

NOTICE

All drawings located at the end of the document.

CLOSURE PLAN

CONTAINER STORAGE FACILITIES:

PROPERTY UTILIZATION AND DISPOSAL CONTAINER STORAGE FACILITIES
SWINERTON AND WALBERG BUILDING 880 CONTAINER STORAGE FACILITY
SWINERTON AND WALBERG CONTRACTOR STORAGE YARD
BUILDING 885 DRUM STORAGE AREA
BUILDING 881 DRUM STORAGE AREA
BUILDING 865 DRUM STORAGE AREA
BUILDING 883 DRUM STORAGE AREA
BUILDING 334 CARGO CONTAINER AREA
BUILDING 444/468 DRUM STORAGE AREA

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
APRIL 5, 1988

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
ROCKY FLATS PLANT

ADMIN RECORD

A-SW-000303

REVIEWED BY
By *[Signature]*
Date *[Date]*

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BUILDING 444/453 DRUM STORAGE AREA

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO
APRIL 5, 1988

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1.0 INTRODUCTION

1.1 Description of the Rocky Flats Plant

1.1.1 Location and Operator

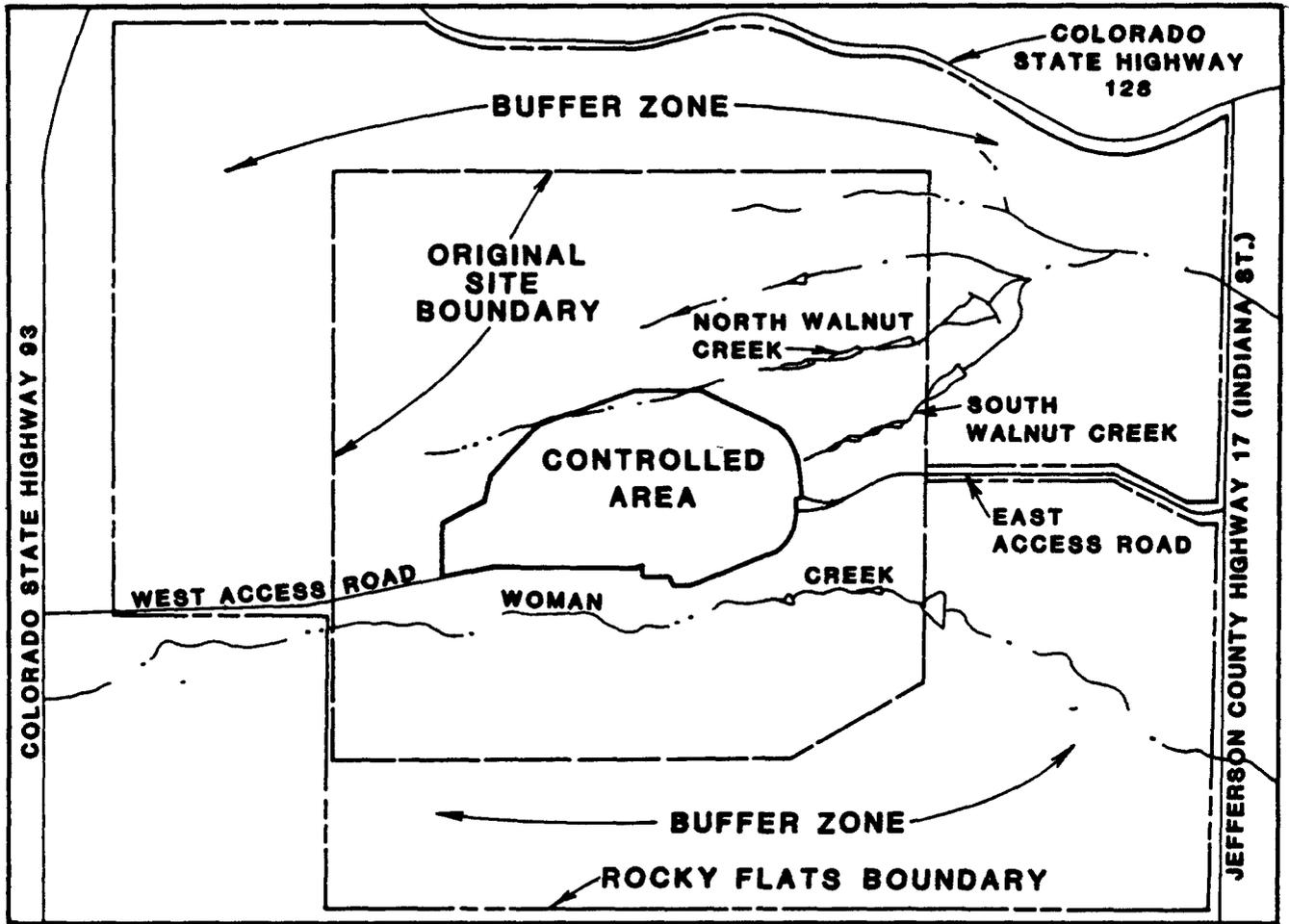
The U.S. Department of Energy's Rocky Flats Plant is located in north-central Colorado, northwest of the City of Denver (Figure 1). The Plant is located in Sections 1 through 4 and 9 through 15 of T. 2 S., R. 70 W. The facility's EPA identification number is CO7890010526. The mailing address is:

U.S. Department of Energy
Rocky Flats Plant
P.O. Box 928
Golden, Colorado 80402

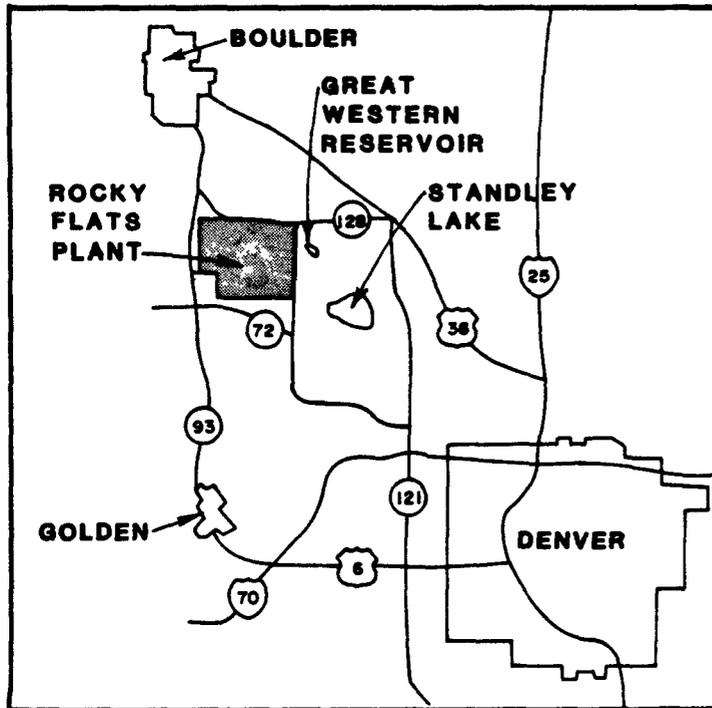
The facility contact is:

Albert E. Whiteman, Area Manager
Phone: (303) 966-2025

The facility covers approximately 6,550 acres of federally owned land in northern Jefferson County, Colorado, which is centered at 105° 11' 30" west longitude, 39° 53' 30" north latitude. The facility is approximately 16 miles northwest



APPROXIMATE SCALE 1"=3,300'



APPROXIMATE SCALE 1"=40,000'

of Denver and 9 to 12 miles from the neighboring communities of Boulder, Broomfield, Golden and Arvada. It is bounded on the north by State Highway 128, on the west by a parcel of land east of State Highway 93, on the south by a parcel of land north of State Highway 72 and on the east by Jefferson County Highway 17. Access to the plant is from an east access road exiting from Jefferson County Highway 17 and a west access road exiting from State Highway 93.

The facility is situated at an elevation of approximately 6,000 feet. It is on the eastern edge of a geological bench known locally as Rocky Flats. The bench is approximately 5 miles wide and flanks the eastern edge of the foothills of the Rocky Mountains.

1.1.2 Mission

The Rocky Flats Plant is a government-owned and contractor-operated facility. It is part of a nationwide nuclear weapons research, development and production complex administered by the Albuquerque Operations Office of the U.S. Department of Energy (DOE). The prime operating

contractor for the Rocky Flats Plant is Aerospace Operations of Rockwell International.

The facility produces metal components for nuclear weapons; therefore, its product is directly related to national defense. The facility fabricates components from plutonium, uranium, beryllium and stainless steel. Other production activities include chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly and related quality control functions. Other activities include research and development in metallurgy, machining, non-destructive testing, coatings, remote engineering, chemistry and physics. Parts at the plant are shipped elsewhere for final assembly (U.S. Department of Energy, 1987a).

1.1.3 Brief History

Construction of the Rocky Flats Plant was approved by the U.S. Government in 1951 as an addition to the nation's nuclear weapons production complex. Operations began in 1952 under direction of the Atomic Energy Commission. The original facility covered an area of approximately 2,520 acres (Figure 1).

A buffer zone was added in 1974-1975 to enlarge the plant to its present size of approximately 6,550 acres. The buffer zone had been used for grazing cattle and horses and is enclosed within a cattle fence which is posted with signs indicating restricted access. Two office buildings, a warehouse, firebreaks, holding ponds along three watercourses, environmental monitoring instrumentation, a sanitary landfill area, a salvage yard, power lines, inactive gravel pits, clay pits and two target ranges are located in the buffer zone. Additionally, a former wind energy test site now used as an office building and a Ground Wave Emergency Network (GWEN) tower being installed by the U.S. Air Force are located in the buffer zone.

Major facility structures are located in a 400-acre controlled area near the center of the property. Production, research and development facilities at the plant are located in the controlled area which contains approximately 134 structures with a combined floor space of approximately 2.67 million square feet.

1.2 Introduction of the Container Storage Facilities

The container storage facilities covered under this closure plan are listed in Table I. Table I also includes the known or approximated dates operations began and ended at each of the facilities.

1.3 Description of the Property Utilization and Disposal Container Storage Facilities

1.3.1 Dates of Operation

The Property Utilization and Disposal (PU&D) storage yard (Figure 2) began operations in 1974. Drum storage in the yard began between 1974 and 1976 and ended in August 1985. Dumpster storage in the yard began in 1974 and ended in August 1985 (Elvey, 1986).

TABLE I
LIST OF CONTAINER STORAGE FACILITIES

<u>Facility</u>	<u>Date Operations Began</u>	<u>Date Operations Ended</u>
Property Utilization and Disposal Container Storage Facilities		
. Drum Storage Area	1974-1976	August 1985
. Dumpster Storage Area	1974	August 1985
Swinerton & Walberg Building 980 Container Storage Facility	1980	Sept. 1986 ⁽¹⁾
Swinerton & Walberg Contractor Storage Yard	1970	1985
Building 885 Drum Storage Area	mid-1950s	Fall 1986 ⁽¹⁾
Building 881 Drum Storage Area	mid-1950s	Fall 1986 ⁽¹⁾
Building 865 Drum Storage Area	1970	Fall 1986 ⁽¹⁾
Building 883 Drum Storage Area	1981	Fall 1986 ⁽¹⁾
Building 334 Cargo Container Area	Summer 1984	July 1986
Building 444/453 Drum Storage Area	Late 1960s	Fall 1986

Note:

(1) Area currently used as a 90-day accumulation area.

1.3.2 Location and Size of Container Storage Facilities

Drum Storage Area

The PU&D drum storage area was located in the northeast corner of the PU&D storage yard. The drum storage area was approximately 60 feet by 60 feet in size (Elvey, 1986).

Dumpster Storage Area

The PU&D dumpster storage area was located in the northwest area of the PU&D storage yard. Only one dumpster containing materials regulated by the Resource Conservation and Recovery Act (RCRA) has been present in the area at any one time. The dumpster was located immediately south of the northern fence line and approximately 300 feet east of the western fence line. The area was approximately 12 feet by 16 feet in size (Elvey, 1986).

1.3.3 Number, Types and Sizes of Containers Used

Drum Storage Area

Fifty-five gallon steel drums accumulated in the PU&D drum storage area at the rates of approximately 50 drums per year over the last five to eight years and approximately 20 drums

per year prior to that (Elvey, 1986). Assuming 20 drums accumulated each year from 1974 through 1977 and 50 drums accumulated each year from 1978 through 1985, 460 drums were stored at the PU&D drum storage area over its operating life. The maximum number of drums stored at any one time is unknown but is at least 158 (Elvey, 1986). Drum accumulation often occurred for approximately one to two years prior to removal of drums from the area. Following drum removal, their contents were recycled (Elvey, 1988).

Dumpster Storage Area

A maximum of one, 12-foot by 16-foot dumpster was stored in this area (Elvey, 1988).

1.3.4 Total Container Storage Capacity

Drum Storage Area

Assuming a maximum of 460 drums were stored at any one time, the total storage capacity of the PU&D drum storage area over its operating life was 25,300 gallons.

