

INTERIM REMEDIAL ACTION PLAN

881 HILLSIDE AREA

HIGH PRIORITY SITES

U.S. DEPARTMENT OF ENERGY

**Rocky Flats Plant
Golden, Colorado**

September, 1989



**Rockwell International
Aerospace Operations
Rocky Flats Plant**

Volume I - Text

DRAFT

ADMIN RECORD

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REVIEWED FOR CLASSIFICATION/UCNI

By F. J. Curran

Date 3-19-91

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VOLUME II
LIST OF APPENDICES

APPENDIX NO.

TITLE

1	Volatile Organic Compound, Dissolved Metals, and Inorganic Contaminant Data for Alluvial Ground Water at the 881 Hillside Area
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SECTION 1.0
INTRODUCTION

1.1 BACKGROUND

The Department of Energy (DOE) wishes to pursue an Interim Remedial Action (IRA) at the High Priority Sites (881 Hillside Area) at the Rocky Flats Plant (RFP). This interim action is to be conducted to minimize the release of hazardous substances from this Area that pose a potential long-term threat to the public health and environment. Although this is considered a "non-time-critical" interim action, DOE would like to implement this action because of the length of time it typically takes to finalize the Remedial Investigation/Feasibility Study (RI/FS) and Record of Decision (ROD), and to implement remedial action under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or Superfund) process.

Rockwell International has prepared this IRA Plan to identify, screen, and evaluate appropriate interim remedial action alternatives, and select the preferred interim remedial action for the Area. This IRA Plan has been prepared to conform with the requirements for an Engineering Evaluation/Cost Analysis (EE/CA) as defined in the proposed National Contingency Plan [40 CFR 300.415(b)(4)].

In March 1987, a remedial investigation under the Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)] began at the twelve sites comprising the 881 Hillside Area. The investigation consisted of the preparation of detailed topographic maps, radiometric and organic vapor screening surveys, surface geophysical surveys, a soil gas survey, a boring and well completion program, soil sampling and ground and surface water sampling. The results of this remedial investigation are presented in the Draft Final Remedial Investigation Report for High Priority Sites (Rockwell International, 1988a). A feasibility study was also conducted for the 881 Hillside Area, the results of which are presented in the Draft Feasibility Study Report for High Priority Sites (Rockwell International, 1988b). Rockwell has also prepared a detailed response to EPA comments on the RI and FS reports (Rockwell International, 1989). Final RI and FS Reports will be prepared to address the potential remediation needed for any contaminated soils, bedrock ground water and alluvial ground water not addressed in the IRA.

1.2 IRA PLAN ORGANIZATION

Volume I of this IRA Plan is divided into six sections addressing the details of the plan. Section 2.0 of this IRA Plan describes the results of previous investigations of the 881 Hillside. Most of the information included in Section 2.0 has been derived from the RI report, although chemical data has been updated to include all data received to date.

Section 3.0 identifies the objectives of the IRA. The objectives will define criteria used to identify and evaluate IRA options.

Section 4.0 identifies technically feasible ground water treatment technologies, screens these technologies based on implementability, effectiveness, and costs, integrates the preferred ground water treatment technology into alternative IRA options that address the objectives, and screens these alternatives based on implementability, effectiveness, and costs. Most of the information included in Section 4.0 has been derived from the FS report, however, this document expands upon the FS report by addressing treatment of inorganic contaminants in the alluvial ground water.

Section 5.0 summarizes the detailed analysis performed in Section 4.0, and Section 6.0 presents the preferred IRA. Volume II of this IRA Plan contains the Appendices.

SECTION 2.0
SITE CHARACTERIZATION

2.1 SITE DESCRIPTION AND BACKGROUND

2.1.1 Location and Facility Type

The Rocky Flats Plant (RFP) is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 2-1). The Plant site consists of approximately 6,550 acres of federally owned land in Sections 1 through 4, and 9 through 15, of T2S, R70W, 6th principal meridian. Major buildings are located within an area of approximately 400 acres, known as RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The RFP is a government-owned, contractor-operated (GOCO) facility. It is part of a nation-wide nuclear weapons research, development, and production complex administered by the Albuquerque Operations Office of the U.S. Department of Energy. The operating contractor for the Rocky Flats Plant is Rockwell International. The facility manufactures components for nuclear weapons and has been in operation since 1951. RFP fabricates components from plutonium, uranium, beryllium, and stainless steel. Production activities include metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive materials at other DOE facilities.

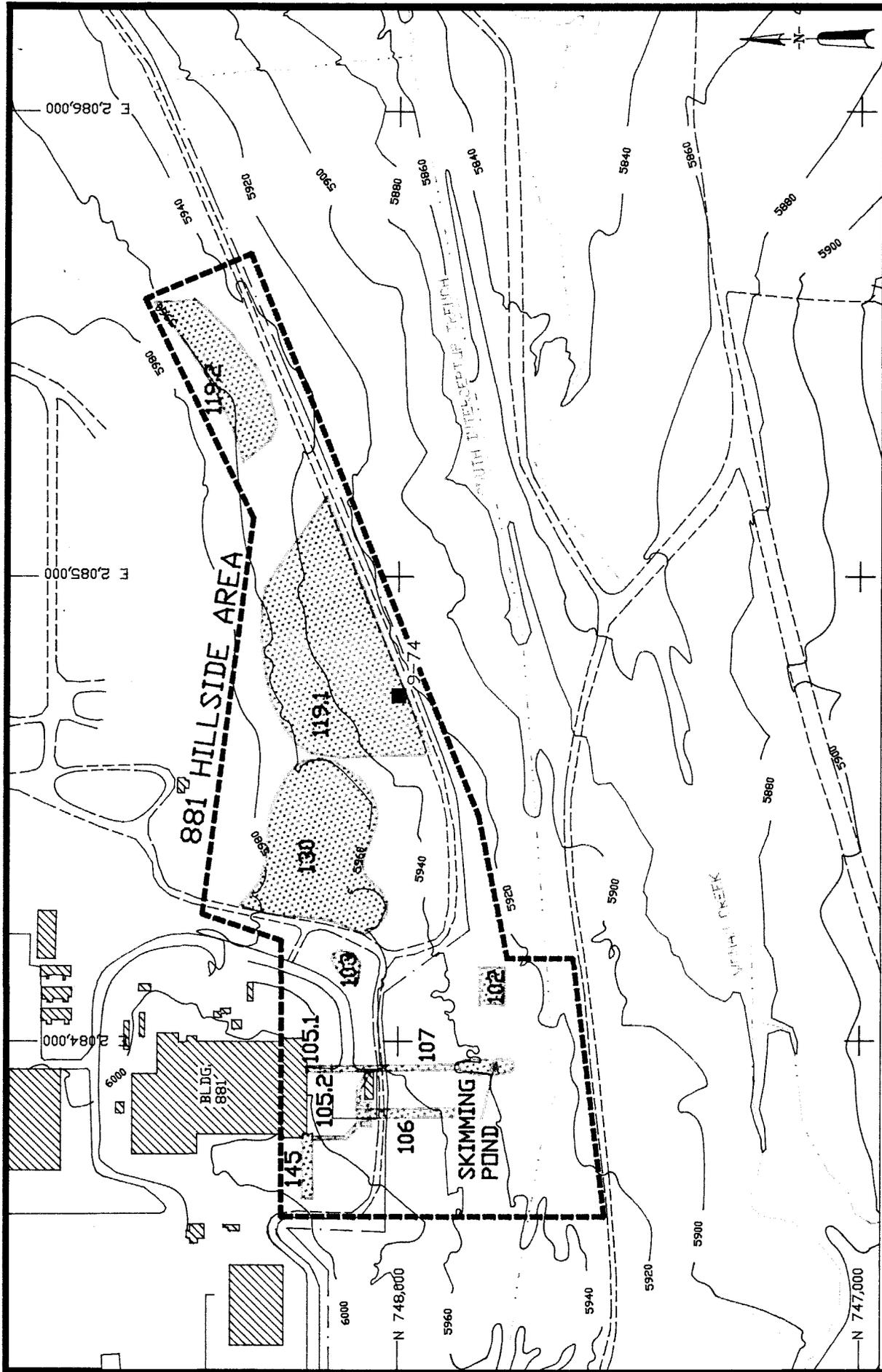
The RFP is currently an interim status Resource Recovery and Conservation Act (RCRA) hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations.

Preliminary assessments conducted under Phase 1 of the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.

2.1.2 881 Hillside Area Description

There are twelve sites, designated as solid waste management units (SWMUs), which comprise the 881 Hillside Area. These sites were investigated as high priority sites because of elevated concentrations of volatile organic compounds in the ground water and the proximity of the sites to a surface drainage. The 881 Hillside Area is located at the southeast corner of RFP (Figure 2-2). A brief description of each site in the 881 Hillside Area is presented below.

1. **Oil Sludge Pit (SWMU 102)** -- A small pond located south of Building 881 was used for disposal of oil sludges in the late 1950s.
2. **Chemical Burial Site (SWMU 103)** -- A small pit was used for disposal of liquid wastes southeast of Building 881 in the early 1960s.
3. **Liquid Dumping (SWMU 104)** -- An area east of Building 881 was reportedly used for disposal of unknown liquids prior to 1969. This was not substantiated by results of drilling the area in 1987. Therefore, this site may not exist and its location is not shown on the map.
- 4,5. **No. 6 Fuel Oil Tanks (SWMUs 105.1 & 105.2)** -- Two fuel oil tanks are located south of Building 881; they are out of service and filled with concrete.
6. **Outfall Site (SWMU 106)** -- An overflow line from the sanitary sewer sump south of Building 881 daylighted on the slope below the Building.
7. **Hillside Oil Leak (SWMU 107)** -- Oil was discovered flowing from the Building 881 footing drain in early 1973. The source of the oil was never positively identified but the oil was collected in a skimming pond and transported off site. There is an ongoing discharge of water from the footing drain.
- 8,9. **Multiple Solvent Spills (SWMUs 119.1 & 119.2)** -- Two areas east of Building 881 were used for barrel storage between 1969 and 1972.
10. **Radioactive Site (SWMU 130)** -- Soils contaminated with low levels of radionuclides were placed on the hillside east of Building 881 and covered with soil between 1969 and 1972.
11. **Sanitary Sewer Line Leak (SWMU 145)** -- The sanitary sewer line leaked on the hillside southwest of Building 881 in early 1981.
12. **Drum Storage Area (SWMU 177)** -- Building 885 is currently used for satellite collection and 90-day accumulation of RCRA-regulated wastes. The building will be closed and soil remediation addressed under RCRA Interim Status (6 CCR 1007-3). Ground-water contamination will be addressed as part of the 881 Hillside Area RI/FS performed under CERCLA.



SCALE: 1" = 300'

FIGURE 2--2:
881 HILLSIDE AREA SITE MAP

2.1.3 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area (Figure 2-3). There are no public facilities or institutions such as schools, prisons, or hospitals within five miles of RFP. The nearest educational facility is the Sierra Elementary School, which is six miles southeast of RFP. Other schools are located in the same general area, but somewhat farther from RFP. The closest hospital to RFP is Boulder Memorial Hospital, 10 miles northwest. The closest park and recreational area is the Standley Lake area, which is approximately 5 miles from RFP site. Boating, picnicking, and limited overnight camping are permitted. Several other small parks exist in communities within 10 miles of RFP. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of RFP, but all are more than 15 miles away.

Some of the land adjacent to RFP is zoned for industrial development. Industrial facilities within 5 miles of RFP include the TOSCO laboratory (40-acre site located 2 miles south), the Great Western Inorganics Plant (2 miles south), the Frontier Forest Products yard (2 miles south), the Idealite lightweight aggregate plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (990-acre site located 4.8 miles northeast).

Several ranches are located within 10 miles of RFP, primarily in Jefferson and Boulder Counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1977 Colorado Agricultural Statistics, 14,000 acres of crops were planted in 1976 in Jefferson County (total land area of approximately 475,000 acres) and 56,200 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 9,500 head of cattle, 200 pigs, and 400 sheep in Jefferson County, and 34,000 head of cattle, 2,300 pigs, and 6,500 sheep in Boulder County.

Approximately 50 percent of the area within 10 miles of RFP is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land was unused or was used for agriculture. Since that time, portions of this land have been converted to housing, with several new housing subdivisions being started within a few miles of the buffer zone. One such subdivision is located south of the Jefferson County Airport and several are located southeast of RFP.

A demographic study using 1980 census data (Setlock and Barker, 1985) shows that approximately 1.8 million people lived within 50 miles of RFP in 1980. This was projected to increase to 3.5 million people by the year 2000. Approximately 9,500 people lived within 5

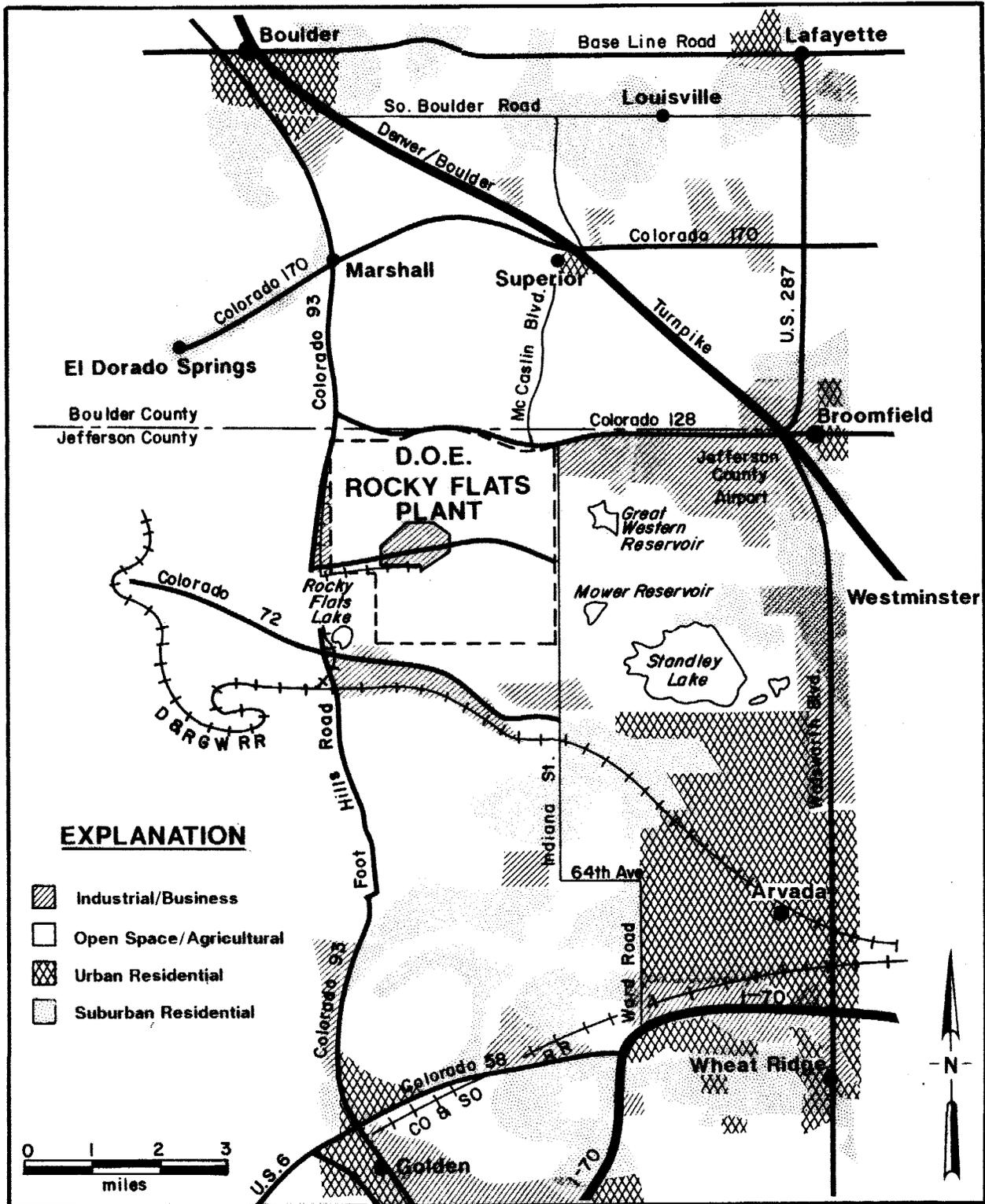


Figure 2-3:
LAND USE IN THE VICINITY OF ROCKY FLATS PLANT

miles of RFP in 1980, with a projected increase to 20,000 people by the year 2000. The most populous sector was to the southeast, toward the center of Denver. This sector had a 1980 population of about 555,000 people living between 10 and 50 miles from RFP, with a projected increase to 1.5 million by the year 2000.

2.1.4 Site Topography and Geology

2.1.4.1 Topography

The Rocky Flats Plant is located at an elevation of approximately 6,000 feet above mean sea level. The site is on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province. The piedmont represents an old erosional surface along the eastern margin of the Rocky Mountains. It is underlain by gently dipping sedimentary rocks (Paleozoic to Cenozoic in age) which are abruptly upturned at the Front Range (just west of RFP) to form hogback ridges parallel to the mountain front. The piedmont surface is broadly rolling and slopes gently to the east with a topographic relief of only several hundred feet. This relief is due both to resistant bedrock units that locally rise above the surrounding landscape and to the presence of incised stream valleys.

2.1.4.2 881 Hillside Area Geology

The following geologic information is based on the RI Report (Rockwell International, 1988a), and the reader is referred to this report for additional details.

Surficial Materials

Surficial materials at the 881 Hillside Area consist of the Rocky Flats Alluvium, colluvium, valley fill alluvium, and artificial fill overlying bedrock. In addition, there are a few isolated exposures of claystone bedrock. The study area is located on the south-facing hillside which slopes down from the Rocky Flats terrace surface toward Woman Creek on the south side of RFP. Rocky Flats Alluvium caps the top of the slope, and colluvium (slope wash) covers the hillside. Artificial fill and disturbed surficial materials are present around Building 881 and south of the building to the South Interceptor Ditch. Artificial fill overlies colluvium at SWMU 130, and surficial materials are disturbed in the vicinity of SWMUs 119.1 and 119.2. Valley fill alluvium is present along the drainage of Woman Creek south of the 881 Hillside Area, and terrace alluvium occurs on the north side of the Woman Creek valley fill alluvium.

as seepage from ditches and creeks. The shallow ground-water flow system is quite dynamic, with large water level changes occurring in response to precipitation events and to stream and ditch flow.

Ground water flows from the Rocky Flats Alluvium at the top of the 881 Hillside south through colluvial materials toward Woman Creek. Ground water in Rocky Flat Alluvium or colluvium is hereinafter referred to as alluvial ground-water. Flow through colluvial materials primarily occurs in the gravel within the colluvium. At the Rocky Flats terrace edges, ground water emerges as seeps and springs at the contact between the alluvium and claystone bedrock (contact seeps), is consumed by evapotranspiration, or flows through colluvial materials following topography toward the valley fill and terrace alluviums. The maximum and mean ground-water velocities through colluvial materials are estimated at 780 ft/yr and 150 ft/yr, respectively. Once ground water reaches the valley, it either flows down-valley in the alluvium, is consumed by evapotranspiration, or discharges to Woman Creek. The maximum and mean ground-water velocities in Woman Creek valley fill have been estimated at 650 ft/yr and 145 ft/yr, respectively.

Bedrock Ground-Water Flow System

Ground-water flow in the Arapahoe Formation occurs primarily in the sandstones contained within the claystones. Ground-water recharge to sandstones occurs as infiltration from an alluvial ground water where sandstones subcrop beneath the alluvium and by leakage through the claystones overlying the sandstones.

There is a strong downward gradient between ground water in surficial materials and bedrock. Vertical gradient data are provided in the RI report (Rockwell International, 1988a). Calculated vertical gradients ranging from about 2 to 0.3 ft/ft indicate a hydraulic potential for downward flow. The presence of unsaturated conditions in some locations and high vertical gradients where subsurface materials are continuously saturated indicates that the intervening material (claystone) has a very low hydraulic conductivity. Ground-water flow within individual sandstones is from west to east. The maximum horizontal ground-water velocity in sandstone is estimated at about 36 ft/yr while the mean velocity is estimated to be 12 ft/yr. Ground water moves at these rates only if the sandstone unit is continuous or has good interconnection with an adjacent unit. To date, lateral continuity of sandstone units along strike has been demonstrated to be small and only a few correlations have been made along dip.

Usable ground water occurs in the Arapahoe Aquifer. Water from the sandstones of the Arapahoe Aquifer is used for irrigation, livestock watering, and domestic purposes east of RFP.

2.1.6 Contaminants -- Description and Sources

2.1.6.1 Ground-Water Contamination

Organic contamination of alluvial ground-water at the 881 Hillside Area is evident. However, the existence of inorganic contamination in either alluvial or bedrock ground-water is uncertain at this time. This uncertainty is due to the limited data on background chemical conditions for alluvial and bedrock ground-water. Water-quality data from wells 55- 86 (alluvial) and 54-86 (bedrock), located southwest of the plant and upgradient of all known SWMUs, are the only current data available for characterizing background ground-water chemistry. Over two years of quarterly data exist for these wells.

This data has been used to preliminarily determine which constituents in ground water at the 881 Hillside Area are contaminants. Constituent concentrations in ground water at the 881 Hillside Area that exceed the upper limit of the range of concentrations in either well 55- 86 (alluvial) or 54-86 (bedrock) are presumed to represent contaminants.

A background characterization study is currently underway to provide more definitive information of the spatial and temporal variability of alluvial, colluvial, valley fill, and bedrock ground-water quality. These data will be used to better evaluate the nature and extent of inorganic contamination at the 881 Hillside and remedial action alternatives that address this contamination for the final RI/FS report. For this removal action, clean-up criteria are defined by applicable or relevant and appropriate requirements (ARARs) or proposed requirements to be considered (TBC) as discussed in Section 3. Variances from ARARs may be appropriate in the future when background chemical conditions are adequately characterized.

Alluvial ground water is contaminated with various volatile organic compounds (VOCs) and possibly various metals, major ions, and uranium. Alluvial ground water at the 881 Hillside Area has been divided into three groups on the basis of contaminant migration pathway or nature of the contamination as follows:

- 1) The Building 881 footing drain discharge (SWMU 107), i.e., alluvial ground water discharging to a surface water pathway.
- 2) Alluvial ground water beneath or in the immediate vicinity of the 881 Hillside Area characterized by the presence of VOCs in many of the wells.
- 3) Alluvial ground water downgradient of the 881 Hillside Area beyond the limits of VOC contamination.

For each of these groups, the nature of contamination is summarized in Tables 2-1, 2-2, and 2-3. Well locations are identified on Figure 2-5. Each table identifies the maximum, minimum, and average concentrations of VOCs, metals, and other major ions that were detected. The chemical-specific ARARs are also identified in the tables. Table 2-4 similarly summarizes total uranium concentrations for each group. Uranium was the only radionuclide occurring above estimated background concentrations.

The footing drain discharge is characterized by low concentrations of VOCs, and above estimated background concentrations of a few metals, major ions, and uranium. The average concentrations for specific volatile organics exceed ARARs for trichloroethene (TCE) and tetrachloroethene (PCE). Average values for total dissolved solids and mercury exceeded ARARs/TBCs for the inorganic constituents; however, the high average mercury concentration is considered an artifact of including only one apparent erroneous data point (0.9 ug/l). Subsequent analyses show mercury concentrations to be below ARARs/TBCs.

Alluvial ground water at the 881 Hillside Area is characterized by significant VOC contamination. High concentrations of VOCs are notably present in the vicinity of SWMU 119.1 at well 9-74. The maximum concentration for most of the metals exceed estimated alluvial ground-water background concentrations and ARARs. However, only the ARARs for manganese and selenium are exceeded for the average concentrations. Total dissolved solids, chloride, nitrate-nitrite, and sulfate have average values that exceed the ARAR or TBC guidelines. Average total and dissolved uranium concentrations exceed background, but not ARAR.

Downgradient of the 881 Hillside Area, the alluvial ground-water chemistry is characterized by the absence of VOC contamination, with the exception of low concentrations of methylene chloride, acetone, and 1,1-dichloroethene. The methylene chloride and acetone are suspected laboratory contaminants because of their presence in associated laboratory blanks, and the 1,1-dichloroethene was detected only once, in July 1987, in well 2-87 at a level (6 ug/l) just above the detection limit of 5 ug/l. This compound has not been detected since then in either well 2-87 or any other well downgradient of the 881 Hillside Area. It is, therefore, considered to be lab or field sampling contamination. Average concentrations of several metals, major ions, and uranium are above the estimated background for alluvial ground water. Concentrations of these inorganic constituents are somewhat lower than at the 881 Hillside Area, and nitrate, chloride, and sulfate do not exceed ARAR on the average. Inorganic constituents have apparently migrated from the 881 Hillside Area, but organic contaminants have not migrated to any appreciable extent.

Table 2-1

TABLE 2-1
VOLATILE ORGANIC COMPOUND CONCENTRATIONS
ABOVE ESTIMATED BACKGROUND FOR BUILDING 881 FOOTING DRAIN DISCHARGE
ALL CONCENTRATIONS IN ug/l

Reported when the maximum value exceeds Background

Analyte	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Chloromethane	10	U				
Bromomethane	10	U				
Vinyl Chloride	10	U				
Chloroethane	10	U				
Methylene Chloride	5	200	21	5	U	SW45
Acetone	10	50				
Carbon Disulfide	5	U				
1,1-Dichloroethane	5	U				
1,1-Dichloroethane	5	U*				
Trans-1,2-Dichloroethane	5	70				
Chloroform	5	5				
1,2-Dichloroethane	5	5				
2-Butanone	10	U				
1,1,1-Trichloroethane	5	U				
Carbon Tetrachloride	5	U	6 +	4	U	SW45
Vinyl Acetate	10	U			3	
Bromodichloromethane	5	U				
1,2-Dichloropropane	5	U				
cis-1,3-Dichloropropene	5	U				
Trichloroethene	5	U	14 +	5	U	SW45
Dibromochloromethane	5	U				
1,1,2-Trichloroethane	5	U				
Benzene	5	U				
Trans-1,3-Dichloropropene	5	U				
2-Chloroethylvinylether	10	U				
Bromoform	5	U				
4-Methyl-2-pentanone	10	U				
2-Hexanone	10	U				
Tetrachloroethene	5	U	128 +	2	J	SW45
1,1,2,2-Tetrachloroethane	5	U			31 +	
Toluene	5	U	12	5	U	SW45
Chlorobenzene	5	U				
Ethylbenzene	5	U				
Styrene	5	U				
Total Xylenes	5	U				

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988/1989 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: SW45

TABLE 2-1 (Continued)
 DISSOLVED METAL CONSTITUENT CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR BUILDING 881 FOOTING DRAIN DISCHARGE
 ALL CONCENTRATIONS IN mg/l

Reported when the maximum value exceeds Background

Analyte	Detec. Limit	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Aluminum (Al)	0.0290	0.223	5.0				
Antimony (Sb)	0.0600	0.06 U	1.6				
Arsenic (As)	0.0100	0.01 U	0.05				
Barium (Ba)	0.0100	0.071	1.0	0.1547	0.1547	0.0799	SW45
Beryllium (Be)	0.0050	0.005 U	0.1				
Cadmium (Cd)	0.0050	0.005 U	0.01				
Calcium (Ca)	0.7500	33.8	NS	85.342	78.0	82	SW45
Cesium (Cs)	0.0200	0.02 U	NS				
Chromium (Cr)	0.0100	0.026	0.05				
Cobalt (Co)	0.0220	0.022 U	0.022 U*				
Copper (Cu)	0.0063	0.046	0.2				
Iron (Fe)	0.0069	0.162	0.3				
Lead (Pb)	0.0050	0.016	0.05				
Lithium (Li)	0.1000	0.1 U	NS				
Magnesium (Mg)	0.0500	5.9	NS	21.0	19.021	20	SW45
Manganese (Mn)	0.0051	0.066	0.05				
Mercury (Hg)	0.0002	0.0002U	0.002	0.90 +	0.0002 U	0.3001 +	SW45
Molybdenum(Mo)	0.0220	0.022 U	0.1				
Nickel (Ni)	0.0370	0.037 U	0.20				
Potassium (K)	0.5000	0.8	NS	3.8	3.8	1.4333	SW45
Selenium (Se)	0.0050	0.005 U	0.01	0.018 +	0.005 U	0.0077	SW45
Silver (Ag)	0.0076	0.083	0.05				
Sodium (Na)	2.1000	13.1	NS	46	41.761	44	SW45
Strontium (Sr)	0.0200	0.15	NS	0.7	0.6411	0.6705	SW45
Thallium (Tl)	0.0100	0.01 U	0.01				
Vanadium (V)	0.0240	0.024	0.10				
Zinc (Zn)	0.0200	0.164	2.0	0.6	0.0426	0.2175	SW45

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: SW45

TABLE 2-1 (Continued)
 INORGANIC CONSTITUENT CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR BUILDING 881 FOOTING DRAIN DISCHARGE
 ALL CONCENTRATIONS IN MG/L

Reported when the maximum value exceeds Background

Analyte	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Total Dissolved Solids	167	400	464 +	456 +	460 +	SW45
Chloride	19	250	77	74.1	76	SW45
Nitrate-Nitrite as N	1.5	10	8.50	8	8.250	SW45
Sulfate	27	250	56	44.0	50	SW45
HCO3- as CaCO3	79	NS	232	216	224	SW45

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: SW45

TABLE 2-2
 VOLATILE ORGANIC COMPOUND CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS AT THE 881 HILLSIDE
 ALL CONCENTRATIONS IN ug/l

