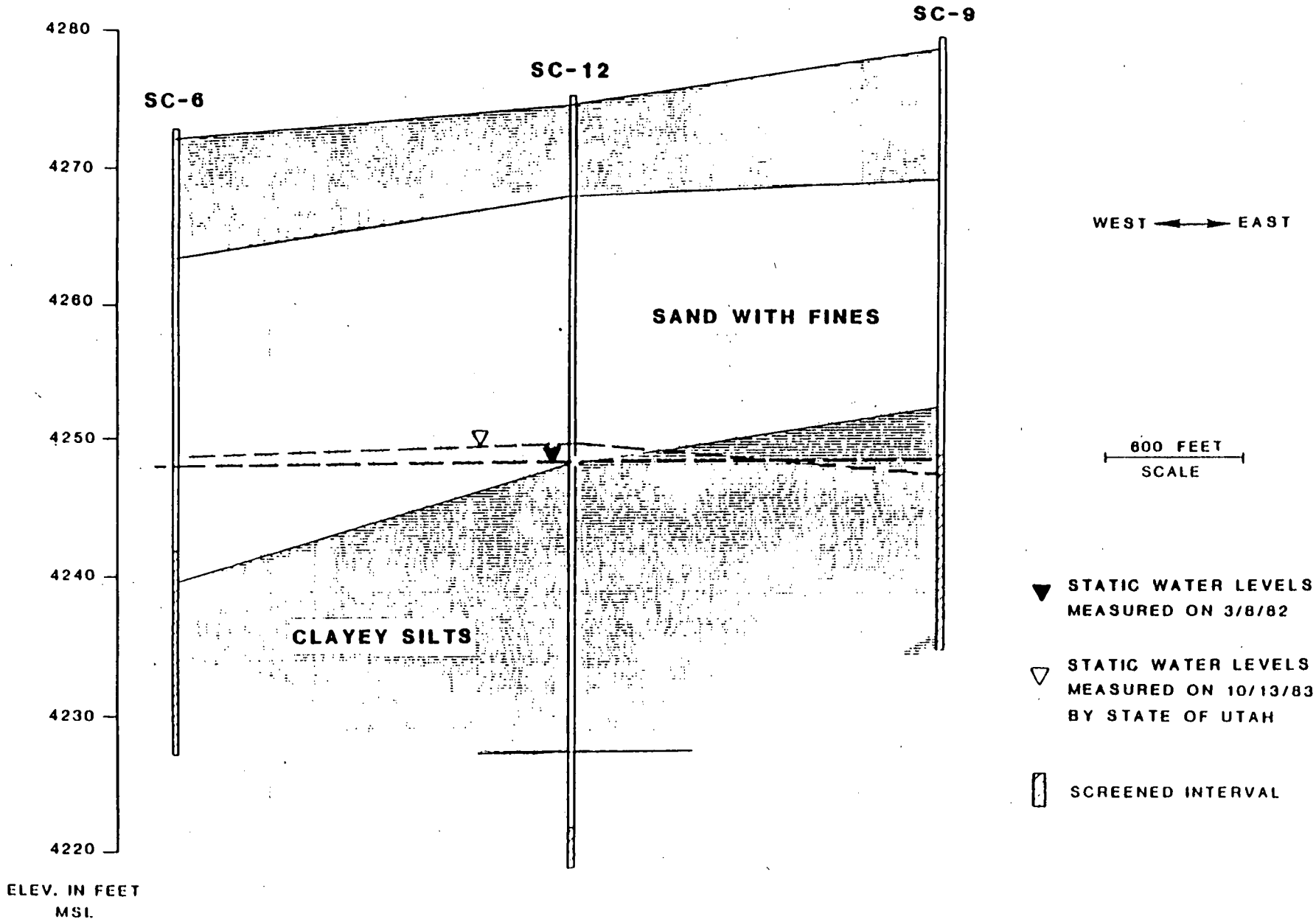

FIGURE D-16
EAST-WEST SOIL PROFILE CENTER OF SOUTH CLIVE DISPOSAL SITE

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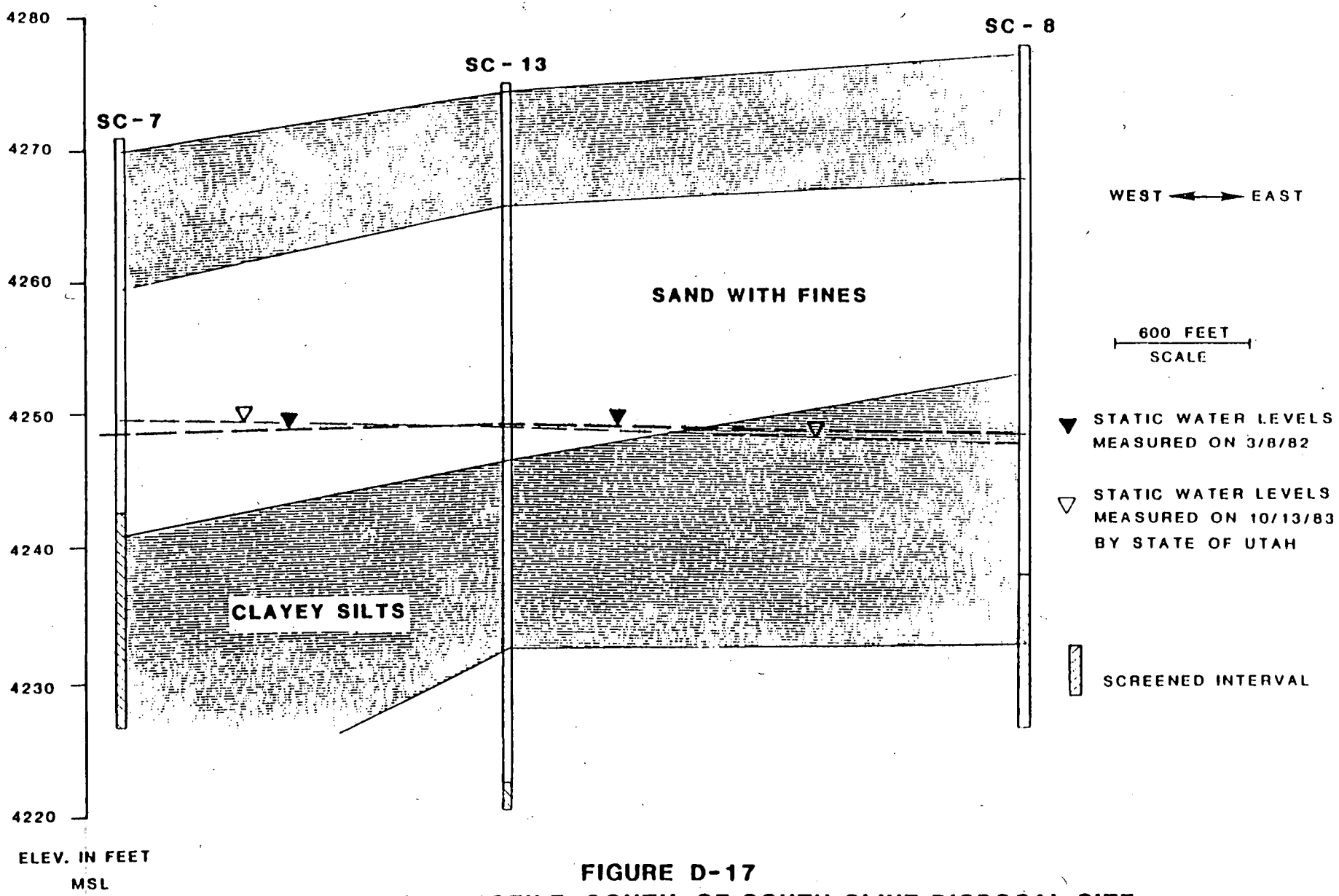

FIGURE D-17
EAST-WEST SOIL PROFILE SOUTH OF SOUTH CLIVE DISPOSAL SITE

000577

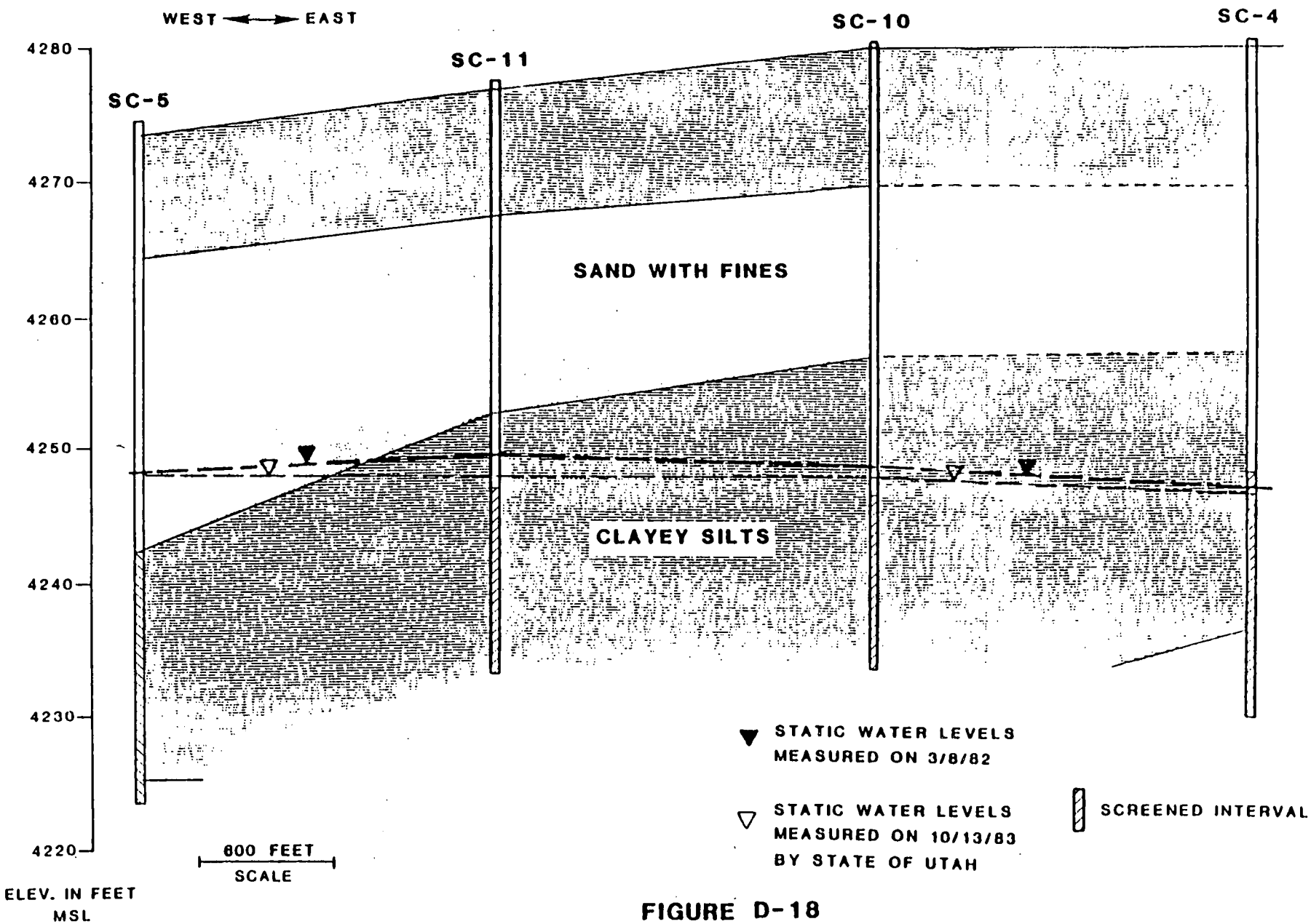

FIGURE D-18
EAST-WEST SOIL PROFILE NORTH OF SOUTH CLIVE DISPOSAL SITE

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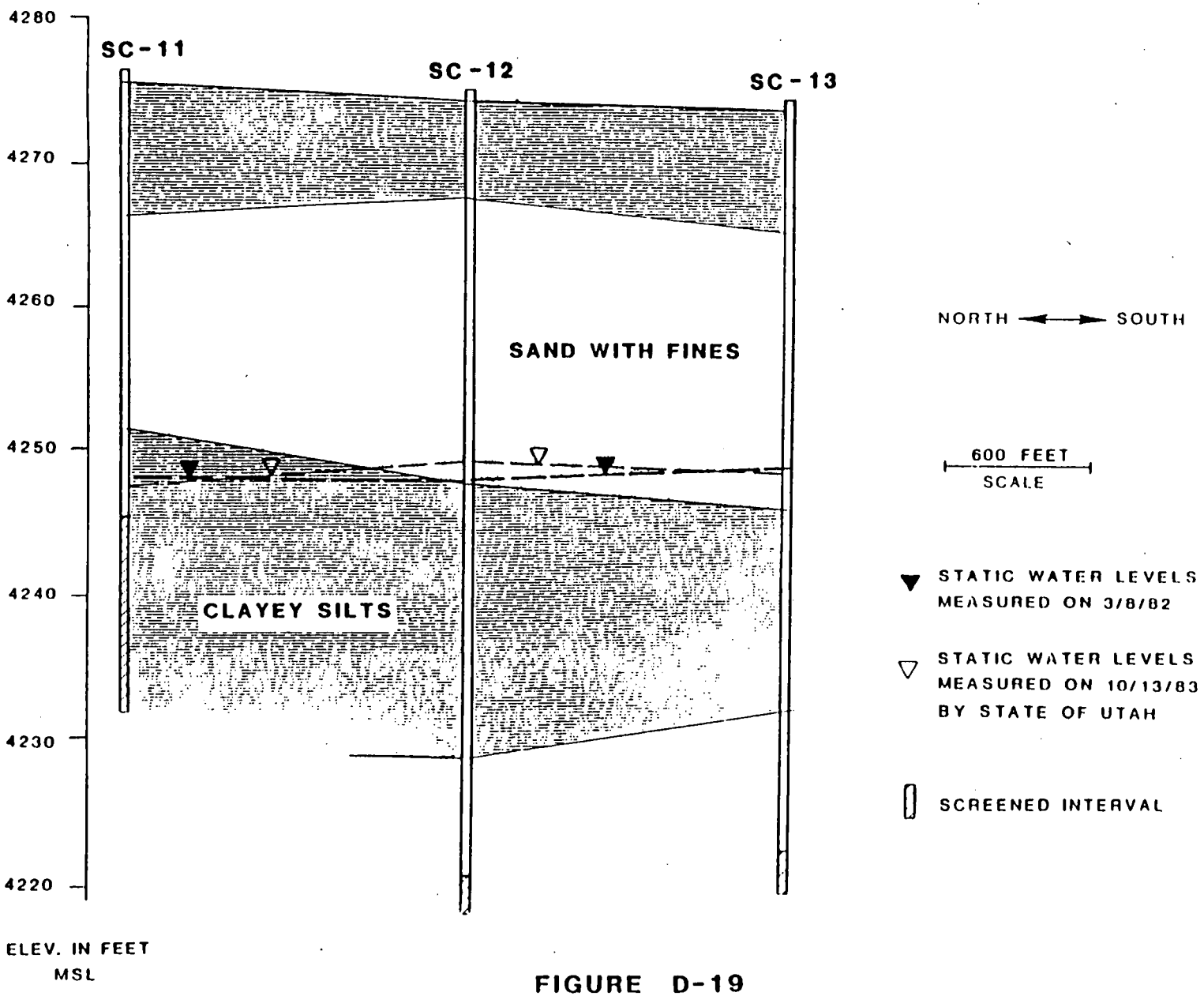

FIGURE D-19

NORTH-SOUTH SOIL PROFILE CENTER OF CLIVE DISPOSAL SITE

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Pump tests were done at two wells, no. 7 and no. 8. For each of the tests, water levels were measured in both the pumping well and two nearby observation wells (Table D-34). Water levels were measured in all wells during both the drawdown and the recovery phases of the test. Initial analyses of the test data, using the Theis method, Jacob's method, and Theis' Recovery Method, indicate transmissivities ranging between 0.8 to 166 ft^2/day, with a mean value of approximately 40 ft^2/day.

D.5.3 Existing water quality

Ground-water samples from five monitoring wells at the South Clive site were obtained and analyzed for major cations and anions, metals, and radionuclides. The wells were sampled four times over the course of a year in order to define temporal variation in water quality. Results of the analyses are presented in Table D-35.

The ground water at the South Clive site is characterized by high levels of sodium, chloride, magnesium, sulfate, bicarbonate, and total dissolved solids. There is no indication of significant seasonal variation in water quality. Concentrations of total dissolved solids ranged between about 20,000 mg/l to about 50,000 mg/l. The water can be classified as unfit for all but limited industrial uses without extensive treatment, but could be used for dust control during disposal of tailings.

Significant concentrations of radionuclides are reported for analyses of water samples at the South Clive site. Dissolved uranium ranged from 2.7 to 35.9 pCi/l (0.004 to 0.053 mg/l). Reported concentrations of radon daughters were mostly reported on a "total" basis rather than a "dissolved" basis, but one analysis reported 6.8 $\pm$ 1.6 pCi/l of Pb-210 on a dissolved basis. Ra-226 was not reported on a dissolved basis.

D.5.4 Water uses

Other than the 17 monitoring wells installed for the UMTRA project, there are no existing ground-water wells on or near the South Clive site. The closest known wells are approximately 3 miles northwest and 3.4 miles east of the site. Locations of these and other nearby wells are listed in Table D-36 and shown on Figure D-20. The well west of the site has been destroyed; one of the two wells east of the site is in current use to water livestock--the second well was destroyed. In the Bonneville Salt Flats to the west, high salinity ground water is used for mineral extraction.

Without extensive treatment, use of the ground water in the South Clive area would appear to be confined to very limited industrial uses. In general, the use of ground water and surface water in the Great Salt Lake Desert is concentrated along mountain fronts where the majority of fresh ground water and spring discharge occurs.

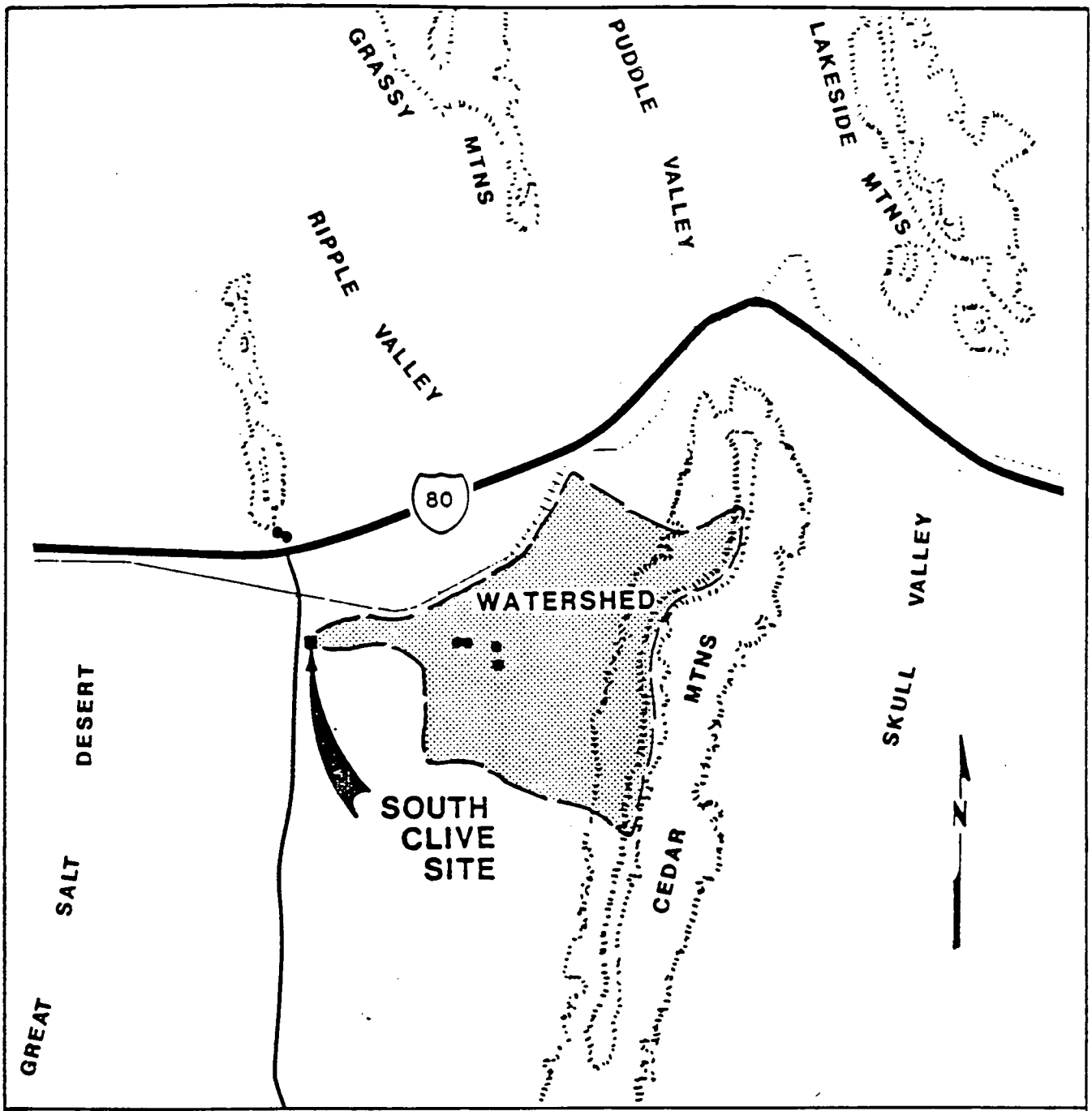
Table D-34. Pump tests - South Clive site

Test No. 1

Well ID	Use of well	Distance to pumped well (ft)
7	pumping	0
7A	observation	8.9
7B	observation	15.7

Test No. 2

Well ID	Use of well	Distance to pumped well (ft)
8	pumping	0
8A	observation	9.4
8B	observation	21.5



2 0 2 4
SCALE IN MILES

LEGEND

● SELECTED WELL IN THE SOUTH CLIVE AREA

FIGURE D-20
SOUTH CLIVE WATERSHED

Table D-35. Chemical ground-water quality - South Clive site

Parameter (metals)	Well number[a]				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	9/30/81	9/22/81	9/24/81	9/29/81	9/23/81
Aluminum - (Al)	<0.1[b]	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	-[c]	-	-	-	-
Arsenic - total (As)	0.01	0.01	0.04	0.07	0.01
Barium (Ba)	-	-	-	-	-
Barium - total (Ba)	<0.1	0.1	2.9	4.2	2.7
Boron - total (B)	0.24	0.98	2.99	0.28	0.56
Cadmium (Cd)	-	-	-	-	-
Cadmium - total (Cd)	0.11	0.12	0.17	0.15	0.18
Chromium (Cr)	-	-	-	-	-
Chromium - total (Cr)	0.03	0.07	0.27	0.37	0.26
Cobalt (Co)	-	-	-	-	-
Copper (Cu)	-	-	-	-	-
Copper - total (Cu)	0.07	0.10	0.26	0.36	0.34
Iron (Fe)	0.14	0.25	0.16	0.14	0.11
Iron - total (Fe)	2.50	24.70	146	229	167
Lead (Pb)	-	-	-	-	-
Lead - total (Pb)	0.6	<0.05	<0.1	0.8	<0.1
Magnesium (Mg)	460	920	400	420	310
Manganese (Mn)	0.63	0.11	0.08	0.22	0.11
Manganese - total (Mn)	-	-	-	-	-
Mercury - total (Hg) (in micrograms per liter)	2.7	1.0	0.8	2.0	1.9
Molybdenum (Mo)	<0.1	0.8	<0.1	<0.1	<0.1
Nickel - (Ni)	-	-	-	-	-
Potassium (K)	310	530	430	320	390
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	-	-	-	-	-
Silver (Ag)	0.07	0.09	0.05	0.07	0.04
Silver - total (Ag)	-	-	-	-	-
Sodium (Na)	11,500	160,000	11,000	12,000	9,140
Sodium - total (Na)	-	-	-	-	-
Strontium (Sr)	9.50	15.20	10.70	12.50	14.60
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	0.07	0.05	0.08	0.05	0.06
Zinc - total (Zn)	-	-	-	-	-

[a] For well locations, see Figure D-15.
[b] All values in milligrams per liter on a dissolved basis, unless otherwise noted.
[c] - indicates concentration not determined.

000583

Table D-35. (continued)

Parameter (metals)	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	2/8/82	2/8/82	2/8/82	2/8/82	2/8/82
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	0.02	0.06	0.01	0.01	0.02
Arsenic - total (As)	0.02	0.06	0.02	0.01	0.03
Barium (Ba)	0.4	<0.1	<0.1	<0.1	<0.1
Barium - total (Ba)	0.4	0.5	5.4	1.2	2.7
Boron (B)	0.93	1.90	1.80	1.50	1.30
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (Cr)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium - total (Cr)	0.01	0.04	0.23	0.10	0.14
Cobalt (Co)	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Cu)	<0.01	<0.01	<0.01	<0.01	<0.01
Copper - total (Cu)	0.01	0.04	0.27	0.07	0.18
Iron (Fe)	0.07	0.17	0.14	0.12	0.13
Iron - total (Fe)	0.84	27.00	240	59.00	150
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05
Lead - total (Pb)	<0.05	<0.05	0.14	0.05	0.12
Magnesium (Mg)	310	790	400	400	270
Manganese (Mn)	0.24	0.09	0.09	0.13	0.11
Manganese - total (Mn)	0.28	0.83	6.40	1.21	3.84
Mercury - total (Hg) (in micrograms per liter)	<0.3	0.3	<0.3	<0.3	0.3
Molybdenum (Mo)	<0.1	0.5	<0.1	<0.1	<0.1
Nickel (Ni)	<0.05	<0.05	<0.05	<0.05	<0.05
Potassium (K)	220	400	360	310	300
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	<0.01	0.02	0.01	0.01	<0.01
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	6,200	17,000	12,000	12,000	8,700
Sodium - total (Na)	6,200	17,000	12,000	12,000	8,700
Strontium (Sr)	9.90	20.60	14.60	15.40	18.70
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	0.04	0.05	0.08	0.16	0.09
Zinc - total (Zn)	0.05	0.15	3.10	0.28	0.58

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Table D-35. (continued)

Parameter (metals)	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	6/2/82	6/2/82	6/2/82	6/2/82	6/2/82
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	0.01	0.05	0.01	0.01	0.02
Arsenic - total (As)	0.01	0.05	0.02	0.01	0.02
Barium (Ba)	<0.1	<0.1	<0.1	<0.1	<0.1
Barium - total (Ba)	0.2	1.4	2.5	1.2	0.4
Boron (B)	2.63	3.08	2.63	2.53	2.43
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (Cr)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium - total (Cr)	<0.01	0.10	0.16	0.14	0.02
Cobalt (Co)	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Cu)	<0.01	<0.01	<0.01	<0.01	<0.01
Copper - total (Cu)	0.02	0.11	0.14	0.11	0.10
Iron (Fe)	0.20	0.18	0.11	0.12	0.06
Iron - total (Fe)	1.11	38.00	65.00	47.00	6.00
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05
Lead - total (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium (Mg)	560	850	470	450	280
Manganese (Mn)	0.92	0.06	0.04	0.11	0.09
Manganese - total (Mn)	0.95	0.06	0.04	0.13	0.10
Mercury - total (Hg) (in micrograms per liter)	<0.3	<0.3	<0.3	<0.3	<0.3
Molybdenum (Mo)	<0.1	0.5	<0.1	<0.1	<0.1
Nickel (Ni)	<0.05	<0.05	<0.05	<0.05	<0.05
Potassium (K)	310	380	350	300	280
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	12,000	14,000	11,500	11,500	8,150
Sodium - total (Na)	12,000	14,000	11,500	12,000	8,700
Strontium (Sr)	10.90	16.20	12.00	12.20	14.00
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc - total (Zn)	0.30	2.20	1.50	2.10	1.30

000585

Table D-35. (continued)

Parameter (metals)	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	8/25/82	8/25/82	8/25/82	8/25/82	8/25/82
Aluminum (Al)	<0.1	0.5	0.1	<0.1	<0.1
Arsenic (As)	<0.01	0.02	<0.01	<0.01	0.02
Arsenic - total (As)	<0.01	0.02	0.01	<0.01	0.02
Barium (Ba)	<0.1	<0.1	<0.1	<0.1	<0.1
Barium - total (Ba)	0.2	0.4	3.3	0.2	0.2
Boron (B)	1.95	2.68	2.79	2.10	1.96
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (Cr)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium - total (Cr)	<0.01	0.03	0.13	0.02	0.01
Cobalt (Co)	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Cu)	0.01	0.02	<0.01	<0.01	0.10
Copper - total (Cu)	0.01	0.02	0.22	0.04	0.10
Iron (Fe)	<0.05	0.34	0.09	<0.05	<0.05
Iron - total (Fe)	1.39	17.00	110	12.00	9.00
Lead (Pb)	<0.01	<0.01	<0.01	<0.01	<0.01
Lead - total (Pb)	0.01	0.01	0.05	0.01	0.01
Magnesium (Mg)	520	870	430	410	270
Manganese (Mn)	1.07	0.09	0.08	0.08	0.07
Manganese - total (Mn)	1.08	0.60	3.50	0.31	0.37
Mercury - total (Hg) (in micrograms per liter)	<0.3	<0.3	<0.3	<0.3	<0.3
Molybdenum (Mo)	<0.1	0.5	<0.11	<0.1	<0.1
Nickel (Ni)	<0.05	<0.05	<0.055	<0.05	<0.0
Potassium (K)	390	470	430	370	340
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium (Na)	12,600	15,000	12,000	11,500	8,500
Sodium - total (Na)	12,600	15,000	12,000	11,500	8,500
Strontium (Sr)	13.00	20.00	15.00	15.00	18.00
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	<0.01	0.07	0.03	0.01	0.10
Zinc - total (Zn)	0.04	0.15	0.72	0.07	0.10

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Table D-35. (continued)

General parameters	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	9/30/81	9/22/81	9/24/81	9/29/81	9/23/81
Ammonia (NH_3-N)	0.09	0.19	<0.05	0.05	0.10
Bicarbonate (HCO_3)	271	151	329	383	183
Carbonate (CO_3)	<1	<1	<1	<1	<1
Calcium (Ca)	360	600	280	360	240
Chloride (Cl)	18,417	25,347	18,309	19,936	14,934
Chloride - total (Cl)	-	-	-	-	-
Conductivity - field (in micromhos per centimeter)	61,500	66,500	52,500	57,000	51,500
Cyanide - total (CN)	-	-	-	-	-
Fluoride (F)	0.49	0.82	1.35	0.42	0.53
Fluoride - total (F)	-	-	-	-	-
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	<0.1	0.9	<0.1	<.01	0.5
Nitrate - total (NO_3-N)	-	-	-	-	-
pH - field	7.9	8.7	7.8	7.8	8.2
pH -lab @ 25°C	7.79	7.80	7.81	8.25	7.50
Phenol	-	-	-	-	-
Phosphate - total (PO_4-P)	0.13	0.04	0.02	0.13	0.06
Redox potential (EH) (in millivolts)	55	91	105	54	104
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	1,761	5,144	1,564	2,041	1,778
Sulfate - total (SO_4)	-	-	-	-	-
Sulfide (H_2S)	-	-	-	-	-
Temperature - field (°C)	14.6	14.6	14.9	13.4	19.3
Total alkalinity (as $CaCO_3$)	235	139	289	331	169
Total dissolved solids (as calcium)	33,699	50,130	34,830	36,150	27,050
Total hardness (as $CaCO_3$)	2,792	5,284	2,345	2,627	1,875
Total organic carbon	-	-	-	-	-

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Table D-35. (continued)

General parameters	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	2/8/82	2/8/82	2/8/82	2/8/82	2/8/82
Ammonia (NH_3-N) (un-ionized)	<0.02	<0.02	<0.02	<0.02	<0.02
Bicarbonate (HCO_3)	168	171	342	366	201
Carbonate (CO_3)	<1	<1	-	<1	<1
Calcium (Ca)	310	560	300	330	240
Chloride (Cl)	10,720	27,169	19,362	19,228	14,690
Chloride - total (Cl)	10,890	27,169	19,362	19,682	14,861
Conductivity - field (in microhmos per centimeter)	45,000	70,000	64,000	60,000	53,000
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride (F)	0.87	1.46	1.40	1.04	1.10
Fluoride - total (F)	0.90	1.50	1.40	1.04	1.10
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate - total (NO_3)	<0.1	<0.1	<0.1	<0.1	<0.1
pH - field	8.3	7.8	7.7	7.8	8.2
pH - lab @25°C	7.81	7.58	8.00	8.02	8.10
Phenol	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.05	0.08	0.14	0.27	0.09
Redox potential (EH) (in millivolts)	71	50	60	60	67
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	545	4,447	1,475	1,534	1,036
Sulfate - total (SO_4)	639	4,499	1,524	1,857	1,116
Sulfide (H_2S)	<0.05	<0.05	<0.05	<0.05	<0.05
Temperature - field (°C)	8.9	8.7	8.9	9.7	10.6
Total alkalinity (as $CaCO_3$)	157	159	299	319	182
Total dissolved solids (as calcium)	19,717	49,935	34,747	34,879	25,277
Total hardness (as $CaCO_3$)	2,050	4,649	2,395	2,470	1,710
Total organic carbon	2	4	3	6	4

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Table D-35. (continued)

General parameters	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	6/2/82	6/2/82	6/2/82	6/2/82	6/2/82
Ammonia (NH_3-N) (un-ionized)	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate (HCO_3)	268	164	338	359	203
Carbonate (CO_3)	<1	<1	<1	<1	<1
Calcium (Ca)	400	610	310	350	260
Chloride (Cl)	20,725	24,832	19,149	19,047	13,511
Chloride - total (Cl)	20,725	24,832	19,149	19,047	13,545
Conductivity - field (in micromhos per centimeter)	83,000	96,000	79,000	79,000	60,000
Cyanide - total (CN)	<0.005	<0.005	<0.005	<0.005	<0.005
Fluoride (F)	0.53	1.00	0.94	0.48	0.65
Fluoride - total (F)	0.56	1.20	2.21	0.55	0.70
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate - total (NO_3)	0.36	0.57	2.22	0.36	0.17
pH - field	7.7	7.5	7.5	7.5	7.7
pH - lab @25°C	7.49	7.77	7.88	7.84	7.83
Phenol	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.13	0.14	0.18	0.13	0.14
Redox potential (EH) (in millivolts)	52	48	53	55	62
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	13.6	18.1	14.4	15.2	10.3
Sulfate - total (SO_4)	13.6	33.7	43.6	37.0	10.3
Sulfide (H_2S)	<0.05	<0.05	<0.05	<0.05	<0.05
Temperature - field (°C)	13.0	12.0	12.0	13.0	13.0
Total alkalinity (as $CaCO_3$)	239	153	294	312	183
Total dissolved solids (as calcium)	37,512	44,120	34,418	34,520	24,618
Total hardness (as $CaCO_3$)					
Total organic carbon	10	17	25	23	12

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Table D-35. (continued)

General parameters	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	8/25/82	8/25/82	8/25/82	8/25/82	8/25/82
Ammonia (NH_3-N) (un-ionized)	0.22	0.14	<0.01	0.31	0.41
Bicarbonate (HCO_3)	249	160	338	340	196
Carbonate (CO_3)	<1	<1	<1	<1	<1
Calcium (Ca)	350	570	300	320	230
Chloride (Cl)	20,774	24,585	19,270	18,863	13,502
Chloride - total (Cl)	20,830	24,879	19,485	18,817	13,785
Conductivity - field (in micromhos per centimeter)	57,000	96,000	70,000	79,000	60,000
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride (F)	0.62	1.13	1.03	0.52	0.76
Fluoride - total (F)	0.65	1.25	1.36	0.57	0.88
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	0.2	2.1	<0.1	0.3	<0.1
Nitrate - total (NO_3)	0.26	3.83	0.18	0.35	0.19
pH - field	7.4	7.6	7.5	7.5	7.8
pH - lab @25°C	7.70	7.59	7.72	7.80	8.00
Phenol	<0.005	<0.005	<0 005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.16	0.05	0.08	0.07	0.14
Redox potential (EH) (in millivolts)	50	45	50	52	57
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	1,773	4,152	1,437	1,477	951
Sulfate - total (SO_4)	1,793	4,271	1,473	1,475	990
Sulfide (H_2S)	<0.1	<0.1	<0.1	<0.1	<0.1
Temperature - field (°C)	17.6	15.0	14.0	13.0	14.0
Total alkalinity (as $CaCO_3$)	223	147	291	291	171
Total dissolved solids (as calcium)	37,238	46,842	34,474	33,860	24,270
Total hardness (as $CaCO_3$)	3,014	5,004	2,518	2,486	1,685
Total organic carbon	4	12	4	7	23

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Table D-35. (continued)

Radiochemistry[d]	Well number[a]				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	9/30/81	9/22/81	9/24/81	9/29/81	9/23/81
Gross alpha, dissolved	0±110[b]	155±188	0±170	0±200	0±196
Gross beta, dissolved	710±140	588±358	481±166	411±188	564±193
Radium - 226, dissolved	0.8±0.2	0.3±0.2	0.4±0.2	0.5±0.2	0.6±0.2
Radium - 228, dissolved	-[c]	-	-	-	-
Thorium - 230, dissolved	3.4±0.8	2.2±1.1	2.7±0.5	3.8±0.8	14.0±4.0
Lead - 210, dissolved	6.8±1.6	0.6±0.6	0.5±0.7	1.0±0.9	0.2±0.7
Polonium - 210, dissolved	0.0±0.3	0.1±0.2	0.0±0.2	0.0±0.4	0.0±0.2
Uranium (U_3O_8), dissolved	8.1	27.1	6.8	8.8	3.4
Uranium (U_3O_8), total	8.1	29.8	14.2	16.2	14.2

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Table D-35. (continued)

Radiochemistry	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	2/8/82	2/8/82	2/8/82	2/8/82	2/8/82
Gross alpha, total	0.0±72.7	76.3±183	35.4±155	0.0±131	0.0±92.9
Gross beta, total	192±188	299±206	282±203	346±205	320±198
Radium-226, total	0.7±0.2	0.8±0.2	0.9±0.2	1.5±0.3	0.8±0.2
Radium-228, total	3.4±3.7	2.2±3.9	2.9±3.4	1.4±3.5	0.3±3.7
Thorium-230, total	0.0±2.1	2.6±1.4	1.0±1.1	0.0±2.3	1.8±2.7
Lead-210, total	0.3±1.3	0.4±1.3	0.0±1.3	0.3±1.4	0.0±1.4
Polonium-210, total	0.2±0.4	0.2±0.4	0.0±0.0	0.1±0.2	0.2±0.2
Uranium (U_3O_8), dissolved	2.7	35.2	11.5	11.5	2.7
Uranium (U_3O_8), total	2.7	39.3	49.4	19.6	24.4

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Table D-35. (continued)

Radiochemistry	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	6/2/82	6/2/82	6/2/82	6/2/82	6/2/82
Gross alpha, total	0.0±235	345±435	374±414	90.2±343	25.3±271
Gross beta, total	0.0±720	412±765	478±764	198±748	309±405
Radium-226, total	1.2±0.2	0.8±0.2	0.5±0.1	2.0±0.2	1.0±0.2
Radium-228, total	4.1±1.5	1.6±1.5	0.8±1.2	2.7±1.4	1.2±1.3
Thorium-230, total	2.5±1.2	2.7±1.1	9.3±2.0	0.8±1.0	6.4±1.6
Lead-210, total	0.1±1.0	0.8±1.2	0.5±1.1	0.6±1.4	0.9±1.1
Polonium-210, total	0.3±0.2	0.0±0.2	0.2±0.2	0.2±0.2	0.0±0.1
Uranium (U_3O_8), dissolved	7.4	35.9	11.5	13.5	6.1
Uranium (U_3O_8), total	8.8	35.9	14.9	13.5	6.1

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Table D-35. (continued)

Radiochemistry	Well number				
	SC-1	SC-2	SC-3	SC-4	SC-5
Date sampled	8/25/82	8/25/82	8/25/82	8/25/82	8/25/82
Gross alpha, total	0.0±132	0.0±252	13.9±196	0.0±131	0.0±90.6
Gross beta, total	393±237	481±255	477±313	323±232	231±218
Radium-226, total	1.2±0.3	3.0±0.4	0.2±0.1	1.1±0.2	2.0±0.3
Radium-228, total	4.9±3.2	3.1±3.4	0.0±2.8	5.1±3.2	2.8±3.2
Thorium-230, total	0.6±2.4	3.7±2.1	5.8±2.4	14.2±4.3	8.1±2.7
Lead-210, total	3.6±2.1	5.4±2.4	7.4±2.2	1.6±2.0	1.9±2.0
Polonium-210, total	0.5±0.4	3.6±0.9	8.1±1.7	0.8±0.5	1.7±0.6
Uranium (U_3O_8), dissolved	5.4	22.1	6.0	10.1	2.7
Uranium (U_3O_8), total	5.4	32.8	11.4	10.7	4.7

[d] All values in picocuries per liter.

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Table D-36. Records of selected wells in the South Clive area

Location[c]	Owner/User name	Year drilled	Depth of well (ft)	Casing diameter	Depth to top of perforated section (ft)	Altitude (ft)	Water level below land surface datum (ft)
[a]T1S, R11W Sec. 18	U.S. Bureau of Land Management (Clive well)	-	90	-	-	-	-
[a]T1S, R11W Sec. 18 bcd	Cox Construction Company	1969	350	8	185	4,350	53
[a]T1S, R11W Sec. 36 bba	Desert Livestock Company	1940	276	6	-	4,550	264
[b]T1S, R11W Sec. 36 bba	Desert Livestock Company	1946	293	6	265	4,550	263
[b]T1S, R10W Sec. 31 cab	U.S. Bureau of Reclamation	1976	300	-	-	-	-
[b]T1S, R10W Sec. 31 bdb	U.S. Bureau of Reclamation	1976	180	6-5/8	80	-	8

[a]Stephens, J.C., 1974. Hydrologic Reconnaissance of the Northern Great Salt Lake Desert and Summary Hydrologic Reconnaissance of Northwestern Utah, U.S. Geol. Survey in Cooperation with the Utah Department of Natural Resources, Technical Publication 42, Salt Lake City, Utah.

[b]Data obtained from the State of Utah Office of State Engineer, May 1981.

[c]The proposed tailings embankment at the South Clive site would be in the North half of T1S, R11W, Sec. 32.

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Table D-36. (continued)

Location	Owner/User name	Rate of Discharge (gpm)	Drawdown (ft)	Date of measurement	Method of lift	Use of water or well	Remarks or data available
T1S, R11W Sec. 18	U.S. Bureau of Land Management (Clive well)	-	-	-	none	unused	Well never used; water reported to have contained 35,700 ppm of NaCl.
T1S, R11W Sec. 18 bcd	Cox Construction Company	600	120	12-29-69	none	unused	Specific capacity = 5 gpm/ft drawdown; supplied water for road construction; later destroyed.
T1S, R11W Sec. 36 bba	Desert Livestock Company	18	-	5-04-40	none	unused	Well has been destroyed.
T1S, R11W Sec. 36 bba	Desert Livestock Company	-	-	11-10-46	piston pump	livestock	Log available.
T1S, R10W Sec. 31 cab	U.S. Bureau of Reclamation	-	-	-	none	none	Abandoned and destroyed; dry hole; log available.
T1S, R10W Sec. 31 beb	U.S. Bureau of Reclamation	40	90	9-14-76	-	-	Log available.

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D.6. CONCLUSIONS AND SUMMARY--SOUTH CLIVE SITE

- Two ground-water systems can be found in the vicinity of the South Clive site: valley fill and alluvial fan.
- The South Clive site overlies briny ground water downgradient of the recharge to any usable ground water in the alluvial fan aquifer.
- The potential for infiltration at the site is minimal.
- Shallow ground water at the site is characterized by high TDS and certain radionuclides with little seasonal variation in quality.
- Water uses in the area are limited to a few stock wells, due to the poor quality of the ground water.

D.7 SURFACE-WATER QUALITY, TRANSPORTATION ROUTE

Additional water-quality data are available for surface-water sampling sites along the transportation route between the Vitro and South Clive sites. Sampling locations are shown in Figure D-21 and described in Table D-37. The data are presented in Table D-38. At least 27 other water-quality monitoring stations of the State of Utah and the US Geological Survey have been identified as being on or near the transportation route.

Table D-37. Surface-water sampling locations

Location ID	Location description
5-1	Jordan River west of White's ballpark, south side of West N. Temple St.
5-2	Jordan River southeast of Salt Lake Airport, west bank of river.
5-3	Great Salt Lake at Salt Air Marina and boat launch ramp, at rock embankment northeast of marina.
5-4	Ephemeral drainage course 1/2 mile from Timpie, Utah, south side of eastbound highway I-80.
5-5	Ephemeral drainage course 3 miles east of Delle, Utah, south side of eastbound highway I-80.

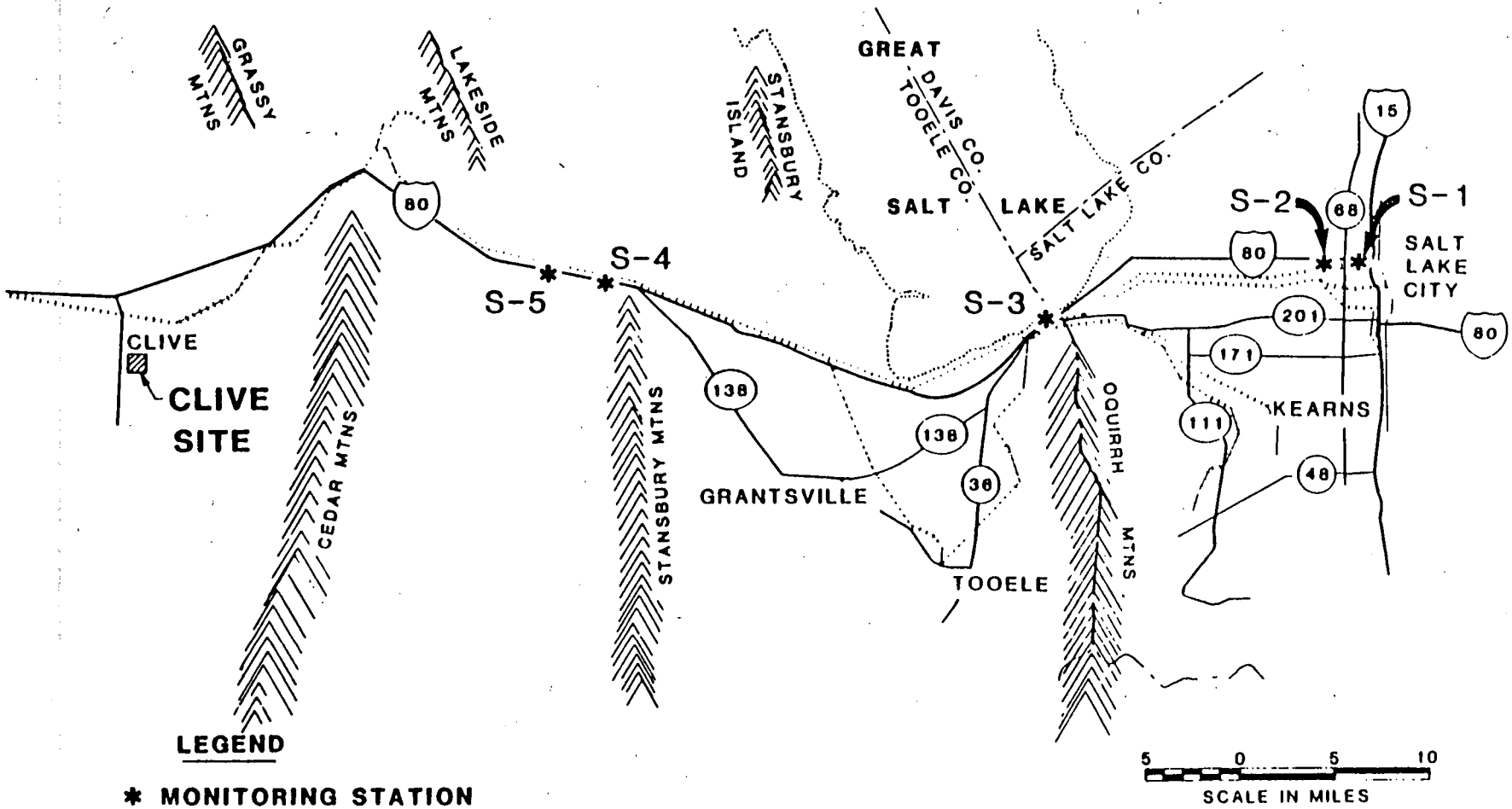

FIGURE D-21

LOCATIONS OF SURFACE WATER QUALITY SAMPLING STATIONS.

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Table D-38. Surface-water quality - Vitro to South Clive transportation route

Parameter (metals)	Location number[a]				
	S-1	S-2	S-3	S-4	S-5
Date sampled	9/10/81	9/10/81	9/8/81	9/9/81	9/9/81
Aluminum - (Al)	<0.1[b]	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	-[c]	-	-	-	-
Arsenic - total (As)	<0.01	<0.01	0.03	<0.01	<0.01
Barium (Ba)	-	-	-	-	-
Barium - total (Ba)	<0.1	<0.1	<0.1	<0.1	<0.1
Boron - total (B)	0.30	0.26	2.76	0.34	0.61
Cadmium (Cd)	-	-	-	-	-
Cadmium - total (Cd)	<0.01	<0.01	0.22	0.01	0.04
Chromium (Cr)	-	-	-	-	-
Chromium - total (Cr)	<0.01	<0.01	0.10	<0.01	<0.01
Cobalt (Co)	-	-	-	-	-
Copper (Cu)	-	-	-	-	-
Copper - total (Cu)	-	-	-	-	-
Iron (Fe)	<0.05	<0.05	0.73	<0.05	<0.05
Iron - total (Fe)	0.88	0.72	0.75	<0.05	0.74
Lead (Pb)	-	-	-	-	-
Lead - total (Pb)	<0.1	<0.1	1.7	<0.1	<0.1
Magnesium (Mg)	54.0	56.0	4,500	73.0	120
Manganese (Mn)	0.04	0.05	0.23	0.01	0.05
Manganese - total (Mn)	-	-	-	-	-
Mercury - total (Hg) (in micrograms per liter)	<0.3	<0.3	1.2	0.4	<0.3
Molybdenum (Mo)	<0.1	<0.1	0.4	<0.1	<0.1
Nickel - (Ni)	-	-	-	-	-
Potassium (K)	13.0	14.0	2,700	92.0	160
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	-	-	-	-	-
Silver (Ag)	<0.01	<0.01	0.17	<0.01	0.01
Silver - total (Ag)	-	-	-	-	-
Sodium (Na)	180	190	44,500	2,600	4,600
Sodium - total (Na)	-	-	-	-	-
Strontium (Sr)	0.74	0.74	2.55	0.97	6.40
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	<0.01	0.03	0.13	0.01	0.02
Zinc - total (Zn)	-	-	-	-	-

[a] For sampling locations, see Figure D-12.
[b] All values in milligrams per liter on a dissolved basis, unless otherwise noted.
[c] - indicates concentration not determined.

000600

6442

Table D-38. (continued)

Parameters (metals)	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	1/27/82	1/27/82	1/27/82	1/27/82	1/27/82
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic (As)	0.01	<0.01	0.03	0.02	<0.01
Arsenic - total (As)	0.01	0.01	0.15	0.02	0.01
Barium (Ba)	<0.1	<0.1	<0.1	<0.1	<0.1
Barium - total (Ba)	<0.1	<0.1	<0.1	<0.1	<0.1
Boron (B)	0.12	0.20	13.52	0.75	0.85
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (Cr)	<0.01	<0.01	0.08	<0.01	<0.01
Chromium - total (Cr)	0.02	0.01	0.08	<0.01	<0.01
Cobalt (Co)	<0.1	<0.1	1.1	0.1	0.1
Copper (Cu)	<0.01	<0.01	0.22	0.01	0.03
Copper - total (Cu)	0.04	0.07	0.22	0.02	0.04
Iron (Fe)	<0.05	<0.05	0.51	<0.05	<0.05
Iron - total (Fe)	4.11	5.80	0.53	0.07	0.45
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	<0.05
Lead - total (Pb)	0.11	<0.05	<0.05	<0.05	<0.05
Magnesium (Mg)	42.0	55.0	5,000	76.0	190
Manganese (Mn)	0.04	0.05	0.23	<0.01	0.02
Manganese - total (Mn)	0.11	0.14	0.23	<0.01	0.03
Mercury - total (Hg) (in micrograms per liter)	<0.3	<0.3	<0.3	<0.3	<0.3
Molybdenum (Mo)	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel (Ni)	<0.05	<0.05	1.10	0.10	0.18
Potassium (K)	11.0	16.0	3,000	100	200
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium - total (Se)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium - (Na)	290	170	43,800	2,770	6,300
Sodium - total (Na)	290	170	44,000	2,800	6,300
Strontium (Sr)	0.70	0.75	2.68	1.05	3.33
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	<0.5
Zinc (Zn)	0.03	0.02	0.12	0.02	0.04
Zinc - total (Zn)	0.29	0.21	0.21	0.08	0.09

000601

Table D-38. (continued)

Parameter (metals)	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	4/26/82	4/26/82	4/26/82	4/26/82	4/26/82
Aluminum (Al)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic (As)	< 0.01	< 0.01	0.07	0.02	0.02
Arsenic - total (As)	< 0.01	< 0.01	0.07	0.02	0.02
Barium (Ba)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Barium - total (Ba)	0.3	< 0.1	< 0.1	< 0.1	< 0.1
Boron (B)	0.25	0.51	18.13	0.99	3.75
Cadmium (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium - total (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium - total (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt (Co)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Copper (Cu)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Copper - total (Cu)	0.02	0.02	< 0.01	< 0.01	< 0.01
Iron (Fe)	< 0.05	< 0.05	0.51	< 0.05	0.16
Iron - total (Fe)	2.94	2.72	0.54	< 0.05	0.18
Lead (Pb)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Lead - total (Pb)	< 0.05	0.06	< 0.05	< 0.05	< 0.05
Magnesium (Mg)	36.0	48.0	4,400	76.0	490
Manganese (Mn)	0.02	0.01	0.15	< 0.01	0.06
Manganese - total (Mn)	0.12	0.08	0.15	< 0.01	0.06
Mercury - total (Hg) (in micrograms per liter)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Molybdenum (Mo)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel (Ni)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Potassium (K)	6.40	11.0	1,700	100	440
Selenium (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Selenium - total (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver - total (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium (Na)	80.0	130	40,000	2,800	15,000
Sodium - total (Na)	80.0	130	40,000	2,800	15,000
Strontium (Sr)	0.60	0.77	3.02	1.20	9.50
Vanadium (V)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc (Zn)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zinc - total (Zn)	0.08	0.08	0.03	0.03	0.03

000602

6442

Table D-38. (continued)

Parameter (metals)	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	6/16/82	6/16/82	6/16/82	6/16/82	6/16/82
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	NS[d]
Arsenic (As)	<0.01	<0.01	0.04	0.01	NS
Arsenic - total (As)	<0.01	<0.01	0.04	<0.01	NS
Barium (Ba)	<0.1	<0.1	<0.1	<0.1	NS
Barium - total (Ba)	<0.1	<0.1	<0.1	<0.1	NS
Boron (B)	0.25	0.38	9.78	1.00	NS
Cadmium (Cd)	<0.01	<0.01	<0.01	<0.01	NS
Cadmium - total (Cd)	<0.01	<0.01	<0.01	<0.01	NS
Chromium (Cr)	<0.01	<0.01	<0.01	<0.01	NS
Chromium - total (Cr)	<0.01	<0.01	<0.01	<0.01	NS
Cobalt (Co)	<0.1	<0.1	<0.1	<0.1	NS
Copper (Cu)	<0.01	<0.01	0.03	<0.01	NS
Copper - total (Cu)	0.06	0.05	0.03	<0.01	NS
Iron (Fe)	<0.05	<0.05	<0.05	<0.05	NS
Iron - total (Fe)	1.03	0.96	0.50	0.05	NS
Lead (Pb)	<0.05	<0.05	<0.05	<0.05	NS
Lead - total (Pb)	0.06	0.05	<0.05	<0.05	NS
Magnesium (Mg)	28.0	30.0	2,500	75.0	NS
Manganese (Mn)	0.01	<0.01	0.05	<0.01	NS
Manganese - total (Mn)	0.06	0.05	0.05	0.08	NS
Mercury - total (Hg) (in micrograms per liter)	<0.3	<0.3	<0.3	<0.3	NS
Molybdenum (Mo)	<0.1	<0.1	0.3	<0.1	NS
Nickel (Ni)	<0.05	<0.05	<0.05	<0.05	NS
Potassium (K)	6.00	7.50	1,600	95.0	NS
Selenium (Se)	<0.01	<0.01	<0.01	<0.01	NS
Selenium - total (Se)	<0.01	<0.01	<0.01	<0.01	NS
Silver (Ag)	<0.01	<0.01	<0.01	<0.01	NS
Silver - total (Ag)	<0.01	<0.01	<0.01	<0.01	NS
Sodium (Na)	67.0	80.0	24,000	2,700	NS
Sodium - total (Na)	67.0	80.0	24,000	2,700	NS
Strontium (Sr)	0.42	0.42	2.21	1.14	NS
Vanadium (V)	<0.5	<0.5	<0.5	<0.5	NS
Zinc (Zn)	0.20	0.65	<0.01	<0.01	NS
Zinc - total (Zn)	1.10	2.00	0.87	0.12	NS

[d]NS-Not sampled because of insufficient flow.