The drums and their contents were sold periodically for recycling until September 1984, when the oil in the drums

was determined to contain hazardous constituents. In August 1985 the last drums being stored were removed from the site for disposal by Oil and Solvent Process Company. At that time, 154 drums of waste oil and four drums of spent paint thinner were removed (Elvey, 1986).

Dumpster Storage Area

The total capacity of the dumpster is approximately 860 cubic feet.

1.3.5 Monitoring and Containment Systems

Visual monitoring of the drum and dumpster storage areas was conducted periodically.

The drums and dumpsters were placed directly on the ground surface. Forms of containment, such as a concrete or asphalt pads or berms, were not present (Elvey, 1986).

1.3.6 Types of Wastes Stored in the Containers

Drum Storage Area

The drums stored in this area typically contained used oils from equipment and vehicle maintenance activities. The drums were stored in this location while awaiting recycling at an off-site facility. Some waste paints and paint thinners were also stored in this area from the Rocky Flats Paint Shop.

Samples from 101 of the 158 drums from the PU&D drum storage area were composited into twelve samples for analyses in May 1985. The components of the composited samples (Rockwell, 1985a) are shown on Tables II and III. As indicated by the analyses results, volatile organic compounds were present in the drums. Due to administrative controls at the Rocky Flats Plant (RFP), radioactive contamination of the soils is not expected at the PU&D yard. All drums should have been externally monitored by the Radiation Monitoring Department prior to shipment to the PU&D yard. The contents of any drums coming from an area at the RFP that handled radioactive materials would have been sampled and analyzed prior to shipment to the PU&D yard. Any drums with contents above detection limits, approximately 20 disintegrations per

TABLE II

COMPONENTS OF COMPOSITED DRUM SAMPLES
FROM THE PU & D DRUM STORAGE AREA
TAKEN IN MAY 1985

(Rockwell, 1985a)

<u>Sample Identification</u>	<u>Components</u>
PU & D C-1	- oil* - a volatile hydrocarbon solvent (e.g., mineral spirits: aliphatic naphtha) - carbon dioxide (minor) - water (major)(bottom layer) pH=9
PU & D C-2	- oil* - carbon dioxide (minor) - methyl alcohol (minor)
PU & D C-3	- oil* - carbon dioxide (minor)
PU & D C-4	- oil* - silicone lubricant (minor) - water (major)(bottom layer) pH=6
PU & D C-5	- oil* - silicone lubricant (minor) - carbon dioxide (minor)
PU & D C-6	- oil* - carbon dioxide (minor) - Freon (minor) - water (major)(bottom layer) pH=7
PU & D C-7	- oil* - silicone lubricant (minor) - carbon dioxide (minor) - water (major)(bottom layer) pH=7

TABLE II (cont.)

COMPONENTS OF COMPOSITED DRUM SAMPLES
FROM THE PU & D CONTAINER STORAGE FACILITY
TAKEN IN MAY 1985

(Rockwell, 1985a)

<u>Sample Identification</u>	<u>Components</u>
PU & D C-8	- oil* - silicone lubricant (minor) - carbon dioxide (major) - methyl alcohol (minor) - xylenes (minor) - water (major) (bottom layer) pH=6
PU & D C-9	- oil* - Freon TF (major) - carbon dioxide (minor) - water (major) (bottom layer) pH=7
PU & D C-10	- oil* - silicone lubricant (minor) - carbon dioxide (minor) - water (major) (bottom layer) pH=6
PU & D C-11	- oil* - Freon TF (major) - carbon dioxide (minor) - water (major) (bottom layer) pH=7
PU & D C-12	- silicone lubricant (major) - oil* - carbon dioxide - Freon TF (minor) - water (major) (bottom layer) pH=7

* A paraffinic base mineral oil.

TABLE III

PU & D DRUM STORAGE AREA
RESULTS OF METALS, PCBs AND GAMMA SCAN LABORATORY TESTING

(Rockwell, 1985a)

<u>Constituent</u>	PU & D	PU & D	PU & D	PU & D
	<u>C-1</u>	<u>C-2</u>	<u>C-3</u>	<u>C-4</u>
Aluminum (ug/ml)	25	20	18	60
Barium (ug/ml)	150	125	80	60
Beryllium (ug/ml)	<.10	<.10	<.10	<.10
Calcium (ug/ml)	>500	>500	>500	400
Cadmium (ug/ml)	<5.0	<5.0	<5.0	<5.0
Cobalt (ug/ml)	<10	<10	<10	<10
Chromium (ug/ml)	4.0	3.0	3.0	2.0
Copper (ug/ml)	10	9.0	7.0	6.0
Iron (ug/ml)	100	65	60	100
Potassium (ug/ml)	10	45	35	10
Lithium (ug/ml)	<1.0	<1.0	<1.0	<1.0
Magnesium (ug/ml)	70	90	100	70
Manganese (ug/ml)	<10	<10	<10	<10
Molybdenum (ug/ml)	<10	15	<10	<10
Sodium (ug/ml)	70	80	55	50
Nickel (ug/ml)	<1.0	<1.0	<1.0	<1.0
Lead (ug/ml)	130	70	110	35
Silicon (ug/ml)	45	18	20	130
Tin (ug/ml)	<10	<10	<10	<10
Vanadium (ug/ml)	<1.0	<1.0	<1.0	<1.0
Zinc (ug/ml)	215	175	175	125
Gamma Scan (pCi/l)	Pb212-26.4	Pb212-43.2	Pb212-12.2	Pb212-16.4
PCB (ppm)	<6.22	<6.00	<6.23	<6.04

TABLE III (Continued)

<u>Constituent</u>	<u>PU & D</u> <u>C-5</u>	<u>PU & D</u> <u>C-6</u>	<u>PU & D</u> <u>C-7</u>	<u>PU & D</u> <u>C-8</u>
Aluminum (ug/ml)	18	10	60	35
Barium (ug/ml)	110	<5.0	30	80
Beryllium (ug/ml)	<.10	<.10	.10	<.10
Calcium (ug/ml)	500	85	500	250
Cadmium (ug/ml)	<5.0	<5.0	<5.0	<5.0
Cobalt (ug/ml)	<10	<10	<10	<10
Chromium (ug/ml)	3.0	3.0	4.0	<1.0
Copper (ug/ml)	8.0	3.0	18	2.0
Iron (ug/ml)	0	35	170	125
Potassium (ug/ml)	<10	25	<10	20
Lithium (ug/ml)	<1.0	<1.0	<1.0	<1.0
Magnesium (ug/ml)	100	23	40	23
Manganese (ug/ml)	<10	<10	<10	<10
Molybdenum (ug/ml)	<10	<10	<10	<10
Sodium (ug/ml)	45	50	16	40
Nickel (ug/ml)	<1.0	4.0	2.0	<1.0
Lead (ug/ml)	80	4.0	50	7.0
Silicon (ug/ml)	45	18	130	130
Tin (ug/ml)	<10	<10	<10	<10
Vanadium (ug/ml)	<1.0	<1.0	<1.0	<1.0
Zinc (ug/ml)	180	10	120	15
Gamma Scan (pCi/l)	<background	Pb212-20.4 Th234-30.7	Pb212-6.5	Pb212-28.3
PCB (ppm)	<6.02	<50	<6.20	<6.22

TABLE III (Continued)

<u>Constituent</u>	<u>PU & D C-9</u>	<u>PU & D C-10</u>	<u>PU & D C-11</u>	<u>PU & D C-12</u>
Aluminum (ug/ml)	3.0	100	110	10
Barium (ug/ml)	15	25	13	20
Beryllium (ug/ml)	<.10	.50	<.10	<.10
Calcium (ug/ml)	70	225	250	90
Cadmium (ug/ml)	<5.0	<5.0	<5.0	<5.0
Cobalt (ug/ml)	<10	<10	<10	<10
Chromium (ug/ml)	2.0	6.0	7.0	1.0
Copper (ug/ml)	1.0	20	20	3.0
Iron (ug/ml)	25	200	225	60
Potassium (ug/ml)	60	25	25	15
Lithium (ug/ml)	3.0	<1.0	<1.0	<1.0
Magnesium (ug/ml)	15	45	40	9.0
Manganese (ug/ml)	<10	<10	<10	<10
Molybdenum (ug/ml)	<10	<10	<10	<10
Sodium (ug/ml)	80	60	60	60
Nickel (ug/ml)	<1.0	3.0	2.0	1.0
Lead (ug/ml)	2.0	160	200	1.0
Silicon (ug/ml)	11	300	250	120
Tin (ug/ml)	<10	<10	<10	<10
Vanadium (ug/ml)	<1.0	<1.0	<1.0	<1.0
Zinc(ug/ml)	<10	130	<130	<25
Gamma Scan (pCi/l)	<background	<background	<background	<background
PCB (ppm)	<6.03	<6.08	<6.10	<6.18

minute per 100 square centimeters (dpm/100cm²) would not have been allowed to be shipped to the PU&D yard. This level of radioactivity is at times exceeded by incoming raw oils.

The analyses performed that are reported on Table II were qualitative in nature. The oil layers of the composited samples were analyzed to determine their base materials. The remaining portions of the samples were analyzed by infrared spectroscopy. Descriptions of "major" and "minor" provide a relative comparison of compound quantity (Bell, 1986).

Dumpster Storage Area

The dumpster contained stainless steel chips coated with lathe coolant. The lathe coolant was either Freon based or oil based. The oil based coolant typically was comprised of 70 percent hydraulic oil and 30 percent carbon tetrachloride. Recently, solvents were eliminated from the process that produced the chips. Radioactive contamination of these chips should not have been present due to the presence of administrative controls at the RFP to prevent

the shipment of radioactively contaminated materials to this storage yard. (Elvey, 1988).

1.3.7 Existing Conditions of Area

Drum Storage Area

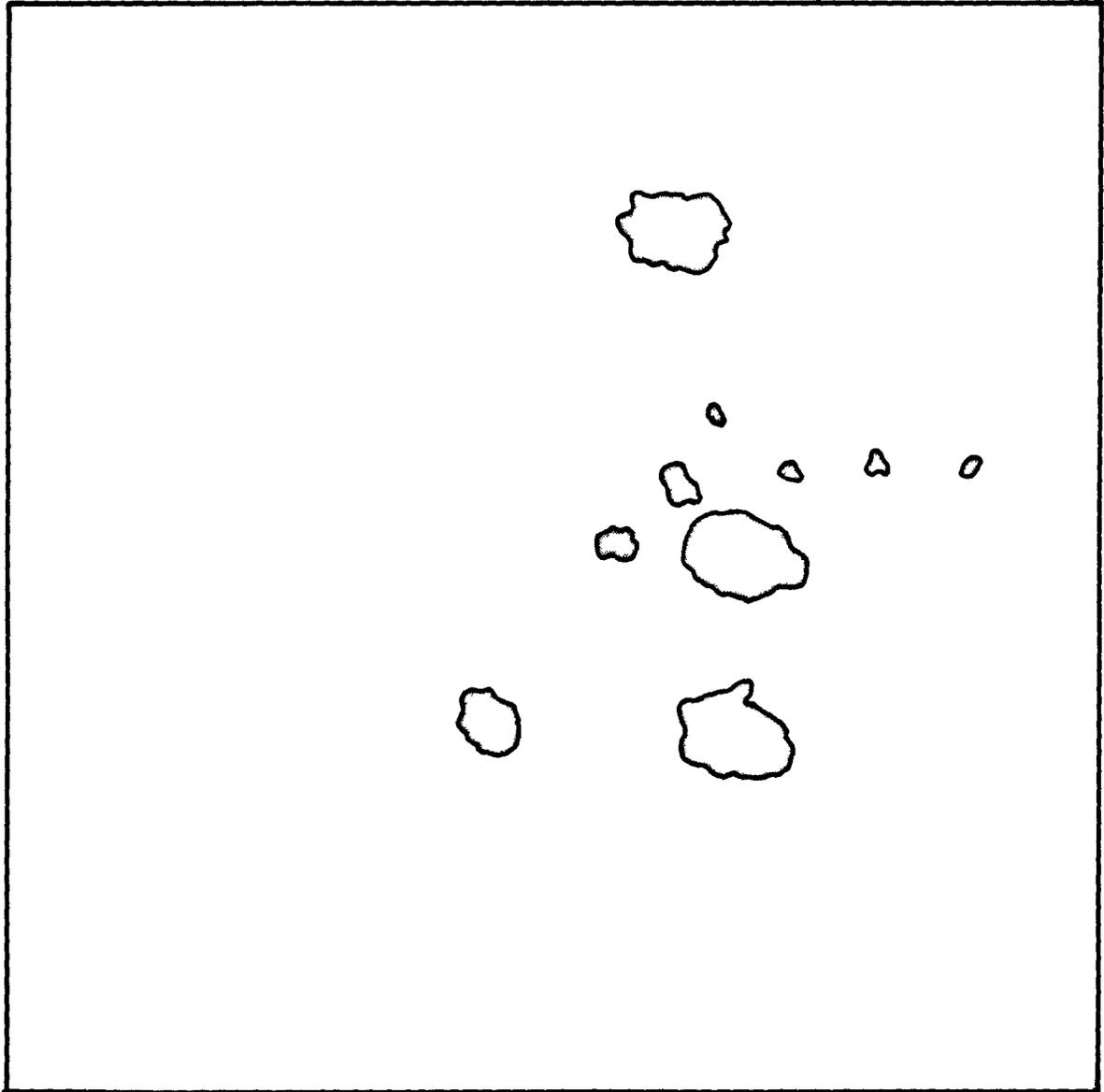
Currently, there are no containers stored at the PU&D drum storage area that contain hazardous wastes. Future hazardous waste container storage in the area is not planned. Visual evidence of staining of the ground surface exists; however, there have been no documented leaks or spills. A map of a visual survey conducted March 1, 1988, to observe the locations of soil staining is presented on Figure 3. The large PU&D yard does store empty containers awaiting off-site recycle.