Analyte	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Reported when the maximum value exceeds Background	
						Wells/Stations in which Background Value was exceeded	Value
Chloromethane	10	U					
Bromomethane	10	U					
Vinyl Chloride	10	U					
Chloroethane	5	U					
Methylene Chloride	10	U	61	1.	7	0974, 1074, 0487, 4387, 5287, 5387	
Acetone	10	U	130	4	10	1074, 4387, 5287, 5487	
Carbon Disulfide	5	U					
1,1-Dichloroethene	5	U	48000 +	3	2298 +	0974, 0487, 4387, 5387	
1,1-Dichloroethane	5	U	350E +	5	28 +	0974, 4387	
Trans-1,2-Dichloroethene	5	U					
Chloroform	5	U	51 +	3	5	1074, 0487, 5487	
1,2-Dichloroethane	5	U	16000 +	4	159 +	0974, 1074, 0487, 4387	
2-Butanone	10	U					
1,1,1-Trichloroethane	5	U	30250 +	2	1915 +	0974, 1074, 0487, 4387, 5387	
Carbon Tetrachloride	5	U	28000 +	4	460 +	0974, 1074, 0487, 4387, 5387	
Vinyl Acetate	10	U					
Bromodichloromethane	5	U					
1,2-Dichloropropane	5	U					
cis-1,3-Dichloropropene	5	U					
Trichloroethene	5	U					
Dibromochloromethane	5	U					
1,1,2-Trichloroethane	5	U					
Benzene	5	U					
Trans-1,3-Dichloropropene	5	U					
2-Chloroethylvinylether	10	U					
Bromoform	5	U					
4-Methyl-2-pentanone	10	U					
2-Hexanone	10	U					
Tetrachloroethene	5	U					
1,1,2,2-Tetrachloroethane	5	U					
Toluene	5	U					
Chlorobenzene	5	U	13200 +	2	946 +	0974, 1074, 0487, 4387	
Ethylbenzene	5	U	227	0.9	10	0974, 4387, 5387	
Styrene	5	U					
Total Xylenes	5	U					

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988/1989 quarterly data.
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 0974, 1074, 0187, 0487, 4387, 4487, 4987, 5087, 5187, 5287, 5387, 5487

TABLE 2-2 (Continued)
DISSOLVED METAL CONSTITUENT CONCENTRATIONS
ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS AT THE 881 HILLSIDE
ALL CONCENTRATIONS IN mg/l

Reported when the maximum value exceeds Background

Analyte	Detec. Limit	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Aluminum (Al)	0.0290	0.223	5.0	0.0798	0.006 J	0.0387	0974, 1074, 0487, 5287
Antimony (Sb)	0.0600	0.06 U	1.6				
Arsenic (As)	0.0100	0.01 U	0.05				
Barium (Ba)	0.0100	0.071	1.0	0.1774	0.0382	0.0922	0974, 0487, 0687, 4387, 5287
Beryllium (Be)	0.0050	0.005 U	0.1				
Cadmium (Cd)	0.0050	0.005 U	0.01	355.99	85.697	184	0974, 1074, 0487, 0687, 4387, 5287
Calcium (Ca)	0.7500	33.8	NS	0.04 J	0.02 U	0.0107	0487
Cesium (Cs)	0.0200	0.02 U	0.05	0.0782 +	0.0100 U	0.0086	0487
Chromium (Cr)	0.0100	0.026	0.022 U*				
Cobalt (Co)	0.0220	0.022 U	0.022 U*	0.9515 +	0.0063 U	0.0937	4387
Copper (Cu)	0.0063	0.046	0.2	0.1739	0.0063 U	0.0322	0687
Iron (Fe)	0.0069	0.162	0.3				
Lead (Pb)	0.0050	0.016	0.05				
Lithium (Li)	0.1000	0.1 U	NS	0.7	0.02	0.1289	0974
Magnesium (Mg)	0.0500	5.9	NS	73.274	19.547	44	0974, 1074, 0487, 0687, 4387, 5287
Manganese (Mn)	0.0051	0.066	0.05	0.9586 +	0.0051 U	0.2405 +	0487, 0687, 4387, 5287
Mercury (Hg)	0.0002	0.0002U	0.002	0.0003	0.0002 U	0.0001	0687
Molybdenum(Mo)	0.0220	0.022 U	0.1	0.0265	0.0220 U	0.0122	1074, 4387
Nickel (Ni)	0.0370	0.037 U	0.20	0.8644 +	0.0370 U	0.1899	0487, 0687, 4387, 5287
Potassium (K)	0.5000	0.8	NS	12.3	0.5	2.3500	0974, 1074, 0487, 0687, 4387, 5287
Selenium (Se)	0.0050	0.005 U	0.01	3.2 +	0.003 J	0.5962 +	0974, 1074, 0487, 0687, 4387
Silver (Ag)	0.0076	0.083	0.05				
Sodium (Na)	2.1000	13.1	NS	341.74	124.79	196	0974, 1074, 0487, 0687, 4387, 5287
Strontium (Sr)	0.0200	0.15	NS	2.4291	0.7136	1.4372	0974, 1074, 0487, 0687, 4387, 5287
Thallium (Tl)	0.0100	0.01 U	0.01				
Vanadium (V)	0.0240	0.024	0.10	0.0302	0.0240 U	0.0125	0487
Zinc (Zn)	0.0200	0.164	2.0	2.4500 +	0.0200 U	0.3067	1074, 4387, 5287

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 0974, 1074, 0187, 0487, 0687, 4387, 4487, 4987, 5087, 5187, 5287, 5387, 5487

TABLE 2-2 (Continued)
 INORGANIC CONSTITUENT CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS AT THE 881 HILLSIDE
 ALL CONCENTRATIONS IN MG/L

Reported when the maximum value exceeds Background

Analyte	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of		Wells/Stations in which Background Value was exceeded
					All	Values**	
Total Dissolved Solids	167	400	2374 +	700 +	1345 +	0974, 1074, 0487, 0687, 4387, 5287	
Chloride	19	250	458 +	2.90	251 +	0974, 1074, 0487, 0687, 4387, 5287	
Nitrate-Nitrite as N	1.5	10	55 +	0.02 U	11 +	0974, 1074, 0487, 4387	
Sulfate	27	250	700 +	133	297 +	0974, 1074, 0487, 0687, 4387, 5287	
HCO3- as CaCO3	79	NS	502	112	317	0974, 1074, 0487, 0687, 4387, 5287	

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data.
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 0974, 1074, 0187, 0487, 0687, 4387, 4487, 4987, 5087, 5187, 5287, 5387, 5487

TABLE 2-3
VOLATILE ORGANIC COMPOUND CONCENTRATIONS
ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE
ALL CONCENTRATIONS IN ug/l

Analyte	Reported when the maximum value exceeds Background					
	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Chloromethane	10	U				
Bromomethane	10	U				
Vinyl Chloride	10	U				
Chloroethane	10	U				
Methylene Chloride	5	U	35	2	6	6586, 6686, 0287, 4787, 5587
Acetone	10	U	65	2	7	0287, 4887, 5587
Carbon Disulfide	5	U	6	4	3	0287
1,1-Dichloroethene	5	U				
1,1-Dichloroethane	5	U				
Trans-1,2-Dichloroethene	5	U				
Chloroform	5	U				
1,2-Dichloroethane	5	U				
2-Butanone	10	U				
1,1,1-Trichloroethane	5	U				
Carbon Tetrachloride	5	U				
Vinyl Acetate	10	U				
Bromodichloromethane	5	U				
1,2-Dichloropropane	5	U				
cis-1,3-Dichloropropene	5	U				
Trichloroethene	5	U				
Dibromochloromethane	5	U				
1,1,2-Trichloroethane	5	U				
Benzene	5	U				
Trans-1,3-Dichloropropene	5	U				
2-Chloroethylvinylether	10	U				
Bromoform	5	U				
4-Methyl-2-pentanone	10	U				
2-Hexanone	10	U				
Tetrachloroethene	5	U	35	4	3	6486, 0287
1,1,2,2-Tetrachloroethane	5	U				
Toluene	5	U				
Chlorobenzene	5	U				
Ethylbenzene	5	U				
Styrene	5	U				
Total Xylenes	5	U				

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. K-Present in Blank. L-Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988/1989 quarterly data.
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 6486, 6586, 6686, 6986, 0287, 4787, 4887, 5587

TABLE 2-3 (Continued)
 DISSOLVED METAL CONSTITUENT CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE
 ALL CONCENTRATIONS IN mg/l

Reported when the maximum value exceeds Background

Analyte	Detec. Limit	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**	Wells/Stations in which Background Value was exceeded
Aluminum (Al)	0.0290	0.223	5.0	0.2600	0.0290 U	0.0441	6586, 0287
Antimony (Sb)	0.0600	0.06 U	1.6	0.0618	0.02 U	0.0321	6986
Arsenic (As)	0.0100	0.01 U	0.05				
Barium (Ba)	0.0100	0.071	1.0	0.3110	0.0411	0.1326	6486, 6586, 6686, 6986, 0287, 4887
Beryllium (Be)	0.0050	0.005 U	0.1				
Cadmium (Cd)	0.0050	0.005 U	0.01				
Calcium (Ca)	0.7500	33.8	NS	299.33	24.184	114	6486, 6586, 6686, 6986, 0287, 4887
Cesium (Cs)	0.0200	0.02 U	NS				
Chromium (Cr)	0.0100	0.026	0.05				
Cobalt (Co)	0.0220	0.022 U	0.022 U*				
Copper (Cu)	0.0063	0.046	0.2	0.3270 +	0.0063 U	0.0621	4887
Iron (Fe)	0.0069	0.162	0.3	0.4065 +	0.0069 U	0.0446	6586, 0287
Lead (Pb)	0.0050	0.016	0.05	0.024	0.001 J	0.0039	6586, 6686
Lithium (Li)	0.1000	0.1 U	NS				
Magnesium (Mg)	0.0500	5.9	NS	95.507	5.4617	34	6486, 6586, 6686, 6986, 0287, 4887
Manganese (Mn)	0.0051	0.066	0.05	0.5431 +	0.0051 U	0.1788 +	6486, 6586, 6686, 0287, 4887
Mercury (Hg)	0.0002	0.0002U	0.002	0.006 +	0.0001 J	0.0004	6486, 6986, 0287
Molybdenum(Mo)	0.0220	0.022 U	0.1	0.0533	0.0220 U	0.0204	6486, 0287, 4887
Nickel (Ni)	0.0370	0.037 U	0.20	1.1827 +	0.0370 U	0.2377 +	6486, 6586, 6686, 6986, 4887
Potassium (K)	0.5000	0.8	NS	7.0	0.7	2.2887	6486, 6586, 6686, 6986, 0287, 4887
Selenium (Se)	0.0050	0.005 U	0.01	0.24 +	0.002 J	0.0297 +	
Silver (Ag)	0.0076	0.083	0.05				
Sodium (Na)	2.1000	13.1	NS	211.34	21.123	114	6486, 6586, 6686, 6986, 0287, 4887
Strontium (Sr)	0.0200	0.15	NS	2.9066	0.1450	1.0202	6486, 6586, 6686, 6986, 0287, 4887
Thallium (Tl)	0.0100	0.01 U	0.01				
Vanadium (V)	0.0240	0.024	0.10	0.0368	0.0240 U	0.0130	6486
Zinc (Zn)	0.0200	0.164	2.0	2.4559 +	0.02	0.4357	4887

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 6486, 6586, 6686, 6986, 0287, 4787, 4887, 5587

TABLE 2-3 (Continued)
 INORGANIC CONSTITUENT CONCENTRATIONS
 ABOVE ESTIMATED BACKGROUND FOR ALLUVIAL WELLS DOWNGRADIENT OF THE 881 HILLSIDE
 ALL CONCENTRATIONS IN MG/L

Reported when the maximum value exceeds Background

Analyte	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values**		Wells/Stations in which Background Value was exceeded
					Value	Value	
Total Dissolved Solids	167	400	2081 +	163	816 +		6486, 6586, 6686, 6986, 0287, 4887
Chloride	19	250	838 +	17.0	188		6486, 6586, 6686, 6986, 0287, 4887
Nitrate-Nitrite as N	1.5	10	4.29	0.02 U	0.674		6986, 0287
Sulfate	27	250	270 +	24.8	139		6486, 6586, 6686, 6986, 0287, 4887
HCO3- as CaCO3	79	NS	401	73.9	245		6486, 6586, 6686, 6986, 0287, 4887

* No standard, RCRA Appendix IX constituent, therefore background value is TBC + - Value exceeds ARAR/TBC
 **The average is computed by first determining the arithmetic mean concentration at individual wells/stations and then using this data to compute the arithmetic mean for the wells/stations in this group. If a datum indicates non-detected, the value used in the computation is one-half the detection limit.
 NS-No Standard. U-Detection Limit. J-Estimated below Detection Limit. B-Present in Blank _____ - Average exceeds background
 Notes: Minimum, Maximum, and Average based on 1987/1988 Quarterly Data. E-Estimated
 Background values based on upper limit of values found in well 55-86 for alluvial wells and well 54-86 for bedrock wells.
 Wells/Stations in this group: 6486, 6586, 6686, 6986, 0287, 4787, 4887, 5587

TABLE 2-4
 DISSOLVED AND TOTAL URANIUM CONCENTRATIONS FOR
 881 HILLSIDE AREA
 ALL CONCENTRATIONS REPORTED IN pCi/l

Area	Background Value	ARAR/TBC Value	Maximum Value	Minimum Value	Average of All Values	Wells/Stations in which Background Value was exceeded
Footing Drain*** Dissolved Value Total Value	1.8**	40*	10 ± 2 10 ± 4	10 ± 2 9 ± 1	10 ± 2 9.5 ± 2.5	Surface Water Station 045
Site Alluvial Wells*** Dissolved Value Total Value	1.8**	40*	56 ± 8 37 ± 7	9 ± 1 10 ± 3	32 ± 4 17 ± 4	Wells 0974, 1074, 0187, 0487, 0687, 4387, 5287
Alluvial Wells Downgradient*** Dissolved Value Total Value	1.8**	40*	19 ± 5 46 ± 9	0 ± 0 1 ± 2	11 ± 2 13 ± 4	Wells 6486, 6586, 6986, 0287, 4887

* Colorado Surface Water Standard
 ** Minimum Detectable Activity
 *** Footing Drain: Surface Water Station 45
 Site Alluvial Wells: 0974, 1074, 0187, 0487, 0687, 4387, 4487, 4987, 5087, 5187, 5287, 5387, 5487
 Alluvial Wells Downgradient: 6486, 6586, 6686, 6986, 0287, 4787, 4887, 5587

Of particular significance with respect to contaminant transport in alluvial ground water are the presence of gravel layers in colluvial materials overlying bedrock and near surface. These gravels were likely deposited in a south (downslope) direction by creep and slope wash erosion of the Rocky Flats Alluvium and can be expected to be elongated in the north-south direction with rather limited extent in the east-west. The gravel layers range between 1.3 feet to 5.5 feet in thickness.

Bedrock Material

The Cretaceous Arapahoe Formation underlies surficial materials at the 881 Hillside Area. Six wells were completed in various zones of the bedrock in the 1986 and 1987 drilling programs. The Arapahoe Formation beneath the 881 Hillside Area consists of claystones with interbedded lenticular sandstones, siltstones, and occasional lignite deposits. The Arapahoe Formation was deposited by meandering streams flowing generally from west to east off the Front Range. Sandstones were deposited in stream channels and as overbank splays, and claystones were deposited in back swamp and floodplain areas. Leaf fossils, organic matter, and lignite beds were encountered within the claystones during drilling at the 881 Hillside. Contacts between various lithologies are both gradational and sharp. Bedrock is estimated to dip approximately 2 degrees to the east.

Claystone bedrock was the most frequently encountered lithology of the Arapahoe Formation immediately below the bedrock contact. Weathered bedrock was encountered directly beneath surficial materials in all of the boreholes and wells, and weathering appears to penetrate as much as 60 feet below ground surface. The weathered claystone is also characterized by moderate fracturing and thus exhibits higher hydraulic conductivities than unweathered claystone.

Arapahoe sandstones were encountered beneath the 881 Hillside Area. These sandstones range from poorly-sorted to well-sorted, subrounded to rounded, very fine- to medium-grained, poorly- to moderately-well-cemented quartz sand with up to 10% lithic fragments. The thickness of individual sandstone beds ranged between 5 to 12 feet.

2.1.5 Sensitive Environments, Surface Water, and Ground Water

2.1.5.1 Sensitive Environments

The Endangered Species Act of 1973 (Public Law 93-0205), as amended, provides that all federal agencies shall carry out programs for the conservation of listed endangered and threatened species. Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened

species or result in the destruction or adverse modification of critical habitats as determined by the Secretary of the Interior.

The 881 Hillside Area is not used, nor intended for use, as a public or recreational area, nor for the development of any unique natural resource. No unique ecosystems were found at RFP during extensive biological studies. Communication with the U.S. Fish and Wildlife Service resulted in a finding of no affect on endangered species due to activities at the 881 Hillside Area.

There are no flood plains, wetlands, or historical/archaeological features at the 881 Hillside Area.

2.1.5.2 Surface Water

Woman Creek is an eastward-flowing, ephemeral stream located to the south of the 881 Hillside. The stream drains the southern portion of the Rocky Flats Plant site, and delivers water to Mower Reservoir and Standley Lake which are respectively used for agricultural and domestic water supply (see Figure 2-4). The South Interceptor Ditch, located between the 881 Hillside and Woman Creek, extends from south of the inner west gate entrance to Pond C-2 in the Woman Creek drainage. The ditch isolates runoff from the south side of RFP (including the 881 Hillside) from Woman Creek. Surface water flowing in an easterly direction along the South Interceptor Ditch is collected in Pond C-2, from which it is discharged to Woman Creek in accordance with the RFP National Pollutant Discharge Elimination System (NPDES) permit. The permitted discharge point is designated as 007. Pond C-1 receives flow from Woman Creek. A diversion structure located upstream of Pond C-2 diverts flow in Woman Creek around Pond C-2 and into the Woman Creek channel downstream. Along Woman Creek and the South Interceptor Ditch, retention ponds C-1 and C-2, and the associated diversion structures, control surface water discharge from the RFP site.

2.1.5.3 Ground Water

Ground water occurs in surficial materials (Rocky Flats Alluvium, colluvium, terrace alluvium, valley fill alluvium, and artificial fill) and in Arapahoe sandstones and claystones at the 881 Hillside Area. These two hydraulically connected flow systems are discussed separately below.

Ground Water in Surficial Materials

Ground water is present in surficial materials at the 881 Hillside under unconfined conditions. Recharge to the water table occurs as infiltration of incident precipitation and

Volatile organic compounds are at high concentrations in the proximity of SWMU 119.1, but decrease to non-detectable concentrations within approximately 300 feet (Rockwell International, 1988a). This rapid reduction in concentrations is in good agreement with the results of the soil gas surveys. The analysis of bedrock ground water for possible contamination is under investigation. A detailed sampling and analysis program of existing bedrock monitoring wells and background monitoring wells is currently being conducted.

2.1.6.2 Soil Contamination

Volatile and semivolatile organic contamination of soils exists at the 881 Hillside Area. Volatile organic contamination is not extensive. It occurred in soils from only 3 of the 23 boreholes that were drilled. The highest concentrations detected for chlorinated solvents were PCE at 190 ug/kg, TCE at 150 ug/kg, and 1,1,1-TCA at 110 ug/kg. However, phthalates occurred regularly and were the principal semivolatile contaminant of the soil, particularly bis(2-ethylhexyl)phthalate (DEHP). The maximum concentration of DEHP in the soil was 7,216 ug/kg. The risk assessment conducted as part of the FS for the 881 Hillside Area concludes that organic contamination of soils does not present an unacceptable risk to public health from direct contact via absorption through the skin, inhalation of dust, soil ingestion, or ingestion of vegetables grown in the soils.

2.1.6.3 Surface-Water Contamination

Surface waters of Woman Creek and the South Interceptor Ditch flow to Ponds C-1 and C-2, respectively. Discharge from the ponds to Woman Creek is monitored in accordance with RFP's NPDES permit. Sampling of the ponds indicates no VOCs are present, and radionuclides, metals, and major ions are within the estimated background levels identified in Section 6 of the 881 Hillside Area Draft Final Remedial Investigation Report for High Priority Sites (Rockwell International, 1988a). VOCs are present in the 881 Building footing drain which flows to Pond C-2; however VOCs are not found in Pond C-2. Elevated levels of uranium-238 occur in the South Interceptor Ditch upgradient of the 881 Hillside Area, but concentrations decrease to background levels at Pond C-2.

2.2 ANALYTICAL DATA

Organic and inorganic contaminants exist in the ground water beneath the 881 Hillside Area. Appendix 1 lists the results of volatile organic and inorganic analyses from alluvial ground-water samples collected at the 881 Hillside Area from 1987 and 1988 volatile organic analysis for the first and second quarter 1989 are also included..

2.3 SITE CONDITIONS THAT JUSTIFY AN IRA

There is no immediate threat to the public health and environment posed by ground-water contaminants at the 881 Hillside Area because the affected water is contained within the plant boundary. However, an unacceptable risk would be posed to the public by consumption of the contaminated alluvial ground water at or immediately downgradient of the 881 Hillside Area. Although consumption of this water is not likely, an IRA will be implemented in order to prevent further contaminant migration from the 881 Hillside Area that could otherwise exacerbate final cleanup efforts at the site.

SECTION 3.0

IDENTIFICATION OF INTERIM REMEDIAL ACTION OBJECTIVES

3.1 DETERMINATION OF REMEDIAL ACTION SCOPE

The overall objective of the IRA at the 881 Hillside Area is prevention of release and migration of alluvial ground-water contaminants downgradient, and the cleanup of alluvial ground-water contamination to within acceptable levels. The effort is to be performed in the interest of protecting public health as well as the environment.

Specific objectives of the IRA are:

- Contain, reduce, and/or eliminate site contaminants identified as posing potential threats to human health or the environment.
- Reduce or eliminate exposure to site contaminants for potential receptors by controlling potential contaminant pathways.
- Demonstrate technical feasibility and environmental and cost effectiveness of the interim remedial action.

3.2 INTERIM REMEDIAL ACTION SCHEDULE

<u>ACTIVITY</u>	<u>COMPLETION TIME FRAME</u>
• Issuance of FONSI ¹	September 1989
• Engineering Design	
Treatment Building ²	November 1989
Volatile Organic Treatment System ²	August 1989
Inorganic Treatment System	January 1990
Groundwater Collection System	June 1990
• Procurement	
Treatment Building ²	October 1989
Volatile Organic Treatment System	January 1990
Inorganic Treatment System	May 1990
• Construction	
Treatment Building ²	July 1990
Treatment System	November 1990
Startup/Test Treatment System	December 1990
Groundwater Collection System	March 1991
Startup/Test Entire System	April 1991

¹ National Environmental Policy Act finding no significant impact

² Activity started

3.3 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Response actions at Superfund sites must meet two fundamental clean-up requirements. First, they must attain a level of cleanup which, at a minimum, ensures protection of human health and the environment [CERCLA Section 121(d)(2), 42 U.S.C. Section 9621(d)(2)]. Second, it is EPA policy that CERCLA cleanups attain or exceed the requirements of all applicable or relevant and appropriate federal and state health and environmental requirements (ARARs). This section identifies and analyzes ARARs relevant to the IRA at the 881 Hillside Area. This remedial action is considered an on-site IRA; therefore, only substantive and not administrative requirements apply.

"Applicable standards" may be defined as substantive environmental protection requirements, criteria, or limitations, promulgated under federal or state law, that specifically address a hazardous substance, pollutant, contaminant, response action, location, or other circumstances at a Superfund site. "Relevant and appropriate requirements" are those substantive environmental protection requirements, promulgated under federal or state law, that, while not jurisdictionally applicable to circumstances at the site, address problems sufficiently similar to those encountered at the site that their use is well suited to the particular site. ARARs must be identified on a site-specific, case-by-case basis. In general, there are three categories of potential ARARs at any Superfund site. These categories are:

- Ambient or chemical-specific requirements.
- Locational requirements.
- Performance, design, or other action-specific requirements. Each category is discussed in more detail below.

3.3.1 Ambient or Chemical-Specific Requirements

Ambient or chemical-specific requirements set health- or risk- based concentration limits in various environmental media for specific hazardous substances or pollutants. These requirements set protective clean-up levels for the chemicals of concern in the designated media, or indicate a safe level of air emission or wastewater discharge.

Chemical-specific ARARs are derived primarily from federal and state health and environmental statutes and regulations. Health Effects Assessments, Health Advisories, Chemical Advisories, and Guidance Documents may also be considered when establishing clean-up standards, but are not considered to be ARARs. These and any proposed standards are classified as items to be considered, or TBCs. Where background concentrations for

constituents are above the chemical- specific ARAR for that constituent, a variance from the ARAR is appropriate. A summary of chemical- specific ARARs for the contaminants found at the 881 Hillside Area is presented in Table 3-1. When more than one chemical-specific ARAR has been identified for a contaminant, a screening process is used to determine the specific ARAR to be applied. This screening process involves three steps as outlined below:

1. The lowest human health or agricultural-based promulgated standard among the SDWA MCL, MCLG, and CDH ground and surface water standards is applied.
2. In the absence of any promulgated standard in step 1 above, the RCRA Land Disposal Restriction is applied.
3. In the absence of a promulgated standard in steps 1 or 2 above, the RCRA Subpart F limit or the proposed ground water and surface water standards are applied.

Screening for these ARARs is presented in Table 3-2. The screening process includes consideration of both ground water and surface water standards because in the proposed IRA (see Section 6.0), treated ground water is discharged to the South Interceptor Ditch (SID). The surface water in the SID often infiltrates the alluvium and recharges the alluvial ground water.

3.3.1.1 Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and MCL Goals

Because ground water beneath the 881 Hillside Area is a potential source of drinking water, Maximum Contaminant Levels (MCLs) are relevant and appropriate for all phases of the IRA. MCLs are derived from the Safe Drinking Water Act (PL 93-523). They represent the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system [40 CFR 141.2(C)]. Maximum Contaminant Level Goals (MCLGs) have also been considered in developing clean-up standards. Section 121(d) of CERCLA as amended by SARA suggests that MCLGs may be appropriate under certain circumstances of the release or threatened release of hazardous substances. This is reinforced in EPA's document entitled, Draft CERCLA Compliance with Other Laws Manual, Volume II, Maximum Contaminant Level Goals, (EPA, June 1987, that identifies the special circumstances where MCLGs should be considered as ARAR. These circumstances generally occur when there are multiple contaminants in ground water, or where multiple pathways of exposure present extraordinary risks. According to the guidance document, the use of MCLGs should be determined on a site-specific basis in consultation with EPA headquarters.

TABLE 3-1

SUMMARY OF SCREENING CHEMICAL SPECIFIC ARARS
PERTINENT TO 881 HILLSIDE REMEDIAL ACTIONS

<u>Chemicals Exceeding ARARS</u>	<u>Arithmetic Mean 881 Hillside Alluvial Wells</u>	<u>ARAR</u>	<u>Applicable, Relevant and Appropriate or To be Considered</u>	<u>Standard Criteria or Guidance</u>	<u>Citation</u>	<u>Comment</u>
Cadmium	0.013 mg/l	0.01 mg/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Mercury	0.214 mg/l	0.002 mg/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Manganese	0.116 mg/l	0.05 mg/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Selenium	0.165 mg/l	0.01 mg/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Carbon Tetrachloride	35 ug/l	5 ug/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
1,1-Dichloroethene	255 ug/l	7 ug/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Tetrachloroethene	153 ug/l	5 ug/l	Applicable	CDH Surface Water Fish and Water Ingestion Standard	5 CCR 1002-8 Section 3.8.29	CDH std. (0.8 ug/l) is below detection limit (BDL), so detection limit of 5 ug/l is used
1,1-Dichloroethane	6 ug/l	5 ug/l	TBC	RCRA Subpart F Limit	40 CFR Part 264.92	No CDH or SDWA Standards Exist
1,1,1-Trichloroethane	470 ug/l	200 ug/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	

TABLE 3-1 (cont.)