000603

Table D-38. (continued)

Parameter (metals)	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	8/18/82	8/18/82	8/18/82	8/18/82	8/18/82
Aluminum (Al)	< 0.1	< 0.1	< 0.1	< 0.1	
Arsenic (As)	< 0.01	< 0.01	0.05	< 0.01	NS
Arsenic - total (As)	0.01	0.01	0.08	0.01	NS
Barium (Ba)	< 0.1	< 0.1	< 0.1	< 0.1	NS
Barium - total (Ba)	< 0.1	< 0.1	< 0.1	< 0.1	NS
Boron (B)	0.45	0.49	17.10	0.89	NS
Cadmium (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Cadmium - total (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Chromium (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Chromium - total (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Cobalt (Co)	< 0.1	< 0.1	0.9	< 0.1	NS
Copper (Cu)	< 0.01	< 0.01	0.04	< 0.01	NS
Copper - total (Cu)	< 0.01	< 0.01	0.04	< 0.01	NS
Iron (Fe)	< 0.05	< 0.05	0.41	< 0.05	NS
Iron - total (Fe)	0.73	0.72	0.43	< 0.05	NS
Lead (Pb)	< 0.05	< 0.05	< 0.05	< 0.05	NS
Lead - total (Pb)	< 0.05	< 0.05	< 0.05	< 0.05	NS
Magnesium (Mg)	51.0	55.0	4,500	75.0	NS
Manganese (Mn)	0.03	0.03	0.15	< 0.01	NS
Manganese - total (Mn)	0.05	0.05	0.15	< 0.01	NS
Mercury - total (Hg) (in micrograms per liter)	< 0.3	< 0.3	< 0.3	< 0.3	NS
Molybdenum (Mo)	< 0.1	< 0.1	< 0.1	< 0.1	NS
Nickel (Ni)	< 0.05	< 0.05	1.03	< 0.05	NS
Potassium (K)	16.0	16.0	1,700	106	NS
Selenium (Se)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Selenium - total (Se)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Silver (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Silver - total (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	NS
Sodium (Na)	160	180	38,000	2,800	NS
Sodium - total (Na)	160	180	38,000	2,800	NS
Strontium (Sr)	1.05	1.06	3.35	1.23	NS
Vanadium (V)	< 0.5	< 0.5	< 0.5	< 0.5	NS
Zinc (Zn)	0.02	0.02	0.09	< 0.01	NS
Zinc - total (Zn)	0.23	0.11	0.34	0.07	NS

000604

6442

Table D-38. (continued)

Parameter (metals)	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	10/14/82	10/14/82	10/14/82	10/14/82	10/14/82
Aluminum (Al)	< 0.1	< 0.1	< 0.1	< 0.1	0.1
Aluminum - total (Al)	1.3	1.9	< 0.1	< 0.1	< 0.1
Arsenic (As)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic - total (As)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Barium (Ba)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Barium - total (Ba)	< 0.1	< 0.1	0.1	< 0.1	0.2
Boron (B)	0.34	0.37	10.9	0.92	2.53
Cadmium (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cadmium - total (Cd)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium (Cr)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chromium - total (Cr)	0.01	0.01	< 0.01	< 0.01	0.01
Cobalt (Co)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Copper (Cu)	0.03	0.04	< 0.01	< 0.01	< 0.01
Copper - total (Cu)	0.07	0.11	0.03	0.03	0.08
Iron (Fe)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Iron - total (Fe)	1.23	2.54	0.07	0.08	0.11
Lead (Pb)	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Lead - total (Pb)	0.02	0.03	< 0.01	< 0.01	< 0.01
Magnesium (Mg)	50	50	4,200	80	240
Manganese (Mn)	0.01	0.01	0.01	< 0.01	0.01
Manganese - total (Mn)	0.04	0.09	0.05	< 0.01	0.01
Mercury - total (Hg) (in micrograms per liter)	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Molybdenum (Mo)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nickel (Ni)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Potassium (K)	7.5	8.6	2,500	89	260
Selenium (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Selenium - total (Se)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Silver - total (Ag)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sodium (Na)	130	140	37,000	2,500	8,000
Sodium - total (Na)	130	140	27,000	2,500	8,000
Strontium (Sr)	0.82	0.77	3.00	1.17	6.8
Vanadium (V)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Zinc (Zn)	0.06	0.10	0.18	0.07	0.06
Zinc - total (Zn)	0.02	0.02	0.03	< 0.01	< 0.01

000605

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	9/10/81	9/10/81	9/8/81	9/9/81	9/9/81
Ammonia (NH_3-N)	0.95	1.27	6.50	0.05	0.34
Bicarbonate (HCO_3)	297	299	600	178	56.1
Carbonate (CO_3)	< 1	< 1	3.61	< 1	< 1
Calcium (Ca)	98.0	100	270	150	500
Chloride (Cl)	238	251	80,689	4,360	7,689
Chloride - total (Cl)	-	-	-	-	-
Conductivity - field (in micromhos per centimeter)	2,190	2,000	80,000	19,500	61,000
Conductivity - lab (in micromhos)	1,715	1,757	-	13,829	27,446
Fluoride (F)	0.64	0.67	0.29	0.31	0.19
Fluoride - total (F)	-	-	-	-	-
Hydroxide (OH)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nitrate (NO_3-N)	1.8	1.9	0.1	0.6	0.3
Nitrate - total (NO_3-N)	-	-	-	-	-
pH - field	8.1	8.3	8.7	9.1	8.7
pH -lab @ 25°C	7.89	7.98	8.40	8.42	7.61
Phenol	-	-	-	-	-
Phosphate - total (PO_4-P)	0.97	0.97	0.50	0.01	0.01
Redox potential (EH) (in millivolts)	157	156	26	90	76
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	298	313	10,711	314	1,217
Sulfate - total (SO_4)	-	-	-	-	-
Sulfide (H_2S)	-	-	-	-	-
Temperature - field (°C)	18.7	18.5	22.5	22.0	14.3
Total alkalinity (as $CaCO_3$)	257	261	579	184	64
Total dissolved solids (as calcium)	1,140	1,153	154,740	8,160	15,252
Total hardness (as $CaCO_3$)	466	480	19,196	675	1,742
Total organic carbon	-	-	-	-	-

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	1/27/82	1/27/82	1/27/82	1/27/82	1/27/82
Ammonia (NH_3-N) (un-ionized)	0.03	<0.02	<0.02	<0.02	<0.02
Bicarbonate (HCO_3)	235	297	638	211	174
Carbonate (CO_3)	< 1	< 1	< 1	< 1	< 1
Calcium (Ca)	72.0	79.0	290	110	250
Chloride (Cl)	458	253	79,238	4,481	10,425
Chloride - total (Cl)	458	253	79,465	4,492	10,425
Conductivity - field (in micromhos)	2,200	1,600	77,000	22,000	42,000
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride (F)	0.68	0.82	0.66	0.50	0.58
Fluoride - total (F)	0.68	0.82	1.2	0.53	0.82
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	1.2	1.2	0.1	0.7	0.3
Nitrate - total (NO_3)	2.9	3.6	0.1	0.7	0.3
pH - field	8.1	8.1	8.9	8.8	8.5
pH - lab @25°C	7.60	8.50	8.20	8.50	8.05
Phenol	0.009	<0.005	<0.005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.91	0.94	0.23	0.03	0.02
Redox potential (EH) (in millivolts)	150	152	-90	-20	-50
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	184	229	9,984	327	876
Sulfate - total (SO_4)	222	299	9,984	331	904
Sulfide (H_2S)	<0.05	<0.05	<0.05	<0.05	<0.05
Temperature - field (°C)	5.0	7.3	3.8	12.2	4.0
Total alkalinity (as $CaCO_3$)	210	261	557	190	160
Total dissolved solids (as calcium)	1,273	981	144,512	8,092	18,472
Total hardness (as $CaCO_3$)	352	423	21,304	587	1,406
Total organic carbon	28	25	64	12	20

000607

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	4/26/82	4/26/82	4/26/82	4/26/82	4/26/82
Ammonia (NH_3-N) (un-ionized)	<0.05	<0.05	<0.05	<0.05	<0.05
Bicarbonate (HCO_3)	268	262	617	194	117
Carbonate (CO_3)	<1	<1	<1	<1	<1
Calcium (Ca)	79.0	75.0	270	140	540
Chloride (Cl)	109	171	70,843	4,436	24,923
Chloride - total (Cl)	109	172	70,843	4,492	24,979
Conductivity - field (in micromhos per centimeter)	760	1,400	77,000	20,500	63,000
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride (F)	0.33	0.54	0.59	0.37	0.59
Fluoride - total (F)	0.35	0.56	0.59	0.37	0.59
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate - total (NO_3)	0.1	0.2	<0.1	<0.1	<0.1
pH - field	8.2	8.1	8.8	8.7	8.9
pH - lab @25°C	8.00	7.90	8.20	8.40	8.20
Phenol	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.55	0.58	0.65	0.02	0.06
Redox potential (EH) (in millivolts)	178	164	21	89	49
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	140	212	9,444	331	2,066
Sulfate - total (SO_4)	145	219	9,658	332	2,090
Sulfide (H_2S)	<0.05	<0.05	<0.05	<0.05	<0.05
Temperature - field (°C)	12.6	14.5	12.8	16.3	14.4
Total alkalinity (as $CaCO_3$)	234	227	533	187	116
Total dissolved solids (as calcium)	620	830	135,175	8,360	45,106
Total hardness (as $CaCO_3$)	345	384	18,784	662	3,365
Total organic carbon	11	8	37	3	18

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	6/16/82	6/16/82	6/16/82	6/16/82	6/16/82
Ammonia (NH_3-N) (un-ionized)	< 0.05	< 0.05	< 0.05	0.05	NS
Bicarbonate (HCO_3)	207	186	431	196	NS
Carbonate (CO_3)	< 1	< 1	< 1	< 1	NS
Calcium (Ca)	66.0	58.0	250	130	NS
Chloride (Cl)	94.6	107	39,603	4,388	NS
Chloride - total (Cl)	92.6	105.2	38,845.0	4,456.5	NS
Conductivity - field (in micromhos per centimeter)	730	730	89,000	21,000	NS
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	NS
Fluoride (F)	0.34	0.38	0.67	0.35	NS
Fluoride - total (F)	0.31	0.37	0.66	0.34	NS
Hydroxide (OH)	<0.5	<0.05	<0.5	<0.5	NS
Nitrate (NO_3-N)	1.0	1.0	<0.1	0.2	NS
Nitrate - total (NO_3)	0.9	0.9	<0.1	0.2	NS
pH - field	8.1	8.0	8.3	8.4	NS
pH - lab @25°C	7.88	7.78	8.32	8.43	NS
Phenol	<0.005	<0.005	<0.005	<0.005	NS
Phosphate - total (PO_4-P)	0.28	0.35	0.80	0.02	NS
Redox potential (EH) (in millivolts)	184	178	32	83	NS
Salinity - field (0/00)	-	-	-	-	NS
Sulfate (SO_4)	117	138	5,162	319	NS
Sulfate - total (SO_4)	119	142	5,033	334	NS
Sulfide (H_2S)	<0.05	<0.05	<0.05	<0.05	NS
Temperature - field (°C)	17.0	16.0	26.0	23.0	NS
Total alkalinity (as $CaCO_3$)	183	164	375	183	NS
Total dissolved solids (as calcium)	482	516	76,602	8,122	NS
Total hardness (as $CaCO_3$)	280	268	10,914	633	NS
Total organic carbon	12	10	29	6	NS

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	8/18/82	8/18/82	8/18/82	8/18/82	8/18/82
Ammonia (NH_3-N) (un-ionized)	<0.05	0.07	<0.05	<0.05	NS
Bicarbonate (HCO_3)	309	327	617	206	NS
Carbonate (CO_3)	<1	<1	<1	<1	NS
Calcium (Ca)	100	105	250	120	NS
Chloride (Cl)	214	250	70,673	4,416	NS
Chloride - total (Cl)	213	238	74,178	4,423	NS
Conductivity - field (in micromhos)	2,000	2,200	97,000	20,000	NS
Cyanide - total (CN)	<0.05	<0.05	<0.05	<0.05	NS
Fluoride (F)	0.62	0.70	0.62	0.46	NS
Fluoride - total (F)	0.68	0.73	0.65	0.37	NS
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	NS
Nitrate (NO_3-N)	2.3	1.8	<0.1	0.4	NS
Nitrate - total (NO_3)	2.2	1.7	<0.1	0.4	NS
pH - field	7.88	8.00	8.42	8.40	NS
pH - lab @25°C	7.90	8.00	8.07	8.30	NS
Phenol	<0.005	<0.005	<0.005	<0.005	NS
Phosphate - total (PO_4-P)	1.29	1.32	0.22	<0.01	NS
Redox potential (EH) (in millivolts)	160	160	22	83	NS
Salinity - field (0/00)	-	-	-	-	NS
Sulfate (SO_4)	289	334	9,497	322	NS
Sulfate - total (SO_4)	279	318	9,275	316	NS
Sulfide (H_2S)	0.05	0.04	0.03	0.04	NS
Temperature - field (°C)	22.0	22.0	28.0	22.0	NS
Total alkalinity (as $CaCO_3$)	268	281	532	182	NS
Total dissolved solids (as calcium)	1,096	1,178	130,628	7,844	NS
Total hardness (as $CaCO_3$)	459	488	19,146	608	NS
Total organic carbon	10	9	35	3	NS

Table D-38. (continued)

General parameters	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	10/14/82	10/14/82	10/14/82	10/14/82	10/14/82
Ammonia (NH_3-N) (un-ionized)	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Bicarbonate (HCO_3)	270.0	264.0	442.0	209.0	172.0
Carbonate (CO_3)	< 1	< 1	< 1	< 1	< 1
Calcium (Ca)	77	71	280	150	420
Chloride (Cl)	180.0	194.8	49,072	4,438.5	13,009
Chloride - total (Cl)	180.0	194.8	47,544	4,438.5	13,123
Conductivity - field (in micromhos per centimeter)	2,500	2,800	72,000	26,000	62,000
Cyanide - total (CN)	<0.05	<0.05	<0.05	< 0.05	<0.05
Fluoride (F)	0.6	0.6	0.9	0.4	0.5
Fluoride - total (F)	0.6	0.6	1.0	0.4	0.6
Hydroxide (OH)	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate (NO_3-N)	1.5	1.4	0.2	0.8	0.1
Nitrate - total (NO_3)	1.7	1.4	0.7	0.8	0.1
pH - field	7.96	8.09	8.50	8.40	8.27
pH - lab @ 25°C	8.18	8.20	8.21	8.15	8.10
Phenol	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate - total (PO_4-P)	0.40	0.46	0.25	<0.01	0.03
Redox potential (EH) (in millivolts)	160	158	35	73	62
Salinity - field (0/00)	-	-	-	-	-
Sulfate (SO_4)	213	248	5,889	328	1,304
Sulfate - total (SO_4)	238	248	5,893	321	1,335
Sulfide (H_2S)	0.05	0.06	0.07	0.06	0.07
Temperature - field (°C)	13	12	15	11.5	7.5
Total alkalinity (as $CaCO_3$)	236	229	379	182	151
Total dissolved solids (as calcium)	858	890	93,014	8,018	23,830
Total hardness (as $CaCO_3$)	398	383	17,995	704	2,037
Total organic carbon	9	7	25	8	18

Table D-38. (continued)

Radiochemistry[d]	Location number				
	S-1	S-2	S-3	S-4	S-5
Date sampled	9/10/81	9/10/81	9/8/81	9/9/81	9/9/81
Gross alpha, dissolved	10±6	2±6	207±187	0±37	0±48
Gross beta, dissolved	6±4	20±5	1075±222	0±40	10±45
Radium - 226, dissolved	0.0±0.02	1.4±0.3	0.7±0.2	0.4±0.2	1.8±0.3
Radium - 228, dissolved	-	-	-	-	-
Thorium - 230, dissolved	0.5±0.5	0.6±0.6	0.7±0.6	0.3±0.4	1.1±0.7
Lead - 210, dissolved	0.9±0.6	0.5±0.7	5.2±1.6	0.6±0.7	0.3±0.8
Polonium - 210, dissolved	0.1±0.2	0.3±0.3	0.0±0.2	0.0±0.2	0.0±0.2
Uranium (U_3O_8), dissolved	<0.7	<0.7	8.1	<0.7	<0.7

[d]All values in picocuries per liter.

Table D-38. (continued)

Radiochemistry	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	1/27/82	1/27/82	1/27/82	1/27/82	1/27/82
Gross alpha, total	6.6±9.2	11.2±10.4	290±400	2.5±10.9	12.0±28.0
Gross beta, total	0.0±23.0	34.5±25.0	460±405	31.0±20.0	85.0±41.0
Radium - 226, total	0.4±0.2	0.6±0.2	0.9±0.4	0.5±0.2	0.5±0.1
Radium - 228, total	0.9±3.5	1.0±3.8	0.0±3.1	1.3±3.5	0.0±1.4
Thorium - 230, total	0.6±1.1	2.4±4.0	0.0±11.3	1.0±0.9	2.4±1.4
Lead - 210, total	0.5±1.7	0.7±1.3	0.3±1.3	0.0±1.3	0.0±1.3
Polonium - 210, total	0.4±0.7	0.0±0.6	0.0±0.4	0.0±0.5	0.0±0.5
Uranium (U_3O_8), dissolved	3.4	6.1	7.4	2.0	5.4
Uranium (U_3O_8), total	3.4	13.5	13.5	3.4	6.8

Table D-38. (continued)

Radiochemistry	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	4/26/82	4/26/82	4/26/82	4/26/82	4/26/82
Gross alpha, total	6.0±6.0	100±22.0	1.6±8.3	0.0±50.0	0.0±147
Gross beta, total	11.5±3.3	0.0±8.0	650±120	203±121	453±145
Radium-226, total	0.0±0.1	0.5±0.2	0.7±0.2	1.8±0.2	0.5±0.2
Radium-228, total	0.0±0.0	0.0±1.8	0.0±2.0	1.8±1.6	3.7±2.0
Thorium-230, total	0.0±0.5	1.6±1.0	0.0±0.6	0.0±0.4	0.2±0.6
Lead-210, total	0.1±0.8	0.5±0.8	0.5±0.8	0.0±0.9	0.0±0.9
Polonium-210, total	0.5±0.3	0.7±0.4	1.3±0.7	0.4±0.2	0.5±0.4
Uranium (U_3O_8) dissolved	2.0	4.7	6.1	<0.7	3.4
Uranium (U_3O_8), total	2.0	6.1	8.1	2.0	5.4

Table D-38. (continued)

Radiochemistry	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	6/16/82	6/16/82	6/16/82	6/16/82	6/16/82
Gross alpha, total	7.3±4.6	6.3±4.3	0.0±194	0.0±27.2	NS[e]
Gross beta, total	10.0±12.0	6.4±11.8	1836±593	15.8±87.7	NS
Radium-226, total	0.5±0.1	0.4±0.1	1.1±0.3	1.4±0.2	NS
Radium-228, total	2.9±1.9	0.8±1.8	1.5±2.6	1.3±2.1	NS
Thorium-230, total	8.6±2.0	1.9±1.4	1.5±1.1	0.9±1.6	NS
Lead-210, total	1.5±1.0	1.8±1.6	0.3±1.0	2.1±1.1	NS
Polonium-210, total	0.2±0.2	1.4±1.0	0.2±0.3	0.2±0.3	NS
Uranium (U_3O_8) dissolved	0.7	2.0	5.4	<0.7	NS
Uranium (U_3O_8), total	0.7	4.1	5.4	<0.7	NS

[e]NS-not sampled because of insufficient flow.

Table D-38. (continued)

	Location number				
Radiochemistry	S-1	S-2	S-3	S-4	S-5
Date sampled	8/18/82	8/18/82	8/18/82	8/18/82	8/18/82
Gross alpha, total	0.0±9.2	0.0±24.7	0.0±630	0.0±40.9	NS
Gross beta, total	42.0±44.3	0.0±133	744±998	117±216	NS
Radium-226, total	0.4±0.2	0.3±0.2	1.2±0.3	1.8±0.3	NS
Radium-228, total	2.0±4.4	0.0±4.9	0.0±5.0	8.6±5.0	NS
Thorium-230, total	3.0±2.1	2.1±1.5	0.9±1.4	1.3±1.4	NS
Lead-210, total	1.0±1.3	0.4±1.2	0.2±1.2	0.7±1.2	NS
Polonium-210, total	0.6±0.5	0.2±0.3	0.3±0.3	1.1±0.6	NS
Uranium (U_3O_8) dissolved	<1.4	<1.4	<1.4	<1.4	NS
Uranium (U_3O_8), total	<1.4	<1.4	<1.4	<1.4	NS

Table D-38. (continued)

Radiochemistry	Location number S-1	S-2	S-3	S-4	S-5
Date sampled	10/14/82	10/14/82	10/14/82	10/14/82	10/14/82
Gross alpha, total	4.0±4.9	11.6±6.7	0.0±134.1	18.5±26.2	0.0±76.3
Gross beta, total	26.6±19.8	6.3±19.1	1062.4±502.2	67.8±81.4	372.3±129.3
Radium-226, total	0.6±0.2	0.6±0.2	1.6±0.3	1.6±0.3	0.4±0.2
Radium-228, total	1.0±1.0	0.1±1.0	1.6±1.1	0.5±1.2	1.5±1.1
Thorium-230, total	3.2±1.1	8.7±2.2	0.3±1.1	2.3±1.2	31.2±4.3
Lead-210, total	0.0±1.2	0.4±1.2	0.1±1.2	0.0±1.2	0.5±1.3
Polonium-210, total	1.0±0.6	1.0±0.6	1.2±0.4	0.7±0.4	0.9±0.5
Uranium (U_3O_8) dissolved	6.7	8.0	8.0	1.3	6.7
Uranium (U_3O_8), total	7.4	8.0	8.0	1.3	6.7

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Appendix E

SOCIOECONOMIC INFORMATION

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E.1 LAND USE

Regional land-use patterns are distinctly different in heavily urbanized Salt Lake County and the more rural Tooele County. The Salt Lake County population is almost entirely urban (99.1 percent of its population lived in urban areas according to the 1980 census). Of a total county land area of 488,960 acres, 307,978 (63.0 percent) are privately owned and 66,118 acres (13.5 percent) are considered urban or are occupied by roads and railroads. The Federal government owns and controls 110,335 acres (22.6 percent), while the State owns 4,286 acres (0.9 percent). There are 243 acres of small water areas (2 to 40 acres) and streams that are less than 0.13 mile in width (Utah State Department of Agriculture, 1981).

Salt Lake County's 1980 land use included 38,096 acres (16.8 percent) of residential, 52,995 acres (23.4 percent) of agricultural and 78,032 acres (34.5 percent) of vacant land. By 1995, residential land use is projected to increase 36.1 percent to 51,848 acres. While agricultural land use and vacant land are projected to decrease by 30.3 percent and 24.5 percent, respectively (Wasatch Front Regional Council, 1980). In 1980, transportation used 24,815 acres (11.0 percent), industry 15,801 acres (7.0 percent), and commercial 5,073 acres (2.2 percent).

In Tooele County the Federal government owns and controls 82.6 percent of the county land area of 4.43 million acres (Table E-1). The greatest portion (1,948,417 acres) of the Federal land is public domain administered by the U.S. Bureau of Land Management (BLM). The U.S. Department of Defense (DOD) controls the next greatest portion of 1,558,862 acres, and national forests occupy 152,223 acres (Utah State Department of Agriculture, 1981). Regional land ownership is shown in Figure E-1.

Tooele County land, excluding Federal and urban land and small bodies of water, totals 755,288 acres. Land use for this acreage is as follows:

Cropland	39,776
Pasture	2,326
Range	418,469
Forest	214,332
Other	80,385
Subtotal	755,288

Population figures from the 1970 census show that 28.2 percent of Tooele County's population was rural. This is somewhat higher than the 19.6 percent rural population of the state.

Much of the state-owned land in Tooele County is leased to private citizens for grazing cattle. The estimated total number of cattle in Tooele County (18,300) is 2.1 percent of the state total (Utah State Department of Agriculture, 1981).

Table E-1. Land use (by use or ownership) for Tooele County, in acres, 1970

Use or ownership	Acres	Percent of total county
Federal land	3,659,502	82.60
Residential and accessory use	1,546	0.03
Commercial	240	0.01
Industrial (plant sites, 885; salt ponds and other 50,000)	50,885	1.15
Agriculture (crops 39,776: irrigated 18,859 non-irrig. 20,917)	39,776	0.90
Other private lands	425,107	9.60
State lands (no highways)	218,640	4.94
Highways, roads & streets	13,651	0.30
Railroads	3,000	0.06
Indian land	17,763	0.40
Public & quasi-public, in municipalities	588	0.01
Small waters (excluding all of more than 40 acres)[a]	22	0.00
Totals	4,430,720	100.00

[a]Water areas of 2 to 40 acres and streams less than 0.125 mile in width.

Source: Mountain Area Planners, 1972.

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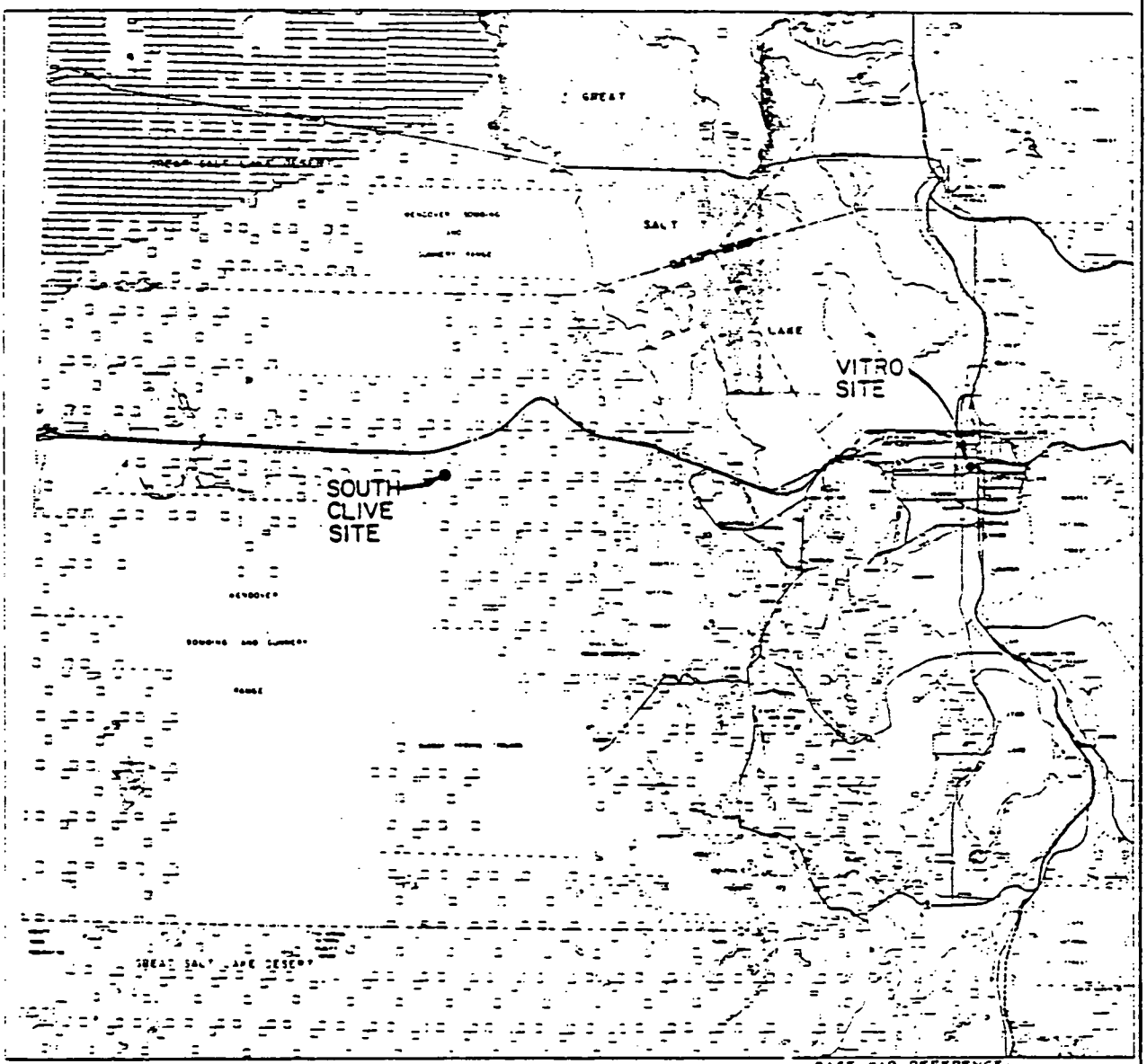

LEGEND

Public Land - BLM, Indian Reservations, and Military

State Land

Private Land

0 5 10 15 25 MILES
SCALE

FIGURE E-1
REGIONAL LAND OWERSHIP

E.1.1 Vitro site

The entire 128-acre Vitro site is owned by the Central Valley Water Reclamation Facility Board, operator of the sewage treatment plant to the north of the site.

Land ownership in the vicinity is predominantly private.

E.1.1.1 Historic land use

The Vitro site was used for an alumina plant during World War II. That plant was converted to produce uranium beginning in May 1951; the output was sold to the U.S. Atomic Energy Commission (AEC) under procurement contracts until February 1964. The plant was then converted to produce commercial vanadium, operating until July 1968. Plant demolition was completed during 1970.

The site is part of a 1979 annexation by the City of South Salt Lake of a portion of unincorporated Salt Lake County. Land use within a 0.5-mile radius of the site began to change from predominantly agricultural and vacant to other uses in 1979. In 1974, a construction moratorium imposed by the Salt Lake City-County Board of Health banned construction within a 0.5-mile radius of the site. This ban was lifted in 1979.

E.1.1.2 Present land use

Land use within a 0.5-mile radius of the site is shown on Figure E-2 and is as follows:

Land Use	Percentage of total within 0.5-mile radius (1370 acres)
Residential	6
Commercial	5
Industrial	18
Transportation/Utility	28
Agriculture	16
Vacant (excluding Vitro site)	27

Source: FBDU, 1981

The Salt Lake City Suburban Sanitary District No. 1 sewage treatment plant is located immediately to the north of the Vitro site (Figure E-1). This facility has been in operation since its initial construction in 1954. The Central Valley Water Reclamation Facility (CVWRF) Board, owner and operator of the treatment facility, is currently building a new facility on the Vitro site. The new plant is planned to be operating by 1987 at sufficient capacity to provide treatment through the year 2000.

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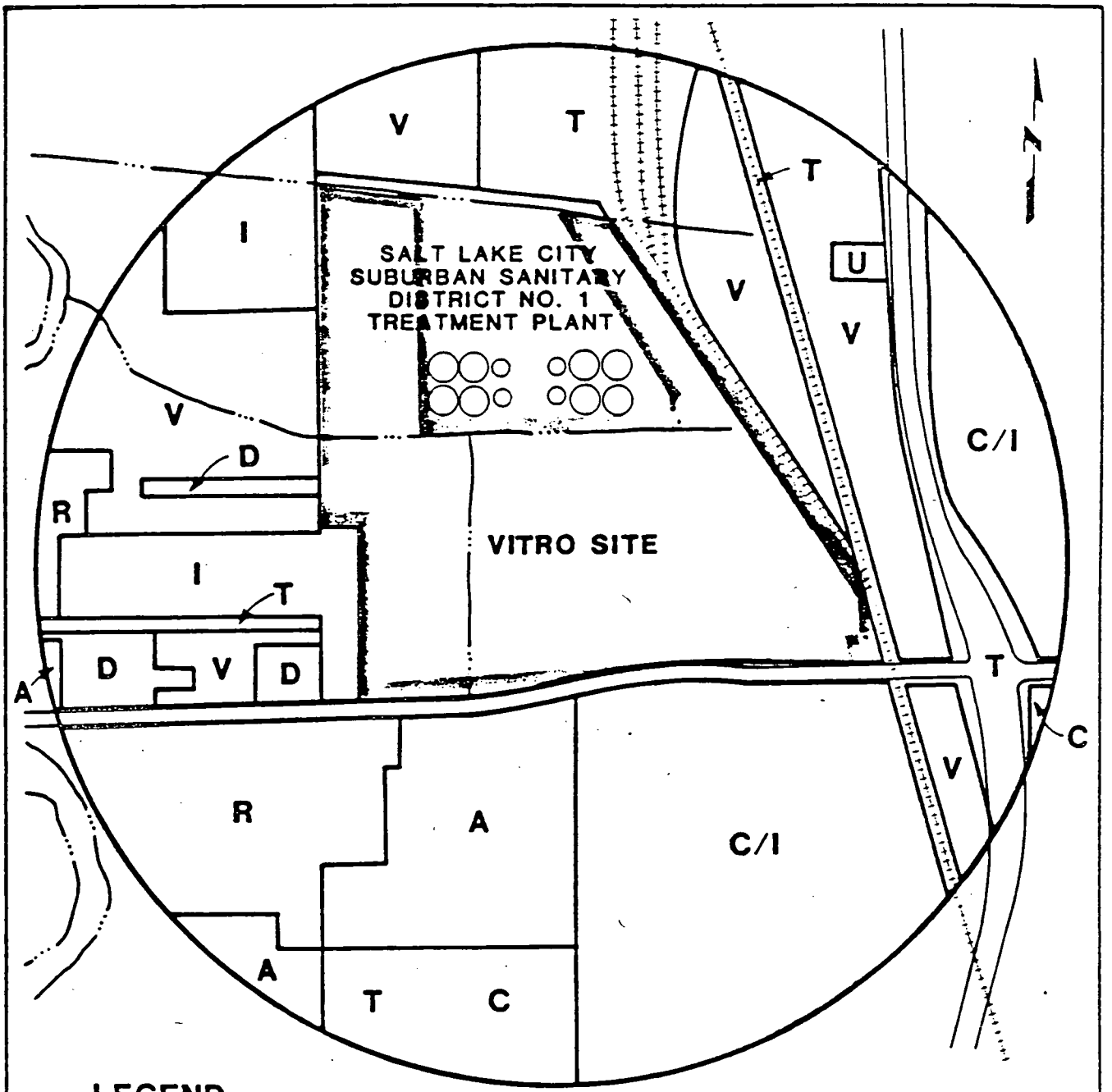


LEGEND

R - RESIDENTIAL
C - COMMERCIAL
I - INDUSTRIAL
T - TRANSPORTATION
U - UTILITY
A - AGRICULTURE
D - DISTURBED
V - VACANT

1000 0 1000 2000
SCALE IN FEET

FIGURE E-2
LAND USE WITHIN 0.5-MILE RADIUS OF VITRO SITE

E.1.1.3 Potential future land use and development

The potential for development of the vacant portions of the 128-acre Vitro site is essentially nil in the absence of some remedial plan to eliminate hazards caused by the presence of the tailings. Plans for CVWRF's expansion of its wastewater treatment facility to 100 million gallons per day, and construction of a temporary industrial park and a municipal solid waste-to-energy facility cannot be implemented without some remedial action.

In the general vicinity of the site, the level topography, soils suited for foundations, and good accessibility render lands suitable for a wide range of urban uses. It is generally agreed by the CVWRF Board, South Salt Lake officials, and Salt Lake County officials that the "highest and best" use for the area is primarily in wholesaling and warehousing functions. However, the 3300 South Street frontage portion of the Vitro site is currently zoned Business (A) which permits a wide variety of business and retail activities.

The City's Master Plan contains estimates of the absorption of vacant land zoned for industrial use in South Salt Lake. The "high estimate" projects that between 82 and 84 percent of the City's development scenario assumes the following "major economic stimuli": (1) deployment of the MX missile system in western Utah; (2) increased extraction of coal reserves in Utah's Overthrust Belt; and (3) continued development of statewide water and power projects. The "low estimate" assumes a moderate national and/or regional recession. Under this scenario, 58 percent of the available industrial land will be absorbed by 1990. Because of the low average income of the city's population, as well as its proximity to the Salt Lake City business district, retail and commercial development in the area is expected to be minimal. South Salt Lake's forecasted growth will be predominantly in wholesaling, distribution, and office/warehouse (70 percent) and industrial uses (16 percent), with the remaining 14 percent being a combination of retailing, office, and service businesses (Vanwagoner and Associates, 1980).

E.1.2 South Clive site

The South Clive site is owned by the State of Utah. Most lands within a 10-mile radius are public domain administered by the BLM, with scattered lands owned by the State of Utah or privately.

Most lands within a 10-mile radius of the site are used very rarely because of their remoteness from urbanized areas and the poor soil, occasional muddy conditions, and sparse vegetation characteristic of the region. Sheep grazing and recreational-vehicle driving are the primary uses made of the area, but such uses are apparently light. The productivity (in terms of animal units supported) of the South Clive site and vicinity for grazing, although relatively good for the area (e.g., the Mud Flats), is low relative to other lands in the region. The Skull Valley Company holds a State grazing lease for the site. Although no reports on land uses in the vicinity could be found, numerous trails in the area indicate that it has been used on occasion for recreational vehicle purposes, and much of the vicinity may be used on occasion for jackrabbit hunting. The only other use of lands within a 10-mile radius is for transportation. Interstate 80 and the Union Pacific System railway pass 2.5 miles and 1 mile north, respectively, of the site.

E.2 SCENIC, HISTORIC, AND CULTURAL RESOURCES

E.2.1 Regional history

During the 1820s, the area around the Great Salt Lake was explored by trappers and scouts of the Ashley party, Jim Bridger, Jedediah S. Smith, Colonel J.G. Fremont, and Kit Carson. Use of the explorers' trails (Figure E-3) soon expanded to cattle drives and settlers, most of whom were headed to California or Oregon. One such group of settlers was the Donner party that opened the route through the Wasatch Range and across the Great Salt Lake Desert north of Clive.

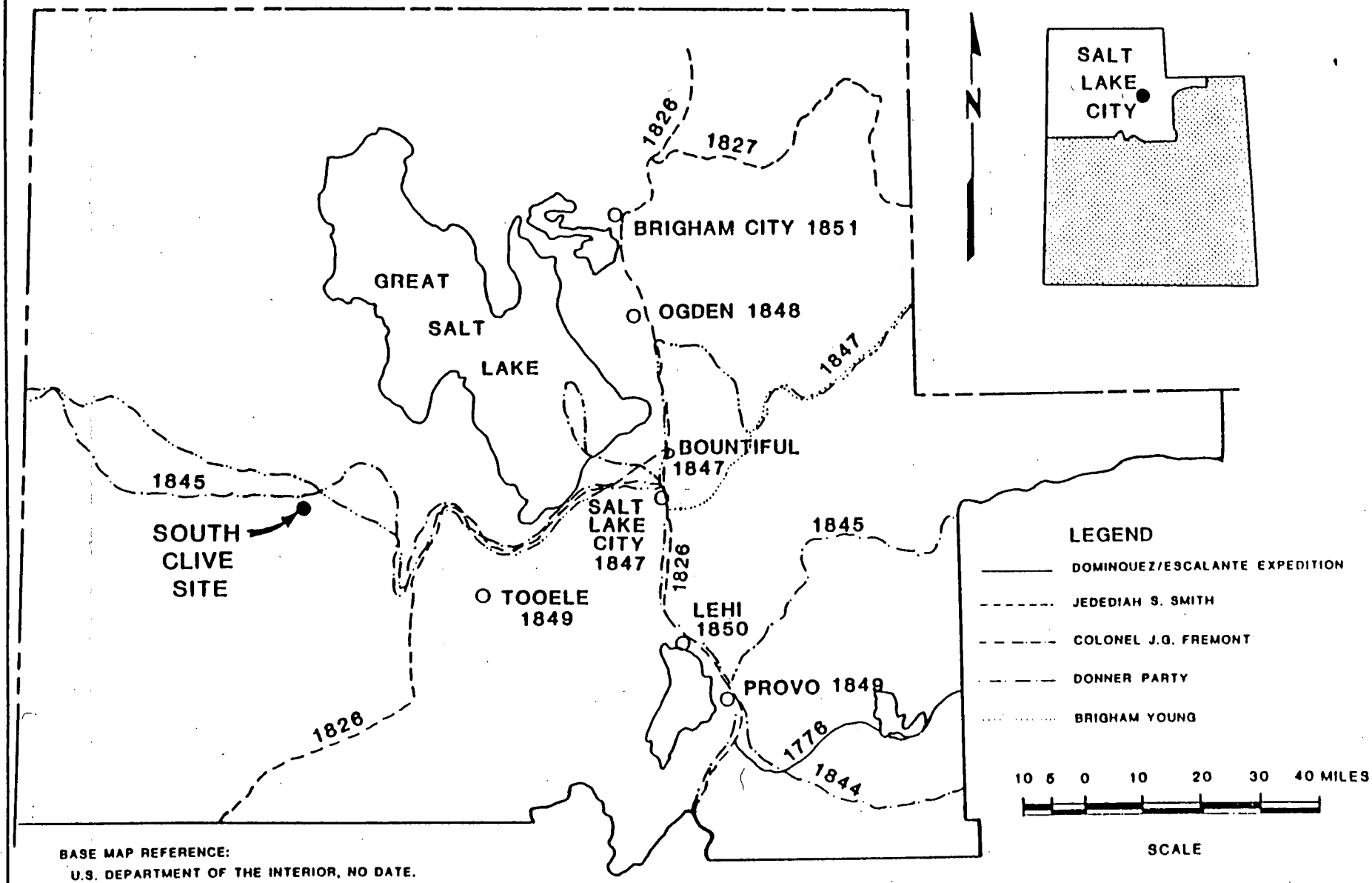
On July 24, 1847, the pioneer party of Mormons led by Brigham Young pulled out of Emigration Canyon, following the Donner route into the Valley of the Great Salt Lake, and settled the site near present Temple Square in Salt Lake City where they built cabins on Settlement Creek and Twin Springs (present Stansbury Park). Within two years another townsite was established at Grantsville. Religious refugees seeking an isolated location to practice their faith in comparative freedom, the Mormons colonized over 300 settlements in and near the Great Basin under the leadership of Brigham Young.

The theodemocratic state of Deseret was proposed in 1849, when a Mormon committee sent a petition to Washington, D.C. asking for a territorial government of their own. The "state" encompassed the vast area of present day Utah, Nevada, Arizona and portions of Oregon, Wyoming, Colorado, New Mexico, Idaho, and California. Tooele County was established by the State of Deseret in January of 1850.

Utah's applications for statehood were denied, however, for over forty years because of theocratic domination of the civil government and the practice of polygamy. After the Manifesto of 1890, the U.S. Congress passed an enabling act inviting Utah to submit a constitution for statehood. The constitution was ratified in November of 1895. On January 4, 1896, President Cleveland signed the statehood act and Utah joined the Union.

During the years since statehood, a split-party system of "middle-of-the-road" conservative politics has maintained the pre-statehood theme of community. The Mormon vote has traditionally been a key factor in political issues. The separation of church and state became more evident with the emergence of a substantial business sector, the commercialization of agriculture, and the development of corporate mining and manufacturing.

With World War I came the sophistication of industrialization. Shortly after the war ended, the cancellation of government contracts, the termination of wartime business controls, and the change of marketing and business patterns that had developed during the war brought to an end the "warborn" economic boom in Utah. Like the rest of the country, Utah was severely affected by the 1929 stock market crash. All aspects of Utah's economy plummeted, and did not recover until the outbreak of World War II. During the course of the war, Utah became the site of ten major military bases and an army hospital, employing approximately 100,000 people. Fort Douglas, established in 1862, became the nerve center for states west of the Rockies, and Kearns Army Air Base was rapidly constructed and trained over 90,000 airmen between August 1942 and October 1943. The nation's largest military reserve, covering three and a half million acres, is the Wendover Air Force Base in Tooele County where the 509th Composite that dropped the atomic



BASE MAP REFERENCE:
U.S. DEPARTMENT OF THE INTERIOR, NO DATE.

FIGURE E-3
ROUTES OF UTAH'S EARLY EXPLORERS

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bombs on Hiroshima and Nagasaki trained. Also constructed were the Tooele Army Depot, the Deseret Chemical Depot, and the Dugway Proving Ground. The building of military installations during the war and the continuation of their use has resulted in Utah being the state with the largest number of government employees. In 1974, more than 11 percent of the population was employed by the government (Peterson, 1977).

Agriculture and mining industries have taken a less substantial place in the economy than government employment. However, energy prices have created a stimulus for production of fossil fuels and coal mining has made a recent comeback in Utah. Other mining industries continue to flourish. In recent years tourism has provided a great boost to Utah's economy.

E.2.2 History of South Salt Lake

On September 29, 1938, South Salt Lake was incorporated in time to make the September 30 deadline for application for a Public Works Administration grant for federal financial aid to build a sewer system. By the fall of 1940, the main sewer system had been installed. The city would not grow until it could provide a potable water system; a water revenue bond election was held and the issue was passed in 1947. The town also established its own bank and obtained a charter for Valley State Bank in 1947. In 1950, the town's first post office was built and it became a third-class city. The population at the time of incorporation was 4000; by 1950 it had grown to 5000. The city expanded its boundaries in 1955 by annexing to Eighth West Street. During the 1950s, the city grew and became a major industrial center.

By 1970 the city's residential population was declining. In 1979, the city annexed approximately 900 acres, extending its boundaries from Mill Creek to 3300 South Street and from the Jordan River to Seventh East Street, thereby increasing its population to 10,500. The daytime population increases to about 40,000 due to the large commercial-industrial sector of the city.

E.2.3 Scenic quality rating of South Clive site

The BLM Visual Resource Inventory and Evaluation System (BLM, 1978) was used to rate the scenic quality of the site relative to the physiographic province. This rating system employs a scale of 0 to 33, with higher ratings (19 or above) indicating that special management attention is required. The numerical rating system is shown below, with the ratings for the South Clive site underlined.

Scenic Quality Rating

Category	Score		
	High	Medium	Low
Landform	5	3	1
Vegetation	5	3	1
Water	5	3	0
Color	5	3	1
Influence	5	3	0
Scarcity	6	2	1
Cultural Modification	2	0	4

The total score of 12 assigned to the South Clive Site is a low-to-medium rating for scenic quality, indicating that no special management attention is necessary.

E.2.4 Archaeologic, historic, and cultural significance of South Clive site

On August 24-26, 1981, an intensive cultural resource inventory of the South Clive site and vicinity was conducted by the Archaeological-Environmental Research Corporation. No cultural resource sites were identified during the inventory but one isolated artifact (designated 615A/X1) was found. This artifact is four pieces of broken purple glass from some unknown historic glass object. It does not appear that such a find indicates the existence on the site of significant archaeologic artifacts.

The Ground to Air Pilotless Aircraft Launch Site and Blockhouse listed in the National Register of Historical Places is approximately 10 miles west of Clive at Knolls. To the southeast of Clive (approximately 23 air miles) is the site of the Iosepa Settlement Cemetery. These are the historic sites closest to the transportation corridors between the Vitro site and the South Clive site.

E.3 SOCIOECONOMICS

E.3.1 Regional Population

According to the 1980 census (U.S. Department of Commerce, 1981), the state of Utah had a total population of 1,461,037 (Table E-2). This was an increase of 37.9 percent since 1970, the largest since the 1940-1950 decade when the population grew by 25.2 percent. Most of the state's population (80.4 percent) lived in urban areas (places of 2500 or more), predominantly in the Wasatch Front. The median age of Utah residents in 1980 was 24.2 years, lowest in the nation. The state's population growth between 1950 and 1960 was 95 percent from natural increase (births minus deaths), with only a small amount of inmigration (10,000 people). During the next decade, natural increase offset the outmigration of approximately 11,000, to increase the total population by 18.9 percent. "Baseline" population projections indicate that by the year 2000 the state could increase its total population to 2.3 million persons, 60 percent over that of 1980 (Utah State Planning Coordinator, 1981).

Table E-2. Historic population data

	Population (percent change from previous Census)				
	1940	1950	1960	1970	1980
State	550,310	688,862	890,627	1,059,273	1,461,037
	(8.4)	(25.2)	(29.3)	(18.9)	(37.9)
Tooele County	9,133	14,636	17,868	21,545	26,033
	(-2.97)	(60.3)	(22.1)	(20.6)	(20.8)
Salt Lake County	211,623	274,895	383,035	458,607	619,066
	(9.0)	(29.8)	(39.3)	(19.7)	(35.0)

Source: U.S. Department of Commerce, 1952, 1963, 1973, and 1981.

E.3.1.1 Local population and demography

Historic and current populations and trends are described in the following sections for the City of South Salt Lake, the area within 0.5 mile of the Vitro site, Tooele City, and Grantsville. The sources of demographic information are the decennial census counts, unless otherwise indicated.

City of South Salt Lake

The population of South Salt Lake decreased at an average annual rate of 2.0 percent during the 1960-1970 period, from 9520 in 1960 to 7810 in 1970. It then grew by an average annual rate of 3.1 percent during the 1970s, reaching 10,561 in 1980. In 1980, 92.6 percent of its population was classified as white,

compared to 94.3 percent for Salt Lake County and 94.6 percent for the state as a whole. South Salt Lake can be characterized as an area with small families, in life cycle stages either before or after the child-rearing stage. The proportion of families with incomes below poverty level in 1970 was 10.3 percent, higher than the statewide average of 9.2 percent.

Vitro site vicinity

Population counts were conducted for the area within 0.5 mile of the Vitro site by FBDU (1981). These counts indicated that 497 persons resided in the area, with average residential densities generally increasing with distance from the site. Average population density within 0.5 mile of the Vitro site was about one person per acre. Beyond 0.5 mile, density increased rapidly to 4.3 persons per acre within 2 miles.

Tooele City

Tooele City's population grew from 9133 in 1960 to 12,539 in 1970, an average annual increase of 3.2 percent. In the following decade the growth rate decreased to 1.3 percent per year, to a 1980 city population of 14,335. Nonwhite persons made up 8 percent of the city's population in 1980.

Tooele City's population was, on the average, older than the state's in 1970 (24.7 versus 23.1 years of age), and had a lower percent of persons over 64 years old (6.2 percent versus 7.3 percent for the state). A relatively high proportion of its population was married (69 percent of males versus 56.6 percent for the state) and its birth rate* (435) was about equal to the state average (436).

The average household size in Tooele City was 3.38 persons in 1970, slightly less than the statewide average. Thus, much of the city's population appears to be in the early child-rearing life cycle stage. Its population was slightly less educated (an average of 12.2 years of education) than the statewide average but far more educated than the national average. Only 4.8 percent of its families had incomes less than the poverty level. The County mortality rate decreased more rapidly than the birth rate during the 1970s, causing an increase in the net natural population. However, net outmigration during the 1970s (including annexation of land) caused a loss of 682 residents.

Grantsville

Grantsville's population grew by an average annual rate of 3.1 percent between 1960 and 1970, from 2166 to 2931 persons, and increased by 4.2 percent per year during the 1970s to a 1980 population of 4419. Only 4.2 percent of its population was nonwhite in 1980.

Grantsville's population had a high birth rate in 1970 (517 versus 436 for the state), a large average household size (3.71), a low proportion of population over 65, and a high proportion under 18. Thus, many Grantsville residents appear to be members of families in the early child-rearing life cycle stage.

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*Live births per 100,000 population.

E.3.1.2 Population projections

A growth rate averaging 3.1 percent is assumed most probable for Salt Lake County through the year 2005 because it corresponds to the growth rate of the County from 1970 to 1978. The development of synthetic fuels within the state, however, could create a short-lived rapid growth which should taper off. Assuming that rapid developments in the energy field occur, the growth rate could go up to "7.0 percent declining," meaning in 25 years the growth rate will taper off to zero (FBDU, 1981). A growth rate of 0.8 percent would be consistent with that of the entire United States.

It is projected that Tooele County will increase its population at an annual rate of 3.8 percent until 1985; thereafter, its growth rate will decline. This projection is based on expected energy development and subsequent employment opportunity that should also taper off. It is expected that the largest percentages of growth will occur in Tooele City, Grantsville, and Wendover (Mountain Area Planners, 1972).

E.3.2 Economic structure

The distribution of Utah's employment and income among industrial sectors indicates a well-balanced and healthy economy similar in structure to that of the United States as a whole. The state's most prominent employment sectors in 1979 were services with a 16.4 percent share of total wage and salary employment, government with a 24.0 percent share, retail trade at 17.0 percent, and manufacturing with 15.4 percent (U.S. Department of Commerce, 1981). Per capita income in 1979 was $7182, which placed Utah below both the Rocky Mountain state and national averages. During the 1970s, the economy grew and matured sufficiently to begin providing a nearly full range of goods and services to its residents without extensive dependence, as had been previously the case, on other regions in obtaining those goods and services (Utah State Planning Coordinator, 1981).

E.3.2.1 Regional economic conditions

The economies of Salt Lake and Tooele Counties, the two counties in the immediate project region, differ in structure although the two are classified as being in the same (Salt Lake City) Standard Metropolitan Statistical Area. Thus, the following discussion distinguishes the two counties.

Salt Lake County, which is the State of Utah's central economic area, exhibits the same general economic health as the state as a whole. Its unemployment rate in 1980 averaged 5.1 percent, compared to a 5.4 percent statewide average (Utah Department of Employment Security, 1980). As is true for the state as a whole, the County unemployment rate has been increasing since 1979. It was 6.0 percent in February 1981, 7.4 percent during 1982 and 7.5 percent as of May 1983. Based on an analysis of 1979 employment patterns by industrial sector, the County's export base consisted primarily of durable goods manufacturing, transportation and public utilities, wholesale and retail trade,

finance, insurance, and real estate, and services; the importance of these sectors underscores the County's role as the state's economic services center. Government employment is less prominent in Salt Lake County than in the state as a whole. Based on the 2.5 employment multiplier used by the Utah State Planning Coordinator's Office for the Wasatch Front planning area, the basic/nonbasic employment multiplier for Salt Lake County is estimated at approximately 2.5 jobs for every job created in the basic, or export, sector of the economy.

Tooele County's economy is based primarily on Federal employment. Employment at the Deseret Test Center and Army Depot were primarily responsible for the Federal government employment share of 49.7 percent of the total 1979 wage and salary jobs in the County. Mining is the second most important sector of the export base of the County, providing 7.3 percent of the wage and salary jobs. The major nonmanufacturing employers in Tooele County are the Tooele Army Depot (3800 employees), the Deseret Test Center (680 employees), the Tooele County School District (710 employees), and Anaconda Copper (665 employees). Major employers in the manufacturing, mining, and processing sectors are N.L. Industries (735 employees), Catalina Sportswear (75 employees), American Salt (70 employees), and Kaiser Aluminum and Chemical (65 employees). The mining and processing sector primarily produces magnesium, potash, salt, tin, lead, silver, zinc, and copper (Utah Industrial Development Information System, no date).

The remaining sectors of the Tooele County economy have far lower shares of total County employment than the state average, indicating that much of the income earned by workers in the basic sectors of the County is spent in other counties, particularly Salt Lake County. The basic to nonbasic employment multiplier for Tooele County, assuming that all Federal and mining employment, 75 percent of all employment in the manufacturing sector, and 10 percent of all state and local government employment can be classified as basic, is estimated at a total of 1.5 jobs for every job created in the basic sectors. This estimate of the county's multiplier is consistent with multipliers often estimated for rural areas with underdeveloped service economies.

Tooele County's unemployment rate remained close to 5.8 percent through 1980 and early 1981, having increased from 5.0 percent in 1979 (Utah Department of Employment Security, 1980). By contrast, the statewide unemployment rate for 1980 was 5.4 percent. Unemployment in Tooele County during 1982 was 9.9 percent. This compares to a figure of 7.8 percent for the entire state during 1982. Current (May 1983) unemployment rates for the State of Utah and Tooele County are 8.8 percent and 9.9 percent, respectively. Future unemployment rates in the county, which depend to a large extent upon employment at Dugway, are expected to moderate as Federal defense expenditures rise and the nationwide economy stabilizes.

Per capita income in Tooele County in 1979 was $6782, 94.4 percent of the statewide average (U.S. Department of Commerce, 1981). In 1974, per capita income in Tooele County exceeded the state average by 2.5 percent, and in 1969 the County had 6.0 percent more income per capita than the state. Thus, while per capita income in Tooele County has grown in real terms since 1969, its rate of growth has been significantly less than that for the state as a whole. Transfer payments represented 15.2 percent of Tooele County personal income in 1979, compared to an 11.7 percent statewide average. This is a reflection both of the

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higher proportion of elderly persons (and, therefore, social security income) in Tooele County than in the state, and the lower per capita income and hence higher per capita rate of welfare payments. In general, the economic data reveal that the Tooele County economy is stable due to Federal military employment but, like most rural areas in the state, it has a relatively high unemployment rate and underdeveloped secondary economy.

E.3.2.2 Local economic conditions

This section contains brief descriptions of the economies of towns and cities near the Vitro site and the South Clive site--the City of South Salt Lake, in which the Vitro site is located, and Tooele, Grantsville, and Wendover in Tooele County.

City of South Salt Lake

The economy of the City of South Salt Lake is based primarily in manufacturing, transportation, and wholesale and retail trade (Utah Department of Employment Security, 1980). Much of the manufacturing and warehousing in the Salt Lake City urban area is located in South Salt Lake. Major employers (Utah Industrial Development Division, no date) include the ZCMI Central Warehouse (695 employees) and EDO Western Corporation (270 employees). The city's proximity to major highways makes it an ideal location for warehousing and transportation oriented industry. The existence of significant amounts of vacant land in the city, primarily near the Vitro site, will permit further industrial/warehouse development uses for which the area is planned and zoned.

The large industrial tax base in South Salt Lake permits the city to levy a relatively low city property tax (the 1982 mil levy was 6.25). The city also has a sales tax of 0.75 percent which, in combination with a large taxable sales base ($254,513,460 in 1979), yields large revenues for the city (Utah Industrial Development Division, no date). Sales taxes are anticipated to yield about $2.2 million in revenue in the 1981-82 fiscal year, 64.7 percent of total city general fund revenues of $3,406,916. Property tax receipts are projected to total $465,000, 13.6 percent of all general fund revenues (City of South Salt Lake, 1981). The city will also receive about $399,000 in Federal revenue sharing monies.

City of Tooele

The economy of the city of Tooele, the economic and population center of Tooele County, closely resembles that of Tooele County. Principal employers in the city in 1979 were the U.S. Army Depot (3800 employees), Anaconda Copper (850 employees), Federal, state, and local offices (500 employees), the Tooele School District (400 employees), Tooele Valley Hospital (85), Catalina Sportswear (75 employees), and the Lake Point Salt Company (45 employees) (Utah Industrial Development Division, no date). Military, other governmental, and mining-related employment form the city's economic base. However, to the extent that the city functions as an economic center for the county, retail and wholesale trade and financial service employment also contribute to the city's economic base. Thus,

a portion of the income earned by residents of Tooele County is spent in Tooele City, adding to the city's employment. The city's total employment in May 1981 was estimated at 7412 or about 70 percent of the total county employment.

Several new industrial developments are planned for the city, chief among which is EMKO's industrial park, which includes 1783 acres and will be developed over the next 8 years. In addition, Getty Oil is planning a gold processing facility, to employ 250-300 persons, in Mercus, 15 miles south of Tooele. The Army Depot will also be increasing employment by 500 persons.

The city's 1981 property tax rate was 25.16 mils. With a citywide assessed valuation of $31,474,748, property tax billings for the tax year will be approximately $757,300. The city also has a sales tax of 0.75 percent, which is anticipated to bring in $470,000 in sales tax revenue (Tooele City Corporation, 1981).

Grantsville

Grantsville, located appromixately 34 miles from the South Clive site, had a 1980 population of 4419 (U.S. Department of Commerce, 1981). Grantsville's economy is based primarily on chemical manufacture and mineral mining and processing. The largest employer is NL Industries' Mineral Division, manufacturers of organic chemicals, with 725 employees (Utah Industrial Development Division, no date). Other major employers are Teddy Bear/Skyline, Inc., a food service company (80 employees), the American Salt Company (70 employees), the Tooele School District (65 employees), and U.S. Lime (45 employees).

Most of these firms, however, are not actually located within the city boundaries, as evidenced by the fact the State Employment Security Division estimated Grantsville employment at only 248 in May 1981. The city's property tax base is small, being approximately $7 million; hence, a relatively high tax rate of 23.77 mils is levied by the city, which is expected to yield about $167,000 in the coming year. No major industrial developments are foreseen to improve the property tax base.

In addition to the property tax base, the city receives sales tax revenues at a rate of 0.75 percent, which are expected to total about $45,000 in the 1981 fiscal year. With a planned city budget of $403,459 for 1982, miscellaneous intergovernmental transfers (such as returns from the state gas and liquor tax) and operating revenues (such as for water and sewer service and garbage collection) are, in sum, important revenue sources that help support city services. Services include police and fire protection, garbage collection, and water and sewer service.

E.3.3 Governmental structures

South Salt Lake, Tooele City, and Grantsville all have similar governmental structures, being governed by a mayor and five councilpersons. Likewise, both Tooele and Salt Lake Counties are governed by three elected county commissioners who make certain decisions, such as those concerning zoning, and oversee the provision of services in their respective counties. For instance, Salt Lake

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County provides flood protection and health services to the City of South Salt Lake but delegates to the city the responsibility for maintenance of county roads within the city. Special districts, though not governmental entities, are important in both counties, providing services such as sewage treatment and public education.

E.3.4 Housing

The total number of housing units in Tooele County increased from 6455 to 8566, an increase of 32.7 percent, between 1970 and 1980 (U.S. Department of Commerce, 1981). Housing unit supplies increased more rapidly than population, indicating a decreased average household size. Housing unit growth was greatest, percentage-wise, in the Grantsville area, at 64.8 percent but Grantsville's 1980 housing stock was still small at only 1348 units. The 1980 Census preliminary count indicated that 5 percent of all units in Grantsville were vacant. Wendover also experienced a housing stock growth from 278 to 409 units in the 1970-80 period, a 47.1 percent increase; this rate of growth was, however, still less than the statewide 55.2 percent average. Tooele City's housing stock grew by 26.5 percent to 4877 units. Actual 1980 vacancy rate data are not yet available from the Bureau of Census, but the preliminary count indicated approximately 5.3 percent of the units are vacant. The County averaged 3.23 persons per dwelling unit in 1980.

In all jurisdictions, residential building activity virtually stopped with the high interest rates of 1980-82.

E.3.5 Community services

This section focuses upon the demand for and supply of social services in the areas of concern (Tooele City, Grantsville, South Salt Lake, and Tooele County). The services described below include schools, police and fire protection, public water and sewer systems, health services, and general government.

E.3.5.1 Schools

Schools are provided at the county or district level.

Tooele County

Total enrollment in the Tooele County School District was 7011 students during the 1981-82 school year, 0.3 percent higher than the previous year (1980-81) and 2.5 percent higher than the second previous year (1979-80) (Tooele County Schools, 1981). It appears that enrollment will increase in the short-term future at about the same rate (1.2 percent per year) as in the recent past. In the short term, this rate of enrollment growth is not expected to cause physical capacity or fiscal problems since the system is not experiencing significant overcrowding and has some excess bonding capacity. A new elementary

school is being built in Grantsville to alleviate overcrowding and will be completed by the 1982-83 school year. If Wendover's casino sector grows as is rumored some crowding may ultimately result. District-wide per student operating costs were $1712 in 1981, and total per student costs were $2535.