Dumpster Storage Area

Currently, one dumpster is located in the RCRA-regulated dumpster storage area. This dumpster contains stainless steel chips awaiting recycle that are not contaminated with hazardous or radioactive constituents. Two other dumpsters in the vicinity contain carbon steel awaiting recycling. There have been no documented leaks or spills in this area.



APPROXIMATE
SCALE · 1"=10'



LEGEND



AREA OF SOIL STAINING

A fence surrounds the entire PU&D storage yard (Elvey, 1988). A visual survey conducted March 1, 1988, indicated there was no soil staining in the PU&D dumpster storage area.

1.3.8 Geologic Setting

The location of a cross section in the vicinity of the PU&D yard is shown on Figure 4. The cross section, shown on Figure 5, illustrates the geologic setting. Cross sections C-C', D-D' and E-E' are shown on Figure 6.

The geologic materials in the vicinity of the PU&D yard consist of Rocky Flats Alluvium, colluvium and Arapahoe Formation deposits. The Rocky Flats Alluvium consists of poorly to moderately sorted clay, silt, sand, gravel and cobbles which were deposited in a series of laterally coalescing alluvial fans (Hurr, 1976). The thickness of the alluvium is variable due to deposition on an erosional surface and recent erosional processes.

Colluvial materials consisting predominantly of clay with common occurrences of sandy clay and gravel layers are present on the surface of the North Walnut Creek drainage.

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000303

Titled: Figure 5: Cross Sections A-A', and B-B'

Fiche location: A-5W-M20

NOTICE

This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000303

Titled: Figure 6' Cross Sections C-C', D-D',
and E-E'

Fiche location: A-SW-M20

These materials were deposited by slope wash and downslope creep of Rocky Flats Alluvium and claystone bedrock. The thickness of the colluvium is not known in the vicinity of the PU&D storage yard.

Ground water in the Rocky Flats Alluvium and other surficial materials on the plant site occur under unconfined conditions. This shallow ground-water flow system is quite dynamic with average depths to water ranging from four to 14 feet below the ground surface. Ground-water flow generally follows the topography and is also governed by the configuration of the top of bedrock beneath the surficial materials. Generally, the shallow ground-water flow system direction is eastward from the plant.

The Arapahoe Formation consists of fluvial claystones with interbedded sandstones and siltstones. Weathering has penetrated to depths ranging from 10 to 40 feet below the base of the surficial deposits. Sandstones ranging from 10 to 35 feet in thickness were encountered in the borings in the vicinity of the PU&D storage yard. Most of the ground-water flow in the Arapahoe Formation occurs in these lenticular sandstones. Ground water in the sandstone units

generally flows to the east toward the point of regional discharge along the South Platte River (Robson, 1981).

1.4 Description of the Swinerton and Walberg Building 980 Container Storage Facility

1.4.1 Dates of Operation

The Swinerton and Walberg (S&W) Building 980 container storage facility (Figure 2) has been in use since approximately 1980. Use of the area for storage of containers for more than 90 days stopped in approximately September 1986 (Richards, 1986).

1.4.2 Location and Size of Container Storage Area

The storage facility is located approximately 75 feet south of Building 980. The storage area was approximately 25 feet by 25 feet in size and was the eastern portion of a storage yard with dimensions of approximately 25 feet by 75 feet (Richards, 1986).

1.4.3 Number, Types and Sizes of Containers Used

The maximum number of containers stored at any given time was ten. The containers were 55-gallon steel drums (Richards, 1986).

1.4.4 Total Container Storage Capacity

The total capacity of ten 55-gallon drums is 550 gallons.

1.4.5 Monitoring and Containment System

Visual monitoring of the storage area was conducted periodically. Written records of this monitoring were not maintained.

The 55-gallon drums were placed directly on the ground surface. A berm approximately 1 to 1 1/2 feet high was located on the west, south and east sides of the overall storage yard (Richards, 1986).

1.4.6 Types of Wastes Stored in the Containers

The wastes stored in the drums were generated in the on-site contractor's maintenance and fabrication shops (Rose, 1988) and should not have contained radioactive contamination. These wastes typically came from vehicle maintenance and miscellaneous painting activities.

Samples from seven drums from the S & W container storage facility were composited into five samples for analyses in May 1985. The components of the composited samples (Rockwell, 1985a) are shown on Tables IV and V. Generally, the drums contained waste oils and thinners.

The analyses performed that are reported on Table IV were qualitative in nature. The oil layers of the composited samples were analyzed to determine their base materials. The remaining portions of the samples were analyzed by infrared spectroscopy. Descriptions of "major" and "minor" provide a relative comparison of compound quantity (Bell, 1986).

TABLE IV

COMPONENTS OF COMPOSITED DRUM SAMPLES
FROM THE S & W BUILDING 980
CONTAINER STORAGE AREA TAKEN IN MAY 1985

(Rockwell, 1985a)

<u>Sample Identification</u>	<u>Components</u>
S & W Oil -5-	Oil**
S & W Texaco Oil	Oil**
S & W Brake Fluid	Glycol ether/borate base brake fluid
Texaco Meropa & Thurban	Oil*
Zep Dyna-Sol -2-	Oil* Xylenes (major) Freon TF (minor)

* A paraffinic base mineral oil.

** A mix of paraffinic and naphthinic base mineral oil.

TABLE V

S&W BUILDING 980 CONTAINER STORAGE FACILITY
RESULTS OF METALS, PCBs AND
GAMMA SCAN LABORATORY TESTING

(Rockwell, 1985a)

<u>Constituent</u>	<u>S&W Oil -5-</u>	<u>S&W Texaco Oil</u>	<u>S&W Brake Fluid</u>
Aluminum (ug/ml)	2.0	3.0	2.0
Barium (ug/ml)	<5.0	<5.0	500
Beryllium (ug/ml)	<.10	<.10	.20
Calcium (ug/ml)	200	2.0	4.0
Cadmium (ug/ml)	<5.0	<5.0	<5.0
Cobalt (ug/ml)	<10	<10	<10
Chromium (ug/ml)	<1.0	<1.0	<1.0
Copper (ug/ml)	<1.0	<1.0	<1.0
Iron (ug/ml)	<10	<10	<10
Potassium (ug/ml)	<10	<10	<10
Lithium (ug/ml)	<1.0	<1.0	<1.0
Magnesium (ug/ml)	<1.0	<1.0	<1.0
Manganese (ug/ml)	<10	<10	<10
Molybdenum (ug/ml)	<10	<10	<10
Sodium (ug/ml)	<16	<16	160
Nickel (ug/ml)	<1.0	<1.0	<1.0
Lead (ug/ml)	25	<1.0	15
Silicon (ug/ml)	2.0	3.0	3.0
Tin (ug/ml)	<10	<10	<10
Vanadium (ug/ml)	<1.0	<1.0	<1.0
Zinc (ug/ml)	50	<10	<10
Gamma Scan (pCi/l)	<background	Th234-547	Pb212-18.5
PCB (ppm)	<6.15	<6.03	<6.14

TABLE V (Continued)

<u>Constituent</u>	<u>Texaco Meropa and Thurban</u>	<u>Zep Dyna- Sol -2-</u>
Aluminum (ug/ml)	<1.0	<1.0
Barium (ug/ml)	<5.0	<5.0
Beryllium (ug/ml)	<.10	<.10
Calcium (ug/ml)	4.0	2.0
Cadmium (ug/ml)	<5.0	<5.0
Cobalt (ug/ml)	<10	<10
Chromium (ug/ml)	<1.0	<1.0
Copper (ug/ml)	<1.0	<1.0
Iron (ug/ml)	<10	<10
Potassium (ug/ml)	<10	<10
Lithium (ug/ml)	<1.0	<1.0
Magnesium (ug/ml)	<1.0	<1.0
Manganese (ug/ml)	<10	<10
Molybdenum (ug/ml)	<10	<10
Sodium (ug/ml)	<16	<16
Nickel (ug/ml)	<1.0	<1.0
Lead (ug/ml)	<1.0	<1.0
Silicon (ug/ml)	2.0	3.0
Tin (ug/ml)	<10	<10
Vanadium (ug/ml)	<1.0	<1.0
Zinc (ug/ml)	<10	<10
Gamma Scan (pCi/l)	Pb212-2.2	<background
PCB (ppm)	<50.0	<6.34

1.4.7 Existing Conditions of Area

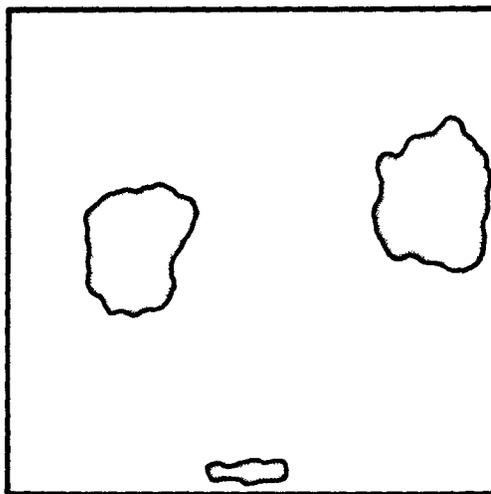
The storage area has been used for less than 90-day storage since approximately September 1986. Continued use of the area in this manner is planned. As determined by a site visit in November 1986, the area then contained ten drums. Eight or nine of the ten drums were empty. As of March 1988, the area contained approximately 35 drums. Only one of these drums contained hazardous waste. This waste is managed in full compliance with all applicable RCRA regulations. The others contained either nonhazardous waste or unused materials (Rose, 1988). Visual evidence of staining of the ground surface exists; however, there have been no documented leaks or spills. A map of a visual survey conducted March 1, 1988, to observe the locations of soil staining is presented on Figure 7.

1.4.8 Geologic Setting

The geologic settings of the S&W Building 980 container storage facility and S&W contractor storage yard are depicted in Sections C-C' and D-D' of Figure 6. The geologic materials encountered included approximately 10 feet of Rocky Flats Alluvium overlying the Arapahoe



APPROXIMATE SCALE: 1"=10'



LEGEND:



AREA OF SOIL STAINING

Formation. The thickness of the Rocky Flats Alluvium is variable due to deposition on an erosional surface and recent erosional processes. Ground water was encountered at the base of the Rocky Flats Alluvium under unconfined conditions and within the sandstones of the Arapahoe Formation. The position of the sandstone bodies encountered in the vicinity of these areas are indicated on Sections C-C' and D-D'. Ground-water flow is generally eastward from the plant.

1.5 Description of the Swinerton and Walberg Contractor Storage Yard

1.5.1 Dates of Operation

Use of the Swinerton and Walberg (S&W) contractor storage yard (Figure 2) began in approximately 1970. Drum storage began at that time and continued until 1985 (Baker, 1986). This yard has been used for storage of contractor materials for use in various projects at the RFP. The storage of waste materials was never intended; however, unneeded materials that qualified as a hazardous waste were identified in the yard in 1985. These materials were subsequently disposed of as hazardous waste.