SUMMARY OF SCREENING CHEMICAL SPECIFIC ARARS
PERTINENT TO 881 HILLSIDE REMEDIAL ACTIONS

<u>Chemicals Exceeding ARARS</u>	<u>Arithmetic Mean 881 Hillside Alluvial Wells</u>	<u>ARAR</u>	<u>Applicable, Relevant and Appropriate or To be Considered</u>	<u>Standard Criteria or Guidance</u>	<u>Citation</u>	<u>Comment</u>
Trichloroethene	400 ug/l	5 ug/l	Applicable	CDH Surface Water Drinking Water Standard	5 CCR 1002-8 Section 3.8.29	
Gross Alpha	56 pCi/l	15 pCi/l	Applicable	CDH Ground Water Quality Standard	5 CCR 1002-8 Section 3.11.5	Note that the calculated geo-metric mean does not include the counting error associated with individual analyses
Total Dissolved Solids	715 mg/l	400 mg/l	Applicable	CDH Ground Water Quality Water Quality Standard	5 CCR 1002-8 Section 3.11.5	The identified ARAR applies directly to ground water quality

TABLE 3-2
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (ug/l)	CDH Ground Water Quality Standards ^b (ug/l)	SDWA Maximum Contaminant Level (MCL) ^c (ug/l)	For Use In Special Circumstances SDWA/MCLG ^d (ug/l)	RCRA Land Disposal Restrictions (ug/l) ^e	CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (ug/l)	CDH Surface Water Quality Standards ^e (ug/l)	Arithmetic Mean 881 Hillside Alluvial Ground Water ^f (ug/l)	ARAR	Comment
<u>Organic Compounds</u>										
Acetone	10U	-	-	-	50	-	-	BDL	RCRA LDR is relevant and appropriate (R&A)	ARAR is not exceeded
Benzene	5U	5	5	0	-	5,300 ^g	5	BDL	CDH Surface Water Drinking Water Standard is applicable	ARAR is not exceeded
#Carbon Tetrachloride	5U	5	5	0	50	35,000/	5	35	CDH Surface Water Drinking Water Standard is applicable	ARAR is exceeded
Chloroform	5U	0.19	100 ^j	-	-	28,000/1,200 ^g	0.19	BDL	CDH Surface Water and Fish Ingestion Standard (0.19 ug/l) is below detection limits (DBL), so detection limit of 5 ug/l is applicable	ARAR is not exceeded
#1,1 Dichloroethane	5U	-	-	-	-	-	-	6	RCRA Subpart F Limit is TBC ^k	TBC limit is exceeded
1,2 Dichloroethane	5U	5	5	0	-	110,000/20,000 ^g	5	BDL	CDH Surface Water Drinking Water Standard is applicable	ARAR is not exceeded
#1,1 Dichloroethene	5U	7	7	7	-	11,000 ^{g/l}	7	255	CDH Surface Water Drinking Water Standard is applicable	ARAR is exceeded
t-1,2 Dichloroethene	5U	70	-	70 ^h	-	11,000 ^{g/l}	70	BDL	CDH Surface Water Drinking Water Standard is applicable	ARAR is not exceeded
Methyl Ethyl Ketone	10U	-	-	-	50	-	-	BDL	RCRA LDR is R&A	ARAR is not exceeded
Methylene Chloride	5U	-	-	-	200	-	-	9	RCRA LDR is R&A	ARAR is not exceeded
#Tetrachloroethene	5U	0.8	-	0 ^g	79	5,200/840 ^g	0.8	153	CDH Surface Water Fish and Water Ingestion Standard (0.8 ug/l) is BDL, so detection limit of 5 ug/l is applicable	ARAR is not exceeded

TABLE 3-2 (cont.)
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (ug/l)	CDH Ground Water Quality Standards ^b (ug/l)	SDWA Maximum Contaminant Level (MCL) ^c (ug/l)	For Use In Special Circumstances SDWA/MCLG ^d (ug/l)	RCRA Land Disposal Restrictions (ug/l) ^e	CMA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (ug/l)	CDH Surface Water Quality Standards ^e (ug/l)	Arithmetic Mean 881 Hillside Alluvial Ground Water (ug/l)	ARAR	Comment
<u>Organic Compounds (cont.)</u>										
Toluene	50	14,300	-	2,000	1,120	17,000 ^g	2,420	6	SDWA MCLG is R&A	ARAR is not exceeded
#1,1,1 Trichloroethane	50	200	200	200	1,050	-	200	470	CDH Surface Water Drinking Water Standard is applicable	ARAR is exceeded
1,1,2 Trichloroethane	50	0.6	-	-	-	-	0.6	BDL	CDH Surface Water Fish and Ingestion Standard (0.6 ug/l) is BDL, so detection limit of 5 ug/l is applicable	ARAR is not exceeded
#Trichloroethane	50	5	5	0	62	45,000/21,000 ^g	5	400	CDH Surface Water Drinking Water Standard is applicable	ARAR is exceeded

U - Detection Limit
 BDL - Below Detection Limit
 # - Analytes that exceed ARARs.
 (a) - 40 CFR Part 264.92 Subpart F releases from solid waste management units.
 (b) - 5 CFR 1002-8, Section 3.11.5^o Basic Standards for Ground Water August 17, 1989.
 (c) - 40 CFR Part 141.61 National Primary Drinking Water Standards.
 (d) - 40 CFR Part 141.50 National Primary Drinking Water Standards.
 (e) - 5 CFR 1002-8, Section 3.8.29, Temporary Rule Adopted July 11, 1989.
 (f) - Based on a flow weighted average of the 881 footing drain flow (5 gpm) and alluvial groundwater at the 881 Hillside that would be collected in the french drain (2 gpm). Averages computed from the 1987 and 1988 data base, except organics. Organic compound concentrations determined from first and second quarter 1989 data.
 (g) - Means are calculated by including analyses that were found to be below detection limits. The value of 0.5 times the detection limit was used to calculate the mean well concentrations for analyses below detection limits.
 (h) - Lowest observed effect level.
 (i) - Proposed value Federal Register 46936 (Nov. 13, 1985).
 (j) - To be considered. The most recent EPA guidance on the identification of ARARs states that existing criteria, advisories, guidance, or proposed standards should be considered for a chemical in the absence of a promulgated standard.
 (k) - Proposed value Oct. 1986.
 (l) - 40 CFR Part 268.41 Subpart D - Treatment Standards.

TABLE 3-2
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (mg/l)	CDH Ground Water Standard Human Health/ Agriculture (mg/l)	SDWA Maximum Contaminant Level (MCL) ^c (mg/l)	For Use In Special Circumstances SDWA/MCLG (mg/l)	CWA Ambient Water Quality Criteria for Protection of Aquatic Life		CDH Surface Water Quality Standard ^d Drink Water/ Agriculture (mg/l)	Arithmetic Mean 881 Hillside Alluvial Wells ^e (mg/l)	ARAR	Comment
					Freshwater	Chronic				
<u>Metals</u>										
Aluminum		/5.0						0.223	CDH Agriculture Standard is applicable	ARAR is not exceeded
Antimony	0.060				9.0/1.6			0.030	RCRA Subpart F is TBC	ARAR is not exceeded
Arsenic and Compounds	0.05	0.05/0.1	0.05		0.69/0.048 ^g		0.05/0.1	BDL	CDH Surface Water Drinking Standard is applicable; SDWA MCL is R&A	ARAR is not exceeded
Barium	1.0	1.0/	1.0	1.5 ^f			1.0/	0.117	CDH Surface Water Drinking Water Standard is applicable; SDWA MCL is R&A	ARAR is not exceeded
Beryllium	0.0050	/0.1			0.19/0.0053 ^g		/0.1	BDL	CDH Agriculture Standard is applicable	ARAR is not exceeded
Cadmium and Compounds	0.01	0.01/0.01	0.01	0.005	0.0039 ^h /0.0011 ^h		0.01/0.01	0.013	CDH Surface Water Drinking Water Standard is applicable; SDWA MCL is R&A	ARAR is exceeded
Chromium III (Compounds)		0.05/0.1			1.7 ^h /0.2 ^h		0.05/0.1	0.021	CDH Surface Water Drinking Water Standard is applicable	Analytical result is total chromium. CDH standard is not exceeded
Chromium VI	0.05	0.05/0.1	0.05	0.0012	0.016/0.011		0.05/0.1	0.021	CDH Surface Water Drinking Water Standard is applicable; SDWA MCL is R&A	Analytical result is total chromium. CDH standard is not exceeded
Copper	0.046	1.0/0.2	1.0	1.3 ^f	0.018 ^h /0.012 ^h		1.0/0.2	0.059	CDH Agriculture Standard is applicable	CDH Standard is not exceeded
Iron		0.3/5.0	0.3				0.3/	0.124	CDH Surface Water Drinking Water Standard is applicable	Analytical results are soluble iron; soluble iron does not exceed CDH Standard

TABLE 3-2 (cont.)
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 801 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (mg/l)	CDH Ground Water Standard Human Health/ ^b Agriculture (mg/l)	SDMA Maximum Contaminant Level (MCL) ^c (mg/l)	For Use In Special Circumstances SDMA/MCLG (mg/l)	CUA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/l)	CDH Surface Water Quality Standard ^d Drink Water/Agriculture (mg/l)	Arithmetic Mean 801 Hillside Alluvial Wells ^e (mg/l)	ARAR	Comment
Metals (cont.)									
Lead	0.05	0.05/0.1	0.05	0.002 ^f	.0082 ^h /.0032	0.05/0.1	BDL	CDH Surface Drinking Water Standard is applicable; SDMA MCL is R&A	CDH Standard and MCLG are not exceeded
Manganese		0.05/0.2	0.05			0.05/0.2	0.116	CDH Surface Drinking Water Standard is applicable	Analytical results are soluble manganese; CDH Standard for soluble manganese is exceeded. Reanalysis required to determine if total recoverable standard is exceeded
Mercury	0.002	0.002/0.01	0.002	0.003	.0024/.000012	0.002	0.214	CDH Surface Drinking Water Standard is applicable; SDMA MCL is R&A	ARAR is exceeded
Polybromine		/0.1					0.011	CDH Agriculture Standard is applicable	ARAR is not exceeded
Nickel and Compounds		/0.20			1.8 ^h /.096 ^h	/0.2	0.068	CDH Agriculture Standard is applicable	ARARs are not exceeded
Selenium	0.01	0.01/0.02	0.01	0.045 ^f	0.26/0.35	0.01/0.02	0.165	CDH Surface Drinking Water Standard is applicable; SDMA MCL is R&A	CDH Standard and SDMA MCL are exceeded
Silver	0.05	0.05/	0.05		.004 ^h /.00014	0.05/	BDL	CDH Surface Drinking Water Standard is applicable	ARARs are not exceeded
Thallium	0.010				1.4 ^g /.04 ^g		BDL	RCRA Subpart F is 18C	ARARs are not exceeded

TABLE 3-2 (cont.)
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limits ^a (mg/L)	CDH Ground Water Standard Human Health/ Agriculture ^b (mg/L)	SDMA Maximum Contaminant Level (MCL) ^c (mg/L)	For Use In Special Circumstances SDMA/MCLG (mg/L)	CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/L)	CDH Surface Water Quality Standard ^d Drink Water/ Agriculture (mg/L)	Arithmetic Mean 881 Hillside Alluvial Wells ^e (mg/L)	ARAR	Comment
Vanadium	0.024	0.1					0.021	CDH Agriculture Standard is applicable	ARAR is not exceeded
Zinc		5.0/2.0	5.0		0.32 ^h /0.047 ^h	5.0/2.0	0.247	CDH Agriculture Standard is applicable	CDH Standard and MCL are not exceeded

Details (cont.)

- Analytes that exceed ARARS

- TBC - To be considered
- BDL - Below Detection Limit
- (a) - 40 CFR Part 264.92 Subpart F Releases from solid waste management units
- (b) - 5 CFR 1002-8, Section 3.11-5, Ground Water Quality Standards
- (c) - 40 CFR Part 141.11 National Primary Drinking Water Standards
- (d) - 5 CFR 1002-8, Section 3.8-29, Temporary Rule adopted July 11, 1989 (Total Recoverable Concentrations)
- (e) - Based on a flow weighted average of the 881 footing drain flow (5 gpm) and alluvial groundwater at the 881 Hillside that would be collected in the french drain (2 gpm). Averages computed from the 1987 and 1988 data base, except organics. Organic compound concentrations determined from first and second quarter 1989 data.
- (f) - Proposed value as of October 1986
- (g) - Lowest Observed Effect Level
- (h) - Hardness dependent criteria (100 mg/l)

TABLE 3-2
SCREENING OF CHEMICAL SPECIFIC ARARS
PERTINENT TO 881 HILLSIDE AREA IRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (mg/l)	CDH Ground Water Standard Human Health/ Agriculture ^b (mg/l)	SDWA Maximum Contaminant Level (MCL) ^c (mg/l)	For Use In Special Circumstances SDWA/MCLG (mg/l)	CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/l)	CDH Surface Water Quality Limited Standard ^d Drinking Water/ Agriculture (mg/l)	Arithmetic Mean 881 Hillside Alluvial Wells ^e (mg/l)	ARAR	Comment
<u>Conventional Pollutants</u>									
pH	-	6.5-8.5	6.5-8.5 ^f	-	-	5.0-9.0 units	N.M.	CDH Ground Water is applicable	Average pH for the alluvial wells is within acceptable limits for discharge. ARARs are not exceeded
Fecal Coliform	-	1/100 ml (total coliform)	-	-	-	2000/100 ml	N.M.	CDH Ground Water Standard is applicable	Fecal coliforms were not measured in well samples
Dissolved Oxygen	-	-	-	-	-	3/3	N.M.	CDH Surface Water Standard is applicable	Dissolved Oxygen was not measured in well samples
Temperature	-	-	-	-	-	-	13.8° C	None	-
Ammonia (unionized)	-	-	-	-	-	70.5 ^g	N.M.	CDH Surface Water Standard is applicable	Ammonia nitrogen not measured in well samples
Nitrite	-	1.0 as N/ 10.0 as N	-	-	-	1 ^h /10 ^h	9	CDH Ground Water Standard is applicable	Analytical results are total nitrate plus nitrate nitrogen. Reanalysis required to determine if nitrite ARAR is exceeded
Nitrate	-	10.0 as N/ 100 as NO ₂ +NO ₃ -N	10	-	-	10 ⁱ /100 ^h	9	CDH Ground Water Standard is applicable	Analytical results are total nitrate nitrogen. Results indicate that nitrate ARAR is not exceeded
Fluoride	-	4.0/2.0	2.0 ^f	-	-	2.0	N.M.	CDH Ground Water Standard is applicable	Fluoride was not measured in wells

TABLE 3-2 (cont.)
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA TMA OPTIONS

Chemical	RCRA Subpart F Concentration Limit ^a (mg/l)	CDH Ground Water Standard Human Health/Agriculture (mg/l)	SDWA Maximum Contaminant Level (MCL) ^c (mg/l)	For Use In Special Circumstances SDWA/MCLG (mg/l)	CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/l)	CDH Surface Water Quality Limited Standard ^d Drinking Water/Agriculture (mg/l)	Arithmetic Mean 881 Hillside Alluvial Wells ^e (mg/l)	ARAR	Comment
<u>Conventional Pollutants (cont.)</u>									
Boron	-	/0.75	-	-	-	/0.75	N.M.	CDH Ground Water Standard is applicable	Boron was not measured in wells
Chloride	-	250/	250	-	-	250/	127	CDH Ground Water Standard is applicable	ARAR is not exceeded
Sulfate	-	250/	250 ^f	-	-	250/	121	CDH Ground Water Standard is applicable	ARAR is not exceeded
Sulfide (as H ₂ S) undiss.	10	-	-	-	-	0.05/	N.M.	CDH Surface Water Standard is applicable	Sulfide was not measured in wells
Cyanide	-	0.20/	-	-	-	0.2/0.2	N.M.	CDH Ground Water Standard is applicable	Free cyanide was not measured in wells
#T.D.S.	-	400 mg/l or 1.25 times background, whichever is least restrictive	500 ^f	-	-	-	715	CDH Ground Water Standard is applicable	1.25 time background TDS is 209 mg/l. ARAR is exceeded for alluvial wells

- Analytes that exceed ARARS

- N.M. - Not measured
- (a) - 40 CFR Part 264.92 Subpart F releases from solid waste management units
- (b) - 5 CFR 1002-8, Section 3.11-5, Groundwater Quality Standards
- (c) - 40 CFR Part 141.11(b,c) National Primary Drinking Water Standards
- (d) - 5 CFR 1002-8, Section 3.8.29, Temporary Rule Adopted July 11, 1989.
- (e) - Based on a flow weighted average of the 881 footing drain flow (5 gpm) and alluvial groundwater at the 881 Hillside that would be collected in the french drain (2 gpm). Averages computed from the 1987 and 1988 data base, except organics. Organic compound concentrations determined from first and second quarter 1989 data.
- (f) - 40 CFR Part 143.3 National Secondary Drinking Water Standards
- (g) - To be applied at the point of water supply intake

TABLE 3-2
 SCREENING OF CHEMICAL SPECIFIC ARARs
 PERTINENT TO 881 HILLSIDE AREA TIA OPTIONS

Chemical	RCRA Subpart F Concentration Limit (pCi/l)	CDH Ground Water Standard ^a (pCi/l)	SDWA Maximum Contaminant Level (MCL) ^b (pCi/l)	For Use In Special Circumstances SDWA/MCLG	CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic	CDH Surface Water Quality Standard ^c (pCi/l)	Arithmetic Mean 881 Hillside Alluvial Wells ^d (pCi/l)	ARAR	Comment
<u>Radionuclides</u>									
#Gross Alpha	-	15	15	-	-	-	56	CDH Ground Water Standard is applicable; SDWA MCL is R&A	Mean gross alpha exceeds ARAR; however, error associated with individual analyses exceeds the reported values in some cases. Also, value includes Uranium and Radon
Gross Beta	-	4 mrem/yr ^e	50	-	-	-	41	SDWA MCL is R&A	Mean gross beta does not exceed ARAR; note that error associated with individual analyses exceeds the reported values in some cases
Pu ^{238,239,240}	-	15	40 ^f	-	-	15	0	CDH Surface Water Standard is applicable	ARAR is not exceeded
Am ²⁴¹	-	-	4 ^f	-	-	30	0.03	CDH Surface Water Standard is applicable	ARAR is not exceeded; note that the error associated with individual analyses exceeds the reported value in some cases
H ³	-	20,000	20,000	-	-	20,000	N.M.	CDH Surface Water Standard is applicable	H ³ was not measured in well samples
Sr ⁹⁰	-	8	8	-	-	8	0.85	CDH Surface Water Standard is applicable	CDH Standard is not exceeded; note the error associated with individual analyses exceeds the reported value in some cases

TABLE 3-2 (cont.)
 SCREENING OF CHEMICAL SPECIFIC ARARS
 PERTINENT TO 881 HILLSIDE AREA TRA OPTIONS

Chemical	RCRA Subpart F Concentration Limit (pCi/l)	CDH Ground Water Standard ^a (pCi/l)	SDWA Maximum Contaminant Level (MCL) ^b (pCi/l)	For Use In Special Circumstances SDWA/MCLG	CWA Ambient Water Quality Criteria for Protection of Aquatic Life/Freshwater Acute/Chronic	CDH Surface Water Quality Standard ^c (pCi/l)	Arithmetic Mean 881 Hillside Alluvial Wells ^d (pCi/l)	ARAR	Comment
Radionuclides (cont.)									
Cs ¹³⁴	-	80	100,000 ^f	-	-	80	N.M.	CDH Surface Water Standard is applicable	Cesium ¹³⁴ was not measured
Cs ¹³⁷	-	-	100	-	-	-	N.M.	SDWA MCL is R&A	Cesium ¹³⁷ was not measured
Radium ^{226,228}	-	5	5	-	-	5	N.M.	CDH Surface Water Standard is applicable	Radium isotopes were not measured
Thorium ^{230,232}	-	60	-	-	-	60	N.M.	CDH Surface Water Standard is applicable	Thorium isotopes were not measured
Uranium total	-	-	-	-	-	40	16.3±3	CDH Surface Water Standard is applicable	Mean concentration of total uranium does not exceed the ARAR; note that the error associated with individual analysis exceeds the value reported in some cases

- Analytes that exceed ARARS

N.M. - Not measured

(a) - 5 CFR 1002-8, Section 3.11.5(B), Basic Standards Applicable to Ground Waters of the State

(b) - 40 CFR Parts 141.15, 16, National Primary Drinking Water Standards

(c) - 5 CFR 1002-8, Section 3.8.29, Temporary Rule Adopted July 11, 1989.

(d) - Based on a flow weighted average of the 881 footing drain flow (5 gpm) and alluvial groundwater at the 881 Hillside that would be collected in the french drain (2 gpm). Averages computed from the 1987 and 1988 data base, except organics. Organic compound concentrations determined from first and second quarter 1989 data.

(e) - For beta and photon emitters, if two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem per year. Except for Tritium and Strontium 90 the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burden and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended, August 1963, US Department of Commerce.

(f) - Proposed value in drinking water yielding a risk equal to that from a dose rate of 4 mrem/year, September 30, 1986 (51 FR 34659).

The clean-up criteria for the interim remedial action at the 881 Hillside Area consider MCLs and MCLGs as ARAR wherever such standards have been promulgated for the contaminants of concern. Proposed MCLs and MCLGs are considered TBCs in this analysis.

3.3.1.2 Ambient Water Quality Criteria

The Ambient Water Quality Criteria are nonenforceable guidance developed under the Clean Water Act. Guidance is set for surface waters for the protection of aquatic life and for the protection of human health, based on both drinking water and consuming aquatic organisms from that water. Since the IRA proposed here involves the treatment and subsequent discharge to surface water, the Water Quality Criteria are considered relevant and appropriate for this action.

3.3.1.3 Colorado Surface and Ground-Water Quality Standards

The Colorado Department of Health (CDH) has adopted interim ground-water quality standards for many organic compounds. These are considered ARARs for the constituents where they exist. Some of the standards are lower than the current standard detection limits for the compounds of concern. When this occurs, the detection limit will be considered as ARAR.

The CDH has also promulgated ground-water quality standards for many inorganic compounds for both human health and agricultural uses. These standards are considered to be relevant and appropriate since future or downgradient use of the aquifer is not restricted. Where standards exist for both human health and agricultural uses, the more stringent standard is considered to be the ARAR.

On July 11, 1989, the CDH adopted temporary surface-water quality standards for Walnut Creek and Woman Creek. These include standards for many organic, inorganic and radionuclide parameters. These temporary standards are in effect until March 30, 1990 (unless permanent standards are adopted at an earlier date) and are considered ARAR.

3.3.1.4 RCRA Ground-Water Protection Standards

Owners or operators of facilities that treat, store, or dispose of hazardous waste must ensure that hazardous constituents listed in 40 CFR 264, Appendix IX, entering the ground water from a regulated unit do not exceed concentration limits under 40 CFR 264.94. The concentration limits include standards for fourteen compounds, with background used as the standard for the other RCRA Appendix IX constituents. These concentration limits apply to RCRA-regulated units subject to permitting (landfills, surface impoundments, waste piles, and

land treatment units) that received RCRA hazardous waste after July 26, 1982. This site is not a RCRA-regulated unit and it is not known that RCRA hazardous wastes are involved with the site. Therefore, the RCRA clean-up criterion of background concentrations for Appendix IX constituents is relevant but not appropriate. This criterion is, however, considered TBC at this site in the absence of any human-health based standards.

RCRA land disposal restrictions (LDRs) for certain organic contaminants (40 CFR Part 268.40) are considered relevant and appropriate for the discharge of treated ground water to either a surface or ground water body. The LDRs are technology based standards and are considered relevant and appropriate in the absence of a health based standard.

3.3.2 Locational Requirements

Locational requirements are statutes or regulations which set restrictions on activities or limits on contaminant levels, depending on the characteristics of a site or its immediate environs. Examples of locational requirements are federal and state siting laws for hazardous waste facilities, or sites on the National Register of Historic Places. Also included are the Wilderness Protection Act and floodplain regulations promulgated pursuant to the Federal Emergency Management Agency's National Flood Insurance Program.

Location-specific ARARs that are relevant and appropriate are the State of Colorado siting criteria for RCRA treatment units, and for surface-water discharges, the CDH Water Quality Division's regulations pertaining to pre-approval of treatment facility location.

3.3.3 Performance, Design, or Other Action-Specific Requirements

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by the particular IRA alternatives that are evaluated as part of this plan. Action-specific ARARs are technology-based performance standards, such as the Best Available Technology standard of the Federal Water Pollution Control Act. Other examples include RCRA treatment, storage, and disposal standards, and Clean Water Act pretreatment standards for discharges to publicly-owned treatment works (POTWs). Action specific ARARs for the interim remedial actions evaluated here are included in Table 3-3.

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Treatment	<p>BDAT standards for spent solvent wastes and dioxin-containing wastes are based on one of four technologies or combinations; for waste waters, (1) steam stripping, (2) biological treatment, or (3) carbon absorption (alone or in combination with (1) or (2)); and for all other wastes, incineration. Any technology may be used, however, if it will achieve the concentration levels specified.</p>	<p>Effective November 8, 1988, disposal of contaminated soil or debris resulting from CERCLA response actions or RCRA corrective actions is subject to land disposal prohibitions and/or treatment standards established for spent solvent wastes, dioxin-containing wastes, and "California List" wastes.</p>	<p>RCRA Sections 3004 (d)(3), (e)(3) 42 U.S.C. 6924(d)(3), (e)(3)</p>	Applicable	<p>Movement of excavated soil onsite or transportation of soil offsite for disposal must be treated to attain levels achievable by best demonstrated available treatment technologies before being land-disposed.</p>
Capping	<p>Placement of a cap over waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed to:</p> <ul style="list-style-type: none"> o Provide long-term minimization migration of liquids through the capped area; o Function with minimum maintenance; o Promote drainage and minimize erosion or abrasion of the cover; 	<p>RCRA hazardous waste placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination will make requirements applicable. Capping without such movement will not make requirements applicable, but technical requirements are likely to be relevant and appropriate.</p>	<p>40 CFR 264.258(b) 40 CFR 264.310(a)</p>	R&A	<p>Capping of waste in place using R&A technical requirements R&A</p>

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	<ul style="list-style-type: none"> o Accommodate settling and subsidence so that the cover's integrity is maintained; and o Have a permeability less than or equal to the permeability of any bottom liner system or natural sub-soils present. 		40 CFR 264.228(a)		
	Eliminate free liquids, stabilize wastes before capping (surface impoundments).		40 CFR 264.117(c)		
	Restrict post-closure use of property as necessary to prevent damage to the cover.		40 CFR 264.228(b) 40 CFR 264.310(b)		
	Prevent run-on and run-off from damaging cover.		40 CFR 264.310(b)		
	Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles).				

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
<p>losure with aste in lace (Capping)</p>	<p>Eliminate free liquids by removal or solidification. Stabilization of remaining waste and waste residues to support cover.</p>	<p>Disposal of RCRA hazardous waste (listed or characteristic) at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980.</p>	<p>40 CFR 264.228 (a)(2) 40 CFR 264.228 (a)(2) and 40 CFR 264.258(b)</p>	<p>See capping</p>	<p>See capping</p>
<p>Installation of final cover to provide long-term minimization of infiltration.</p>			<p>40 CFR 264.310</p>		
<p>Post-closure care and ground- water monitoring.</p>			<p>40 CFR 264.310</p>		
<p>lean Closure (removal)</p>	<p>General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leadhate, contaminated run- off, or hazardous waste decomposition products. Disposal of decontamination of equipment, structures, and soils.</p>	<p>RCRA hazardous waste (listed or character- istic) placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980</p> <p>May apply to surface impoundment; contaminated soil, including soil from dredging or soil disturbed in the course of drilling or excavation, and returned to land.</p>	<p>40 CFR 264.111</p>	<p>RSA</p>	<p>Applicable to soil excavated for off-site disposal.</p>

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	Removal or decontamination of all waste residues, contaminated containment system components (e.g. liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste.		40 CFR 264.228(a)(1) and 40 CFR 264.258		
	Meet health-based levels at unit.		40 CFR 244.111		
Excavation/ Consolidation	Area from which materials are excavated may require cleanup to levels established by closure requirements Consolidation in storage piles/storage tanks will trigger storage requirements.	Movement of hazardous waste (listed or characteristic) from one unit or area of contamination into another. Consolidation within a unit or area of contamination does not trigger applicability.	See Clean Closure	R&A R&A	RCRA requirements for clean closure are R&A to remedial action involving soil excavation. RCRA requirements for storage in waste piles or tanks are relevant and appropriate for interim storage of excavated soil destined for consolidation or offsite disposal. R&A because soil may not be RCRA hazardous waste.
	Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions.		40 CFR 268 (Subpart D)	R&A	Soil excavated during installation of French drains is subject to land disposal restrictions for solvent containing waste. Requirements are applicable for RCRA hazardous waste; R&A if not RCRA hazardous waste.

TABLE 3-3
 SCREENING OF PROBABLE ACTION SPECIFIC ARARS
 FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
 (continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Groundwater Diversion	Excavation of soil for construction of slurry wall may trigger cleanup or land disposal restrictions.	RCRA hazardous waste placed at site after November 19, 1980, or movement hazardous waste from one unit, area of contamination, or location into another unit or area of contamination	See Excavation/ Consolidation	R&A	See Excavation/Consolidation

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Treatment or Storage in Tanks	<p>Tanks must have sufficient shell strength (thickness), and, for closed tanks, pressure controls, to assure that they do not collapse or rupture.</p> <p>Waste must not be incompatible with the tank material unless the tank is protected by a liner or by other means.</p> <p>Tanks must be provided with controls to prevent overfilling, and sufficient freeboard maintained in open tanks to prevent overtopping by wave action or precipitation.</p> <p>Inspect the following: overfilling control, control equipment, monitoring data, waste level (for uncovered tanks), tank condition, above-ground portions of tanks, (to assess their structural integrity) and the area surrounding the tank (to identify signs of leakage).</p> <p>Repair any corrosion, crack, or leak.</p>	<p>RCRA hazardous waste (listed or characteristic), held for temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10) in a tank.</p>	<p>40 CFR 264.190</p> <p>40 CFR 264.191</p> <p>40 CFR 264.194</p> <p>40 CFR 264.195</p> <p>40 CFR 264.196</p>	<p>R&A</p>	<p>Relevant and Appropriate for treatment and storage tanks used in treating contaminated groundwater</p>

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment, and discharge confinement structures.		40 CFR 264.197		
	Store ignitable and reactive waste so as to prevent the waste from igniting or reacting. Ignitable or reactive wastes in covered tanks must comply with buffer zone requirements in "Flammable and Combustible Liquids Code," Tables 2-1 through 2-6 (National Fire Protection Association, 1976 or 1981).		40 CFR 264.198		
Container Storage (On-Site)	Containers of hazardous waste must be: <ul style="list-style-type: none"> o Maintained in good condition; o Compatible with hazardous waste to be stored; and o Closed during storage (except to add or remove waste). Inspect container storage areas weekly for deterioration.	RCRA hazardous waste (listed or characteristic) held for a temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10) in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled) (40 CFR 264.10)	40 CFR 264.171 40 CFR 264.172 40 CFR 264.173 40 CFR 264.174	RSA RCA	RCRA container storage requirements at the RSA

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	APAR	Comments
	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10% of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.		40 CFR 264.175		
	Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line.		40 CFR 264.176		
	Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier.		40 CFR 264.177		
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners.		40 CFR 264.178		

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE B81 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
Off-Site Treatment Storage or Disposal	<p>In the case of any removal or remedial action involving the transfer of any hazardous substance or pollutant or contaminant offsite, such hazardous substance or pollutant or contaminant shall only be transferred to a facility which is operating in compliance with section 3004 and 3005 of the Solid Waste Disposal Act (or where applicable, in compliance with the Toxic Substances Control Act or other applicable Federal law) and all applicable State requirements. Such substance or pollutant or contaminant may be transferred to a land disposal facility only if the President determines that both of the following requirements are met:</p> <ul style="list-style-type: none"> <li data-bbox="1216 1576 1434 1920">o The unit to which the hazardous substance or pollutant or contaminant is transferred is not releasing any hazardous waste, or constituent thereof, into the groundwater or surface water or soil. 		SARA section 121 (d)(2)(C)	Applicable	Applicable to the offsite treatment, storage, or disposal of wastes generated during onsite remedial actions.