City of South Salt Lake

Education in the City of South Salt Lake and other nearby areas is provided by the Granite School District, one of four districts in Salt Lake County. Total district enrollment was 61,485 in September 1981, only about 2360 of whom were residents of South Salt Lake. Overall district enrollment declined during the 1970s, but has recently begun to rise again. This gradual enrollment rise is expected to continue. The four schools that service the bulk of South Salt Lake, however, are expected to continue to have stable enrollments. No crowding problems exist or are expected in these schools. District-wide per student operating costs were $1769 in 1981, and total per student costs were $2241.

E.3.5.2 Tooele County social services

Tooele County is governed by three County Commissioners. Economic planning and development agencies are the Tooele County Planning Office, Tooele County Chamber of Commerce, and the Wasatch Front Range Council of Governments.

Police protection is provided to the unincorporated areas in the county by a sheriff and 14 deputies (an average of 2.0 officers per 1000 population), and by 20-member Jeep Patrol (Tooele County Chamber of Commerce, 1980). The county sheriff also directs the county volunteer fire department which has 18 fire trucks at 9 fire substations located in Vernon, Clover, Terra, Ophir, Stockton, Pine Canyon, Lake Point, Stansbury Park, and Grantsville.

The county's single hospital, with 36 beds, is located in Tooele City and has a low average occupancy rate of 35 to 38 percent. Other medical services include two health clinics, one mental health clinic serving out-patients on a 24-hour basis, a vision center and optometrists, a foot clinic, and a veterinary clinic. Ambulance service is provided for the county by one privately-owned company in Tooele with one ambulance and by three vehicles managed by Advanced Health Systems located in Grantsville. The Tooele Valley Rest Home is also located in Tooele City. It has 46 beds, a 100 percent occupancy rate, and a waiting list (Tooele County Chamber of Commerce, 1980).

The county operates one public library housing 48,786 volumes, two bookmobiles and a storage facility in Grantsville that is open to the public. The library has a 1981-82 appropriations budget of $73,350. Because this library services the entire county and has a high circulation rate per capita, some improvements are recommended (University of Utah Planning Program, 1981).

E.3.5.3 Tooele City social services

Tooele City is governed by a mayor and five city councilmen. It has one full-time licensed city engineer. Tooele City employs 22 full-time police

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officers (1.53 officers per 1000 population), 2 animal control officers, 4 dispatchers, and 1 records officer, and maintains 10 pieces of motorized equipment. A minimum of three patrolmen and cars plus at least one detective are on duty at any given time within a 24-hour period within the city limits. The city budget for police protection was $663,393 for the 1980-81 fiscal year and $723,438 for the 1981-82 year. Protection is considered adequate.

Tooele City has an all-volunteer fire department consisting of about 50 volunteers. Firefighting equipment includes one equipment truck, two 1500-gallon pumper trucks, one 1000-gallon pumper truck, and two 1500-gallon brush and grass fire trucks. Fire hydrants throughout the city limits are located every 800 feet. The 1980-81 fiscal year budget for fire protection was $90,238; for 1981-82 it increased to $123,172. Fire protection is considered to be adequate; the fire insurance rate classification within the city limits is 5 and outside the city limits the classification is 10. These classifications are determined by the American Insurance Association on a scale of 1 to 10, with 10 being lowest rating (Tooele County Chamber of Commerce, 1980).

Tooele's water system is city-owned and is supplied by wells and springs. The system has an above ground storage capacity of 7 million gallons (mg) utilizing two 2 mg tanks, one 2.5 mg tank, and one 0.5 mg tank. The city's well system consists of 5 wells with a total rated pumping capacity of 4250 gallons per minute (gpm), or 6.12 million gallons per day (mgd). Average daily use is approximately 2 mgd, but during the summer it ranges as high as 8 mgd which is above the rated capacity of the system. The city is currently investigating the purchase of water from outside sources. Tooele also has two irrigation companies. One is a pressure system that is dual to the culinary system. The other is a gravity flow system. To the north of Tooele are two small unincorporated communities, Erda and Stansbury Park. Water for both agricultural and domestic use is provided by flowing artesian wells. Five irrigation companies within the area (Tooele, Grantsville, and Stockton) provide water for agricultural use and domestic gardening within each city's limits.

Tooele's sewage treatment plant is a combination primary settling tank, trickling filter, and digester. A recent addition to the system, within the past three years, has brought its life expectancy to 20 years. Average peak use is 25 percent below capacity of 2 mgd.

E.3.5.4 Grantsville social services

Grantsville is governed by a mayor and five city councilmen. It employs one part-time licensed city engineer. Grantsville currently employs three full-time police officers and expects to hire a fourth in the near future for 0.9 officers per 1000 population. The department maintains four pieces of motorized equipment. The city budget for police protection is $122,000 for fiscal year 1981-82. According to the Grantsville Mayor, police protection is adequate.

Grantsville's fire department is manned by 30 volunteers. Firefighting equipment consists of 5 trucks, 4 pumpers, and 1 brush and grass fire truck. The American Insurance Association rate classification is 10. The fiscal year 1981-82 city budget for fire protection is $15,000.

Grantsville's water source is local wells and the water is untreated. Storage capacity is 0.725 mg and deliverable capacity is 1.96 mgd (Bureau of Economic and Business Research, 1980). The system is projected to be sufficient until 1990 or until a population of 5200 is reached (using 1320 connections). At that time the demand requirement will reach just over 2 mgd.

Based on 20 average water users and 9 high users, an engineering study indicated that a population of 3500 would require an average daily demand of 102,192 gallons per day (Engineering Associates, 1975).

Line improvements are currently being made to improve the water pressure. To decrease wasteful consumption, North Willow Irrigation Company is currently building a reservoir and will soon be piping irrigation water to customers in Grantsville.

The sewage-treatment plant utilizes an aerated lagoon system, with a design rate capacity of 0.6 million gallons per day (mgd). The average daily flow is 0.4 mgd. The system is currently deemed to be adequate until 1990; when built in 1970, the design capacity was for an expected ten years or adequate for a population of 3850. When needed, expansion of the evaporation ponds will be relatively easy as the city owns the adjoining land.

E.3.5.5 City of South Salt Lake social services

South Salt Lake is governed by a mayor and five councilmen. The city employs a part-time licensed engineer (Utah Industrial Development Division, no date).

The South Salt Lake Police Department employs 22 officers (2.0 officers per 1000 population) as well as a public relations specialist, lieutenant, and chief. It operates 17 vehicles and has 3 to 4 patrolmen on-duty at any hour, providing an average response time of 2-3 minutes. Its budget for fiscal year 1981-82 was $897,816, of which $727,326 (81 percent) is personnel-related expenses (salaries, benefits, training, uniforms, etc.).

The South Salt Lake Fire Department employs 16 men on a full-time basis and has 25 volunteers. Firefighting equipment includes two ladder trucks, two squad trucks, three pumper trucks and one utility/service truck. Response time is two to three minutes. The American Insurance Association rating for South Salt Lake is 5. The department's budget for 1981-82 fiscal year is $581,159.

South Salt Lake utilizes a gravity water system from six wells. Three wells flow directly into the system while the remaining require pressure pumps to circulate their water. The pressure required for this circulation is 64 to 84 pounds per square inch. The system's storage capacity and peak pumping capacity is 9 million gallons per day (mgd). The average pumping capacity is 5.5 mgd.

The sewage-treatment facility for South Salt Lake is a combination primary clarifier, trickling filter, and anaerobic digester. The design average flow capacity is 3 mgd. Current average flow is 2.4 mgd.

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Located immediately to the north of the Vitro site is the Salt Lake City Suburban Sanitary District No. 1 treatment plant. This system is biofilter primary sedimentation type with a design average flow capacity of 17.25 mgd. The Central Valley Water Reclamation Facility is currently building a new facility on the site utilizing a portion of the existing plant. Operation is planned for 1987. This plant will have a design average flow of 50 mgd and is expected to last until the year 2000. Once completed, this system will replace the South Salt Lake and the Salt Lake City Suburban District No. 1 plants as well as the 7.5-mgd Granger-Hunter District plant, the 8-mgd Cottonwood District plant, and the 4-mgd Murray City plant.

E.3.6 Transportation networks

The major transportation routes from the Vitro site to the South Clive site are defined in the following two sections. Annual average daily traffic counts for potential haul routes (borrow and tailings) were provided by the Utah Department of Transportation (1980, 1984).

E.3.6.1 Highways

The Vitro site is bounded on the south by 3300 South Street, which is Utah State Highway 171 and on the west by 900 West Street. State Highway 171 extends west through Granger and Hunter and ends at the intersection with State Highway 111 just south of Magna. 900 West Street runs north-south and intersects State Highway 201 (U.S. Alternate) approximately 1.75 miles to the north of Highway 171. State Highway 201 also runs east-west, passes Magna on the north and, 8 miles to the west, joins Interstate 80 that extends west past Clive (Figure E-4).

An automatic traffic recorder station located very near the Vitro site on State Highway 171 indicated an annual average daily traffic count of 24,850 in 1979. Near the new Interstate 215, the volume increased to about 32,000 and then to 34,385 near Granger. From just west of Granger, the volume decreased from 18,575 near Hunter to 13,790 near Magna at the intersection with State Highway 111. North of this intersection, the traffic volume on State Highway 111 between State Highways 171 and 201 averaged 8380. Just before joining Interstate 80, the volume on State Highway 201 was over 10,000.

To utilize the four-lane highway system from the Vitro site to Clive, the most logical route would be north on Interstate 15 to State Highway 201. However, traffic volumes are much higher using this route. At the intersection of I-15 and 3300 South Street, the average daily traffic count was about 24,850 vehicles in 1980. On I-15 the count was 102,230 just before the interchange with I-80 and then 123,015 just north of the interchange. Just west of I-15 on State Highway 201 the count was 67,670 and reduced to 41,700 about a mile west of I-215. By about half way to Magna from I-15 the count decreased further to 17,680, dropping again to 10,810 just before the intersection with State Highway 111. West of this intersection the volume was only 9720 and continued to become less (6060) before joining Interstate 80. On I-80, vehicle counts were 15,515 between the junction with State Highway 201 and the turnoff to Tooele (State

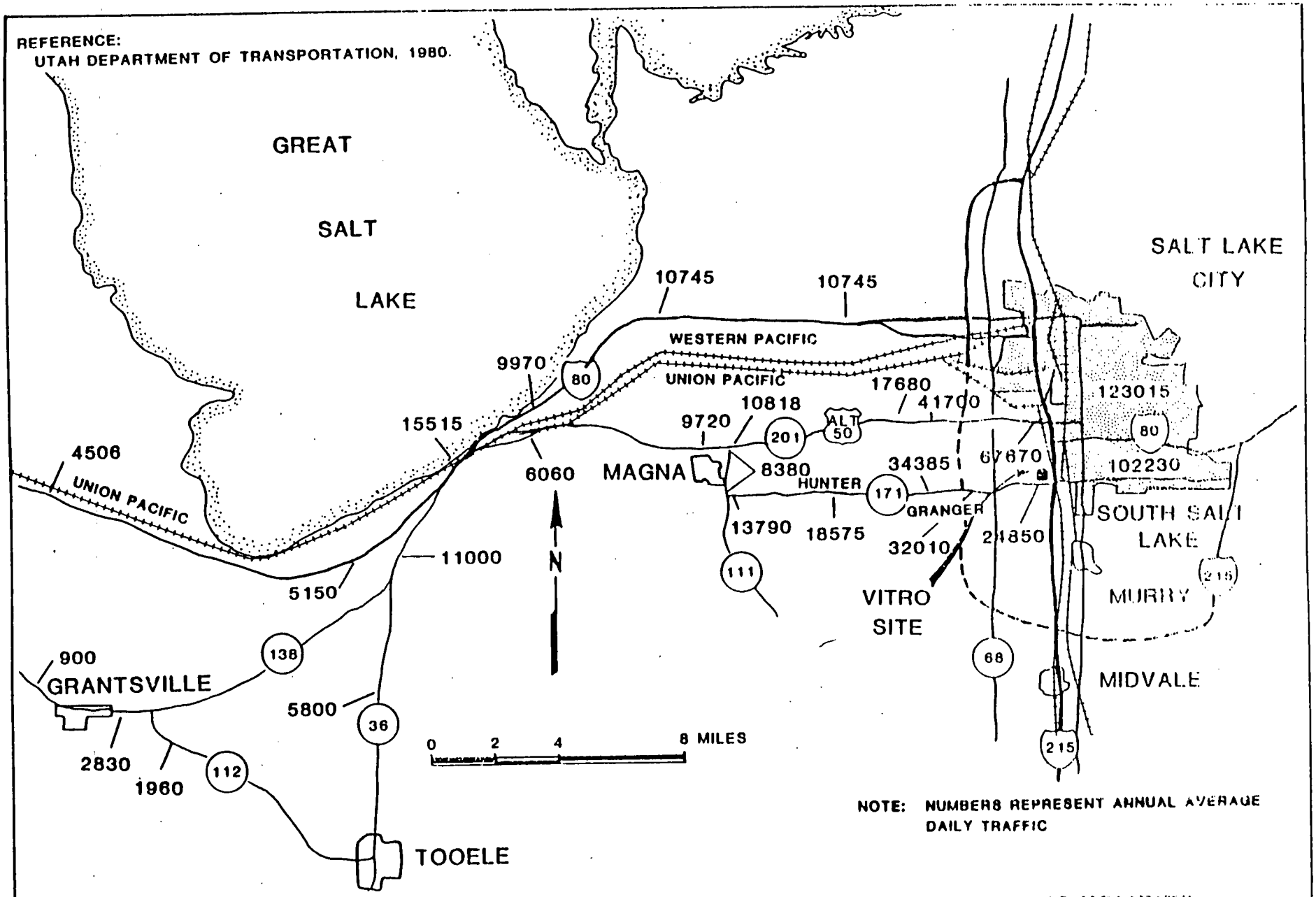

FIGURE E-4. TRANSPORTATION ROUTES AND TRAFFIC VOLUMES

Highway 36). Progressing westward, the traffic volumes continue to decrease; first, from 5150 to 4560 (to the north of Grantsville) and then to 3465 at Rowley Junction, another 10 miles distant. From here, and proceeding past Clive, the average volume remains constant at 3465 to Wendover.

E.3.6.2 Railroads

The Denver and Rio Grande Western Railroad forms the east boundary of the Vitro site. The tailings would be transported into Salt Lake City and then along the Union Pacific line to Clive.

E.3.7 Recreation

In 1975, the Institute for the Study of Outdoor Recreation and Tourism at Utah State University inventoried facilities for most types of outdoor recreation within the state of Utah.

In Tooele County, the greatest number of facilities were available for four-wheeling with open space, playgrounds, tennis courts, and softball fields next. Facilities available for picnicking and camping were also abundant, the Wasatch National Forests providing a total of 936 sites for outdoor activities such as fishing, hiking, camping and picnicking, and hunting (Utah Travel Council, 1979). State Parks within Tooele County include the Great Salt Lake State Park Saltair Beach, located 15 miles west of Salt Lake City, the Bonneville Salt Flats, and Danger Cave located near Wendover. The salt flats are listed in the National Register of Historical Places, being approximately 44,000 acres of the remains of ancient Lake Bonneville that at one time covered nearly one-third of the state. The salt flats' fame derives primarily from land speed record attempts at the Bonneville Race Track.

Recreational use of land within a 5-mile radius of Clive is limited to occasional recreational vehicle use and jackrabbit hunting. Jackrabbit hunting throughout the county is allowed any time without a permit or license. Hunting other game is allowed only seasonally and requires a permit or license. Off-road vehicle use near the site is rare because of the number of mud flats in the vicinity.

In Salt Lake County, facilities for softball, playgrounds, open space, soccer, tennis, and swimming are the most numerous with football, golf, and picnicking next. South Salt Lake has three parks for general picnic and recreation purposes and one ballfield, and borders a public golf course.

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Appendix F

Radiological Information

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RADIOLOGICAL INFORMATION

This appendix contains: (1) basic facts about radiation and its measurement useful for understanding the methods and calculations which follow, (2) a description of the methods used to calculate health effects of the various alternatives, (3) the data and calculations for the radioactive release source term represented by the various alternatives, and (4) estimates of the health effects of the occupational and population radiation exposures from the alternative remedial actions.

The radiation doses and health impacts for the general population and remedial action workers are addressed for each of the Vitro tailings site remedial action alternatives. The slightly increased doses received by these individuals can, in a statistical sense, increase the potential for individual and population health effects (excess fatal cancers) above those expected from normal causes. Assumptions made during the calculations of health effects for the general population and for remedial action workers are realistically conservative, in order to give a realistic upper limit for the excess cancers that might occur.

F.1 BASIC FACTS ABOUT RADIATION AND ITS MEASUREMENT

Atoms that spontaneously transform, or "decay," into new atoms are termed "radioactive." The decaying atom is called the "parent," and the atom produced by the transformation is called the "daughter." The rate at which atoms decay is the "activity" measured by the unit "curie." A more convenient unit for measuring the activity of radioactive atoms in tailings piles is the picocurie (pCi), which is one-millionth of one-millionth (1×10^{-12}) of a curie. The half-life of a radioactive substance is the time required for the radioactive substance to lose 50 percent of its activity by decay. Each "radionuclide" has a unique half-life.

When atoms undergo radioactive decay, they emit "radiation." The most common types of radiation are alpha particles, beta particles, and gamma rays. "Alpha" and "beta" radiation are tiny particles with excess energy, and "gamma" radiation is pure energy without mass. Radiation transfers energy to matter as it travels through matter. Alpha radiation penetrates only a few millimeters into matter and beta radiation penetrates a few centimeters, unlike gamma radiation which can travel deeper into matter in the same way as x-rays. Alpha radiation will not penetrate through a layer of skin, whereas gamma radiation has some probability of travelling through the whole body without transferring energy.

The amount of radiation to which an individual is exposed may be expressed in terms of the amount of energy imparted to cells and tissue by the radiation and the degree of biological damage associated with the energy as it is absorbed. This absorbed energy is termed the absorbed dose and is given in units of rads, where one rad equals 100 ergs of energy absorbed per gram of material irradiated. When the irradiated material is living tissue, the damage per rad varies depending on the type of radiation. By applying a "quality factor" to each specific type of radiation, the degree of biological damage can be expressed independently of the type of radiation causing it. The biologically relevant absorbed energy is termed the dose equivalent and the unit is the rem. One rad is equal to one rem for less damaging radiations where the quality factor is one (e.g., gamma rays). For comparison, one rad of internal alpha-deposited energy is equal to 20 rem because alpha particles are more damaging to tissue and the quality factor for alpha radiation is 20. The millirem equals one-thousandth (1×10^{-3}) of a rem and is in more common usage when expressing doses from environmental levels of radiation.

When a succession of radioactive parent atoms decay to radioactive daughter atoms, a "radioactive decay series" is formed. U-238 is such a radioactive parent atom and the U-238 decay series is shown in Figure F-1 (Lederer et al., 1967; BRH, 1970). The U-238 decay series includes Th-230, Ra-226, Rn-222 (radon), short-lived radon daughters, and other long-lived radioactive atoms. The U-238 decay series ends with Pb-206, an atom that is stable and not radioactive. When the daughters in a radioactive decay chain have shorter half-lives than the parent, the daughter activities will increase (termed "ingrowth"), until they equal the activity of the parent.

Radon is the radionuclide of primary importance to the UMTRA Project because it represents the largest radiation exposure pathway to the general

population. The half-life of radon (3.8 days) is short relative to the half-life of Ra-226 (1620 years). As Ra-226 decays, the newly produced radon will begin to decay, and the radon activity will become equal to the Ra-226 activity within 30 days. Similarly, the short-lived radon daughter activities will ingrow within 4 hours to equal the activity of radon. When the activities of the parent and its daughters are equal, the daughters are said to be in "100-percent equilibrium" or simply in "equilibrium." If the daughters are diluted or carried away as they are formed, they will not reach 100-percent equilibrium.

The only member of the U-238 decay series that is not a solid is radon. Radon is an inert gas and does not react chemically with other elements; it therefore can diffuse out of matter and into the atmosphere. Atmospheric radon concentration is measured in units of picocurie per liter (pCi/l). In the uranium milling process, Ra-226, the parent of radon, is left in the tailings, which then become a source from which radon diffuses into the atomosphere. Once in the atmosphere, radon is transported downwind and, according to its 3.8-day half-life, decays into the short-lived radon daughters which can attach to particulates in the air. Since radon is an inert gas, it is inhaled and exhaled, contributing very little radiation exposure to the lung. The radon daughters are solids, however, and once inhaled can deposit in or attach to the lung and then decay, transmitting alpha energy in the lung. Because of the short half-life, these daughters will decay before being removed from the lung.

Trace amounts of U-238 and its daughters are found everywhere on the earth; therefore, radon and its short-lived daughters contribute significantly to the background radiation exposure of the general population. Human exposure to radiation originates from both natural and man-made sources. The major natural radiations originate from cosmic and terrestrial external sources, and from naturally occurring radionuclides which are deposited inside the body via the ingestion and inhalation pathways. Exposure to man-made sources results primarily from medical exposures (e.g., diagnostic x-rays), with minor contributions from sources such as airline travel, atmospheric weapons tests, the nuclear power industry, consumer products, and technologically enhanced natural radiation (TENR).

Medical usage of radiation is responsible for the highest contribution to man's radiation exposure, accounting for approximatedly 50 percent of man's total radiation exposure. Other man-made contributors, including airline travel, atomospheric weapons tests, the nuclear industry, and consumer and industrial products together account for approximately 5 percent. The remaining 45 percent of man's total radiation exposure results from exposure to natural radiation sources.

The health effects attributed to a radiation dose are categorized into two general types: somatic and genetic. Somatic effects are manifested in the exposed individual (e.g., cancer) and genetic effects are manifested in the descendants of the exposed individual. The International Commission on Radiation Protection (ICRP, 1977) estimated the genetic effect to be less than the somatic effects; therefore, only risk of somatic effects are considered.

Nuclide	Historical name	Half-life	Major radiation energies (MeV) and intensities*		
			α	β	γ
$^{238}_{92}U$	Uranium I	4.51×10^{9}y	4.15 (25%) 4.20 (75%)	---	---
$^{234}_{90}Th$	Uranium X_1	24.1d	---	0.103 (21%) 0.193 (79%)	0.063c* (3.5%) 0.093c (4%)
$^{234}_{91}Pa^{m}$	Uranium X_2	1.17m	---	2.29 (98%)	0.765 (0.30%) 1.001 (0.60%)
99.87% | 0.13%					
$^{234}_{91}Pa$	Uranium Z	6.75h	---	0.53 (66%) 1.13 (13%)	0.100 (50%) 0.70 (24%) 0.90 (70%)
$^{234}_{92}U$	Uranium II	2.47×10^{5}y	4.72 (28%) 4.77 (72%)	---	0.053 (0.2%)
$^{230}_{90}Th$	Ionium	8.0×10^{4}y	4.62 (24%) 4.68 (76%)	---	0.068 (0.6%) 0.142 (0.07%)
$^{226}_{88}Ra$	Radium	1602y	4.60 (6%) 4.78 (95%)	---	0.186 (4%)
$^{222}_{86}Rn$	Emanation Radon (Rn)	3.823d	5.49 (100%)	---	0.510 (0.07%)
$^{218}_{84}Po$	Radium A	3.05m	6.00 (~100%)	0.33 (~0.019%)	---
99.98% | 0.02%					
$^{214}_{82}Pb$	Radium B	26.8m	---	0.65 (50%) 0.71 (40%) 0.98 (6%)	0.295 (19%) 0.352 (36%)
$^{218}_{85}At$	Astatine	~2s	6.65 (6%) 6.70 (94%)	? (~0.1%)	---
$^{214}_{83}Bi$	Radium C	19.7m	5.45 (0.012%) 5.51 (0.008%)	1.0 (23%) 1.51 (~0%) 3.26 (19%)	0.609 (47%) 1.120 (17%) 1.764 (17%)
99.98% | 0.02%					
$^{214}_{84}Po$	Radium C'	164μs	7.69 (100%)	---	0.799 (0.014%)
$^{210}_{81}Tl$	Radium C"	1.3m	---	1.3 (25%) 1.9 (56%) 2.3 (19%)	0.296 (80%) 0.795 (100%) 1.31 (21%)
$^{210}_{82}Pb$	Radium D	21y	3.72 (.000002%)	0.016 (85%) 0.061 (15%)	0.047 (4%)
$^{210}_{83}Bi$	Radium E	5.01d	4.65 (.00007%) 4.69 (.00005%)	1.161 (~100%)	---
~100% | .00013%					
$^{210}_{84}Po$	Radium F	138.4d	5.305 (100%)	---	0.803 (0.0011%)
$^{206}_{81}Tl$	Radium E"	4.19m	---	1.571 (100%)	---
$^{206}_{82}Pb$	Radium G	Stable	---	---	---

FIGURE F-1
URANIUM 238 DECAY SERIES

F.2 METHOD OF ANALYSIS

Radiation and its associated health effects have been studied more thoroughly than health effects from other carcinogenic agents. The evaluation of health effects caused by low-level radiation is, however, a difficult task, and many uncertainties are associated with the estimation of risks from radiation. The traditional approach for estimating risks from low-level radiation exposures is to extrapolate from effects observed at high radiation exposures using the linear dose-response and no threshold assumptions. Synergistic effects of other health effect agents (e.g., chemicals), are not considered in this analysis.

There are five principal pathways which could potentially result in exposure of man to radiation from the tailings pile. These are (1) inhalation of radon daughters; (2) direct exposure to gamma radiation emitted from the contaminated area; (3) inhalation and ingestion of airborne radioactive particulates; (4) ingestion of ground and surface water contaminated with radioactive materials; and (5) ingestion of contaminated foodstuff produced in areas contaminated by tailings. For calculations of health effects in this appendix, only the most significant radiation exposure pathways are considered; they are inhalation of radon daughters and direct exposure to gamma radiation. Analyses for the latter three radiation exposure pathways lead to doses that are much smaller (several orders of magnitude) than doses from radon daughter inahlation and direct gamma radiation. The latter three radiation exposure pathways are not considered in this analysis.

The health effect estimations made in this appendix are primarily based on data and models presented in the BEIR-III report (NAS, 1980). Quantitative risk estimation of somatic effects for various organs of the body can be obtained using available human radiation exposure data. The manifestation of a cancer caused by radiation exposure would occur after a latent period of up to 25 years, depending on the type of cancer and the age of the person exposed. The risks from radiation will vary with adult age and sex, but are presented as average values where variation due to adult age and sex is small. No data are available that indicate whether risk estimates for adults are appropriate for radiation exposure during childhood. Because the BEIR-III report does not always make firm recommendations for application of the data, health risk estimates in this appendix also make use of recommendations published in scientific journals.

F.2.1 Health effects of exposure to radon daughters

The health effects of radon diffusion from tailings arise from inhalation of the short-lived radon daughters which then deposit energy from alpha particles in the lung. For radiation protection purposes, the ICRP (1977) proposed an individual lung-cancer risk factor of 20×10^{-6} per rem, or 20 excess cancer deaths where one million individuals each receive a one-rem lung dose equivalent from radon daughters.

Other standards-setting organizations express the excess risk of lung cancer based on the lung collective dose equivalent in person-working-level months (person-WLM). The unit of working level (WL) is defined as any

combination of short-lived radon daughters in one liter of air which, on complete decay, gives a total emission of 1.3×10^5 million electron volts of alpha radiation. One WL is equivalent to 100 pCi of radon per liter of air with the short-lived radon daughters in 100-percent equilibrium. At equilibrium levels less than 100 percent, the WL corresponding to a given radon concentration is reduced. The working-level month (WLM) is a unit defined as the exposure resulting from the inhalation of air with a concentration of 1 WL of radon daughters for 170 working hours. The total dose of one or more persons is the product of the number of persons and the average dose they receive; the unit for the measurement of such a population dose is the person-WLM.

Some of the estimates of excess fatal lung cancers given in terms of person-WLM follow. The United Nations Scientific Committee on the Effects of Atomic Radiation quoted a range of 200 to 450 x 10^{-6} deaths per person-WLM (UNSCEAR, 1977), while the NRC in its environmental impact statement on uranium milling quoted 360 x 10^{-6} deaths per person-WLM (NRC, 1980b). The BEIR-III report formulated an age-dependent model for predicting the risk of lung cancer based on several studies of uranium and fluorspar miners. Evans et al., (1981), reviewed the BEIR-III study, lung-cancer risk estimates published by other authors, and epidemiological evidence. They concluded that the most defensible upper-bound to the lifetime lung-cancer risk for the general population is 100 x 10^{-6} deaths per person-WLM.

The BEIR-III committee reported the conversion factor that one WLM is approximately equal to a 5-rem dose equivalent commitment to the lung. The risk estimate of 100 x 10^{-6} deaths per person-WLM is therefore equivalent to the ICRP risk estimate, 20 x 10^{-6} deaths per person-rem, which is used in this appendix.

To estimate the radon daughter concentrations breathed by the general population and remedial action workers, two methods are used: (1) atmospheric dispersion calculations for radon released from the tailings pile (the MILDOS computer code was used, see Section F.3), and (2) long-term measurements of atmospheric radon concentrations around the Vitro tailings site (see Section F.3).

In order to convert measured or modeled radon and radon daughter concentrations in air to rem of dose equivalent commitment, the following conversion factor was developed assuming a conservative 25 percent equilibrium of radon daughters both on the pile and within 1 km of the pile:

$$7.4 \times 10^{-5} \text{ (rem/(hr x pCi/l))}.$$

This is derived from the calculation

$$\frac{5 \text{ rem}}{\text{WLM}} = \frac{5 \text{ rem}}{\text{WLM (170 hr/M)(100(pCi/l)/WL)}} = \frac{2.94 \times 10^{-4} \text{ rem}}{\text{hr x (pCi/l)}} \text{ (at 100\% eq.)}$$

$$\text{or, } = \frac{7.4 \times 10^{-5} \text{ rem}}{\text{hr x (pCi/l)}} \text{ (at 25\% eq.)}$$

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F.2.2 Health effects of exposure to gamma radiaion

Tailings piles emit gamma radiation that delivers an external exposure to the whole body of people near the pile. The BEIR-III report contains several models for estimating cancer risk resulting from exposure to gamma radiation. Health effect estimates in this appendix for excess cancer deaths due to gamma radiation use a risk factor of 120×10^{-6} deaths per person-rem (NAS, 1980; Cohen, 1981). This is equivalent to 120 excess cancer deaths in an exposed population for each 1,000,000 person-rem of collective dose equivalent. A person-rem is the product of the radiation dose equivalent multiplied by the number of people receiving that dose equivalent.

Health effect estimates for gamma radiation exposure were performed for remedial action workers and for the general population within 1 km from the tailings site. The contribution from the tailings pile to gamma radiation levels becomes negligible beyond approximately 1 km from the tailings pile perimeter. A health effect analysis was done for the general population and remedial action workers to determine gamma radiation impacts during transportation of tailings material in the relocation alternative actions.

For gamma radiation, 1 rem is approximately equal to one roentgen (R) which is the unit for measuring gamma-radiation intensity in air. A microroentgen (microR) is 1×10^{-6} R, and typical environmental gamma radiation levels are expressed in microR/hr.

The ICRP (1977) reported that the average risk estimated for genetic effects, as expressed in the first two generations and considered genetically significant, is 40×10^{-6} per rem. For all subsequent generations, the risk is estimated to be equal to that expressed in the first two generations. The total genetic risk (all generations) is, therefore, 80×10^{-6} per rem. This is sufficiently similar to the somatic risk estimate so that protection of the individual against somatic effects will ensure adequate protection against genetic effects.

The gamma radiation exposures on and around the Vitro tailings pile are estimated from direct measurements and from the radium-226 content of the tailings. The exposures to workers takes account of substantial shielding offered by the working environment.

F.3 SITE RADIOLOGICAL CHARACTERISTICS

In this section the data concerning the environmental radiation conditions of the Vitro pile, the areas around the Vitro site, the South Clive site, and the transportation corridor are described.

F.3.1 Existing pile characteristics

The Vitro site is a 128-acre tract located about 4 miles southwest of downtown Salt Lake City, Utah. As described in Appendix A, there are approximately 2.3 million cubic yards of uranium mill tailings, rubble, sewage sludge, and other mill wastes on the site. An additional 0.15 million cubic yards of windblown and other off-site contaminated materials will be included in the final stabilization (Table A-1, Appendix A).

The tailings materials are located in three roughly rectangular areas, designated as the northwest (NW), southwest (SW), and southeast (SE) tailings. The original mill location is a triangular area to the east of the SE tailings, which is also contaminated and included in the volume estimates above. The Central Valley Water Reclamation Facility (CVWRF) sewage treatment plant No. 1 is situated to the north of the SE tailings and east of the NW tailings. A descriptive map of the Vitro site showing the approximate locations of the three tailings areas, the original mill site, and the CVWRF plant is presented in Figure 1-2 of the main text.

The cross sections of the three main piles (NW, SW, and SE tailings) are variable and their overall dimensions (average areas and thicknesses) are not uniformly reported (FBDU, 1981; ORNL, 1977; Martin et al., 1980; Schiager, 1974). Martin et al. reported 90 acres of tailings, Schiager 93 acres, and ORNL 117 acres. FBDU (1981) did not give an area for the tailings, but stated that the site is 128 acres. For the source term calculations, 128 acres was chosen as the area to be remediated.

Depths of the tailings on the bulk of the site were reported to vary from 6 to 17 feet (Martin et al., 1980) but the more recent data of Mountain States Research and Development, Inc. (MSRD, 1982) indicate the range may go as much as 40 feet deep on the SE pile. The bulk of the material is in the SE pile, which appears to be the thickest. Based on the MSRD sampling program, it appears that a reasonable average for the depth of contaminated material beneath the site is 2 feet (MSRD, 1982; Brewer et al., 1982).

Physical characteristics

Physical characteristics of the tailings are described by Martin et al., (1980) and by MSRD (1982). The NW tailings consist mainly of medium to fine sands. The SW and SE piles contain mostly fine sands with varying proportions of slimes. The site average tailings moisture content is 20 percent, with the contaminated material beneath the site averaging 23 percent (MSRD, 1982).

An average tailings moisture content of 20 percent was assumed for the in-situ condition. If the tailings materials are moved to the South Clive disposal site, it is reasonable to expect that the moisture content will be lower. The NRC (1980a) reports data indicating that nonclayey soils would be

expected to retain 6 to 10 percent moisture, and that clayey soils would retain 9 to 12 percent moisture or more. Soil tests indicate that Vitro tailings could retain more moisture than this. Nevertheless, lacking site-specific data, a value of 10 percent was assumed as a reasonable generic value for long-term tailings moisture retention at the South Clive site.

In-situ densities are on the order of 1.4 g/cm^3. Results of standard Proctor tests indicate that maximum densities of 1.6 to 1.8 g/cm^3 would be obtained for the sandier materials at 10 to 16 percent moisture content. The maximum densities for the finer materials would be about 1.5 g/cm^3 at 20 to 30 percent moisture. Most field samples were at 75 to 85 percent of the maximum Proctor density (FBDU 1981). A tailings density of 1.6 g/cm^3 was used in this appendix for stabilized tailings.

The radon emanation coefficient is the fraction of radon produced within the soil or tailings grains that is released to the interstitial pore spaces. Vitro tailings samples analyzed at LASL (1981) ranged from 0.12 to 0.20. The NRC (1979) reported a measured value of 0.2 for Vitro tailings and considered this to be a good generic value for tailings. An emanation coefficient of 0.20 was used in this appendix.

Radionuclide content

The principal isotopes of concern in assessing the radiological impacts of the proposed alternatives are U-238, Th-230, and Ra-226. Concentrations of other isotopes may be estimated based on these three radionuclides and the assumption of secular equilibrium. Although many estimates of the radionuclide contents of the Vitro tailings have been made (FBDU, 1981; ORNL, 1977; LASL, 1981; Schiager, 1974), the values used in this appendix are based on the statistically designed drilling and sampling program of MSRD (1982). Additional work using MSRD samples has been done by Sandia (1982a) and Bendix (1983).

MRSD (1982) found a site average of 0.014 percent uranium (U_3O_8) in the tailings. This corresponds to about 40 pCi/g of U-238, based on 104 boreholes sampled every 2.5 feet. This concentration is at the low end of the ranges of previously reported values, 20 to 107 pCi/g, (FBDU, 1981; ORNL, 1977; LASL, 1981) but is based on the most complete data available.

The Ra-226 concentration in the material on the site averages 560 pCi/g based on 181 samples from 66 of the 104 boreholes drilled by MSRD. The Ra-226 analyses were done by Bendix Field Engineering (Bendix, 1983) on all samples of sufficient volume that remained from the sampling program. This is in the range of previously reported values, 100 to 2000 pCi/g (FBDU, 1981; ORNL, 1977; Schiager, 1974; LASL, 1981), and is based on the most complete data available.

A Th-230 concentration of 560 pCi/g may be estimated assuming the Ra-226 is in secular equilibrium. Other information indicates the Th-230 concentration is perhaps 30 percent lower than this (LASL, 1981), probably due to extraction during the acid leach process. The value 560 pCi/g is used in this report as a conservative estimate.

In summary, the radionuclide concentrations used in this appendix are 560 pCi/g for Ra-226, 560 pCi/g for Th-230, and 40 pCi/g for U-238.

Radon flux

Radon flux at the Vitro site has been measured or calculated by various groups. Short-term flux measurements by ORNL (1977) averaged 320 pCi/m^{2}s, although ORNL also calculated a flux of 550 pCi/m^{2}s based on Ra-226 content of the material. Schiager (1974) reported values that, when weighted by the area of the source, yield an average of 400 pCi/m^{2}s; although he assumed a value of 350 pCi/m^{2}s. FBDU (1981) reported a measured range of 19 to 440 pCi/m^{2}s and an area-weighted average of 250 pCi/m^{2}s, but used a calculated value of 600 pCi/m^{2}s in estimating the health effects. The NRC (1979) reported radon flux-to-radium concentration ratios of 0.35 for wet tailings, and 1.2 for dry tailings in units of pCi/m^{2}s radon flux per pCi/g of Ra-226; however, the NRC prefers a generic value of 1.0 for this ratio. Based on the above estimated average radium concentration of 560 pCi/g, an assumed radon flux-to-radium concentration ratio of 1 gram per square meter-second would yield a radon flux of 560 pCi/m^{2}s. This value will be used in this appendix.

Radon in air

On-site, ambient air radon concentrations are needed to estimate exposures of workers during remedial action. Long-term radon concentration measurements made around the Vitro pile (see Section F.3.2.1) show high values at the edge of the pile of 4 or 5 pCi/l. Assuming isotropic winds, it could be argued that a reasonable value for the interior of the pile would be about 10 pCi/l on the long-term average.

Schiager (1974) estimated, for very conservative conditions, that the radon concentration might average 6.8 pCi/l. However, his estimate was based on a flux of 350 pCi/m^{2}s Rn-222 rather than the 560 pCi/m^{2}s indicated above. The comparable estimate is thus 11 pCi/l.

Based on the available information, it is believed that 30 pCi/l is a conservative upper bound for the long-term average radon concentration in air on the Vitro pile.

F.3.2 Environmental radiation measurements

The environmental radiation levels for the area surrounding the Vitro site and the South Clive site have been studied (EPA, 1975; FBDU, 1981; ORNL, 1977; ANL, 1983a), and are summarized here.

F.3.2.1 Vitro site environmental radioactivity

Airborne particulates

Radioactive airborne particulate concentrations were measured in the vicinity of the tailings pile at the Vitro site by the EPA (1975). The average airborne radionuclide concentrations were determined at the CVWRF sewage-treatment plant for a one-year sampling program during which 26

consecutive two-week samples were collected and analyzed (ORNL, 1977). Average concentrations of the nine radionuclides reported at this location ranged from 6.5×10^{-5} pCi/l (Po-210) to 2.5×10^{-8} pCi/l (U-235) and are presented in Table F-1.

Table F-1. Radioactive airborne particulate concentrations at the Central Valley Water Reclamation Facility

Radionuclide	Concentration (pCi/l)	Reference concentration[a] (pCi/l)
Uranium-238	2.0×10^{-7}	3×10^{-3}
Uranium-235	2.5×10^{-8}	4×10^{-3}
Uranium-234	2.2×10^{-7}	4×10^{-3}
Thorium-232	6.4×10^{-8}	1×10^{-3}
Thorium-230	8.8×10^{-7}	8×10^{-5}
Radium-228	1.7×10^{-6}	1×10^{-3}
Radium-226	1.8×10^{-6}	2×10^{-3}
Polonium-210	6.5×10^{-5}	7×10^{-3}
Lead-210	1.0×10^{-5}	4×10^{-3}

[a]The smaller of the two concentrations for soluble and insoluble particulates in air given in 10 CFR Part 20, Appendix B, Table II, Column 1.
Source: ORNL, 1977.

Radon in air

Ambient-air Rn-222 concentrations have been measured and calculated for the area surrounding the Vitro pile (FBDU, 1981; ORNL, 1977; Shearer and Sills, 1969). Previous estimates indicated 7 pCi/l Rn-222 at about 0.1 mile from the edge of the pile, decreasing to 0.38 pCi/l at about 1 mile from the pile edge. These were short-term measurements, and have been improved on by more recent long-term measurements by Monsanto (1983). Beginning in January 1982, an ambient radon monitoring program in the Vitro site vicinity began which ran for 18 months at 40 locations. Weekly average radon concentrations were measured with Passive Environmental Radon Monitors (PERMs). The locations of the monitors and results of the measurements are shown in Figure F-2. The contour lines indicate isopleths of the 18-month average radon concentration. The concentration field is a result of the radon released from the site and its subsequent atmospheric dispersion, on an average basis. The background radon concentration of about 0.25 pCi/l is approached at an excess of a mile from the site. The maximum concentrations are the 4 to 5 pCi/l at the pile edges.

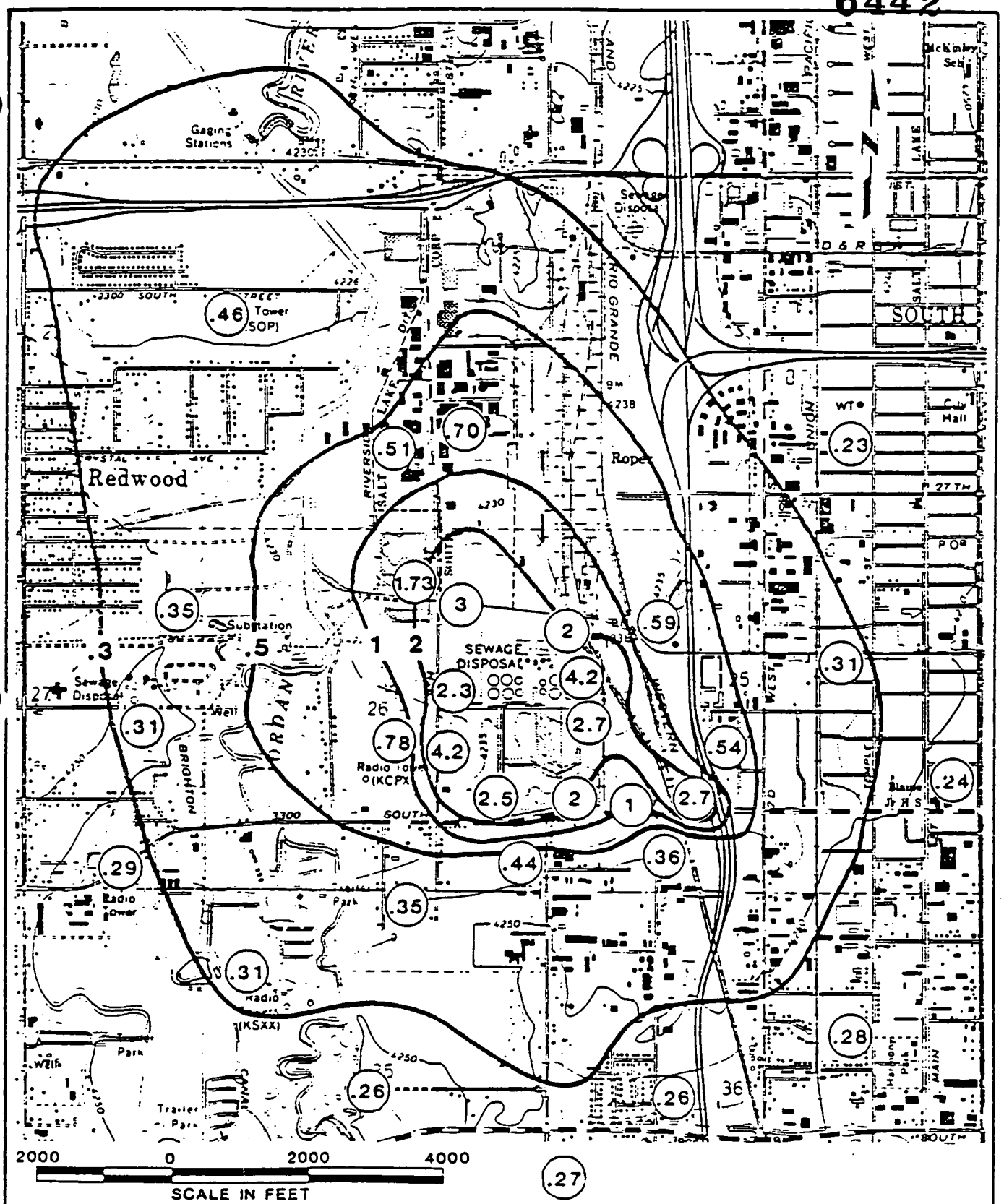

FIGURE F-2
LOCATION AND MEASUREMENT RESULTS, PERMS

Gamma radiation

Gamma radiation exposure rates have been measured around the Vitro tailings piles by FBDU (1981). They presented data reproduced here as Figure F-3, but the location of the edge of the tailings and the direction in which the data were taken were not given. In a study of Salt Lake City, the background gamma radiation exposure rate was found to be 12 microR/hr, with a range from 9 to 17 microR/hr. The contribution of the tailings piles becomes negligible at about 1 km (0.6 mile) from the perimeter of the pile, based on Figure F-3. This is much closer to the pile than the distance over which the radon releases influence atmospheric radon concentrations.

Soil and sediment radioactivity

Background concentrations of radionuclides in soils have been measured in and around Salt Lake City by a number of investigators (ORNL, 1977). Results are generally comparable and are typified by the ORNL results, which indicate the following values (geometric mean plus or minus geometric standard deviation): Ra-226, 1.5 $\pm$ 1.2 picocuries per gram, and U-238, 2.0 $\pm$ 3.6 picocuries per gram. In addition, soil samples were collected by ORNL (1977) from 58 locations within about 400 to 1000 meters of the (south) tailings pile. Samples were collected at the surface and at one-foot depth and were analyzed for Ra-226. Concentrations in surface samples ranged from background levels (about 1 pCi/g) away from the pile to 560 pCi/g of Ra-226 near the pile. Samples obtained from the one-foot depth ranged from background to 460 pCi/g of Ra-226.

Sediment samples from the Jordan River, Mill Creek, and the Vitro drainage ditch were collected and analyzed for U-238, Th-230, Ra-226, and Pb-210 (ORNL, 1977). Results showed no contamination in Jordan River sediments, and slightly elevated levels (roughly twice estimated background) in Mill Creek sediments. The drainage ditch sediments, however, were shown to contain relatively elevated concentrations of all three radionuclides. Ra-226 concentrations range from 60 to 120 pCi/g, while Th-230 concentrations ranged up to 284 pCi/g, which was higher than any other reported radionuclide.

Radionuclides in biota

The concentration and uptake of radioactive elements by plants and animals was qualitatively investigated by FBDU (1981). Based upon this preliminary study, the contribution of biota to human exposures as a result of uptake of radionuclides originating in the tailings was found to be negligible compared to the major pathways of inhalation and direct radiation exposure. The uptake of radioactive elements by plants and their subsequent concentration in the food chain is not an important pathway because there is little actively-cultivated land near the Vitro site; the 220 acres of agricultural property within 0.5 mile of the site are mainly located upwind from the site and, therefore, receive no windblown material; the small amount of agricultural land within 1500 feet of the site that may receive some windblown contamination would be cleaned up during the vicinity property remedial actions if the levels of radioactivity in surface soils exceeded EPA standards. Consequently, the food-chain pathway was not considered in this assessment.

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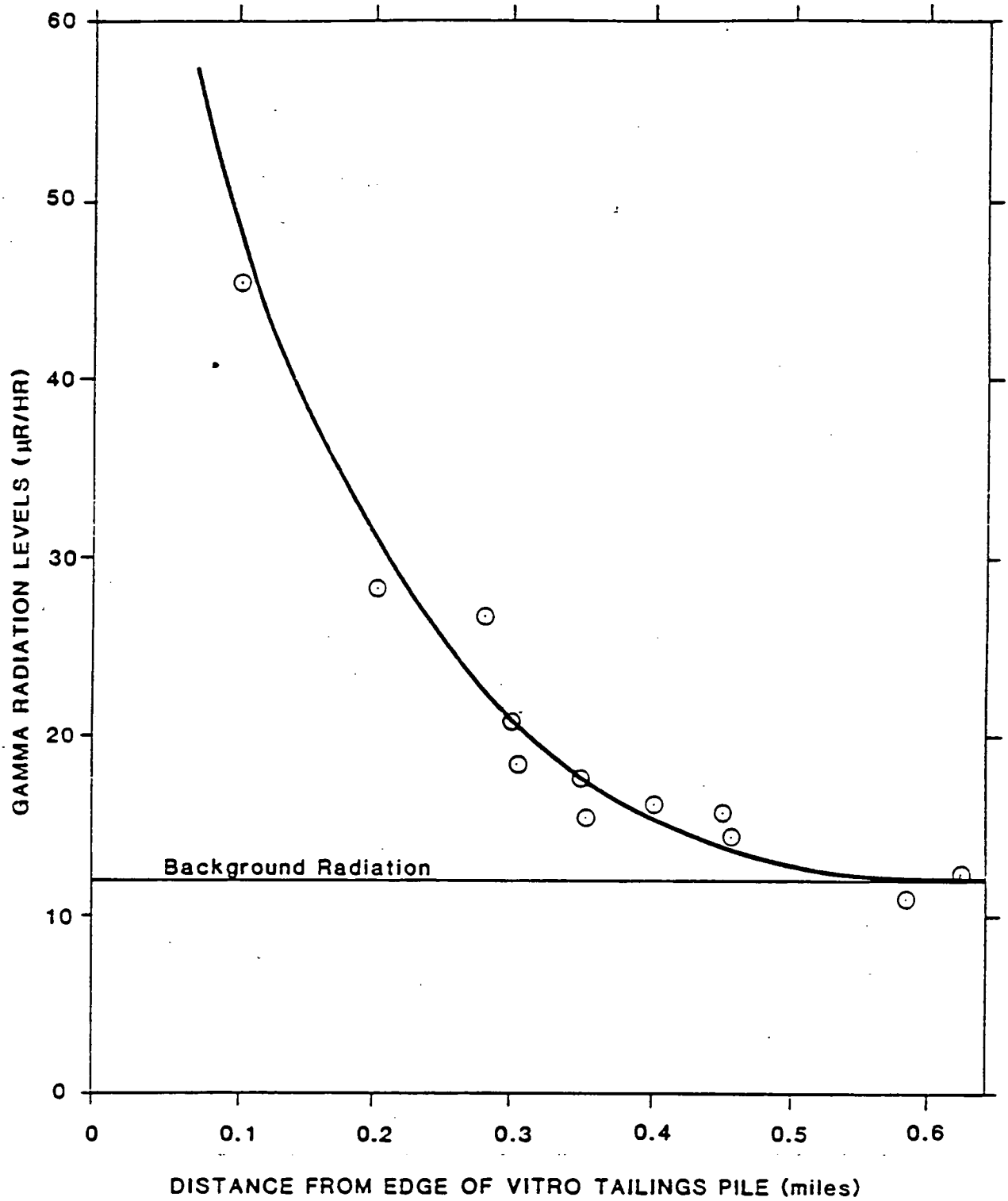


Reference: FBDU, 1981

FIGURE F-3
EXTERNAL GAMMA RADIATION LEVELS AS A FUNCTION OF DISTANCE FROM THE TAILINGS PILE

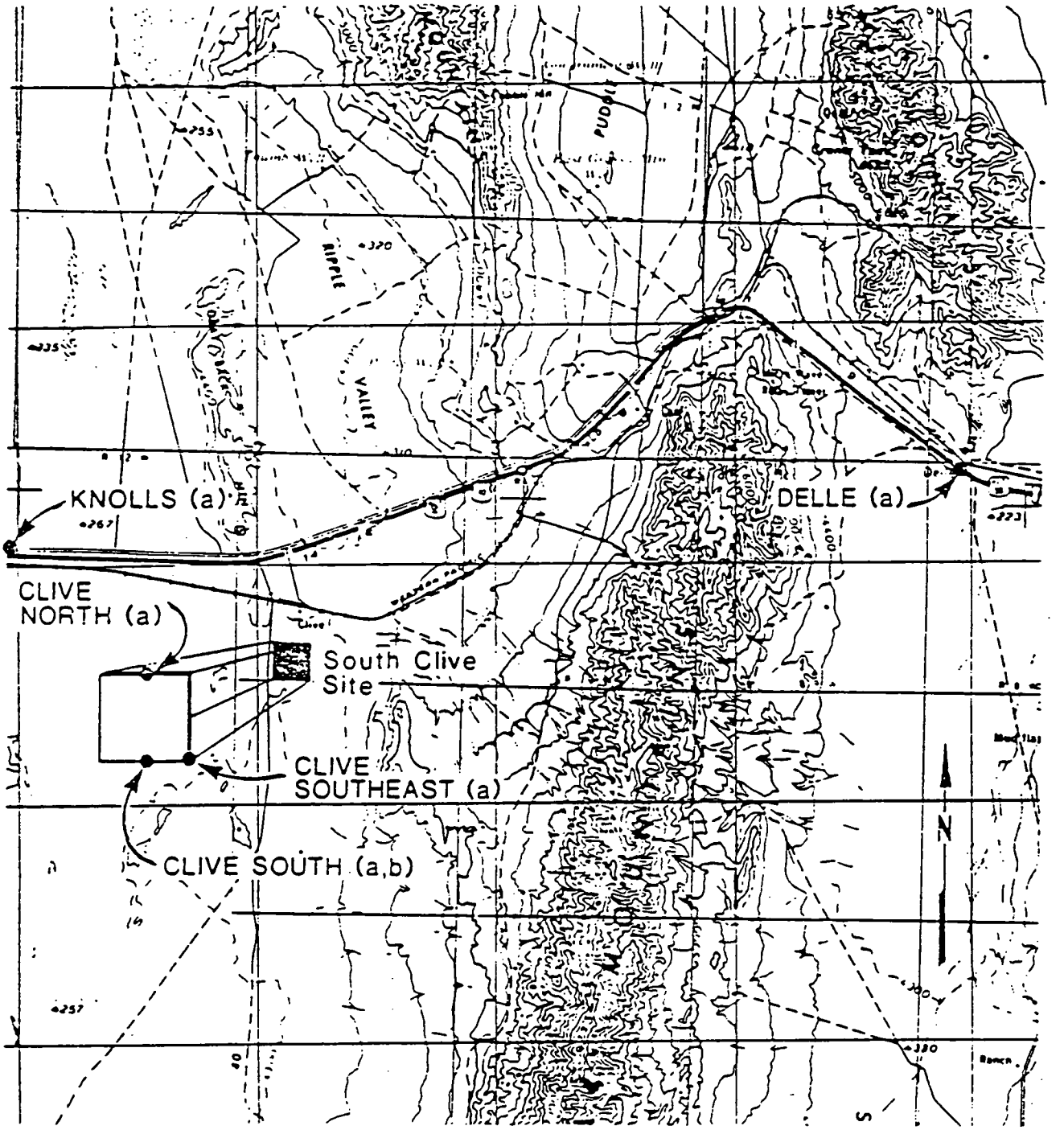
F.3.2.2 South Clive site environmental radioactivity

Radiation levels currently existing at the South Clive site have been determined from monitoring programs conducted by Dames & Moore and Argonne National Laboratory (ANL). The data presented below are the result of three months of monitoring (December 1981 to February 1982). The environmental characterization program included measurement of the radionuclide content of airborne particulates, ambient radon concentrations in air, gamma radiation exposure rates, and radionuclide concentrations in surface soils, vegetation, and animals.

The radiological environmental sampling program formulated for South Clive is summarized in Table F-2, and the sampling locations are identified in Figure F-4. Surface and ground waters were sampled (when present) and analyzed as part of the water quality program (Appendix D). The lower limits of detection for the environmental radiological monitoring program were sufficiently sensitive to meet the specifications of the US NRC (NRC, 1980a).

Table F-2. Summary of radiological sampling program

Sampling	Method	Number of sampling points	Frequency
Air particulate	Eberline Model RAS-1 regulated air samplers	5	continuous
Ambient air radon-222	Eberline Model RGM-2 radon Gas monitors	5	continuous 7-day periods (quarterly)
	Track-etch	5	continuous
Radon flux	Charcoal cannister	9	24-hr periods 3 times/year (spring, summer, fall)
External gamma radiation	Eberline Model PRM-7 scintillation survey meters	80	once
	Thermoluminescent dosimeters (TLDs)	5	quarterly
Soil	Surface - ring method	46	once
	Subsurface - trench method	15	once
Biota vegetation	---	3	3 times/yr (spring, summer, fall)
wildlife	---	3	once



BASE MAP REFERENCE:
USGS TOOELE 1° x 2° QUADRANGLE, UTAH, 1953 (REVISED 1972).

SCALE 1:250,000
(1 INCH EQUALS APPROXIMATELY 4 MILES)

LEGEND

a Air particulates, ambient air radon (RGM-2 and Track-Etch), and external gamma (TLD).

b Soil, biota, radon flux, and external gamma (survey meter).

FIGURE F-4
LOCATIONS OF ENVIRONMENTAL RADIATION SAMPLING PROGRAMS FOR SOUTH CLIVE SITE

Airborne particulates

Continuous sampling for airborne particulates with low-volume air samplers was done for four quarters, with weekly filter changes. The filters were composited for each location on a quarterly basis and analyzed for uranium, Ra-226, Th-230 and Pb-210. The results of the quarterly composits are given in Table F-3.

Radon-222 in air

Radon concentrations were measured by Argonne National Laboratory at the locations of the airborne particulate samplers using the following instrumentation and schedule:

Instrument	Frequency	Type
Eberline RGM-2 radon gas monitor	Quarterly	1 week, continuous
Track-etch detectors	Monthly	Integrated
Track-etch detectors	Quarterly	Integrated
Track-etch detectors	Annual	Integrated

One of the quarterly seven-day continuous records for the RGM-2 is shown in Figure F-5. It indicates the typical diurnal variation characteristic of remote locations with no elevated radon source present. In comparison, the monthly values of radon concentration using track-etch detectors are presented in Table F-4. The RGM-2 measurement averaged 0.8 pCi/l for the week shown; the track-etch detector gives a monthly average of 0.31 pCi/l.

Gamma radiation

A general area survey of gamma radiation exposure rates was conducted by Argonne National Laboratory at the South Clive site. The measurements averaged 14 microR/hr and ranged from 11.0 to 16 micro R/hr. (ANL, 1982a).

Soil radioactivity

Soil sampling of surface soils (top 5 cm of soil) and subsurface soils (1 m below surface) was done at some locations. The samples were collected using the methods described by US AEC Regulatory Guide 4.5 (AEC, 1974). The results of soil analyses are presented in Table F-5.