1.5.2 Location and Size of Container Storage Area

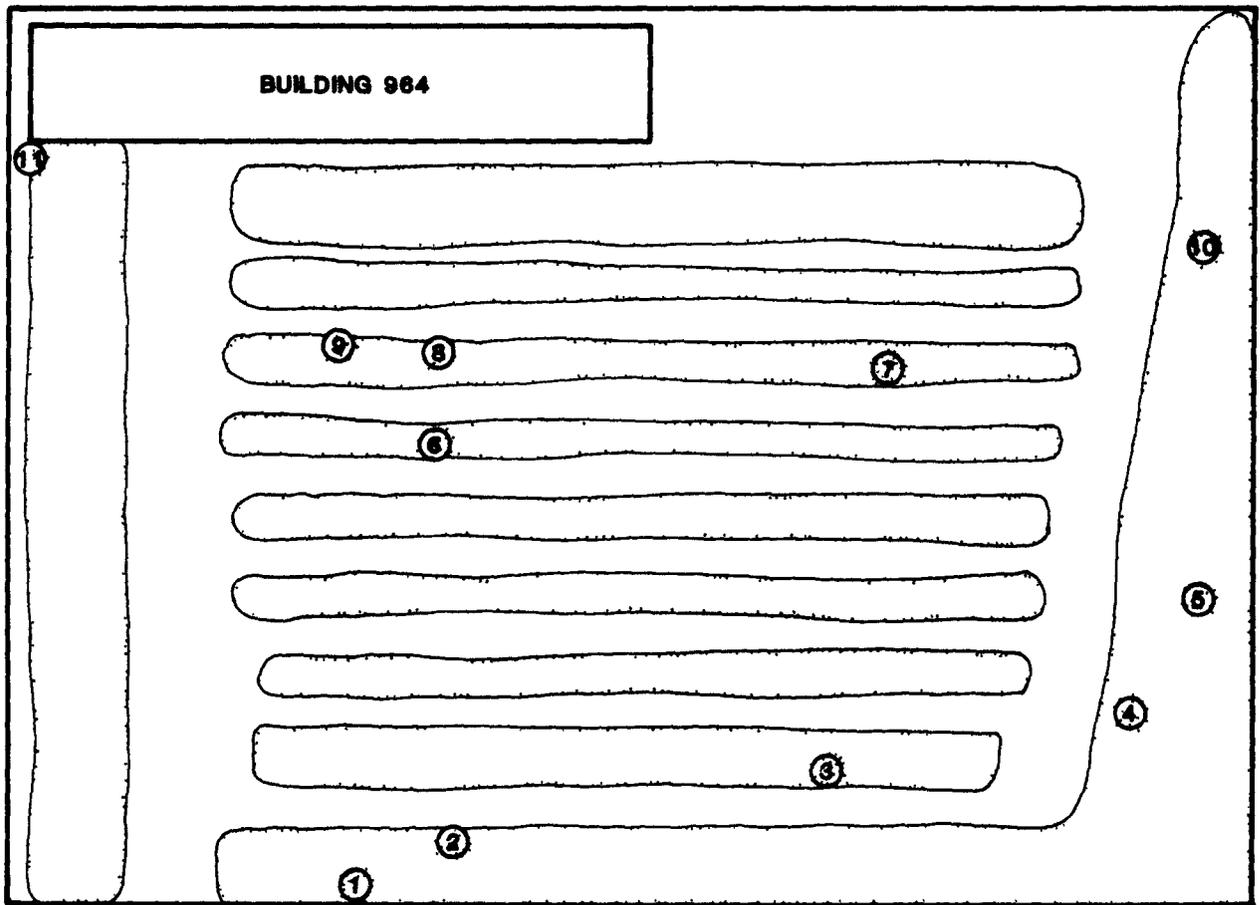
The western boundary of the S&W contractor storage yard is located approximately 50 feet east of the 207-B ponds. The yard is approximately 320 feet by 230 feet in size. The containers were stored in numerous areas of the yard over its use; however, the exact locations of the storage areas throughout the yard's life are unknown (Baker, 1986). The locations of the drums containing material that qualified as a hazardous waste in 1985 is presented on Figure 8. The descriptions of the containers indicated on Figure 8 are presented in Table VI. As shown on Figure 8, storage of materials qualifying as a hazardous waste was limited in extent compared with the rest of the yard. The majority of the yard has been used for storage of surplus or raw materials awaiting contractor use in construction or maintenance projects. The entire yard was at no time used for drum storage. The drums stored at the site have been relatively few in number.

1.5.3 Number, Types and Size of Containers Used

The total number of containers stored in the yard over the life of the facility or the maximum stored at any given time



APPROXIMATE SCALE: 1"=50'



LEGEND:



HISTORICAL LOCATION OF MATERIAL STORAGE



**LOCATION OF CONTAINERS OBSERVED IN 1985 SURVEY OF AREA.
SEE TABLE VI FOR DESCRIPTION OF CONTAINERS STORED IN AREA.**

TABLE VI

LIST OF CONTAINERS STORED IN THE
S&W CONTRACTOR STORAGE YARD IN 1985

<u>Location</u> ⁽¹⁾	<u>Container(s)</u>
1	Pile of small containers
2	4 - 5 gallon cans
3	19 - 55 gallon drums, 3 were nearly full, most were empty
4	3 - 55 gallon drums, all full
5	9 - 55 gallon drums, 3 were full
6	1 - 30 gallon drum of gear lube
7	2 - 5 gallon cans
8	1 - 55 gallon drum, empty 4 - 20 gallon drums, all full 1 - 5 gallon can
9	5 containers, 4 were full, 1 was half full
10	1 - 55 gallon drum, full
11	1 - 5 gallon pail

Note:

(1) Location refers to Figure 8

are unknown. The containers stored were 55-gallon steel drums (Baker, 1986). The maximum number of containers is considerably less than the total storage capacity of the yard, since container storage was incidental and numerous roads and aisles have existed and currently exist.

1.5.4 Total Container Storage Capacity

The total amount of waste stored at the S&W contractor storage yard is unknown (Baker, 1986). Based on records from the 1985 survey of the yard, the maximum amount of waste that could have been placed in the drums that were present at the time was 1,965 gallons.

1.5.5 Monitoring and Containment Systems

Visual monitoring of the storage yard was conducted periodically. Written records of this monitoring were not maintained.

The drums were placed directly on the ground surface or on pallets. There were no berms or other forms of containment around the stored drums (Baker, 1986).

1.5.6 Types of Wastes Stored in the Containers

Samples from 31 of the containers present during the 1985 survey were obtained and analyzed for their composition and metals. Results of these analyses are presented in Appendix 1. In general, the drums contained waste oils and mineral spirits with some volatile organics and metals present (Baker, 1986 and Rockwell, 1985b).

1.5.7 Existing Conditions of Area

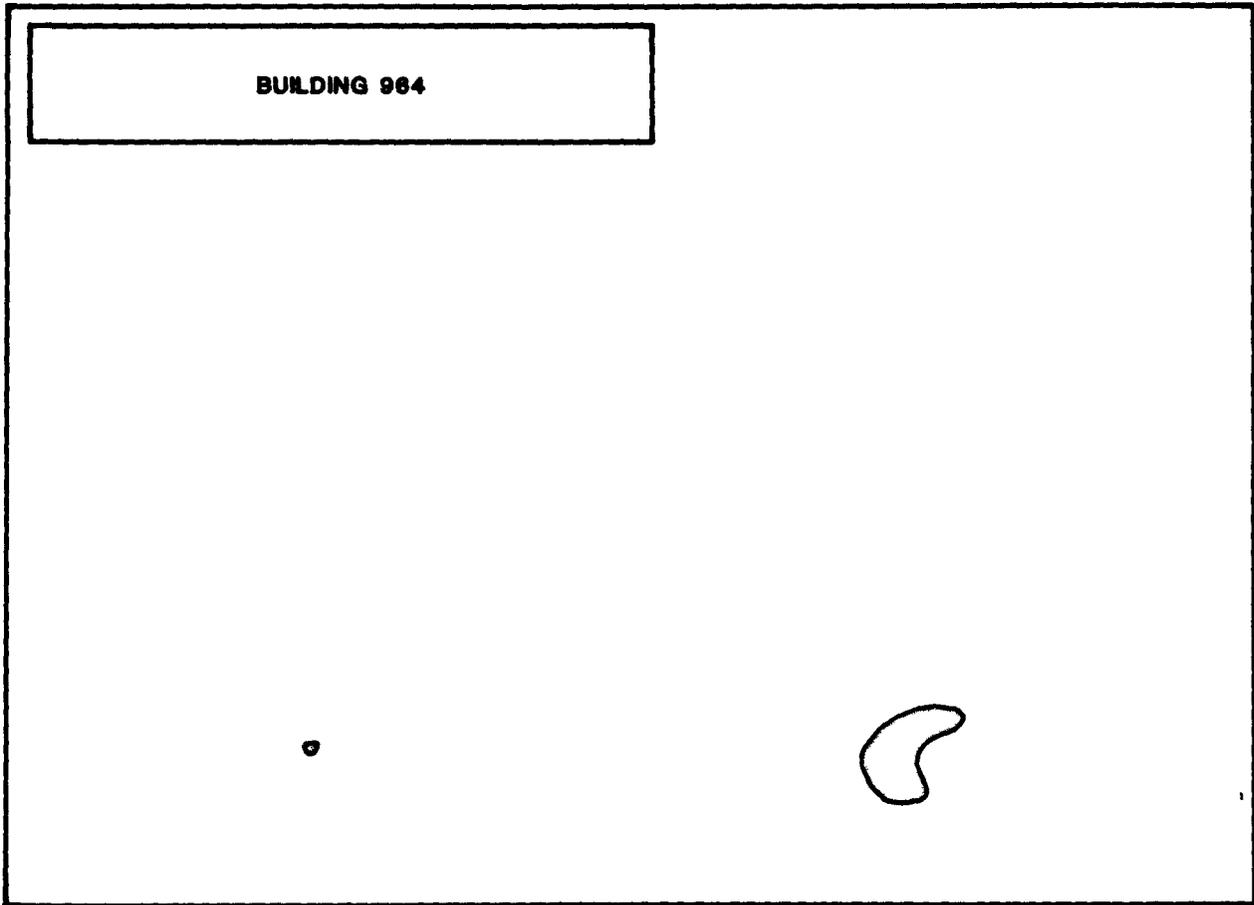
As of March 1988, there were no containers at the S&W contractor storage yard that contained hazardous wastes or constituents. Visual evidence of spills or leakage in the storage yard exists (Baker, 1986). A map of a visual survey conducted March 1, 1988, to observe the locations of soil staining is presented on Figure 9.

1.5.8 Geologic Setting

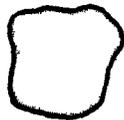
The geologic setting of the S&W contractor storage yard is the same as discussed in Section 1.4.8 for the S&W Building 980 container storage facility.



APPROXIMATE
SCALE. 1"=50'



LEGEND



AREA OF SOIL STAINING

1.6 Description of the Building 885 Drum Storage Area

1.6.1 Dates of Operation

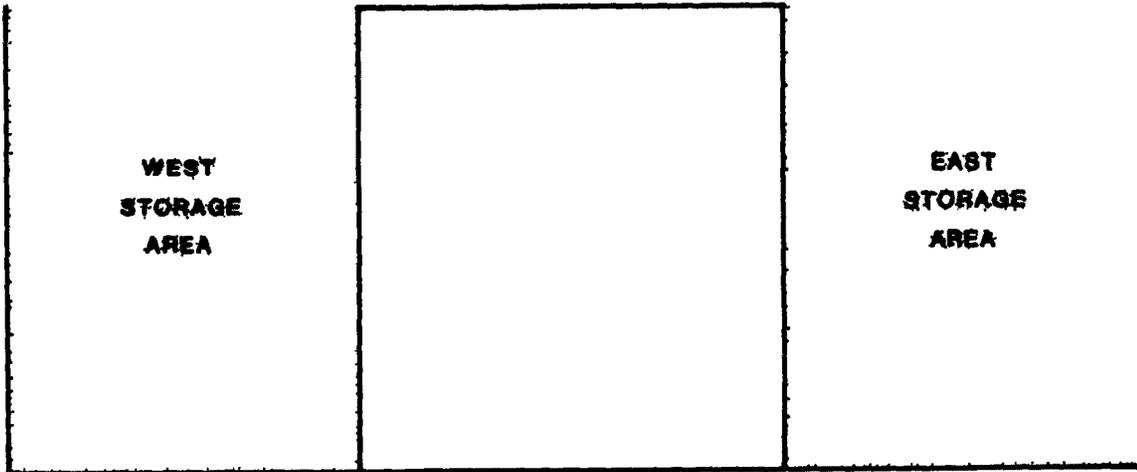
The Building 885 drum storage area (Figure 2) was first used when Building 881 was completed in the mid 1950's. The area is still in use as a 90-day accumulation area and as a satellite collection station (Gonzales, 1986 and U.S. Department of Energy, 1987a).

1.6.2 Location and Size of Container Storage Area

Building 885 is divided into three sections, as shown on Figure 10. The east section has a southern and western wall and roof and is exposed on the north and east. The center section is completely enclosed. The west section is enclosed on the west, south and east sides by walls and by a roof. The storage areas are located in the east and west sections of Building 885. Both storage areas were approximately 10 feet by 20 feet in size (Lyons, 1986).



NOT TO SCALE



1.6.3 Number, Types and Sizes of Containers Used

The containers stored in the Building 885 drum storage area were 55-gallon steel drums. The storage area was divided into two sections. The west section stored unused and waste oils and the east section stored unused and waste paint and paint solvents used by maintenance. The maximum number of drums stored in each section was 10 to 20. Only one drum in each section contained waste material. The remaining drums contained unused oils and solvents (Gonzales, 1986 and Lyons, 1986).

1.6.4 Total Container Storage Capacity

Assuming only one drum from each section contained waste material, the total container storage capacity was 110 gallons.

1.6.5 Monitoring and Containment Systems

Visual monitoring of the storage area was conducted periodically. Written records of this monitoring were not maintained.

The drums were stored on pallets. The ground surfaces in the east and west sections were covered with concrete slabs. There were no berms around the storage area (Gonzales, 1986 and Lyons, 1986).

1.6.6 Types of Wastes Stored in the Containers

The drums contained waste oils, waste paints and waste solvents. The waste material also contained low-level radioactive wastes (Gonzales, 1986 and Lyons, 1986).