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
hazardous waste operations	<p>o All such releases from other units at the facility are being controlled by a corrective action program approved by the Administrator under subtitle C of the Solid Waste Disposal Act.</p>		29 CFR Part 1910.120		
hazardous waste operations	<p>As mandated by SARA, OSHA has promulgated regulations that require employers to develop and implement a written safety/health program designed to regulate employee safety and health during hazardous waste operations. The safety and health program must include: releases of hazardous substances.</p>	<p>Regulations apply to hazardous substance response operations under CERCLA; Corrective cleanup under RCRA; hazardous waste operations that have been designated for cleanup by state or local authorities; most operations involving the treatment, storage or disposal of hazardous wastes regulated under RCRA; and emergency response operations for releases or threats of</p>	29 CFR Part 1910.120		
o	<p><u>Organizational structure:</u> Establish and implement chain of command and specify the responsibilities of key personnel.</p>				
o	<p><u>Comprehensive Work Plan:</u> Identify anticipated activities, define work tasks, establish personnel requirements, and provide for the implementation of medical surveillance and training programs as required by these regulations.</p>				

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ABARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ABAR	Comments
o <u>Site-Specific Health and Safety Plans</u>	A site health and safety plan must be prepared for each phase of operation that addresses key personnel; hazard recognition; training assignments; personnel protective equipment to be used; medical surveillance; frequency and type of monitoring, including air and personal monitoring; site control measures; decontamination procedures; emergency contingency plans.				
	General Requirements of these regulations:				
o <u>Site characterization and analysis-</u>	Identify site hazards to determine levels of personnel protection		29 CFR 1910.120(c)	Applicable	Site hazards have been characterized through the RI/FS process
o <u>Site Control-</u>	Implement site control zones to minimize employee exposure to hazardous substances.		29 CFR 1910.120(d)	Applicable	Site control zones will be defined in site-specific health and safety plans.
o <u>Training-</u>	Initial training and refresher training required before employee is permitted to engage in site activities.		29 CFR 1910.120(e)	Applicable	Personnel engaged in remedial actions at the 881 hillside are required to meet minimum training requirements as specified in the OSHA standards

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ABARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ABAR	Comments
o	<u>Material Handling</u> Hazardous substances, contaminated soils, liquids or other residues shall be handled, transported, and labeled according to subsection (j) of the OSHA standard		29 CFR 1910.120(j)	Applicable	D.O.T. specification containers will be used to handle, store, or transport.
o	<u>Decontamination</u> Decontamination procedures outlined in subsection (k) of the standard must be complied with during onsite remedial action.		29 CFR 1910.120(k)	Applicable	Decontamination procedures will be presented in the site health and safety plan.
o	<u>Emergency Response</u> Contingency plans must be developed as part of site health and safety planning		29 CFR 1910.120(l)	Applicable	Contingency plans will developed for the site health and safety plan
o	<u>Illumination/Sanitation</u> Minimum illumination and sanitation facilities must be provided for employees involved in hazardous waste operations		29 CFR 1910.120(m)(n)	Applicable	

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ABARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	APAR	Comments
	<ul style="list-style-type: none"> o <u>Medical Surveillance</u> Employers must implement medical surveillance for employees potentially exposed to hazardous substances. 		29 CFR 1910.120(f)	Applicable	
	<ul style="list-style-type: none"> o <u>Engineering Controls, work practices and personal protective equipment</u> One or all of these shall be used to minimize exposure of employees to hazardous substances and health hazards 		29 CFR 1910.120(g)	Applicable	
	<ul style="list-style-type: none"> o <u>Monitoring</u> Monitoring of exposures of employees to hazardous substances is required to determine the efficacy of protective equipment and engineering controls. 		29 CFR 1910.120(h)	Applicable	
	<ul style="list-style-type: none"> o <u>Informational Programs</u> Employees, contractors, and subcontractors shall be informed of the degree and nature of hazards associated with site activities. 		29 CFR 1910.120(i)	Applicable	All personnel involved in site activities will be required to read and comply with the site safety plan. The safety plan will outline the anticipated physical and chemical hazards.

TABLE 3-3

SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT THE 881 HILLSIDE AREA
(continued)

Action	Requirement	Prerequisite	Citation	ARAR	Comments
	<ul style="list-style-type: none"> o <u>Site Excavation</u> 		29 CFR 1910.120/1926	Applicable	
	<p>Site excavations must be shored or sloped to prevent collapse.</p>				
	<ul style="list-style-type: none"> o <u>Contractors and Subcontractors</u> 		29 CFR 1910.120	Applicable	
	<p>Employers must inform contractors or subcontractors of potential hazards associated with site activities</p>				

SECTION 4.0
IDENTIFICATION AND SCREENING OF
POTENTIAL IRA OPTIONS

4.1 SUMMARY OF THE FS TECHNOLOGY AND REMEDIAL ALTERNATIVE SCREENING PROCESS

The 881 Hillside Area FS Report (Rockwell International, 1988b) was prepared according to the EPA Feasibility Study Guidance (EPA, 1985) available at the time. The initial screening process eliminated infeasible, inappropriate or environmentally unacceptable technologies. The following technologies were retained after screening:

1. No remedial action - monitoring only (not considered here)
2. Off-site RCRA landfill
3. Well arrays
4. Subsurface drains
5. Soil-bentonite slurry wall
6. Multi-layer cap
7. Grading and vegetation
8. Surface water diversion
9. In situ immobilization (grouting)
10. Soil flushing
11. UV/Peroxide water treatment
12. Air stripping water treatment
13. Activated carbon adsorption water treatment
14. Discharge to surface-water
15. Re-injection to ground-water

Technologies were then combined that are complementary and interrelated, to form alternatives that address the site issues and control contaminant pathways. The three water treatment technologies were subjected to a more detailed evaluation to determine the most cost-effective, reliable treatment system for inclusion with the alternatives requiring water treatment. Provisions of the Superfund Amendments and Reauthorization Act of 1986 (SARA) also require that alternatives be developed that consider:

- o Elimination of long term site management;
- o Reduction of waste toxicity, mobility, or volume;
- o Waste containment with little or no treatment;
- o Use of innovative technologies.

The developed alternatives are as follows:

1. Collection of ground water using a line of downgradient wells and a source well at SWMU 119.1, collection of footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage.
2. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage.
3. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow from, and discharge of treated water to the surface, and in situ treatment of soils using soil flushing.
4. Total encapsulation of source areas using a multi-layer cap and slurry wall with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant).
5. Pump a source well at SWMU 119.1, collect footing drain flow, and reinjection of treated water downgradient of the 881 Hillside Area in the Valley Fill Alluvium of the Woman Creek drainage.
6. Immobilization of contaminants using a chemical grout.
7. Collection of ground water using a french drain and a source well at SWMU 119.1, collection of footing drain flow, reinjection of treated water downgradient of the 881 Hillside in the Valley Fill Alluvium of the Woman Creek drainage, and partial removal of soils to a RCRA-permitted disposal facility.

Three broad considerations, consistent with the National Contingency Plan, were used as the basis for the preliminary screening of developed alternatives:

- o Cost - The cost of implementing the remedial action was considered including operating and maintenance costs. An alternative whose cost far exceeds that of others being evaluated without providing significantly greater protection was eliminated.
- o Acceptable Engineering Practices - Alternatives which do not provide a proven and reliable means of addressing the problem were eliminated.
- o Effectiveness - Alternatives which do not effectively contribute to the protection of public health, welfare, and the environment were eliminated. Alternatives posing significant adverse environmental effects and only limited benefits were also excluded from further consideration.

Of the seven remedial action alternatives developed, four of the alternatives were eliminated because they did not provide adequate protection of public health, welfare, and the environment, or were much more costly without providing significantly greater protection. The 881 Hillside Area Feasibility Study Report (Rockwell International, 1988b) provides the details of the screening process to this point.

The remaining three alternatives from the FS Report were retained for a further detailed evaluation based on additional treatment requirements imposed by the DOE agreement with the State of Colorado in June 1989. This agreement requires the treatment of collected ground-water for removal of inorganic contaminants including radionuclides until the background ground water study is completed. In addition, the treated water will be discharged to surface water as opposed to ground-water reinjection, as originally proposed in the FS. The reinjection of treated ground water downgradient of the french drain is deemed not to be necessary because of the interaction between surface-water and alluvial ground-water. The three alternatives remaining are:

1. Collection of ground water using a french drain and a source well, collection of footing drain flow, treatment of collected water in a new treatment plant and discharge to surface water.

2. Total encapsulation of source areas using a multi-layer cap and slurry wall with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant).
3. Pump a source well at SWMU 119.1, collect footing drain flow, treat collected water at a new treatment plant, and discharge to surface water.

The detailed analysis of the three remaining alternatives is presented in this document and is based on the March 30, 1988 EE/CA Guidance. Each alternative is evaluated individually based on effectiveness, implementability, and cost.

4.2 IRA PLAN SCREENING PROCESS

4.2.1 Effectiveness

The criteria for evaluation of effectiveness of removal alternatives includes protectiveness and use of alternatives to land disposal. Protectiveness includes protection of the community and workers during the removal action; threat reduction (mitigation of identified threats); determination of the length of time until protection is achieved; compliance with chemical- and location-specific ARARs; compliance with criteria, advisories and guidances; description of potential exposure to residuals remaining on-site; and long-term reliability for providing continued protection. The effectiveness criteria also includes use of alternatives to land disposal, thus promoting utilization of treatment or recycling instead of land disposal.

4.2.2 Implementability

The criteria for evaluation of implementability of removal alternatives includes technical feasibility, availability, and administrative feasibility. Technical feasibility includes the ability to construct the technology and to maintain its operation; compliance with action-specific ARARs; ability to meet process efficiencies or

performance goals; demonstrated performance; evaluation of impact of environmental conditions; and compliance with the SARA requirement that removal actions should contribute to the efficient performance of long-term remedial action to the extent practicable. Availability includes the availability of necessary equipment, materials and personnel; availability of adequate off-site treatment, storage, and disposal capacity, if appropriate; and description of post-removal site controls which will be required at the completion of the action. Administrative feasibility includes the likelihood of public acceptance of the alternative, including state and local concern; coordination of activities with other agencies; and ability to obtain any necessary approvals or permits.

4.2.3 Cost

The criteria for evaluation of cost of removal alternatives includes total cost and statutory limits. Total cost includes direct capital costs, indirect capital costs, and any post-removal site control costs. Since the IRA at the 881 Hillside Area is not an EPA-financed removal action, the \$2 million statutory cost limit does not apply.

4.3 GROUND-WATER TREATMENT TECHNOLOGIES EVALUATION

The ground-water treatment technologies that were selected for detailed evaluation include carbon adsorption, UV/peroxide (chemical oxidation), and air stripping for organic compounds, and ion exchange, electro dialysis, and reverse osmosis for inorganic compounds. The specific treatment systems listed are provided as examples of systems that can provide the level of treatment needed to meet chemical-specific ARARs for the organic and inorganic contaminants of concern. It is recognized that many companies provide similar treatment systems, and the system

ultimately selected for installation will be required to provide the same level of efficiency as that specified here.

The treatment system selected must be capable of treating 30 gpm of contaminated ground water with influent characteristics as shown in Table 4-1. The effluent quality must meet the chemical-specific ARARs.

The location- and action-specific ARARs are similar for each of the treatment technologies, and are discussed in Section 3. Only air stripping has unique action specific requirements because it is subject to the Colorado Department of Health Air Quality regulations for the air emissions.

4.3.1. Activated Carbon Adsorption (Organic Contaminant Removal)

4.3.1.1 Description

For the granular activated carbon (GAC) adsorption system, the ground water will be pumped through two GAC columns in series operated in downflow fixed-bed mode (Figure 4-1). A second set of GAC columns for stand-by operation are in parallel to the first set. Each carbon column is 44 inches in diameter and 89 inches high, and contains 1,800 pounds of carbon. Based on a peak flow rate of 30 gpm, the hydraulic loading to each column will be approximately 1.4 gpm/ft². Contact time for each column will be approximately 25 minutes.

To completely utilize the carbon, columns are arranged in series allowing the lead column to become fully exhausted before regeneration while the second (polishing) column ensures effluent quality. Periodic samples will be taken from the effluent of each unit, and when the lead unit effluent exceeds chemical-specific ARARs, the lead carbon column will be removed, the polishing (second) column will become the lead column, and a stock carbon column carbon will be put in service as

TABLE 4-1
BASIS FOR DESIGN OF
881 HILLSIDE TREATMENT PLANT

	<u>Units</u>	<u>Influent ^a Concentration</u>	<u>Treatment Requirements</u>
<u>ORGANICS</u>			
Trichloroethene	ug/l	400	5
Carbon Tetrachloride	ug/l	35	5
1,1-Dichloroethene	ug/l	255	7
1,1,1-Trichloroethane	ug/l	470	200
Tetrachloroethene	ug/l	153	5
1,1-Dichloroethane	ug/l	6	5 (TBC) ^c
1,1,2-Trichloroethane	ug/l	<5 ^b	5
1,2-Dichloroethane	ug/l	<5 ^b	5
Methylene Chloride	ug/l	9	200
Toluene	ug/l	6	2000
<u>METALS</u>			
Aluminum	mg/l	0.223	5.0
Antimony	mg/l	0.030	0.06 (TBC)
Barium	mg/l	0.117	1.0
Chromium	mg/l	0.021	0.05 (hex.)
Copper	mg/l	0.059	0.20
Iron	mg/l	0.124	0.3
Manganese	mg/l	0.116	0.05
Mercury	mg/l	0.214	0.002
Molybdenum	mg/l	0.011	0.1
Nickel	mg/l	0.068	0.20
Selenium	mg/l	0.165	0.01
Uranium (dissolved)	pCi/l	16.3±3	40.0
Vanadium	mg/l	0.021	0.1
Zinc	mg/l	0.247	2.0

TABLE 4-1
(continued)

BASIS FOR DESIGN OF
881 HILLSIDE TREATMENT PLANT

	<u>Units</u>	<u>Influent ^a Concentration</u>	<u>Treatment Requirements</u>
<u>MAJOR IONS</u>			
Calcium	mg/l	111	---
Magnesium	mg/l	27	---
Potassium	mg/l	3	---
Sodium	mg/l	87	---
Chloride	mg/l	127	250
Nitrate & Nitrite (as N)	mg/l	9	10
Sulfate	mg/l	121	250
Bicarbonate	mg/l	306	---
Total Dissolved Solids	mg/l	715	400 or 1.25 background, whichever is least restrictive

^a Based on a flow weighted average of the 881 Building footing drain flow (5 gpm) and alluvial groundwater at the 881 Hillside that would be collected in the french drain (2 gpm). Averages computed from the 1987 and 1988 data base, except organics. Organic compound concentrations determined from first and second quarter 1989 data. Arsenic, beryllium, cadmium, cobalt, lead, silver, and thallium, and TCL volatiles not listed, were undetected.

^b Detectable concentrations in some wells; however, blend should have non-detectable concentrations.

^c TBC - To be considered; See Section 3.

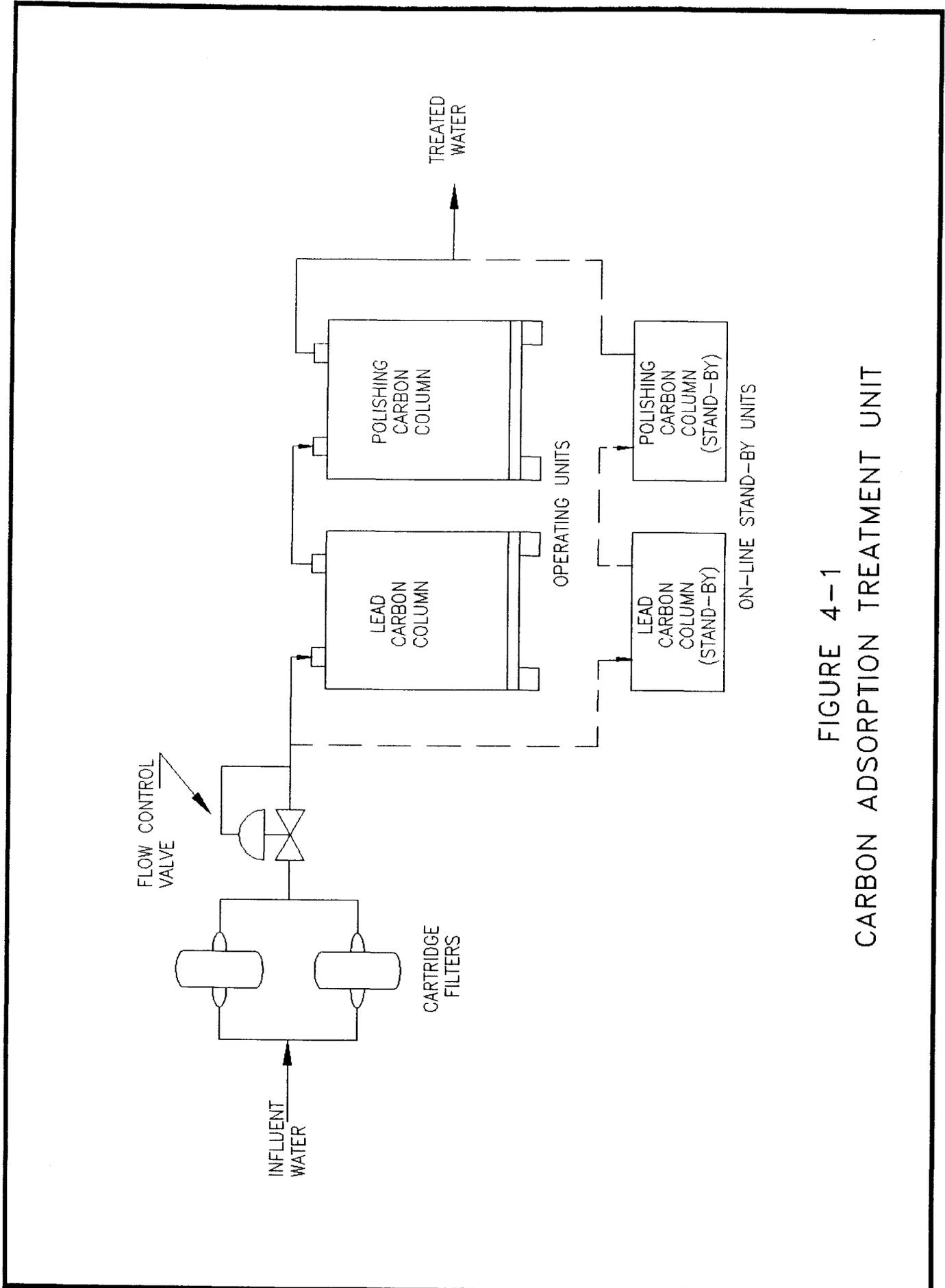


FIGURE 4-1
CARBON ADSORPTION TREATMENT UNIT

the polishing unit. The carbon column with the exhausted carbon will then be shipped to an off-site location for regeneration.

4.3.1.2 Effectiveness

GAC adsorption systems have been shown to remove VOCs from contaminated ground water to levels that comply with the chemical-specific ARARs. The EPA (*Federal Register*, Vol. 52, No. 130, page 25698) has designated carbon adsorption a "Best Available Technology" for the removal of seven specific volatile organic compounds (including TCE and 1,1,1-TCA) from drinking water. The GAC adsorption system that is proposed here for the treatment of the 881 Hillside ground water will be in continuous operation until the concentrations of VOCs in the ground water decrease to chemical-specific ARAR concentrations, at which time further treatment will be unnecessary. The probability of equipment failure will be minimized in this system because of the redundancy of having two (2) parallel on-line units, each of which could treat the design flow. Two stock units on site add to the system reliability.

Appropriate safety measures required when moving and installing large equipment will be complied with during installation. The operation and maintenance of the system will be by personnel who are trained in the handling of hazardous and radioactive wastes. Because carbon will remove oxygen from the air, any time personnel are working in confined areas where oxygen may be limited, special care must be taken to ensure that an adequate air supply is available.

The operators of the GAC system will not be exposed to VOC-laden carbon because the use of the containerized and transportable carbon contactors allows removal and replacement of the exhausted carbon at a remote carbon reactivation site.

Carbon will not be handled at the site. Transporting the entire exhausted carbon column to the regeneration facility ensures operators are protected from the carbon, and the operators need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative to land disposal since the carbon is continuously recycled. However, if the spent carbon was determined to be a mixed waste, then it would require land disposal at the Nevada Test Site.

GAC adsorption treatment in sealed, fixed-bed contractor vessels does not produce any waste streams or vapor emissions. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased. This treatment process will effectively remove organic contaminants from the ground water. Treated water will be monitored at the effluent and also at an intermediate point in the system to ensure contaminants are below the chemical-specific ARAR concentrations before being released to the environment during implementation of the process.

4.3.1.3 Implementability

GAC adsorption is a proven technology for removing volatile organics compounds (VOCs) from ground water. Testing performed by Calgon (Rockwell International, 1988b) demonstrated that activated carbon can remove VOCs to meet chemical-specific ARARs. A second carbon unit connected in series with the lead unit

would serve as a polishing unit and will ensure removal of the VOCs to these levels. The carbon columns can be shipped and readily installed in the treatment building. The system should be ready to operate at full capacity, after initial adjustments and test runs, within a day.

It is estimated that approximately 2 man-hours of operator time will be needed daily, primarily for start up, shutdown, and system monitoring. Periodic change-out of the carbon units and maintenance of the equipment will require approximately 16 hours per month, thus the total labor requirement will be 76 hours/month.

4.3.1.4 Costs

Results of the treatability study indicate the carbon usage rate will be 3.1 pounds per 1,000 gallons of ground water, based on breakthrough of methylene chloride (Rockwell International, 1988b). At a cost of approximately \$1.15 per pound for regenerated carbon, the annual costs are estimated to be \$18,600 for carbon (based on an average flow rate of 10 gpm). The cost of shipping contaminated carbon (as a manifested hazardous waste) for regeneration is estimated to be \$2,500 and \$500 for receiving regenerated carbon, for a total of \$3,000 per exchange. If the spent carbon requires disposal at the Nevada Test Site as a mixed waste, this cost could change substantially. Annual operation and maintenance costs are based on 76 hours per month at a labor rate of \$61/hour.

Using the preceding information, the estimated capital costs for installing a carbon adsorption system and the estimated annual operating costs are shown in Table 4-2. Total cost (Present Worth) of the GAC adsorption system based on 10 percent simple interest, a 30-year duration of operation, and no salvage value, is estimated to be about \$1,201,500.

TABLE 4-2

ESTIMATED COSTS FOR CARBON ADSORPTION SYSTEM

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	162,500	
Carbon Treatment System	79,000	
Operating Costs ²		
Carbon Purchases ³		18,600
Shipping ⁴		27,000
Power ⁵		600
Operation and Maintenance ⁶		55,600

TOTAL	\$241,500	\$101,800
=====		

¹ Volatile organic treatment system assigned 1/2 of building cost

² Based on a flowrate of 30 gpm, 8 hr/d

³ 9 loads/yr @ \$1.15/lb

⁴ 9 units/yr @ \$3,000 each

⁵ 4 HP, 8 hr/d @ \$0.07/kWh

⁶ 76 hr/month @ \$61/hr

PRESENT WORTH:

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$101,800/year x 9.427 = \$ 960,000

1989 Capital Cost = \$ 241,500

\$1,201,500

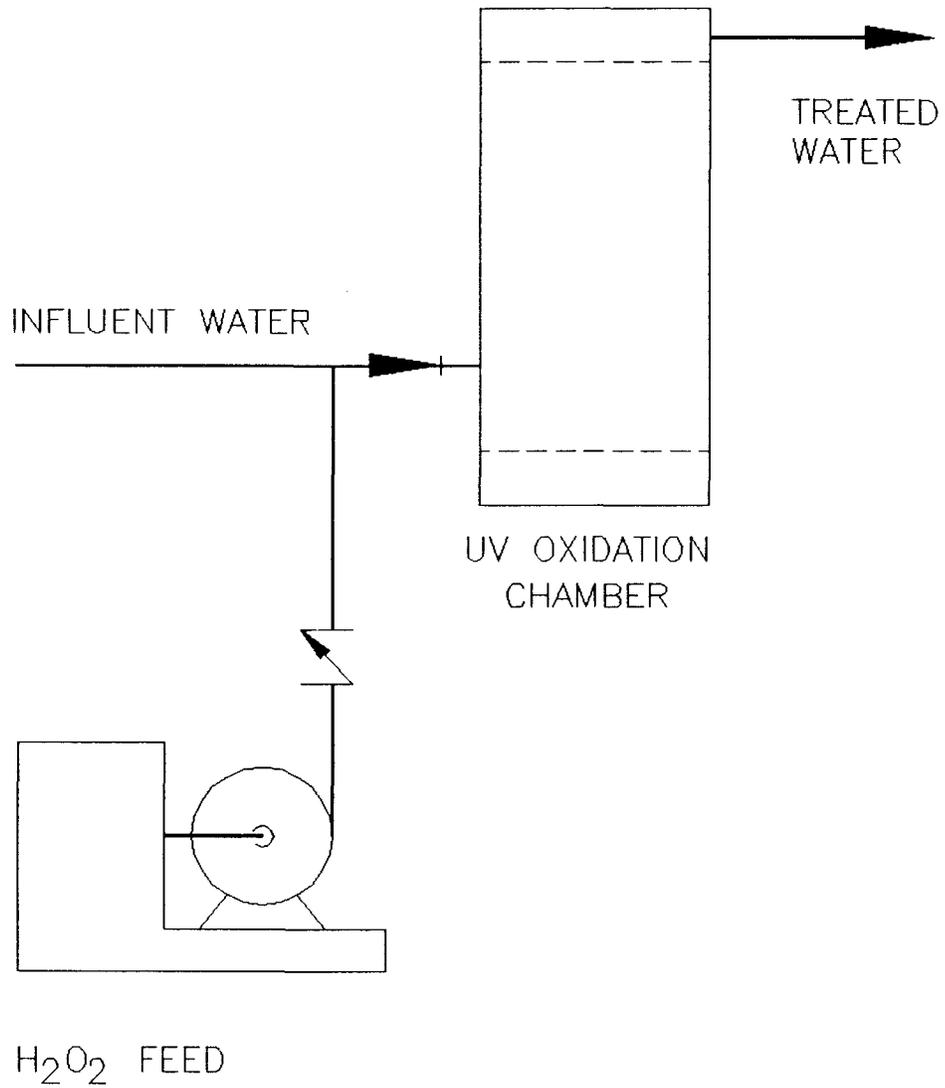
4.3.2 Ultraviolet (UV) Peroxide Oxidation (Organic Contaminant Removal)

4.3.2.1 Description

The UV/peroxide treatment unit as designed by one manufacturer, consists of an 80-gallon stainless-steel oxidation chamber, which provides for a maximum ground-water retention time of 2.66 minutes at a peak system flowrate of 30 gpm (Figure 4-2). The oxidation chamber contains 4 medium pressure UV lamps, which are mounted horizontally in quartz sheaths. A hydrogen peroxide feed system is used to inject approximately 50 mg/l (per ppm of organic contaminants) of a 50 percent H₂O₂ solution into the ground-water feed line. The ground-water/peroxide mixture then passes through an in-line static mixer before entering the bottom of the oxidation chamber. The ground water then flows through the reaction chamber, passing the UV lamps, before it exits the top of the oxidation chamber.

4.3.2.2 Effectiveness

The UV/peroxide system is capable of removing all of the volatile organics from the ground water to levels below the chemical-specific ARARs. Bench-scale studies, using 881 Hillside Area water, were conducted by Peroxidation Systems, Inc. (Rockwell International, 1988b). The bench-scale testing provided a dynamic flow simulation of actual operating conditions of a full-scale UV/peroxide ground-water treatment system. Parameters investigated during the testing included hydrogen peroxide (H₂O₂) dosage and power requirements, retention time, system pH, and influent/effluent chemical conditions. Contaminant concentrations were reduced to non-detectable levels for initial ground-water influent total VOC concentrations of 1 ppm. These results indicate that the UV/peroxide ground-water treatment process is capable of achieving the effluent criteria for all of the volatile organics listed in Table 4-1. The volatile organics will be completely oxidized to carbon dioxide and



NOT TO SCALE

FIGURE 4-2
UV/PEROXIDE SYSTEM

water, and no organic degradation products will be produced. The system will remain in operation until the ground water has been fully treated to these levels. The system requires periodic UV lamp replacement and routine maintenance, but is expected to have long-term reliability in terms of operation and performance. The risk of failure of the system at any time is highly unlikely. Since the volatile organics are destroyed in the UV/peroxide system, no wastes are produced which require ultimate disposal. Thus, this technology provides an alternative to land disposal.

During operation of the UV/peroxide ground-water treatment unit, the use of hydrogen peroxide, a strong oxidizer, will require that operators are aware of this potential hazard. The H₂O₂ bulk storage tank will be properly vented to assure no pressure buildup and minimize handling exposure. Existing DOE and Rockwell health and safety guidelines at Rocky Flats regarding operator safety while working with strong oxidizers will be followed. UV lamps operate utilizing high voltage, and thus caution must be used when working with the system and during the periodic replacement of the UV lamps.