Radionuclides in biota

Biota sampling included collection of vegetation and rabbits in the vicinity of the South Clive site. Vegetation samples consisted of a minimum of 2 kg of the crown of the plant. Three rabbits were taken in the vicinity, and their flesh was analyzed for radionuclide content. The average

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Table F-3. Radionuclide airborne particulate concentrations in the South Clive site vicinity

Radionuclide	Quarter	Concentration (pCi/l ± 2σ) South Clive	North Clive	Southeast Clive
U-nat	1	0 ± 3.5E-08[a]	0 ± 3.5E-08	0 ± 3.5E-08
	2	7.5E-08 ± 5.0E-08	8.7E-08 ± 4.3E-08	6.4E-08 ± 4.3E-08
	3	0 ± 1.9E-08	0 ± 3.8E-08	3.6E-08 ± 1.8E-08
	4	0 ± 1.9E-08	0 ± 2.0E-08	0 ± 1.8E-08
Average		1.9E-08 ± 1.7E-08	2.2E-08 ± 1.8E-08	2.5E-08 ± 1.5E-08
Th-230	1	1.5E-07 ± 1.8E-08	8.9E-08 ± 3.5E-08	2.1E-07 ± 3.5E-08
	2	1.0E-07 ± 2.5E-08	2.2E-07 ± 4.3E-08	6.0E-06 ± 2.1E-08
	3	0 ± 1.9E-08	7.5E-08 ± 1.9E-08	3.6E-08 ± 1.8E-08
	4	5.7E-08 ± 2.5E-08	8.0E-08 ± 2.0E-08	7.3E-08 ± 1.8E-08
Average		7.7E-08 ± 1.0E-08	1.2E-07 ± 1.5E-08	1.6E-06 ± 1.2E-08
Ra-226	1	0 ± 1.4E-08	0 ± 1.4E-08	3.0E-08 ± 1.3E-08
	2	0 ± 7.7E-09	0 ± 6.2E-09	6.2E-09 ± 6.2E-09
	3	2.4E-08 ± 1.5E-08	3.2E-08 ± 1.5E-08	2.9E-08 ± 1.5E-08
	4	1.9E-08 ± 6.6E-09	1.2E-08 ± 1.6E-08	2.9E-08 ± 1.5E-08
Average		1.1E-08 ± 6.6E-08	1.2E-08 ± 6.7E-08	2.4E-06 ± 6.4E-09
Pb-210	1	3.2E-05 ± 1.6E-06	6.2E-05 ± 3.6E-06	1.2E-05 ± 7.0E-07
	2	1.3E-05 ± 7.5E-07	1.3E-05 ± 6.5E-07	2.5E-05 ± 1.3E-06
	3	1.7E-05 ± 7.4E-07	1.7E-05 ± 7.5E-07	1.5E-05 ± 7.2E-07
	4	2.0E-05 ± 9.5E-07	2.1E-05 ± 9.9E-07	2.3E-05 ± 1.1E-06
Average		2.1E-05 ± 5.3E-07	2.8E-05 ± 9.7E-07	1.9E-06 ± 4.9E-07

[a]E-x is equivalent to 10^{-x}

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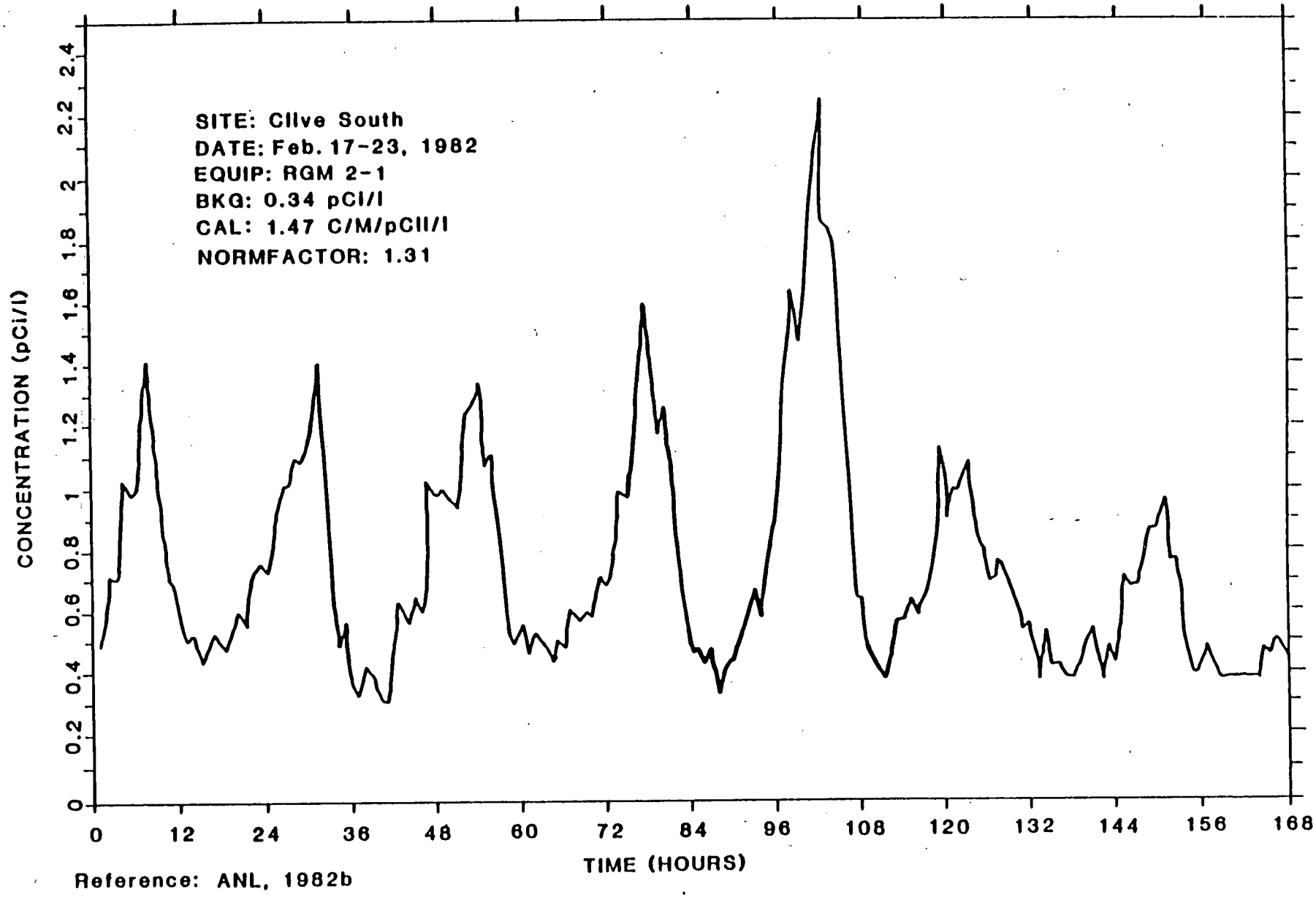

Reference: ANL, 1982b

FIGURE F-5
BACKGROUND RADON CONCENTRATION (WEEK) - SOUTH CLIVE

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Table F-4. Ambient-air radon-222 concentrations in the vicinity of South Clive site (track-etch method)

Collection date	Radon-222 concentration in air (pCi/l)		
	North Clive	South Clive	Southeast Clive
Monthly			
December (11/17-12/15)	0.23 ± 43.1%	0.23 ± 43.1%	0.26 ± 39.6%
1981	0.71 ± 14.5%	0.19 ± 47.7%	0.12 ± 63.8%
January (12/15-1/19)	0.13 ± 48.7%	0.26 ± 33.1%	0.29 ± 31.4%
1982	0.26 ± 33.1%	0.16 ± 43.9%	0.19 ± 40.2%
February (1/19-2/23)	0.21 ± 37.4%	0.32 ± 30.8%	0.61 ± 21.3%
1982	0.58 ± 21.8%	0.34 ± 28.7%	0.19 ± 40.2%
Average	0.35 ± 0.23	0.25 ± 0.07	0.28 ± 0.17
Quarterly			
12/81-2/82	0.25 ± 19.6%	0.30 ± 17.9%	0.28 ± 18.5%
	0.38 ± 16.0%	0.31 ± 17.7%	0.23 ± 20.8%
Average	0.32	0.31	0.26

Source: ANL, 1982a.

Table F-5. Radionuclide concentrations in soil samples from South Clive site vicinity

Location	Radionuclide	Concentration (pCi/g dry wt ±2)
Clive-North (surface)	U-238	1.1 ± 0.1
	Th-230	1.1 ± 0.2
	Ra-226	1.1 ± 0.1
	Pb-210	1.1 ± 0.2
Clive-South (surface)	U-238	0.7 ± 0.1
	Th-230	1.1 ± 0.2
	Ra-226	0.9 ± 0.1
	Pb-210	1.4 ± 0.2
Clive-Southeast (surface)	U-238	0.7 ± 0.1
	Th-230	1.1 ± 0.2
	Ra-226	1.0 ± 0.1
	Pb-210	1.4 ± 0.2
Clive-South (subsurface)	U-238	1.3 ± 0.1
	Th-230	1.1 ± 0.2
	Ra-226	0.7 ± 0.1
	Pb-210	0.9 ± 0.2

Source: Dames & Moore, 1984, unpublished

concentrations of uranium, Ra-226, Th-230, Po-210, and Pb-210 are presented in Table F-6. Note the significantly greater concentrations of the radon daughters in these samples as compared to the concentrations of the radon precursors, and as compared to the concentrations in local soils. This is assumed to be due to the large surface area to mass ratio of plants as opposed to soils, resulting in enhanced deposition and retention of airborne radon daughters by plants. The elevated radon daughter concentrations in rabbits is presumably the result of consuming the vegetation.

F.3.2.3 Transportation corridor environmental radioactivity

The radiation environment existing along the transportation route from the Vitro site to the South Clive site has been monitored by Dames & Moore and Argonne National Laboratory. The Delle and Knolls monitoring sites are located along the corridor, Figure F-4.

Airborne particulates

The radionuclide content of airborne particulates was measured at Delle and Knolls for two quarters (Table F-7). The data presented in Table F-7 indicate no significant differences from the values measured at South Clive.

Radon-222 in air

Three-month average ambient Rn-222 concentrations in air were measured at Delle and Knolls using track-etch detection (ANL, 1982a). The data of Table F-8 average 0.35 pCi/l and 0.23 pCi/l at the two sites.

Gamma radiation

Gamma radiation exposure rates were measured at four locations along the transportation corridor. The average exposure rates were 13 microR/hr at Lake Point Junction, 15 microR/hr at Timpie, 10 microR/hr at Delle, and 10 microR/hr at Knolls (ANL, 1982a).

Soil radioactivity

Radionuclide concentrations in soil along the transportation route were evaluated from soil samples taken at Delle and Knolls. The samples were analyzed for U-238, Ra-226, Th-230, and Pb-210 (Table F-9). The soil concentrations of these radionuclides were not significantly different from those measured for the South Clive site.

Table F-6. Average radionuclide concentrations in vegetation and wildlife in the vicinity of the South Clive site. (pCi/kg wet weight ± 2)

Radionuclide	Vegetation samples	Wildlife samples
U (Nat)	5.4 ± 0.4	0.5 ± 0.2
Th-230	6.0 ± 0.6	0.5 ± 0.2
Ra-226	3.1 ± 0.3	0.6 ± 0.05
Pb-210	198 ± 9	4.0 ± 1.0
Po-210	48 ± 3	8.0 ± 1.0

Source: Dames & Moore, 1984, unpublished

Table F-7. Radionuclide airborne-particulate concentrations along the transportation corridor between Vitro and South Clive sites

Radionuclide	Quarter	Concentration (pCi/l +2) Knolls	Delle
U-Nat	1	3.5E-08[a] ± 1.7E-08	3.5E-08 ± 1.8E-08
	2	1.1E-07 ± 4.5E-08	0 ± 4.0E-08
	3	0 ± 2.3E-08	0 ± 1.9E-08
	4	3.8E-08 ± 1.9E-08	3.5E-08 ± 1.8E-08
Average		4.6E-08 ± 1.4E-08	1.8E-08 ± 1.3E-08
Th-230	1	1.8E-07 ± 3.5E-08	2.7E-06 ± 1.4E-07
	2	1.3E-07 ± 2.2E-08	8.0E-08 ± 4.0E-08
	3	4.6E-08 ± 2.3E-08	2.4E-07 ± 3.7E-08
	4	7.7E-08 ± 1.9E-08	1.1E-07 ± 1.8E-08
Average		1.1E-07 ± 1.3E-08	7.8E-07 ± 3.8E-08
Ra-226	1	2.3E-08 ± 1.4E-08	5.1E-08 ± 1.4E-08
	2	3.3E-08 ± 1.8E-08	2.0E-08 ± 1.6E-08
	3	4.2E-08 ± 1.9E-08	4.5E-08 ± 1.5E-08
	4	3.5E-08 ± 1.5E-08	0 ± 1.4E-08
Average		3.3E-08 ± 8.3E-09	2.9E-08 ± 7.4E-09
Pb-210	1	3.0E-05 ± 1.4E-06	3.3E-05 ± 1.8E-06
	2	1.2E-05 ± 6.7E-07	1.2E-05 ± 6.0E-07
	3	1.6E-05 ± 7.0E-07	1.7E-05 ± 7.4E-07
	4	2.7E-05 ± 5.4E-06	2.2E-05 ± 1.1E-06
Average		2.1E-05 ± 5.4E-07	1.1E-05 ± 5.8E-07

[a]E-x is equivalent to 10^{-x}

Source: Dames & Moore, 1984, published

Table F-8. Ambient-air radon-222 concentrations along the transportation corridor between Vitro and South Clive sites (track-etch method)

Collection date	Radon-222 concentration in air (pCi/l) Delle	Knolls
Monthly		
December (11/17-12/15)	0.67 ± 14.5%	0.19 ± 47.7%
1981	0.23 ± 43.1%	0.12 ± 63.8%
January (12/15-1/19)	0.42 ± 25.7%	0.16 ± 43.9%
1982	0.11 ± 55.5%	0.08 ± 66.0%
February (1/19-2/23)	0.24 ± 35.0%	0.32 ± 30.0%
1982	0.26 ± 33.1%	0.19 ± 40.2%
Average	0.32 ± 0.20	0.18 ± 0.08
Quarterly		
11/81-2/82 --	0.25 ± 20.0%	0.25 ± 19.6%
	0.44 ± 14.7%	0.21 ± 21.8%
Average	0.35	0.23

Source: ANL, 1982a.

Table F-9. Radionuclide concentrations in surface soil along the transportation corridor between Vitro and South Clive sites

Location	Radionuclide	Concentration (pCi/g dry wt ±2)
Knolls	U-238	1.0 ± 0.1
	Th-230	0.9 ± 0.2
	Ra-226	0.7 ± 0.1
	Pb-210	1.6 ± 0.2
Delle	U-238	1.5 ± 0.1
	Th-230	0.9 ± 0.2
	Ra-226	0.7 ± 0.1
	Pb-210	1.1 ± 0.2

Source: Dames & Moore, 1984, published

F.4 RADIOACTIVE SOURCE TERM

In this section the calculations necessary to estimate the radiological effect of the proposed alternative remedial actions are presented. Most of the important radioactive releases occur at the Vitro site; however, calculations for the South Clive site and the transportation corridor are also considered necessary.

F.4.1 Radon release source term

Radon may be released from the tailings during four phases of the remedial action process: (1) prior to remedial action, (2) during the material moving operations, (3) after the relocation of the material but prior to installation of the cover, and (4) after the material has been covered. In Alternative 1 (no action) only phase (1) applies; in Alternatives 2 and 3 all four phases apply.

Alternative 1- no action

For this alternative a radon flux of 560 pCi/m^2s exists on the approximately 128 acres of the site (518,000 m^2). The total estimated radon release is (560 pCi/m^2s) (518,000 m^2) (3.15×10^7 s/yr) = 9.1×10^3 Ci/yr.

Alternative 3 - relocation and stabilization at South Clive

During the material moving operations it is reasonable to assume all interstitial radon would be released. The total quantity of Rn-222 in equilibrium with Ra-226 is estimated to be 1500 Ci. Based on an average emanation coefficient of 0.2, the total radon that could be released from the interstitial spaces is 300 Ci.

The contaminated material at the Vitro site would be excavated and transported to the South Clive site during a three year period. If the excavation rate is uniform, approximately 100 Ci would be released from excavated material each year for the three years. These 100 Ci must be added to the contribution from the tailings areas not yet excavated. The situation is portrayed in the material-removal diagram of Figure F-6, where two thirds of the pile are undisturbed (parts B & C) during removal of the first third of the pile (part A); and, on the average, half of Part A also contributes a yearly flux at a rate of 560 pCi/m^2s. Applying this logic to the three years of pile removal, the radon releases at the Vitro site are:

First year: 6100 Ci + 1/2 (3050) Ci + 100 Ci = 7725 Ci.
Second year: 3050 Ci + 1/2 (3050) Ci + 100 Ci = 4675 Ci.
Third year: 1/2 (3050 Ci) + 100 Ci = 1625 Ci.

In the fourth year and thereafter, the radon flux from the decontaminated Vitro site would be the normal background flux, 1-2 pCi/m^2s. This would result in annual releases of 16 to 30 Ci.

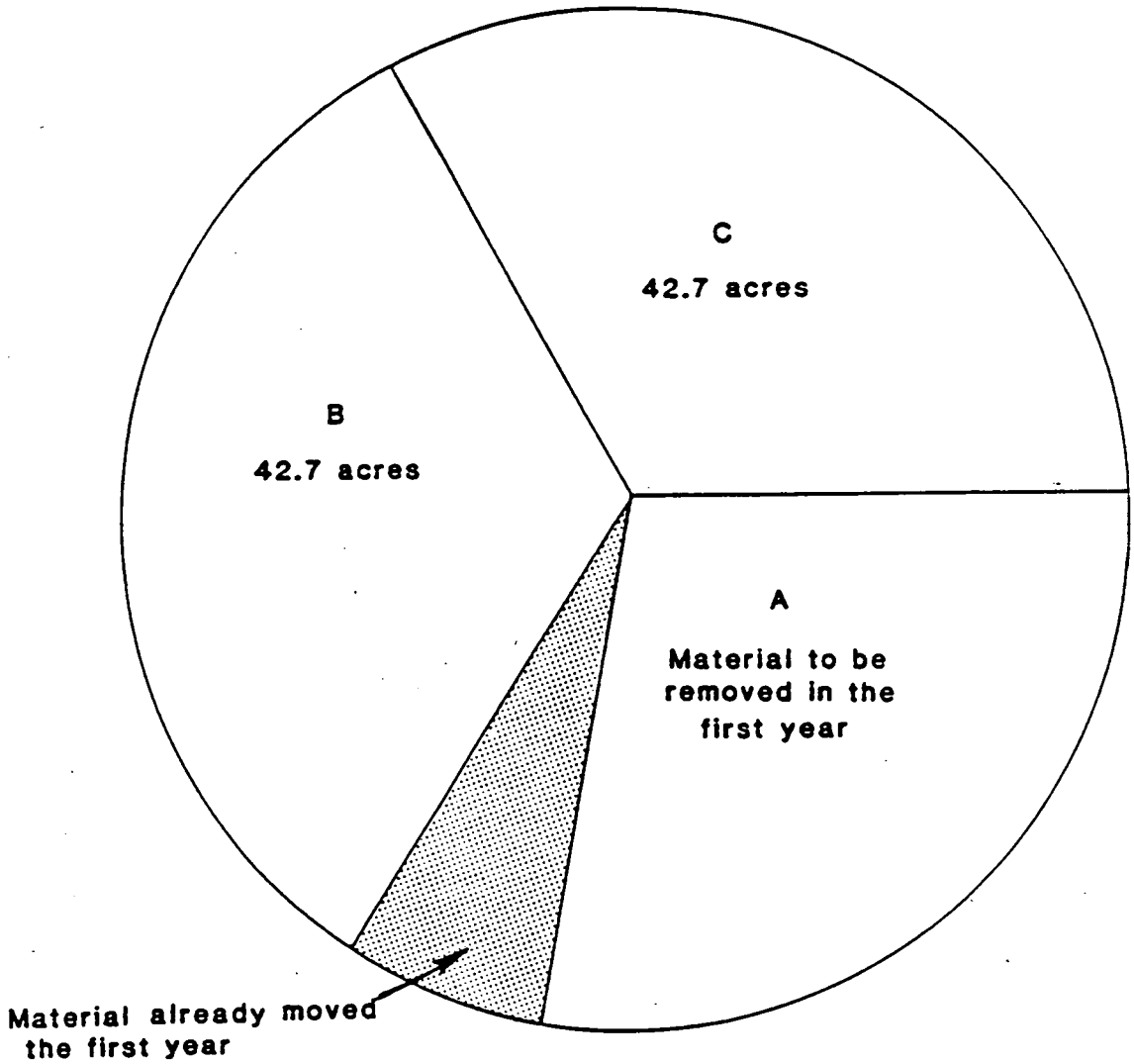

FIGURE F-6
IDEALIZED MATERIAL REMOVAL SCHEMATIC

A radon source term for tailings disposal operations at South Clive during Alternative 3 is not needed as there are no residents within 15 miles of the site. For occupational exposures it is assumed that the radon concentration on the pile will be the same as at the Vitro site, 30 pCi/l.

Alternative 2 - stabilization at Vitro

For disposal at the Vitro site the entire tailings volume will be disturbed, just as in Alternative 3. Although the time scale for the remedial action is slightly shorter, it is convenient to assume the same tailings movement scenario for stabilization at Vitro as for transport to South Clive. Thus the radon source term will be identical, on a yearly basis, to that for Alternative 3.

In the years following completion of on-site stabilization, the radon flux from the 55-acre tailings embankment would be less than or equal to the EPA standard of 20 pCi/m^2s plus 1 to 2 pCi/m^2s background soil flux, or about 160 to 170 Ci/yr.

F.4.2 Particulate release source term during remedial action

This section determines the magnitude of particulate releases from the Vitro site during the various remedial action alternatives. It was found that the radioactive source term due to particulate releases is orders of magnitude below that due to radon. Thus the particulate source term is not of importance in estimating the health effects to surrounding populations.

Alternative 1 - no action

Dust suspension due to wind erosion of the tailings piles is a mechanism for mobilization of tailings material during the no action alternative. As evidenced by the windblown contamination near the tailings pile, this process has operated, to some degree, during the period of existence of the Vitro site (ORNL, 1977).

The mechanism of soil erosion by wind depends on factors such as wind speed, soil properties such as particle size and moisture content, and the nature of the surface. Wind action results in three basic modes of particle motion: surface creep (particles above 500 μm in size), saltation (particles between 100 μm and 500 μm in size), and airborne suspension (particles less than 100 μm in size) (NRC, 1980a). The last mode of particle motion i.e., airborne suspension, which in general is a consequence of the saltation process, is considered herein.

An equation presented in Appendix G-1 of NUREG-0706 was utilized (NRC, 1980b). The model below is identical to the referenced formula except that the algebraic form is made explicit and all units have been cast in the MKS system. The resuspension rate for particulates less than 20 μm in aerodynamic diameter is given by

$$E = 2 \times 10^{-6} \, (U/U_o)^2 \, (U/U_o - 1) \, [(U/U_o)^{P/3} - 1)]$$

where

E = suspension rate, in grams per square meter per second (g/m^2s).
U = shear velocity, meters per second (m/s).
U_o = threshold velocity for saltation (m/s).
p = mass percent of particles less than 20 μm in aerodynamic diameter.

The shear velocity, U, is given by the equation (NRC, 1980b)

$$U = \text{wind speed at height } (z)/[2.5 \times \ln(z/z_o)]$$

where z_o is the height at which the windspeed is equal to zero. Assuming a particle density of 2.4 g/cm^3, and an average particle diameter of 300 μm, typical of fine grained soils, the threshold velocity for saltation U_o can be calculated to yield (NRC, 1980b)

$$U_o = 0.29 \text{ m/s}$$

An average wind speed of 4.5 m/sec (the long-term annual average wind speed in the 48 conterminous states) measured 1 meter above the ground surface yields

$$U = 0.39 \text{ m/s}$$

and the equation for E reduces to

$$E = 1.22 \times 10^{-6} \, [(1.34)^{p/3} - 1] \text{ g/m}^2\text{s}$$

In general, (p) is a coefficient around a few percent. Assuming a value of 3 percent yields a suspension rate due to wind action of

$$E = 4.1 \times 10^{-7} \text{ g/m}^2\text{s}$$

Wind suspension is the source term for the resuspension flux of particles for the no action alternative. The resuspension rate of 4.1×10^{-7} g/m^2sec, along with the concentrations from Section F.3.1 were used to calculate the source terms for the particulates. For the no-action alternative the source terms are listed below.

Ra-226 = 3.8×10^{-3} curies/yr
U-238 = 2.7×10^{-4} curies/yr
Th-230 = 3.8×10^{-3} curies/yr

In comparison to the 9100 Ci/yr of radon released from the Vitro site, these quantities are insignificant over the term of remedial action. It is believed they need not be considered further for population exposures.

Alternatives 2 and 3

For the alternatives involving tailings disturbance by heavy equipment, the particulate-release radioactive source term may be estimated from the air quality data of Appendix G. For the operations involving tailings movement, the resulting dust releases are estimated at 4×10^5 kg/yr. Assuming all of

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this dust contains the average Ra-226, Th-230, and U-238 concentrations estimated for the tailings, the radionuclide releases would be:

Ra-226: $(560 \times 10^{-12}$ Ci/g) $(4 \times 10^{8}$ g/yr) = 0.22 Ci/yr
Th-230: $(560 \times 10^{-12}$ Ci/g) $(4 \times 10^{8}$ g/yr) = 0.22 Ci/yr
U-238: $(40 \times 10^{-12}$ Ci/g) $(4 \times 10^{8}$ g/yr) = 0.016 Ci/yr

By comparison to the roughly 9000 Ci/yr of radon released from the Vitro site these quantities are insignificant. It is believed they need not be considered further for population exposures due to remedial action. No particulate release estimates are needed for the South Clive site since there is no population at risk. It is assumed that there are no routine particulate releases in the transportation corridor because covered vehicles will be used.

After completion of remedial action, the particulate-release radionuclide source term will be due to the natural radioactivity of the cover soils and the effects of wind erosion. It will not differ from that of surrounding natural lands.

Occupational and population exposures to particulates

Occupational exposures for remedial action workers breathing dust in the vicinity of earth moving equipment may be estimated for comparison to the gamma radiation exposure and to the radon daughter exposure. A method proposed by NRC (1981b) was used to estimate doses from inhalation of particulates. These doses would be to the worker's lung from inhalation of respirable particulates (<10 μm in size) that contain trace amounts of U-238, Th-230, and Ra-226. The equation used is:

$$H = (f_o f_d f_w f_s)_{air} \times C_w x PDCF_{air} \qquad \text{(NRC, 1981b)}$$

where

H = the 50-year dose commitment to the lung in mrem.

$PDCF_{air}$ = pathway dose conversion factor for air pathways only, i.e., inhalation and direct radiation.

C_w = the radionuclide concentration in the material in piocuries per cubic meter.

f_o = the time-delay factor which is equal to 1 for this appendix.

f_d = site design factor which is equal to 1 for this appendix.

f_w = waste form and package factor which is equal to 1 for this appendix.

f_s = for the air uptake pathways, f_s, is the product of the soil-to-air transfer factor, T_{sa}, and the exposure duration factor (the fraction of a year that the worker is exposed).

The soil to air transfer factor, T_{sa}, may be expressed in terms of the geometry of the problem, the suspension flux (E), and the empirical equation

$$T_{sa} = \frac{ExGxfr}{uxd}, \text{ in } m^3 \text{ of soil per } m^3 \text{ of air} \qquad \text{(NRC, 1981b)}$$

where

E = suspension rate of transportation (<30 μm) particulates in units of g/m^2s.

fr = fraction of suspended transportable particulates that are respirable (<10 μm).

G = Geometry factor = (area subject to dusting)/(width of area x mixing height).

d = density of the soil (g/cm^3); assume 1.6.

u = wind speed (m/sec); assume 1.6.

The following calculates the transfer factor for particulates from excavation at the Vitro site for the action alternative. The total emission term for the Vitro site from construction would be $4x10^5$ kg/yr. The tailings piles encompass approximately 128 acres of contaminated material or equivalently 518,000 m^2. One third of the pile is removed per year, i.e., 43 acres or equivalently 173,000 m^2.

The total particulate release rate is about 4×10^5 kg/yr as indicated above. Of this, about 65 percent by weight would be in particles larger than 30 μm, based on particle size distributions given by MSRD (1982). This assumes that the particle size distribution of initially suspended dust is proportional to the particle size distribution in the tailings, and assumes that only a small fraction of the tailings mass is in particles too large to be disturbed by earth-moving equipment. The factor E is thus $(0.35)(4 \times 10^5$ kg/yr)(1000 g/kg)(1 yr/3.15×10^7s)(1/1.73×10^5 m^2) = 2.6×10^{-5} g/m^2s.

Roughly 30 percent of the release rate for 30 μm and smaller particles will represent particles smaller than 10 μm. Thus the factor fr in this calculation is 0.3.

The geometry factor was calculated by assuming that the area of construction would be 43 acres or 173,000 m^2 and that the mixing height would be 3 meters. The width of the area is best represented by the diameter of a circle whose area is 173,000 m^2. The width of the area is then equal to 470 meters. These assumptions yield G = 123.

Therefore,

$$T_{sa} = \frac{(2.6x10^{-5}\ g/m^2\ sec)\ (123)\ (.3)}{(1.6\ m/s)\ (1.6x10^6\ g/m^3)} = 3.7x10^{-10}$$

Table F-10 lists the pathway dose conversion factors for the air pathways and also soil concentrations (pCi/m^3) for Ra-226, Th-230, and U-238 at the Vitro site. The dose from Pb-210 has been shown to be small when compared to the three principal radionuclides. Assuming that 20 percent of the radon is released from the soil, the concentration of the Pb-210 and its decay product Po-210 would be approximately 80 percent of the Ra-226 concentration. Calculations presented in ANL, 1983b (Table 4.3) show that the lung dose would increase by only 6 percent if Pb-210 and Po-210 were considered.

Table F-10. Occupational dose parameters

Nuclide	PDCF-air ($mrem\text{-}m^3/Ci$)	Concentration in soil[a] (pCi/m^3)
Ra-226	1.936×10^{14}	8.9×10^{8}
Th-230	8.518×10^{13}	8.9×10^{8}
U-238	7.55×10^{14}	6.3×10^{7}

[a]Assuming a density of 1.6 g/cm^3 and concentrations of 560 pCi/g for Th-230, Ra-226, and 40 pCi/g for U-238.
Source: NRC, 1981b.

The calculated 50-year dose commitments to the lungs from Ra-226, Th-230, and U-238 from excavation at the Vitro site are shown below. An assumption was made that a person would work 8 hours a day, 250 days a year. The fraction of a year that a person would work is, therefore, 0.228.

a) 50-year dose-commitment from Ra-226 to the lung

$$H = (1 \times 1 \times 1 \times 0.228 \times 3.7 \times 10^{-10}) \times 8.9 \times 10^{8} pCi/m^3 \times 1.936 \times 10^{14} \; mrem\text{-}m^3/Ci \times 1 \; Ci/1 \times 10^{12} pCi$$

$$H = 14.5 \text{ mrem}$$

b) 50-year dose-commitment from Th-230 to the lung

$$H = (0.228 \times 3.7 \times 10^{-10}) \times 8.9 \times 10^{8} pCi/m^3 \times 8.518 \times 10^{13} \; mrem\text{-}m^3/Ci \times 1 \; Ci/1 \times 10^{12} pCi$$

$$H = 6.4 \text{ mrem}$$

c) 50-year dose-commitment from U-238 to the lung

$$H = (0.228 \times 3.7 \times 10^{-10}) \times 6.3 \times 10^{7} pCi/m^3 \times 7.55 \times 10^{14} \; mrem\text{-}m^3/Ci \times 1 \; Ci/1 \times 10^{12} pCi$$

$$H = 4.0 \text{ mrem}$$

The doses to remedial action workers resulting from particulate inhalation are very small compared to the doses from radon and radon daughter exposures and gamma radiation exposures. This point is illustrated by the information summarized in Table F-11, where the doses from particulates are compared to the other radiation doses. The other doses are calculated and summarized in different units (person-rem) in Section F.5 and are recalculated and presented here only for comparison. The information presented in the Alternative 2 portion of Table F-11 is specific to that Alternative, but the conclusions regarding the significance of particulate doses would be the same for explicit calculations for Alternative 3.

Also summarized in Table F-11, are doses that might accrue to a remedial action worker on the Vitro tailings pile under the conditions existing if no action were taken (Alternative 1). Of course, no remedial action workers are present for the no action alternative, so these calculations are only for comparision purposes.

It is clear from Table F-11 that particulate doses are a small component of the total radiation doses that a remedial action worker might receive. The particulate doses are less than 10 percent of the gamma radiation dose above, and when the radon and radon daughter doses are considered, the particulate doses are certainly negligible (less than one percent of the dose to the workers).

For populations off the pile, the particulate component of total dose becomes even smaller. The airborne particulate concentrations will decrease more rapidly than airborne radon concentrations due to the more effective removal of the particulates from the lower atmosphere as compared to the gaseous radon.

The particles to which radon daughters attach will, in general, be submicron atmospheric dust particles. Only a small fraction of the particulate releases used in the above calculations ($<10\ \mu m$ was used) will be in a comparable size range and subject to the same prolonged and extensive atmospheric transport.

Based on this, it may be concluded that since particulate doses are negligible for remedial action workers, then particulate doses to off-site populations that result from remedial actions are negligible as well. The major radiaton doses to off-site populations are from radon and radon daughter exposures; particulate releases have no important effect.

F.4.3 Gamma radiation source term

The gamma radiation emissions from the Vitro site are described by Figure F-3. For persons further than 1 km (0.5 miles) from the site, gamma radiation exposure is negligible. For persons living or working within 1 km of the Vitro site, a reasonable average value of 11 microR/hr gamma exposure due to the site may be applied.

For occupational workers on the site gamma radiation exposure is higher. Using the 560 pCi/g concentration of Ra-226 assumed for the tailings, the

Table F-11. Occupational radiation dose summary for comparing significance of radiation sources

No Action[a] (2000 hr/yr exposure)

	Radon			Gamma		Particulates[b]	
	Ci/yr	pCi/l	mrem	μr/hr	mrem	Ci/yr	mrem
yr 1	9,100	30	4,400	140	280	0.008	0.43
yr 2	9,100	30	4,400	140	280	0.008	0.43
yr 3	9,100	30	4,400	140	280	0.008	0.43
Total			13,200		840		1.3 = 14,000

Alternative 2 (2000 hr exposure)

	Radon			Gamma		Particulates[c]	
	Ci/yr	pCi/l	mrem	μr/hr	mrem	Ci/yr	mrem
yr 1	7,725	30	4,400	140	280	0.46	2.49
yr 2	4,675	15	2,200	140	280	0.46	2.49
yr 3	1,625	10	1,500	140	280	0.46	2.49
Total			8,100		840		74.7 = 9,000

[a]No remedial action workers are present for the no action alternative; these calculated exposures are merely for comparison.
[b]Particulate releases due to wind erosion of the tailings pile.
[c]Particulate releases due to earthmoving equipment during remedial action.

average gamma radiation exposure rate can be estimated by the method of Schiager (1974): the gamma exposure rate (microR/hr) is 2.5 times the radium concentration (pCi/g). In this case, (2.5 (microR/hr)/(pCi/g)) (560 pCi/g) = 1400 microR/hr. This would be the hourly exposure to an unshielded worker on the pile. The majority of workers will be enclosed in the cabs of trucks or other earth moving equipment. As an inch of iron reduces the gamma radiation by a factor of 10, a more likely exposure is 140 microR/hr. Also, the placing of cover on the pile will reduce the gamma exposure rate by a factor of 10 per foot of soil; this again leads to the gamma exposure rate of 140 microR/hr as an appropriate upper estimate.

Following remedial action, gamma exposure rates will be at background levels (about 13 microR/hr) since sufficient cover will be applied to block the gamma radiation.

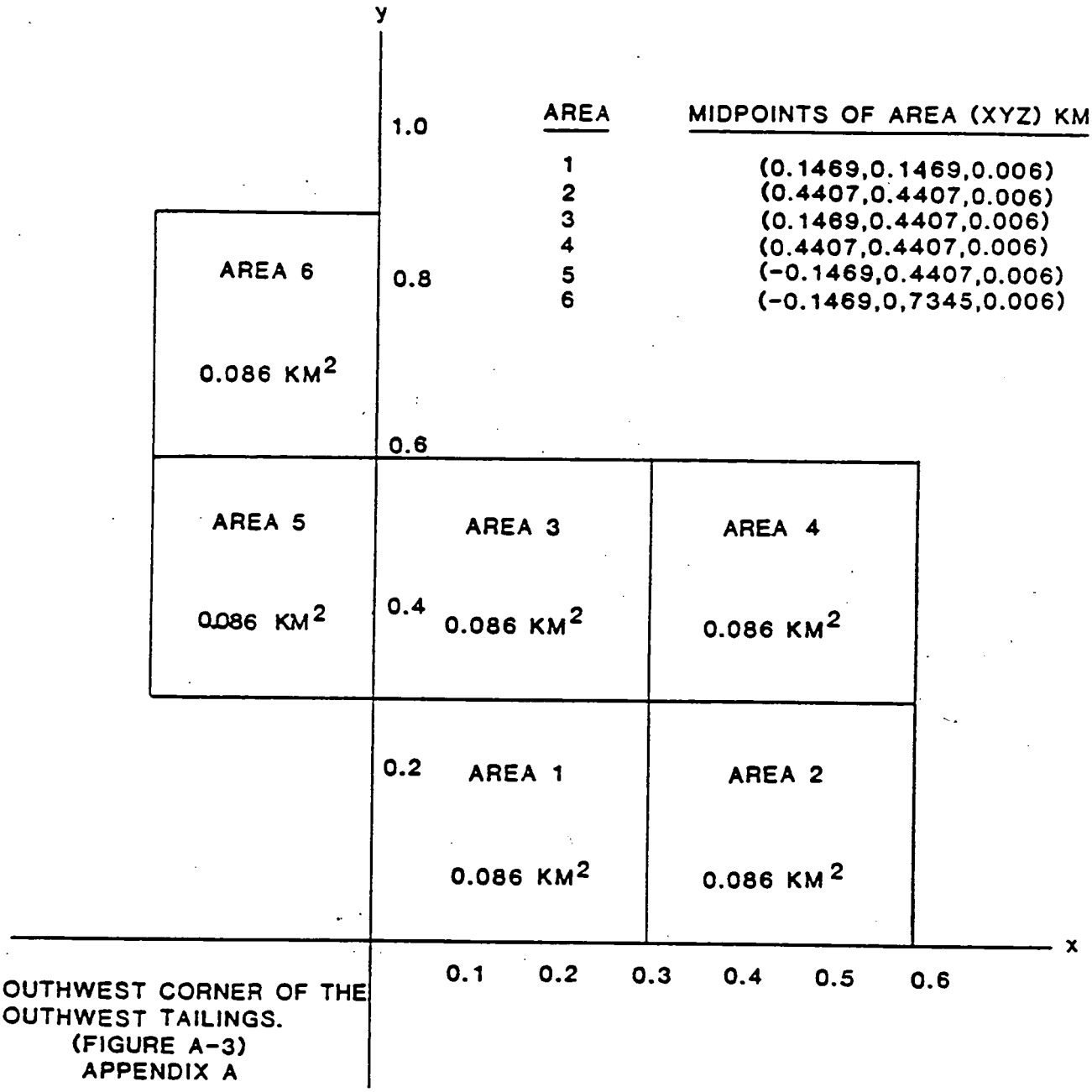
F.4.4 Atmospheric dispersion of Rn-222

Atmospheric-dispersion calculations are used as the basis for estimating the environmental radiation dose (for individuals and populations) resulting from radon and radon daughters from uranium mill tailings piles. In this report, the computer code MILDOS was utilized to calculate the atmospheric dispersion of radon, and the doses received by individuals and the population during the various phases of the proposed alternatives. The results of the MILDOS runs are used in Section F.5.

The computer code MILDOS was developed by the NRC to estimate the impacts from radioactive emission from uranium milling facilities, based on the calculational procedures outlined in Appendix G of NUREG-0706 (NRC, 1980b) and in Chapter 2 of the MILDOS user's manual (NRC, 1981a).

In MILDOS, emissions of radioactive materials from fixed-point sources or area sources are modeled using a sector-averaged Guassian plume dispersion model. Exposure rates are presented for various source and receptor point locations. In order to run the code, four categories of inputs are required: source parameters, meteorlogical and population parameters, translocation parameters, and receptor parameters.

The first source parameter required is the number of sources of discrete effluents. This may be an actual number if there are fixed point sources or an assumed number for area sources. The number of sources of discrete effluents used for area sources is dependent upon the area of the source. Each source considered may be no larger than 0.1 square kilometers (km^2) when input for MILDOS. Therefore, the number of sources should be chosen or assumed such that each one has an area no greater than 0.1 km^2. As mentioned above, approximately 128 acres of the Vitro site contain contaminated materials. The 128 acres were divided into six square areas each of approximately 21.3 acres or 0.086 km^2 (see Figure F-7). Figure F-7 was drawn so that the areas and their locations were representative of the northwest, southwest, and southeast tailings. The coordinates (x, length; y, width; and z, height) of the midpoints of the six source areas were input into MILDOS in units of kilometers.



AREA	MIDPOINTS OF AREA (XYZ) KM
1	(0.1469,0.1469,0.006)
2	(0.4407,0.4407,0.006)
3	(0.1469,0.4407,0.006)
4	(0.4407,0.4407,0.006)
5	(-0.1469,0.4407,0.006)
6	(-0.1469,0,7345,0.006)

SOUTHWEST CORNER OF THE SOUTHWEST TAILINGS.
(FIGURE A-3)
APPENDIX A

FIGURE F-7
SOURCE TERM GEOMETRY

The source terms from the preceding sections were recalculated and entered for a two-year interval as MILDOS calculates concentrations and doses on a two-year minimum time step. For example, a source term for each nuclide was calculated by taking the mean of the first and second years, and dividing by the number of source terms, six.

The particle-size distribution for each source was matched with the appropriate set-number provided in the code and included in the source input. For example, particle-size distribution set-number 3, which represents tailings characteristics, was entered.

The second group of parameters requires population and meteorlogical data for the site. The meteorological data required included the joint fractional frequency distribution of wind in a certain wind direction and in specific wind speeds and atmospheric stability classes. These data were entered for the Vitro site along with the population distribution, for 16 wind sectors, out to a radius of 10 km from the site. The wind data are presented in Appendix G.

The third group of parameters required are the translocation parameters. These parameters, along with the meteorlogical data, determine the actual movement of the radionuclides once they leave the source. Usually, food production in the region for vegetables, milk, and meat must be input in areal units of kilograms per year per square kilometers. For the analyses of the Vitro site, areal food production and forage uptake by animals was assumed to be zero.

The receptor parameters represent the final set of data required for the MILDOS code. Ten individual receptors were located at a radius of 1 km and compass directions of N, ENE, E, SE, SSE, S, SSW, SW, WSW and NNW.

F.4.5 Accident analyses

This section considers accidents that might occur during the transport of tailings to South Clive in Alternative 3. No accidents will occur in the no action alternative, and it is difficult to think of an accident occurring on the Vitro site which will have radiological consequences of any significance in relation to the radiological effect of the site itself. Accidents are considered explicitly for the train-transport option for moving the tailings to South Clive; the impact of a truck transport accident is scaled according to the volume of material carried. Two kinds of accidents are considered: (1) the spill occurs on land and the tailings are dispersed by wind, (2) the spill will fall into the Great Salt Lake.

F.4.5.1 Accidental spill of material on land

The potential impacts from a spill of material on land were calculated using a computer model "AIRREL" (a certified computer model developed by Dames & Moore). AIRREL calculates the theoretical radiological impacts to an individual or to populations resulting from an accidental release of uranium mill tailings to the atmosphere. The particulates released in this fashion would be subject to transportation by prevailing winds to distances where they

might become accessible to the surrounding population. The impacts incurred through this airborne transport mechanism are expressed in terms of the radiological dose that would be received by all individuals (cumulative dose) near the accidental release. The population dose is expressed in units of man-rem.

In the AIRREL code, the population dose is determined by multiplying the radionuclide concentration at a particular downwind distance by the dose conversion factor applicable to the radionuclide and body organ of interest and by the number of persons affected. In this program three radionuclides (U-238, Th-230, and Ra-226) and five body organs (whole body, bone, lung, liver, and kidney) are considered. Dose conversion factors obtained from the program MILDOS are used in the calculations. Up to 10 downwind locations and their respective populations can be considered in a single execution of the program.

The radionuclide concentration at a particular location downwind from a ground-level point source is found using the basic atmospheric diffusion equation (AEC, 1967).

$$X = \frac{Q}{\pi u \sigma_y \sigma_z}$$

where

X = average centerline ground level concentration (Ci/m^3).
Q = radionuclide source term (Ci/sec).
u = wind speed (m/sec) (u = 1 m/sec in the code).
σ_y = horizontal standard deviation of plume (m).
σ_z = vertical standard deviation of plume (m).
π = 3.1416.

The standard deviations σ_y and σ_z are measures of the spatial spread of the particulates plume as a function of downwind distance and meteorological stability class. In this program a Pasquill Type F stability class is assumed based on the recommendations of U.S. NRC Regulatory Guides 1.3 and 1.4. These standard deviations can be computed using the following empirical relations (NRC, 1980a)

$$\sigma_y = 0.04r\ (1 + 0.0001r)^{-1/2}$$

and

$$\sigma_z = 0.016r\ (1 + 0.0003r)^{-1}$$

where r is the downwind distance in meters.

AIRREL expresses the population dose as follows:

$$\text{Dose}\ (r,n,\theta) = c(r,n) \times DCF(n,\theta) \times (T/8760) \times POP\ (r)$$

where

Dose = radiological impact (man-rem).
c = radionuclide concentration (pCi/m^3).

DCF = dose conversion factor (mrem/yr per pCi/m^3).
T = duration time (hours).
POP = population count (number of individuals).
r = downwind distance.
n = radionuclide "n".
θ = body organ "θ".

For a land spill, a worst case accident would be a derailment of the unit train with a subsequent spill of material. As the train would contain 5000 tons of material (or a volume of 2840 m^3), a full derailment was assumed to dump material over an area twice the ground area of the train. Assuming that the cars are 2 meters deep by 3 meters wide, a suspension rate 4.1×10^{-7} g/m^2s (F.2.1.1) leads to estimated source terms for U-238, Th-230, and Ra-226 of

378 pCi/hr, 3220 pCi/hr, and 3200 pCi/hr, respectively.

The 1-hour doses to individuals at 0.1, 1.0, 2.0, and 10 km from this accident, as computed by AIRREL, are listed in Table F-12. An additional but smaller dose of less than 11 percent would be incurred if Pb-210 and Po-210 were considered (ANL, 1983b; Table 4-3).

Table F-12. Doses due to a hypothetical accident

	Distance (m)	Dose (mrem) Whole body	Bone	Lung	Liver	Kidney
U-238	100	4.245E-05[a]	7.176E-04	4.626E-03	0.000E+00	1.634E-04
	500	1.933E-06	3.268E-05	2.106E-04	0.000E+00	7.441E-06
	1000	5.592E-07	9.452E-05	6.093E-05	0.000E+00	2.152E-06
	1500	2.834E-07	4.791E-06	3.088E-05	0.000E+00	1.0910-06
	2000	1.797E-07	3.038E-06	1.958E-05	0.000E+00	6.917E-07
Th-230	100	5.028E-03[a]	1.798E-01	8.698E-02	1.035E-02	5.028E-02
	500	2.289E-04	8.189E-03	3.961E-03	4.713E-04	2.289E-03
	1000	6.622E-05	2.369E-03	1.146E-03	1.363E-04	6.622E-04
	1500	3.3357-05	1.201E-03	5.807E-04	6.909E-05	3.357E-04
	2000	2.128E-05	7.612E-04	3.682E-04	4.381E-05	2.128E-04
Ra-226	100	1.314E-03	1.314E-02	1.791E-01	1.640E-06	4.624E-05
	500	5.983E-05	5.983E-04	8.155E-03	7.470E-08	2.106E-06
	1000	1.731E-05	1.731E-04	2.359E-03	2.161E-08	6.091E-07
	1500	8.772E-06	8.772E-05	1.196E-03	1.095E-08	3.0870-07
	2000	5.562E-06	5.562E-05	7.581E-04	6.994E-09	1.957E-07

[a]E-x is equivalent to 10^{-x}.

These doses are insignificant compared to the doses received by workers on the site and by the population immediately surrounding the Vitro site, as

could be guessed from the small quantity of tailings carried by each train and the limited time of exposure.

Scaling for a truck accident would be according to the ratio of (35 tons per truck/5000 tons per train) or 7×10^{-3}. This implies that the doses due to a truck spill will be more than 100 times smaller than the doses due to a train spill.

The probability of either accident is roughly 9×10^{-7} per mile traveled (SNL 1982b), or about 0.05 spills by rail transport, or 7.0 spills by truck transport over the three years of the relocation to South Clive. Since these estimates are based on the frequency of injury and death accidents (SNL 1982b), it is clear that the major impact will not be radiological, but the actual injuries or deaths involved.

F.4.5.2 Surface-water transport accident

The transport of tailings by rail to the South Clive site during Alternative 3 could also result in a potential spill of material into the Great Salt Lake since the train route is adjacent to the lake for approximately 14 miles or 16 percent of the trip. This results in a total accident probability of 0.008 spills during the three years of relocation to the South Clive site, which is a negligible chance.

In addition to the negligible probability, the consequences of such an accident would also be negligible. The tailings material is largely insoluble and water transport of suspensions would be the major mechanism of dispersion. As the water body considered is not a quick moving stream, the majority of material would settle to the bottom; it would not enter into a drinking water or irrigation pathway. Water from the Great Salt Lake is not used for drinking or farming.

F.5 HEALTH EFFECTS

For each of the proposed alternatives for the Vitro tailings site, the information and calculations presented above are applied to give an estimate of the impact of the remedial action in terms of health effects in the general population and the remedial action workers.

F.5.1 Alternative 1 - no action

Remedial action worker health effects.

No remedial action workers are exposed to radon daughters or gamma radiation under this alternative.

General population and nearby worker health effects from radon daughter exposure.

Two methods are used to estimate these exposures. For the major portion of the population, the computer code MILDOS is used to provide estimates of radon daughter exposure of the population. This code does not provide estimates within 1 km of the source, however. For the small population within 1 km of the Vitro site, radon daughter concentrations are estimated from long-term radon concentration measurements.

Population within 1 km of the Vitro site

For persons living or working within 1 km of the Vitro site, long-term radon concentration measurements are available for estimating radon daughter exposures (Section F.3.2.1). Based on Figure F-2, a suitable average Rn-222 concentration within 1 km of the site is 0.5 pCi/l. Assuming 25 percent equilibrium of the radon daughters at this close distance from the pile (Borak 1983), the conversion factor 7.4×10^{-5} rem/(hr-pCi/l) (Section F.2.1) may be applied.

Five hundred people live to the west and southwest of the site, within 1 km (FBDU, 1981). Using a three-year period of exposure for comparison to the other alternatives, the population dose equivalent commitment is (500 persons) (0.5 pCi/l)(8760 hr/yr)(3 yr)(7.4×10^{-5} rem/(hr-pCi/l)) = 486 person-rem. Applying the lung cancer risk estimator (20×10^{-6} cancer/person-rem, Section F.2.1) gives an estimated excess of 0.0097 lung cancers in this group.

There are approximately 50 full-time workers employed near the Vitro site at the CVWRF. These persons are close enough to the tailings that the 30 pCi/l radon concentration estimated to exist on the pile will be used (Section F.3.1). Assuming 25 percent equilibrium of the radon daughers, and a 40-hour work week per person, the dose equivalent commitment to these nearby workers is (50 persons)(30 pCi/l)(2000 hr/yr)(3 yr)(7.4×10^{-5} rem/(hr-pCi/l)) = 666 person-rem. This results in an estimated excess 0.013 lung cancer deaths in the nearby worker group.

Population beyond 1 km of the Vitro site

The computer code MILDOS was used to estimate population doses beyond 1 km from the Vitro site. The input data required for MILDOS have been described above (Section F.4.4). The output is summarized in Table F-13 for a three-year exposure (comparable to the time for remedial action).

Table F-13. Summary of MILDOS results for no action alternative (person-rem).

Organ	Distance, km 1-2	1-10
Whole body	9.0	220
Bone	9.1	240
Lung	9.0	220
Bronchial epithelium	3600	27000

General population and nearby worker health effects from gamma radiation exposure.

Approximately 500 persons live within 1 km of the Vitro site (FBDU, 1981). Some of these reside in a trailer park to the west at about 0.5 mile, while some reside in an area 0.05 to 0.5 mile extending from the southwestern corner of the site. From Figure F-3 it is seen that gamma exposure is insignificant at 0.5 mile or more. The elevated gamma exposure rate within 0.5 mile averages about 11 microR/hr. Assuming 250 persons live within 0.5 mile, the population dose equivalent is (250 persons)(11 microR/hr)(8760 hr/yr)(3 yr)(1×10^{-6} rem/microR) = 72 person-rem. The estimate of excess health effects is 0.0086 cancer deaths.

About 50 persons work full time near the Vitro site at the CVWRF. Using the same gamma exposure rate for these persons as for remedial action workers on the pile for other alternative remedial actions (see following section), an upper estimate of 140 microR/hr may be applied to the nearby workers. The resulting population dose equivalent is (50 persons)(140 microR/hr)(2000 hr/yr)(3 yr)(1×10^{-6} rem/microR) = 42 person-rem. The estimate of excess fatal cancers due to gamma exposure of nearby workers is 0.0050 cancer deaths.

F.5.2 Alternative 2 - stabilization at Vitro

Remedial action worker health effects from radon daughter exposure.

Worker exposure to radon daughters will occur at the Vitro site during excavation and stabilization of the tailings. A conservative assumption is that a radon concentration of 30 pCi/l will exist on the pile (Section F.3.1). Radon daughter equilibrium is assumed to be 25 percent (Section F.2.1). As given in Table A-4 (Appendix A), the worker exposure hours required for this alternative total 2.3×10^5 person-hr. This worker exposure results in a dose equivalent commitment of (2.3×10^5 person-hr)(30 pCi/l)(7.4×10^{-5} rem/(hr-pCi/l)) = 480 person-rem. This corresponds to an estimated excess of 0.0096 lung cancer deaths among the workers.

Remedial action worker health effects from gamma radiation exposures.

Remedial action workers on the pile will be exposed to gamma radiation from tailings, as well as radon daughters. The estimated gamma exposure rate on the pile in microR/hr is 2.5 times the average Ra-226 concentration in pCi/g (Schiager, 1974), or 1400 microR/hr based on the measured average Ra-226 concentration of 560 pCi/g (Section F.3.1). This is a highly conservative estimate and represents an upper limit which, in practice, is not expected to be received. On a partially reclaimed portion of the tailings pile, the exposure rate would be reduced by a factor of 10 for each foot of cover material. The majority of workers will be enclosed in the cabs of earth moving equipment. This will provide shielding, reducing the exposure rate by a factor of 10 per inch of iron. A more realistic upper bound for the gamma exposure would therefore be 140 microR/hr.

Based on Table A-4 (Appendix A) it is possible to estimate the number of workers exposed during each phase of remedial action for two categories: 1) workers exposed on foot on bare tailings (1400 microR/yr), and 2) workers shielded by heavy equipment or tailings cover (140 microR/hr). It was assumed that the worker classifications of equipment operators and truck drivers will be afforded shielding equivalent to 1 inch of steel. The worker classifications maintenance personnel, miscellaneous personnel, and supervisor/foremen will not be afforded shielding due to heavy equipment. Further, full exposure to tailings is assumed to be possible for the remedial action phases of site preparation, tailings relocation, liner system placement, and tailings consolidation. For the phases of cover installation, site restoration, and general supervision all workers will be afforded a factor of ten reduction in exposure rate. For simplicity only two exposure rates are considered: 1400 microR/hr for exposure on foot on bare tailings, and 140 microR/hr for workers shielded by equipment or cover. Table F-14 summarizes the worker-hours in each remedial action phase and exposure category.

Table F-14. Worker exposure categories by remedial action phase

Phase	Worker hours (000s) No shielding (1400 microR/hr)	Worker hours (000s) Some shielding (140 microR/hr)
Site preparation	1	1
Tailings relocation	3	7
Liner system placement	12	16
Tailings consolidation	10	43
Cover installation		17
Site restoration		25
General supervision		96
	26	205

The worker exposures are (26×10^3 person-hr)(1400 microR/hr)(1×10^{-6} rem/microR) = 36 person-rem for unshielded workers, and (205×10^3 person-hr)(140 microR/hr)(1×10^{-6} rem/microR) = 29 person-rem for workers afforded some shielding. These total 65 person-rem which corresponds to an estimated excess 0.003 cancer death among the workers.

General population and nearby worker health effects from exposure to radon daughters.

During the remedial action at the Vitro site the tailings area available as a radon source term will decrease from 128 to 0 acres. The amount of radon released to the atmosphere will be less than for the no action alternative due to a reduced exposed pile surface. Based on the radon source term calculations given in Section F.4.1, the total radon emission for Alternative 2 is about 0.5 times that for the no action alternative. This scaling factor may be used directly to modify the MILDOS estimates for the no action alternative to give proper values for the stabilization at Vitro alternative. In a general fashion, it is also an appropriate scaling factor to be applied to the radon concentrations that would be measured on the pile or near the pile on an average basis for the period of remedial action.

For the 500 people living within 1 km to the west and southwest of the Vitro site the radon daughter exposure will be to an average concentration of 0.25 pCi/l for roughly 3 years, giving a population dose equivalent commitment of 240 person-rem. This is estimated to result in an excess 0.0048 lung cancer deaths.

For the 50 workers at the CVWRF, an average concentration of 15 pCi/l for 36 months is assumed. This exposure leads to a population dose equivalent commitment of 330 person-rem, and an estimated excess 0.0066 lung cancer deaths.

For the population beyond 1 km of the Vitro site, the estimated population dose equivalent commitments from MILDOS may be scaled by 0.5 as discussed above. The results are summarized in Table F-15.

000695

Table F-15. Summary of MILDOS predicted doses around the Vitro site, scaled for the disposal at Vitro alternative (person-rem).

Organ	Distance, km 1-2	1-10
Whole body	4.5	110
Bone	4.6	120
Lung	4.5	110
Bronchial epithelium	1800	14000

The excess health effects (lung cancer deaths) due to population and nearby population exposure to radon daughters total 0.29 excess death for the population surrounding the Vitro site out to 10 km (438,000 persons).

General population and nearby worker health effects from gamma radiation exposure.

As discussed for the no action alternative, direct gamma exposure due to the Vitro tailings is insignificant beyond 0.5 mile. Over the course of a 36-month stabilization of the tailings at the Vitro site, the excess gamma exposure rate will decrease roughly linearly to zero with time at any given point. Thus the average gamma exposure rate at any point will be about half of that used for the no action alternative. The population dose equivalent is: 36 person-rem to the population of 250 persons living to the southwest within 0.5 mile of the site. The estimate of excess lung cancer deaths is 0.00072 deaths. The dose equivalent to the 50-person work force at the CVWRF may likewise be scaled by one-half, giving 21 person-rem.

The excess health effects to the general population and nearby workers due to direct gamma radiation is estimated at 0.0011 excess death.

F.5.3 Alternative 3--disposal at South Clive

Remedial action worker health effects from radon daughter exposure.

Worker exposure to radon daughters will occur at South Clive during disposal and at Vitro during excavation. A conservative assumption is that a radon concentration of 30 pCi/l will exist on the piles at both locations (Section F.3.1). Radon daughter equilibrium is assumed to be 25 percent (Section F.2.1). Two options are available for this alternative--truck or train transport of the tailings to South Clive. Since the hours of worker exposure differ for the two options, the calculation of dose equivalent commitments is done separately for each option.

Truck haulage option

As given in Table A-8, the worker exposure hours required for this option total 1.73×10^5 person-hr at the Vitro site, and 0.97×10^{-5} person-hr at South Clive. Radon daughter exposure during truck haulage of tailings is negligible due to the effective dilution and dispersion caused by the moving vehicle. The worker exposures result in dose equivalent commitments of $(1.73 \times 10^5$ person-hr)(30 pCi/l)(7.4×10^{-5} rem/(hr-pCi/l)) = 380 person-rem at Vitro, and $(0.97 \times 10^5$ person-hr)(30 pCi/l)(7.4×10^{-5} rem/(hr • pCi/l)) = 220 person-rem at South Clive.

The total remedial action worker dose equivalent commitment from radon daugther exposure under the truck haulage option is 600 person-rem. This corresponds to an estimated excess of 0.012 lung cancer deaths among the workers.

Train haulage option

As given in Table A-7, the worker exposure hours required for the option total 1.91×10^5 person-hr at the Vitro site, and 1.43×10^5 person-hr at South Clive. Radon daughter exposure during train haulage of tailings is negligible due to the effective dilution and dispersion caused by the moving vehicle. The worker exposures result in dose equivalent commitments of $(1.91 \times 10^5$ person-hr)(30 p/Ci/l)(7.4×10^{-5} rem/(hr-pCi/l)) = 420 person-rem at Vitro, and $(1.43 \times 10^5$ person-hr)(30 pCi/l)(7.4×10^{-5} rem/(hr-pCi/l)) 320 person-rem at South Clive.

The total remedial action worker dose equivalent commitment from radon daughter exposure under the train haulage option is 740 person-rem. This corresponds to an estimated excess of 0.015 lung cancer deaths among the workers.