1.6.7 Existing Conditions of Area

The east and west sections contained four and eleven 55-gallon drums, respectively, in November 1986. Visual evidence of staining of the ground surface exists; however, there have been no documented leaks or spills. The areas are currently used as 90-day accumulation areas and satellite collection stations (Gonzales, 1986; Lyons, 1986; and U.S. Department of Energy, 1987a).

1.6.8 Geologic Setting

The geologic setting of the Building 885 drum storage area is depicted in Section E-E' on Figure 6. Geologic materials in the vicinity of the above sites consist of Rocky Flats Alluvium, disturbed ground, and Arapahoe Formation bedrock deposits.

The Rocky Flats Alluvium varies in thickness across the area from less than two feet to over ten feet. The thickness of the alluvium is variable due to deposition on an erosional surface and recent erosional processes. Ground water is occasionally encountered at the base of the alluvium.

Disturbed ground consisting of very poorly sorted and unconsolidated artificial fill is the surficial material over the southern portion of the area. This fill has been derived either from the excavation of the Building 881 foundation or from cleanup of the 1969 fire. The fill materials are generally composed of clay, sand, gravel and cobbles derived from Rocky Flats Alluvium, and claystone bedrock. Ground water is present at the base of the fill.

1.7 Description of the Building 881 Drum Storage Area

1.7.1 Dates of Operation

The Building 881 drum storage area (Figure 2) was first used when Building 881 was completed in the mid 1950's. The area is still in use for less than 90-day storage (Gonzales, 1986).

1.7.2 Location and Size of Container Storage Area

The storage area was located in Room 165. The area was approximately 5 feet by 5 feet in size.

1.7.3 Number, Types and Sizes of Containers Used

The containers used in the storage area consisted of 55-gallon steel drums. The maximum number of drums stored at any given time was five (Lyons, 1986).

1.7.4 Total Container Storage Capacity

The total storage capacity of five 55-gallon drums is 275 gallons.

1.7.5 Monitoring and Containment Systems

Visual monitoring of the storage area was conducted periodically.

The drums were placed directly on a concrete floor. There were no berms around the stored drums (Gonzales, 1986 and Lyons, 1986).

1.7.6 Types of Wastes Stored in the Containers

The drums stored maintenance waste oil which contained hazardous and possibly low-level radioactive wastes (Lyons, 1986).

Results of analyses of wastes from Building 881, typical of those stored in the Building 881 drum storage area, are presented on Table VII (Rockwell, 1983). The analyses for general components reported on this table were qualitative in nature. As indicated by the analyses results, volatile organic compounds and radioactivity were present in the wastes from Building 881.

TABLE VII

TYPICAL COMPONENTS OF DRUMS STORED IN
THE BUILDING 881 DRUM STORAGE AREA

(Rockwell, 1983)

<u>Sample Identification</u>	<u>Total Alpha (pCi/l)</u>	<u>Beryllium (ug/ml)</u>	<u>Components</u>
Samples Taken November 8, 1983			
68	0+70	<0.1	(1)
69	11+96	<0.1	
70	59+86	<0.1	
Samples Taken April 8, 1986			
308			-Freon TF
309			-Freon TF -1,1,1-Trichloroethane
Samples Taken July 18, 1986			
330	8,800+1,400	<0.1	-Freon TF
331	1,900+100	<0.1	-Freon TF -Carbon dioxide
332	840+90	<0.1	-Freon TF -Carbon dioxide
Samples Taken August 8, 1986			
345	5,900+1,000	<0.10	-Water -Freon TF
346	5,400+1,300	<0.10	-Freon TF (<1.0% by volume)

Note: (1) Blanks indicate analysis for components or a specific parameter was not conducted.

1.7.7 Existing Conditions of Area

There is no visual evidence or documented reports of spills or leakage in the storage area. As determined by a site visit in November 1986, the area contained five 55-gallon drums. The area is currently a 90-day accumulation area for hazardous waste (Gonzales, 1986; Lyons, 1986; and U.S. Department of Energy, 1987a).

1.7.8 Geologic Setting

A description of the geologic setting of the Building 881 drum storage area is not necessary since the building provided secondary containment to the area and there have been no known releases to the environment from the area.

1.8 Description of the Building 865 Drum Storage Area

1.8.1 Dates of Operation

Use of the Building 865 drum storage area (Figure 2) began in 1970. The area is currently designated as a 90-day accumulation area (Norris, 1986 and U.S. Department of

Energy, 1987a). The need for 90-day accumulation storage in this area is being reviewed (Norris, 1988).

1.8.2 Location and Size of Container Storage Area

The storage area was located in Room 145. The area was approximately 8 feet by 12 feet in size (Norris, 1986).

1.8.3 Number, Types and Sizes of Containers Used

The storage area contained a maximum of ten 55-gallon steel drums (Norris, 1986).

1.8.4 Total Container Storage Capacity

The total storage capacity of ten 55-gallon drums is 550 gallons.

1.8.5 Monitoring and Containment Systems

Visual monitoring of the storage area was conducted every evening.

The drums were placed on a concrete floor. The floor did not have floor drains. There were no berms around the drums (Norris, 1986).

1.8.6 Types of Wastes Stored in the Containers

In November 1986, the drums contained waste oils, chlorinated solvents and possibly beryllium (Norris, 1986). Since that time, chlorinated solvent usage has been eliminated in the area the wastes are generated. This elimination of chlorinated solvent usage is part of Rocky Flats ongoing waste minimization program. The drums currently contain waste oils that are possibly contaminated with beryllium (Norris, 1988).

Samples from the drums stored in the area on two dates were obtained and analyzed for total alpha, beryllium and/or general components. The results of the analyses (Rockwell, 1986a) are shown on Table VIII. The analyses for general components reported on this table were qualitative in nature. As indicated by the analyses results, volatile organic compounds, beryllium and radioactivity were present in the drums.

TABLE VIII

COMPONENTS OF DRUM SAMPLES FROM THE
BUILDING 865 DRUM STORAGE AREA

(Rockwell, 1986a)

<u>Sample Identification</u>	<u>Total Alpha (pCi/l)</u>	<u>Beryllium (ug/g)</u>	<u>Components</u>
Samples Taken May 2, 1986			
320	3,600 \pm 0	0.21	-1,1,1-Trichloroethane (<0.1% by volume) -Freon TF (<0.1% by volume) -Carbon dioxide
321	4,400 \pm 600	0.40	-1,1,1-Trichloroethane (<0.1% by volume) -Carbon dioxide
Samples Taken July 10, 1986			
333	7,000 \pm 1,400	3.9	(1)
334	2,600 \pm 300	0.35	
335	1,400 \pm 600	1.7	
336	3,800 \pm 600	<0.1	
337	120,000 \pm 0	0.51	

Note:

(1) Blank indicates components not analyzed for.

1.8.7 Existing Conditions of Area

There is no visual evidence or documented reports of spills or leakage in the storage area. As determined by a site visit in November 1986, the area contained one or two drums at that time. The area is currently designated a 90-day accumulation area. The need for a 90-day accumulation point in this area is currently under review (Norris, 1986 and U.S. Department of Energy, 1987a).

1.8.8 Geologic Setting

A description of the geologic setting of the Building 865 drum storage area is not necessary since the building provided secondary containment to the area and there have been no known releases to the environment from the area.

1.9 Description of the Building 883 Drum Storage Area

1.9.1 Dates of Operation

The Building 883 drum storage area (Figure 2) has been used since 1981. The storage area is still in use for less than 90-day storage (Rowzee, 1986 and Rowzee, 1988).

1.9.2 Location and Size of Container Storage Area

The storage area was located in Room 104. The area was a maximum of approximately 10 feet by 16 feet in size (Rowzee, 1986).

1.9.3 Number, Types and Sizes of Containers Used

A maximum of approximately 30 55-gallon drums were held in the storage area. The drums were made of steel (Rowzee, 1986).

1.9.4 Total Container Storage Capacity

The total storage capacity of thirty 55-gallon drums is 1,650 gallons.

1.9.5 Monitoring and Containment Systems

Visual monitoring of the drums was conducted periodically by personnel from Building 883.

The drums were placed directly on a concrete floor. The floor has no drains. There were no berms around the storage area (Rowzee, 1986).

1.9.6 Types of Wastes Stored in the Containers

The drums contained waste oils that were usually contaminated with solvents and uranium (Rowzee, 1988).

Samples from drums stored in the area on five dates were obtained and analyzed for total alpha, beryllium and/or general components. The results of the analyses (Rockwell, 1986a) are shown on Table IX. The analyses for general components reported on Table IX were qualitative in nature. As indicated by the analyses results, volatile organic compounds, beryllium and radioactivity were present in the drums.

1.9.7 Existing Conditions of Area

There is no visual evidence or documented reports of spills or leakage in the storage area. In November 1986, the area contained approximately thirty drums. In February 1988, the area contained approximately four drums. The drums are currently stored for less than 90 days (Rowzee, 1986 and Rowzee, 1988).

TABLE IX
COMPONENTS OF DRUM SAMPLES FROM THE
BUILDING 883 DRUM STORAGE AREA

(Rockwell, 1986a)

<u>Sample Identification</u>	<u>Total Alpha (pCi/l)</u>	<u>Beryllium (ug/g)</u>	<u>Components</u>
Samples Taken February 7, 1986			
290	2,300+600	<.10	(1)
291	1,200+500	<.10	
292	1,600+600	<.10	
293	38,000+0	<.10	
294	4,700+1,500	<.10	
295	1,100+100	<.10	
296	280+70	<.10	
297	3,600+900	<.10	
298	540+80	<.10	
299	670+80	<.10	
300	88,000+20,000	<.10	
301	90,000+8,000	<.10	
302	36,000+9,000	<.10	
303	3,700+1,600	.15	
304	4,800+1,700	<.10	
Samples Taken March 18, 1986			
1			-Carbon dioxide
2			-Carbon dioxide
5			-1,1,1-Trichloroethane -Freon
15			-1,1,1-Trichloroethane -Carbon dioxide -Freon TF -1,1,1-Trichloroethane
Samples Taken May 7, 1986			
322	8,400+400	<.10	
323	110+70	<.10	
324	23,000+13,000	<.10	
325	3,300+200	<.10	

TABLE IX (continued)

COMPONENTS OF DRUM SAMPLES FROM THE
BUILDING 883 DRUM STORAGE AREA

(Rockwell, 1986a)

<u>Sample Identification</u>	<u>Total Alpha (pCi/l)</u>	<u>Beryllium (ug/g)</u>	<u>Components</u>
Samples Taken July 17, 1986			
327	310 _± 60	<0.10	-Freon TF (<0.1% by volume) -Carbon dioxide
328	280 _± 20	<0.10	-Freon TF (<0.1% by volume)
Samples Taken July 18, 1986			
330	8,800 _± 1,400	<0.10	-Freon TF
331	1,900 _± 100	<0.10	-Freon TF -Carbon dioxide
332	840 _± 90	<0.10	-Freon TF -Carbon dioxide

Note:

- (1) Blanks indicate analysis for components or a specific parameter was not conducted.

1.9.8 Geologic Setting

A description of the geologic setting of the Building 883 drum storage area is not necessary since the building provided secondary containment to the area and there have been no known releases to the environment.

1.10 Description of the Building 334 Cargo Container Area

1.10.1 Dates of Operation

The Building 334 cargo container area was used from approximately the summer of 1984 through July 1986 (Baker, 1986).

1.10.2 Location and Size of Container Storage Area

The cargo container was located outside of Building 334. The container area was 8 feet by 20 feet in size (Baker, 1986).

1.10.3 Number, Types and Sizes of Containers Used

The storage area contained one steel cargo container. The container was 8 feet by 8 feet by 20 feet in dimensions. The container was capable of holding a maximum of eighteen 55-gallon drums. However, seven drums was the maximum placed in the container. The drums were made of steel (Baker, 1986).

1.10.4 Total Container Storage Capacity

Based on a maximum of seven drums held in the cargo container, the historical maximum storage capacity of material stored in the container was 385 gallons.

1.10.5 Monitoring and Containment Systems

The cargo container was monitored weekly on the inside and outside during its use.

The cargo container was placed on an asphalt pad. There were no berms surrounding the container; however, a collection pan was located in the bottom of the cargo container, fully complying with all RCRA requirements for

secondary containment related to long-term container storage (Baker, 1986).

1.10.6 Types of Wastes Stored in the Containers

The wastes stored include machine oils, solvents and machine coolants and possibly low-level radioactive wastes (Baker, 1986).

1.10.7 Existing Conditions of Area

There is no visual evidence or documented reports of spills or leakage from any of the drums in the cargo container. There are no known releases to the environment from this storage facility. The container and associated drums have been removed from the area. The cargo container was moved to the Building 444/453 storage area, discussed in Section 1.11.