The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased as this treatment process will effectively destroy ground-water contaminants. Treated water will be monitored to ensure contaminants are within regulatory guidelines before being released to the environment.

4.3.2.3 Implementability

UV/peroxide oxidation is an innovative technology for the complete destruction and detoxification of hazardous organic compounds in aqueous solutions. Although the technology is relatively new and has had limited application in the field,

SARA requires EPA to prefer remedial actions that significantly and permanently reduce the toxicity, mobility, or volume of hazardous wastes by employing innovative technologies that result in the destruction or detoxification of the wastes.

Demonstrated performance of the UV/peroxide ground-water treatment system has been somewhat limited due to the relatively new development of the process. However, Peroxidation Systems, Inc. has 6 UV/peroxide units currently operational or on-line and ready for operation. One of these units is located at Rocketdyne's Santa Susana facility in California. Pilot scale operations were performed by Peroxidation Systems, Inc., on ground water containing VOCs (TCA, TCE, etc.) at system flow rates of approximately 20-40 gpm. Results from the pilot scale testing were favorable, and a UV/peroxide ground-water treatment unit has been purchased, set-up, and site tested. Another UV/peroxide ground-water treatment system, located locally, was visited and appeared to be a low maintenance, highly effective ground-water treatment unit. This system was treating ground water with TCA concentrations significantly lower than those found at the 881 Hillside (approximately 7 ppb). However, the treatment process had initially and effectively treated ground water with much higher concentrations. Based upon actual bench scale results using 881 Hillside ground water and information received regarding currently operating treatment systems, the innovative UV/peroxide ground-water treatment system appears to be a reliable treatment technology.

Operating and maintenance requirements for the UV/peroxide treatment system are relatively minor. The system will require approximately 180 kW of power and 6,100 pounds/year of 50 percent H₂O₂ solution for normal operation. Routine maintenance of the equipment is required and the UV lamps will require replacement approximately every 3-6 months. Routine system maintenance is estimated to be

approximately 16 hours/month. An additional two hours per day will be required for system start up, shutdown, and monitoring. All four system UV lamps can be exchanged in about an hour. The system requires only occasional observation to ensure the system is operating properly, although system alarms will notify operators if a problem does occur.

4.3.2.4 Costs

Estimated costs for the UV/peroxide ground-water treatment unit are shown in Table 4-3. Capital cost for the UV/peroxide ground-water treatment system is approximately \$382,500. Operational costs include procurement of hydrogen peroxide (6,100 pounds/year), power utilization (180 kW), labor (76 hours/month), and lamp replacement (every 3-6 months at a cost of \$300/lamp). Operational costs are based on a system flow rate of 30 gpm, 8 hours per day. Assuming a 10% interest rate and a 30 year operating life, the present worth of the system is \$1,329,500.

4.3.3 Air Stripping with Off-Gas Treatment (Organic Contaminant Removal)

4.3.3.1 Description

During air stripping, VOCs are transferred from the water to a continuously flowing airstream which is in direct contact with the water (Figure 4-3). Influent contaminated ground water will enter the top of a 22-inch diameter, 34-foot air stripping column and subsequently contact clean air supplied through the bottom of the column (column sizes are approximate). Appropriate air-to-water flow rates will be utilized to provide for the optimum (99+%) transfer of the contaminants from the ground water to the air stream. The treated ground water will then be pumped through a 1,800-pound liquid phase carbon treatment polishing unit (identical to the

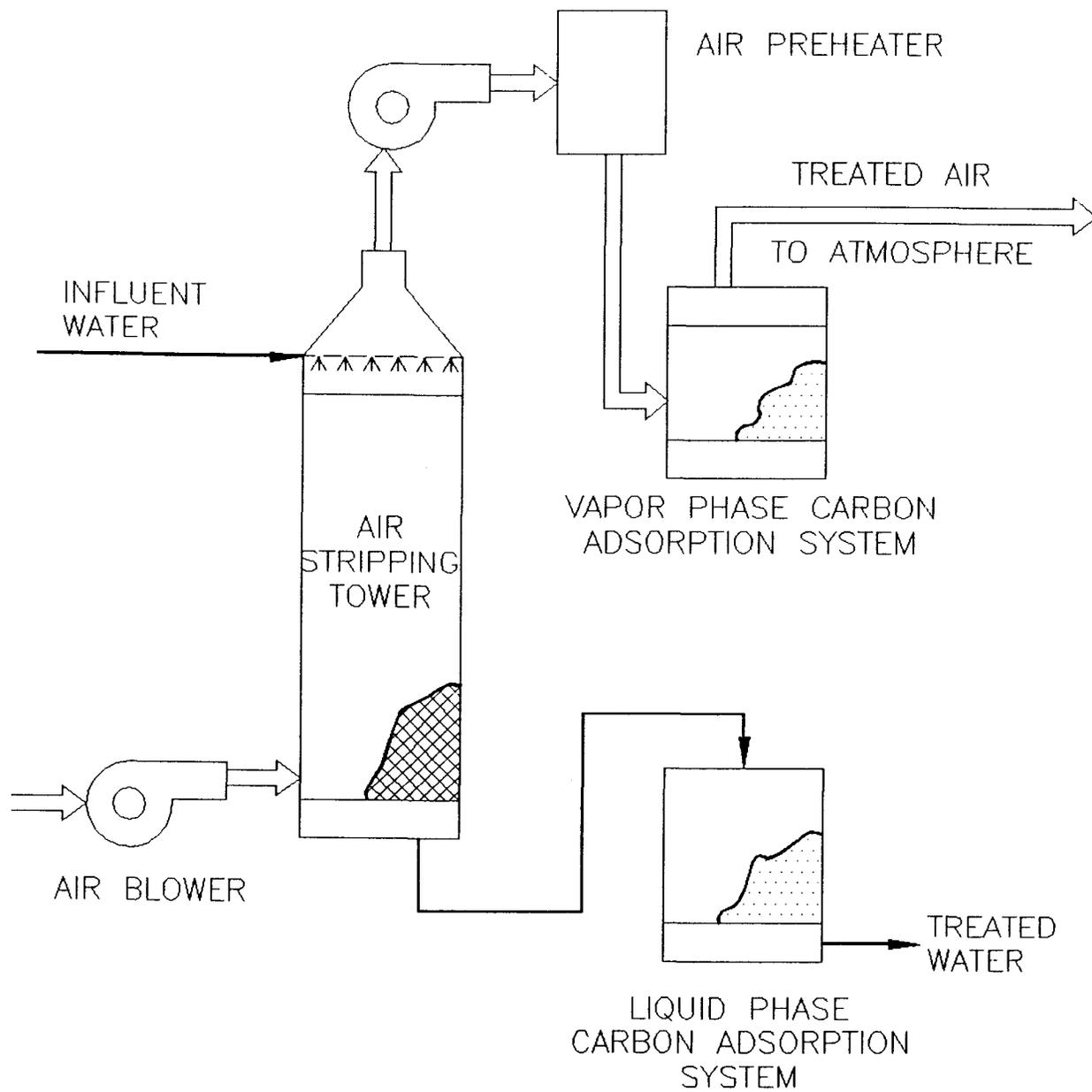


FIGURE 4-3
 AIR STRIPPING WITH VAPOR PHASE
 AND LIQUID PHASE CARBON ADSORPTION

TABLE 4-3

OVERALL COSTS FOR THE UV/PEROXIDE
GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	\$ 162,500	
Treatment Unit & Equipment	220,000	
Operating Costs ²		
- Hydrogen Peroxide ³		3,000
- Power ⁴		36,800
- Lamp Replacement ⁵		5,000
- Operation and Maintenance ⁶		55,600

TOTAL: UV/Peroxide	\$ 382,500	\$ 100,400
=====		

- ¹ Volatile organic treatment system assigned 1/2 of building cost
- ² Operating costs based upon a flowrate of 30 gpm, 8 hr/d
- ³ \$0.52/lb x 6100 lb/yr
- ⁴ 180 kW, 8 hr/d @ \$0.07/kWh
- ⁵ 4 times/year
- ⁶ 76 hrs/month @ \$61/hr

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$100,400/year x 9.427 =	\$ 947,000
1989 capital cost =	<u>\$ 382,500</u>
	<u>\$1,329,500</u>

one described in Section 4.3.1). The air stripper emissions will be dehumidified by use of a heater, and then passed through a vapor phase carbon system to remove the organics before being released to the environment. The vapor phase carbon unit will contain 2,000 pounds of carbon.

4.3.3.2 Effectiveness

The use of an air stripper is a highly effective method of removing hazardous volatile organic compounds (VOCs) from ground water. The efficiency of the process is well documented. The Environmental Protection Agency (Federal Register), Vol. 52, No. 130, page 25698) has designated packed tower aeration along with granular activated carbon, as a Best Available Technology (BAT) for the removal of VOCs from drinking water.

An air stripper coupled with liquid and vapor phase carbon adsorption is a proven system that has a dependable record of use. It is expected that this treatment process, with proper maintenance, will provide the desired level of contaminant control until complete remediation of the 881 Hillside Area has been achieved.

The probability of equipment failure will be minimized because the system is oversized for the intended maximum flow of 30 gpm and includes two vapor phase carbon units - one installed and one stock. The stock on site unit adds to the system reliability.

All appropriate safety measures required when moving and installing large equipment will be complied with during installation. The operation and maintenance of the system will be performed by personnel properly trained in the handling of hazardous and radioactive wastes. Because carbon will remove oxygen from the air,

whenever personnel are working in confined areas (i.e., tanks), special care must be taken to ensure that an adequate air supply is available.

The operators of the system will not be exposed to VOC-laden carbon from the vapor phase or liquid phase carbon units because the use of containerized and transportable carbon contractors allows removal and replacement of the exhausted carbon at a remote carbon reactivation site. Carbon will not be handled at the site. Transporting the entire exhausted carbon column itself to the regeneration facility ensures operators are protected from the carbon itself, and need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative to land disposal since the carbon is continuously recycled. However, if the spent liquid phase carbon was determined to be a mixed waste, then it would require land disposal at the Nevada Test site. The vapor phase carbon adsorption system will remove the organics from the air stripper emissions before being released to the environment. Therefore, the vapor phase carbon adsorption system will eliminate the impact of any air stripper emissions on the public health. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased. Treated water and air will be monitored to ensure contaminant levels are within regulatory guidelines before being released to the environment.

4.3.3.3 Implementability

The air stripper will remove greater than 99% of the contaminants in the ground water. Because the air stripper performance is sensitive to changes in flow and contaminant concentrations, a liquid phase carbon adsorption unit is in series with the air stripper to enhance system performance and to ensure that the treated effluent meets chemical-specific ARARs for volatile organic compounds. Based on a flow rate of 30 gpm, 8 hours per day, liquid phase carbon usage will be approximately 9 pounds/day and each 1,800-pound carbon unit will require replacement approximately every six months. Vapor phase carbon usage will be approximately 10 pounds/day and each 2,000-pound carbon unit will require replacement approximately every six months.

Operation of the treatment process is relatively simple, requiring occasional cleaning of the air stripping column and replacement of carbon. The air stripper will require cleaning to remove scale buildup on the packing material in order to maintain optimum removal efficiency. Effluent from the cleaning operation will require treatment in the Building 374 Process Waste Treatment System. Transportation and regeneration of the liquid phase and vapor phase carbon units at a remote carbon reactivation site will be required. The air stripping with off-gas treatment system for remediating VOC contaminated ground water is available commercially and could be implemented quickly. No difficulties are anticipated during the installation and start-up of this treatment system. Replacement of the spent carbon and other maintenance activities are expected to require approximately 16 hours per month. Daily operation of the system will require two hours per day.

4.3.3.4 Costs

Estimated costs for the air stripping ground-water treatment system are shown in Table 4-4. The total capital cost for the system is \$257,500. The liquid phase carbon unit is the same unit described in Section 4.3.1. The majority of the operating costs result from the replacement of spent vapor phase and liquid phase carbon. These costs were derived from the same treatability study results and unit pricing presented in Section 4.3.1.4. It should be noted that these operating costs are based on regeneration of the spent carbon as a hazardous waste. If the spent carbon requires disposal at the Nevada Test Site as a mixed waste, these costs could change substantially.

The total present worth cost of the system based on 10% simple interest, a 30 year period of operation, and no salvage is estimated to be approximately \$960,000. These costs do not include any capital or operating costs for the Building 374 Process Waste Treatment System associated with the treatment of the air stripper cleaning effluent.

4.3.4 Ion Exchange Treatment (Inorganic Contaminant Removal)

4.3.4.1 Description

The ion exchange treatment system consists of multiple units staged to remove the inorganic contaminants from the ground-water (Figure 4-4). In the first stage, uranium is removed in a strong base anion unit. Next, heavy metals including strontium and manganese are removed with a weak acid cation unit. This unit also

TABLE 4-4

OVERALL COSTS FOR THE AIR STRIPPER
GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	\$162,500	
Treatment Unit & Equipment		
- Air Stripper Column	25,000	
- Liquid Phase Carbon System	45,000	
- Vapor Phase Carbon System	25,000	
Operating Costs ²		
- Liquid phase carbon ³		\$ 4,200
- Vapor phase carbon ⁴		4,000
- Shipping ⁵		12,000
- Power ⁶		800
- Operation and Maintenance ⁷ (76 hr/mo)		55,600

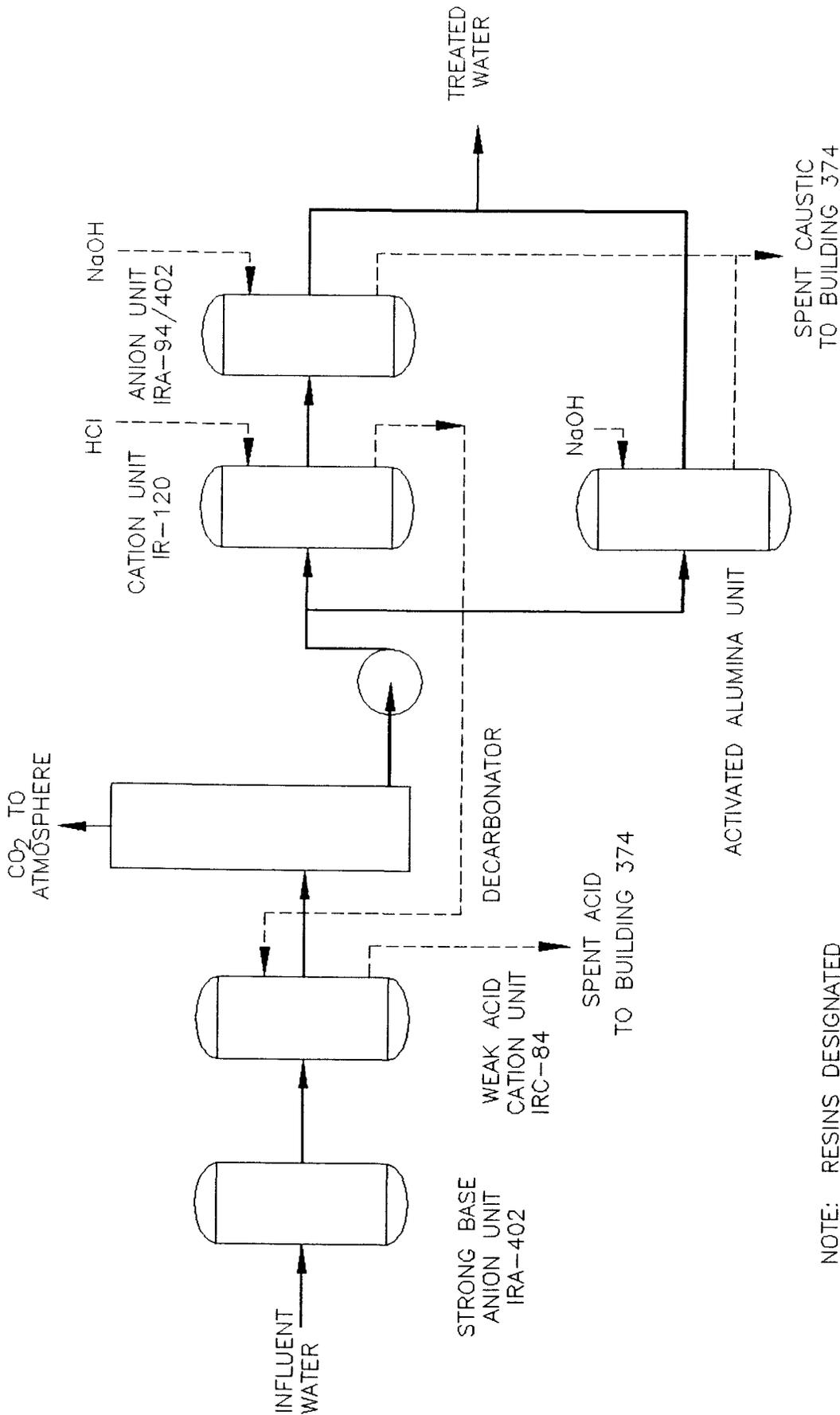
TOTAL	\$ 257,500	\$ 74,500
=====		

- ¹ Volatile organic treatment system assigned 1/2 of building cost
² Operating costs are based upon flowrate of 30 gpm, 8 hr/d.
³ 2 loads/year @ \$1.15/lb
⁴ 2 loads/year @ \$1.00/lb
⁵ 4 units/year @ \$3,000 each
⁶ 5HP, 8 hr/d @ \$0.07/kWh
⁷ 76 hr/month @ \$61/hr

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$74,500/year x 9.427 =	\$703,000
1989 capital cost =	<u>\$257,000</u>
	<u>\$960,500</u>



NOTE: RESINS DESIGNATED BY ROHM & HAAS

FIGURE 4-4
ION EXCHANGE

removes the total dissolved solids (TDS) associated with carbonate hardness with subsequent production of carbonic acid. The carbonic acid formed is removed by decarbonation (air stripping). Following decarbonation, the flow is split between a two-bed demineralizer for TDS removal and an activated alumina unit for selenium removal. The two-bed demineralizer consists of a strong acid cation exchanger and an anion exchanger arranged in series to further reduce TDS. The treated waters from the demineralizer and activated alumina units will be blended, resulting in a final effluent which will meet all chemical-specific ARARs. A split flow is cost effective as it is unnecessary to completely demineralize the entire flow.

The ion exchange and activated alumina resins both require periodic regeneration using HCl or NaOH. Rocky Flats' potable water supply will provide the water for regeneration of all the units. The regeneration wastes would be sent to the Building 374 Process Waste Treatment System for final treatment and disposal.

4.3.4.2 Effectiveness

Ion exchange treatment technology has been proven to remove inorganic contaminants from groundwater to levels that comply with the chemical-specific ARARs. Resins used to adsorb contaminants require regeneration to maintain treatment levels.

All appropriate safety measures required when moving and installing large equipment will be complied with during installation. Use of acids and caustics will require that operators are aware of this potential hazard. The operation of the system will be by personnel that are properly supervised and trained. Treated water will be monitored to ensure that the removal of inorganic contaminants is maintained prior to discharge to the environment.

Over 99% of the uranium passing through the system will be removed in the strong base anion exchange unit containing Rohm and Haas IRA-402 in the chloride form. This unit will selectively remove uranium, while allowing the other metals and major ions to pass through. This is very advantageous because only this unit will be accumulating the radioactivity. This unit will not be regenerated because uranium is not readily desorbed from the resin. Instead, the unit will be shipped off-site and disposed as a low level radioactive waste when its activity reaches a predetermined level. Based on an influent uranium concentration of 16 pCi/l and a resin volume of 28 ft³, this unit could be run for more than 30 years without exhausting the resin.

The second exchange unit is a weakly acidic cation exchanger operated in the hydrogen form. The use of a weakly acidic resin has several advantages for this application, including high regeneration efficiency, high operating capacity for carbonate hardness, and a strong affinity for heavy metals. Rohm & Haas IRC-84 is the resin selected for its ability to remove all heavy metals of interest. In addition, the hardness associated with bicarbonate alkalinity is transformed by the exchange of hydrogen ions into carbonic acid which is removed in a decarbonator where carbon dioxide is vented to the atmosphere.

Reduction of dissolved solids is effected by a two-bed demineralizer designed to work in conjunction with the weak acid cation exchanger and decarbonator. Rohm & Haas IR-120 is the resin of choice for the strong acid cation resin exchange. The anion portion of the two-bed demineralizer will be composed of both strong base and weak base anion resins in a "stratified bed" configuration. While a weak base resin alone would normally suffice here, the acidity of the weak base resin would require subsequent caustic addition for pH control. The inclusion of about 30% of a strong base resin in the anion exchange unit results in a neutral pH with only a small penalty

in caustic consumption. The resins of choice here are Rohm & Haas Stratabed quality IRA-94 and IRA-402, respectively. The weak acid cation unit preceding the decarbonator will be regenerated with the regenerate from the strong acid unit to effectively utilize the acid regenerate. The two-bed demineralizer is capable of removing TDS to as low as 10 to 20 ppm.

To lower capital costs by reducing the equipment sizes, only one-third of the flow need be demineralized to obtain the ARAR for TDS. The other two-thirds of the flow would be fed through the activated alumina unit for selenium removal. Actual design conditions have been selected for a 50/50 flow split to be conservative. This design reduces the volume of regenerate chemicals needed as well as waste water produced, compared with sending all of the flow through the demineralizer. Activated alumina regenerated with caustic soda and operating on the slightly acidic effluent from the decarbonator provides the conditions to optimize the selective adsorption of selenium. With a 50/50 flow split, the ARARs for both TDS and selenium would be easily achieved in the final effluent. This system will include a conductivity controller on the final plant effluent to automatically maintain the desired TDS level.

The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased as this treatment process will effectively remove inorganic contaminants from the ground water.

4.3.4.3 Implementability

Ion exchange technology utilizes specific resins to remove by adsorption the ground-water contaminants including heavy metals and total dissolved solids. Resins are selected based on contaminants to be removed. Ion exchange units are commercially available off-the-shelf systems that can be purchased and installed

readily. The operation of ion exchangers require the resins to be periodically regenerated before treatment can resume. The regenerated waste products will require additional treatment in the Building 374 Process Waste Treatment System.

The proposed system is designed for ease of operation and minimizes the volume of regeneration wastes requiring treatment in the Building 374 Process Waste Treatment System. Based on a flow rate of 30 gpm, 8 hours per day, and the influent characteristics indicated in Table 4-1, regeneration of the exchange resins will be needed once every three days. A total of approximately 6,000 gallons of waste water will be produced each regeneration period. This is equivalent to 14,000 gallons per week. It is estimated that the system will require 40 man-hours per month for operating, maintenance, and monitoring. The majority of this time is required during the regeneration periods.

4.3.4.4 Costs

Estimated capital and operational costs for the ion exchange treatment unit are shown in Table 4-5. The capital cost for the ion exchange system is \$287,500. The operational costs include labor, power consumption, annual replacement of the strong base anion unit, and the procurement of hydrochloric acid and sodium hydroxide used for regeneration of the ionic resins.

Assuming a 10% interest rate, a 30-year operating life, and no salvage value, the present worth of the system is \$699,500. These costs do not include any capital or operating costs associated with the treatment and final disposal of the ion exchange and activated alumina regeneration wastes. These waste streams will be treated in the

TABLE 4-5

OVERALL COSTS FOR THE ION EXCHANGE
GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	\$162,500	
Treatment Unit & Equipment	125,000	
Operating Costs ²		
- Acid ³		2,300
- Caustic ⁴		1,600
- Power ⁵		1,800
- Strong Base Anion Unit Replacement ⁶		9,000
- Operation and Maintenance ⁷		29,000

TOTAL	\$287,500	\$ 43,700
=====		

¹ Inorganic treatment system assigned 1/2 of building cost

² Based on a flowrate of 30 gpm, 8 hr/d with a recycle stream 24 hr/d

³ 3.08 lb/1000 gal @ \$0.14/lb for 100% HCl

⁴ 2.45 lb/1000 gal @ \$0.125/lb for 100% NaOH

⁵ 4 HP, 24 hr/d @ \$0.07/kWh

⁶ 1/year

⁷ 40 hrs/month @ \$61/hour

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$43,700/year x 9.427 = \$412,000

1989 capital cost = \$287,500

\$699,500

Building 374 Process Waste Treatment System. The other two inorganic treatment systems being considered for use (electrodialysis and reverse osmosis) also will be utilizing Building 374 for treatment of waste products.

4.3.5 Electrodialysis (Inorganic Contaminant Removal)

4.3.5.1 Description

In the electrodialysis process, the application of an electrical potential between a cathode and anode causes the separation of ionic components of a solution. This is accomplished by alternately placing anionic and cationic semipermeable membranes across the current pathway. When a current is applied, the cations migrate toward the negative electrode and the anions migrate toward the positive electrode. Because of the alternate spacing of cation- and anion-permeable membranes, cells of concentrated and dilute salts are formed. The electrodialysis process is shown in Figure 4-5. Because electrodialysis will not meet ARAR-based performance standards for selenium, ion exchange will also be required for effective treatment. Furthermore, to avoid uranium loading on the selenium-specific exchange unit (which would ultimately render it non-regenerable), a uranium-specific exchange unit is necessary. Thus, the first unit used is a strong base anion exchanger designed selectively for uranium removal. The ground water is then passed through an activated alumina unit prior to electrodialysis to achieve selenium removal. This is necessary since vendors have indicated that electrodialysis may not be capable of removing selenium to the ARAR of 0.01 mg/l. The activated alumina would be sized to require regeneration once every three days. Rocky Flats' potable water supply will be used to provide the water for regeneration.

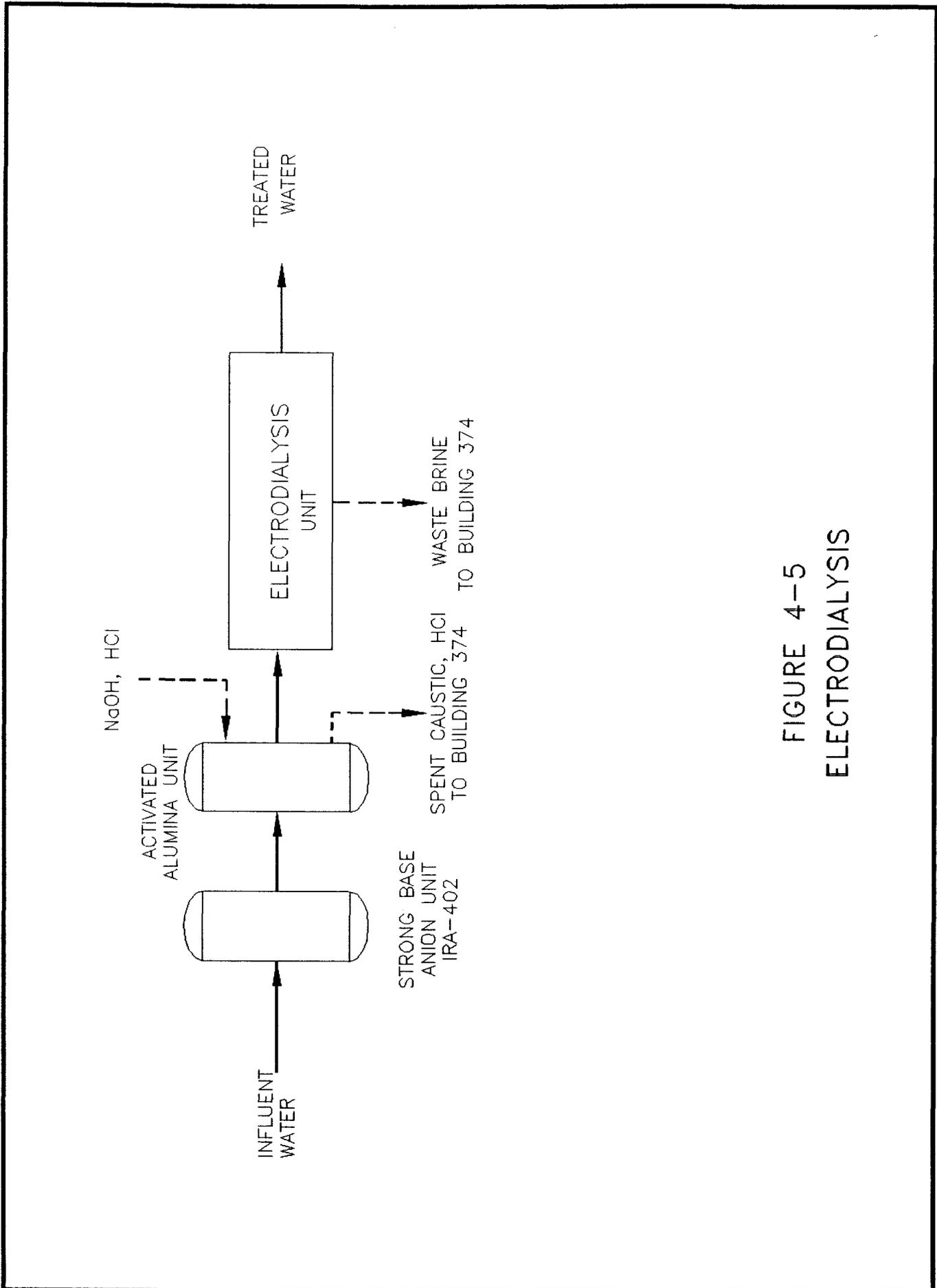


FIGURE 4-5
ELECTRODIALYSIS

Following the activated alumina unit, ground water to be treated is pumped through the electro dialysis membranes which are separated by spacers and assembled into stacks. As the water passes through, the salinity becomes more concentrated in one space, and less concentrated in the adjacent space. The water is passed through several stacks until the desired salinity concentrations are achieved. The water is usually retained for about 10 to 20 seconds in a single stack or stage. This process may be operated in either a continuous or batch mode. Multiple units can be arranged either in parallel to provide the necessary hydraulic capacity or in series to effect the desired degree of demineralization. Makeup water is used to continuously clean the semipermeable membranes during operation.