Remedial action worker health effects from gamma radiation exposure.

Remedial action workers on foot on bare tailings will be exposed to 1400 microR/hr and those afforded shielding by heavy equipment or cover will be exposed to 140 microR/hr as discussed above for Alternative 2.

For tailings transport by truck or train, workers on the vehicles will be exposed to elevated gamma radiation. Exposures during transport may be conservatively estimated by using an exposure rate of 140 microR/hr in the occupied areas of a vehicle. This is based on assuming that the estimated 1400 microR/hr near a large volume of tailings applies to a train or truck, and allowing a factor of 10 reduction to account for vehicle shielding of the workers.

Truck haulage option

Table F-16 details the number or worker hours in each exposure category according to the phase of remedial action work, for the truck transport option.

Table F-16. Worker exposure categories by remedial action phase - truck transport

Phase	Worker hours (000s)		
	No shielding (1400 microR/hr)	Some shielding (140 microR/hr) on-site	transport
Site preparation - Vitro	1.5	.5	-
Site preparation - Clive	-	-	-
Tailings relocation - Vitro	106.5	30.5	489
Embankment construction - Clive	71	26	-
Site restoration - Vitro	15	20	-
Total	194	77	489

As given in Table F-16 the worker-hours of exposure on foot on bare tailings total 1.23×10^5 at Vitro and 0.71×10^5 at South Clive, and result in (1.94×10^5 person-hr)(1400 microR/hr)(1×10^{-6} rem/microR) = 270 person-rem. Heavy equipment operator-hours total 0.51×10^5 at Vitro and 0.26×10^5 at South Clive, and result in (0.77×10^5 person-hr)(140 microR/hr)(1×10^{-6} rem/microR) = 11 person-rem. The transport of tailings requires 489×10^5 worker-hours, and results in (489×10^5 person-hr)(140 microR/hr)(1×10^{-6} rem/microR) = 68 person-rem.

The total remedial action worker exposure for the truck transport option is 350 person-rem. This corresponds to an estimated excess of 0.042 cancer deaths among the workers.

Train haulage option

As given in Table F-17, the worker exposure hours on foot on bare tailings total 1.08×10^5 at Vitro and 0.71×10^5 at South Clive, and result in (1.79×10^5 person-hr)(1400 microR/hr)(1×10^{-6} rem/microR) = 250 person-rem. Heavy equipment operator-hours are 0.84×10^5 at Vitro and 0.72×10^5 at South Clive, resulting in (1.56×10^5 person-hr)(140 microR/hr)(1×10^{-6} rem/microR) = 22 person-rem. The transport of tailings requires 0.25×10^5 person-hr, and results in (0.25×10^5 person-hr)(140 microR/hr)(1×10^{-6} rem/microR) = 4 person-rem.

The total remedial action worker dose exposure for the train transport option is 280 person-rem. This corresponds to an estimated excess of 0.034 cancer death among the workers.

Table F-17. Worker exposure categories by remedial action phase - train transport

Phase	Worker hours (000s)		
	No shielding (1400 microR/hr)	Some shielding (140 microR/hr) on-site	transport
Site preparation - Vitro	7	3	-
Site preparation - Clive	-	-	-
Tailings relocation - Vitro	86	61	25
Embankment construction - Clive	71	72	-
Site restoration - Vitro	15	20	-
Total	179	156	25

General population and nearby worker health effects from radon daughter exposure.

There are no residents within 10 km of the South Clive site, thus no population exposures accrue from the uncovered tailings at South Clive. The population exposures for this alternative will occur around the Vitro site and along the transportation corridor to South Clive.

The excavation and transport of the tailings will take approximately three years. Over the course of this period, the tailings radon source term will decrease at the Vitro site as described in Section F.4.1. The total radon released over the three-year remedial action is about 0.5 times the amount released during three years of the no action alternative. Using this as a scaling factor, the population dose equivalent commitments around the Vitro site are about 0.5 times those for the no action alternative. The estimated population dose equivalent commitments are: 240 person-rem to 500 persons living within 1 km of the site, 330 person-rem to 50 nearby workers at the Central Valley Water Facility, and doses based on MILDOS for the population beyond 1 km as summarized in Table F-18.

Table F-18. Summary of MILDOS predicted doses around the Vitro site, scaled for the disposal at South Clive alternative (person-rem).

Organ	Distance, km 1-2	1-10
Whole body	4.5	110
Bone	4.6	120
Lung	4.5	110
Bronchial epithelium	1800	14000

The excess health effects (lung cancer deaths) due to population and nearby population exposure to radon daughters totals 0.29 excess death for the entire population surrounding the Vitro site out to 10 km (438,000 persons).

General population and nearby worker health effects from gamma radiation exposure.

As discussed for the no action alternative, direct gamma exposure due to the Vitro tailings is insignificant beyond 0.5 mile. Over the course of the three-year removal of the tailings to South Clive, the excess gamma exposure rate at any point will decrease roughly linearly with time from the present value to zero. Thus, the average gamma exposure rate at any point for this alternative will be one-half that used for the no action alternative. In the no action alternative a population of 250 persons living to the southwest was exposed to 11 microR/hr. Scaling by half gives an exposure rate of 5.5 microR/hr, indicating a population dose equivalent of 36 person-rem for the three-year period of tailings relocation. The dose equivalent to the 50-person work force at the Central Valley Water Facility may likewise be scaled by one-half, giving 21 person-rem.

The excess health effects to the general population and nearby workers due to direct gamma radiation is estimated at 0.0011 excess deaths.

General population health effects from transportation of tailings to South Clive.

The exposure rate for people living along the shipping route during normal transport conditions can be determined according to the following equation (AEC, 1972; Dames & Moore, 1975; NRC, 1981b).

$$D(d) = \frac{2\ K}{V}\ I(d)$$

where

$D(d)$ = total integrated dose at distance d, in mrem.
K = dose rate factor in mrem-ft^2 per hour.
V = shipment speed in feet per hour.
d = perpendicular distance of an individual from the shipment path, in feet, where

$$I(d) = \int_d^{\infty} \frac{\exp(-ur)\ B(r)\ dr}{r\ (r^2 - d^2)^{1/2}}$$

and where u is the linear absorption coefficient for air in reciprocal feet (taken to be 0.00118 ft^{-1} in this appendix), and B(r) is the dimensionless Berger buildup factor in air given by the formula

$$B(r) = 1 + 0.0006\ r$$

where r is distance expressed in feet.

For the transportation of the uranium tailings, the dose rate (K) was assumed to be 140 mrem-ft^2/hr. This rate was based on the assumed EGR dose rate of about 1400 microR/hr (or 1.4 mrem/hr) at a distance of 10 feet from the tailings; the shielding effect of the railroad-car sides was ignored.

A computer program TRANSDOS was developed to solve the integral and evaluate the individual exposures. The doses to onlookers were calculated at 10, 50, 100, and 500 meters using a speed of 10 miles/hour and the above dose rate factor of 140 mrem/ft^2/hr. The resulting doses are listed in Table F-19.

Table F-19. Dose to an "onlooker" along tailings transportation route

Perpendicular distance of observer from shipment route (m)	Dose/shipment (rem)
10	2.4E-07
50	3.9E-08
100	1.5E-08
500	5.7E-10

These small doses total to such small population dose equivalents for the number of trips and low population densities along the transport corridor that they are not considered further.

F.5.4 Maximally exposed resident

The maximally exposed resident would be one who lives about 300 feet from the southwestern corner of the Vitro site (Figure 1-1). Assuming the edge of the Vitro site corresponds to the origin of the abcissa in Figure F-3, the person might be exposed to 50 microR/hr in addition to background gamma radiation. This would yield a dose equivalent of (50 microR/hr)(8670 hr/yr)(1 x 10^{-6} rem/microR) = 0.4 rem/yr. The EPA (EPA, 1980) estimated the gamma dose equivalent as 0.5 rem/yr for that location.

The radon daughter exposure may be estimated from the data of Figure F-2. The location of interest falls close to the 1 pCi/l concentration line. For a resident living fulltime at this location the 1 pCi/l concentration would result in a dose equivalent commitment of (1 pCi/l)(7.4 x 10^{-5} rem/(hr-pCi/l))(8670 hr/yr) = 0.6 rem/yr.

F.5.5 Health effects perspective

The health effects calculations presented in this appendix are summarized in Section 5.1.4 of the main text. For comparison to the impacts of remedial action, estimates of the collective dose equivalents due to natural radioactivity (which would result from continuous exposure at the EPA limits for remedial action as discussed in Section 3.1.1 of the main text) are presented in Table 5-3. It is quickly seen that the incremental radiation dose equvalents due to remedial action are small by comparison to the dose equivalents resulting from natural radioactivity.

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Appendix G

MISCELLANEOUS INFORMATION AND CALCULATIONS

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Appendix G

MISCELLANEOUS INFORMATION AND CALCULATIONS

This appendix contains miscellaneous information and calculations that are necessary for a full understanding of some of the impact assessments made in this report, but which are not presented elsewhere in the main text or the other appendices.

G.1 EMISSION RATES FOR CONSTRUCTION ACTIVITIES DURING ALTERNATIVES 2 AND 3

The following material outlines the emission-factors proposed by a Public Health Engineer in the Utah Department of Health's Bureau of Air Quality (personal communication to Dames & Moore from Montie R. Keller, March 16, 1982). These emission factors have been used in Section 5.2 and in Appendix F to estimate the amount of particulate matter that would be raised into the air at the several sites of construction activity. Additional emission factors not covered in the March 16, 1982 memo were taken from AP-42 (EPA, 1977 and supplements). AP-42 factors were also used if they were more conservative.

Bulldozers:

Emission factor = 16 lbs per dozer-hour

Front-end loader operations:

Emission factor = 0.06 lbs per ton of material loaded

Scrapers:

Emission factor = 16 lbs per scraper-hour

Grader:

Emission factor = 32 lbs per grader-hour

Haul-road emissions:

Assumes 18-wheel, 40-ton trucks travelling at 20 mph; 15 percent silt

Emission factor = 8.91 lbs per vehicle-mile on dirt or gravel surfaces

Exhaust (combustive) emissions from railroad engines:

Assume 135 gallons of fuel/engine-hour and 24 engine-hours/day

Emission factors = CO = 130 lb/10^3 gal
HC = 94 lb/10^3 gal
NO_x = 370 lb/10^3 gal
SO_x = 57 lb/10^3 gal
TSP = 25 lb/10^3 gal

Exhaust (combustive) emissions from haul trucks:

Emission factors = CO = 28.7 g/mi
HC = 4.6 g/mi
NO_x = 20.9 g/mi
SO_x = 2.8 g/mi
TSP = 1.3 g/mi

Railroad car dump:

Emission factor = 0.02 lbs per ton of material dumped

Conveyor dump into surge bins:

Emission factor = 0.02 lbs per ton of material dumped

Conveyor belts:

Emission factor = 0.02 lbs per ton of material moved

G.2 POPULATION AND WIND DISTRIBUTIONS NEAR THE VITRO SITE

The distribution of population near the Vitro site was used in the atmospheric dispersion calculations with MILDOS (see Appendix F, Section F.4.4) to estimate population radiological doses during the alternative remedial actions. The population distribution out to 10 km from the center of the site, and in 16 directions, is shown in Table G-1.

The distribution of winds near the Vitro site was also used in the atmospheric dispersion calculations with MILDOS. The assumed wind distributions (frequency of occurrence of wind-speed intervals versus direction) for 6 classes of atmospheric stability are shown in Table G-2.

Table G-1. Population distribution

KILOMETERS	N 0.0	NNE 22.5	NE 45.0	ENE 67.5	E 90.0	ESE 112.5	SE 135.0	SSE 157.5	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
1.0- 2.0	49	0	130	1373	1348	1438	500	134	196	312	841	625	641	344	436	230
2.0- 3.0	53	383	1033	2674	2979	2779	1313	576	923	1835	2203	998	1414	511	834	333
3.0- 4.0	820	1927	4120	3389	3923	3264	4672	1515	1751	2864	2292	2628	3139	356	346	1326
4.0- 5.0	2857	4154	5778	3270	4908	4115	3331	1706	1798	2079	3045	4780	4160	507	3	2957
5.0-10.0	19685	38510	28454	24716	25771	24483	23521	25089	14676	17378	24795	25714	15097	419	259	11556
10.0-20.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.0-30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0-40.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.0-50.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50.0-60.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60.0-70.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70.0-80.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.0-80.0	23464	44974	39515	35422	38929	36079	33337	29020	19344	24468	33176	34745	24451	2137	1898	16402

TOTAL 1-80 KM POPULATION IS 437361 PERSONS

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Table G-2. Vitro site joint frequency wind data

JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.07945,0.31358,0.38002,0.17660,0.03756,0.01278

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	0.0290	0.0246	0.0066	0.0202	0.0088	0.0044	0.0180	0.0066	0.0202	0.0000	0.0158	0.0044	0.0044	0.0044	0.0154	0.0330	0.2166
5.5	0.0799	0.0571	0.0342	0.0342	0.0457	0.0228	0.0228	0.0342	0.0342	0.0000	0.0114	0.0228	0.0228	0.0228	0.0799	0.0342	0.5590
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.1089	0.0817	0.0408	0.0541	0.0545	0.0272	0.0408	0.0408	0.0544	0.0000	0.0272	0.0272	0.0272	0.0272	0.0953	0.0680	0.7756
STABILITY CLASS 2																	
1.5	0.1366	0.0541	0.0328	0.0306	0.0828	0.0431	0.0611	0.0721	0.1543	0.0361	0.1046	0.0317	0.1476	0.1119	0.1372	0.0744	1.3130
5.5	0.3767	0.1712	0.0799	0.0571	0.0799	0.0571	0.1142	0.2283	0.1712	0.1142	0.0457	0.0685	0.1027	0.2511	0.2740	0.2511	2.4429
10.0	0.4795	0.0799	0.0342	0.0228	0.0457	0.0685	0.0913	0.1027	0.0457	0.0114	0.0685	0.0228	0.1941	0.4452	0.2397		1.9862
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.9928	0.3052	0.1469	0.1219	0.1855	0.1459	0.2438	0.3917	0.4282	0.1960	0.1617	0.1687	0.2731	0.5571	0.8584	0.5652	5.7421
STABILITY CLASS 3																	
1.5	0.0664	0.0295	0.0629	0.0523	0.0042	0.0266	0.0619	0.0778	0.0394	0.0384	0.0527	0.0282	0.0079	0.0540	0.0205	0.0509	0.6736
5.5	0.5251	0.1598	0.1027	0.1370	0.1142	0.0799	0.3995	0.5137	0.4338	0.0799	0.1484	0.1256	0.2169	0.1826	0.2397	0.4224	3.8812
10.0	1.3813	0.2968	0.1370	0.0114	0.0685	0.1941	0.6050	0.9247	0.9132	0.0799	0.0571	0.0913	0.1484	0.3653	1.0616	1.2215	7.5571
15.5	0.3653	0.0114	0.0114	0.0000	0.0114	0.0114	0.0114	0.1484	0.2626	0.0114	0.0000	0.0000	0.0228	0.0342	0.1598	0.3311	1.3926
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0342	0.0571	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0228	0.1141
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0571	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0571
ALL	2.3381	0.4975	0.3140	0.2007	0.1983	0.3120	1.0778	1.6988	1.7632	0.2096	0.2582	0.2451	0.3960	0.6361	1.4816	2.0487	13.6757
STABILITY CLASS 4																	
1.5	0.1601	0.0697	0.0883	0.0427	0.0370	0.0526	0.0874	0.1336	0.1265	0.0463	0.0719	0.1147	0.0690	0.1738	0.1316	0.0561	1.4613
5.5	0.6279	0.3425	0.2511	0.1027	0.2055	0.2626	0.6279	0.7877	0.8676	0.1598	0.1826	0.2854	0.3311	0.4566	0.5594	0.5137	6.5641
10.0	1.9521	0.5594	0.2740	0.0457	0.2626	0.7763	4.0868	3.5731	2.7511	0.3881	0.2511	0.2740	0.4909	0.8904	0.8447	1.4155	18.8358
15.5	1.6553	0.3311	0.1027	0.0114	0.1027	0.3881	1.8265	2.8767	4.3151	0.2626	0.0913	0.1027	0.3311	0.9018	1.0502	1.9178	16.2671
21.5	0.2854	0.0114	0.0114	0.0228	0.0114	0.0457	0.0799	0.4452	1.8721	0.0685	0.0342	0.0114	0.1142	0.1941	0.1712	0.2626	3.6415
28.0	0.0571	0.0114	0.0000	0.0000	0.0000	0.0000	0.0114	0.1256	0.7763	0.0342	0.0114	0.0114	0.0342	0.0342	0.0114	0.1027	1.2213
ALL	4.7379	1.3255	0.7275	0.2253	0.6192	1.5253	6.7199	7.941910.7087	9.9595	0.6425	0.7996	1.3705	2.6509	2.7685	4.2684	47.9911	
STABILITY CLASS 5																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	0.8790	0.2626	0.2626	0.1027	0.2968	0.4224	1.0274	1.1416	1.4612	0.2968	0.3995	0.2740	0.5369	0.4224	0.2283	0.4338	8.4476
10.0	0.6621	0.2169	0.0114	0.0228	0.0228	0.4224	2.4201	3.2534	1.3927	0.1598	0.0228	0.0342	0.1826	0.1712	0.2169	0.4110	9.6231
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.5411	0.4795	0.2740	0.1255	0.3196	0.8448	3.4475	4.3950	2.8539	0.4566	0.4223	0.3082	0.7191	0.5936	0.4452	0.8448	18.0707
STABILITY CLASS 6																	
1.5	0.4489	0.3119	0.2038	0.1004	0.1537	0.1860	0.4083	0.4341	0.6321	0.2334	0.2044	0.1798	0.2747	0.2155	0.1824	0.1113	4.2807
5.5	0.7877	0.4224	0.1826	0.0799	0.1941	0.4452	1.0731	1.5753	2.2146	0.5137	0.3881	0.2968	0.4338	0.2740	0.2169	0.3653	9.4635
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.2366	0.7343	0.3864	0.1803	0.3478	0.6312	1.4814	2.0094	2.8467	0.7471	0.5925	0.4766	0.7085	0.4895	0.3993	0.4766	13.7442
ALL	10.9554	3.4237	1.8896	0.9081	1.7249	3.486413.011216.477618.6551	2.5688	2.1044	2.0254	3.4944	4.9544	6.0403	8.2717	99.9994			

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Appendix H

SEISMIC INFORMATION

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H.1 INTRODUCTION

This appendix presents an evaluation of the potential seismic effects on the reclaimed tailings embankment at the Vitro site (Alternative 2) as described in the DEIS, and at the South Clive site (Alternative 3) as described in this FEIS. This appendix includes an assessment of the seismic hazard and earthquake design parameters, the potential for liquefaction affecting the stability of the piles, and the potential for flow slides subsequent to liquefaction (SH&B, 1983).

For stabilization in place and as a result of this assessment and in consultation with Sergent, Hauskins, & Beckwith (SH&B), the concept presented in Section 3.2.3 and in Appendix A for the Vitro site is a refined version of the concept in the DEIS and, as such, contains measures (e.g., desaturate and compact tailings) to mitigate seismically induced liquefaction (see A.3.2.2 and 5.19.6).

Regarding relocation to the South Clive site, the sections of this appendix are based on available literature and data and do not include on-site evaluations or photogeologic studies. Preliminary calculations of a Maximum Credible Earthquake (MCE) for the site and the possible effects at the site from that event are included; however, additional studies are necessary to finalize site design parameters.

H.2 ENGINEERING SEISMOLOGY - VITRO SITE

H.2.1 Regional seismotectonic setting

The Vitro site is located along the Wasatch Front which delineates the boundaries between the Great Basin to the west and the Colorado Plateau in southeastern Utah and the Middle Rocky Mountains in northeastern Utah. The Wasatch Front has been described by Smith (1978) as a transition between major subplates of the Western Cordillera. This transition possesses a thin crust, substantial seismicity, and high heat flow. These features appear to extend eastward from the Wasatch Front for about 50 kilometers (km) under the Colorado Plateau. East-west extensional activity within the Great Basin is believed to have commenced during Oligocene time (25 to 36 million years B.P.) (Hintze, 1971). This activity has resulted in major Great Basin block faulting and possibly 3 to 5 km of normal displacement along the Wasatch Fault System (Hintze, 1971).

The Wasatch Front is part of a distinct north-trending zone of elevated seismic activity which extends from northern Arizona to northwestern Montana. This 100-km wide by 1,300-km long zone has been identified as the Intermountain Seismic Belt (ISB) by Smith and Sbar (1974). The ISB encompasses a region which has experienced more than 15 recorded earthquakes with magnitudes greater than 5.5, including the 7.1 magnitude event in 1959 at Hebgen Lake, Montana. The ISB can be classified as the most seismically active region of the Western Cordillera, excluding earthquake source areas of California and Nevada.

H.2.2 Local seismotectonic setting

H.2.2.1 Historical seismicity

The earthquake record in Utah has been the subject of intense research since the early 1960's. Historical documentation has been completed from the period of 1850 until about 1962, followed by seismographic recording by the University of Utah (Arabasz et al., 1979; Richins et al., 1981). Since 1974, telemetered seismic arrays have been operated by the University.

As presented in Table H-1, 15 moderate earthquakes have been recorded in the Utah region between 1850 and 1978. Two of these significant earthquakes may be directly related to the Wasatch Fault, the events of 1910 and 1914. As indicated by the distribution of 1962 to 1978 epicenters depicted in Figure H-1, concentrations of North Central Utah seismic events occur in the vicinity of the Hansel Valley Fault north of the Great Salt Lake and near the East Cache Fault north of Salt Lake City.

The most damaging earthquakes of the north central region of Utah occurred in Hansel Valley on March 12, 1934, and in Cache Valley on August 30, 1962. The 6.6 M_L Hansel Valley earthquake produced about 50 cm of vertical fault displacement and disruption of the land surface due to liquefaction and ground movement (Smith, 1978; Marsell, 1964). The 5.7 M_L Cache Valley event caused about one million dollars of property damage in Logan and surrounding communities (Cook, 1971).

Table H-1. Largest earthquakes in the Utah region 1850 through 1978*

Local date	Lat (°N)	Long (°W)	Intensity I_o	Magnitude M_L	Location
1884 Nov 10	42.0	111.3	VIII	(6)	Bear Lake Valley
1887 Dec 5	37.1	112.5	VII	(5-1/2)	Kanab
1900 Aug 1	40.0	112.1	VII	(5-1/2)	Eureka
1901 Nov 13	38.8	112.1	IX	(6-1/2+)	Richfield
1902 Nov 17	37.4	113.5	VIII	(6)	Pine Valley
1909 Oct 5	41.8	112.7	VIII	(6)	Hansel Valley
1910 May 22	40.8	111.9	VII	(5-1/2)	Salt Lake City
1914 May 13	41.2	112.0	VII	(5-1/2)	Ogden
1921 Sep 29	38.7	112.2	VIII	(6)	Elsinore
1921 Oct 1	38.7	112.2	VIII	(6)	Elsinore
1934 Mar 12	41.7	112.8	IX	6.6	Hansel Valley (Kosmo)
1959 Jul 21	37.0	112.5	VI	5.5+	Utah-Arizona border (Kanab)
1962 Aug 30	42.0	111.7	VII	5.7	Cache Valley (Logan)
1966 Aug 16	37.5	114.2	VI	5.6	Nevada-Utah border
1975 Mar 28	42.1	112.5	VIII	6.0	Idaho-Utah border (Pocatello Valley)

*Table includes earthquakes of maximum Modified Mercalli intensity (I_o) of VII or greater, or of Richter magnitude 5.5 or greater. Magnitudes in parentheses are estimated from I_o. Sample area: 36°45'N - 42°30'N, 108°45'W - 114°15'W. Aftershocks are excluded.

Source: Arabasz et al., (1979).

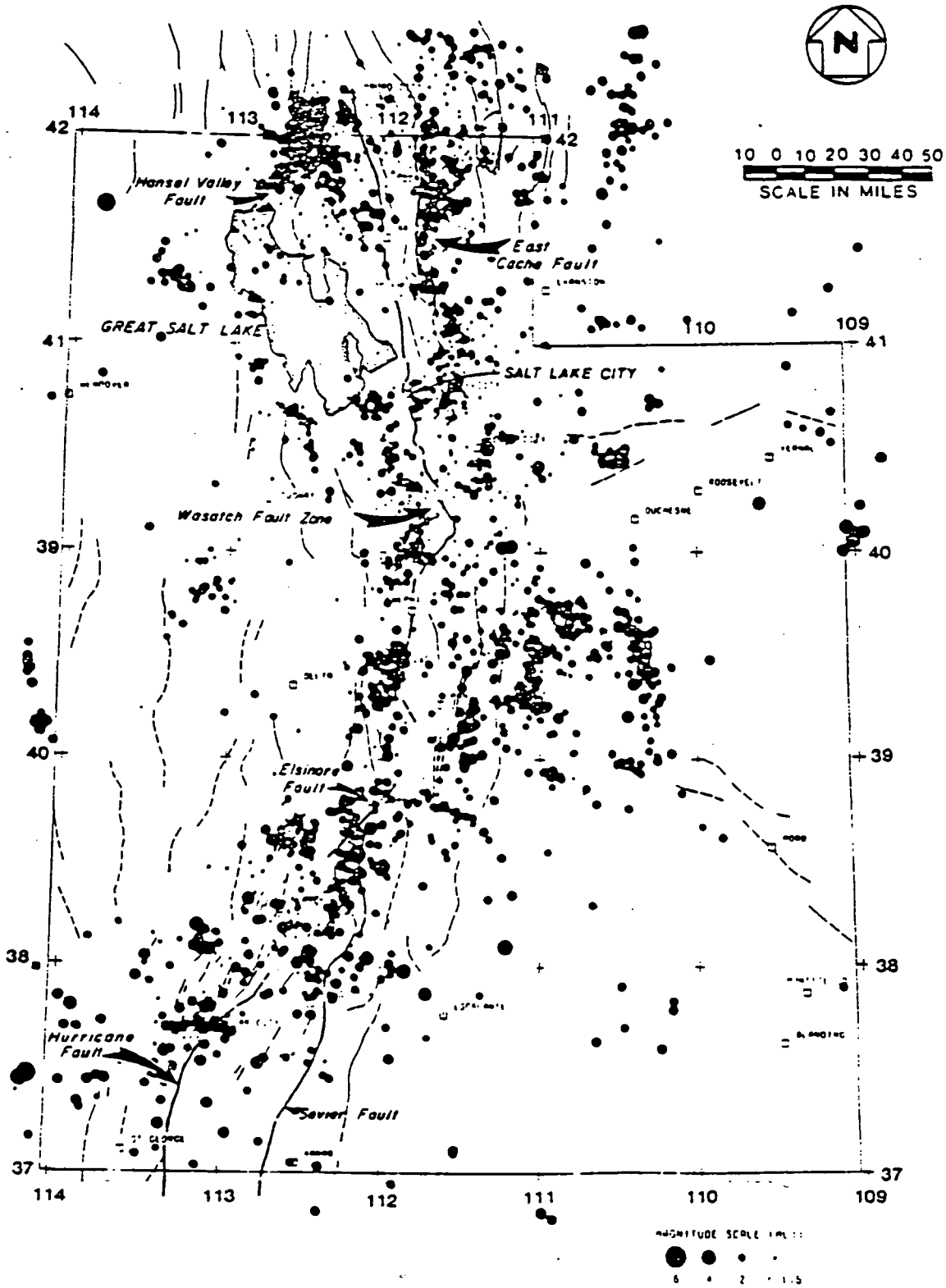

FIGURE H-1

UTAH EARTHQUAKES, JULY 1962 - JUNE 1978

REF: ARABASZ, (1979)

H.2.2.2 Active faulting

A definitive assessment of earthquake risk cannot be fully ascertained from the relatively short and incomplete 132-year record of earthquake events. Geologic evidence of past fault ruptures along the Wasatch Fault and other potential source faults has been the subject of current research in order to estimate maximum earthquake magnitude and recurrences.

Based on earthquake history and geologic evidence, the Salt Lake City region contains numerous young faults, including the Hansel Valley, East Cache, Wasatch, and unnamed faults along the west flank of the Oquirrh Mountains south of the Great Salt Lake (Figure H-2). Due to the close proximity of the Wasatch Fault to the Vitro site and its suspected activity, the earthquake risk imposed by the Wasatch Fault is greater than the risk from earthquakes generated by rupture of the other fault systems mentioned above. In terms of current criteria, an active fault is defined as a structure which has experienced displacement in the last 10 to 12 thousand years. The northern portion of the Wasatch Fault has been identified as falling within the active fault category.

The Wasatch Fault zone trends north-south through central Utah from Gunnison, Utah, to Malad City, Idaho. Swan et al., (1980) suggest that the fault system may have as many as ten, 30- to 40-km segments which are capable of separate rupture. The fault expresses Late Quaternary movement almost throughout its entire length (Swan et al., 1980). These geomorphic expressions are in the form of scarps, sagponds, springs, slickensided and sheared surfaces, and displaced beds (Van Horn, 1971). These features have been extensively documented by Cluff et al., (1970), Cluff and Slemmons (1971) and Marsell (1964).

The patterns and history of displacement along the Wasatch Fault zone appear to be highly variable. However, the predominant movement of the fault system is normal and steeply dipping to the west with valleys such as the Utah Valley near Provo lagging behind the upward movement of the Wasatch Mountain block (Hintze, 1971). A total vertical displacement of 3,000 to 4,000 meters may be present in the Utah Valley region (Hintze, 1971).

There have been no surface faulting events along the Wasatch Fault during the past 138 years (Swan et al., 1980). Geologic evidence, however, identifies multiple displacement episodes in the northern portion of the fault system. From a study of remnant facets of the Wasatch Mountain front near Provo, Hamblin (1976) estimates eight periods of fault movement separated by periods of quiesence, and three active periods in the Salt Lake City area. The most comprehensive evaluation of displacement history was performed by Swan et al., (1980). At Kaysville, 30 km north of Salt Lake City, at least three surface faulting events with displacements of 1.7 to 3.7 meters have occurred since the Middle Holocene. At Hobble Creek, 46 km south of Salt Lake City, six to seven events with displacements of 0.8 to 2.8 meters have occurred in the past 12,000 years.

As depicted on Figure H-3, the segment of the Wasatch Fault zone closest to the Vitro site is the East Bench Fault, which is about 5 km east of the

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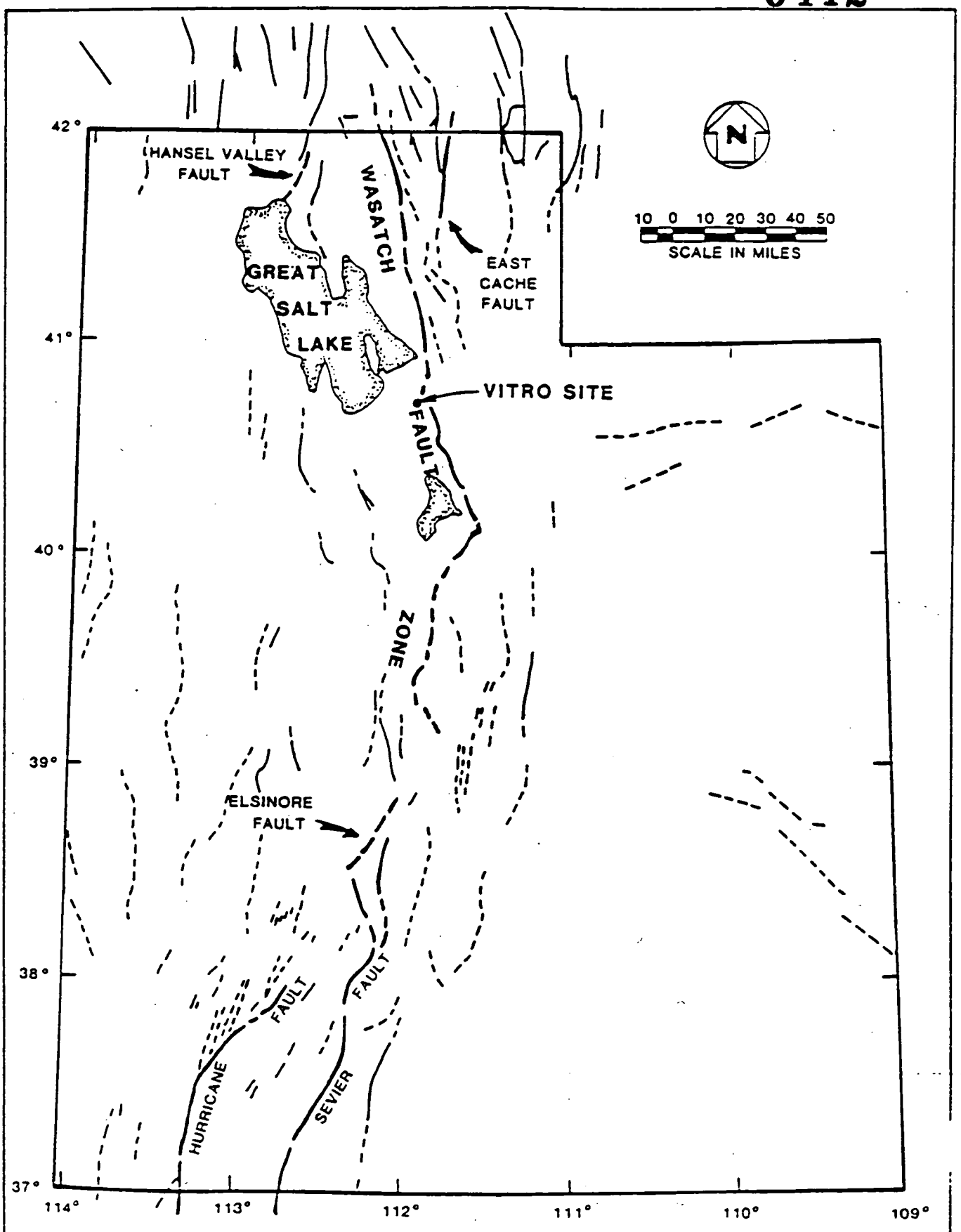

FIGURE H-2. GENERALIZED MAP OF YOUNG FAULTS IN UTAH

REF: ANDERSON & MILLER (1979)

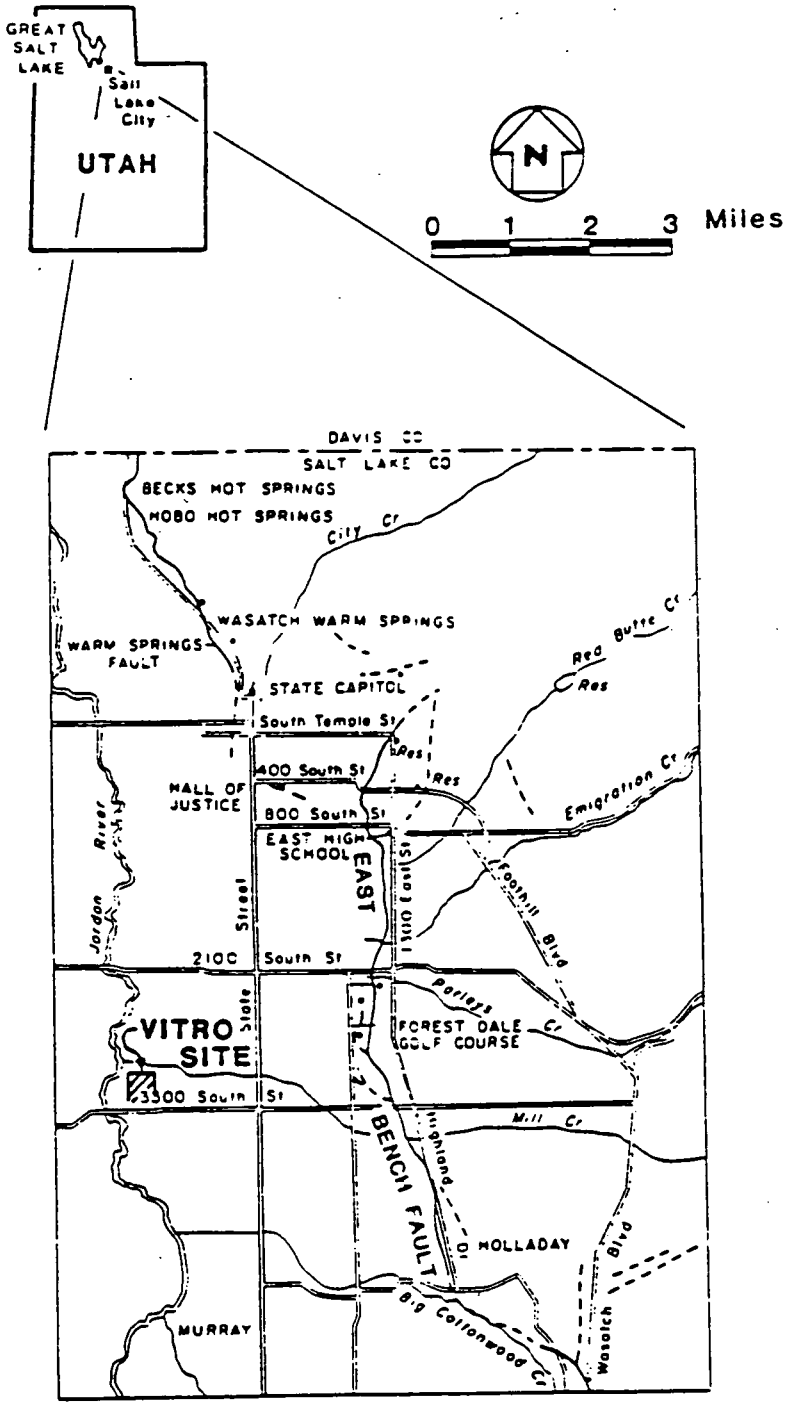

FIGURE H-3
LOCATION OF EAST BENCH FAULT

REF: VAN HORN (1971)

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site. No detailed displacement history is available for this fault segment; however, its geomorphic expression definitely indicates Quaternary movement (Cluff et al., 1970).

H.2.2.3 Seismic gaps

Based upon recent microseismic data, Smith (1971) has possibly detected two major seismic gaps along the Wasatch Fault zone. One extends from Brigham City south 70 km to Salt Lake City and the other extends from Salt Lake City south 70 km to Provo. These zones of low earthquake activity are separated by an area of persistent low-to-moderate intensity earthquake events (Arabasz et al., 1980). Several hypotheses have been proposed in an attempt to explain the seismic gaps, one of which indicates that these areas could be the sites of future large earthquakes due to a long-term accumulation of tectonic stress (Smith, 1974).

H.2.3 Maximum Credible Earthquake and recurrence interval

The major objective of the investigations cited herein, and the subject of ongoing research, has been to establish the Maximum Credible Earthquake (MCE) and the recurrence interval of major earthquakes along the Wasatch Front. These studies have not presently established conclusive values for these parameters. Sufficient analysis has been completed, however, to establish reasonable seismic design criteria for the reclamation of the Vitro site. Based on various analyses of geologic data and earthquake history, several investigators have proposed values for recurrence interval and earthquake magnitude. These are summarized on Table H-2.

It is necessary to obtain specific geologic data concerning the displacement history of that particular segment to evaluate the return period of a moderate to large earthquake resulting from rupture along a Wasatch Fault segment such as the East Bench Fault. As discussed by Swan et al., (1980), there may be as many as ten fault segments which rupture separately at different return periods. As an example of the difference between the generalized return periods presented in Table H-2 and the return period of a fault segment, Swan, et al., (1980), estimate the average return periods of surface fault events of the Kaysville and Hobble Creek segments as 500 to 1,000 and 1,500 to 2,600 years, respectively. As evident from this example, the recurrence estimates for the entire Wasatch Fault zone may substantially underestimate the return period of moderate to large earthquakes along any one fault segment.

Table H-2. Summary of earthquake magnitude & recurrence interval estimates for the Utah region

Source	Magnitude/recurrence
1. US Geological Survey (1976)	Assigned an estimated maximum credible earthquake for the entire state of Utah of magnitude 7.5.
2. Arabasz et al., (1979)	Based on historical earthquake data - following return periods presented: 22-25 years for $M_L \geqq 6.0$; 111 to 115 years for $M_L \geqq 7.0$; 232 to 263 years for $M_L \geqq 7.5$. Estimates for the Wasatch Front area (92,810 km^2).
3. Swan et al., (1980)	For entire Wasatch Zone, moderate to large earthquake (M 6.5-7.5) return period of 50 - 430 years estimated. Values derived from recurrence intervals evidence along the Kaysville and Hobble Creek segments of the Wasatch Zone. Evidence of recurrence along other segments not available.
4. Doser & Smith (1982)	387 - 667 year return period estimated from analysis of geologic moment rates for $6.5 \leqq M_L \leqq 7.5$ along entire Wasatch fault.

Source: SH&B, 1983

H.2.4 Seismic zoning studies

Various investigators have conducted seismic zoning studies to which contours of effective peak accelerations (EPA) were estimated for the area of the Vitro site. These studies are based on statistical analysis of the seismic history and a general appraisal of regional faulting and tectonics. The following is a list of these estimates:

EPA	References	Remarks
0.6g	Algermissen et al., (1982)	90 percent probability of not being exceeded in 250 years.
0.21g	Algermissen & Perkins (1976)	90 percent probability of not being exceeded in 50 years.
0.2g	Applied Technology Council (1978)	90 percent probability of not being exceeded in 50 years.
0.08g	Liu and DeCapua (1975)	100 year return.

Because of the inadequate nature of the brief historical earthquake record, these regionalized studies only provide a rough indication of seismic hazard. The analysis and conclusions presented herein concerning the seismic risk and expected ground motions have been oriented specifically toward the Vitro site and should be considered as the criteria for design rather than the above-mentioned regionalized studies.

H.2.5 Design parameters

It is understood that an Environmental Protection Agency 200-year, no-active-maintenance criterion will be applied to the reclamation design of the Vitro site. Based upon current knowledge of the recurrence interval of damaging earthquakes which would result from fault rupture along the Wasatch Front, it is concluded that there is a reasonable possibility that an M_L 7.0 or greater earthquake on the East Bench Fault will cause substantial ground shaking at the Vitro site within the next 200 years. As will be discussed in the report sections which follow, this ground motion could cause local liquefaction and ground movements of the unconsolidated deposits of Jordan Valley.

Due to its proximity to the Vitro site, rupture of the East Bench Fault segment of the Wasatch Fault system probably would cause the most intense ground shaking. The displacement history of this fault segment is not fully known; therefore, it is reasonable to apply a return period of the entire Wasatch source area to the near-site segment. This return period has been estimated to be between 50 to 667 years for earthquakes in the range of M_L 6.5 to 7.5. As with the Kaysville and Hobble Creek Fault segments, the true return period of a

fault rupture event along the East Bench Segment may be several times longer than that of the entire Wasatch Fault zone. The risk of a damaging earthquake generated by rupture along the East Bench segment should be reassessed when more local geologic data become available.

The design earthquakes discussed above probably would be in the range of M_L 6.0 to 7.5. This near-field event would produce maximum accelerations in rock in the range of about 0.3 to 0.55g (Buckman et al., 1980). Amplification or damping effects in the unconsolidated deposits of Jordan Valley are possible, but any accelerations in this range would produce similar on-site damage.

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H.3 GEOTECHNICAL PROFILE - VITRO SITE

Subsurface conditions at the Vitro site are characterized by their variability. Based on boring logs and test data presented in Dames & Moore (1982), Chen & Associates, Inc. (1980a, 1980b), Sergent, Hauskins & Beckwith (1981), Martin et al., (1980), and Colorado State University (1982), a typical geotechnical profile for a north-south section through the middle of the southern section of the existing tailings deposit was developed. This section is shown in Figure H-4. It is necessarily simplified, because of the variability of conditions, but it does include trends important to a consideration of liquefaction potential.

As shown in Figure H-4, the top of the existing tailings pile, at this location, is at elevation 4248. Considering the complete site, variations from 4232 to 4252 are encountered. The interface between natural soils and tailings is at elevation 4231, with variations from 4225 to 4235 throughout the site.

The ground-water table at the time of the above listed investigations was at elevation 4231, or coincident with the surface of the natural soils in the model employed herein, with variations from 4226 to 4235. Tailings above the water table appear to be saturated in many places, probably because of perched water-table conditions.

The initial natural soil stratum encountered is composed of predominantly clayey soils, classifying at CL-ML to CL in the Unified Soil Classification System, grading to ML and CH in places. This layer is relatively thin, with a model thickness of 5 feet as shown in Figure H-4.

Sandy soils, classifying predominately as SP-SM to SP, underlay the clayey soils to an average depth of 11 feet. This layer is not apparent in a few borings and has a thickness of approximately 20 feet in other borings.

The sandy soils are underlain by a second layer of clayey soils, tending to be more sandy in some locations. Only six of the eight Dames & Moore (1982) borings penetrated to these depths, obviating an estimate of their thickness.

Typical properties of the different soil strata encountered are listed in Table H-3. Grain-size distributions for tailings and natural or foundation soils are plotted in Figure H-5. Gradations of the more sandy tailings are comparable to the in-situ sandy soils. Similarly, gradations of the more clayey tailings, or slimes, are comparable to the in-situ clayey soils.

Standard penetration testing (SPT) blow counts (N-values), recorded primarily in the upper sandy soil stratum, are plotted in Figure H-6, as a function of depth from the ground surface. The values are very scattered, but tend to increase with depth, though the correlation for this trend is weak. Dames & Moore values are typically higher than Chen & Associates, Inc. values. The latter values were predominantly recorded in the northeast section of the site, while the former include values from all areas of the site. Blow counts range from 5 to 25 with a mean value of 15.

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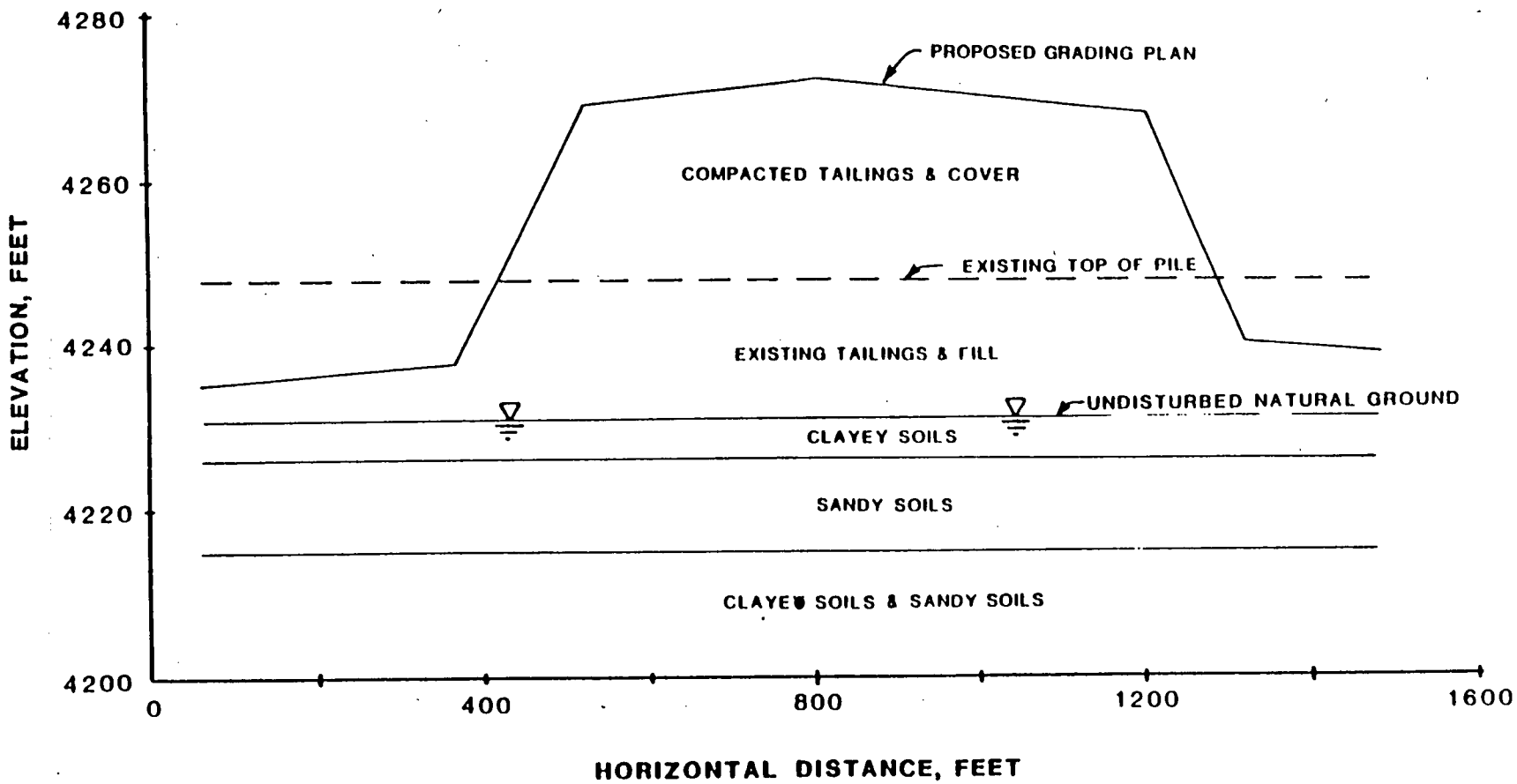

FIGURE H-4. TYPICAL GEOTECHNICAL PROFILE

Table H-3. Soil parameters

Soil type	Total unit weight pcf	Friction angle	Undrained cohesive strength psf
Cover & compacted tailings	125	35	200
Existing tailings & fill	115	30	0
Clayey soils	115	0	600
Sandy soils	120	35	0

Source: SH&B, 1983

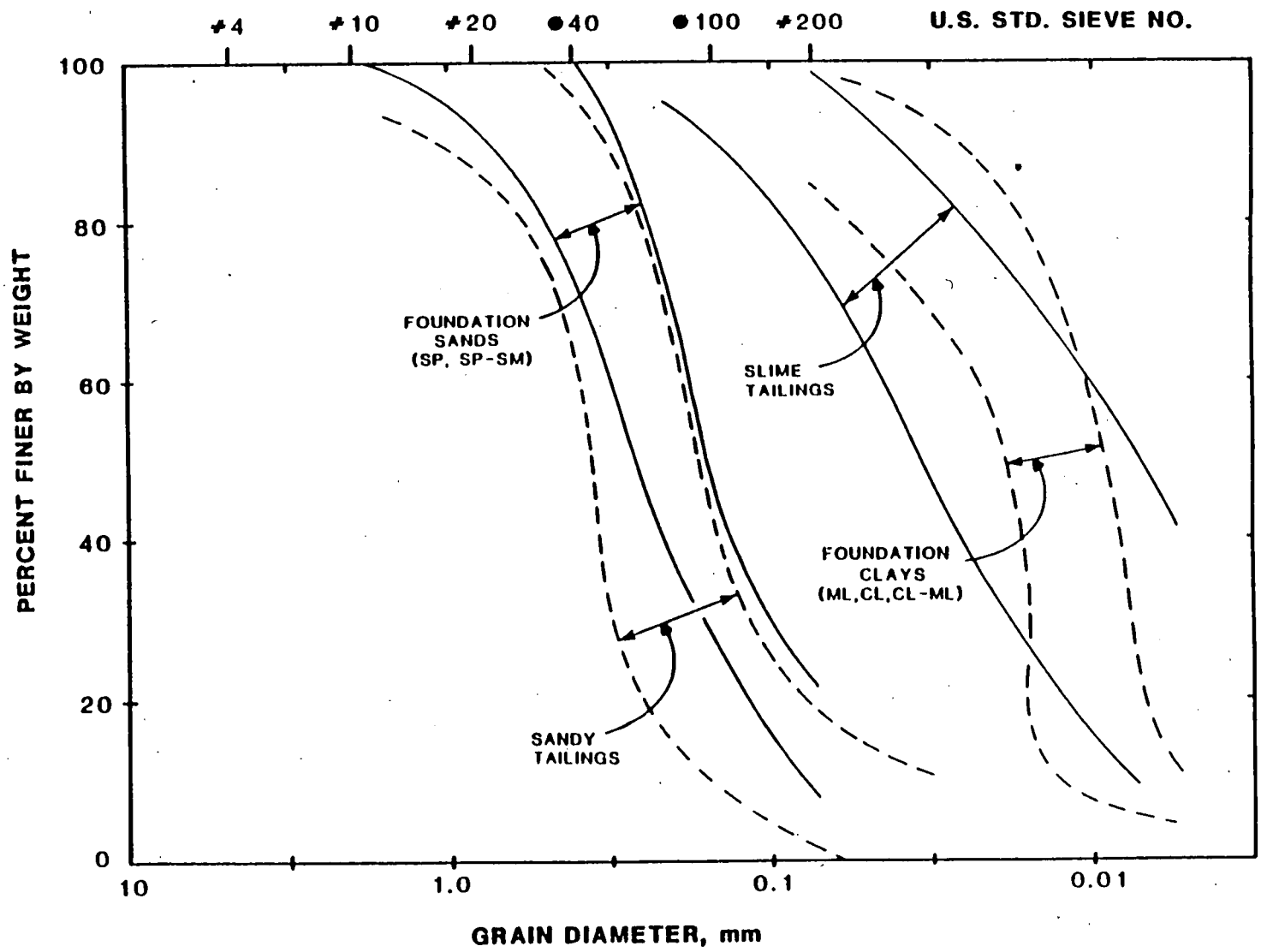

FIGURE H-5. GRAIN SIZE DISTRIBUTIONS

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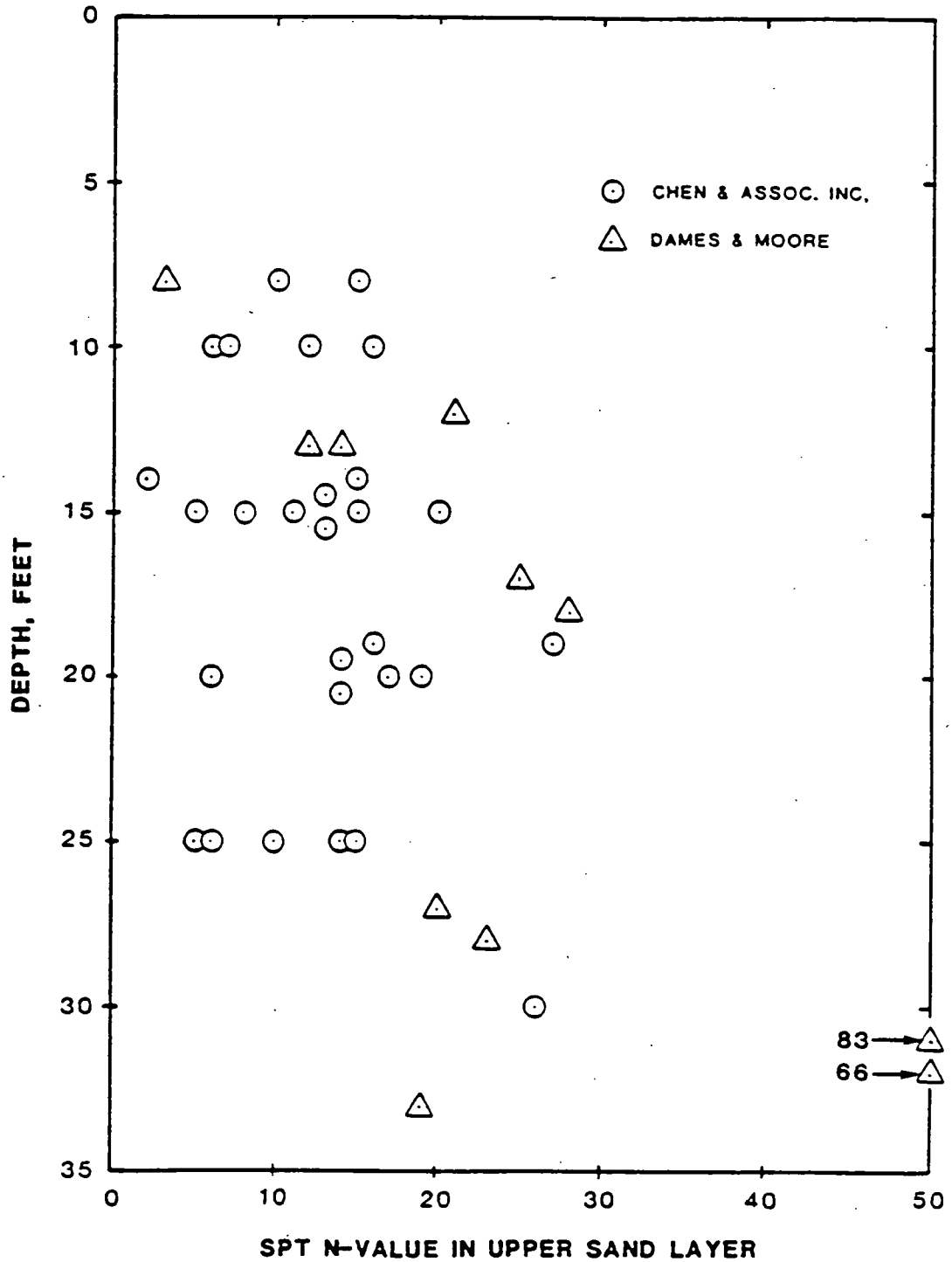

FIGURE H-6. BLOWCOUNTS IN UPPER SAND LAYER

The tailings, foundation sandy soils, and, to a lesser extent, the foundation clayey soils are susceptible to liquefaction during earthquake shaking. Particularly, the sandy soils and tailings below the water table, or those in a saturated state, have a grain-size distribution that would preclude quick dissipation of excess pore water pressures expected during a seismic event. Since the soils are lenticular, sands having a coarse gradation that otherwise would not be susceptible to liquefaction may be confined by more silty or clayey lenses. This could result in their being liquefied, or their losing a significant portion of their strength.

The more clayey soils, based on criteria reported by Seed and Idriss (1981), may also have lenses susceptible to liquefaction or significant strength loss. They suggest liquefaction can occur in clayey soils if the liquid limit is less than 35, the in-situ water content is less than 0.9 times the liquid limit, and the soil fraction finer than 0.005 mm is less than 15 percent. Based on the data presented in Table H-3, the first of these criteria is marginally met, but the last two are met, indicating at least a susceptibility of lenses of clayey soils to liquefaction. This assessment is made more critical if the potential effects of clay sensitivity are considered. Parry (1974) has indicated clays along the Wasatch Front may have sensitivities as high as 11, making them susceptible to a greater strength loss during earthquake shaking than less sensitive clays.

H.4. ANALYSIS OF LIQUEFACTION POTENTIAL & EMBANKMENT STABILITY - VITRO SITE

H.4.1 Seed & Idriss empirical method

Liquefaction of the upper sand layer of Figure H-4 was assessed using the Seed and Idriss (1981) empirical method. In this updated approach, the shear stress on horizontal planes induced by earthquake shaking is estimated in the same manner as in their earlier procedure (Seed and Idriss, 1971). The resistance to liquefaction during a seismic event, expressed in terms of a cyclic stress ratio, can be determined from laboratory testing or estimated from SPT blow count data, the mean grain-size, and effective overburden pressure. Since appropriate test data were not available, the latter approach was taken.

Three geotechnical profiles were considered, representing the range in existing and proposed conditions at the site. For these analyses, the ground surface is assumed level, which is appropriate in the center of the separate piles, but not near their edges. The first profile has a ground surface elevation of 4235, the second 4250 and the third 4270. The first is representative of the lower existing piles, the second the higher existing piles, and the third the proposed graded and covered pile.

The shear stress induced is calculated from

$$(T_h)_{ave}/\sigma_o = 0.65\ (a_{max}/g)\ (\sigma_o/\sigma'_o)\ r_d,$$

where a_{max} is the maximum acceleration in g-units, σ_o and σ'_o = are the total and effective overburden stresses, and r_d is a reduction factor dependent on depth. Considering the center of the upper sand layer, and assuming r_d = 0.9 in all cases, an expression for induced stress as a function of a_{max}/g was developed for each case.

The shear resistance was estimated for uncorrected blow count values of 5, 15, and 25, representing the lower bound, mean, and upper bound, respectively, of data presented in Figure H-6 for the upper sand layer. Uncorrected blow counts, rather than corrected values, were used because of the scatter in data and because the range in effective overburden pressures (1 ksf < σ'_o < 3 ksf) results in correction terms varying from only 0.8 to 1.2. The larger term is associated with shallower depths. Seed and Idriss (1981) suggest that for depths of 10 feet or less, the recorded N-value should be further modified by a factor of 0.75 which offsets the 1.2 correction factor.