1.10.8 Geologic Setting

The geologic setting of the Building 334 cargo container area and the Building 444/453 drum storage area is depicted in Section A-A' on Figure 5. Surficial deposits in these

areas consist of approximately 20 feet of Rocky Flats Alluvium and lesser amounts of colluvium overlying claystone bedrock of the Arapahoe Formation. The Rocky Flats Alluvium caps the upland areas while colluvium blankets the Woman Creek drainage. Ground water is encountered at the base of the Rocky Flats Alluvium and within the sandstones of the Arapahoe Formation, flowing basically east from the facility.

1.11 Description of the Building 444/453 Drum Storage Area

1.11.1 Dates of Operation

The Building 444/453 drum storage area was first used when the two buildings were constructed in the late 1960's. The storage area was used until the fall of 1986 (Gibson, 1986 and Sargent, 1988).

1.11.2 Location and Size of Container Storage Area

The storage area was located between Buildings 444 and 453. The area was the shape of a square with the southwest corner removed. The square had sides of 45 feet and the removed

corner was a rectangle approximately 15 feet by 20 feet in size. The total area covered was approximately 1,700 square feet (Gibson, 1986).

1.11.3 Number, Types and Sizes of Containers Used

The area stored 55-gallon steel drums. The maximum number of drums ever stored at one time was approximately 200 (Gibson, 1986). However, some of the approximately 200 drums contained unused oil (Baker, 1986). The maximum number of drums stored in this area that contained contaminated waste oils or solvents is unknown.

1.11.4 Total Container Storage Capacity

Based on storage of 200 55-gallon drums, the total container storage capacity at any given time was 11,000 gallons.

1.11.5 Monitoring and Containment Systems

Visual monitoring of the storage area was conducted periodically.

Originally, the 55-gallon drums were placed directly on the ground surface. In approximately the mid 1970's, the top 4 inches of soil in a portion of the storage area was removed and replaced with 4 inches of asphalt. The removed material was believed to be contaminated. Drums were still placed on the soil in remaining portions of the storage area. There are no berms around the storage area (Gibson, 1986).

1.11.6 Types of Wastes Stored in the Containers

Waste hydraulic oils and chlorinated solvents were stored in the 55-gallon drums. Beryllium and low-level uranium contamination was sometimes present in the waste (Gibson, 1986 and Sargent, 1988).

1.11.7 Existing Conditions of Area

There currently are no drums of waste oils or solvents stored at the outside Building 444/453 drum storage area. This area is currently roped off and is usually empty. Trash, such as wood, is sometimes temporarily placed in the roped-off area (Sargent, 1988). Soil staining, apparently due to spillage of oils, is generally present throughout the

storage area. The cargo container that was used outside of Building 334 prior to August 1986 was located adjacent to the Building 444/453 storage area in the fall of 1986 (Gibson, 1986). This cargo container was moved out of this area to the RFP main hazardous waste storage area, identified as Unit #1 in the RCRA Part B Permit Application (U.S. Department of Energy, 1987a). A radiation survey of the area identified above background levels of ionizing radiation at some locations of the Building 444/453 drum storage area.

1.11.8 Geologic Setting

The geologic setting of the Building 444/453 drum storage area is discussed in Section 1.10.8.

1.12 Maximum Extent of Operation

A closure plan must "identify the maximum extent of the operation which will be unclosed during the life of the facility" [40 CFR 265.112(a)(1)]. The estimate must be high enough to ensure that if an inspector came onto the facility, none of the conditions observed would exceed those stated in the plan.

1.12.1 Maximum Number of Containers Stored

The maximum number of containers to be stored for more than 90 days at any of the container storage facilities covered in this closure plan is zero.

1.12.2 Maximum Container Treatment and Storage Area Available

The maximum areas used for container treatment and storage are shown on Table X.

TABLE X

MAXIMUM AREAS WHICH MAY
REQUIRE DECONTAMINATION

<u>Facility</u>	<u>Area (sq. ft.)</u>
PU & D Container Storage Facilities	
Drum Storage Area	3,600
Dumpster Storage Area	768
S&W Building 980 Container Storage Facility	625
S&W Contractor Storage Yard	73,600
Building 885 Drum Storage Area	400
Building 881 Drum Storage Area	25
Building 865 Drum Storage Area	96
Building 883 Drum Storage Area	160
Building 334 Cargo Container Area	160
Building 444/453 Drum Storage Area	1,700

The maximum area at the PU&D dumpster storage area which may require decontamination is based on the area occupied by

four adjacent dumpsters. The dumpster stored in this area was always placed in the same general location, but perhaps not in the exact 12-foot by 16-foot area.

1.13 Description of Auxiliary Equipment

There was no currently identifiable auxiliary equipment used at any of the container storage facilities.

1.14 Closure Plan Summary

1.14.1 Closure Objectives

This closure plan has been prepared to meet the performance standards of 6 CCR 1007-3, Section 265.111. The promulgated standards require a facility must be closed in a manner that:

- . minimizes the need for further maintenance, and
- . controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

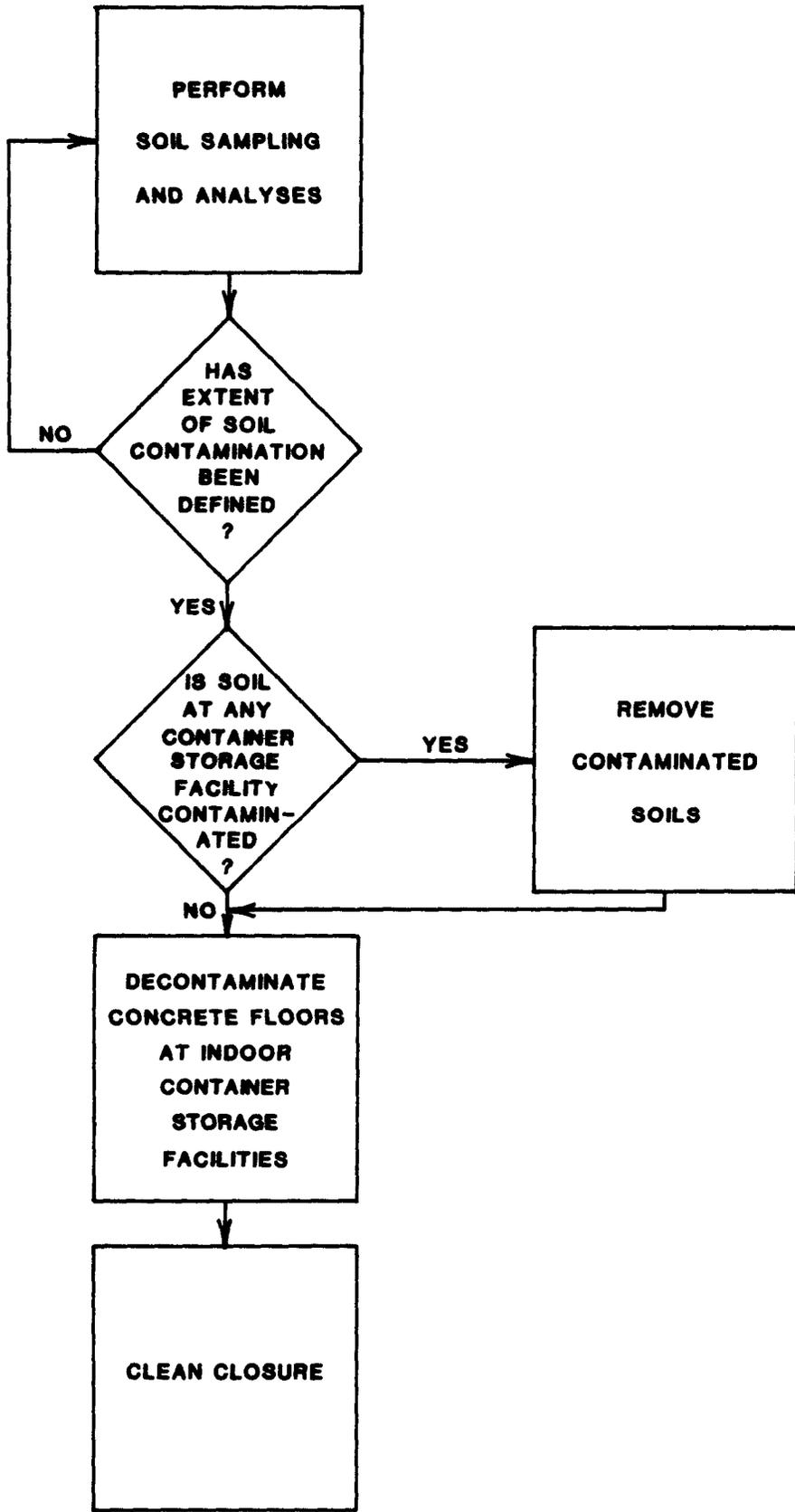
1.14.2 Closure Plan

The activities necessary to complete closure are shown on the diagram on Figure 11. The activities in the closure plan related to soil and concrete floors include:

- . characterizing the soils at the outdoor container storage facilities,
- . screening and decontaminating the concrete floors at the indoor container storage facilities.

Activities required to evaluate the impacts of outdoor container storage facilities on ground-water quality will be conducted if the closure activities indicate releases have occurred. These activities, if necessary, will be selected once the occurrence of releases has been determined.

It is currently believed that a clean closure can be implemented at all of the container storage facilities without performing any soil removal and by decontaminating the concrete at the indoor container storage facilities. If soil characterization indicates contaminated soils are present, the contaminated soils will be removed.