4.3.5.2 Effectiveness

Electrodialysis is capable of removing all of the inorganics to below the chemical-specific ARARs except for selenium. To accomplish the selenium removal, the activated alumina unit is used. Total dissolved solids (TDS) reduction can be controlled by adjusting the current level in the electro dialysis unit. The system would be operated until the inorganic chemical-specific ARARs in the ground water are all met, at which time further treatment will be unnecessary. A strong base anion unit is used to remove the uranium. This unit will not be regenerated, but will be periodically disposed as a low-level radioactive waste and replaced. In this way, no radioactive regenerate wastes will be produced, and only one unit need be handled and disposed as a radioactive waste.

Appropriate safety measures required when moving and installing large equipment will be complied with during construction. The operation and maintenance of the system will be by personnel who are trained in the handling of hazardous chemicals as well as hazardous and radioactive wastes. The operators will not be

exposed to any chemical hazards during routine system operation. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased.

The only other waste generated from the process requiring ultimate landfill disposal will be the salts produced in the Building 374 Process Waste Treatment System. Thus, this alternative minimizes the amount of waste requiring land disposal.

4.3.5.3 Implementability

While no treatability studies have been performed, process modeling indicates that the activated alumina, strong base cation, and electro dialysis units would meet all of the performance goals. A discussion of the performance efficiency and implementability of the activated alumina and strong base anion units is given in Section 4.3.4.3. Electro dialysis is not a widely used technology for this type of application, and the number of case studies available for comparison is limited.

One problem associated with the use of the electro dialysis process involves the use of the semipermeable membranes. These membranes are non-chemical-specific and cannot be designed to selectively remove the metals of concern from the ground water. As with other membrane processes, scaling and clogging of the membranes with salts of low solubility is a potential problem. Precise process control and system monitoring are required to ensure proper membrane operation. The concentrate from the electro dialysis unit and the activated alumina regeneration waste will both be treated in the Building 374 Process Waste Treatment System.

Approximately 10% of the influent flow to the electro dialysis unit will be rejected as concentrate. This concentrate, along with the activated alumina regeneration waste, will total approximately 15,000 gallons per week. Since the

concentrate will be sent to Building 374, only 90% of the influent flow will be returned as treated effluent to the South Interceptor Trench (see Section 4.5). The consumptive use of ground-water potentially tributary to the South Platte River normally requires an approved augmentation plan from the Colorado State Engineer; however, an augmentation plan will not be required for the IRA because it is a CERCLA action. Nevertheless the 10% return flow deficit will be replaced by the addition of water from the Rocky Flats Plant potable water supply prior to discharge.

It is estimated that 30 man-hours per month will be required for operation, maintenance, and system monitoring. Most of this time will be required during the activated alumina regeneration periods, and for monitoring of proper membrane function.

4.3.5.4 Costs

Estimated costs for the electro dialysis treatment unit are shown in Table 4-6. Capital costs for the electro dialysis system are approximately \$307,500. Operational costs include the procurement of acid and caustic for activated alumina regeneration, replacement of resins and membranes, labor, and power consumption. The present worth for the system based on a 10% simple interest rate, a 30-year duration of operation, and no salvage value, is estimated to be \$844,500.

These costs do not include any capital or operating costs associated with the treatment and final disposal of the activated alumina regeneration waste and electro dialysis waste brine. These waste streams will be treated in the Building 374 Process Waste Treatment System. The other two inorganic treatment systems being considered for use (ion exchange and reverse osmosis) also will be utilizing Building

TABLE 4-6

OVERALL COSTS FOR THE ELECTRODIALYSIS
GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	\$162,500	
Treatment Unit & Equipment	145,000	
Operating Costs ²		
- Acid ³		500
- Caustic ⁴		500
- Power ⁵		1,800
- Membranes ⁶		1,100
- Strong Base Anion Unit Replacement ⁷		9,000
- Operation and Maintenance ⁸		44,000

TOTAL	\$307,500	\$ 56,900
=====		

¹ Inorganic treatment system assigned 1/2 of building cost

² Based on a flowrate of 30 gpm, 8 hr/d

³ 0.67 lb/1000 gal @ \$0.14/lb or 100% HCl

⁴ 0.76 lb/1000 gal @ \$0.125/lb for 100% NaOH

⁵ 4.8 kWh/1000 gal @ \$0.07/kWh

⁶ \$0.02/1000 gal

⁷ 1/yr

⁸ 60 hrs/month @ \$61/hour

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$56,900/year x 9.427 = \$537,000

1989 capital cost = \$307,500

\$844,500

374 for treatment of waste products. The disposal costs of the strong base anion unit as a low-level radioactive waste have not been included.

4.3.6 Reverse Osmosis (Inorganic Contaminant Removal)

4.3.6.1 Description

The reverse osmosis (RO) treatment system shown in Figure 4-6 is similar in concept to the ion exchange alternative described in 4.3.4. Ground water is first treated with a strong anion exchange to remove uranium. The water is next passed through a weak acid cation exchange unit for the removal of heavy metals, including strontium and manganese. This unit also removes the TDS associated with carbonate hardness with subsequent production of carbonic acid. The carbonic acid formed is removed by decarbonation. Following decarbonation, the flow is split between a reverse osmosis treatment unit (for TDS removal) and an activated alumina unit for selective selenium removal.

The reverse osmosis unit separates dissolved salts from water by filtering water through a semi-permeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salts. The operating pressure required can approach 10,000 kN/m² (1,000 lb/in²). The treated water that passes through the membrane is called the permeate while the reject solution is called the concentrate. As the permeate is typically 10 to 15% of the influent, several membranes must be staged in series for treatment of the concentrate to maximize permeate output and minimize concentrate rejected. Concentrate rejected from the RO unit and wastes from regeneration of the resins will be treated in the Building 374 Process Waste Treatment System. Rocky Flats' potable water supply will be used to provide the regeneration water for the weak acid cation unit and the activated alumina unit.

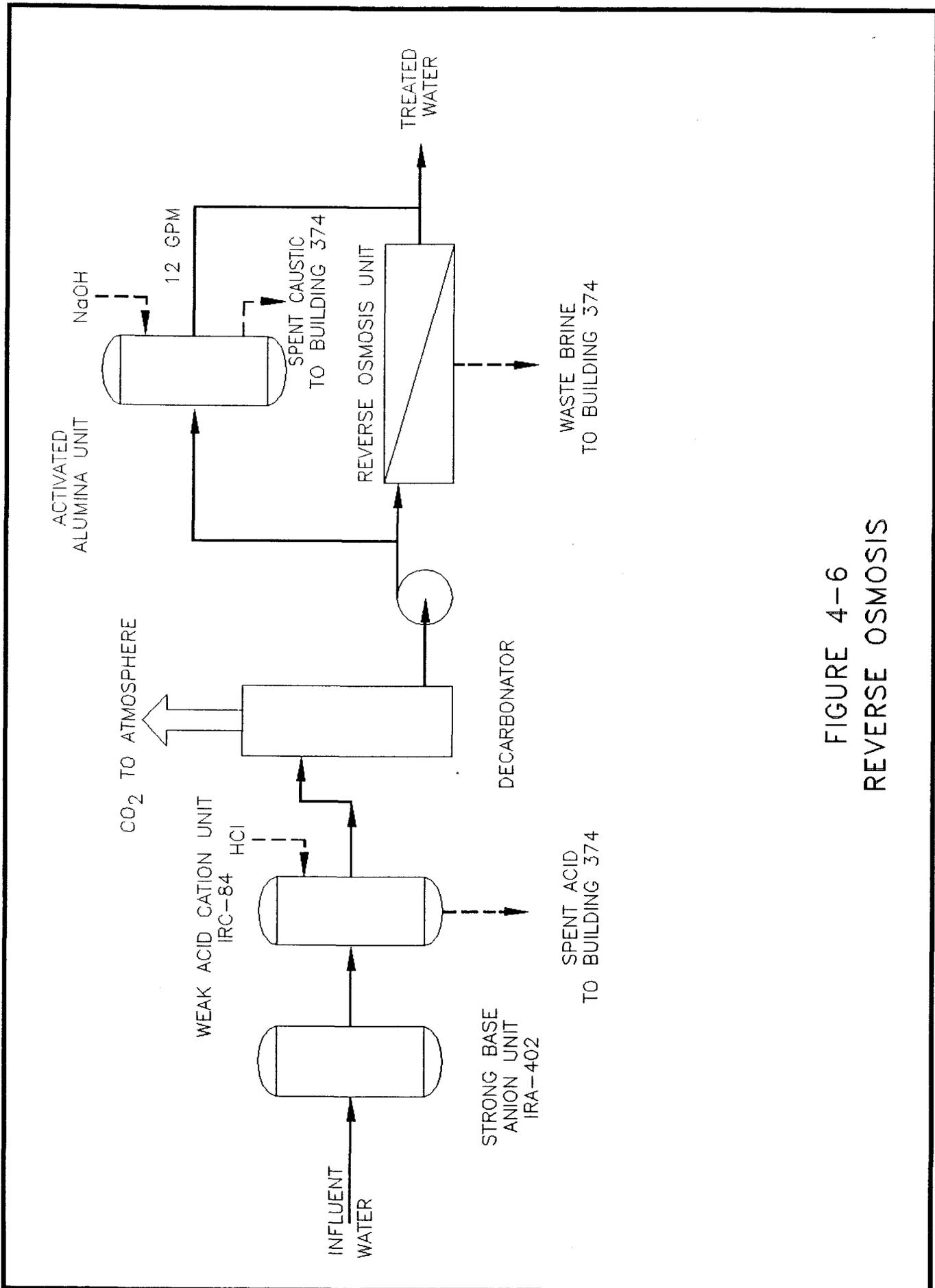


FIGURE 4-6
REVERSE OSMOSIS

4.3.6.2 Effectiveness

Reverse osmosis treatment technology has been proven to remove inorganic contaminants from ground water to levels that comply with the chemical-specific ARARs. This technology does have several problems associated with fouling of the filter membrane which can be mitigated by pretreatment to extend the membrane life.

Pretreatment with a strong acid anion exchange unit is used for selective uranium removal. This confines the buildup of radioactivity to this unit, which is advantageous from a health and safety and operational viewpoint. The performance of this unit is described more fully in Section 4.3.4.3. The ground water is then passed through a weak acid cation exchange unit followed by decarbonation for the removal of iron and manganese. This yields an acidic feed which reduces the potential for scaling within the reverse osmosis unit. Based on the influent design criteria indicated in Table 4-1, one vendor of reverse osmosis has indicated that 12 membranes in series are required to achieve a permeate flow of 75% of the total flow including recycle.

To lower the capital cost by reducing the reverse osmosis equipment sizes, only one-third of the total flow need be sent through the reverse osmosis unit to obtain the ARAR for TDS and metals other than selenium. The other two-thirds of the flow would be fed through the activated alumina unit for selenium removal. With such a split flow, all of the inorganic chemical-specific ARARs would be achieved in the final effluent.

Approximately 25% of the influent flow to the reverse osmosis unit will be rejected as concentrate. This concentrate, as well as the regeneration wastes from the ion exchange units, will total approximately 21,000 gallons per week. Since these wastes would be sent to Building 374, only 75% of the influent flow would be returned

as treated effluent to the South Interceptor Trench (see Section 4.5). The consumptive use of ground-water potentially tributary to the South Platte River normally requires an approved augmentation plan from the Colorado State Engineer; however, an augmentation plan will not be required for the IRA because it is a CERCLA action. Nevertheless the 25% return flow deficit will be replaced by the addition of water from the Rocky Flats Plant potable water supply prior to discharge.

The weak acid cation resin and activated alumina will have to be regenerated using acid and caustic soda to maintain the treatment efficiency. The use of acids and caustics will require that operators are aware of this potential hazard. The operation of the system will be by personnel that are properly supervised and trained in the system operation and potential hazards.

Treated water will be monitored to ensure that the removal of inorganic contaminants is maintained prior to discharge to the environment.

Nearby communities and the environment should realize no safety concerns as this treatment process will effectively remove inorganic contaminants from the ground water. No short term safety concerns for nearby communities and the environment are anticipated during implementation of this process.

4.3.6.3 Implementability

As with ion exchange, reverse osmosis units are commercially available and routinely used to desalinate water supplies. The unit can be readily purchased and installed.

It is estimated that 60 man-hours per month will be required for operation, maintenance, and system monitoring. The majority of this time will be required for the regeneration periods, and for monitoring the reverse osmosis membrane operation.

4.3.6.4 Costs

Estimated capital and operational costs for the reverse osmosis treatment alternative are shown in Table 4-7. The capital cost for the reverse osmosis system is \$302,500. The operational costs include the costs of power, labor, membrane and resin replacement, and the procurement of hydrochloric acid and sodium hydroxide for regeneration of the cation resin and activated alumina.

Assuming a 10% interest rate, a 30-year operating life, and no salvage value, the present worth of the system is \$853,500. These costs do not include any capital or operating costs associated with the treatment and final disposal of the reverse osmosis concentrate and regeneration wastes. These waste streams will be treated in the Building 374 Process Waste Treatment System. The other two inorganic treatment systems being considered for use (ion exchange and electrodialysis) also will be utilizing Building 374 for treatment of waste products. The disposal costs of the strong base anion unit as a low-level radioactive waste have not been included.

4.4 COMPARATIVE ANALYSIS OF THE GROUND WATER TREATMENT TECHNOLOGIES

4.4.1 Organic Contaminant Treatment Technologies

Based on performance, reliability, implementability, safety, and environmental and institutional impacts, there is not a substantial difference between the three processes. The present worth of each of the three alternatives has been estimated

TABLE 4-7

OVERALL COSTS FOR THE REVERSE OSMOSIS
GROUND-WATER TREATMENT UNIT

ITEM	CAPITAL COST (Dollars)	ANNUAL COST (Dollars)
Building ¹	\$162,500	
Treatment Unit & Equipment	140,000	
Operating Costs ²		
- Acid ³		1,300
- Caustic ⁴		300
- Power ⁵		1,600
- Membranes ⁶		2,200
- Strong Base Anion Unit Replacement ⁷		9,000
- Operation and Maintenance ⁸		44,000

TOTAL	\$302,500	\$ 58,400
=====		

¹ Inorganic treatment system assigned 1/2 of building cost

² Based on a flowrate of 30 gpm, 8 hr/d

³ 1.74 lb/1000 gal @ \$0.14/lb for 100% HCl

⁴ 0.39 lb/1000 gal @ \$0.125/lb for 100% NaOH

⁵ 10 HP, 8 hr/d @ \$0.07/kWh

⁶ \$6/day.

⁷ 1/yr

⁸ 60 hrs/month @ \$61/hr.

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (for annual operating costs)

\$58,400/year x 9.427 =	\$551,000
1989 capital cost =	<u>\$302,500</u>
	<u>\$853,500</u>

assuming a simple interest rate of 10% over a 30-year period of operation with no salvage value. For activated carbon adsorption, the present worth is \$1,201,500; for UV/peroxide oxidation, \$1,329,500; and for air stripping with both liquid and vapor phase activated carbon, \$960,500. The UV/peroxide oxidation system is more expensive than the other two treatment systems.

Since all three processes will effectively decontaminate the ground-water, the ultimate destruction of ground-water contaminants has become a factor in the choice of treatment. The air stripping and activated carbon adsorption systems both use activated carbon, and with regeneration, the contaminants that have adsorbed onto the carbon would eventually be destroyed. However, this assumes that the carbon is not radioactively contaminated, thereby requiring shipment to the Nevada Test Site for disposal. Uranium, either naturally occurring or resulting from past waste disposal, will likely adsorb to the activated carbon but would pass through the UV/peroxide system. Although use of an ion exchange unit before activated carbon treatment would obviate this issue, adsorption of organics on the exchange resin would reduce resin performance and render this treatment scheme inefficient. SARA favors innovative treatment technologies that destroy contaminants, and UV/peroxide meets this objective. Therefore, the advantage provided by a UV/peroxide system of directly destroying the volatile organic ground-water contaminants is the deciding factor in selecting UV/peroxide as the preferred process for ground-water treatment.

4.4.2 Inorganic Contaminant Treatment Alternatives

Based on effectiveness and cost, there is not a substantial difference between the three inorganic treatment processes. All three are capable of meeting the chemical-specific ARARs, and they compare favorably in terms of operational safety and environmental considerations. The present worth of each alternative has been

estimated assuming a simple interest rate of 10% over a 30-year period of operation with no salvage value. For ion exchange, the present worth is \$862,000; for electro dialysis, \$1,007,000; and for reverse osmosis, \$1,016,000. The capital costs of the three alternatives are within roughly 10% of each other and are all considered competitive.

The electro dialysis and reverse osmosis processes are both membrane processes which require a high degree of process control for effective operation. The membranes are very sensitive to fouling, and proper pretreatment is needed to ensure steady performance over time. The ion exchange process utilizes resin beds in place of membranes and is considered more reliable for long term operation.

All these processes produce wastes which would be treated in the Building 374 Process Waste Treatment System. Electro dialysis and ion exchange produce nearly equal volumes of waste (14,000-15,000 gallons per week). The reverse osmosis system produces roughly 50% more, or 24,000 gallons per week.

In both the electro dialysis and reverse osmosis alternatives, a portion of the water being treated is discharged to Building 374 as process waste. This requires that a supplemental water source is needed to augment the treated effluent prior to discharge in order to ensure complete recharge. Since this interim remedial action is being executed under CERCLA, it would not be necessary to obtain a ground-water augmentation permit. However, Rockwell would be required to maintain records documenting the augmentation and would have to sample the supplemental water source periodically to ensure compliance with the ARARs. These tasks represent an institutional requirement and cost (not included here) which ion exchange would not be subject to. For this reason and reasons discussed above, ion exchange has been

selected as the preferred alternative for the removal of the inorganic contaminants from the ground water.

4.4.3 Preferred Ground Water Treatment System

As summarized above, the UV/peroxide treatment system has been selected for the removal of organic contaminants, and ion exchange for the removal of inorganic contaminants. In order to maximize the overall system performance, the ground water will be treated as shown in the flow diagram in Figure 4-7.

As shown in this figure, the ground water will be pumped into two surge tanks. The surge tanks insure that the treatment system will receive a constant flow of 30 GPM, 8 hours per day. These tanks also provide approximately two days of collection potential when the treatment system is not operating.

From the surge tanks, the water is pumped through filters to remove suspended solids. The water next is sent to the UV/peroxide unit where the volatile organic contaminants are destroyed. While iron may be oxidized by the peroxide, the concentrations of ferric iron formed will not adversely affect performance of the unit. Should the ferric iron precipitate from solution within the resin bed of the weak acid cation unit, it will be removed during the regeneration cycle with HCl.

Finally, the water is passed through the ion exchange units for the removal of uranium and inorganic contaminants. With the exception of the uranium removal unit which is not regenerated, the regenerate wastes from the other ion exchange resins are sent to Building 374 for final treatment. Treated water is pumped to the effluent storage tanks for analysis prior to discharge. Should the effluent quality be unacceptable for discharge, the water will be returned to the influent storage tanks for further treatment.

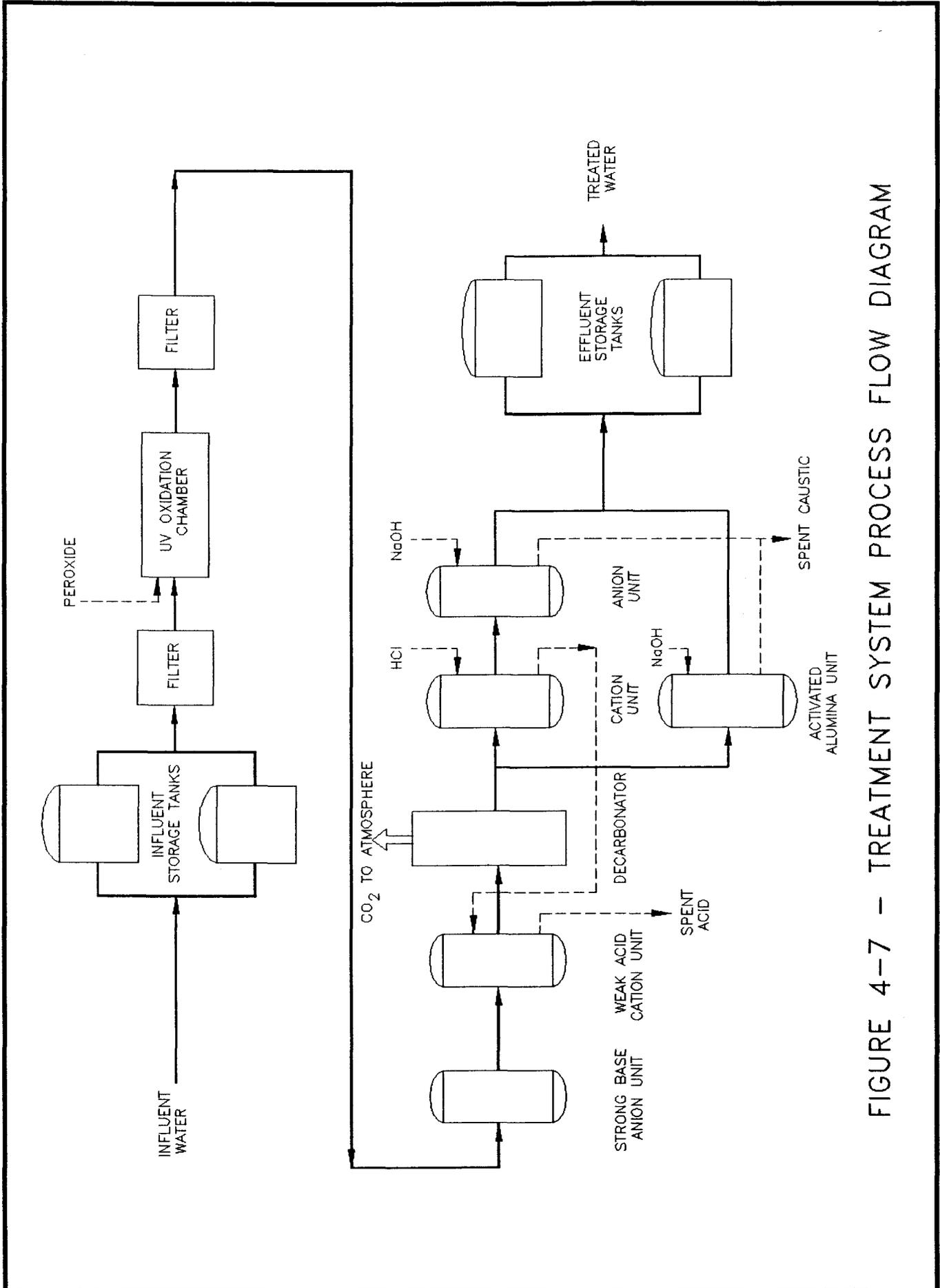


FIGURE 4-7 - TREATMENT SYSTEM PROCESS FLOW DIAGRAM

4.5 DETAILED EVALUATION OF REMEDIAL ACTION ALTERNATIVES

4.5.1 Alternative 1: Collect Ground Water from Footing Drain, Source Well, and French Drain, and Discharge to the South Interceptor Trench Downgradient of the 881 Hillside Area

4.5.1.1 Description

This alternative involves construction of a french drain (trench) at the location shown on Figure 4-8. The drain is located downgradient of the 881 Hillside SWMUs and upgradient of the South Interceptor Trench. This location is downgradient of VOC contaminated alluvial ground water. The french drain will extend along the entire length of the saturated alluvium. The drain will be keyed at least two feet into bedrock in order to fully penetrate the soils and will be approximately 2,100 feet long. As such, the drain will intercept and contain all alluvial ground-water flowing from the area. A PVC drainage pipe will direct flow under gravity to two 3-foot diameter concrete collection sumps. Each sump will be equipped with a submersible sump pump to deliver water from the drain to the new treatment plant (see Section 4.4). Each of the two pumps will have sufficient capacity to deliver the entire discharge of the drain to the treatment plant. The downstream face of the french drain will be covered with a synthetic membrane to limit flow from the clean side of the trench (Figure 4-9). The inclusion of the downstream synthetic membrane coupled with the continuity of the drain is expected to provide positive cutoff of the ground water. Water collected from a source well at SWMU 119.1 (a new well near well 9-74) will also be treated in the new treatment plant. In addition, a sump will be built to collect the flow from the Building 881 footing drain. Two sump pumps will be used to transfer the footing drain flow to the treatment plant in a separate piping system. Effluent from the treatment plant will be discharged to the South Interceptor

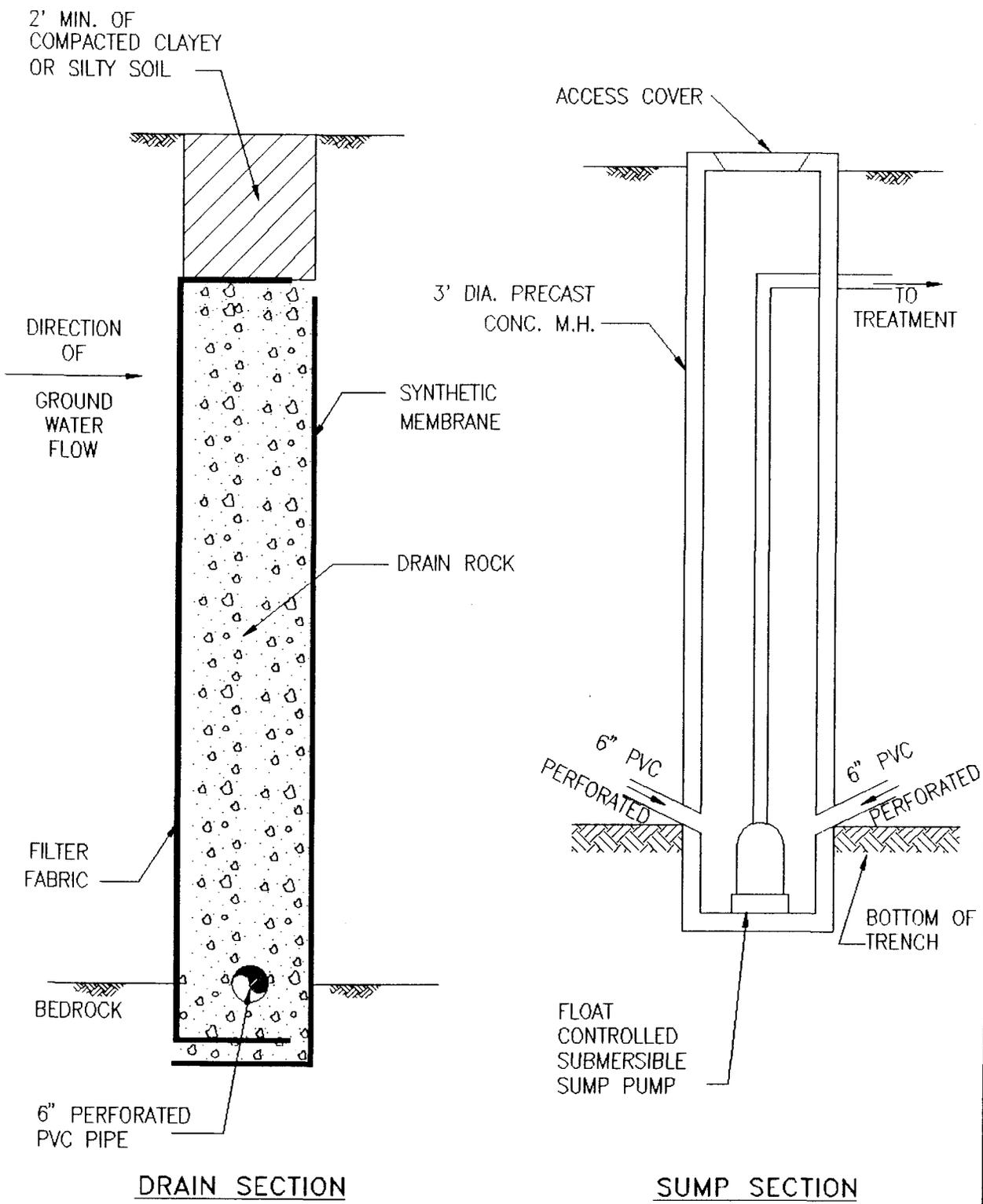


FIGURE 4-9
FRENCH DRAIN SECTION

NOT TO SCALE

Trench which flows into Pond C-2. Pond C-2 discharges to Woman Creek under provision of RFP's NPDES Permit.

Flow from the trench could be on the order of 10 gpm initially, but is expected to drop to less than 5 gpm within a few days. The combined steady state flow from the trench and source well is estimated to be as low as 2 gpm. Flow from the Building 881 footing drain is expected to be 5 gpm or less.

4.5.1.2 Effectiveness

The proposed interim action will collect ground water from the soils on the 881 Hillside Area in a french drain with a downstream impermeable membrane. The french drain that will be constructed on the 881 Hillside is intended to collect ground water containing volatile organics from the colluvium/alluvium system. The drain will be sufficiently deep to fully penetrate the colluvium so that ground water will not flow under the drain in the colluvium. The design calls for two feet of penetration into bedrock (the bedrock has a hydraulic conductivity more than two orders of magnitude smaller than the colluvium). Therefore, the drain will be effective in collecting colluvial ground water.

The penetration into bedrock is not intended to reduce the migration of contaminants into bedrock; however, the installation and operation of the drain will have two beneficial impacts on the bedrock ground-water flow system. First, the drain will slightly decrease the rate of downward movement of colluvial ground water because the potentiometric surface in the colluvium will gradually be lowered and, as a consequence, the gradient between the colluvium and the bedrock will be slightly less. Second, the drain will remove the contaminated colluvial/alluvial ground water that is a potential source for contamination of bedrock ground water. The interim action is

intended to remove volatile organics from the colluvial/alluvial ground-water and is anticipated that the french drain will be effective in both collecting the colluvial/alluvial ground water and limiting releases from the 881 Hillside Area.