Seed and Idriss (1981) present two sets of curves plotting N-value versus cyclic stress ratio (for σ'_o = 2 ksf) for different earthquake magnitudes, M. The first set is for sands with D_{50} larger than 0.25 mm, and the second for low plasticity silts and sands with D_{50} less than 0.15 mm. As indicated in Figure H-5 the D_{50} size varies from 0.16 to 0.36 for the sandy foundation soils and the sandy tailings. Thus, the set of curves for sands is applicable to the major portion of tailings and in-situ soils. Using these curves, cyclic stress ratios were estimated. Finally, these ratios were equated to the induced stress ratio and a value of maximum acceleration likely to cause liquefaction calculated.

Results of the analyses are presented in Figure H-7, which plots the calculated acceleration versus blow count for two cases and two values of earthquake magnitude. For M = 6 and a ground surface elevation of 4235, for example, the maximum acceleration likely to induce liquefaction varies from 0.07g for N = 5 to 0.39g for N = 25. For M = 6 and a ground surface elevation of 4270, the proposed grading plan, the acceleration value varies from 0.1g for N = 5 to 0.55g for N = 25. This illustrates the effect that increasing confining pressure has in decreasing the susceptibility to liquefaction. Since ground surface accelerations of 0.1g to 0.5g are probable during any 200-year period, liquefaction of at least some zones of foundation soils and tailings is probable.

H.4.2 Yegian & Whitman empirical approach

Yegian and Whitman (1978) analyzed historical data on liquefaction and developed a predictive methodology that includes the effect of both earthquake magnitude and hypocentral distance. Required input to the methodology is blow count data. Recorded blow count values are corrected using the relationship $N' = 50N/(\sigma'_v+10)^{\frac{1}{2}}$, where σ'_v is the effective overburden pressure in units of psi. For the upper sand layer under consideration, the correction term is 1.6 to 3, resulting in corrected blow counts, N', varying from 15 to 40, with a mean value of approximately 30.

The value of N' is used to estimate a parameter S_c related to the potential for liquefaction. In the simplified approach, a boundary line representing a 50 percent probability of liquefaction occurring is computed from $M = 2 \text{ Ln } ((R+16)\ \sigma'_v S_c/H)$, where R is the hypocentral distance in miles and H is the depth to the point of consideration in feet. Relationships between M and R for each of the three profiles were computed using $S_c = 1.7$. The point of consideration was taken as the center of the upper sand layer.

Results of the analyses are presented in Figure H-8. For a section with ground surface elevation of 4235, a seismic event with magnitude 6.1 or larger occurring 10 miles from the Vitro site would have a 50 percent or larger probability of producing liquefaction at the site. If the ground surface were at elevation 4270, a magnitude 6.8 or larger event at the same distance would result in the same likelihood of liquefaction. This comparison confirms the Seed and Idriss (1981) analysis results concerning effect of confinement. Also, since seismic events of M = 6 or larger occurring within 10 miles are probable during any 200-year period, the analysis confirms the conclusion that liquefaction during the design life is probable.

For comparison, two empirical relationships between M and R are included in Figure H-8. The first from Youd and Perkins (1978), defines R as the furthest distance from point of energy release to a liquefied site. Thus, it defines an upper bound envelope for R; sites more distant than R from the point of energy release for the same M are unlikely to liquefy, but sites less distant than R could liquefy. The relationship is based on a limited number of major seismic events, and considers soil conditions generally similar to those at the Vitro site. The relationship of Kuribayshi and Tatsuoka (1977) is similar, except that it is a mean relationship for Japanese data, and R is defined as the epicentral distance. The close comparison of calculated relationships for the Vitro site to the empirical relationships lends confidence to the predictions indicated for the Vitro site.

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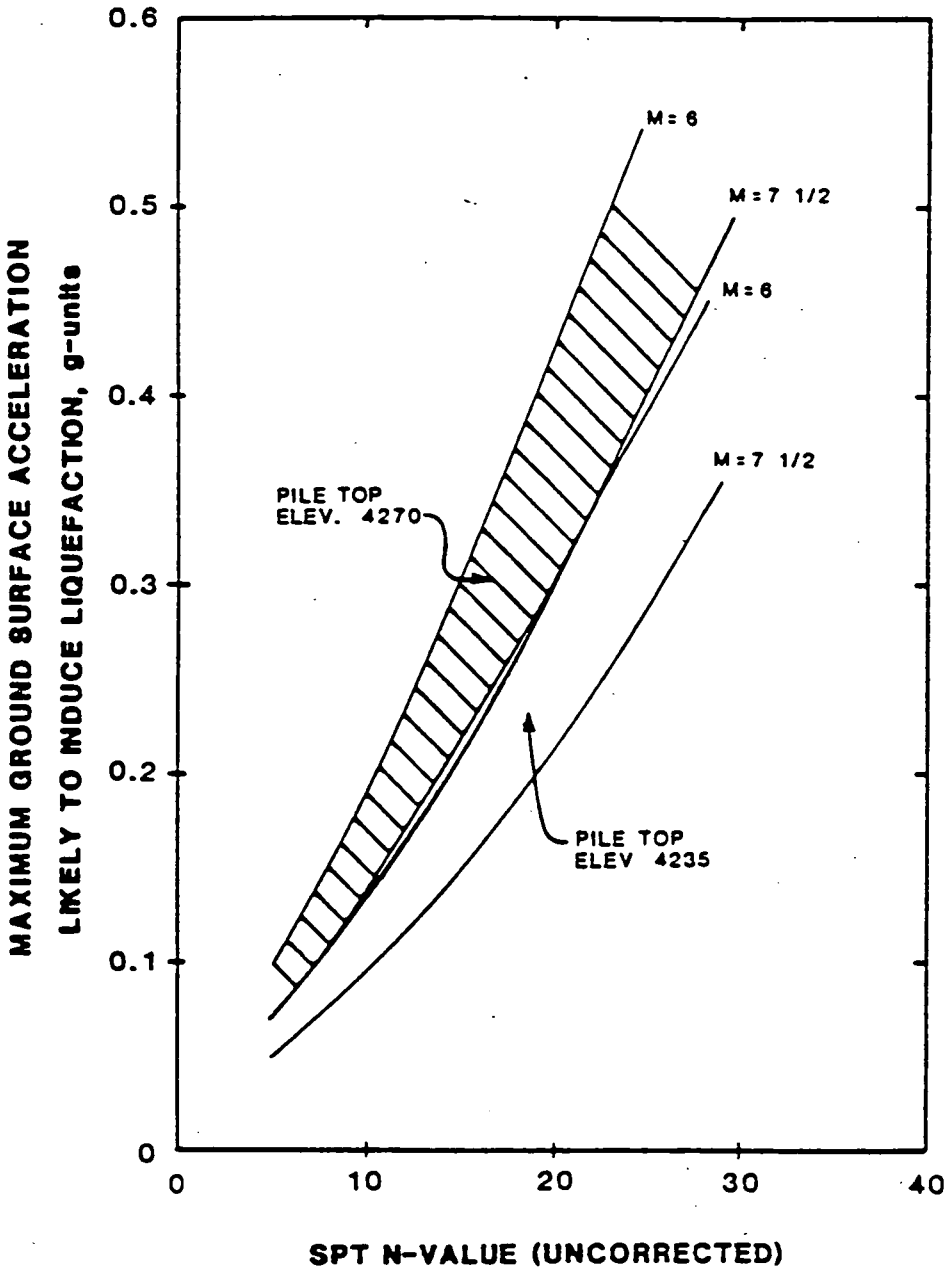


FIGURE H-7
RESULTS OF SEED & IDRISS ANALYSIS
OF LIQUEFACTION POTENTIAL

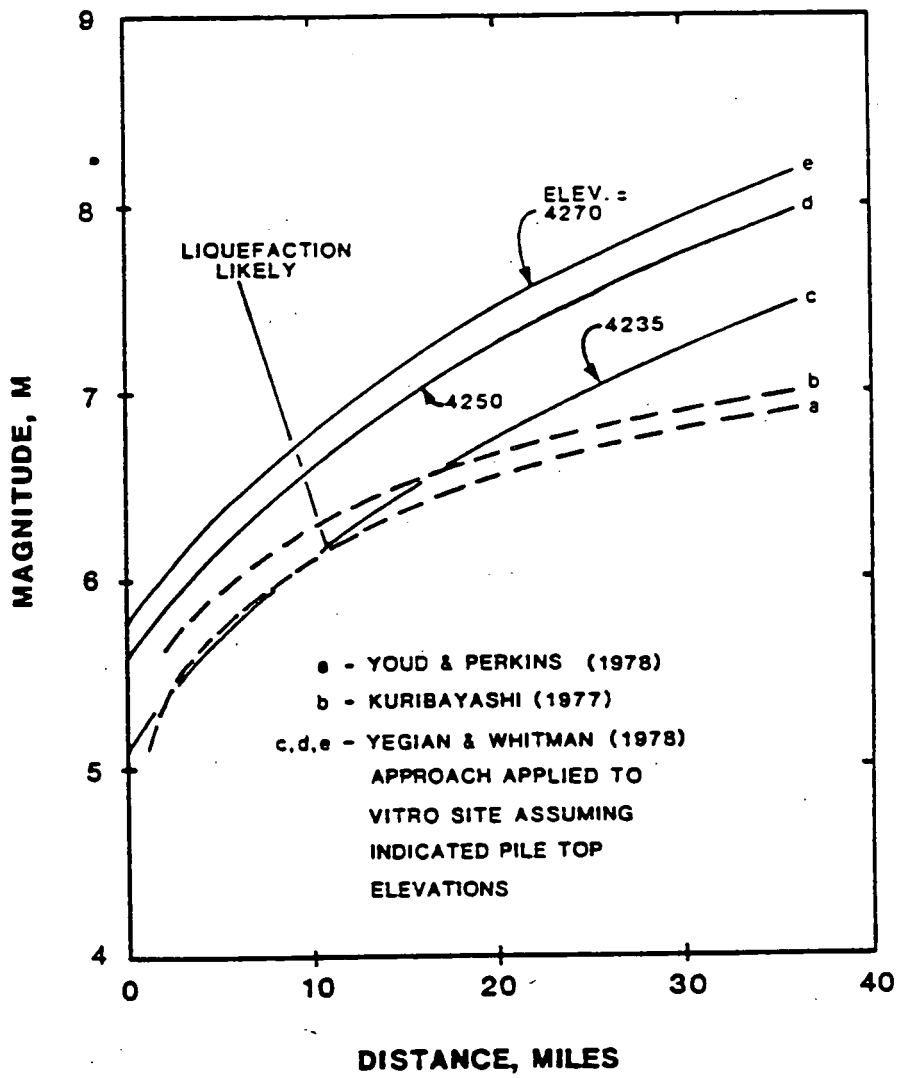


FIGURE H-8
RESULTS OF YEGIAN & WHITMAN ANALYSIS OF LIQUEFACTION POTENTIAL

000740

H.4.3 Embankment stability

A preliminary and somewhat simplistic assessment was made of embankment stability by performing ordinary-method-of-slices stability analysis of potential failure surfaces A and B of Figure H-9. Strengths utilized are given in Table H-3 for static loading conditions. For earthquake loading conditions, various zones of the profile were considered liquefied, or having a complete or significant strength loss. In the analyses, a horizontal seismic coefficient was not employed, since this would tend to overstate the effect of seismic shaking in the type of analysis performed.

Results of the analyses are listed in Table H-4. Because the slope angle is relatively small, static safety factors are greater than 3. If it is assumed the upper sand layer suffers a complete strength loss during a seismic event, the safety factor is reduced to a value of approximately 2. If, in addition, the existing tailings suffer a complete strength loss, the safety factor is reduced to near 1. If only the natural soils suffer a complete strength loss, the safety factor is reduced to 1.6 for surface A and 1.0 for surface B, illustrating the stability rendered by the clay layer for the shallower failure surface. If the natural soils and existing tailings all suffer complete strength loss, the safety factors are reduced to well below 1.0.

While these results are approximate and do not address deformation of the slopes or the mechanism of failure, they do indicate the potential effect of a major seismic event with a relatively long duration of shaking on embankment stability. The worst case listed in Table H-4 is likely only for a very major event. Other cases can generally be associated with events that are probable for a 200-year design life. Though complete failure is unlikely, significant deformations that would impair the functioning of the cover, and require reconstruction and repair are probable. A further assessment of movements could be made using techniques developed by Makdisi and Seed (1978; 1979), Sarma (1979) and Franklin and Chang (1977), based on more complete soil strength parameters.

H.4.4 Potential for flow slides

A potential consequence of seismically induced slope failures of tailings piles is a flow slide. Historically, earthquake-induced liquefaction of saturated tailings piles has resulted in a part of the mass of tailings flowing distances of from several hundred feet to tens of miles.

The existing tailings piles at the Vitro site are 15 to 20 feet high and contain saturated zones. The proposed single pile will be approximately 35 feet high with 5 to 1 (horizontal to vertical) slopes. The additional 15 to 20 feet will be compacted and covered with a moisture barrier of approximately 10 feet in thickness. Thus, only zones of the lower 15 to 20 feet, and the foundation soils, will be saturated. The ground slope in the area of the proposed pile varies from essentially flat to 1.5 degrees.

000742

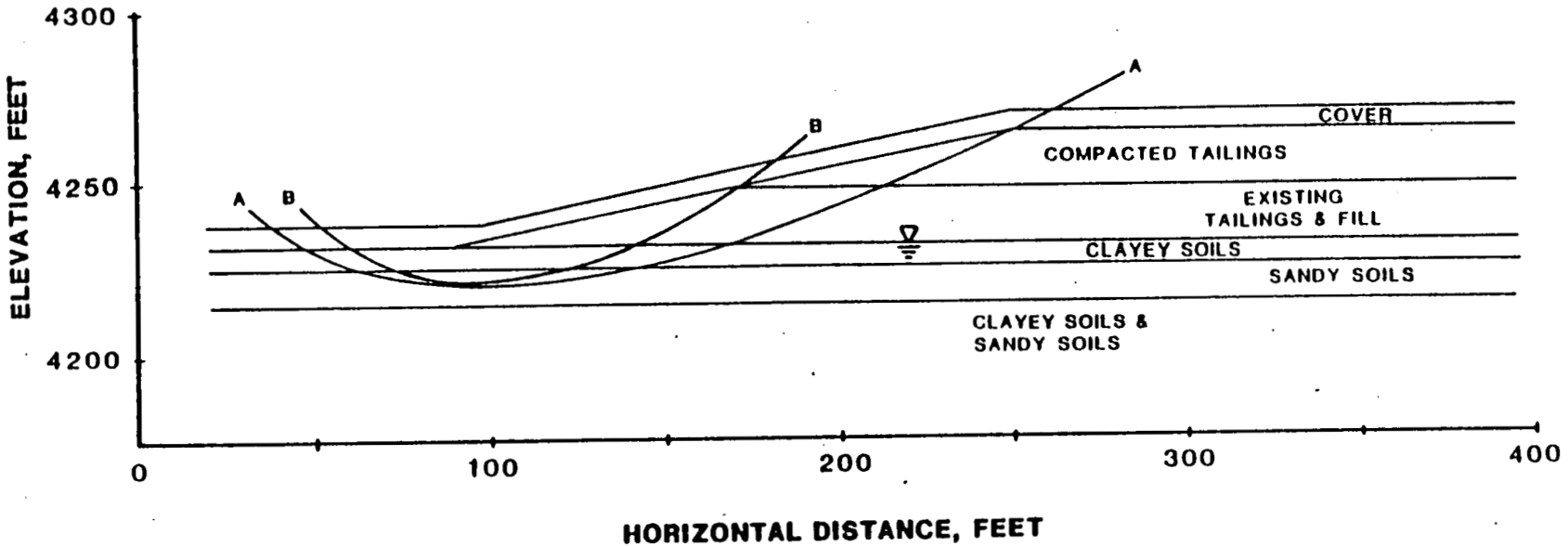


FIGURE H-9

FAILURE SURFACES CONSIDERED IN EMBANKMENT STABILITY ANALYSIS

Table H-4. Stability analysis results

Condition	Safety factor	
	Surface A	Surface B
Static	3.2	3.7
Dynamic - No strength in in-situ sands	1.9	1.9
Dynamic - No strength in in-situ sands & existing tailings	1.1	1.2
Dynamic - No strength in in-situ sands & clayey soils	1.6	1.0
Dynamic - No strength in in-situ sands, existing tailings & clayey soils	0.7	0.4

Source: SH&B, 1983

The conditions described generally preclude the occurrence of flow slides subsequent to liquefaction failure. Cases of flow slides summarized by Lucia et al., (1981) and Jeyapalan et al., (1983) indicate liquefied mine tailings will come to rest at slopes of 1 to 4 degrees after flowing over slopes of 3 to 4 degrees. In order to flow, the tailings must suffer a near total strength loss, becoming essentially a viscous fluid. The most catastrophic failures reported occurred at sites with tailings piles constructed on ground slopes of 6 degrees or greater.

Considering the predominantly partially saturated conditions of the proposed tailings at the Vitro site, and the nearly level ground surface, it is improbable that a major flow slide would occur if a liquefaction failure were to occur. The most probable effect would be slope failures and embankment cracking requiring clean-up and reconstruction.

Potential remedial measures that would mitigate the possible effects of ground shaking include vertical gravel drains near the toe of the embankment, densification of existing tailings by vibroflotation or other means, and installation of a horizontal drain at or below the bottom of the upper layer of clayey soils.

H.5 ENGINEERING SEISMOLOGY - SOUTH CLIVE SITE

H.5.1 Regional seismotectonic setting

The South Clive site is located near the eastern margin of the seismically active northern portion of the Basin and Range province (BAR) of southwestern North America (Fig. H-10). The BAR is an extensional system of horst mountain ranges and graben valleys. Systems of high-angle normal faults separate the horsts and grabens; fault-displacements in excess of 5000 feet are common across these zones (Cook et al., 1964; Stewart, 1971). Zoback and Zoback (1980) indicate that the direction of crustal extension is about N75W-S75E in the site area, as determined from stress studies, while earthquake focal mechanisms show an extensional direction of about N80E-S80W (Smith and Sbar, 1974; Arabasz et al., 1980). Stewart (1971) estimates the northern portion of the BAR (The Great Basin) has undergone about 190 km of extension since mid-Miocene time (about 15 million years before present).

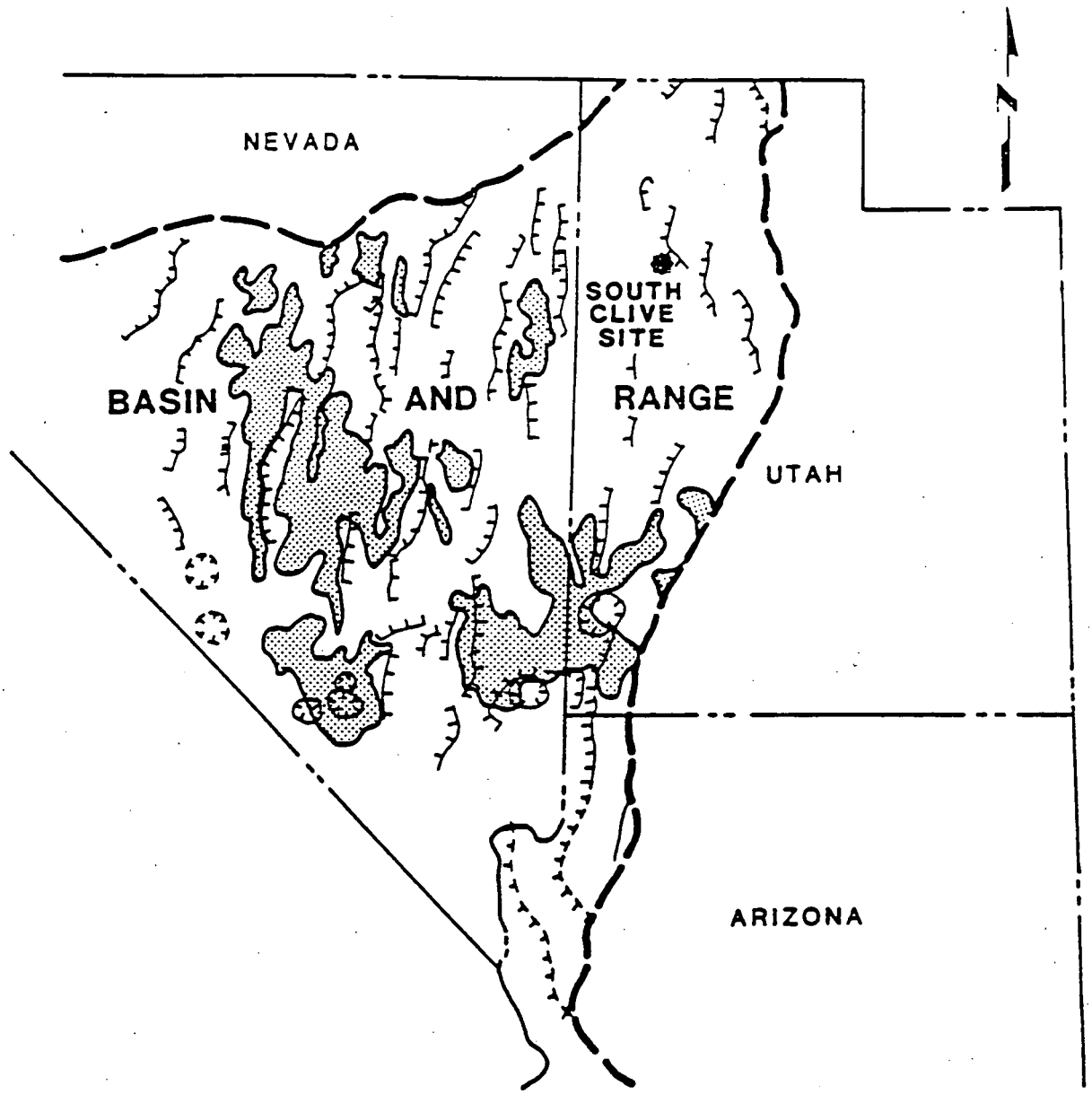
Geodetic measurements in The Great Basin indicate ongoing tectonic uplift of the region from 1 to 2 mm/year between central Nevada and the Wasatch Front (Reilinger, 1977). Additional uplift of 1.5 $\pm$ 0.5 mm/yr in western Utah occurs from isostatic crustal adjustments from unloading; the result of the desiccation of ancient Lake Bonneville about 10,000-13,000 years ago (Reilinger, 1977).

The South Clive site is on the eastern edge of the Great Salt Lake Desert in western Utah, about 105 km west of the Wasatch Front. BAR faulting to the east of the site has created several horst mountain ranges between the site and the Wasatch Front, including the seismically active Stansbury Mountains, and the Cedar Mountains. The site is on the far reaches of the alluvial apron extending from the western flank of the Cedar Mountains. Cook et al., (1964) have completed a regional gravity survey of the northern portion of the Great Salt Lake Desert, and report BAR horst and graben topography below the surface of the nearly flat desert. Extensive high-angle normal faulting bounds the buried structures and has gravity-determined displacements of several thousand feet (Cook et al., 1964). The site is in a transition zone between buried to exposed BAR topography.

H.5.2 Local seismotectonic setting

H.5.2.1 Historical seismicity

Regional seismicity maps have been compiled for Utah based on available historical data from 1850 through 1980. A selected number of these maps are presented as Figures H-11 through H-17. These data are from regional seismic nets and detect all earthquakes of about magnitude 2.5 and larger since 1962 (Arabasz et al., 1979; Richins et al., 1981). Detected events with smaller than 2.5 magnitudes are included in the data. The epicenter maps show earthquakes of about magnitude 2.5 and larger have not occurred in the site area since 1962. Maps for 1961 and earlier years depict data from the worldwide seismograph network and earlier maps from "felt" reports; thus, these maps do not have a definable lower detectability limit for earthquake size in the site area. All earthquakes above about magnitude 5.5 have probably been reported since 1850.



NOTE: FAULTS SHOWN DATE FROM
LATE CENOZOIC AND QUATERNARY.

LEGEND

TERTIARY AND QUARTERNARY VOLCANIC ROCKS

PHYSIOGRAPHIC BOUNDARY

FIGURE H-10
GENERALIZED LATE MESOZOIC-CENOZOIC TECTONIC MAP
OF BASIN AND RANGE

REF: SMITH & SBAR (1974)

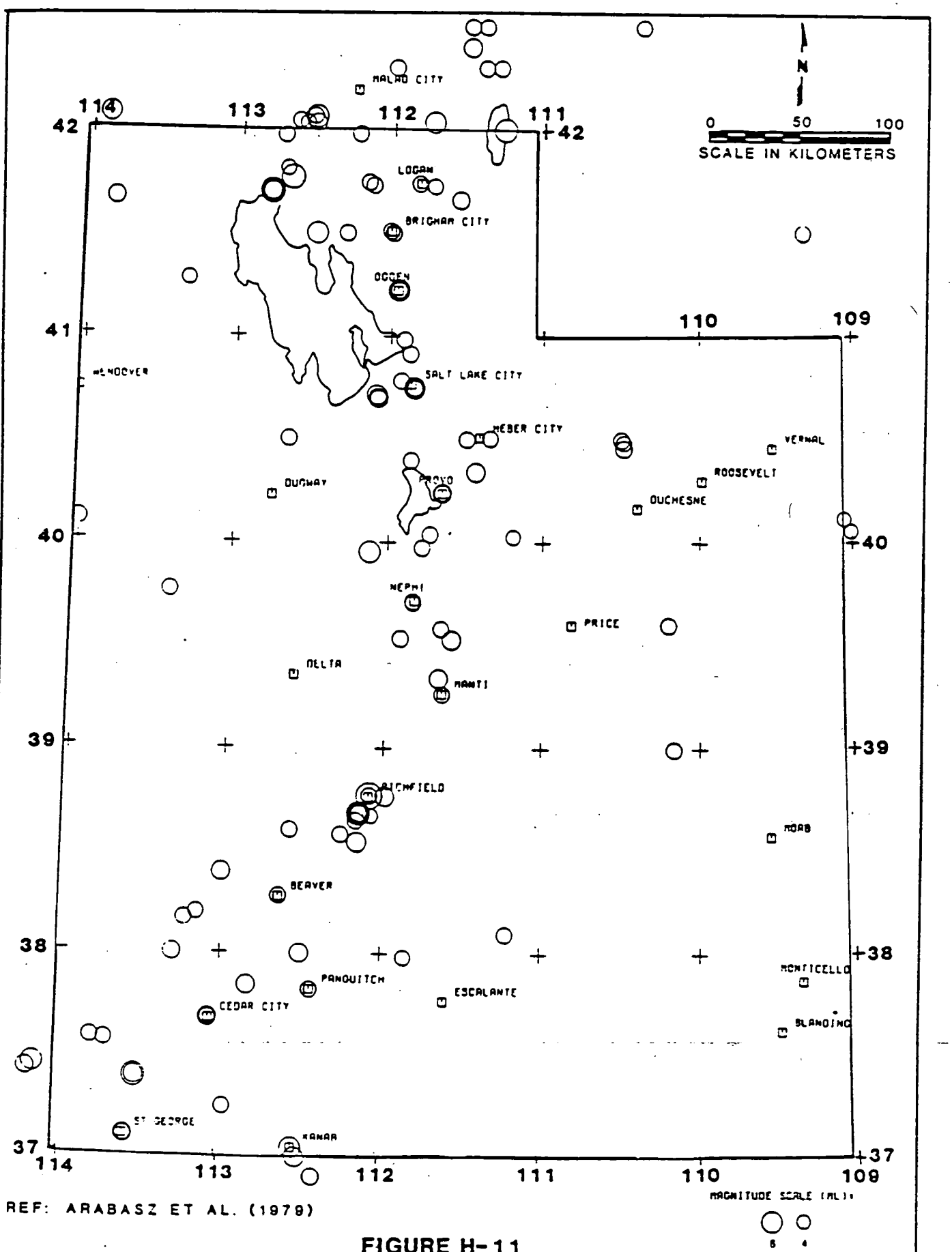
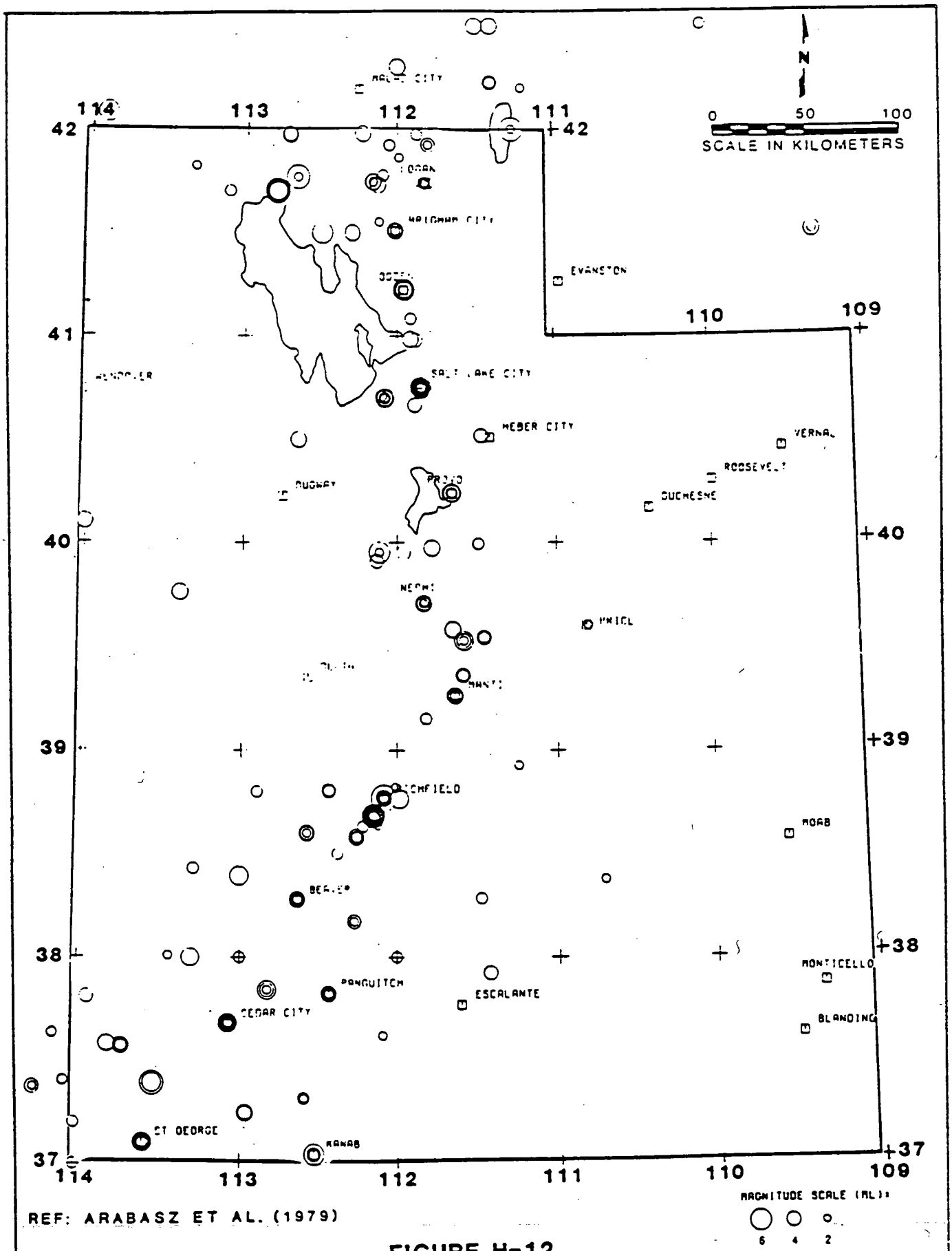


FIGURE H-11

1850 - JUNE 1978, MAG 4.0 (INT V) OR GREATER

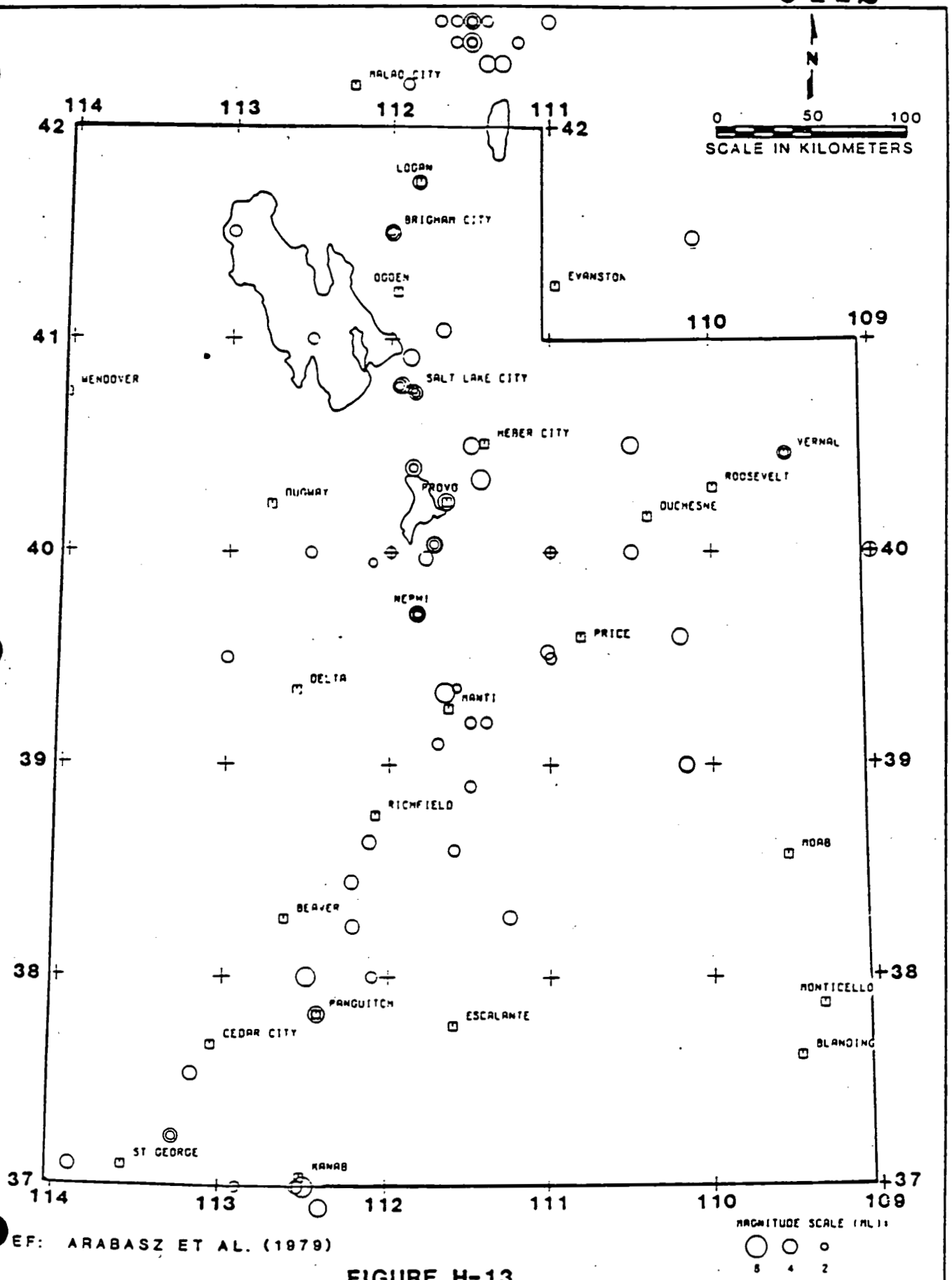


REF: ARABASZ ET AL. (1979)

FIGURE H-12

UTAH EARTHQUAKES: 1850 - 1949

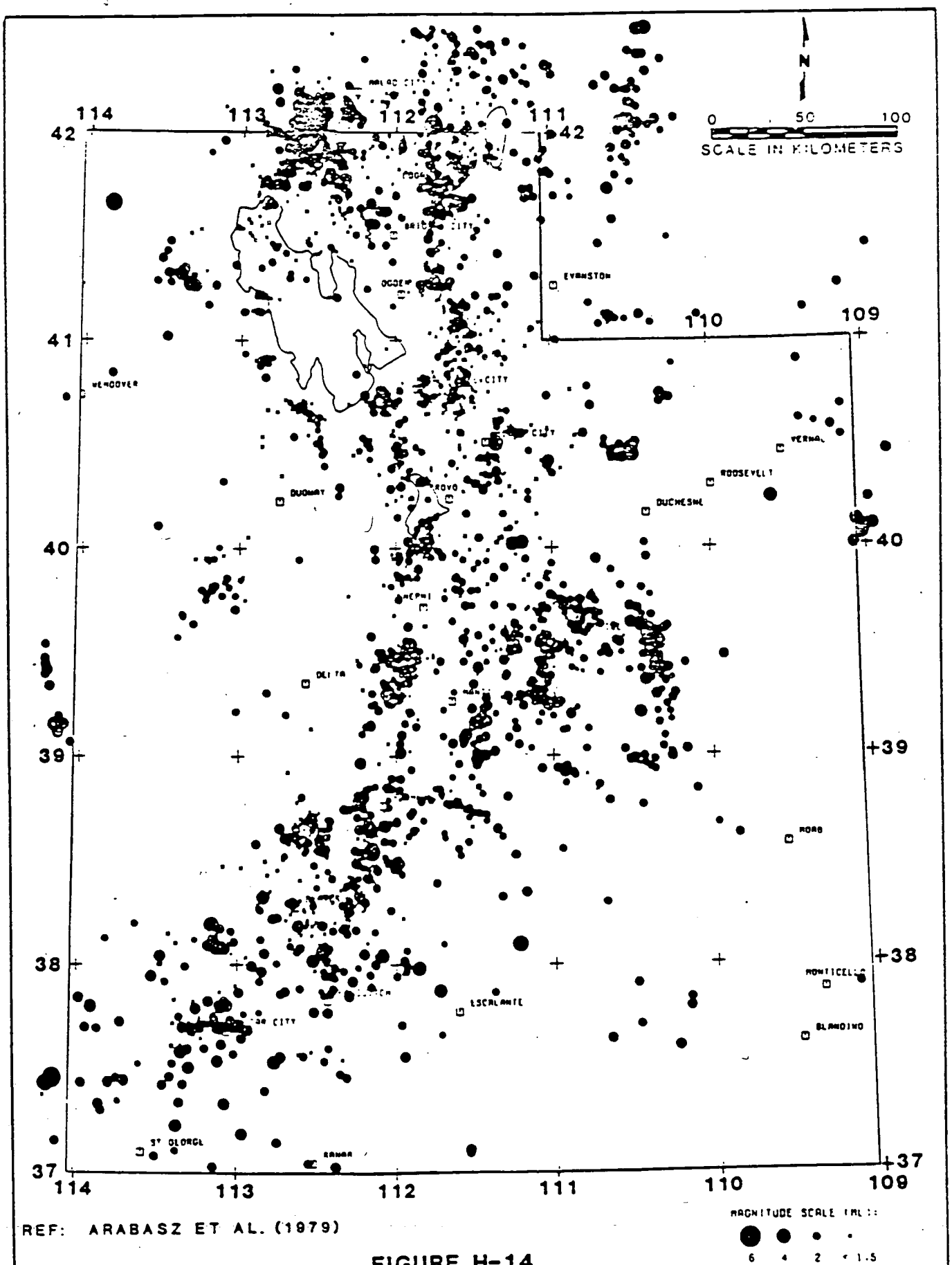
000748



EF: ARABASZ ET AL. (1979)

FIGURE H-13

UTAH EARTHQUAKES: 1950 - 1962

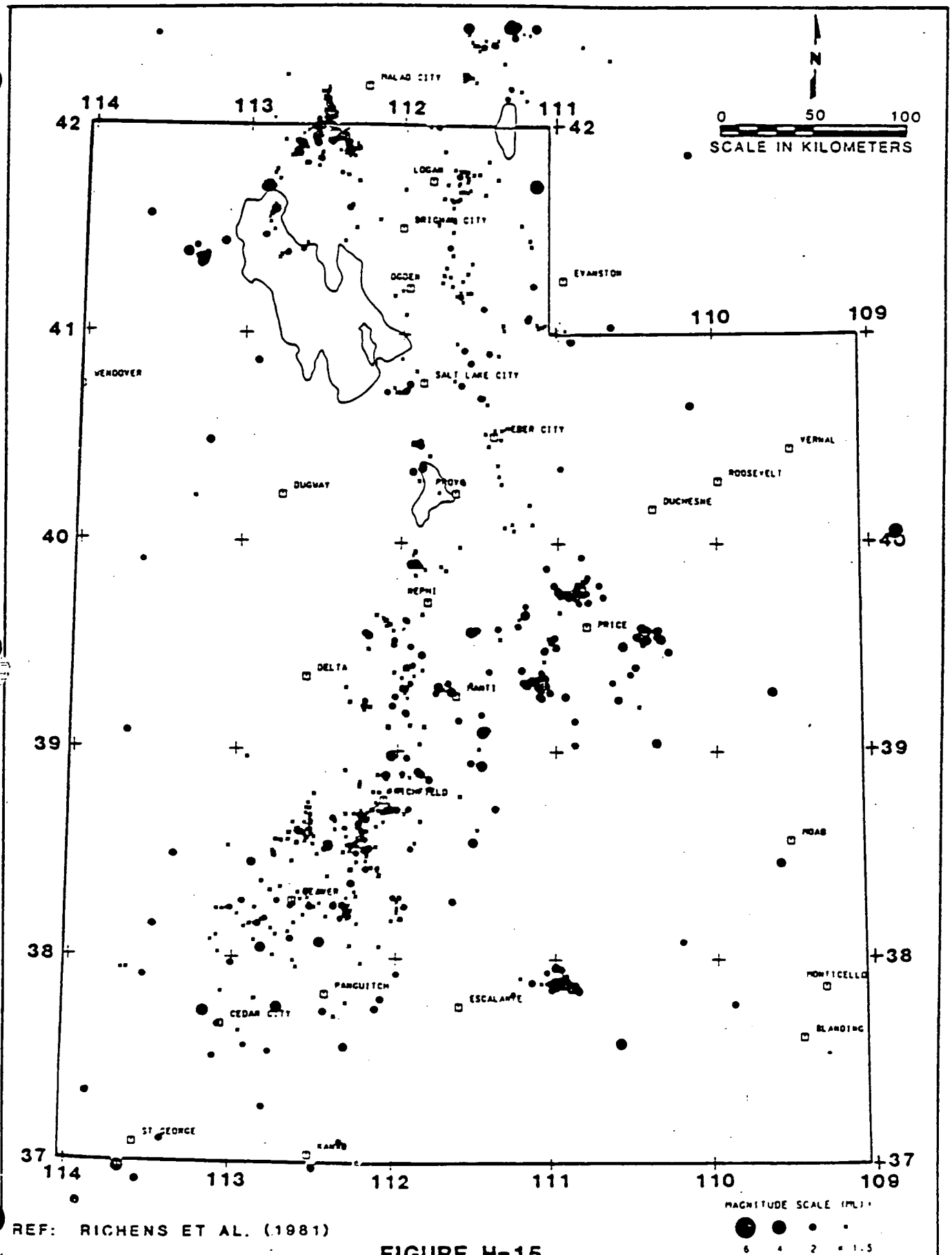


REF: ARABASZ ET AL. (1979)

FIGURE H-14

UTAH EARTHQUAKES: JULY 1962 - JUNE 1978

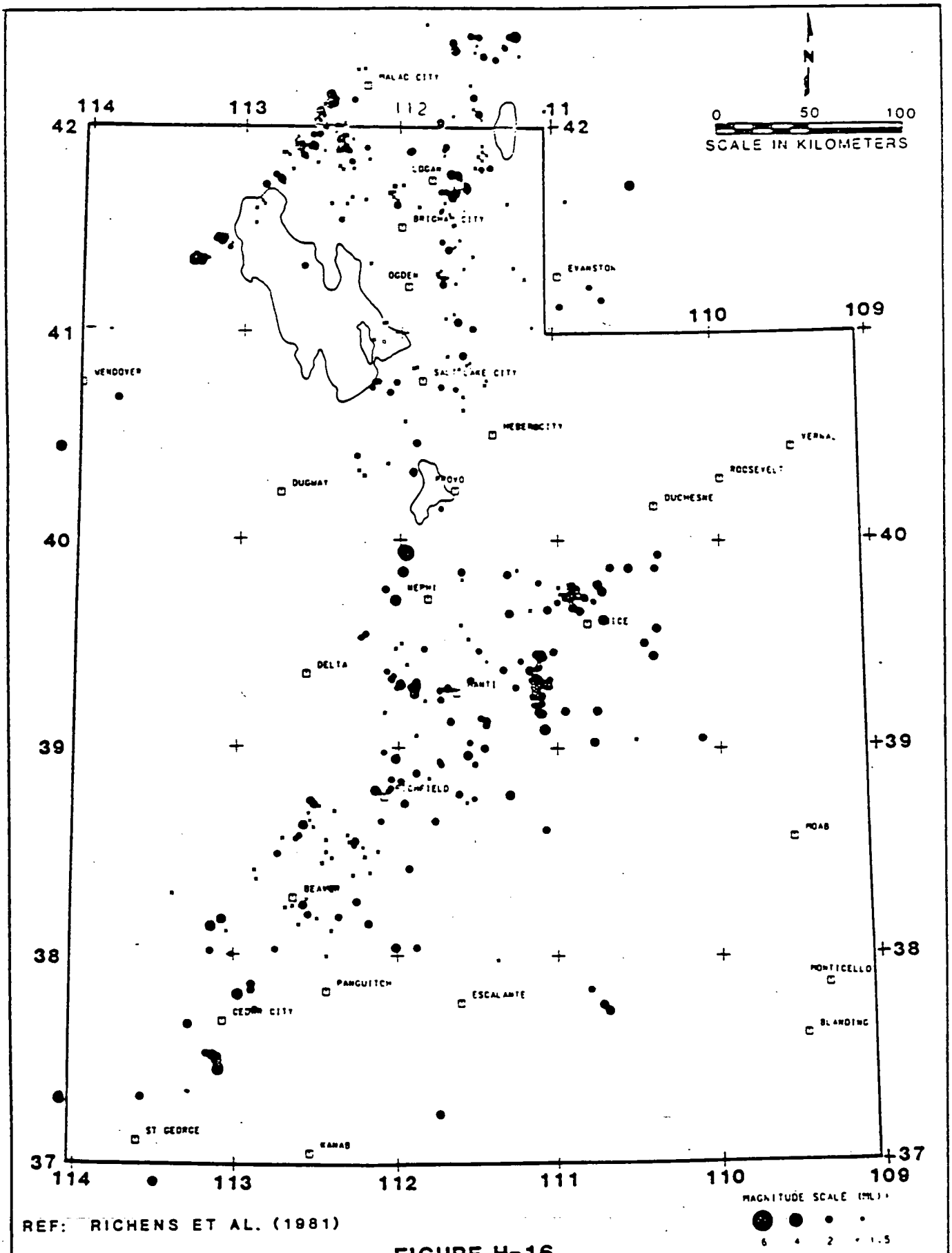
060750



REF: RICHENS ET AL. (1981)

FIGURE H-15

UTAH EARTHQUAKES: 1979

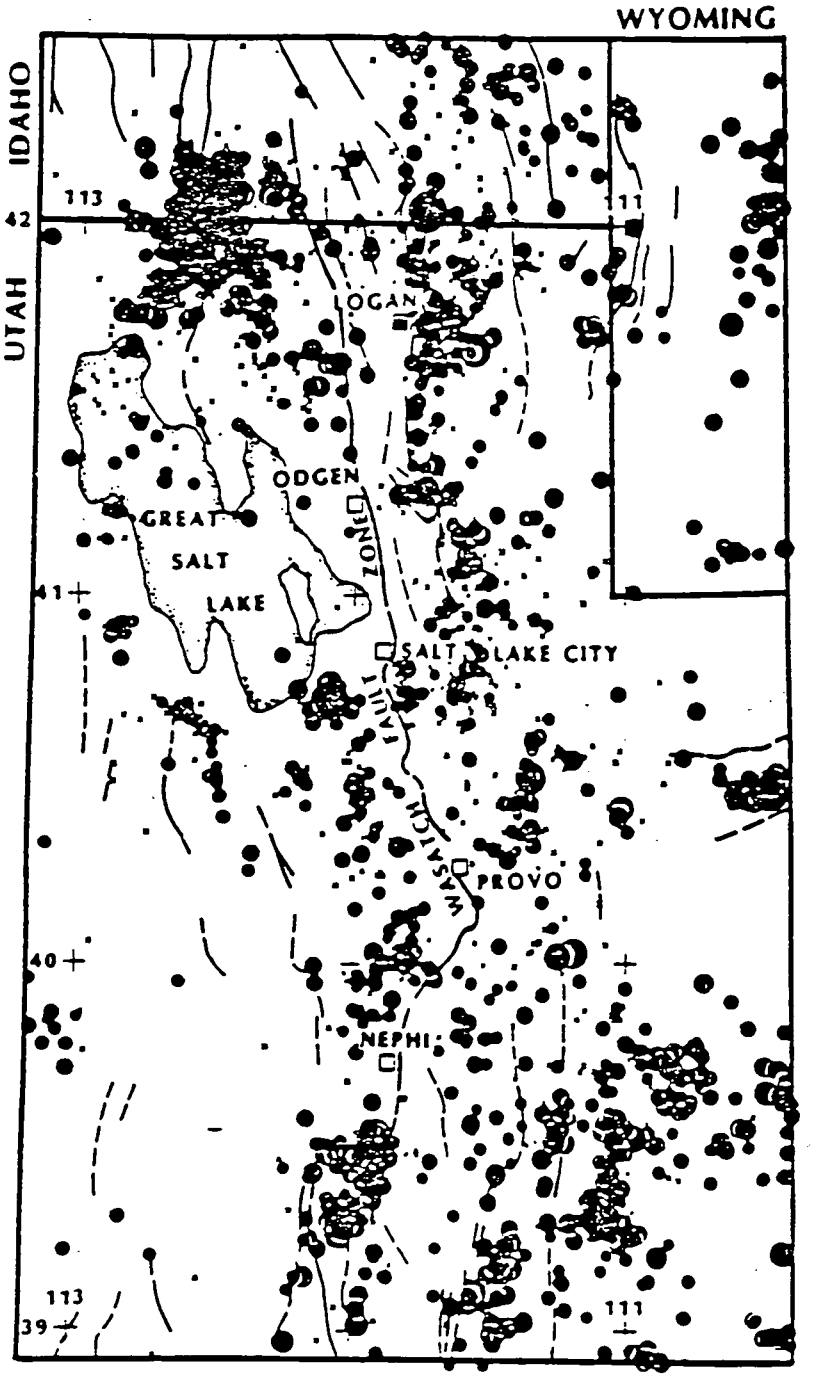


REF: RICHENS ET AL. (1981)

FIGURE H-16

UTAH EARTHQUAKES: 1980

000752



0 50 100
SCALE IN KILOMETERS

MAGNITUDE SCALE (ML)
6 4 2 < 1.5

REF: ARABASZ ET AL. (1979)

FIGURE H-17
EARTHQUAKES EPICENTER MAP OF
WASATCH FRONT, UTAH FOR PERIOD 1962 - JUNE, 1978.

The only historical earthquake in Utah with surface rupturing occurred in Hansel Valley in 1934 (Bucknam et al., 1980). The site is about 100 km north of the South Clive area. The surface rupture occurred on a fault which had previous Holocene displacement. The majority of historical seismicity occurs on the Wasatch Front, but the areas of lower seismicity away from the Wasatch Front do experience small to moderate events with occasional large events, as is the case with the Hansel Valley area.

A computer search of all recorded events within a 50-km radius of Clive, Utah, from October 1974 through September 1983 is shown in Table H-5 and Figure H-18. Richins (personal communication, 1984) indicates many of these events, possibly most of them, are the result of blasts from mining operations in the vicinity of the site.

H.5.2.2 Active faulting

Bucknam and others (1980) have included the site in a region in Utah believed to contain Holocene faulting. The boundaries of their source regions encompass identified locations of Holocene faulting (Figure H-19).

Various authors have presented regional fault maps which include the South Clive site. Williams (1953) maps an unnamed fault about 25 miles in length which borders the western flank of the Cedar Mountains. This fault passes within about 5 miles of the Clive site. No age of faulting is given. Bucknam (1977) and Anderson and Miller (1979; 1980) do not include this fault in suspected Quaternary fault maps. Slemmons (personal communication, 1984) has reported several Holocene scarps of up to 6 miles in length along the west front of the Cedar Mountains, which are lower in elevation than the late Pleistocene shorelines of Lake Bonneville (Figure H-20). Both Slemmons and Buckman indicate their reported faulting is based on interpretation of small-scale (1:60,000) conventional black-and-white aerial photography and smaller scarps may be overlooked and other geomorphic features, such as fire-burns and shorelines, may be mistaken for fault scarps.

Dodge and Grose (1980) have indicated detection of young fault scarps in lake muds or lake gravels is difficult because they have considerably lower slope angles than equal height scarps in alluvial gravels. Their work in the Black Rock Desert in northwestern Nevada indicates that for 1-m-high scarp, which is less than 1,100 years old, the present scarp slope angle in alluvial gravels would be about 15 degrees, in lake gravels, about 10 degrees, and in lake muds, about 8 degrees. Thus scarps near the site in lake muds and gravels would be subtle geomorphic features and could be easily overlooked in regional studies. Their evaluation does not include scarps of between 1,100 and 10,000 years in age, but they do support the concept that early Holocene scarps may now be very subtle geomorphic features in and near the site area which are best delineated by low-sun angle techniques (Cluft and Slemmons, 1971; Slemmons, 1977).

Additional studies to clarify the delineation of fault activity in the site region were conducted. These included field reconaissance, low-sun angle (LSA) aerial reconnaissance, and photogeologic interpretation of existing 1:24,000 scale color, infrared aerial photography. The results of these studies indicate

000754

Table II-5 Earthquakes within 50 km of Clive, Utah,
October, 1974 - September, 1983

YR	DATE	ORIG TIME	LAT-N	LONG-W	DEPTH	MAG	NO	GAP	DMN	RMS	Q	I	KM	AZ
75	0104	0850 8.30	40-39.61	112-46.14	7.0*	1.2	5	315	61	.12	D	1	29.25	99.80
75	0204	1540 29.56	40-19.42	113- 6.52	7.0*	1.7	5	321	28	.16	D	2	42.35	179.85
75	0610	0933 48.25	40-32.45	112-51.90	7.0*	1.2	11	210	38	.16	C	3	27.61	131.32
75	1103	1820 26.51	40-39.16	112-33.05	7.0*	.7	6	165	20	.35	C	4	47.61	97.01
76	0123	0054 56.48	40-40.86	112-36.86	7.0*	1.3	11	175	20	.32	C	5	41.98	93.64
76	0207	0418 29.66	40-38.81	112-33.84	7.0*	1.1	12	166	31	.21	C	6	46.60	97.97
76	0224	2249 37.81	40-40.59	112-36.34	7.0*	1.1	7	174	20	.57	D	7	42.74	94.25
76	0330	1500 2.26	40-29.61	112-51.96	7.0*	.7	10	209	33	.28	C	8	31.28	138.68
76	0423	1829 41.02	40-38.91	112-34.38	7.0*	1.3	10	167	21	.47	C	9	45.82	97.87
76	0520	2159 21.31	40-39.15	112-33.19	7.0*	1.3	6	165	20	.18	C	10	47.42	97.06
76	0528	0042 39.85	40-53.57	112-49.89	7.0*	1.8	13	192	31	.37	D	11	31.42	48.41
76	0604	2225 42.53	40-42.35	112-41.33	7.0*	1.5	7	187	22	.55	D	12	35.60	89.85
76	0628	2329 54.12	40-43.02	112-36.17	1.0	1.0	10	165	16	.68	D	13	42.88	88.22
76	0702	2045 41.26	40-54.68	112-52.68	7.0*	1.9	11	196	79	.24	C	14	30.14	40.51
76	0807	0129 36.23	40-39.89	112-35.29	7.0*	1.8	6	175	47	.50	D	15	44.33	95.78
76	0903	2136 8.95	40-39.51	112-34.20	2.1	1.1	7	173	20	.30	C	16	45.93	96.46
76	0908	2052 41.95	40-56.45	112-58.75	7.0*	1.5	12	236	84	.39	D	17	28.42	22.86
76	0910	2038 29.17	41- 8.44	112-59.13	7.0*	1.9	9	207	106	.24	C	18	49.51	12.23
76	0915	1734 41.26	40-39.36	112-33.36	7.0*	1.9	6	184	45	.40	D	19	47.14	96.63
76	1013	2048 13.60	40-54.70	112-51.38	7.0*	2.2	13	209	29	.34	D	20	31.38	43.01
76	1019	1651 33.68	40-43.29	112-43.12	7.0*	.8	7	213	27	.09	C	21	33.12	86.83
76	1023	1503 22.96	40-40.34	112-49.89	7.0*	1.3	10	206	38	.17	C	22	23.82	98.76
76	1105	2313 13.28	40-39.63	112-33.49	7.0*	1.1	14	166	27	.45	C	23	46.90	96.05
76	1123	2354 34.84	40-41.79	112-35.08	7.0*	.9	11	172	24	.30	C	24	44.41	91.22
76	1204	0345 38.60	40-40.61	112-40.41	7.0*	1.4	6	187	29	.21	D	25	37.02	94.85
76	1209	0313 45.18	40-39.11	112-31.83	7.0*	.8	5	159	28	.26	D	26	49.33	96.87
77	0115	2156 16.03	40-54.13	112-48.96	7.0*	1.3	6	190	26	.20	C	27	33.09	48.57
77	0126	1307 28.01	40-39.15	112-34.73	7.0*	1.1	12	167	29	.36	C	28	45.27	97.40
77	0204	2036 12.98	40-39.81	112-34.54	7.0*	.7	7	151	27	.43	C	29	45.39	95.83
77	0218	1443 56.27	40-40.68	112-37.50	7.0*	.8	12	158	27	.31	C	30	41.10	94.18
77	0228	2159 1.38	40-54.07	112-49.33	7.0*	1.0	9	191	26	.20	C	31	32.63	48.11
77	0302	0303 56.80	40-41.45	112-39.69	7.0*	.7	8	162	27	.37	C	32	37.94	92.38
77	0309	2325 49.60	40-37.66	112-33.33	7.0*	.5	6	163	31	.17	C	33	47.64	100.38
77	0311	2246 16.30	40-21.33	112-44.38	7.0*	.9	6	174	18	.30	C	34	49.92	141.03
77	0315	1318 13.68	40-38.79	112-33.81	7.0*	1.1	8	165	29	.25	C	35	46.64	98.01
77	0331	0359 23.12	40-39.05	112-34.17	7.0*	.8	13	150	29	.28	C	36	46.07	97.50
77	0401	1700 10.27	40-54.32	112-51.56	7.0*	1.8	7	187	29	.20	D	37	30.70	43.56
77	0405	0232 22.78	40-37.21	112-32.29	7.0*	.9	8	145	32	.17	C	38	49.24	101.03
77	0420	2053 28.01	40-42.76	112-36.36	7.0*	.8	12	156	23	.41	C	39	42.60	88.85
77	0425	1935 30.18	40-54.40	112-50.03	7.0*	1.3	9	192	27	.24	C	40	32.32	46.14

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6442

Table H-5 (Concluded)

YR	DATE	ORIG TIME	LAT-N	LONG-W	DEPTH	MAG	NO	GAP	DMN	RMS	Q	I	KM	AZ
77	0429	0624 28.33	40-39.44	112-33.28	7.0*	1.2	11	148	28	.33	C	41	47.23	96.44
77	0504	2307 6.95	40-37.36	112-34.21	7.0*	1.2	15	149	32	.29	C	42	46.53	101.33
77	0525	2046 14.38	40-55.28	112-51.26	7.0*	1.7	9	186	29	.35	D	43	32.29	41.93
77	0622	2051 16.86	40-55.35	112-50.31	7.0*	1.9	11	193	28	.41	D	44	33.29	43.49
77	0623	2221 6.30	40-39.49	112-33.06	7.0*	.7	5	164	28	.33	D	45	47.53	96.28
77	0707	1233 47.19	40-39.95	112-37.80	7.0*	.8	6	176	28	.10	C	46	40.80	96.12
77	0713	2234 17.03	40-42.23	112-32.90	7.0*	.9	4	167	23	.12	D	47	47.47	90.16
77	0721	2020 46.36	40-33.13	112-34.11	7.0*	1.2	5	194	39	.18	D	48	48.88	110.32
77	0801	2242 51.02	40-41.98	112-37.65	7.0*	1.5	10	178	58	.44	D	49	40.78	90.83
77	0810	1328 46.35	40-40.10	112-36.40	7.0*	1.4	7	155	55	.22	C	50	42.73	95.47
77	0817	2246 46.42	40-39.39	112-36.00	7.0*	1.1	5	184	29	.10	D	51	43.44	97.12
77	0831	2052 32.93	40-53.05	112-53.02	7.0*	2.0	12	190	31	.31	D	52	27.58	43.83
77	0930	2211 22.88	40-39.96	112-37.81	7.0*	1.0	10	158	28	.36	C	53	40.78	96.10
77	1013	0232 11.12	40-41.05	112-39.01	7.0*	1.0	8	177	27	.38	C	54	38.93	93.41
78	0116	2153 57.02	40-39.85	112-38.57	7.0*	.1	7	159	29	.50	D	55	39.74	96.55
78	0124	1436 30.48	40-39.66	112-33.60	7.0*	.7	7	169	27	.28	C	56	46.74	96.00
78	0206	2257 28.94	40-54.67	112-54.46	7.0*	1.3	10	192	79	.33	D	57	28.56	36.71
78	0424	2200 15.96	40-55.03	112-50.17	7.0*	1.7	6	192	80	.05	D	58	33.00	44.44
78	0510	2308 7.34	40-42.87	112-35.25	1.1	1.1	6	210	13	.40	D	59	44.17	88.63
78	0606	2059 12.55	40-55.47	112-48.11	7.0*	1.5	8	204	24	.43	D	60	35.64	46.85
79	0329	1017 15.75	40-28.84	113-12.55	7.0*	2.2	28	264	76	.40	D	61	26.29	198.62
79	1115	1229 47.61	40-52.01	112-55.04	7.0*	2.0	20	193	34	.41	D	62	24.24	42.13
81	0711	1120 17.33	40-26.98	113- 9.93	7.0*	1.8	21	179	41	.43	C	63	28.74	189.41

NUMBER OF EVENTS = 63

Ref. University of Utah, Department of Geology and Geophysics, 1984.