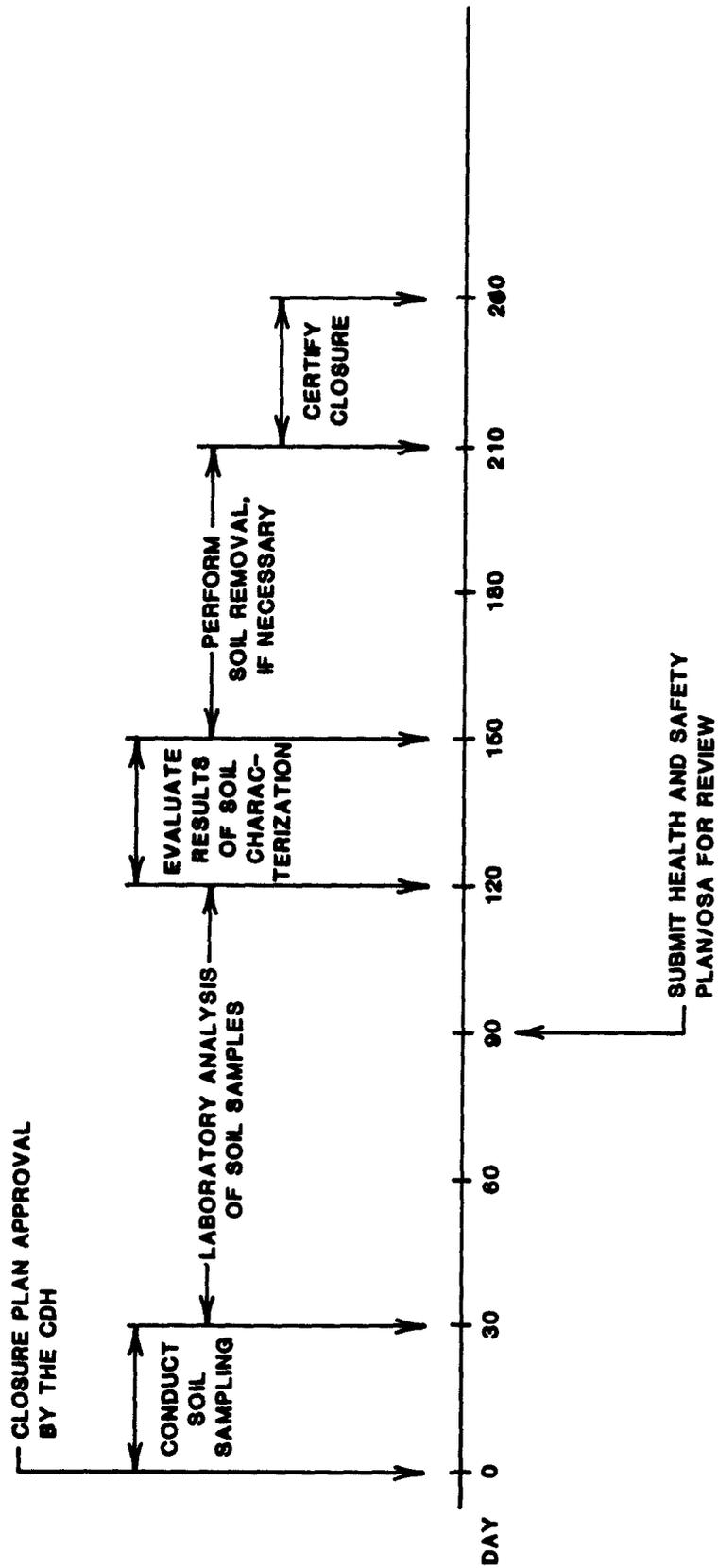


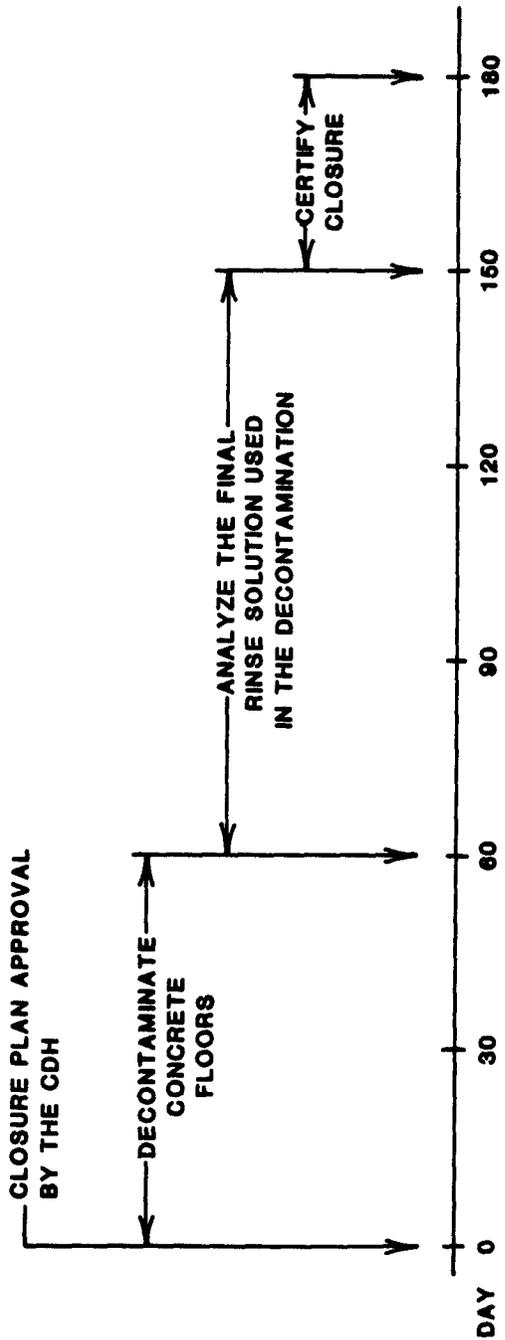
If decontamination of the concrete at the indoor container storage facilities is shown to be ineffective, a revised closure plan will be prepared and submitted to the Colorado Department of health (CDH), within 30 days of making that determination, for approval. The effectiveness of concrete decontamination will be evaluated by sampling and analyzing the rinse water used after decontaminating the concrete.

1.14.3 Closure Schedule

The estimated times required for closure activities at the indoor and the outdoor container storage facilities are shown on Figures 12 and 13, respectively.

As shown on Figure 12, Phase I and Phase II soil sampling will be completed within 30 days after approval of the closure plan. Laboratory analyses of the soil samples obtained are anticipated to take approximately three months and will be conducted from 30 days to 120 days after closure plan approval. Evaluation of the soil characterization results will be conducted from 120 days to 150 days after closure plan approval. If contaminated soils are present, they will be removed between 150 and 210 days after closure plan approval. Closure will be certified within 30 days





after removing soils, if necessary, or within 30 days after determining that soil removal is not necessary.

As shown on Figure 13, the concrete floors will be decontaminated within 60 days after closure plan approval. Analyses of the final rinse solution used in the decontamination process is anticipated to take three months and will be conducted from 60 to 150 days after closure plan approval. Assuming the concrete is shown to be decontaminated after one decontamination, closure will be certified between 150 to 180 days after closure plan approval. If the analysis of the final rinse solution indicates contamination is still present, the closure schedule will be extended to allow additional time for further decontamination and analysis.

1.14.4 Justification for Extension of Schedule

6 CCR 1007-3, Section 265.113(b) states, in part, that closure activities will be completed within 180 days after approval of the closure plan unless closure activities will, by necessity, take longer than 180 days to complete. If closure activities will take longer than 180 days, then

steps must be taken to prevent threats to human health and the environment from the unclosed facility.

The schedule for closure activities exceeds the time required by the regulations. An extended closure schedule is required due to the length of time necessary to characterize, evaluate and remove soils, if contaminated soils are present.

Threats to human health and the environment are prevented by the routine monitoring activities conducted at Rocky Flats and by restricted access to the facility. Specific details of the routine monitoring program are summarized in the "Annual Environmental Monitoring Report" (Rockwell, 1986b). This document is reviewed and updated on an annual basis. Brief discussions of the monitoring activities that are conducted and the security procedures at the plant are presented below.

The routine environmental monitoring program includes the sampling and analysis of airborne effluents, ambient air, surface and ground water, and soil. External penetrating gamma radiation exposures are also measured using

thermoluminescent dosimeters. Samples are collected from on-site, boundary and off-site locations.

Particulate and tritium sampling of building exhaust systems is conducted continuously. For immediate detection of abnormal conditions, ventilation systems that service areas containing plutonium are equipped with Selective Alpha Air Monitors. These monitors trigger an alarm automatically if out-of-tolerance conditions are experienced. Particulate samples are collected from ambient air samplers operated continuously on site. The ambient air samples are analyzed for Total Long-Lived (TLL) Alpha activity or for plutonium activity. There are currently 51 of these ambient air samplers. Twenty-three are located within and adjacent to the Rocky Flats exclusion area, 14 are located along or near the plant's perimeter and 14 are located in nearby communities.

The majority of the water used at the RFP for plan process operations and sanitary purposes is treated and evaporated and/or reused for cooling tower makeup or steam plant use. The discharge of water off-site is minimized to the greatest extent possible. Water discharges from the Rocky Flats Plant are monitored for compliance with appropriate CDH

standards and EPA National Pollutant Discharge Elimination System (NPDES) permit limitations. Surface runoff from precipitation is collected in surface water control ponds and discharged off site after monitoring. Routine water monitoring is conducted for two downstream reservoirs and for drinking water sources in nine communities. Ground-water monitoring was conducted during 1987 at approximately 160 ground-water sampling locations.

Soil samples were collected during 1987 from 40 sites located on radii from Rocky Flats at distances of 1.6 and 3.2 kilometers (1 and 2 miles). The purpose of this soil sampling is to determine if there are any changes in plutonium concentrations in the soil around the plant.

When higher concentrations than usual are found in any of the routine monitoring activities or when out-of-compliance conditions are identified, the cause of the problem is investigated. If any of the container storage facilities are found to be the cause of an out-of-compliance condition, then this closure plan will be revised within 30 days.

Access to the plant is limited by:

- . a three-strand barbed wire cattle fence surrounding the facility (Figure 1) posted to identify the land as a government reservation/restricted area,
- . a fence surrounding and guards posted 24 hours per day at two gates to the controlled area of the facility (Figure 1),
- . a 6-foot high chain link fence topped by 2 feet of three-strand barbed wire surrounding and guards posted 24 hours per day at gates to the perimeter security zone (PSZ),
- . guards patrolling the controlled area and the PSZ 24 hours per day, and
- . surveillance by security cameras 24 hours per day.

The existing fences and gates are operated and maintained by the U.S. Department of Energy.

The monitoring and security measures outlined above are designed to protect human health and the environment by threats posed by the RFP as a whole. More specifically, they protect human health and the environment from threats posed by the container storage facilities.

1.15 Administration of Closure Plan

The closure plan for the container storage facilities will be kept at the Rocky Flats Area Office, Building 111, U.S.

Department of Energy. The person responsible for storing and updating this copy of the closure plan is:

Mr. Albert E. Whiteman
Area Manager

His address and phone number are:

U.S. Department of Energy
Rocky Flats Plant
P.O. Box 928
Golden, Colorado 80402
Phone: (303) 966-2025

Mr. Whiteman is also responsible for updating other copies of the closure plan held off-site by sending additions or revisions by registered mail.

1.16 Closure Cost Estimates and Financial Assurance

State and Federal governments are exempt from the financial requirements imposed by Subpart H of 6 CCR 1007-3, Section 264.140(c). Because the Rocky Flats Plant is a federally-owned facility, no cost estimates or financial assurance documentation are required. However, cost estimates are presented for planning, budgeting and informational purposes. The cost estimate for areas with possible soil contamination are presented on Table XI. The cost estimate

TABLE XI

COST ESTIMATES FOR CONTAINER STORAGE AREAS
WITH POSSIBLE SOIL CONTAMINATION

PU&D Container Storage Facilities (Assumes 5700 cubic feet of soil to be removed):

Engineering Design and Inspection	\$ 11,400
Equipment	31,200
Removal	32,500
Decontamination and Monitoring	6,300
Disposal	57,800
Contingency	<u>13,000</u>
Subtotal	\$152,200

S&W Building 980 Container Storage Facility (Assumes 940 cubic feet of soil to be removed):

Engineering Design and Inspection	\$ 1,900
Equipment	5,200
Removal	5,400
Decontamination and Monitoring	1,100
Disposal	9,500
Contingency	<u>2,200</u>
Subtotal	\$ 25,300

S&W Contractor Storage Yard (Assumes 172,000 cubic feet of soil to be removed):

Engineering Design and Inspection	\$ 345,700
Equipment	942,600
Removal	980,400
Decontamination and Monitoring	190,900
Disposal	1,744,100
Contingency	<u>393,500</u>
Subtotal	\$4,597,200

TABLE XI (continued)

COST ESTIMATES FOR CONTAINER STORAGE AREAS
WITH POSSIBLE SOIL CONTAMINATION

Building 444/453 Drum Storage Area (Assumes 2,600 cubic feet
of soil to be removed):

Engineering Design and Inspection	\$ 5,200
Equipment	14,200
Removal	14,800
Decontamination and Monitoring	2,900
Disposal	88,400
Contingency	5,900
Subtotal	<u>\$131,400</u>

TOTAL OF ALL CONTAINER STORAGE FACILITIES THAT MAY HAVE SOIL
CONTAMINATION = \$5,000,000

for areas with possible concrete contamination are discussed below. These estimates can in no way be considered binding.

The estimates presented on Table XI are based on a worst case scenario in which the entire outdoor unit undergoing closure is found to be contaminated to a depth of 13 inches, but that excavation to a depth of 18 inches will be conducted to insure all contamination is removed. These assumptions are expected to result in an overestimation of the actual costs that will be incurred since these areas are expected to be clean and require no soil removal.

These costs represent worst case assumptions resulting in maximum possible costs. All excavated soil from these areas is assumed to qualify as a hazardous waste for these costs, with the exception of the 444/453 area which is assumed to qualify as a low-level mixed waste. All soil is assumed to meet Land Ban requirements for landfilling.

The total cost estimate for decontamination of areas with possible concrete contamination is \$10,200. This estimate assumes 0.14 gallons of foam per square foot of concrete is required for decontamination and an additional 0.28 gallons of water per square foot of concrete is required for rinsing

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after vacuuming the foam. This estimate also assumes that the foam and rinsate will be handled as a mixed waste by solidifying it on-site and disposing of it at an approved facility.

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2.0 REMOVAL OF WASTE INVENTORY

There are and will be no containers or wastes in treatment stored for more than 90 days at the container storage facilities covered under this closure plan. Therefore, there is no inventory to be removed.

3.0 FACILITY DECONTAMINATION

3.1 Areas of Facilities with Potential Soil Contamination

3.1.1 Soil Characterization

The soil sampling plan has been designed to provide an adequate data base for determining if soil removal activities are required at the following container storage facilities:

- . PU&D container storage facilities,
- . S&W Building 980 container storage facility,
- . S&W contractor storage yard,
- . Building 885 drum storage area, and
- . Building 444/453 drum storage area.

These container storage facilities, except for the Building 885 drum storage area, were operated such that waste containers were placed directly on the ground surface. At the Building 885 drum storage area, the drums were placed on pallets on concrete slabs. However, the drum storage areas were not completely surrounded by building walls and any leaks or spills could have flowed onto the surrounding soil surface.

The drums in the following areas were placed on concrete floors inside buildings:

- . Building 881 drum storage area
- . Building 865 drum storage area
- . Building 883 drum storage area

At the remaining container storage facility, the Building 334 cargo container area, drums that had already been filled were placed in a cargo container that had a collection pan at the bottom of the container. Based on the secondary containment at these facilities, soil characterization in these areas is deemed to be unnecessary.

Procedures to be followed to characterize soils at facilities with potential soil contamination are presented in Appendix 2.

3.1.2 Soil Removal

3.1.2.1 Introduction

All soil removal activities must comply with a Rocky Flats Plant Operational Safety Analysis (OSA) procedure. These OSAs are required for all activities with a potential risk for serious injury, radiation exposure to personnel, or

damage to property or the environment. The OSA requirement and definition are currently under review. The current draft of this requirement, RFOSA-1 (Rockwell, 1988), presented in Appendix 3, describes the procedures for removal of plutonium and/or uranium contaminated soil at the Rocky Flats Plant. If possible, the scope of RFOSA-1 will be expanded to also cover removal of soil contaminated with non-radioactive hazardous substances, as well as removal of soil contaminated with mixed waste. If this is not possible, a new OSA will be developed to govern these new concerns. The approved OSA appropriate for soil removal activities at any container storage facility undergoing closure will be submitted to the CDH and U.S. EPA at least two months before soil removal activities begin, for review. Given the limited time schedule for closure of container storage areas, OSAs for soil removal may be submitted to CDH and U.S. EPA prior to the determination of whether or not soil removal activities will be necessary.