The proposed treatment system will remove both the organic and inorganic ground-water contaminants to below the chemical-specific ARARs given in Section 3.3.1. A complete analysis of chemical-specific ARARs pertinent to subsurface discharge is presented in Section 3.3. Location-specific ARARs are discussed in Section 3.3.2.

The interim action at the 881 Hillside Area is expected to have minimal impacts on Woman Creek. Although the french drain is expected to intercept all of the colluvial flow from the hillside area, the water will be returned to the hillside by means of surface discharge (after treatment) to the South Interceptor Ditch. The point of discharge will be at the west end of the hillside area (upstream) and the discharged water will flow along the ditch to Pond C-2. The treated water is expected to return to the ground-water system by infiltration from the South Interceptor Ditch and Pond C-2.

Losses from the ground-water system resulting from the interim action are expected to be as follows:

- o It is possible that a certain diminution of flow in the creek will occur directly downhill of the area because not all of the discharge will infiltrate from the South Interceptor Ditch. However, this possible diminution is expected to be negligible because the hillside area only amounts to about 10 percent of the recharge area to the creek (total length of both banks is approximately 20,000 feet from the hillside to the headwaters of the creek, while the cut-off length at the hillside is approximately 2,000 feet). In any event, the creek will be nearly fully recharged by infiltration from Pond C-2.
- o Some evaporation will occur from both the South Interceptor Ditch and Pond C-2.

The impacts of the losses are expected to be negligible because the total flow currently recharging the ground-water system of the Woman Creek Valley Fill Alluvium is a small proportion of the total flow and most of the intercepted ground water will return to the system in any event. The losses are expected to have no noticeable impact on the availability of off-site because the vast majority of the ground water in the Alluvium is currently consumed by evapotranspiration within the plant boundary.

Worker safety precaution will be required during construction of this alternative because of the potential for encountering contaminated soil or water in the excavation. However, at the location of the drain it is expected that contamination in both soil and water will not be detected. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased from the construction or operation of this remedial action alternative. Treated water will be monitored to ensure contaminants are within regulatory guidelines prior to discharge.

4.5.1.3 Implementability

The useful life of the french drain system is expected to be at least thirty years. French drains have been used successfully for many years for control of ground water. French drains are almost always effective, except when ground water can flow over, under or around the drain, or when the drain becomes clogged. The drain proposed for the 881 Hillside will fully penetrate the colluvium and be keyed into claystone bedrock, precluding the possibility of flow under or over the drain. It extends uphill on the west side to an elevation equal to that of SWMU 107 and is

keyed into a dry ridge on the east end. This should preclude flow around the drain. Clogging is not expected to be a problem based on past experience of the footing drain at Building 881, which has been in service since the early 1950's without clogging. Replacement of the pumps in the sumps should be expected as part of routine operation.

Operation and maintenance requirements are small for a french drain. Flow to the sump is by gravity. Liquid level controllers switch on a submersible pump in the central sump whenever there is sufficient water present. Pumping records will be reviewed regularly to ensure that the system is operating. If long periods of non-pumpage are observed, water levels in the drain will be investigated to determine if the pumps have failed. In addition, five piezometers will be installed along the trench and downgradient to monitor the effectiveness of the french drain in intercepting contaminated ground-water. Changes in ground-water quality upgradient and downgradient of the french drain will be monitored by existing and new ground-water monitoring wells.

A large diameter withdrawal well will provide efficient dewatering of the alluvium in the vicinity of well 9-74. The well will be surrounded by monitoring wells so that an evaluation of the efficiency of the well can be easily made. It appears likely that pumping of this well will be continuous for the first several years of remediation, but may not be required later. This is due to the small amount of ground water in the vicinity of SWMU 119.1.

The footing drain at SWMU 107 has already been functioning satisfactorily for thirty years and there is no reason to believe that this will change. Collection of the footing drain flow will likely be required for the full thirty years if the source of the

contaminants cannot be identified and removed. A source characterization study is currently in progress as part of the final RI/FS investigation.

Operation and maintenance requirements for collection of the footing drain flow are minimal. Discharge from the drain will be pumped to the treatment plant based on liquid level switches. Two pumps will be provided to protect against pump failure. Operation and maintenance of the dewatering well are similar. It too will be operated with a liquid level controller and requires little more than routine inspection. The system is highly implementable because the withdrawal well and associated pumps and mechanical connections are standard items.

Action-specific ARARs relating to soil excavation which may be pertinent to this alternative include the requirements under RCRA that address the storage of RCRA wastes in waste piles, and restrictions on the land disposal of solvent-containing wastes that exceed treatment-based standards for those constituents. Soils removed during excavation of the french drain are downgradient of all 881 Hillside Area SWMUs and are not expected to contain hazardous constituents. During excavation, health and safety personnel will monitor for the presence of volatile organic contaminants in the soil. If contaminated soils are encountered, or if soils are suspected to be contaminated, they will be handled as RCRA hazardous waste until confirmatory sampling is performed. Of particular relevance to the handling and storage of contaminated soil is the requirement, under RCRA, of diverting run-on away from waste piles, preventing wind dispersal of wastes, and collecting free liquids or leachate for treatment as a hazardous waste. RCRA requirements for the storage of contaminated soil in containers (roll-off boxes or drums) would also be relevant and appropriate if containers are used for storage. With respect to RCRA restrictions on the land disposal of solvent-containing wastes, contaminated soils may not be disposed

on site or off site unless they have been analyzed and found to contain levels of contamination below threshold limits (treatment-based standards) for those contaminants, or treated to Best Demonstrated Available Technology (BDAT) standards. If concentrations of hazardous constituents in the soils are found to be at or below acceptable concentrations defined in the 881 Hillside risk assessment (Rockwell International, 1988b), it appears a variance from the RCRA ARAR for disposal of hazardous waste is appropriate, i.e., the soils can be used as backfill material for the trenches.

Action-specific ARARs pertinent to surface discharge are the relevant and appropriate requirements under RCRA for the storage and treatment of hazardous waste in containers and tanks prior to surface discharge.

The design, operation, and maintenance of the treatment plant will meet chemical-specific ARARs identified for the contaminants of concern and action-specific ARARs related to the subsurface discharge of the treatment system effluent. A complete ARARs analysis for treatment operations is given in Table 3-3.

Highlights of these action-specific ARARs are listed below:

- o Applicable federally approved state water quality standards must be complied with for discharges to surface or ground waters of the state. These standards may be in addition to or more stringent than other federal standards under the Clean Water Act.
- o General requirements for treatment and storage of RCRA hazardous waste in containers and tanks are relevant and appropriate. Recordkeeping requirements under these sections are not ARARs.

Implementation of this alternative involves only routine construction procedures. Construction of the drain can be completed in a period of approximately two months. Ground water will be effectively contained at the beginning of

construction when the excavation is dewatered. The system will be operational immediately upon completion.

4.5.2 Alternative 2: Total Encapsulation

4.5.2.1 Description

This alternative involves total encapsulation of the contaminant sources near SWMU 107 and within SWMU 119.1 using RCRA caps and slurry walls at the locations shown on Figure 4-10. Each area will be covered with a three-layer cap consisting of six-inches of vegetated topsoil, a minimum of six inches of drain rock, and a composite synthetic membrane/compacted soil cover of at least two-foot thickness (Figure 4-11). The surface of the cover will be sloped at a minimum of 2% to drain toward peripheral ditches. The peripheral ditches will discharge to the South Interceptor Trench. The cover at SWMU 107 is estimated to consist of approximately 6,000 square feet; the cover at SWMU 119.1, approximately 80,000 square feet. The covers will extend a minimum of five feet beyond the slurry walls.

Peripheral containment will be achieved by construction of soil-bentonite slurry walls to completely encircle the contaminated soils. The walls will be keyed into claystone bedrock, which is expected to provide bottom containment. The SWMU 107 slurry wall is estimated to be approximately 320 feet long and depths are anticipated to range from about 4 to 17 feet. It is estimated that the SWMU 119.1 wall will not exceed about 20 feet in depth (15 feet average) and that it will be approximately 1,000 feet long.

In addition, ground water inside the containment systems will be removed using internal sumps. This will result in hydraulic gradients toward the encapsulated soil

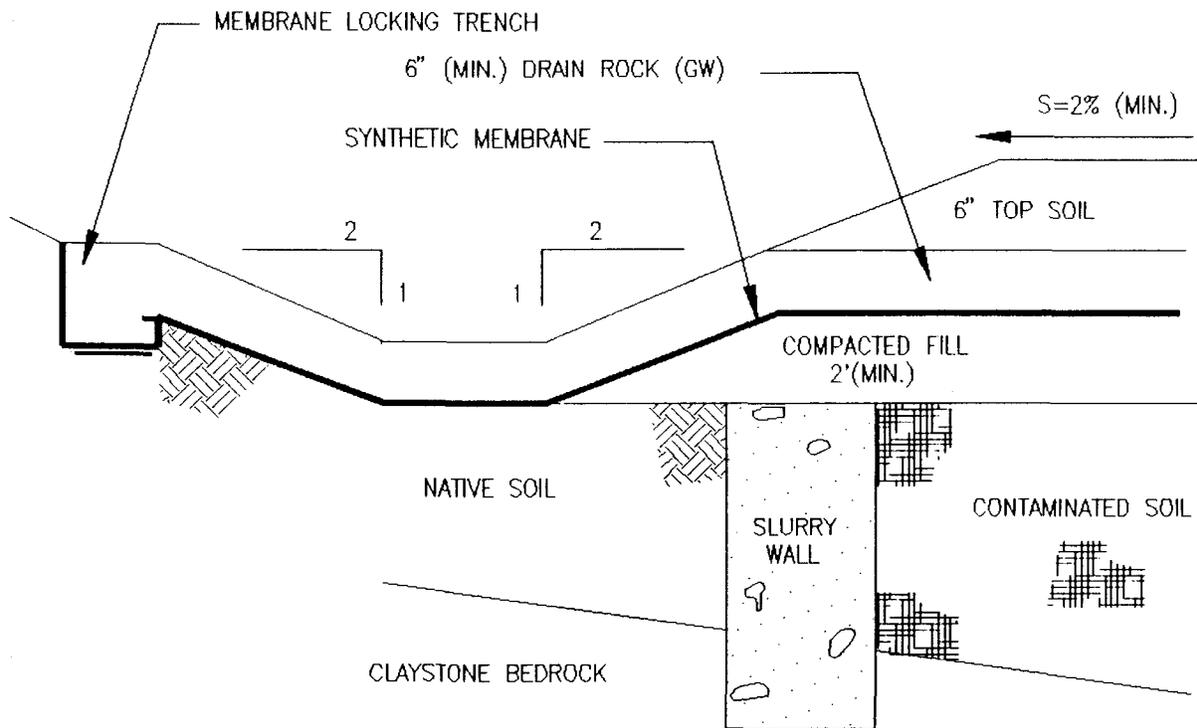


FIGURE 4-11
TOTAL ENCAPSULATION SECTION

NOT TO SCALE

and will reduce the potential for any releases. The small volume of water produced from the sumps will be stored in tanks on site and be transferred to a suitable treatment facility. No capital or operating costs for this treatment have been included.

The cap and perimeter ditches will be inspected on an annual basis and repaired as necessary. The ditches will be maintained in clean and properly graded condition so that collected runoff is rapidly removed from the area.

4.5.2.2 Effectiveness

This alternative will adequately contain and immobilize the sources of contamination. As discussed in Section 2, ground water contamination is known to exist downgradient of SWMU 119.1 and may exist downgradient of SWMU 107. These waters will be released to the environment. This is expected to nominally impact the quality of the ground water within the Valley Fill Alluvium. Therefore, this alternative minimizes future contaminant migration from the sources and thus minimizes future public exposure to contaminants off site.

Partial control of the SWMUs will be achieved as soon as the peripheral containment structures are constructed. Full control will not be achieved until the entire system is complete and pumping of the sumps begins.

Worker safety precaution will be required during construction of this alternative and during monitoring and dewatering operations. In addition, safety precautions will be required during excavation for and construction of the compacted soil barrier walls. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased during construction or operation of this alternative.

4.5.2.3 Implementability

Infiltration and ground-water flow through the SWMUs is expected to be practically eliminated by the total encapsulation system. As a consequence, the release of contaminants from the SWMUs is also expected to be eliminated. It must be noted that the system will not be as effective if the SWMU areas are not underlain by continuous claystone.

The useful life of the total encapsulation system is expected to exceed thirty years. The containment features involving geologic materials (slurry wall and compacted soil cover) should function indefinitely, particularly given that flow through them will be from the non-contaminated to the contaminated side. The synthetic membrane can be expected to function adequately for at least twenty years, and it is backed-up by the compacted soil layer. The vegetated cover and peripheral ditches will require regular maintenance, and the internal sump will require regular operation.

The technologies proposed in this alternative are all proven technologies. The multi-layer cap system has been used for nearly ten years with good success at many sites. Soil-bentonite slurry walls have also been used for many years to effectively control ground-water flow. The gradient control provided by the sump is a modification of the standard encapsulation system and should provide an extra level of protection.

Operation and maintenance requirements are very small for the total encapsulation alternative. There are essentially no operational requirements, with the exception of routine pumpage of the sump. This is expected to be required no more

frequently than annually after the initial dewatering. Maintenance will involve inspection and cleaning of peripheral ditches, inspection and repair of the vegetated cover, and inspection and replacement of the sump pump. In addition, ground-water and surface water conditions in the vicinity of the 881 Hillside Area will be monitored.

This alternative can be implemented using standard construction practices. Seaming of synthetic membranes has become common enough that a qualified local contractor can be used. Construction of the encapsulation systems will require about three months.

Construction of a slurry wall at SWMU 119.1 may prove impractical where the wall runs parallel to the grade (slope may be too steep). For the two legs of the wall running up the hill, it is recommended that a compacted soil cutoff wall be constructed in an excavated trench. The trench will probably vary from about 15 feet deep at the downhill end to about 2 feet deep at the uphill end. The trench can be excavated with standard earth-moving equipment. Some of the excavated material may be suitable for use in constructing the wall. The length of compacted wall is estimated to be 600 feet, while the remaining slurry portion is about 400 feet long. A compacted soil wall is expected to provide performance characteristics equivalent to a slurry wall.

Material for construction of the compacted soil cover and wall can be obtained from the Arapahoe Formation. The Arapahoe is covered by a thin veneer of colluvium along Woman Creek and could be excavated from a number of nearby areas; however, in order to avoid oversteepening the slopes, the borrow area should be established on the south side of Woman Creek.

ARARs pertinent to the total encapsulation alternative include the relevant and appropriate requirements under RCRA that address the technical specifications of capping closure and post-closure care. In addition, soil that is excavated must be handled as a hazardous waste until sampling and analysis are performed (see Section 4.5.1.3).

Wastewater that is recovered from the source well within the encapsulated area must be treated in a facility operating in compliance with the substantive requirements of RCRA. If recovered ground-water is to be treated on site in a treatment facility, specific RCRA requirements for the treatment of hazardous waste are relevant and appropriate. If wastewater is transported off site, both the substantive and administrative requirements of RCRA will apply to the wastewater management. A complete analysis of chemical-, location-, and action-specific ARARs is presented in Section 3.3.

4.5.3 Alternative 3: Collect Ground Water from Source Well and Footing Drain, and Discharge to the South Interceptor Trench

4.5.3.1 Description

This alternative involves pumping a new source well (located near 9-74) at SWMU 119.1 and collection of the footing drain discharge at SWMU 107 (Figure 4-12). The collected water will be treated in the new treatment plant (see Section 4.4) and discharged to the South Interceptor Trench which flows into Pond C-2. Pond C-2 discharges to Woman Creek under provisions of a NPDES Permit.

It is estimated that flow from a completely dewatered 9-74 will initially be about 1 gpm but will rapidly fall to a steady flow of about 0.04 gpm. It is anticipated that the flow from the drain will be five gpm or less.

4.5.3.2 Effectiveness

Removal of the majority of contamination in the vicinity of well 9-74 will significantly minimize off-site migration of contaminants. Future off-site public exposure to the contaminants is unlikely. However, the migration of contaminated alluvial ground water beyond the 881 Hillside Area is more probable than that expected for Alternative 1 which utilizes a french drain for ground water collection.

The proposed treatment system will remove both the organic and inorganic ground-water contaminants to below the chemical-specific ARARs given in Section 3.3.1. A complete analysis of chemical-specific ARARs pertinent to subsurface discharge is presented in Section 3.3. Location-specific ARARs are discussed in Section 3.3.2.

The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased from the construction or operation of this removal action alternative. Treated water will be monitored to ensure contaminants are within regulatory guidelines prior to discharge.

4.5.3.3 Implementability

The useful life of this alternative is expected to exceed thirty years. A large diameter withdrawal well will provide efficient dewatering of the alluvium in the vicinity of well 9-74. The well will be surrounded by monitoring wells so that an evaluation of the efficiency of the well can be easily made. It appears likely that pumping of this withdrawal well will be continuous for the first several years of remediation, but may not be required later. This is due to the small amount of ground water in the vicinity of SWMU 119.1.

The footing drain at SWMU 107 has already been functioning satisfactorily for thirty years and there is no reason to believe that this will change. Collection of the footing drain flow will likely be required for the full thirty years if the source of the contaminants cannot be identified and removed.

Operation and maintenance requirements for collection of the footing drain flow are minimal. Discharge from the drain will be pumped to the treatment plant based on liquid level controls. Two pumps will be provided to protect against pump failure. Operation and maintenance of the dewatering well are similar. It too will be operated with a liquid level controller and requires little more than routine inspection. The system is highly implementable because the withdrawal well and associated pumps and mechanical connections are standard items.

Action-specific ARARs pertinent to surface discharge are the relevant and appropriate requirements under RCRA for the storage and treatment of hazardous waste in containers and tanks prior to surface discharge.

The design, operation, and maintenance of the treatment plant will meet chemical-specific ARARs identified for the contaminants of concern and action-specific ARARs related to the surface discharge of the treatment system effluent. A complete ARARs analysis for treatment operations is given in Table 3.3.

Highlights of these action-specific ARARs are listed below.

- o General requirements for treatment and storage of RCRA hazardous waste in containers and tanks are relevant and appropriate. Recordkeeping requirements under these sections are not ARARs.
- o Applicable federally approved state water quality standards must be complied with for discharges to surface or ground water of the state. These standards may be in addition to or more stringent than other Federal Standards under the Clean Water Act.

Implementation of this alternative involves only routine construction procedures. Construction of the french drain can be completed in a period of approximately two months. The system will be operational immediately upon completion.

4.6 ESTIMATED COSTS FOR ALTERNATIVES

Cost estimates were prepared using in-house computer software and unit rates. In-house unit rates are based upon Rocky Flats Plant experience in planning and managing similar construction projects at this site. Other recognized references were used where site specific unit rates were unavailable and for comparison or checking. These documents include: "Compendium of Remedial Technologies at Hazardous Waste Sites," U.S. EPA, September 1985; "Treatability Manual, Volume IV. Cost Estimating", U.S. EPA, April 1983; and "Building Construction Data," R.S. Means Co., Inc., 1987.

Costs are reported in 1989 dollars for both initial and future costs. Future costs include replacement of capital cost items (e.g., monitor wells or non-expendable items) and cyclic costs, such as operation and maintenance (O&M) costs, energy costs, and expendable supplies. Life cycle costs for each alternative have been presented, in 1989 dollars, as present worth costs assuming a discount rate of 10%, a duration of active remedy of thirty years, and no salvage value for purchased equipment.

Costs were analyzed by first identifying capital items common to one or more remedial alternatives. These capital items and associated costs are presented for each alternative in Table 4-8. Similarly, identified cyclic costs for each alternative are presented in Table 4-9.

Present worth analyses are performed by using the total costs presented in Tables 4-8 and 4-9, and assuming the duration of the remedy is thirty years. Year "0"

TABLE 4-8

CAPITAL COST COMPONENT WORKSHEET

Component Description	-----Alternative Number-----		
	1	2	3
Ground Water Collection			
Foundation Drain Sump with Pump	17,800		17,800
Withdrawal Well	5,800	5,800	5,800
2,100 lf French Drain with Sumps	364,100		
2,500 lf Influent/Effluent			
Piping and Manholes	50,000		50,000
Influent/Effluent Tanks	78,000		78,000
Ground Water Treatment			
Building	325,000		325,000
Treatment Units	345,000		345,000
Parking Pad	4,300		4,300
Electrical	117,100		117,100
Mechanical	122,600		122,600
Instrumentation	40,500		40,500
Ground Water Isolation			
86,000 sf RCRA Cap		167,500	
19,800 sf Slurry Wall		138,600	
7,500 gal. Tank Wagon		32,000	
Subtotal:	1,470,200	343,900	1,106,100
Design at 15%	220,500	51,600	165,900
Construction Management at 5%	73,500	17,200	55,300
Contingency at 20%	294,000	68,000	221,200
TOTAL CAPITAL COST:	\$2,058,200	\$481,500	\$1,548,500

TABLE 4-9
ANNUAL COST COMPONENT WORKSHEET
(DOLLARS PER YEAR)

Component Description	-----Alternative Number-----		
	1	2	3
Ground Water Collection			
1 Foundation Drain Sump with Pump	200		200
1 Well Pump	200	200	200
2 French Drain Sump Pumps	400		
1 7,500 Gallon Tank Wagon		2,500	
Ground Water Treatment ¹			
Chemicals, Replacement Parts	19,100		19,100
Power	38,600		38,600
Operation and Maintenance ²	84,600		84,600
Monitoring ³	72,000		72,000
Subtotal:	215,100		214,700
Contingency at 20%	43,000		43,000
TOTAL ANNUAL COST:	\$258,100	\$2,700	\$257,700

¹ Based on a slow rate of 30 gpm, 8 hr/day

² 116 hrs/month @ \$61/hr

³ 4 samples/month @ \$1,500/sample

begins upon initiation of design and construction activities, and system operations will continue through the end of year 30. A thirty-year period was selected as the expected duration of the IRA for use in cost analyses for two principal reasons; 40 CFR 264.117 requires a minimum of 30 years post-closure monitoring, and beyond 30 years present value costs are less than 6% of their future worth and thus become insignificant with respect to these analyses. These schedule assumptions are made to facilitate comparisons between alternatives and do not supersede any existing schedules created as a result of any administrative rule, statute, or agreement with agencies authorized to regulate remedial activities at this site. The present worth analysis (in 1989 dollars) is presented for each alternative in Table 4-10.

Rigorous sensitivity analyses demonstrating the effect of possible variations or inaccuracies in assumptions or estimates have not been performed. Only one parameter, the duration of active remedial measures, was identified as being significant with respect to sensitivity analyses. However, uncertainties in the rates of reclamation of the alternatives prevents performance of more rigorous analyses.

A discussion of benefits of individual alternatives is presented in Section 5, *Summary of Alternatives*.

TABLE 4-10
SUMMARY OF ALTERNATIVE COSTS

Component Description	-----Alternative Number-----		
	1	2	3
Annual Costs	\$ 258,100	\$ 2,700	\$ 257,700
Annual Cost x PWF*	2,433,000	26,000	2,429,000
Capital Cost	2,058,200	482,500	1,548,500
Present Worth	\$4,491,200	\$507,500	\$3,977,500

* Present Worth Factor = 9.427 (for annual operating costs)

SECTION 5.0
COMPARATIVE ANALYSIS

5.1 INTRODUCTION

This section summarizes the three screened alternatives and presents a tabular comparison of them (Table 5-1). A recommendation is made for appropriate removal action using the comparative analysis.

5.2 COMPARISON OF ALTERNATIVES

The following alternatives were retained in the screening process and evaluated in detail in Section 4.

1. Collection of ground water using a french drain and a source well, collection of footing drain flow from SWMU 107, treatment of collected water in a new treatment plant and discharge of the treated water to the South Interceptor Trench downgradient of the 881 Hillside.
2. Total encapsulation of source areas using a multi-layer cap and slurry well with control of gradients by pumping an internal sump (dewatering fluids to be treated at an existing treatment plant).
3. Collection of ground water using a source well, collection of footing drain flow from SWMU 107, treatment of collected water at a new treatment plant, and discharge of the treated water to the South Interceptor Trench downgradient of the 881 Hillside.

Alternative 1 is the most extensive interim action considered and will result in effective collection of the contaminated 881 Hillside Area ground water. The french drain will halt all contaminant releases to the alluvial ground water downgradient of the 881 Hillside Area. Collection of the Building 881 footing drain flow and pumping of a new well

TABLE 5-1

SUMMARY OF ALTERNATIVES

<u>Alternatives & Present Worth</u>	<u>Implementability</u>	<u>Effectiveness</u>	<u>Comments</u>
<p>1. French Drain, Source Well, and Footing Drain with Ground-water Treatment \$4,491,200</p>	<p>The alternative relies on proven technologies for collection and treatment of ground water. There are no site conditions that render construction difficult.</p>	<p>The french drain will provide positive collection of all contaminated alluvial ground-water flow from the Hill-side and will therefore prevent contaminant releases to downgradient alluvial ground water.</p>	<p>Complies with action and location specific ARARs, and meets or exceeds chemical specific ARARs for contaminants.</p>
<p>2. Total Encapsulation \$507,500</p>	<p>The encapsulation system uses proven technology and is expected to perform well. Routine maintenance of the cover and ditches, and long-term security and monitoring are required.</p>	<p>Encapsulation will prevent all future contaminant releases from the SWMUs. A small quantity of contaminated ground water will be allowed to flow toward Woman Creek. The impact to downgradient alluvial water is expected to be nominal</p>	<p>Complies with action and location specific ARARs, and meets chemical specific ARARs with the exception of water immediately downgradient of SWMU 119.1 that will be released.</p>
<p>3. Source Well & Footing Drain with Ground-water Treatment \$3,977,500</p>	<p>The alternative relies on proven technologies for ground water treatment. Site earthwork is not required.</p>	<p>Pumping of a well at SWMU 119.1 and collection of footing drain flow, followed by treatment of the collected water, will result in immediate improvement of ground-water quality conditions at SWMU 119.1 and provide added protection against detectable VOC releases to surface water from SWMU 107. Contaminated ground water downgradient of SWMU 119.1 will be released, but this is expected to nominally impact the quality of downgradient alluvial ground water.</p>	<p>Does not meet chemical specific ARARs for organic contaminants but will significantly minimize future hazards to the public health.</p>

at SWMU 119.1 will result in collection of any contaminated water from these areas. The ground-water treatment system will effectively remove both the organic and inorganic contaminants in the ground water to below the chemical-specific ARARs. Discharge of the treated water into the South Interceptor Trench allows for the water to be combined with Pond C-2 water before final discharge off-site in accordance with Rocky Flats Plant NPDES Permit.

Total encapsulation (Alternative 2) will not destroy the contaminants present, but will contain them in place. It will prevent all future contaminant releases from the SWMUs but will allow a small quantity of ground water with concentrations of VOCs in the range of 5 to 150 ug/l to be released. The portion of this water that is not consumed by evapotranspiration will ultimately reach the Woman Creek Valley Fill Alluvium and flow east toward the property boundary. It is unlikely that volatile organics will ever be detected at the boundary from this release. This alternative uses proven technology intended for much higher contamination levels than are present on the 881 Hillside. However, public reception of this may be unfavorable due to the contaminant releases to the Valley Fill Alluvium. Collection of the footing drain flow and pumping of a new well at SWMU 119.1 with treatment of collected water (Alternative 3) is a limited-scope response that should make a significant impact on releases from the two SWMUs. However, this alternative may not result in complete capture of the contaminated ground water as Alternative 1 does with the french drain. Although volatiles currently are not detectable in the surface waters receiving flow from the footing drain, collection and treatment of the footing drain flow will provide an extra level of assurance that significant releases will not occur in the future. Pumping the well completed in the center of SWMU 119.1 will clearly improve conditions by removing the most contaminated ground water. Continued pumping may result in complete dewatering of the colluvial materials beneath the SWMU because of limited recharge to the area. As with Alternative 1, the ground-water treatment system will effectively remove both the organic and inorganic contaminants to below the chemical-specific ARARs.

SECTION 6.0
PROPOSED IRA

Alternative 1 has been chosen as the proposed interim remedial action. This alternative involves construction of a french drain (trench) to intercept all contaminated alluvial/colluvial ground water from the 881 Hillside Area. The drain will be located downgradient of the 881 Hillside SWMUs, will be keyed into bedrock in order to fully penetrate the soils and will be 2,100 feet long.

The bedrock lithology and hydraulic conductivity will be verified before construction of the french drain begins. This verification program will consist of drilling the drain alignment on 100-foot centers (22 holes along the approximately 2,100 foot long drain). Borings will be drilling around SWMU 119.2 in order to verify the extent of saturation. The holes will be drilled using hollow stem augers to the top of bedrock. The top fifteen feet of bedrock will be cored through the augers, using the augers as surface casing. Fifteen feet of penetration into bedrock is sufficient to find sandstone units dipping at two degrees that might subcrop between borings on 100-foot centers. The hydraulic conductivity of the bedrock will be verified by injection tests on five foot intervals using a single packer injection apparatus as the cored hole advances.

Data collected in this program will be used to develop the detailed design of the drain. Required penetration into bedrock, trench bottom slopes and sump locations will be selected based on the depth to bedrock and the hydraulic conductivity of the materials. The drain will penetrate a minimum of two feet into low conductivity bedrock; low conductivity is defined as 1×10^{-6} centimeters per second (cm/s) or lower. The penetration requirement may result in deeper penetration of the drain into bedrock containing sandstones and additional sumps to collect drain inflow at these and other low points.