000256

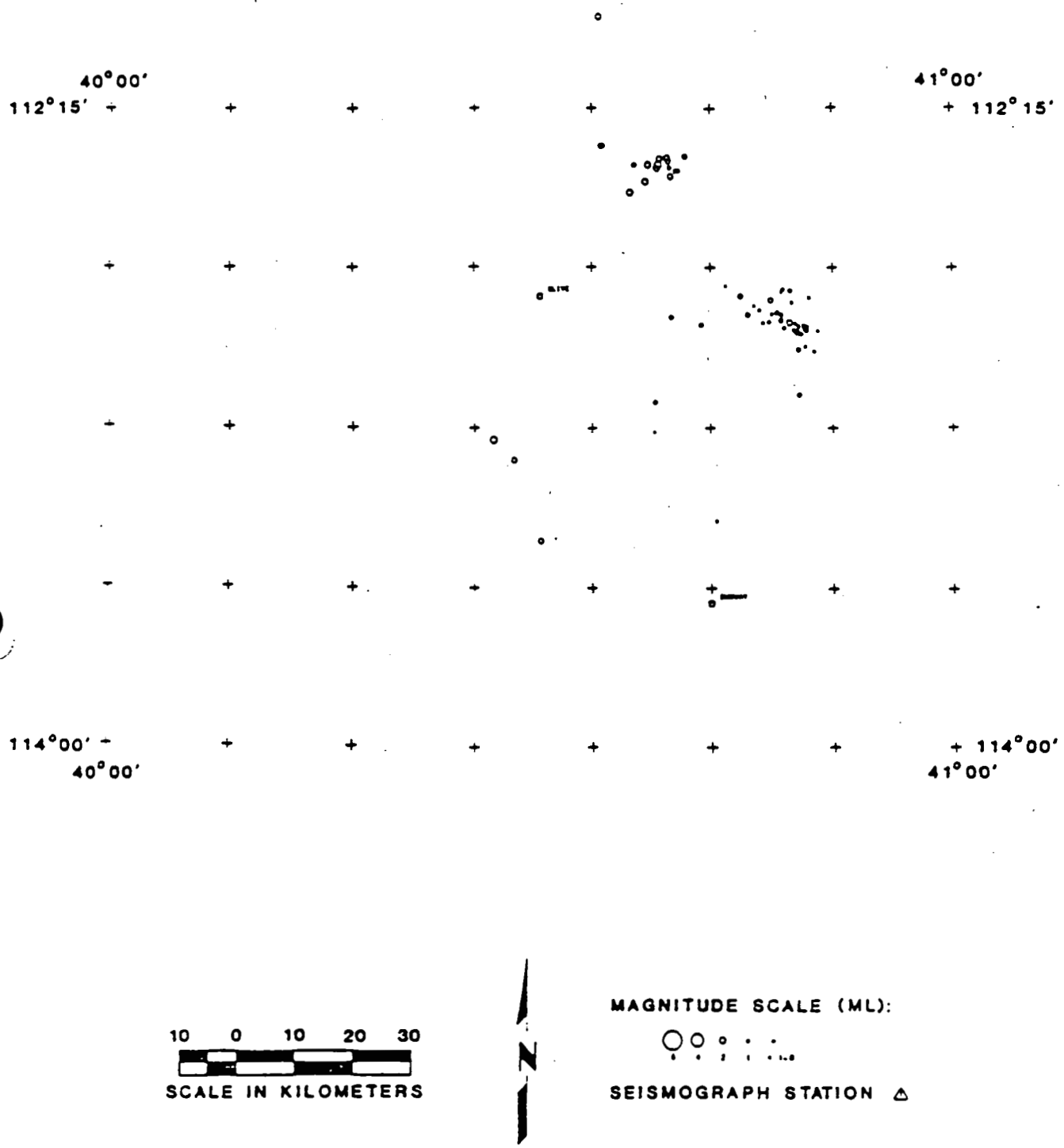
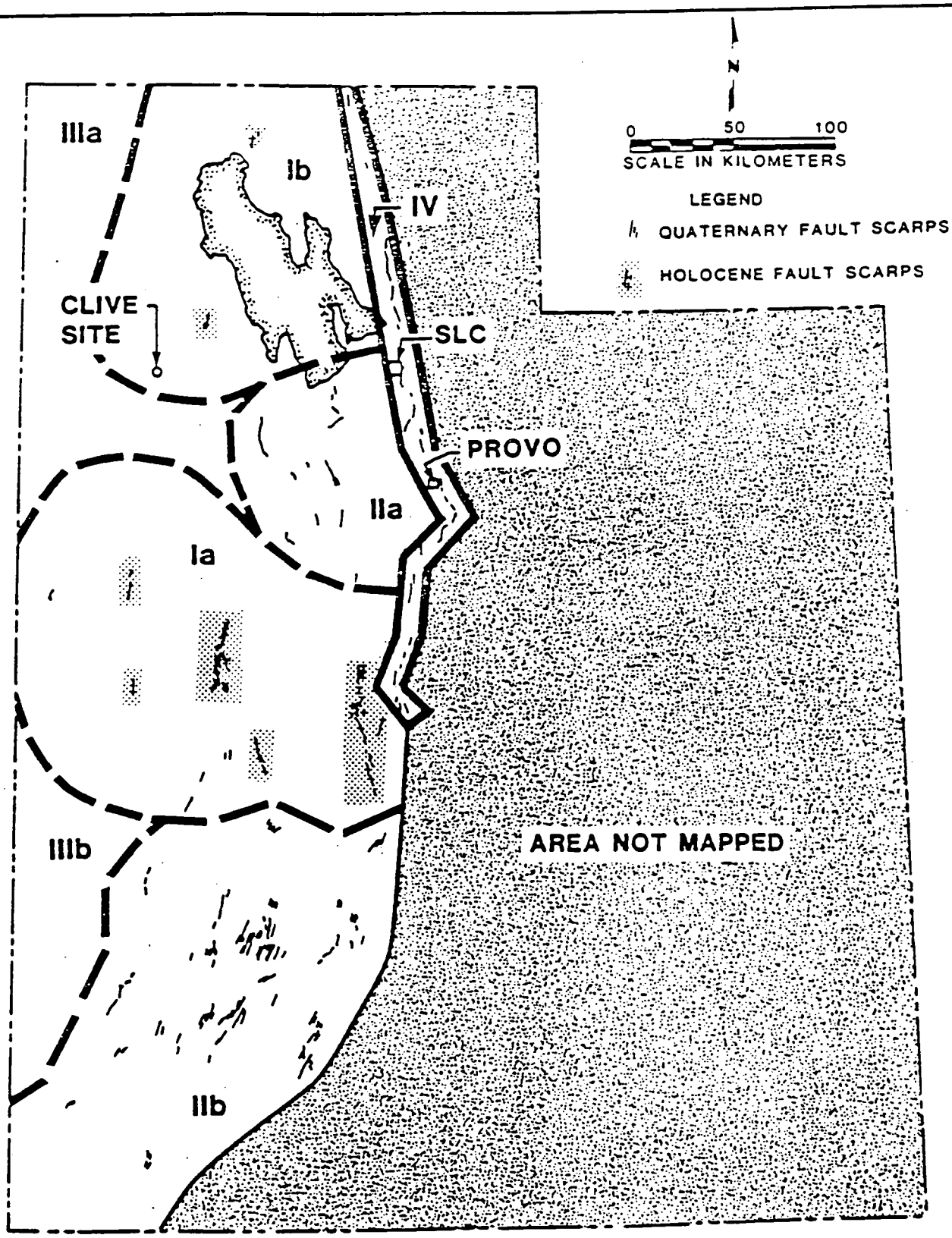


FIGURE H-18
EARTHQUAKES WITHIN 81 MILES (50 KM) OF CLIVE, UT
OCT 1974 - SEPT 1983



REF: BUCKMAN ET AL. (1980)

FIGURE H-19
LATE QUATERNARY, HOLOCENE FAULT SCARPS AND SOURCE REGIONS I, II, III, IV

000758

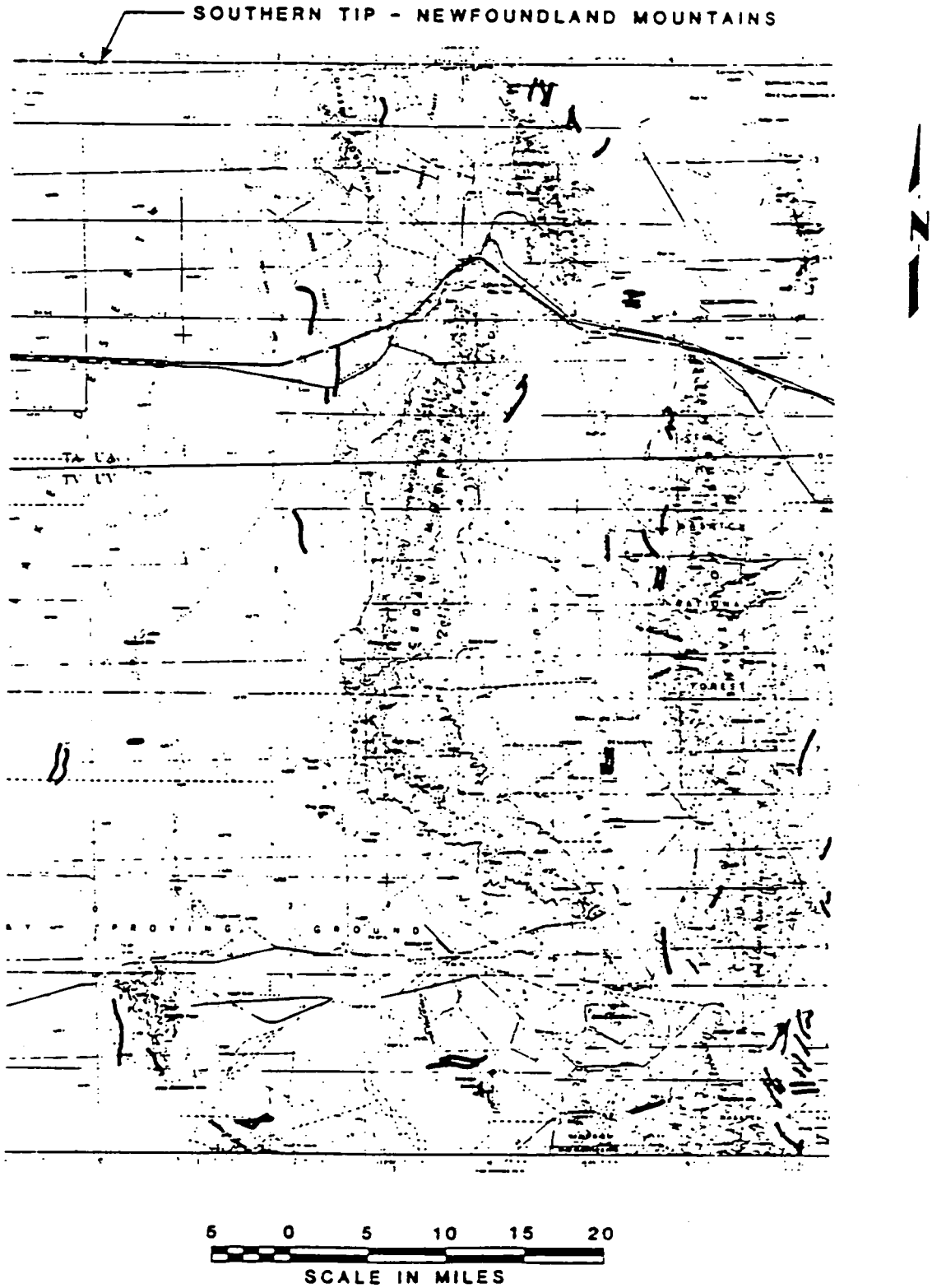


FIGURE H-20
ACTIVE FAULT ZONES
REPORTED BY SLEMMONS (1984, pers. comm.)

active faulting in the site region occurs in five zones, the southeast and northeast front of the Cedar Mountains, the west front of the Stansbury Mountains, the east front of the Newfoundland Mountains, and a zone of faulting in Puddle Valley (Figure H-21).

H.5.3 Seismic zoning

Algermissen et al., (1982) have completed seismic zoning maps for the United States based on energy release during historical earthquakes. Their zoning places the site in an area which, for a 250-year exposure, with a 90 percent probability of nonexceedence, will not have accelerations in rock in excess of about 0.2 to 0.4 g.

H.5.4 Earthquake recurrence intervals

Recurrence intervals vary in different areas of the BAR and range from 500 to 3000 years for active portions such as the Wasatch Front but may be over 10,000 years for the area of the site (Wallace, 1982). Further quantification of the recurrence interval requires extensive fault investigations along those zones considered capable of generating design earthquakes for the site.

H.5.5 Seismic design parameters

Earthquake sources considered in the development of the preliminary site design parameters for the South Clive site are listed in Table H-6 for the zones of active faulting in the site region. Various interpretations of segmentation of the active zones and interaction between the zones is possible. For conservatism, the northern portion of the fault system on the northeastern front of the Cedar Mountains is considered; the Puddle Valley faulting and two segments of active faulting along the southeastern front are considered together. In addition, the entire north-south trending portion of the zone along the east front of the Cedar Mountains is considered as a single fault. For all MCE magnitude calculations, it is assumed that the total fault zone lengths will rupture. The various combined segments and fault zones considered as possible source faults for design parameters at the site are depicted on Figure H-21. Table H-6 lists the MCEs and an estimated on-site maximum acceleration for each of these geometrics. Earthquakes originating along the Wasatch Front and in the Hansel Valley area are too remote to affect the seismic design parameters at the site.

Variations in maximum acceleration at a site from an MCE can be attributed to earthquake size, distance to the site, wave-path attenuation characteristics, source mechanism of the event, direction and speed of fault rupture, and local soil conditions at the site. The expected variation for acceleration values is listed in Table H-6. The maximum acceleration expected at the site is 0.31 $\pm$ 0.06 g from an MCE of $M_S = 7.1$. The source for this event could be either the east front of the Cedar Mountains or the northern segment of this zone combined with the faulting in southeastern Puddle Valley (Figure H-21). As these active zones are far removed from the site, no hazard from surface rupture exists at the site.

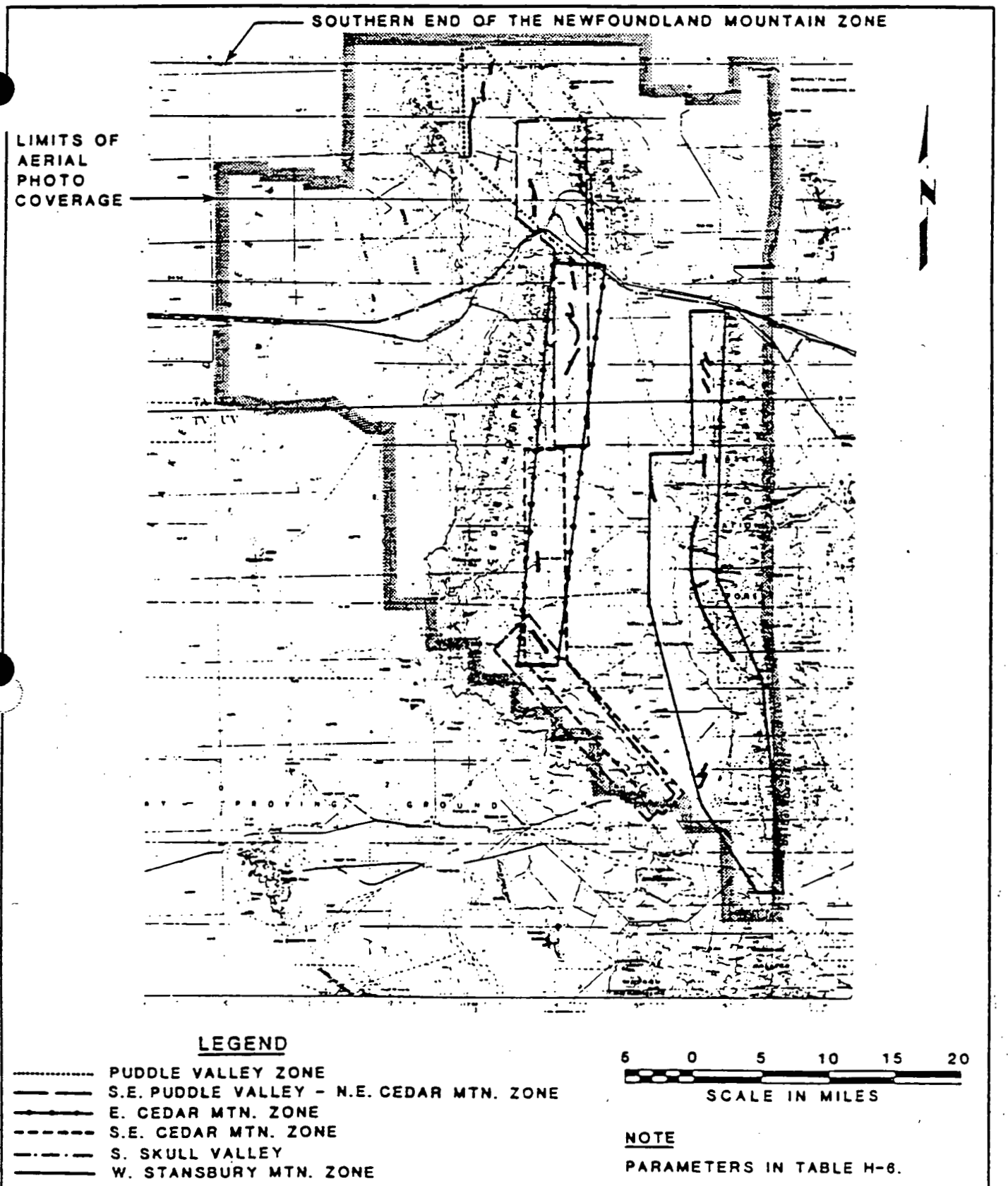


FIGURE H-21
ACTIVE FAULT ZONES
USED FOR DETERMINATION OF SEISMIC DESIGN

Table H-6. Design criteria for potential seismic sources affecting the Clive, Utah, site

Source fault	Age of last movement	Maximum length	Maximum* Credible Earthquake (magnitude)	Distance to site	Estimated** maximum acceleration in rock (fraction of unit gravity)
West flank of Cedar Mountains					
Williams (1953)	Not given	35 mi (57 km)	7.3	5 mi (8 km)	0.4 g
Slemmons, (personal communication), 1984	Holocene	***4 mi (6.4 km)	6.2	3 mi (5 km)	0.5 g
	Holocene	****17 mi (27.5 km)		7.0	3 mi (5 km)
0.6 g					
West flank of Stansburg Mountains					
Bucknam (1977)	Holocene	14 mi (23 km)	6.9	24 mi (39 km)	0.2 g
Slemmons, (personal communciation), 1984	Holocene	23 mi (37 km)	7.1	24 mi (39 km)	0.2 g
Northwest Puddle Valley					
Bucknam (1977)	Holocene	5 mi (8 km)	6.3	17 mi (27.5 km)	0.2 g
East flank of Newfoundland Mountains					
Cook & others (1964)	Holocene (?)	14 mi (23 km)	6.9	24 mi (39 km)	0.2 g

* Calculated from Slemmons (1977), Type A faults using total faults' length, M = 1.845 + (1.151) Log L in m

** Calculated from Schnabel and Seed, 1973

*** Individual Holocene Scarps

**** Zone of Holocene Scarps

000762

H.6 GEOTECHNICAL PROFILE - SOUTH CLIVE SITE

Based on boring logs and test data presented in Dames and Moore (1982), subsurface conditions at the South Clive site consist entirely of alluvial and lacustrine sediments of varying thickness, but continuous beneath the site. Table H-7 lists selected soil parameters tested for by Dames and Moore.

Table H-7. Selected soil paramters

Boring number	Depth (ft)	Moisture content (%)	Dry density (lbs/cu ft)	Soil type (USCS)	Depth to ground water (feet)
SC-1	4.0	31.7	88	ML	27.8
SC-1	21.0	19.4	93	SM-SC	
SC-2	4.0	33.7	79	ML-CL	20.6
SC-2	18.0	34.8	85	CL-SM	
SC-3	19.0	23.2	102	ML-CL	29.3
SC-4	4.0	35.9	87	CL-ML	34.0
SC-4	8.0	33.8	78	CL-ML & SP-SM	
SC-5	9.0	4.5	113	SP-SM	26.1
SC-6	3.0	33.7	88	CL-ML	24.7
SC-6	8.0	4.1	99	SP-SM	
SC-7	6.0	33.8	85	CL-ML	21.6
SC-8	9.0	38.2	80	SM-SP	29.9
SC-8	14.0	10.5	98	SM-SP	
SC-9	3.0	21.0	89	CL-ML	31.2
SC-9	8.0	40.4	79	CL-ML	
SC-10	6.0	34.2	87	CL-ML	32.4
SC-10	11.0	43.7	78	SP-SM	
SC-11	4.0	25.1	93	CL-ML	28.4
SC-12	6.0	34.9	82	CL-ML	27.4
SC-12	11.0	4.3	103	SP-SM	
SC-13	3.0	21.8	97	CL-ML	25.9

The initial soil stratum encountered at the site is composed of predominately clayey soils, classifying as CL to ML in the Unified Soil Classification System. This layer varies in thickness from 3 to 12 feet. Standard penetration testing (SPT) blow counts (N-values) indicate this material to have a consistency ranging from medium stiff to very stiff except in boring SC-7 which is soft from 0.0 to 10.0 feet.

Sandy soils, classifying predominately as SP-SM to SC, underlay the clayey surface soils, with varying thickness ranging from 8 to 25 feet. SPT N-values indicate a density ranging from medium dense to dense.

Underlying both of these strata is another clayey soil stratum classifying predominately as a CL to ML. Four borings penetrated this stratum which has a thickness ranging from 15 to 20 feet. SPT N-values indicate a

consistency ranging from medium stiff to hard with the exception of boring SC-13, 28 to 43 feet, which is soft grading to medium dense at approximately 32 feet.

Boring SC-1 indicates that below this last clayey stratum lies a sandy soil that is in excess of 180 feet thick and has a density ranging from medium dense to hard.

Ground water was encountered in all borings and ranged from elevation 4246.7 to 4248.6 feet.

H.7 LIQUEFACTION POTENTIAL - SOUTH CLIVE SITE

A complete analytical assessment of the liquefaction potential at the South Clive site has not been completed. Two factors would indicate the potential for seismically induced liquefaction of the in-situ soil is very remote. Typically, the first layer of silty sands encountered lies above the static ground-water table. If the water table is encountered within this strata, it is only within the bottom 2 to 5 feet. The water table is located at a depth of 20 to 30 feet below the ground surface. Second, SPT blow count values for sands lying below the water table typically exceed 20, though borings SC-4 and SC-7 indicate values less than 10. Considering the depth to the water table, the relatively large overburden pressure, and the apparent medium to high densities of the sandy layers encountered, significant liquefaction due to an MCE event is improbable.

Prior to fully concluding that the South Clive site is not subject to liquefaction damage, the possibility of a long-term rise in the ground-water table should be assessed. Due to recent changes in the Great Salt Lake level and geologically recorded high-water stands of ancient Lake Bonneville, this possibility of significant changes over the site's design life appears possible.

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Appendix I

ECONOMIC IMPACT OF REMEDIAL ACTION,
ALTERNATIVE 2

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I.1 INTRODUCTION

This report analyzes the regional economic impact of two remedial action options for stabilizing the uranium mill tailings located on the Vitro site. The alternatives include stabilization of all material at the site or removal of the material to a new disposal site. The Vitro site is a 128-acre inactive uranium processing site in South Salt Lake, Utah. The Vitro Corporation of America operated a uranium ore processing mill and related storage and transportation facilities on an eight-acre portion of the site between May 1951 and January 1964. The site is currently owned by the Central Valley Water Reclamation Facility Board (CVWRF). Figure I-1 is a map of the region. The property is bounded on the south by 3300 South Street; on the west by 900 West Street (and six vicinity properties); on the north by CVWRF's waste-water treatment plant and Mill creek; and on the east by Western Dry Mix and property owned by T. R. Woodrow and R. J. Herring. The waste-water treatment plant occupies approximately 40 acres directly north of the site.

CVWRF's approved Master Plan identifies intended land uses on the Vitro site as follows:

- Mechanical treatment plant: 100 acres.
- Sludge lagoons: 23-32 acres.
- Temporary industrial park: 20-25 acres.
- County resource recovery facility: 16 acres.
- City culinary waterwell site: 1 acre.

CVWRF has stated that it will develop a temporary industrial park (22.5 acres) on the Vitro site's 3300 South Street frontage property if tailings removal is the adopted remedial action. Based on this assertion, this report estimates the gross economic benefits that might result from the development of an industrial park on the site. CVWRF has not stated the time period during which it expects the temporary industrial park to operate. However, the following discussion of long-term expansion requirements at CVWRF's waste-water treatment facility appears on pages 1-2 of Final Report, 201 Facilities Plan, Central Valley Water Reclamation Facility Board, February 1982, Coon, King and Knowlton; and Brown and Caldwell; "First-stage construction of the Central Valley WRF will expand the existing capacity of the District 1 plant, which has an average annual daily flow of 17 million gallons per day (mgd), to its projected year 2005 flow of 50 mgd." This suggests that the temporary industrial park could operate until construction for the post-2005 expansion began. Based on the following assumptions a 13 year life is estimated for CVWRF's temporary industrial park.

- Removal of the tailings to South Clive is assumed to be the adopted remedial action.

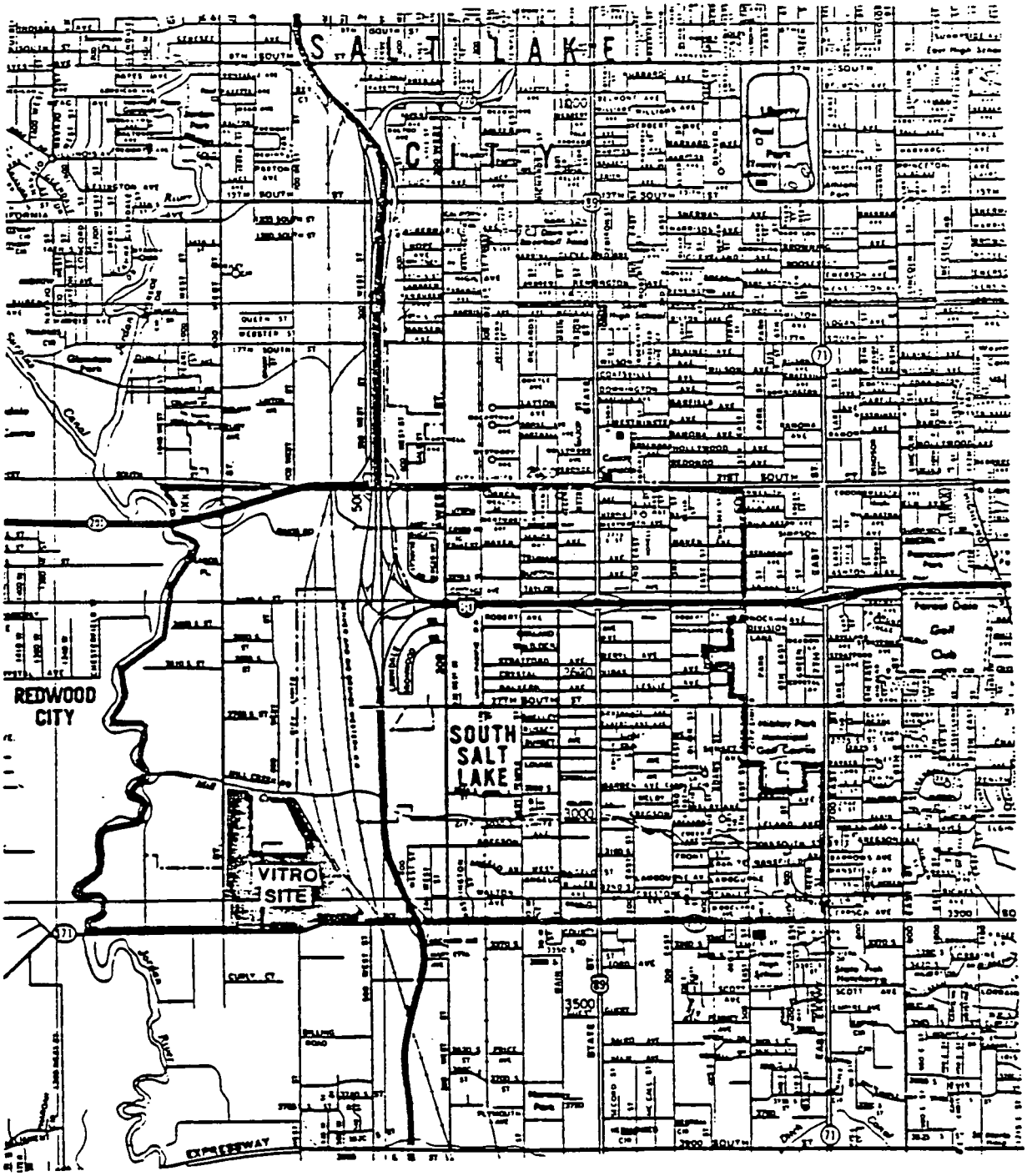

FIGURE I-1

VITRO TAILINGS SITE, CITY OF SOUTH SALT LAKE, UTAH, REGIONAL MAP

- A three-year clean-up period ending December 1986.

- Occupancy of the temporary industrial park beginning January 1988.

- A five-year construction period for the expansion of CVWRF's waste-water treatment facility to 100 mgd.

- Operational start-up of the 100 mgd facility beginning January 2006.

The economic impacts will be delineated in terms of the regional economy.

The balance of this report will address the following areas: (1) zoning; (2) master plan; (3) land use: (4) assessed valuation; (5) demographics; (6) employment; (7) local land values; (8) public revenues; and (9) conclusions. The relationship among these parameters and their uses in deriving an estimate of regional economic benefits are summarized below.

- Zoning

  The zoning designations of the Vitro site will be identified in order to determine if CVWRF's proposed land uses are consistent with the site's current zoning.

- Master plan

  The City of South Salt Lake's Master Plan will be analyzed in terms of the City's prospective commercial and industrial development. The analysis will focus on the salient determinants of South Salt Lake's future growth as set forth in the City's Master Plan.

- Land use

  Data on land use conversion and projections of future land use will be evaluated in order to identify likely geographic areas for commercial and industrial development.

- Assessed valuation

  Data on assessed valuation for South Salt Lake will be analyzed in order to identify trends in the annual rate of change in assessed valuation. In addition, the analysis will focus on commercial and industrial construction permits as indicators of commercial and industrial growth.

- Demographic data

  Data on population, employment, dwelling units, cars, and commercial floor space will be analyzed in order to characterize the demography of the 3.6 square mile area surrounding the Vitro site. Historic information, as well as projections, will be considered.

- Local land values

  The current market value of the 3300 South Street frontage property will be estimated based on: (1) appraisal reports; (2) the highest and best use of the land; (3) the asking price for comparable adjacent property; and (4) a recent transaction involving the property.

- Employment

  The direct and indirect employment impacts of the proposed industrial park will be estimated. The after-tax wages of these employees will constitute the bulk of the region's estimated economic benefits.

- Public revenues

  The estimates of public revenues will be based on an estimate of the industrial park's assessed valuation and the number of direct and indirect jobs created by its development.

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I.2 ZONING

This section considers the zoning of the Vitro site in terms of its effects on the development of the property. These effects will be delineated in terms of limitations on the types of possible development, as well as uses permitted under the code. Figure I-2 is a copy of the City of South Salt Lake's Zoning District Map.

I.2.1 Business (A) district

The portion of the site which abuts 3300 South Street is zoned Business (A) District to a depth of approximately 750 feet. The purpose of a Business (A) District is to "...promote high quality, well-designed business, office, and retail establishments." (City of South Salt Lake, Title Fifteen, Zoning and Land Use, Chapter 20, page 20-1.) In a Business (A) District, those uses consistent with any of the City's residential zoning designations (R-1, R-1A, R-1B and R-M) or the professional office designation (P-O) are permitted. The following is a summary of other permitted uses. (For a complete listing of permitted land uses, see City of South Salt Lake, Title Fifteen, Zoning and Land Use.)

- Office buildings.
- Food stores.
- Retail.
- Restaurants.
- Gasoline service station.
- Hotels and motels.
- Vehicle sales.
- Commercial amusement places.

In addition, there is a minimum lot size of 6,000 square feet and a maximum building height of 40 feet.

I.2.2 Light industrial district

The balance of the site is zoned Light Industrial District. With the exception of two parcels in the southwest corner of the City, which are zoned Agricultural A-1 and Professional Office (see Figure I-2), and the 3300 South Street frontage portion of the Vitro site, all of South Salt Lake west of I-15 is zoned Light Industrial.

The purpose of a Light Industrial District is to "... provide areas in appropriate locations where warehousing and industrial processes not producing objectionable effects may be established, maintained, and protected." (City of South Salt Lake, Title Fifteen, Zoning and Land Use, Chapter 24, page 24-1.) With the exception of residential uses (zoning designations R-1, R-1A, R-1B, R-S and R-M) and mixed use (zoning designation Mixed), any use permitted in the City's zoning ordinances is permitted in a Light Industrial District. It should be noted that any heavy industrial use is prohibited within the City of South Salt Lake. The following is a brief summary of permitted uses. (For a complete listing of permitted uses, see City of South Salt Lake, Title Fifteen, Zoning and Land Use.)

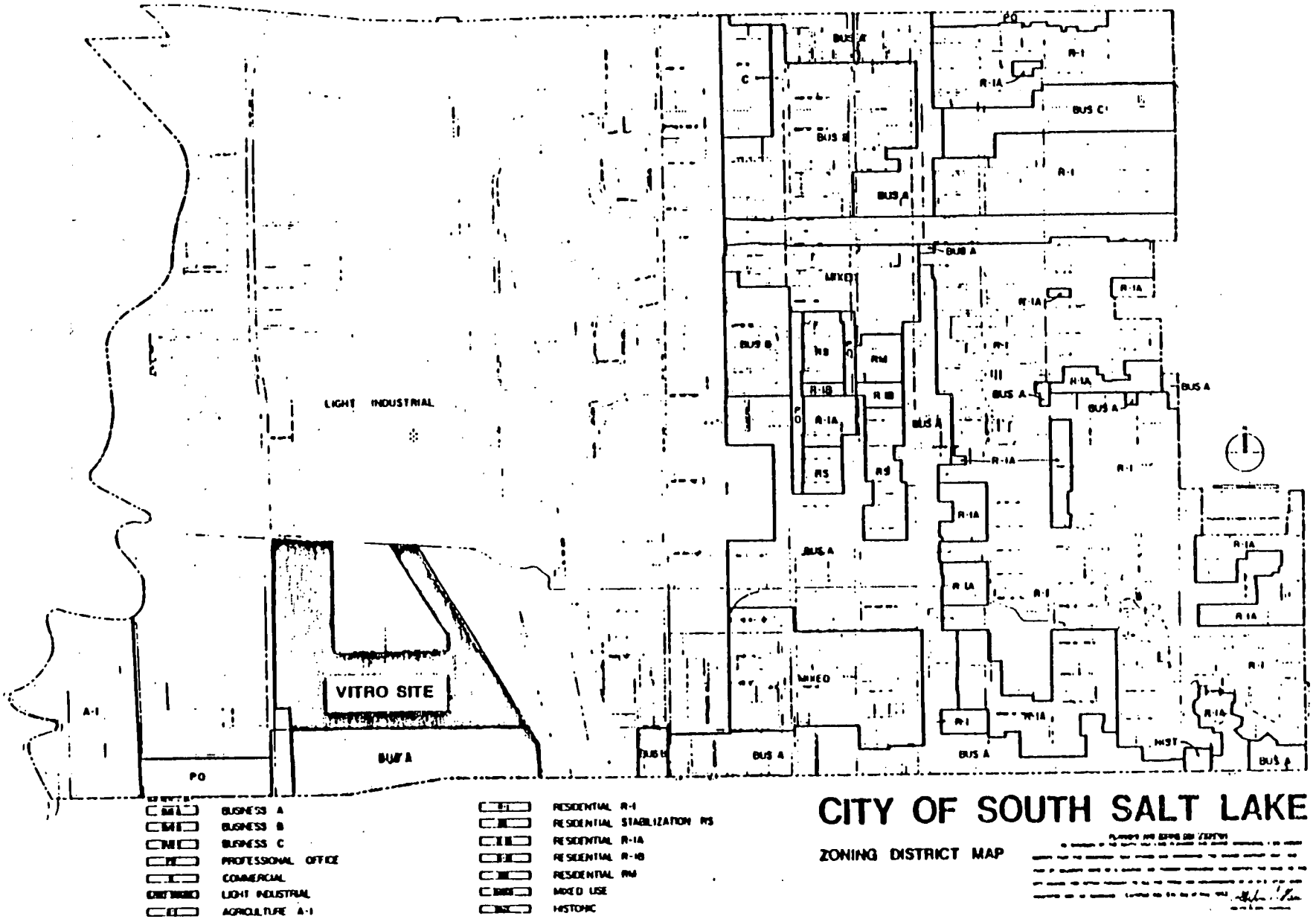

FIGURE I-2: CITY OF SOUTH SALT LAKE, ZONING DISTRICT MAP

- Automobile sales.
- Boiler works.
- Breweries.
- Incinerator.
- Manufacturing.
- Office.
- Service station.
- Warehouse and storage.

There is a setback requirement of 40 to 50 feet in the front. There also is a 20-foot setback requirement for adjacent lots used for parking.

I.2.3 Development potential

Title Fifteen, Zoning and Land Use (City of South Salt Lake) characterizes the uses permitted in a Business (A) District as "limited business and neighborhood shopping" (City of South Salt Lake, Title Fifteen, Zoning and Land Use, Chapter 10, page 10-1). As previously noted, permitted land uses in this District include office buildings, restaurants, hotels, and a variety of retail operations. It should be noted that the 3300 South frontage parcel is the only Business A zoned land west of I-15 in the City of South Salt Lake. Therefore, based on its current zoning, this parcel could be developed for a variety of business, office, and retail uses. However, the permitted uses do not include industrial parks. While this use would be permitted in a Light Industrial District, it is inconsistent with the property's current Business A zoning.

The balance of the Vitro site, which is zoned Light Industrial, can be developed for almost any non-residential or non-heavy industrial use possible.

As previously noted, the development of an industrial park is inconsistent with the 3300 South frontage property's current zoning. In addition, it would appear that, based on existing land uses on adjacent properties and the presence of the waste-water treatment facility, development consistent with a Business A zoning (e.g., office buildings, restaurants, motels) is unlikely. Therefore, a rezoning of the property to Light Industrial to accommodate CVWRF's proposed industrial park seems likely.

I.3 MASTER PLAN

This section is a review of the City of South Salt Lake's Master Plan. The purpose of this review is to analyze the City's goals and expectations with regard to economic growth and industrial and commercial development.

The City of South Salt Lake conducted its master planning process in three phases. The resulting documents and the relationship among the various phases are set forth below.

Phase 1: City of South Salt Lake Policy Plan (no date)

The purpose of Phase I was "to develop an adequate and reliable data base from which problem areas could be defined and quantified for use in subsequent phases in developing the comprehensive plan."

Phase 2: South Salt Lake City Master Plan Phase II, June 1980

The purpose of Phase II was "to analyze the inventory of data that was gathered during Phase I, and identify in quantifiable terms existing trends, problem areas, and strengths of the city.... to recommend goals and objectives for the various alternative futures that exist in the areas of economic development, housing, zoning and land management, code enforcement, transportation facilities, civic pride, and recreational development."

Phase 3: City of South Salt Lake Comprehensive Master Plan, June 1981

Phase III reports on the policies, strategies and procedures that were established in order to achieve the goals and objectives derived in Phase II.

The balance of this section will be devoted to an analysis of those elements of the master planning process which affect economic development in general and development alternatives for the Vitro site in particular.

I.3.1 Policy plan

In the report, it is suggested that a market study be completed in order to determine the City's "potential for attracting or not attracting certain types of businesses." In that regard, the Report notes that the lifting of the Utah Department of Health's ban on development near the Vitro site has resulted in development of a 25-acre industrial park on the old KCPX radio station property by HOMCO Development Co. The property is across 900 West Street from the Vitro site. However, the property was recently sold to the Utah State Retirement Fund (USRF) and is again being offered for sale. A spokesperson for the USRF stated that its proximity to the Vitro site had not affected its value (Blackburn, 1983).

The report states "...there still remains large undeveloped areas for commercial and industrial development particularly in the recently annexed area south of Mill Creek and West of I-15." Although the information is somewhat out-of-date, Table IX, Privately Owned Vacant Land, April 1979 is reproduced below from the Policy Plan.

Zoning	Area (square feet)	Area (acres)
Residential A	199,260	4.6
Residential B	66,991	1.5
Business A	122,670	2.8
Business B	220,240	5.1
Commercial	21,512	0.5
Industrial	12,244,338	281.1
Agricultural	1,029,000	23.6
Total	13,904,011	319.2

These figures appear to include the portion of the Vitro site, which is currently zoned Business A, in the industrial category.

The report characterizes South Salt Lake as becoming an increasingly significant center of "heavy commerce," which includes sales of automobiles, recreational vehicles and large appliances. This is in addition to its traditional manufacturing and wholesaling roles. However, it warns of "impacts on the City cost pattern, demanding participatory expenditures for the cleaning up of heavy commerce areas, more rigorous and effective buffering between potentially conflicting uses, and increased attention to traffic control and flow."

I.3.2 Master plan: phase II

This report focuses on the section titled Forecast of Economic Conditions in South Salt Lake City. This section includes discussions of industrial and wholesaling growth potential in South Salt Lake, demand for office space in South Salt Lake and the City's future retailing role.

The first area to be addressed is a study of the absorption potential of vacant land zoned for industrial use in South Salt Lake. It should be noted that based on discussions between the authors of the report and the principals of the engineering firm of Coon, King and Knowlton, 70 acres associated with the old Vitro operation were excluded from the study. It is assumed that this is separate from the frontage property along 3300 South, since CVWRF did not purchase the property until 1981.

The report presents annual estimates of the absorption of vacant land zoned for industrial use, industrial construction activity and building-to-land coverage ratios for 1980-1990. With the exception of estimated building-to-land coverage ratios, data are shown individually for traffic zones 328, 329, and 351 and as an aggregate for the rest of South Salt Lake. The estimated building-to-land coverage ratios are shown individually for traffic zones 328 and 329 and as an aggregate for the rest of South Salt Lake. Traffic zones 328, 329, and 351 are part of census tract 116. Traffic zone 328 is north of CVWRF's waste-water treatment facility, traffic zone 329 includes the Vitro site, and traffic zone 351 is east of I-15 and north of 3300 South Street. Figure I-3 is a map of the area and indicates the locations of the above traffic zones.

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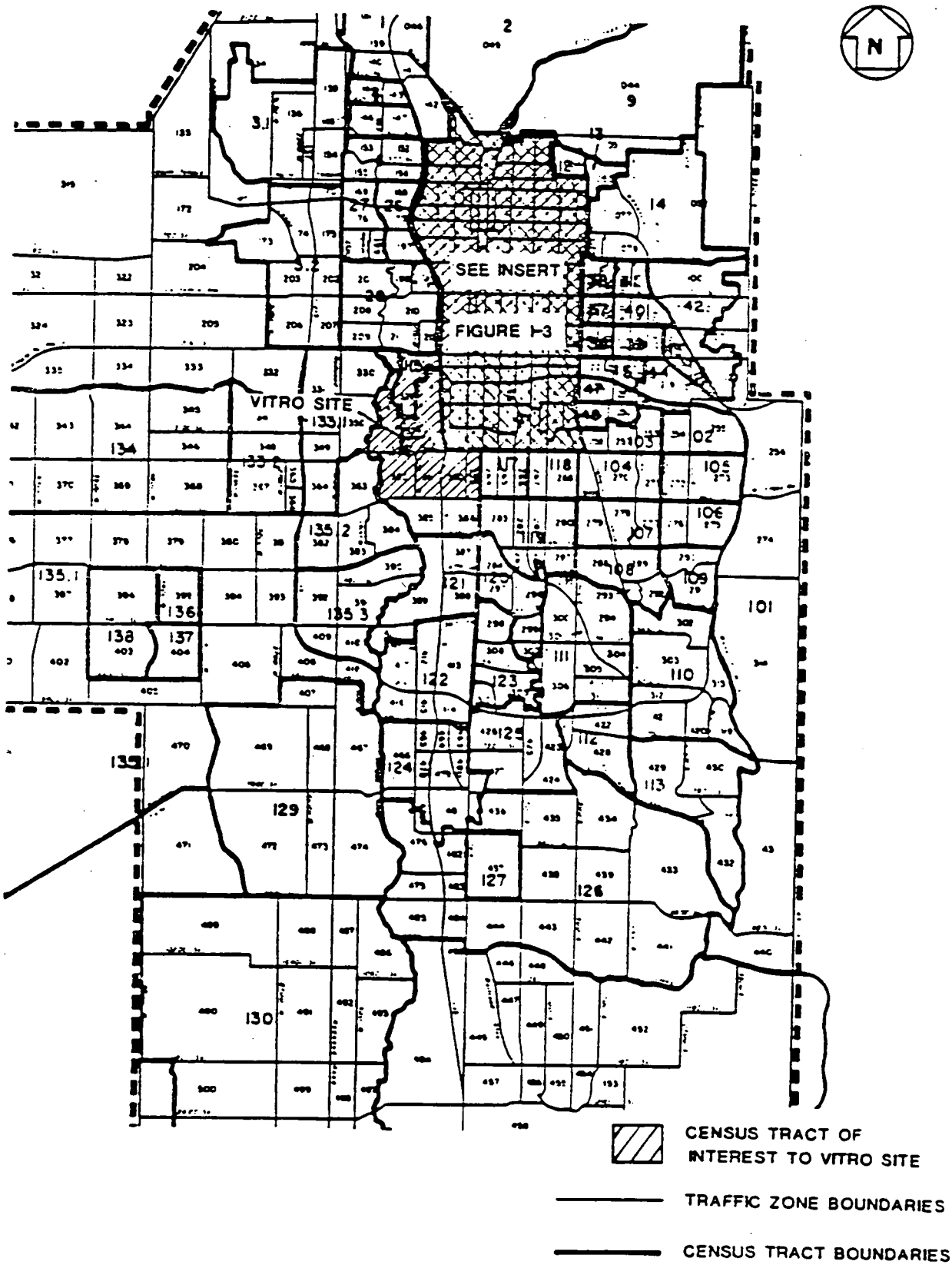

FIGURE I-3

SALT LAKE COUNTY, CENSUS TRACT/TRAFFIC ZONE MAP

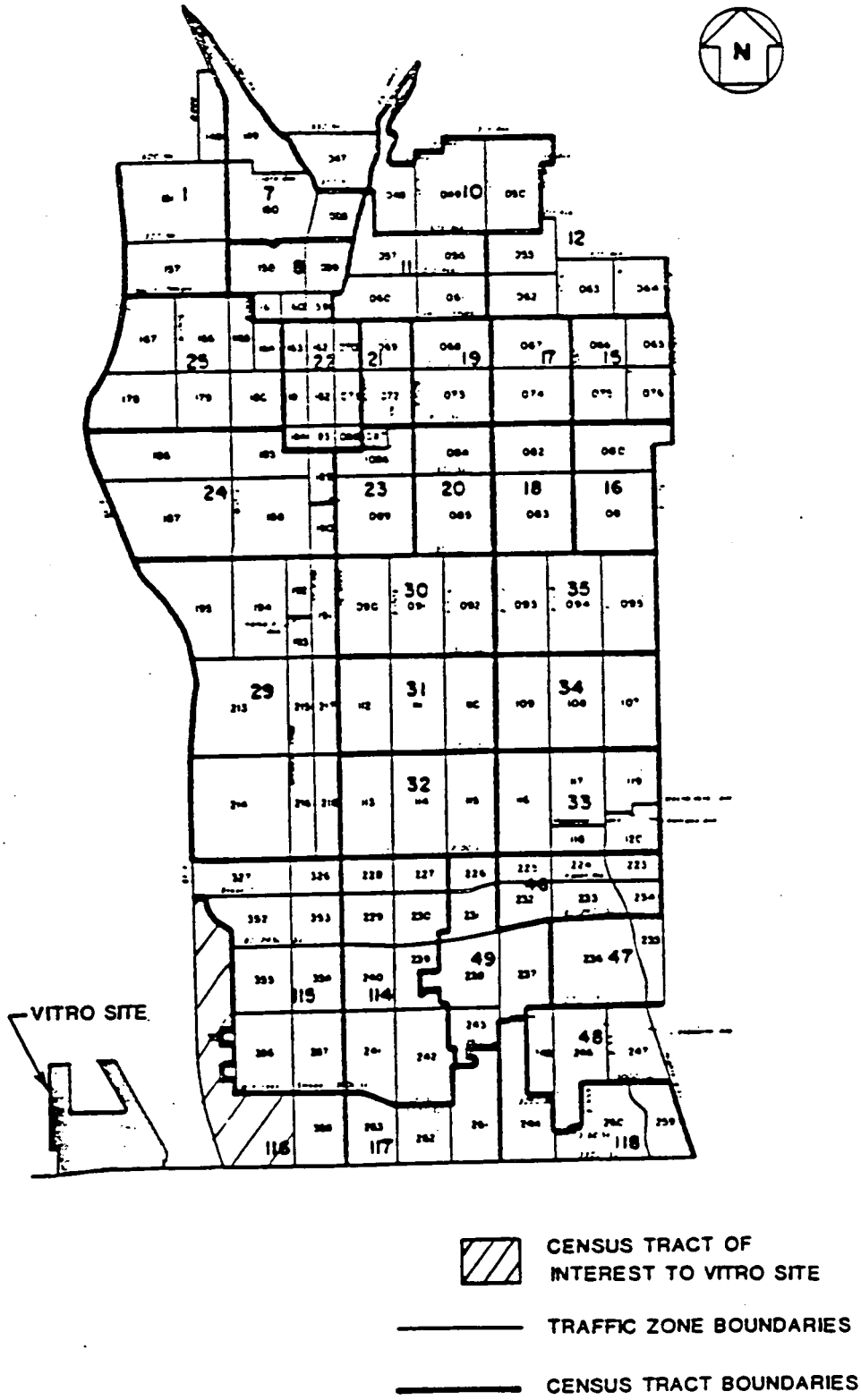

FIGURE I-3
SALT LAKE COUNTY, CENSUS TRACT/TRAFFIC ZONE MAP (INSERT)

It is estimated that given a healthy regional economy, approximately 84.0 percent of the available industrial acreage will be absorbed by 1990. This scenario assumes that the following "major economic stimuli" occur:

- Deployment of the MX missile system in western Utah.
- Increased extraction of coal reserves in Utah's Overthrust Belt.
- Continued development of statewide water and power projects.

This set of assumptions leads to the "high estimate" for the absorption of industrial land in the City. Table I-1 sets forth projected data on the absorption of industrial land, for selected traffic zones, and the rest of South Salt Lake for the period 1980-1990. Table I-1 also includes a "low estimate" for the absorption of industrial land. These data assume a moderate national and/or regional recession with "cyclical upturns and downturns," during the study period. Under this scenario, 58.0 percent of the available land will be absorbed by 1990.

With regard to future development, the report states "the bulk of new construction (about 70 percent) is expected to be in built-to-suit, rather than integrated speculative developments. This construction will also be comparatively disparate and fragmented, rather than being integrally designed industrial parks...." The HOMCO Development Co. project on 3300 South and the Marketplace Square project west of 900 West are mentioned as possible exceptions. However, neither project is currently being developed. In addition, HOMCO's property on 3300 South was recently sold to the Utah State Retirement Fund, which placed it on the market early this year. The report estimates that future development will result in the following types of land uses.

- Wholesaling, distribution and storage functions: 70.0 percent.
- Industrial use: 16.0 percent.
- Retailing, office and service purposes: 14.0 percent.

The report justifies the above land use scenario, in part, on the basis of the image of the City's west side. It is characterized as having "transportation and other advantages" which render the area prime. However, the report concludes that firms which require prestigious locations would not choose a site in the area. In addition, the report states that "the building of the regional sewage treatment plant will negatively impact the quality of development that will occur in the lands adjacent to it."

The report provides low and high estimates of commercial construction, as shown in Table I-2. These data are based on the projected absorption of industrial acreage in Table I-2 and projected building-to-land coverage ratios, which are shown in Table I-3. The increasing average ratios for traffic zones 328 and 329 reflect "the decreasing availability of larger contiguous tracts of land which are attractive to land extensive facilities with a need for large amounts of exterior storage area." (Land extensive facilities are facilities with low building-to-land coverage ratios.) The assumption is that large parcels will be absorbed early in the period and that the remaining land will be "more suitable for building extensive operations with higher coverage ratios." (Building extensive operations are facilities with high building-to-land coverage ratios.)

Table I-1. City of South Salt Lake estimated absorption of industrial land (acres)

1980-1990

Year	Traffic zone 328 High	328 Low	329 High	329 Low	351 High	351 Low	All others High	All others Low	Total High	Total Low
1980	9.28	9.28	21.52	21.52	2.5	1.67	1.23	.55	34.53	33.02
1981	5.27	1.76	24.27	11.77	3.7	1.55	1.07	.52	34.31	15.60
1982	4.48	1.67	20.40	10.80	3.06	1.44	.93	.48	28.86	14.39
1983	3.81	1.59	17.30	10.00	2.53	1.34	.80	.46	24.44	13.39
1984	3.24	1.50	14.60	9.30	2.09	1.25	.69	.43	20.62	12.48
1985	2.75	1.43	12.40	8.60	1.73	1.16	.60	.41	17.48	11.60
1986	2.34	1.36	10.40	7.90	1.42	1.08	.52	.38	14.68	10.72
1987	1.99	1.29	8.80	7.40	1.18	1.00	.45	.36	12.42	10.05
1988	1.69	1.23	7.50	6.70	.97	.93	.39	.33	10.55	9.19
1989	1.44	1.17	6.30	6.30	.80	.87	.33	.31	8.54	8.65
1990	1.22	1.11	5.30	5.80	.66	.81	.29	.29	7.47	8.01
Total	38.19	24.07	148.79	106.09	20.65	13.10	7.29	4.52	214.92	147.78
Percent absorbed 1990	84.7%	53.4%	83.7%	59.7%	86.8%	55.0%	79.7%	49.4%	84.2%	57.9%

Source: South Salt Lake City Master Plan, Phase II, June 1980

Note: Detail may not add to total due to rounding.

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Table I-2. City of South Salt Lake estimated industrial construction
(thousands of square feet)

1980-1990

Year	Traffic zone 328 High	328 Low	329 High	329 Low	351 High	351 Low	All others High	All others Low	Total High	Total Low
1980	69.9	69.9	162.2	162.2	43.3	28.9	21.3	9.5	296.7	270.5
1981	48.3	16.1	222.5	107.9	64.1	26.9	18.6	9.0	353.5	159.9
1982	48.4	17.0	220.4	109.6	53.1	25.0	16.0	8.3	337.9	159.9
1983	51.1	17.2	232.1	108.0	43.9	23.2	13.9	8.0	341.0	156.4
1984	47.7	16.2	215.0	100.5	36.2	21.7	12.0	7.5	310.7	145.9
1985	43.2	15.4	194.7	92.9	30.0	20.1	10.4	7.1	278.3	135.5
1986	40.6	14.7	180.3	85.3	24.6	18.7	9.0	6.6	254.5	125.3
1987	34.5	13.9	152.6	79.9	20.4	17.3	7.8	6.2	215.3	117.3
1988	29.3	13.3	130.0	72.4	16.8	16.1	6.8	5.8	182.9	107.6
1989	25.0	12.6	109.2	68.1	13.8	15.1	5.7	5.3	153.8	101.1
1990	21.1	12.0	91.9	62.7	11.4	14.0	5.0	5.0	129.5	93.7
Total	459.1	218.3	1,910.9	1,049.5	357.6	227.0	126.5	78.3	2,854.1	1,573.1

Source: South Salt Lake City Master Plan, Phase II, June 1980.

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Table I-3. City of South Salt Lake estimated building-to-land coverage ratios 1980-1990

Healthy economic conditions

Traffic Zone	Year 1980	81	82	83	84	85	86	87	88	89	90
328 & 329	.15	.20	.25	.33	.37	.40	.45	.45	.45	.45	.45
All others	.45	.45	.45	.45	.45	.45	.45	.45	.45	.45	.45

Sluggish economic conditions

Traffic Zone	Year 1980	81	82	83	84	85	86	87	88	89	90
328 & 329	.15	.20	.23	.25	.25	.25	.25	.25	.25	.25	.25
All others	.45	.45	.45	.45	.45	.45	.45	.45	.45	.45	.45

Source: South Salt Lake City Master Plan, Phase II, June 1980.

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The report includes an estimate of South Salt Lake's share of office space growth in Salt Lake County between 1980 and 1985. The estimate is based on the following assumptions:

1. Salt Lake County population growth of 84,064.

2. 85 office employees per 1,000 of population.

3. 210 square feet of office space per employee.

4. South Salt Lake's annual share of the growth in office space will be between seven and 13.5 percent.

Based on the above, it is estimated that South Salt Lake's share of total growth will be between 115,600 square feet and 173,000 square feet.

The report also addresses the future of retailing activity in South Salt Lake City. It divides the City's retail structure into three areas.

- Convenience goods.
- Shopping goods.
- General purchases.

Convenience goods are the most frequently purchased types of goods. The amount of purchasing power found in the local area is the key to success in this type of retailing. The report concludes that "... it is extremely doubtful whether additional facilities are warranted either now or in the near future." This is attributed to the declining city population and the fact that the area's income is lower than the regional average. However, the development of some retail space along 900 West to serve the local work force was mentioned as a possibility.

With regard to retail shopping, South Salt Lake is characterized as being "at a distinct disadvantage in any attempt to increase its share of the market for these goods." This is due to the "transient nature of State Street traffic" and the lack of existing or planned shopping centers supplying this level of goods. However, the City appears to be in a relatively good position with regard to general purchases or "heavy commerce retailing." Retail businesses which require large, plain buildings and large outside storage areas, but do not need presitious locations, will contribute to growth in the west and southwest portions of the City.

The section of the report that deals with land use trends contains the following observations regarding the potential for commercial and industrial development in South Salt Lake City.

- Eighty-two percent of the remaining developable industrial land will be absorbed by 1990. As previously noted, the section on economic conditions projects that 58.0 percent (low estimate) to 84.0 percent (high estimate) of the available industrial acreage will be absorbed by 1990.