During construction of the french drain, the excavation will be inspected by a qualified geotechnical engineer to verify the suitability of the materials into which the drain is keyed.

A PVC drainage pipe inside the drain will direct flow under gravity to two 3-foot diameter collection sumps. Each sump will be equipped with a submersible sump pump to deliver the water from the drain to the new treatment plant. The downstream face of the french drain will be covered with a synthetic membrane to limit flow from the clean side of the drain. The inclusion of the downstream synthetic membrane coupled with the continuity of the drain will provide positive cutoff of the ground water verified by monitoring 5 ground-water monitoring wells to be installed along the drain and downgradient.

Water collected from a source well at SWMU 119.1 (a new withdrawal well near well 9-74) will also be treated in the new treatment plant. In addition, a sump will be built to collect the flow from the Building 881 footing drain. Two sump pumps will be used to transfer the footing drain flow to the treatment plant in a separate piping system.

The ground water collected will be treated using a UV peroxide system (for organics removal) and an ion exchange system (for inorganics removal). A new building will be erected for enclosure of the water treatment system to protect weather or temperature sensitive components. External water pipes will be buried approximately four feet to protect against freezing.

Fire protection within the building will be provided by two wall mounted 25 pound dry chemical type fire extinguishers. The building and all treatment units are constructed of non-combustibles. Other than minimal files and records, no combustible materials will be maintained within the building. Major components of the treatment system include:

Exterior to Building

- Two 15,000-gallon influent surge tanks.
- Two 75,000-gallon effluent tanks.
- Piping.
- Associated pumps, gages, and valves.

Interior to Building

- UV/peroxide equipment.
- Ion exchange system equipment.
- Parallel system of filters.
- Sump pump.
- Associated pumps, piping, gages, and valves.
- Support equipment for treatment units, including a hydrogen peroxide supply tank and feed system for the UV/peroxide process, and chemical feed tanks for the ion exchange system.

As shown in Figure 6-1, all of the collected ground water will be pumped into the surge tanks. As the flows from the different sources are expected to vary, the surge tanks will ensure a constant flow through the treatment unit at 30 gpm, 8 hours per day. These tanks will also provide approximately two days collection potential when the treatment unit is down for repairs, cleaning, etc.

When the treatment is initiated, the water will be pumped from the surge tanks through filters to remove suspended materials. The filters will be placed in descending order of size to remove progressively smaller particulates. The water will next enter the UV/peroxide treatment unit.

The UV/peroxide treatment unit consists of an 80-gallon stainless steel oxidation chamber, which provides for a maximum ground-water retention time of 2.66 minutes at a system flowrate of 30 gpm. The oxidation chamber contains four medium pressure UV lamps, which are mounted horizontally in quartz sheaths. A hydrogen peroxide feed system is used to inject approximately 140 mg/l (50 mg/l per ppm of organic contaminants) of a 50 percent H₂O₂ solution into the ground-water feed line. The ground-water/peroxide mixture then passes through an in-line static mixer before entering the bottom of the oxidation chamber. The ground water then flows through the reaction chamber, passing the UV lamps, before it exits the top of the oxidation chamber. As the ground water passes the UV lamps, the organic contaminants will be effectively destroyed to comply with chemical- specific ARARs.

The water is then sent to the ion exchange system for inorganic contaminant removal. The water first passes through a strong base anion exchanger where uranium is selectively removed, to prevent contamination of downstream treatment units. The water then passes through a weak acid cation exchanger, where heavy metals are removed. This unit also transforms the total dissolved solids (TDS) associated with carbonate hardness into carbonic acid. The carbonic acid is subsequently removed by decarbonation. Following decarbonation, the flow is split between a two- bed demineralizer for TDS removal, and an activated alumina unit for selenium removal. The effluent from these two units are blended to produce a final effluent which will meet or exceed all chemical-specific ARARs.

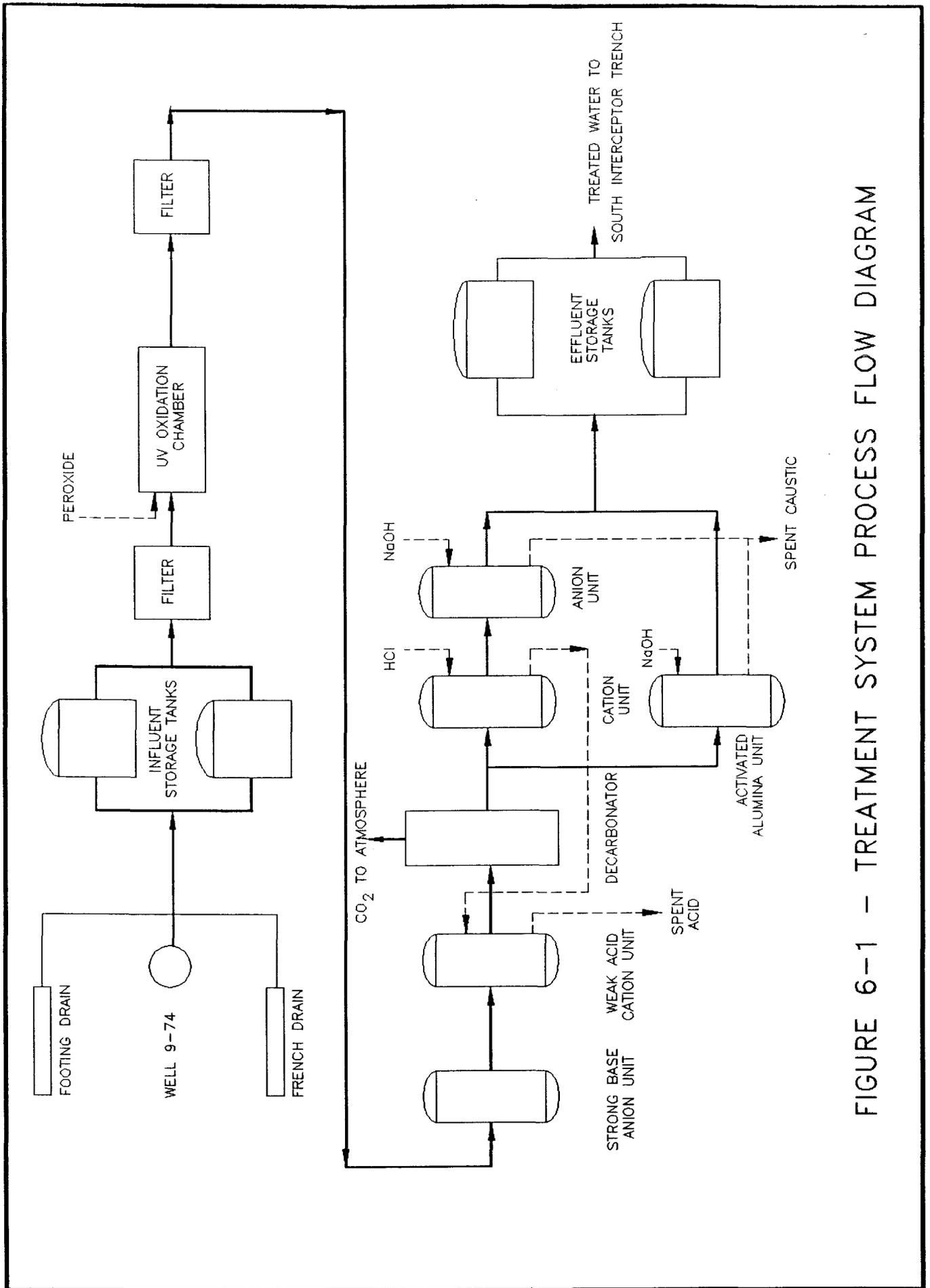


FIGURE 6-1 - TREATMENT SYSTEM PROCESS FLOW DIAGRAM

The ion exchange resins and activated alumina require periodic regeneration to maintain treatment effectiveness. However, the strong base anion exchanger will not be regenerated, but instead will be periodically disposed of as low-level radioactive waste and replaced with a new unit. Rocky Flats' potable water supply will be used to provide the water for the regeneration of all the units. The regeneration wastes will be sent to the Building 374 Process Waste Treatment System for final treatment and disposal.

Following treatment, the water will be directed to an effluent storage tank prior to discharge to the South Interceptor Trench. During start-up of the treatment unit, all effluent will be analyzed prior to discharge. Effluent of unacceptable quality will be returned to the influent storage tanks for additional treatment. After the effectiveness of the treatment system is proven, the frequency of effluent monitoring at the treatment plant will be reduced to a technically-based level.

Water discharged from the treatment system will pass through Pond C-2 and eventually into Woman Creek. This discharge is monitored, according to the Rocky Flats Plant NPDES Permit which was modified on 11 July 1989 on a temporary basis by the Colorado Water Quality Control Commission. The modification calls for analysis of organic and inorganic contaminants in ground water at the RFP, which include promulgated in-stream standards for Walnut and Woman Creek.

Alternatives to direct discharge of treated effluent that were evaluated during the FS include ground-water reinjection downgradient of the french drain in the Valley Fill Alluvium, and ground-water reinjection upgradient of the 881 Hillside Area to facilitate soil washing. Ground-water reinjection for soil washing can hasten the removal of volatile organics from contaminated soils and ground water. However, the effectiveness of this technology in the clayey soils of the 881 Hillside Area is uncertain. The technology may be an appropriate addition to this remedial action in the future if cleanup is deemed to be proceeding slower than expected. The reinjection of treated ground water downgradient of the french drain is deemed not to be necessary because of the interaction between surface water and alluvial ground water.

SECTION 7.0

REFERENCES

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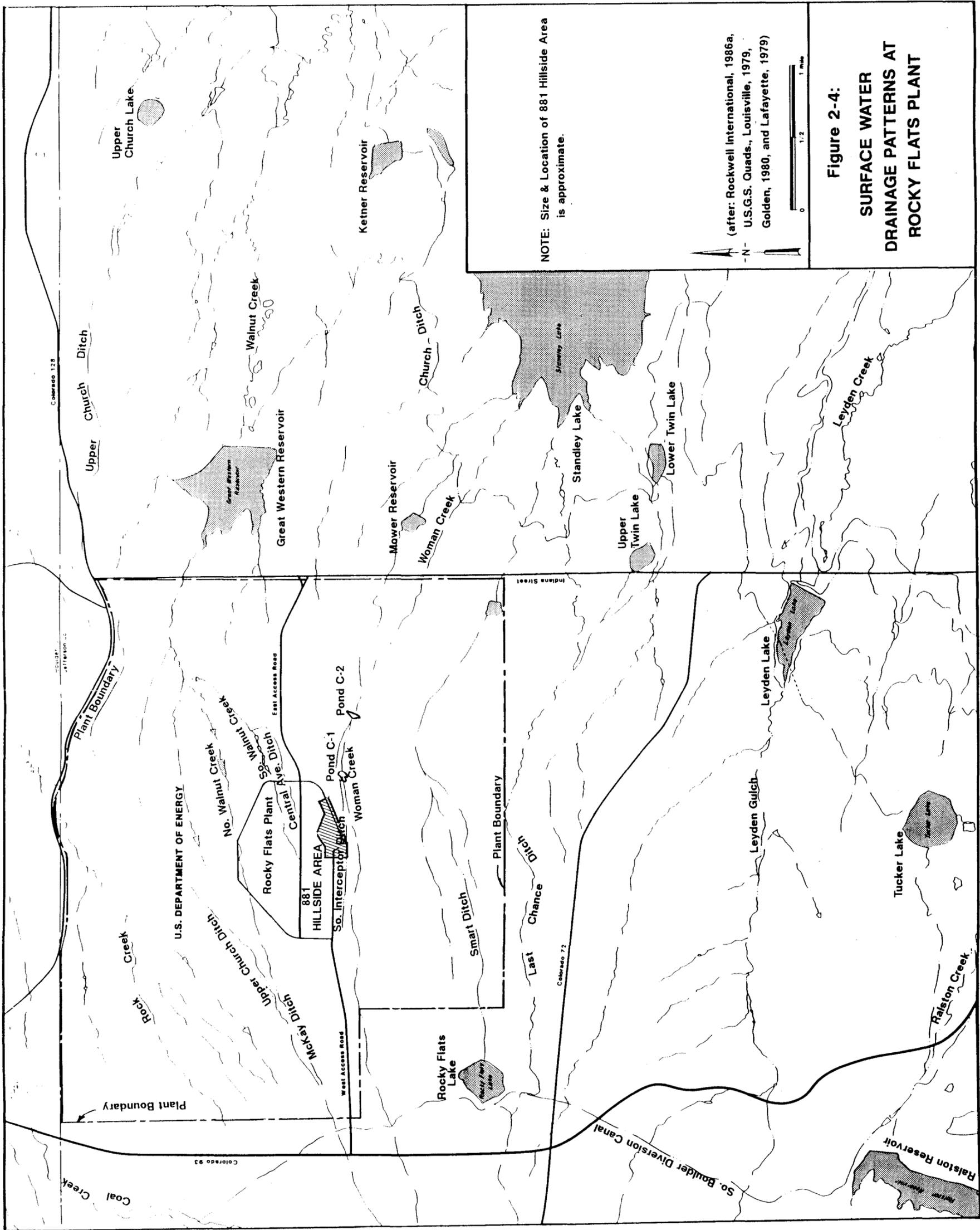
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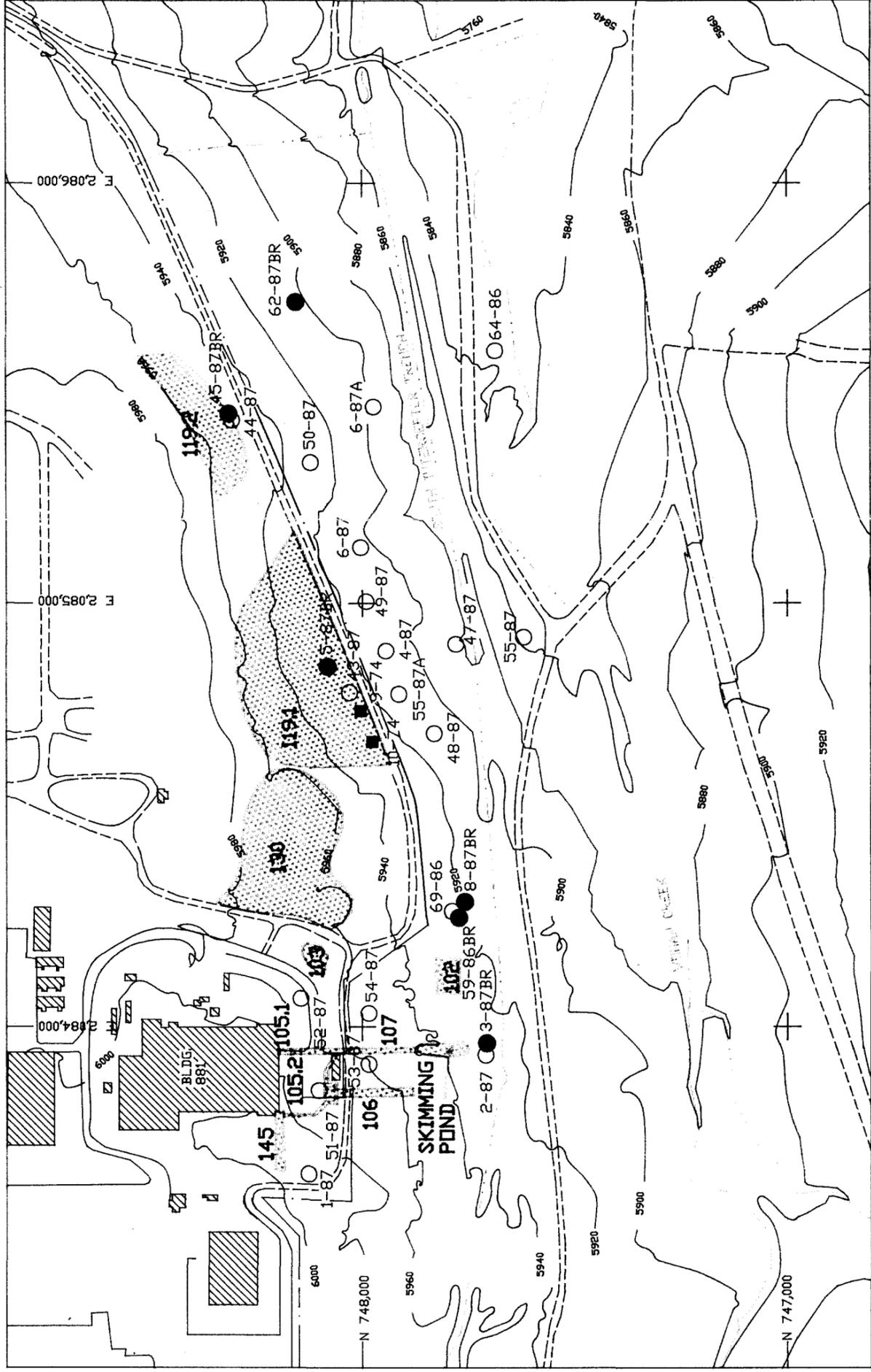
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EXPLANATION

- 62-87BR ● BEDROCK MONITOR WELL
- 64-86 ○ ALLUVIAL MONITOR WELL
- 9-74 ■ PRE-1986 WELL
- 119.1, 119.3 [stippled area] SOLID WASTE MANAGEMENT UNITS

SCALE: 1" = 300'

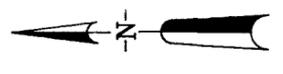
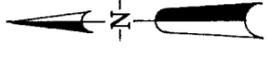
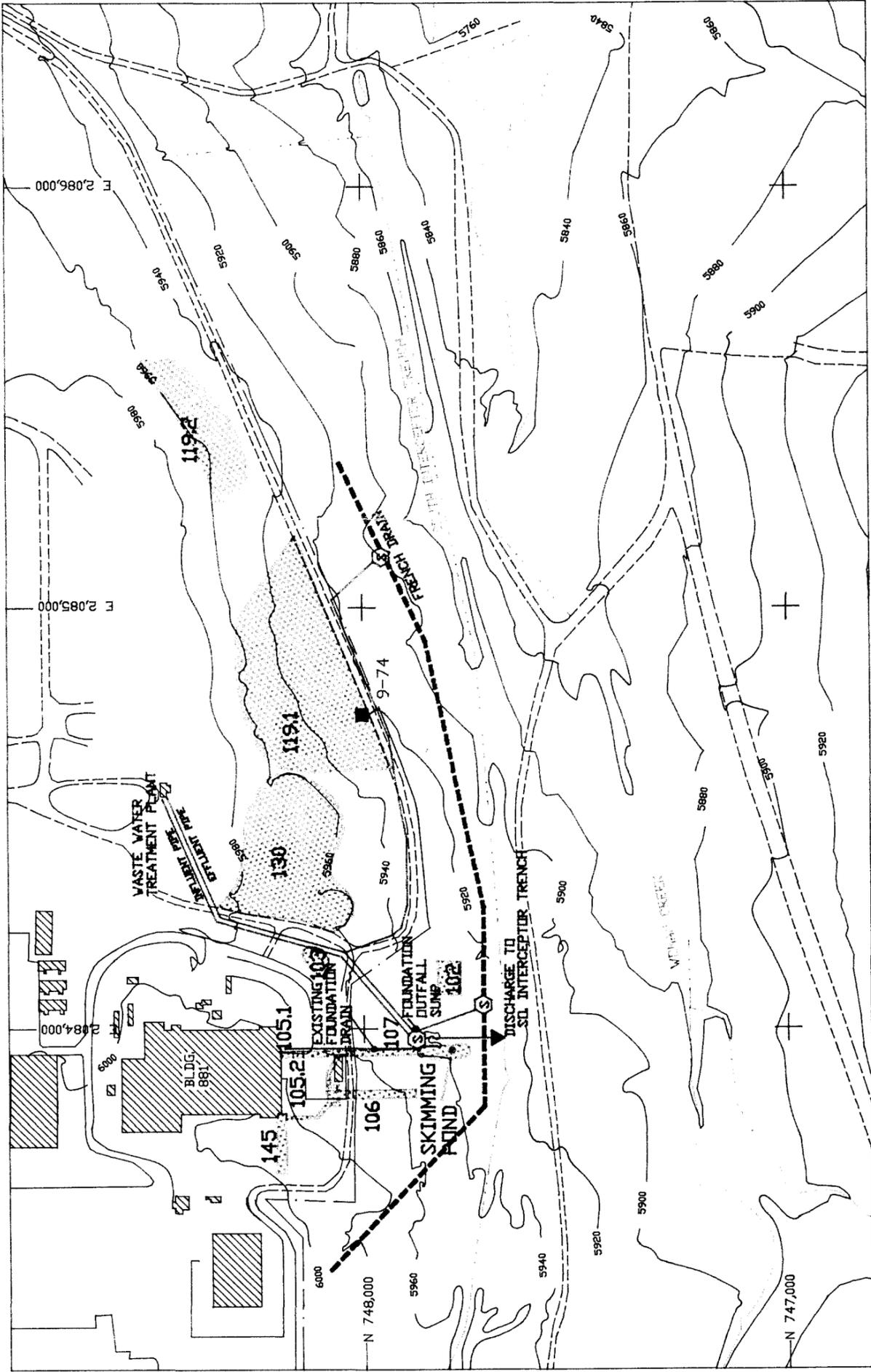


FIGURE 2-5:
WELL LOCATIONS AT 881
HILLSIDE AREA



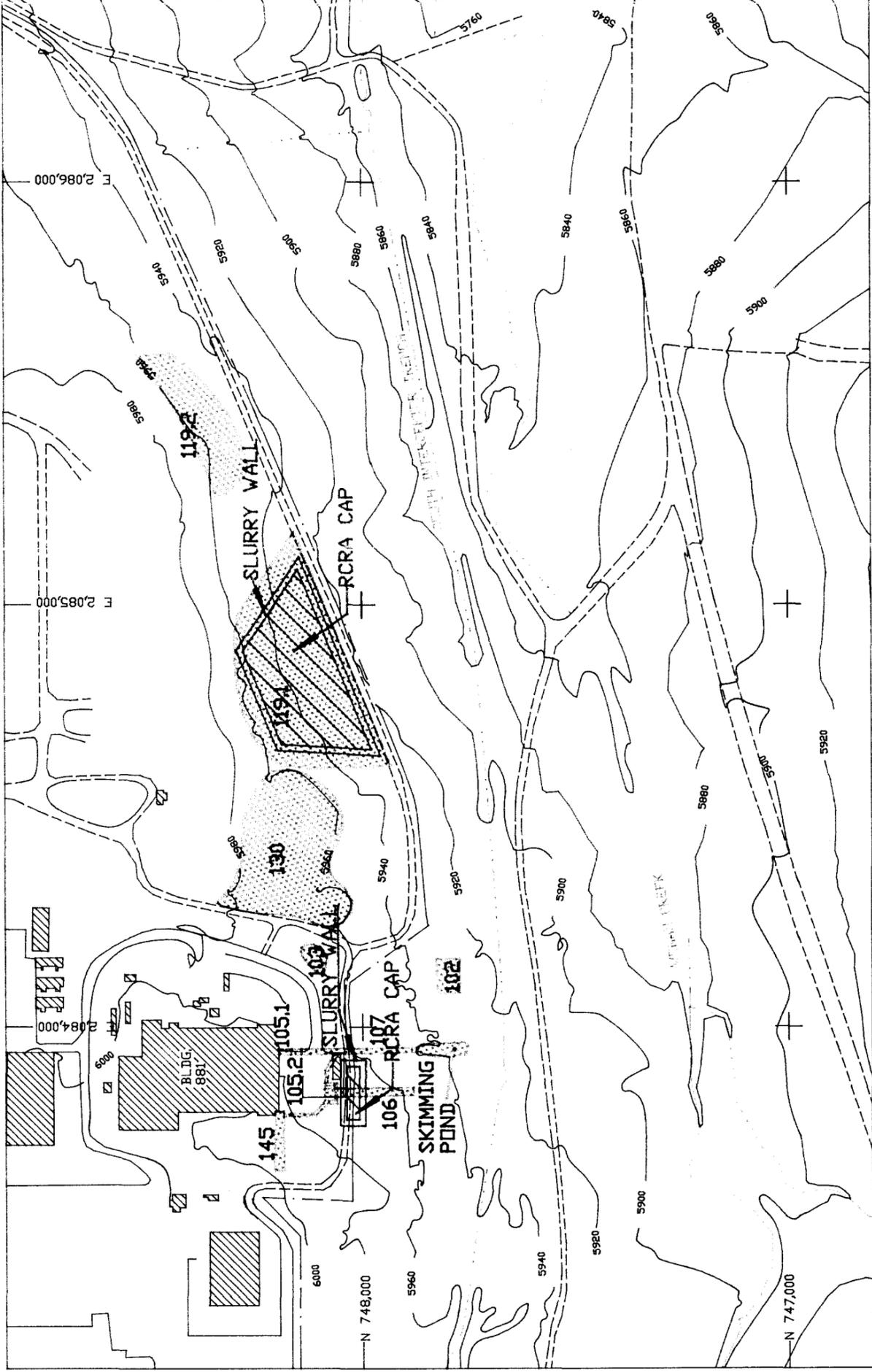
SCALE: 1" = 300'

EXPLANATION

- 102 SOLID WASTE MANAGEMENT UNITS
- FRENCH DRAIN SYSTEM
- ⬡ SUMPS (location to be finalized during detail design)
- ⬢ RECOVERY WELL 9-74

FIGURE 4-8

ALTERNATE 1 -
FRENCH DRAIN COLLECTION
WITH TREATMENT



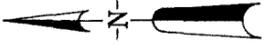
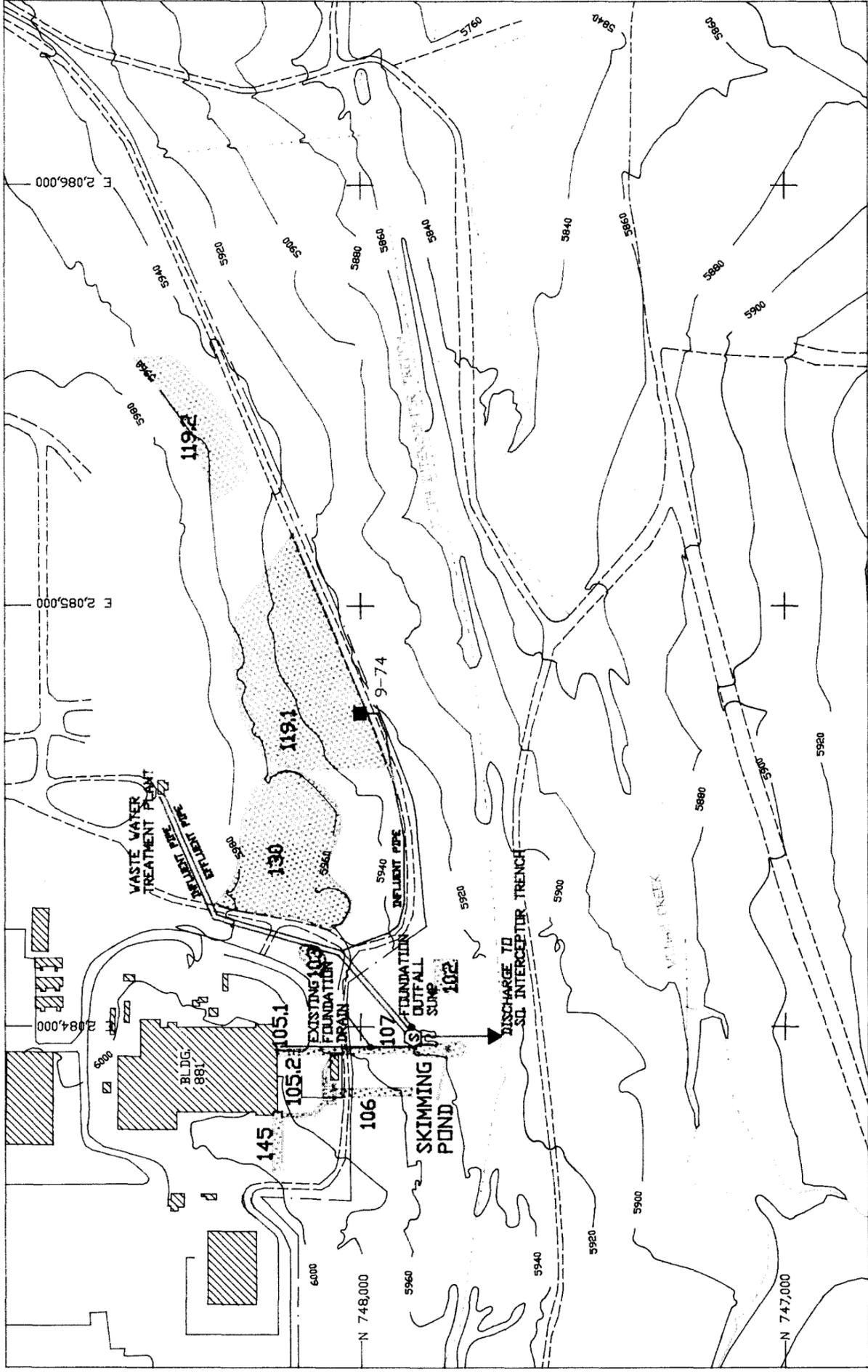
SCALE: 1" = 300'

EXPLANATION

- 119.1 SOLID WASTE MANAGEMENT UNITS
- RCRA CAP WITH SLURRY WALL

FIGURE 4-10:

ALTERNATE 2 -
TOTAL ENCAPSULATION



SCALE: 1" = 300'

EXPLANATION

102 SOLID WASTE MANAGEMENT UNITS

⬡ SUMPS (location to be finalized during detail design)

■ 9-74 RECOVERY WELL

FIGURE 4-12:

ALTERNATE 3 -
FOUNDATION DRAIN & WELL 9-74
COLLECTION WITH TREATMENT