- The City is in a disadvantageous position with regard to commercial development due to the area's low average income, minimal purchasing power, and lack of population growth.

- It is doubtful that any significant growth in shopper's goods will occur due to the area's proximity to Salt Lake City's central business district and Murray City.

- South Salt Lake does not attract businesses looking for a prestigious location due to the area's image and its environmental character.

- Very little growth in office space is forecast due to the lack of large suitably located parcels, the mix of industrial uses in the area and the proximity to Salt Lake City and Murray City.

I.3.3 Comprehensive master plan

The Land Use Master Plan, which is part of the Comprehensive Master Plan, is intended to "provide an overall guide to aid in the City's land management functions."

The Land Use Master Plan focuses on the need for single-family, attached, owner-occupied housing in the City (e.g., townhomes). However, it does indicate that "the City will continue its long history of encouraging quality industrial, warehousing, and distribution development west of the O.S.L. Railroad." O.S.L. refers to Union Pacific's Oregon Short Line, which is located west of I-15 at about 140 West.

I.3.4 Master policy declaration for annexation for South Salt Lake City, Utah, January 1980

Pursuant to the Utah Boundary Commission Act of 1979 (HB 61), the City of South Salt Lake has prepared a declaration of policy regarding future annexations to the City. The conditions under which an area may qualify for annexation are summarized below. (See City of South Salt Lake, Statement of Annexation Criteria, Standards, for a complete discussion.)

- The area must be contiguous to the boundaries of South Salt Lake City.

- The area must be identified in the policy declaration statement.

- With certain exceptions, the area can not be within the boundaries of another incorporated municipality.

- The net fiscal effect on municipal services entities displaced by the annexation shall be approximately zero.

- The annexation shall not be for the purpose of acquiring municipal revenues without providing municipal services.

One of the areas identified for possible annexation, Area 1A, extends south from 3300 South Street to 3900 South Street and west from 700 East Street to the Jordan River. This area includes traffic zones 359, 360, 361 and 362 in census tract 116 and traffic zones 264, 265 and 266 in census tract

117. The area contains approximately 1,537 acres with an assessed valuation of $29.7 million (1977).

Salient demographic and land use data are summarized below.

• population acres	6,059
• dwelling units	2,454
• employment	7,174
• residential acres	335
• commercial acres	169
• industrial acres	218
• agricultural acres	228
• vacant acres	214

Source: Wasatch Front Regional Council, Surveillance of Land Use and Socio-Economic Characteristics 1970, 1979, 1980 and 1995, Surveillance Report, Volume 2, Number 7, April 1982.

I.3.5 Conclusions

In general, the Master Plan characterizes the City of South Salt Lake as being unlikely to experience significant growth in commercial development, shopper's goods, or office space. This is attributed to a declining population and low average income (and, consequently, low purchasing power). The City also is characterized as being at a competitive disadvantage compared to Salt Lake City and Murray City. The Master Plan identifies a target type of firm for business growth in South Salt Lake City -- a business which requires a large plain building with extensive outside storage, but does not require a prestigious location. This is consistent with the area's development as a location for warehousing, distribution, and wholesaling activities.

The Master Plan includes estimates of the annual absorption rate of vacant land zoned for industrial uses in traffic zone 329. Annual absorption ranges from 5.3 acres to 24.3 acres, depending on the year and the underlying economic assumptions. For the period 1980-1990, the average annual absorption rates for the high and low estimates are 13.5 acres and 9.6 acres, respectively. In addition, it is projected that approximately 70.0 percent of the vacant industrial land absorbed in the City between 1980 and I990 will be in traffic zone 329. Therefore, the City has identified traffic zone 329 and, therefore, the 3300 South Street frontage property as a prime area for industrial growth during this decade.

I.4 LAND USE

Land use in the vicinity of the Vitro site will be characterized by reference to data developed by the Wasatch Front Regional Council (WFRC). These data are published in Surveillance of Land Use and Socio-Economic Characteristics, 1970, 1979, 1980 and 1995, Surveillance Report Vol. 2 No. 7, April 1982. Data are available by traffic zone, as well as census tract, for the following types of land use:

- Agricultural.
- Commercial.
- Industrial.
- Institutional.
- Parks and recreation.
- Residential.
- Transportation.
- Utilities.
- Vacant.

Portions of two census tracts have been selected in order to evaluate changes in land use in the vicinity of the Vitro site. These include traffic zone 328, which is part of census tract 115, and traffic zones 329, 351, 360, 361 and 362, which are part of census tract 116. The area encompassed by these traffic zones is approximately 3.6 square miles. (See Figure I-3.)

Traffic zone 328 is north of the waste-water treatment facility; traffic zone 329 includes the Vitro site, as well as Central Valley's facility, traffic zone 351 is east of I-15 and north of 3300 South Street; and traffic zones 360, 361 and 362 are south of the Vitro site and abut 3300 South. Traffic zones 360-362 also are in the unincorporated portion of Salt Lake County. Table I-4 sets forth data on land use for the traffic zones noted above. Table I-5 summarizes these data in a percentage distribution.

I.4.1 Historic and current land use

"Agricultural," "Vacant," and "Other" land uses accounted for almost 80.0 percent of area land use in 1970. This included approximately 460 acres of vacant land in traffic zones 328 and 329, as well as 237 acres of transportation right-of-ways in zone 329. In addition, it includes over 200 acres of agricultural land in traffic zone 362.

Current land use, which is based on 1980 data, is about 70.0 percent "Agricultural," "Vacant," and "Other". Vacant land in traffic zones 328 and 329 stands at 455 acres. This corresponds to approximately 40.0 percent of the land in these two traffic zones. There also are about 180 acres of transportation right-of-ways in zone 329 and slightly less than 200 agricultural acres in zone 362.

Table I-4. Salt Lake County land use conversion data
selected traffic zones
(acres)

1970, 1979, 1980, 1995

Census tract/traffic zone	Land use	1970	1979	1980	1995
116/329	Agricultural	101.4	92.8	89.5	52.8
	Commercial	5.0	7.9	7.9	15.0
	Industrial	87.9	101.5	101.5	265.0
	Residential	17.0	7.3	7.3	5.0
	Vacant	311.7	388.7	355.9	132.5
	Other	290.6	215.4	218.7	343.3
	Total	813.6	813.6	780.8	813.6
116/361	Agricultural	81.2	7.6	7.6	---
	Commercial	38.9	11.2	13.2	20.0
	Industrial	23.9	115.8	114.2	130.0
	Residential	23.5	23.1	23.1	50.0
	Vacant	45.3	46.6	47.7	0.0
	Other	45.0	53.5	53.5	57.8
	Total	257.8	257.8	259.3	257.8
116/362	Agricultural	214.7	229.4	196.8	80.1
	Commercial	2.7	1.3	1.3	25.0
	Industrial	0.0	6.8	6.8	67.0
	Residential	20.2	12.4	12.2	52.4
	Vacant	76.7	52.3	69.7	12.0
	Other	18.0	30.1	62.9	95.8
	Total	332.3	332.3	349.7	332.3
116/351	Agricultural	24.3	5.6	4.7	8.0
	Commercial	32.8	55.0	56.0	60.3
	Industrial	14.2	33.9	35.5	55.0
	Residential	48.8	38.0	37.0	24.7
	Vacant	61.7	27.5	24.5	10.0
	Other	78.4	100.2	100.2	102.2
	Total	260.2	260.2	257.9	260.2
116/360	Agricultural	59.7	13.1	13.1	0.0
	Commercial	37.4	35.6	36.6	60.0
	Industrial	12.6	77.9	78.0	95.0
	Residential	46.5	33.1	32.3	30.0
	Vacant	44.7	32.3	34.2	6.6
	Other	50.3	59.2	59.2	59.6
	Total	251.2	251.2	253.4	251.2

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TABLE I-4 Continued

Census tract/traffic zone	Land use	1970	1979	1980	1995
116/328	Agricultural	0.0	0.0	0.0	0.0
	Commercial	10.5	8.3	8.5	15.0
	Industrial	55.6	119.7	126.7	156.8
	Residential	0.0	0.0	0.3	0.0
	Vacant	148.1	94.2	99.4	45.8
	Other	148.1	140.1	140.1	144.7
	Total	362.3	362.3	375.0	362.3
Total	Agricultural	481.3	348.5	311.7	140.9
	Commercial	127.3	119.3	123.5	195.3
	Industrial	194.2	455.6	462.7	768.8
	Residential	156.0	113.9	112.2	162.1
	Vacant	688.2	641.6	631.4	206.9
	Other	630.4	598.5	634.6	803.4
	Total	2,277.4	2,277.4	2,276.1	2,277.4

Note: Data are updated using building permits. Forecast data for 1995 are based on 1970 to 1976 land use data and are no longer accurate for traffic zones which have experienced rapid growth since 1976.

Agricultural: Agricultural production.

Commercial: Retail trade or services.

Industrial: Manufacturing, processing, or wholesale trade.

Residential: Residential uses.

Other:

Transportation: Land within the boundaries or right-of-way of railroads, pipelines, or streets and highways.

Institutional: Public buildings, educational institutions, prisons, military bases, and other special public uses.

Utilities: Gas, electric, water, or sewer utility purposes.

Parks and Recreation: Parks and recreational uses such as golf courses (cemeteries are attached to this category).

Source: Wasatch Front Regional Council, Surveillance of Land Use and Socio-Economic Characteristics 1970, 1979, 1980 & 1995, Surveillance Report, Volume 2, April 1982.

Table I-5. Salt Lake County land use data -- a percentage distribution selected traffic zones

1970, 1979, 1980 & 1995

	Land use	1970	1979	1980	1995
Traffic Zones 328, 329, 351, 360, 361, & 362	Agricultural	21.1%	15.3%	13.7%	6.2%
	Commercial	5.6	5.2	5.4	8.6
	Industrial	8.5	20.0	20.3	33.8
	Residential	6.8	5.0	4.9	7.1
	Vacant	30.2	28.2	27.7	9.1
	Other	27.7	26.3	27.9	35.3
	Total	100.0	100.0	100.0	100.0

Note: Detail may not add to total due to rounding.

1980 data are calculated based on 2,276.1 acres; all other year's data are based on 2,277.4 acres.

I.4.2 Projected land uses: 1995

The projections of area land use shown on Table I-5 were developed by the WFRC. These data suggest that about one-half of the area's total acreage will still be vacant or devoted to "Agricultural" and "Other" uses in 1995. However, "Agricultural" land use is projected to decrease to approximately 6.2 percent of total land use, as compared to 15.3 percent in 1979. In addition, more than one-third of area land use is projected to be "Industrial" by 1995. Industrial land use in the area stood at 20.0 percent in 1979.

I.4.3 Land use: changes

The net effect of land use conversion between 1970 and 1979 in the vicinity of the Vitro site was a shift from "Agricultural" to "Industrial" land use. There also was a minor shift from "Residential," "Other," and "Vacant" land uses to "Industrial" land use. With regard to individual traffic zones, the following observations can be made:

- Traffic zone 329

  Vacant land and land devoted to other uses remained constant at approximately 600 acres. Commercial and industrial land uses increased approximately 18.0 percent, while agricultural and residential land uses decreased by about 15.0 percent.

- Traffic zone 361

  Residential, vacant, and other land uses increased by less than 10.0 percent. However, industrial land use increased by 91.9 acres or 385.0 percent. Agricultural and commercial land use decreased by approximately 90.0 percent and 70.0 percent, respectively.

- Traffic zone 362

  Land use changes in this traffic zone were relatively minor. They included the development of 6.8 acres of industrial land, a small increase in agricultural land use and relatively small decreases in commercial and residential acreage, as well as vacant land. Industrial land use in 1970 was zero.

- Traffic Zone 351

  Agricultural land use was down from 24.3 acres to 5.6 acres, while combined commercial and industrial land use increased from 47.0 acres to 88.9 acres. In addition, residential and vacant land use decreased.

- Traffic zone 360

  Residential and agricultural land use decreased 60.0 acres, while industrial land use increased 65.3 acres. Other land uses remained relatively constant (unchanged).

- Traffic zone 328

  Agricultural land use remained zero. Industrial land use increased 64.1 acres and vacant land decreased 53.9 acres. All other land uses remained, for the most part unchanged.

Land use changes projected to occur through 1995 will result in reductions in agricultural land use and vacant land of 207.6 acres and 434.7 acres, respectively. The majority of these changes are projected to be 313.2 acres of industrial development. In addition, an increase in other land uses of 204.9 acres is projected; this includes an 85.0-acre increase in park and recreational land use in traffic zones 329 and 362, a 53.5-acre increase in utility land use in zone 329 and a 29.4-acre increase in transportation-related land use also in traffic zone 329.

During the period 1970-1979, industrial land use in the six-traffic-zone analysis area increased at an average rate of 29.0 acres per year. Data developed by the WFRC projected 313.2 acres of additional industrial development by the year 1995. This corresponds to an increase of 19.6 acres per year in industrial land use. Commercial land use in the six traffic zones decreased by eight acres between 1970 and 1979. However, data developed by the WFRC project a modest growth in commercial land use of four and one-half to five acres per year through 1995.

I.4.4 Conclusions

The land use data projected for traffic zone 329, which includes the 3300 South frontage property, indicate an annual rate of growth in industrial land use of 10.9 acres for the period 1980-1995. The projected annual rate of growth in industrial land use for the six-traffic-zone analysis area is about 20.4 acres. Therefore, over half of the growth in industrial land use in the 3.6 square mile analysis area is projected to occur in traffic zone 329.

As previously noted, the City's Master Plan projects that between 10.6 (low estimate) and 14.9 (high estimate) acres of vacant industrial land will be absorbed in traffic zone 329 between 1980 and 1990. This corresponds to approximately 70.0 percent of the City's total absorption of vacant industrial land. The projections of land use conversions developed by the Wasatch Front Regional Council are consistent with the City's low estimate of annual absorption. However, the time period for the City's projections is 1980-1990 and the time period for the projections developed by the Wasatch Front Regional Council is 1980-1995. In addition, the data developed by the Wasatch Front Regional Council are estimates of land use conversion, while the City's Master Plan projects the absorption of existing vacant industrial land. Therefore, comparisons of the share of total growth projected for traffic zone 329 are not made. Finally, the projections of land use conversion set forth above are consistent with industrial growth in the vicinity of, if not on, the Vitro site's 3300 South frontage property.

000799

I.5 ASSESSED VALUATION

This section sets forth an analysis of data provided by the City of South Salt Lake and the Salt Lake County Assessor's Office on changes in the assessed valuation of South Salt Lake. As of January 1, 1983, commercial and industrial property was assessed at 20.0 percent of its 1978 fair market value. Residential property was assessed at 15.0 percent of its 1978 fair market value. A statewide reappraisal program, which is partially responsible for the 55.0 percent increase in the City's 1978 assessed valuation was repealed in 1981. It was replaced with a "Factor Law." This approach involves adjusting the 1978 fair market value based on a sales ratio. The sales ratio is the ratio of the sales price to the assessed value, where the sales price is adjusted to 1978 dollars using the composite construction cost index. The sales ratio studies are prepared by the State Tax Commission using data on recent local real estate transactions and assessed values. The effect of the January 1983 change in assessments was an increase in commercial and industrial assessments and, therefore, an increase in property values in general.

Table I-6 summarizes data on changes in assessed valuation in South Salt Lake. Table I-7 summarizes building permit activity for selected years between 1970 and 1982. Table I-8 sets forth detailed data on building permits issued, by type of construction, and the corresponding valuations which the City uses to determine its permit fees. The valuations shown in Table I-8 generally correspond to the contractor's building cost and exclude land, interior improvements, outside improvements, and equipment. The City's commercial category includes all non-residential structural construction activity. The other category includes, among other things, signs and underground tanks. The City has estimated that a project's fair market value is equal to 130 percent of its building permit valuation plus land value.

I.5.1 Assessed valuation changes: 1940-1982

Assessed valuation in South Salt Lake increased at an average annual rate of 7.6 percent between 1940 and 1977. In 1978, assessed valuation increased 55.0 percent. This was due, in part, to a statewide reappraisal program, which has since been abandoned. Subsequent to 1978, the assessed valuation of South Salt Lake moved in an erratic fashion. It increased by 13.9 percent in 1979 and 29.0 percent in 1980. However, in 1981 the City's assessed valuation decreased 1.1 percent.

The 1980 change in assessed valuation was largely due to an annexation completed by South Salt Lake during 1980. The annexation involved land from Mill Creek to 3300 South Street and the Jordan River to 700 East Street. The area had a population of approximately 3,500 at the time of its annexation.

Table I-6. City of South Salt Lake assessed valuation selected years

1940-1982

Year	Assessed valuation (thousands of Dollars)	Average annual rate of growth (percent)
1940	$ 2,265	---
1945	2,592	2.7
1955	7,189	10.7
1960	10,778	8.4
1965	15,952	8.2
1970	20,842	5.5
1975	28,287	6.3
1976	31,680	12.0
1977	34,070	7.5
1978	52,797	55.0
1979	60,155	13.9
1980	77,582	29.0
1981	76,754	(1.1)
1982	79,345	3.4

Note: Parentheses indicate a decline.

Source: City of South Salt Lake.

Table I-7. City of South Salt Lake building permit activity
commercial/industrial
selected years

1970-1982

Year	Number of permits	Total value
1970	46	$2,123,560
1972	70	4,095,331
1974	49	6,291,426
1976	56	6,286,800
1978	56	4,927,511
1981	63	3,016,271
1982	82[a]	3,848,270[a]

[a]Excludes CVWRF expansion and residential and other permits.

Source: City of South Salt Lake, Policy Plan and Table 8.

TABLE I-8

CITY OF SOUTH SALT LAKE
BUILDING PERMITS AND VALUATIONS
1981-1982

Year/Month	New Commercial Number (1)	New Commercial Valuation (2)	Remodel Commercial Number (3)	Remodel Commercial Valuation (4)	New Residential Number (5)	New Residential Valuation (6)	Remodel Residential Number (7)	Remodel Residential Valuation (8)	Other Number (9)	Other Valuation (10)	Total Number (11)	Total Valuation (12)
1981												
January	2	$ 21,000	3	$ 58,100	1	$ 210,000	1	$ 31,000	3	$ 1,700		
February	2	103,800	0	---	0	---	2	8,200	1	495		
March	2	24,500	1	500	0	---	3	13,572	4	2,280		
April	5	385,000	2	40,874	0	---	3	8,500	4	3,500		
May	5	51,800	4	220,000	0	---	2	1,000	3	8,400		
June	1	325,000	4	156,000	0	---	4	12,000	11	62,500		
July	3	33,500	2	4,200	0	---	2	7,500	5	6,400		
August	1	30,000	2	465,000	0	---	3	6,651	8	1,250		
September	2	213,000	5	54,697	0	---	4	24,000	16	9,750		
October	0	---	3	14,400	1	30,000	0	---	8	37,595		
November	4	501,000	4	92,000	0	---	1	3,000	12	27,500		
December	1	176,000	5	45,900	0	---	2	16,200	9	27,784		
	28	$ 1,864,600	35	$1,151,671	2	$ 240,000	27	$131,623	84	$189,154	176	$ 3,577,048
1982												
January	3	$ 17,000	3	$ 22,280	0	$ ---	0	$ ---	4	$ 2,395		
February	0	---	3	48,300	0	---	2	9,000	3	6,500		
March	0	---	6	64,500	0	---	7	34,300	6	16,450		
April	2	638,000	7	102,750	0	---	4	1,000	4	57,500		
May	3	90,391,000(1	9	360,750	0	---	5	67,480	2	2,500		
June	4	285,590	6	99,500	1	1,250,000	2	21,000	9	58,562		
July	1	260,000	6	39,100	0	---	3	11,200	3	9,500		
August	2	205,000	8	37,400	0	---	1	500	6	7,450		
September	4	838,000	5	80,600	0	---	2	9,500	6	9,200		
October	0	---	5	40,500	0	---	6	36,049	8	15,200		
November	0	---	2	50,000	0	---	4	15,690	4	5,100		
December	2	250,000	2	18,000	0	---	2	6,800	5	8,356		
	21	$92,884,590	62	$ 963,680	1	$1,250,000	38	$212,519	60	$198,713	182	$95,509,502

Note: Data excludes plumbing, electrical and mechanical.

1. Includes expansion of Central Valley Water Reclamation Facility wastewater treatment plant (+ $90,000,000).

Source: City of South Salt Lake.

000603

The decrease in assessed valuation recorded during 1981 was due, in part, to the sale of 26.18 acres along the north side of 3300 South Street by Richards-Moench (Richards Realty & Investments and Moench Realty and Investment Co.) to CVWRF. The sale removed 26.18 acres from the City's tax base. However, records provided by the County Assessor's office show that the property had an assessed value of $70,030 in 1980 and $58,265 in 1981. This decrease may be due to the aforementioned "Factor Law." In recent years, residential property values in South Salt Lake have been declining due to two factors. First, the stock of housing in the city is relatively homogeneous. In general, it includes smaller homes of an older design, which occupy relatively small lots. Second, development in Murray and West Valley City has resulted in the construction of newer, more spacious homes. This has apparently placed the South Salt Lake housing market at a competitive disadvantage. Concurrent with the recent decline in residential property values, growth in commercial/industrial development has both offset the residential decline and resulted in an overall increase in the City's assessed valuation. However, commercial/industrial construction activity was relatively slow during 1981 and 1982. Therefore, the net effect was a decrease of 1.1 percent in the City's 1981 assessed valuation and a 3.4 percent growth in the City's assessed valuation during 1982. The City of South Salt Lake expects permit-related valuations to reach $7.0 million during 1983.

I.5.2 Permit valuation changes: 1970-1982

Details with regard to building permits issued for commercial, residential and other construction are set forth in Table I-8. Also included are data on the valuations associated with these permits. As previously noted, these valuations correspond to the contractor's building cost and are used by the City to calculate permit fees.

During 1981, the year in which total valuation decreased 1.1 percent, the City of South Salt Lake issued 176 building permits with a total valuation of $3.6 million. New commercial and commercial remodeling accounted for 52.1 percent and 32.2 percent, respectively, of total valuation. These two categories also accounted for 35.8 percent of the building permits issued. This is consistent with commercial construction and remodeling having a higher per unit valuation than residential and other construction and remodeling activities.

Permit activity during 1982 was highlighted by the $90.0 million plus expansion of CVWRF's waste-water treatment facility. Assuming that the CVWRF expansion had a valuation of $90.0 million, the city issued 181 other building permits with a total valuation of approximately $5.5 million during 1982. This corresponds to an increase in permit-related valuation of about 54.0 percent.

Based on the data set forth in Table I-7, commercial/industrial permit activity declined in South Salt Lake from 1974 to 1981. From a high of $6.3 million in 1974, permit-related valuations for commercial/industrial construction and remodeling fell to $3.0 million in 1981. Commercial/industrial permit valuations rose to $3.8 million in 1982. As previously noted, the City has estimated that total 1983 permit-related valuations will reach $7.0 million. To the extent the 1983 figure reflects commercial/industrial construction activity, it may indicate a recovery in the local market.

I.5.3 Conclusions

The City of South Salt Lake's Building Official estimates that the market value of a project is equal to 130.0 percent of the permit valuation (contractor's cost) plus the land value (Stone, 1983). The proposed industrial park would have a permit valuation, in 1983 dollars, of approximately $8.4 million (22.5 acres; a coverage ratio of 0.35; a total cost of $32.00 per square foot; and a ratio of total cost to contractor's cost of 1.3). Based on the data set forth in Tables I-7 and I-8, the proposed industrial park (a single project) would have a higher permit valuation than the commercial/industrial construction activity in any year since 1970.

000805

I.6 DEMOGRAPHIC DATA

The demography of the area around the Vitro site will be analyzed by reference to the data and projections published in the WFRC's Surveillance Report Vol. 2, No. 7. These data are set forth in Table I-9. As previously noted, this report also is the source of the data on land use set forth in Tables I-4 and I-5. The analysis will include the six-traffic-zone, 3.6-square-mile area, described in Section I.5, Land Use.

Population data are based on an estimate of population per dwelling unit for each traffic zone and the number of dwelling units in each traffic zone. Data for 1980 were taken from the 1980 census. The number of dwelling units includes single family homes, apartments, mobile homes, and dormitories. Data on dwelling units are updated annually by local planning agencies using building permits. Data for 1980 are based on preliminary census data and data from previous WFRC Surveillance Reports.

Employment is non-agricultural employment and includes wage and salary workers, self-employed workers, and government employees. Data are assembled by the Utah Department of Employment Security and exclude construction employment. Auto registration includes pick-up trucks and is estimated based on a dwelling unit factor developed from 1970 census data and subsequent surveys. Commercial floor area is the area (in hundreds of square feet) in buildings used for retail trade or service industries. These data were originally developed using various survey techniques and, therefore, should be considered estimates. They are updated using building permits.

I.6.1 Historic and current data

The population of the six-traffic-zone analysis area was 1,926 in 1970 and 1,277 in 1980. The total number of dwelling units in the area was 541 in 1970 and 441 in 1980. In addition, the number of cars registered in the area declined from 921 in 1970 to 745 in 1980. Employment in the area increased from 3,529 jobs in 1970 to 9,427 jobs in 1980. Data on the number of square feet of commercial floor area are incomplete. However, commercial floor area in traffic zones 329, 351 and 360-362 increased from 201,300 square feet in 1970 to 285,700 square feet in 1980.

I.6.2 Projected: 1995

Population in the six-traffic-zone analysis area is projected to reach 2,440 by 1995. In addition, the number of dwelling units is projected to reach 1,014 in 1995. Total employment in 1995 is projected to be 12,667. It is estimated that the number of cars in the area will reach 1,666 by 1995. As previously noted, data on the number of square feet of commercial floor area is incomplete. However, commercial floor space, excluding traffic zone 328, is projected at 901,000 square feet by 1995.

Table I-9. Salt Lake County demographic data selected traffic zones

1970, 1979, 1980 & 1995

Census tract/traffic zone	Variable	1970	1979	1980	1995	Average annual rate of growth 1970-1980	Average annual rate of growth 1980-1995
						--(percent)--	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
116/329	Population	87	59	70	40	(2.2)%	(3.7)%
	Dwelling Units	23	21	21	15	(0.9)	(2.2)
	Employment	63	449	472	4,500	22.3	16.2
	Cars	37	34	34	25	(0.8)	(2.0)
	Commercial Floor Area (00 sq. ft.)	39	NA	215	550	18.6	6.5
116/361	Population	484	267	327	833	(3.8)	6.4
	Dwelling Units	107	93	93	333	(1.4)	8.9
	Employment	380	1,178	1,343	1,600	13.5	1.2
	Cars	226	196	196	706	(1.4)	8.9
	Commercial Floor Area (00 sq. ft.)	272	NA	306	1800	1.2	12.5
116/362	Population	148	120	177	1,019	1.8	12.4
	Dwelling Units	47	43	42	443	(1.1)	17.0
	Employment	195	285	275	250	3.5	(0.6)
	Cars	59	54	53	555	(1.1)	17.0
	Commercial Floor Area (00 sq. ft.)	175	NA	175	800	0.0	10.7
116/351	Population	605	464	381	223	(4.5)	(3.5)
	Dwelling Units	185	166	156	93	(1.7)	(3.4)
	Employment	697	1,960	2,009	1,217	11.2	(3.3)
	Cars	254	227	214	129	(1.7)	(3.3)
	Commercial Floor Area (00 sq. ft.)	805	NA	1,408	2,940	5.8	5.0

008007

Table I-9 Continued

Census tract/traffic zone	Variable	1970	1979	1980	1995	Average annual rate of growth 1970-1980	Average annual rate of growth 1980-1995
	(1)	(2)	(3)	(4)	(5)	--(percent)-- (6)	(7)
116/360	Population	602	390	316	325	(6.2)	0.2
	Dwelling Units	179	137	127	130	(3.4)	0.2
	Employment	585	1,554	1,752	1,500	11.6	(1.0)
	Cars	345	264	245	2,920	0.4	9.5
	Commercial Floor Area (00 sq. ft.)	722	NA	753	2,920	0.4	9.5
115/328	Population	0	0	6	0	--	--
	Dwelling Units	0	0	2	0	--	--
	Employment	1,609	3,160	3,576	3,600	8.3	0.0
	Cars	0	0	3	0	--	--
	Commercial Floor Area (00 sq. ft.)	862	NA	NA	2,500	--	--
Total	Population	1,926	1,300	1,277	2,440	(4.1%)[1]	4.4%[1]
	Dwelling Units	541	460	441	1,014	(2.1)[1]	5.7[1]
	Employment	3,529	8,586	9,427	12,667	10.3	2.0
	Cars	921	775	745	1,666	(2.1)[1]	5.5[1]
	Commercial Floor Area (00 sq. ft.)	2,875	NA	2,857	11,510	3.6[1]	8.0[1]

1. Excludes data for traffic zone 328.

Note: Population: The total number of persons residing in the zone or tract. The zonal population is derived by multiplying an estimated population per dwelling unit factor for each zone by the updated number of dwelling units. The 1980 population was taken from 1980 census data. Only population located within tracted areas was included.

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Table I-9 Continued

Dwelling unit: The number of residences within a zone including single family homes, apartments, mobile homes, and domitories. The dwelling unit total is updated annually by the local planning agencies using building permits. 1980 housing units were compiled from 1980 census preliminary data on housing and previous surveillance data.

Employment: The total number of non-agricultural workers employed in a zone including wage and salary workers, self-employed workers, and government workers. The Utah Department of Employment Security assembles these data using the Unemployment Compensation Coverage file as the primary basis and doing considerable supplemental work. (Construction employment has been removed from the totals.)

Auto registration: The number of passenger vehicles including pickups, registered to persons living in a zone. The auto registration data are also estimated based on a dwelling unit factor which was developed from 1970 census data and surveys.

Commercial floor area: The square feet of area within a building used for retail trade or for service type industries. The value shown in the summary is 100's of square feet per zone or tract. Due to variation in the original survey techniques, these figures should be considered as estimates only. These data are updated using building permits.

NA Indicates data not available.

Source: Wasatch Front Regional Council, Surveillance of Land Use and Socio-Economic Characteristics 1970, 1979, 1980 & 1995, Surveillance Report Volume 2, Number 7, April 1982.

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I.6.3 Changes

Population in the analysis area decreased by 649, or 33.7 percent, between 1970 and 1980. The number of dwelling units in the area decreased 18.5 percent during the same time period. However, employment in the area increased substantially during the last decade. Between 1970 and 1980 employment increased by more than 167.0 percent. This corresponds to an average annual rate of growth in excess of 10.0 percent. During the same time period, the area's commercial floor space increased approximately 42.0 percent.

These data illustrate a shift in the demography of the area and are consistent with data on local land use conversion. Both types of information indicate increased industrial development and a movement away from residential land use.

Forecasts of key demographic variables published by the WFRC project considerable growth in the six-traffic-zone analysis area between 1980 and 1995. Population is projected to increase by more than 90.0 percent. The number of dwelling units is expected to reach 1,014, an increase of almost 130.0 percent. In addition, commercial floor space in the area, excluding traffic zone 328, is projected to increase more than 200.0 percent. Growth in employment also is projected to increase, but at a less dramatic rate. The growth which has been projected for the 1980-1995 period will reverse a recent trend in the area. As previously noted, the growth in employment and commercial floor space which occurred during the 1970s was accompanied by a decrease in population, dwelling units and registered motor vehicles. By contrast, growth has been projected for all key demographic variables between 1980 and 1995. The projections of land use changes for the area indicate considerable growth in industrial land use and a relatively minor increase in residential land use. In light of the substantial growth in population forecasted for the area, higher density residential land uses are anticipated.

I.7 LOCAL LAND VALUES

In this section the market value of a porton of the Vitro site is estimated. The analysis will focus on the approximately 26.8 acres that CVWRF purchased from Richards-Moench in 1981. This parcel includes tract "B" south, 12.5 acres and 650 feet of frontage on 3300 South, and tract "C" south, 14.3 acres and 1280 feet of frontage on 3300 South. Per the CVWRF Board's approved Master Plan and Rodney Dahl, CVWRF's General Manager, this acreage corresponds to the site of the proposed County Resource Recovery Facility (16 acres) and a portion of the site of the proposed Temporary Industrial Park (20-25 acres). The balance of the acreage for the proposed Industrial Park is located to the west between 700 West, the entrance to CVWRF's Facility, and the six vicinity properties on 900 West.

The purpose of the analysis in this section is to determine the market value of the portion of the Vitro site proposed for development as a temporary industrial park. For the reasons set forth in the body of the EIS, the municipal solid waste-to-energy facility is not evaluated in this report. Based on the assumption that the development of a temporary industrial park requires the removal of the mill tailings, the value of the land if removal is the remedial action selected can be approximated by this use.

One of the methods for establishing the market value of a property is by appraisal. CVWRF's predecessor, Salt Lake City Suburban Sanitary District No. 1, commissioned such an appraisal by Edward P. Westra, MAI-SRA-CPM. The appraisal was performed in connection with CVWRF's predecessor organization's negotiations to acquire the two-tract 26.8-acre parcel described above. The resulting Appraisal Report dated March 19, 1973, defines market value as follows: "...the highest price, expressed in terms of money, that the property will bring after reasonable exposure in the open market, with both the buyer and the seller being fully informed as to the highest and best use of the property, and neither party acting under compulsion or duress." The Appraisal Report covers five tracts including tract "A" (8.8 acres), tract "B" south, (12.5 acres), tract "B" north (16.0 acres), tract "C" south (14.3 acres) and tract "C" north (25.5 acres). This analysis will concentrate on tracts "B" and "C" south for the reasons previously noted.

The following is a summary of the observations and conclusions of the Appraisal Report with regard to the two southern tracts.

<u>Tract "B" South</u>

- Evidence of high water table in area.
- Parcel has been filled above the water level and appears to be stable.
- 650 feet of frontage and 600 feet of depth.
- A railroad spur comes into the property from the north.
- Immediate potential for industrial development.
- The market value of the tract is $25,000 per acre.

Tract "C" South

Land is built up with tailings from the former Vitro Chemical operation.

- In its present condition, it is unsuitable for development requiring the presence of persons over a sustained period of time.
- No immediate development potential due to the presence of large amounts of radioactive tailings.
- If the tract did not have any fill (tailings) on it, its value would be similar to or slightly lower than tract "B" South.
- Value of frontage along 3300 South drops moving west from the interchange of I-15.
- Therefore, without tailings the average value of this land would be $22,500.
- The market value of the tract is $13,500 an acre.
- The market value of the tract assumes that the land with radioactive fill material on it can be utilized subject to reasonable limitations.

Based on the information set forth above, the market value of the property proposed for development as an industrial park and a municipal solid waste-to-energy facility was appraised at $22,500 to $25,000 per acre in 1973. It should be noted that this estimate of the market value of the frontage property along 3300 South appears in the contemporaneous business document produced in the normal course of business and not in a document prepared in connection with the current proceedings. In addition, the estimate assumes that the land has "immediate potential for industrial development in accordance with the existing zoning" (i.e., no tailings). At the time of the report (1973), the property was zoned M-2 which permits heavy industrial development.

The Chairman of the Board of CVWRF stated that vacant industrial land in the South Salt Lake area historically increases in value at the rate of 12.0 percent per year (Petersen, 1982). Based on a 1973 market value of $22,500 to $25,000 per acre, this indicates a 1983 market value of approximately $69,900 to $77,600 per acre.

Another method for estimating the current market value of CVWRF's 3300 South Street frontage property is to rely on a recent (1982) appraisal report. A recent appraisal report was prepared by the Land Department of the Salt Lake County Assessor's office. It was prepared pursuant to a request by the Administrator of the Appraisal Department for "a more detailed appraisal report on the land owned by Salt Lake Sanitary Suburban District and Central Valley Water Reclamation Facility, and referred to as the Vitro Chemical Property..."

The report notes that the frontage property along 3300 South currently is zoned Business (A) to a depth of approximately 800 feet. The balance of the

parcel, including the frontage along 900 West, is zoned light industrial. The report observes that distribution type industrial parks and high technology oriented operations are the predominant land use and existing parks have prime tenants and low vacancy rates. Based on the preceding, it was determined that the highest and best use of the property was as an industrial park. A 21-acre L-shaped parcel in the vicinity of the intersection of 3300 South and 900 West was chosen as the best location for the industrial park.

In order to determine the market value of the property, a number of newly developed industrial parks similar in location and desirability were considered.
The selected developments and their corresponding land values are set forth below:

- Decker Lake Industrial Park: $35,000 to $75,000 per acre.
- Yates Industrial Park: $40,000 to $87,120 per acre (high end of range based on a value of $2.00 per square foot).
- Pioneer Industrial Park: $40,000 to $80,000 per acre.
- Centennial Park: $43,560 to $130,680 per acre (based on a value of $1.00 to $3.00 per square foot).

Based on the information set forth above, the recent appraisal report concludes that the 21-acre L-shaped parcel (the prime area for development of the Vitro site) has a value of $40,000 to $70,000 per acre. The author of the report indicated that this was the market value, not the assessed value, of the property. As previously noted, vacant industrial property is assumed to appreciate at an annual rate of 12.0 percent. When applied to the range of values noted above, this results in a current market value of $42,400 to $74,200 per acre.

An additional method for estimating the market value of the property on 3300 South is based on an analysis of its value per square foot. The value per square foot is a function of land use. After consulting with a local real estate developer, the following range of values was derived depending upon land use, parcel size and externalities (e.g., adjacent land uses, the presence of the waste-water treatment facility) (Simons, 1983).

A recent transaction involving a two-acre site adjacent to I-15 to be developed as a location for a commercial office building indicates a value of $5.00 per square foot ($217,800 per acre) for this land use. Based on the size differential between this site and the 3300 South frontage portion of the Vitro site, a discount of 25.0 percent was suggested. This corresponds to a value of $3.75 per square foot ($163,350 per acre) for property used as a site for an office building. The prevailing land use in the vicinity of the Vitro site is warehousing and distribution. If the Vitro site's 3300 South frontage property is developed as a location for warehousing activities it is estimated to be worth $1.25 per square foot ($54,450 per acre) (Simons, 1983).

The presence of CVWRF's waste-water treatment facility was thought to eliminate the property's use as a location for an office building. In

addition, if the proposed municipal solid waste-to-energy facility is constructed, it was suggested that the value of the property might fall to $1.00 per square foot ($43,560 per acre). This is based on the fact that after the construction of the solid waste-to-energy facility, any structure on the subject property would be located between a waste-water treatment facility and a solid waste-to-energy facility.

The final approach to be considered for estimating the market value of the 3300 South frontage portion of the Vitro property involves the asking price for comparable adjacent property currently being offered for sale. The 22.71-acre parcel at the northwest corner of 3300 South and 900 West is currently being offered for sale by the Utah State Retirement Fund. The asking price is $1,978,495 or $87,120 an acre. The property was purchased from HOMCO Development Company in the fourth quarter of 1982 and offered for sale early in 1983. A spokesperson for the Utah State Retirement Fund stated that an appraisal report on the property did not mention the Vitro site or the mill tailings (Blackburn, 1983).

In addition to the information set forth above, the following considerations must be evaluated in determining the market value of the Vitro site's frontage property.

- Proximity to the 3300 South interchange with I-15.
- Frontage on 3300 South.
- Availability of a rail spur.
- Construction of the proposed West Valley highway (Goodwin, 1983).
- The availability of utilities.
- Central location.

Another fact is worth noting. In 1981, CVWRF purchased the 3300 South frontage property for $62,500 an acre. Based on the testimony of CVWRF's General Manager at the March 23, 1983 public hearing in this matter, CVWRF purchased the Vitro site (including the 3300 South frontage property) "with the promise from the federal government that it would be immediately cleaned up and that all of this land would be available for Central Valley purposes." This indicates that CVWRF paid $62,500 per acre for the 3300 South frontage property in 1981 with the understanding that it would be cleaned up immediately and made available for use as a location for a temporary industrial park and a municipal solid waste-to-energy facility. On the basis of this transaction and the opinion of CVWRF's Chairman of the Board regarding the market appreciation of vacant industrial land in South Salt Lake the 1983 market value of the 3300 South frontage property is approximately $78,400 per acre.

Based on the data and information set forth above, the 1983 market value of the 3300 South frontage property was estimated to be $78,400 per acre. This assumes the property is available for immediate development as an industrial park. As the presence of the mill tailings precludes immediate

development, this corresponds to the market value of the property in today's dollars if removal is the adopted remedial action.

This figure is less than the asking price for the property to the west of the Vitro site being offered for sale by the Utah State Retirement Fund. However, that property is not adjacent to Central Valley's waste-water treatment facility. In addition, this price is more than that of any of the other estimates detailed in this report. However, it is based on a recent (1981) transaction in which the buyer (CVWRF) was aware of the presence of the mill tailings but purchased the property contingent on a promise by the Federal government to clean up the property and make it available to CVWRF for development consistent with its adopted Master Plan. As previously noted, CVWRF's adopted Master Plan calls for the construction of a temporary industrial park and a municipal solid waste-to-energy facility on the 3300 South frontage property (see Section I, Introduction). This being the case, it is difficult to imagine a better estimate of the market value of the land than the price that CVWRF paid under the assumption that it would be available for development.

I.8 EMPLOYMENT

This section will analyze the effects of developing CVWRF's 3300 South frontage property in terms of direct and indirect employment. The analysis will focus on the regional employment impacts of developing a temporary industrial park. As previously noted, the estimated life of the temporary industrial park is 13 years (see Section I.1, Introduction).

I.8.1 Direct employment

The estimate of direct employment generated by the development of an industrial park along 3300 South will be based on two assumptions. The first is the building-to-land coverage ratios which appear in Salt Lake County Master Plan, Phase II, June 1980. The second is the estimate of the number of square feet per employee required for warehousing and distribution activities which also appears in Phase II of the City's Master Plan. Assuming that the proposed industrial park is 22.5 acres, this corresponds to 980,100 square feet (22.5 acres x 43,560 square feet per acre). The estimates in the City's Master Plan of building-to-land coverage ratios for traffic zones 328 and 329 in 1986 are 0.45 for "healthy economic conditions" and 0.25 for "sluggish economic conditions." By applying the average of the coverage ratios (0.35) to the square feet of land to be developed as an industrial park (980,100), 343,035 square feet of building area will be constructed.

The City's Master Plan reports that 1,265 square feet are required per employee for warehousing and distribution activities. Based on a figure of 343,035 square feet of building area, this corresponds to approximately 271 employees. Therefore, the development of a 22.5 acre industrial park catering to warehousing and distribution activities will provide direct employment for 271 persons.

I.8.2 Indirect employment

The estimate of indirect employment (used herein) attributable to the proposed industrial park will be based on a statistic used in Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, Nile Eatmon, Utah State Division of Community Development, March 21, 1983. The report states that direct employment in the area will generate an additional 1.6 jobs per direct employee in the local economy. This statistic is attributed to the State Planning Coordinator's Office, State of Utah, 1983. Applying the factor of 1.6 to direct employment of 271 results in a figure for indirect employment of approximately 434 jobs. That is, development of the proposed industrial park will result in the indirect employment of 434 persons within the region. Direct and indirect employment impacts will total 705 jobs.

I.9 PUBLIC REVENUES

This section will delineate the public fiscal consequences of the proposed industrial park in terms of property taxes, sales taxes, income taxes, business licenses, water sales, and sewer service charges. It should be noted that the estimates set forth in this section are estimates of revenue and, therefore, do not reflect incremental capital or operating costs occasioned by the development of the proposed industrial park. The analysis in this section is in 1983 dollars.

I.9.1 Property taxes

The estimate of property taxes attributable to the proposed industrial park is based on the following assumptions.

- The industrial park will be 22.5 acres. This is based on a range of 20-to-25 acres provided by the General Manager of the CVWRF.

- The building-to-land coverage ratio will be 0.35. This is based on data in the City's Master Plan Phase II as described in Section IX, Employment.

- Construction costs will be $32.00 a square foot. This is based on an estimated construction cost of $32.00 per square foot, which appears in Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, Nile Eatmon, Utah State Department of Community Development, March 21, 1983.

- The mill levy in tax district 14B is 81.21. This was the 1982 mill levy for tax district 14B. The components of the 1982 mill levy for tax district 14B are set forth below, in mills.

Salt Lake County General Fund	17.42
South Salt Lake City	6.25
Granite School District	45.25
County Library Fund	3.35
Salt Lake County Water Conservancy District	2.00
Salt Lake County Mosquito District	0.18
Salt Lake City Water and Sewer District	4.16
Central Utah Water Conservancy District	2.00
Hansen Planetarium	0.20
Hogle Zoo	0.40
Total	81.21

- The roll-back figure, which is used to convert current market value to 1978 market values, is 0.69. This figure was used by the Salt Lake County Assessor's Office to convert 1982 market values to 1978 market values. This is done because assessments in Utah are currently based on 1978 market values.

- The commercial/industrial assessment will be 20.0 percent of the 1978 fair market value. The current (as of January 1, 1983) commercial/industrial assessment is 20.0 percent of the 1978 fair market value.

Table I-10 details the calculation of the estimated property taxes attributable to the proposed industrial park.

Table I-10. Vitro tailings site proposed industrial park estimated property tax revenues

1983 dollars

(1)	Land	
	22.5 acres @ $78,400 per acre	$ 1,764,000
(2)	Improvement	
	22.5 acres assuming a building-to-land coverage ratio of 0.35 and a construction cost of $32.00 per square foot	$10,977,120
(3)	Total Market Value	
	(1) + (2)	$12,741,120
(4)	Assessed Valuation	
	Assumes a roll-back figure of 0.69 and an assessment of 20.0 percent of the 1978 fair market value	$ 1,758,275
(5)	Mill Levy	81.21
(6)	Estimated Property Tax Revenues	
	(4) x (5×10^{-3})	$ 142,790

I.9.2 Other public revenues

Sales tax revenues are assumed to be zero. This is because an industrial park, which caters to warehousing and distribution activities, would not generate sales subject to sales taxes.

State and federal income tax revenues, as well as corporate income tax revenues, were estimated based on assumptions set forth in Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, Nile Eatmon, Utah State Division of Community Development, March 21, 1983. These assumptions are set forth below.

- The average annual salary of each direct and indirect employee is $14,313.
- State individual income tax revenue is three percent of total salary. This figure is sourced to Statistical Abstract State of Utah, Bureau of Economic and Business Research, 1983.
- Federal individual income tax revenue is 11.0 percent of total salary. The source is the same as above.
- Corporate earnings are six percent of total gross salaries. The source is the same as above.
- Corporate income tax revenues are 48.0 percent of earnings.

Table I-11 below, sets forth details with regard to the calculation of estimated income tax revenues arising from the development of the proposed industrial park.

Table I-11. Vitro tailings site proposed industrial park estimated income tax revenue

1983 dollars

Individual Income Tax Revenues		
(1) Employment:	a. Direct	271
	b. Indirect	434
	c. Total	705
(2) Average Annual Income		$ 14,313
(3) Total Wages		
	(1.c.) x (2)	$10,090,665
(4) State Individual Income Tax Revenue		
	(3) x 0.03	$ 302,720
(5) Federal Individual Income Tax Revenue		
	(3) x 0.11	$ 1,109,973
Corporate Income Tax Revenues		
(6) Corporate Earnings		
	(3) x 0.06	$ 605,440
(7) Corporate Income Tax		
	(6) x 0.48	$ 290,611
(8) Total Income Tax Revenues		
	(4) + (5) + (7)	$ 1,703,304

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Revenues from business licenses are estimated assuming an average license fee of $275 and 29 businesses operating in the proposed industrial park. These estimates were contained in a October 8, 1982, letter from Richard D. Chong of Richard D. Chong and Associates to Jonnalyne Walker, Community Services Coordinator, City of South Salt Lake. On the basis of this information, revenues from business licenses are estimated at $7,975 per year.

The estimates of revenues from water sales and sewer service charges also are based on data set forth in Richard D. Chong's October 8, 1982, letter to Jonnalyne Walker. Water sales revenues are estimated assuming an average annual water bill of $240 and 29 businesses. Sewer service revenues are estimated assuming an average annual bill of $150 and 29 businesses. This corresponds to water sales revenues of $6,960 per year and sewer service revenues of $4,350 per year.

I.10 CONCLUSIONS

In this section conclusions regarding the development potential of CVWRF's 3300 South frontage property, as well as an estimate of the gross economic benefits that might result from the proposed project are presented. The development potential will be delineated in terms of zoning, Master Plan, land use and demographic considerations. The conclusions also will address historic data on construction permit activity. The potential economic benefits to the region will be developed based on estimated property values, direct and indirect employment impacts, and projected public fiscal revenues.

I.10.1 Development potential

I.10.1.1 Zoning

The 3300 South frontage portion of the Vitro site is currently zoned Business (A). This zoning designation is inconsistent with an industrial park, as well as a municipal solid waste-to-energy facility. However, most of the permitted uses (e.g., offices, restaurants, retail) appear to be inconsistent with adjacent land uses (e.g., CVWRF's waste-water treatment facility, automobile junk yard). Therefore, it is anticipated that the property could be rezoned to accommodate CVWRF's proposed industrial park.

I.10.1.2 Master Plan

The City's Master Plan emphasizes South Salt Lake's deficiencies in terms of attracting commercial, retail, and office development. This is attributed to the City's declining population and its modest purchasing power. The Master Plan also notes that the area's mixed land use is inconsistent with other, more highly valued, land uses. The Master Plan identifies South Salt Lake as a location for firms seeking large, plain buildings in a non-prestige area. It also characterizes the City as being in a good position with regard to "heavy commerce" (e.g., automobiles, large appliances) and warehouse and distribution activities. Finally, the Master Plan notes that additional operating costs will be incurred by the City as the result of any commercial and industrial growth.

I.10.1.3 Land use

Current and projected land use data identify traffic zone 329, which includes Central Valley's 3300 South frontage property, as a likely area for industrial development. Projections of land use conversion developed by the Wasatch Front Regional Council estimate that industrial land use in traffic zone 329 will increase 10.9 acres per year between 1980 and 1995. This corresponds to more than half of the annual average increase in industrial land use projected for the six-traffic-zone analysis area during this period.

The City's Master Plan contains estimates of the annual absorption of vacant industrial land. These data project an annual average absorption of between 10.6 (low estimate) and 14.9 (high estimate) acres per year between 1980 and 1990 for traffic zone 329. This corresponds to approximately 70.0 percent of the annual average absorption projected for the entire City during this time period.

I.10.1.4 Construction permit activity

Construction of the proposed industrial park will result in construction permits with a combined valuation of approximately $8.4 million (1983 dollars). For selected years between 1970 and 1982, the total valuation of commercial construction permits issued ranged between $2.1 million and $6.3 million per year, excluding the CVWRF expansion. This means that the temporary industrial park proposed by CVWRF would have a permit valuation greater than the total commercial and industrial construction activity during any year for which data were provided since 1970.

I.10.1.5 Demographics

Recent growth (1970-1980) in the six-traffic-zone analysis area has favored employment (167.1 percent) and commercial floor space (41.9 percent). However, for the period 1980-1995, growth is projected for population (91.1 percent) and the number of dwelling units (129.9 percent), as well as employment (34.4 percent) and commercial floor space (215.4 percent, excluding traffic zone 328).

Projections for the period 1980-1995 indicate a decline in the average annual rate of growth in employment from 10.3 percent (the historic average for the period 1970-1980) to 2.0 percent. In addition, approximately 70.0 percent of the projected growth in commercial floor space is expected to take place in the unincorporated portion of the six-traffic-zone analysis area.

I.10.2 Economic benefits

I.10.2.1 Property value

The estimated 1983 market value of CVWRF's 3300 South frontage property is $78,400 per acre. This is based on the assumption that the property could be immediately developed as a temporary industrial park. This estimate was developed based on the following considerations.

- A 1973 Appraisal Report prepared by Edward P. Westra for Salt Lake City Suburban Sanitation District No. 1. This report concluded that the 3300 South frontage property had a 1973 market value of $22,500 to $25,000 per acre, based on the assumption that the property was available for immediate industrial development. This corresponds to a 1983 market value of $69,900 to $77,600 per acre based on an annual market appreciation rate for vacant industrial property in the area of 12.0 percent. This market appreciation rate was supplied by the Chairman of the Board of CVWRF.

- In 1983 an Appraisal Report was prepared by the Salt Lake County Assessor's Land Department. This report concluded that, based on development as an industrial park, the property in the vicinity of 3300 South and 900 West had a 1982 market value of $40,000 to $70,000 per acre. Based on the assumption that vacant industrial property appreciates at 12.0 percent per year, this corresponds to a 1983 market value of $42,400 to $74,200 per acre.

- Based on discussions with a local real estate developer, the 3300 South frontage property has a 1983 market value of $3.75 per square foot ($163,350 per acre) if developed as a location for an office building and $1.25 per square foot ($54,450 per acre) if developed for warehousing and distribution activities. The presence of CVWRF's waste-water treatment facility, as well as other adjacent properties (e.g., junkyard), was thought to preclude the development of office space on the land.

- A 22.71-acre parcel at the northwest corner of 3300 South and 900 West is being offered for sale by the Utah State Retirement Fund for $1,978,495 or $87,120 per acre. This property is comparable to the 3300 South frontage property. However, it is not adjacent to CVWRF's waste-water treatment facility.

- In 1981, CVWRF purchased most of the 3300 South frontage property from Richards-Moench for $62,500 per acre. Based on statements made by CVWRF's General Manager, this property was purchased with the understanding that it would be immediately cleaned up by the Federal government, which would allow CVWRF to use the property. Per CVWRF's approved Master Plan, the intended use of the property is, in part, the development of a temporary industrial park. Adjusted for the local market appreciation rate for vacant industrial property provided by the Chairman of the Board of CVWRF, this corresponds to a 1983 market value of $78,400 per acre. This is the price (adjusted to 1983 dollars) which CVWRF paid for the 3300 South frontage property under the assumption that it would be cleaned up by the Federal government and available for development as a temporary industrial park (i.e., the 1983 market value).

I.10.2.2 Employment impacts

The estimate of direct employment attributable to the development of the proposed temporary industrial park is based on the following assumptions.

- A 22.5-acre (980,100 square feet) industrial park.

- A building-to-land coverage ratio of 0.35.

- 1,265 square feet of building per employee for warehousing and distribution activities.

This results in an estimate for direct employment of 271 jobs.

The estimate of indirect employment assumes that each direct job created by the proposed industrial park will result in 1.6 indirect jobs in the local economy. This corresponds to an indirect employment impact of approximately 434 jobs. It should be noted that the local economy refers to a geographic area considerably larger than South Salt Lake. This is because the communities in which the indirect employment impacts will be felt depend on the geographic distribution of the residences of the 271 direct employees. To the extent that the geographic distribution includes all of Salt Lake County,

the economic benefits in terms of employment and, therefore, private sector income will be widely dispersed.

I.10.2.3 Public fiscal revenues

Based on the following assumptions, property tax revenues are estimated at $142,800 a year.

- Land value of $78,400 per acre.
- A 22.5 acre industrial park with a building-to-land coverage ratio of 0.35.
- Construction costs of $32.00 per square foot (1983).
- A roll-back figure of 0.69 (1983 market value to 1978 market value).
- A mill levy of 81.21.

Based on the following assumption, sales tax revenues will be zero.

- An industrial park catering to warehousing and distribution activities will not have any taxable sales.

Based on the following assumptions, income tax revenues will be $1,703,000 per year.

- Average annual wages of $14,313 for direct and indirect jobs.
- State income tax is 3.0 percent of total wages.
- Federal income tax is 11.0 percent of total wages.
- Corporate earnings are 6 percent of total wages.
- Corporate income tax is 48.0 percent.

Based on the following assumptions, annual revenues from business licenses, water fees and sewer charges will be $8,000, $7,000 and $4,400, respectively.

- 29 businesses in the industrial park.
- Average business license fee of $275/year.
- Average water bill of $246/year.
- Average sewer charge of $150/year.

Based on the following assumptions, after-tax wages will be $8,678,000 per year.

- Average annual wages of $14,313 for direct and indirect jobs.

- 271 direct jobs.
- 434 indirect jobs.
- State and Federal income taxes are 3.0 percent and 11.0 percent of total wages, respectively.

After-tax corporate profits of the companies providing the 705 jobs will be $290,600 per year based on the following assumption.

- Annual corporate earnings are six percent of total wages.
- The corporate tax rate is 48.0 percent.

Based on the following assumptions, rental income from the industrial park will be $176,400 per year.

- A 22.5 acre industrial park.
- A market value of $78,400 per acre.
- An annual rental rate per acre equal to 10.0 percent of the market value per acre.

Table I-12 summarizes the estimated annual economic benefits. Total public revenues are estimated to be $1,865,000 per year, total after-tax private sector benefits are estimated to be $8,993,000 and annual rental payments to CVWRF are estimated to be $176,000.

Table I-12 clearly illustrates that the majority of the economic benefits are a function of after-tax private sector income. The geographic distribution of this benefit is dependent upon the geographic distribution of the direct employees. Therefore, it was not distributed between the City of South Salt Lake and the rest of Salt Lake County. In addition, the estimate of economic benefits associated with the proposed industrial park is not dependent upon estimated land values. This is because only two components of estimated economic benefits are directly related to property values. They are property taxes estimated at $143,000 per year and rental payments to CVWRF estimated at $176,000 per year.

Finally, construction expenditures for the proposed industrial park are estimated at approximately $11.0 million (see Table I-10, Line 2). It is estimated that each dollar invested in the proposed industrial park will result in $1.40 of additional economic activity due to the multiplier effect. (See Economic Impacts of Alternative Remedial Actions for the Vitro Tailings, Utah State Division of Community Development, Nile Eatmon, March 21, 1983.) This corresponds to an estimated $15.4 million in additional economic activity due to the construction of CVWRF's temporary industrial park. The geographic distribution of this activity will depend on the geographic distribution of the construction employee's residences, as well as the geographic distribution of construction material purchases.

Finally, construction of an industrial park on an alternate portion of the Vitro site or on a comparable vicinity property could mitigate the potential loss of all of the economic benefits estimated above.

Table I-12. Vitro tailings site proposed industrial park summary of annual benefits

1983 dollars
(000)

Benefit	South Salt Lake	Salt Lake County	Total
• Public Revenues	(1)	(2)	(3)
Property Taxes	11	132	143
Sales Taxes	0	0	--
Income Taxes	1)	1)	1,703
Business Licenses	8	0	8
Water Fees	7	0	7
Sewer Service Charges	4	0	4
Subtotal	$ 30	$132	$ 1,865
• After-Tax Wages	1)	1)	$ 8,678
• After-Tax Corporate Profits	$315	0	315
• Rental Income	176	0	176
Total	$521	$132	$11,034

1) Depends on geographic distribution of direct employees.

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Appendix J

LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS RECEIVING COPIES OF THIS FEIS

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- Tom Skordal

Department of the Interior
- Bureau of Land Management
  - Frank Snell
  - Gary Wicks
  - Joe Sovick
- Fish and Wildlife Service
  - Larry England

Environmental Protection Agency
- Headquarters, Washington, D.C. (5)
- Stanley Lichtman

Region VIII (5)
- John Welles
- John Geidt
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Department of Energy
- Donald H. Groelsema
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UMTRA Project, Albuquerque Operations
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- M. L. Matthews

Housing and Urban Development
- Headquarters, Washington, D.C.

Nuclear Regulatory Commission
- Leo B. Higginbotham (10)

Office of Management and Budget
- Richard Brozen

Sandia National Laboratories
- F. W. Bingham
- M. L. Merritt
- M. S. Tierney

Office of Technology Assessment, U.S. Congress
Fran Rudoff

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Reed Russell
Charles Stromberg, Chairman

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James W. Davis, Mayor

City of Tooele
John Cluff, Mayor

City of Grantsville
Keith Brown, Mayor

State Agencies

Utah Governor's Office
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- Division of Community Health Services
  - Richard E. Johns, Jr., M.D.
- Division of Environmental Health
  - Ken Alkema
  - Bureau of Air Quality, Brent C. Bradford
  - Bureau of Public Water Supplies, Gayle J. Smith
  - Bureau of Radiation Control, Darrell Warren
  - Bureau of Sanitation, Mervin R. Reid
  - Bureau of Solid and Hazardous Waste Management
    - Dale D. Parker
  - Bureau of Uranium Mill Tailings Management
    - Larry F. Anderson
  - Bureau of Water Pollution Control
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Salt Lake County Administrative Services
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Tooele County Building and Zoning
Joe Urbanik

Tooele County Human Services
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Uranium Mill Tailings Task Force
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Wasatch Front Range Council
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Environmental Defense Fund

Friends of the Earth

League of Women Voters

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