If soil contamination at the container storage facilities where soil characterization will be conducted is found, these procedures will be reviewed in light of the physical constraints of the contaminated area, as well as the levels

of contamination identified. If necessary, these procedures will be revised to protect human health and the environment of both the workers and the public.

The contaminants that may be present at the container storage facilities with possible soil contamination are expected to be volatile organic compounds (VOCs) and heavy metals. Plutonium should not be present at any of these facilities due to administrative controls to prevent its presence in all of these areas. Uranium could possibly be found in the Building 444/453 drum storage area due to the machining of uranium parts in Building 444. The oils used in these uranium machining operations were stored in this drum storage area along with used oils from other operations.

3.1.2.2 Removal, Packaging and Disposal

A small front end loader will be used to excavate contaminated soil. Hand excavation will be conducted in areas where the loader cannot be used due to clearance or other limitations.

Following removal, any contaminated soil will be packaged in either 55-gallon steel drums or boxes made of plastic-lined, triple-wall fiberboard with capacities of approximately 15 cubic feet. The containers selected for use will depend upon the requirements of the facility used for disposal. The containers will be labeled and shipped off-site for disposal. Disposal will be at either an approved hazardous waste disposal facility or at an approved mixed waste disposal facility, depending on the characteristics of the soil removed.

The amount of area excavated at any given time will depend on the anticipated total area to be excavated. Water and/or dust palliatives will be used to control resuspension and transport by wind of contaminated soil during excavation. The need to implement dust control and the procedures selected will be based on visual observations of the work area and the results of air monitoring.

3.1.2.3 Site Restoration

Subsequent to removing contaminated soil, the excavation will be backfilled with clean soils or will be paved,

depending on the amount of soil removed and the planned long-term usage of the site. Soils removed from the excavation that are clean may be reused for backfill. Clean soils from other areas of Rocky Flats may also be used. The soils will be adjusted to near optimum moisture content and placed and compacted to at least 90 percent of the maximum standard Proctor density (ASTM D-698) in landscape areas and to at least 95 percent of the maximum standard Proctor density (ASTM D-698) in paved areas.

The equipment used for compaction will be appropriate to achieve the required compaction characteristics for the types of soils being compacted. For example, a sheepsfoot compactor may be used for clay soils and a smooth-drum roller may be used for granular soils.

The surface of the backfill will be graded to the approximate elevations that existed prior to soil removal. The graded surface will be finished in a manner consistent with the existing use of the area or in a manner consistent with the planned long-term use of the area.

3.1.2.4 Access Control

Access to the work area will be limited to authorized personnel only.

An area immediately outside the excavation area will be used for the first phase of equipment decontamination and for personnel decontamination. The equipment decontamination area will have tarpaulins spread over the ground and will be used to scrape or brush chunks of soil or debris off the equipment. Additional decontamination information is presented in Section 4.0. The personnel decontamination area will be used by personnel about to leave the site for removing and discarding the disposable protective clothing. This clothing will be temporarily stored in containers prior to transport and treatment or disposal at an approved facility.

3.1.2.5 Health and Safety Plan

A site specific Health and Safety Plan, or such health and safety procedures identified in the OSA, covering contaminated soil removal will be prepared two months before soil excavation activities begin. The plan will be submitted to the Colorado Department of Health for review and will comply with all applicable requirements. The procedures presented below are guidelines that will be followed during closure activities. Additional procedures and details will be presented in the site specific Health and Safety Plan or the OSA. Worker safety guidelines, such as OSHA regulations, DOE orders and Rocky Flats Plant policies will be followed. Protective clothing will be similar in nature to:

- . hardhats,
- . hard-toe boots,
- . Tyvek overboots,
- . Tyvek suits,
- . dust masks, and
- . air-purifying respirators or self-contained breathing apparatus (optional).

The intent of this equipment is to provide a barrier to inhalation, ingestion and absorption of contaminated materials. Appropriate protective gloves will be used based on the contamination found at any particular site.

Air monitoring will be conducted in the work area. Portable high-volume (40 cfm) samplers or fixed radioactive ambient air samplers (25 cfm) will be located around the excavation area, including at probable downwind locations.

Air monitoring will also be conducted using hand-held photoionization detectors. The site specific health and safety plan or OSA will present levels, which if exceeded, will require some action be taken, such as increasing respiratory protection or work cessation.

A Rocky Flats Environmental Sciences representative will be monitoring conditions during excavation activities. This person will have the authority and responsibility to terminate the work if any of the following events occur.

- . Wind speeds exceed 24 km/hr (15 mph).
- . Any visible dust is present or there is any indication that dust control measures were inadequate.
- . The total long-lived alpha concentrations measured on filters from high-volume samplers exceed 0.06 pCi/m^3 in order to re-evaluate dust control procedures.
- . Power failure.
- . Heavy rainfall or snow.

Airborne contamination may require upgrading dust masks to air-purifying respirators or self-contained breathing apparatus. Sudden increases in airborne contamination due to excavation in localized highly contaminated areas may be addressed by a temporary cessation of work until natural dissipation reduces contamination.

3.2 Areas of Facilities with Potential Concrete Contamination

3.2.1 Introduction

This section discusses the storage facilities covered under this closure plan that may have areas of contaminated concrete. These storage areas are the:

- . Building 885 drum storage area,
- . Building 881 drum storage area,
- . Building 865 drum storage area, and
- . Building 883 drum storage area.

The concrete floors in these areas will be screened for gross radioactive contamination and will then be decontaminated.

The decontamination procedures presented in Section 3.2.3 involves foam cleaning with a decontamination agent that

will remove oils, solvents, organic compounds and low-level radioactive contaminants. Since there are no reports of spills or leakage onto the floors in these areas and no visual evidence of concrete staining, a foam decontamination procedure should be adequate for the floors in these areas, unless gross radioactive contamination is detected by the screening procedures.

If the screening procedures detect possible radioactive concrete contamination, the closure plan will be amended to address revised concrete closure activities.

3.2.2 Radioactive Screening Procedures

3.2.2.1 Surveying for Alpha

The floors will be surveyed for removable alpha contamination by performing swipe tests and counting the swipe in a scintillation-type counter instrument. To be considered clean, the floor must have removable alpha contamination less than 20 disintegrations per minute (dpm) per one hundred square centimeters.

The floors will also be surveyed for non-removable or fixed contamination using the air proportional-type alpha survey instrument. The direct count must be less than detectable, approximately 500 dpm per 50 square centimeters, to be considered clean.

3.2.2.2 Surveying for Beta-Gamma

The floors will be surveyed for removable beta-gamma contamination by performing swipe tests and counting the swipe in a beta-sensitive smear counter. To be considered clean, the floor must have removable beta-gamma contamination less than the activities defined in Table XII (Rockwell, 1985).

The floors will also be surveyed for fixed beta-gamma contamination using a Ludlum Model 31, Geiger-Mueller type instrument. The instrument probe will be placed close to and moved slowly over the floor and the count-rate reading noted. The reading must be less than those defined in Table XII (Rockwell, 1985).

TABLE XII
ACCEPTABLE SURFACE CONTAMINATION LEVELS
(U.S. Department of Energy, 1985)

<u>Nuclide (1)</u>	<u>Average (2), (3)</u>	<u>Maximum (2), (4)</u>	<u>Removable (2), (5)</u>
U-nat, U-235, U-238, and Associated Decay Products	5,000 dpm alpha per 100 cm ²	15,000 dpm ₂ alpha per 100 cm ²	1,000 dpm alpha per 100 cm ²
Transuranics, Ra-226, Ra-288, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm ²	3,000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 dmp beta - gamma/100 cm ²	15,000 dpm beta- gamma/100 cm ²	1,000 dpm beta- gamma/100 cm ²

TABLE XII (continued)
ACCEPTABLE SURFACE CONTAMINATION LEVELS
(U.S. Department of Energy, 1985)

Notes:

- (1) Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.
- (2) As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- (3) Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.
- (4) The maximum contamination level applies to an area of not more than 100 cm^2 .
- (5) The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent level should be reduced proportionally and the entire surface should be wiped.

3.2.3 Procedures for Decontaminating Concrete

The concrete floors will be decontaminated by foam cleaning. The foam holds the decontamination agents at the surface, permitting them to act on the contaminants, lifting them into the foam. The foam with the suspended contaminants, is then directly removed from the surface by vacuum techniques.

A commercial decontamination agent consisting of inhibited acidic powder containing oxalate, citrate and ammonium ions, inhibitors, a surfactant and a foam suppressant will be used. This decontamination agent will remove oils, solvents, organic compounds and low-level radioactive contaminants. The foam cleaning will be conducted once and will be followed by rinsing three times.

The final rinse water will be sampled for the presence of hazardous substance list (HSL) volatile organic compounds, which includes the hazardous constituents stored in these areas. If the levels of HSL volatiles are below contract required detection limits, the concrete will be considered decontaminated and the area will be considered clean.

If the levels of HSL volatiles are not below contract required detection limits, the concrete will be decontaminated again using the procedure outlined above. Repeated decontamination will be conducted until the concrete is considered clean or until further decontamination appears to be ineffective. If the concrete cannot be decontaminated, this closure plan will be amended.

All rinsate will be collected and will be transported to a temporary holding tank. The rinsate will then be characterized for final disposition. The sampling methods, analytical methods, and quality assurance/quality control procedures to be followed are presented in Appendix C-2, Section C-5, and Section C-7 of the Waste Characteristics and Analysis Plan, Section C, of the RCRA Part B Permit Application (U.S. Department of Energy, 1987a). These sections are reproduced in Appendices 4 through 6, respectively, in this closure plan.

If the rinsate contains solvents in dilute concentrations, it will be disposed of by OSCO. If the rinsate contains hazardous substances in quantities too great for OSCO to handle, it will be disposed of at an approved hazardous waste disposal facility. If the rinsate is a small volume

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of mixed waste, it will be processed through the process waste treatment system in Building 374. If the rinsate is a large volume of mixed waste, it will be solidified on-site and disposed of at an approved mixed waste disposal facility.

4.0 DECONTAMINATION OF EQUIPMENT

4.1 Introduction

As required by 6 CCR 1007-3, Sections 265.112(b)(4) and 265.114, construction equipment used during removal of contaminated soil or for concrete decontamination will be decontaminated. There is no currently identifiable auxiliary equipment associated with the container storage facilities. Decontamination of construction equipment will involve the procedures described in the following section.

4.2 Decontamination Procedures

All construction equipment involved with removing contaminated soils will be scraped or brushed to remove chunks of soil or debris whenever the equipment leaves the excavation area. The area used for scraping or brushing will have tarpaulins spread over the ground and will be raked and/or swept to collect all removed materials. The collected material will initially be handled as a hazardous waste. A representative sample of this material will be obtained and analyzed and the material will be handled appropriately based on the results of this analysis. If

this waste qualifies as a hazardous waste or a mixed waste, it will be shipped off-site to an approved RCRA treatment or disposal facility or an approved mixed waste disposal facility, respectively.

At the end of all closure activities, all construction equipment that came into contact with contaminated soils or rinsate, are anticipated to be decontaminated in the Building 889 decontamination facility. This facility is currently equipped to decontaminate up to moderately sized construction equipment. The facility is planned to be enlarged by January 1989 to accommodate large construction equipment.

The decontamination system expected to be used, is expected to heat water to approximately 350°F at 250 psig pressure. The super-heated, high-pressure stream will be sprayed on the contaminated surface through a series of nozzles incorporated into the vacuum/spray cleaning head. The exact equipment used for decontamination will vary depending on procurement of capital equipment. The equipment used will provide for adequate decontamination of the construction equipment. Rinse water from the facility will be collected

in a series of underdrains and transferred to Building 374 for process waste treatment.

4.3 Auxiliary Equipment

As discussed in Section 1.13, there was no currently identifiable auxiliary equipment used at any of the container storage facilities.

4.4 Construction Equipment Used During Closure

Construction equipment to be used during closure may include backhoes, front-end loaders, small front-end loaders, soil compactors, water trucks and concrete decontamination equipment. If large quantities of soil are to be removed, additional equipment, such as haul trucks and scrapers, may be used. Only the concrete decontamination equipment that comes in contact with the foam and contaminated rinse water will require decontamination. Additional equipment may be used during closure, if necessary.

5.0 GROUND WATER

5.1 Summary of Applicable Requirements

Ground-water contamination at the Rocky Flats Plant is currently the subject of ongoing investigations being performed pursuant to the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the U.S. DOE Comprehensive Environmental Assessment and Response Program (CEARP). In addition to the container storage facilities, other solid waste management units (SWMUs) in the vicinity of and upgradient of each facility may have impacted ground-water quality.

If contaminated soils are encountered all the way to the water table, then ground-water monitoring will be provided. This monitoring will be in compliance with all CDH and U.S. EPA regulations. Three downgradient monitoring wells and one upgradient well will be located at each container storage facility requiring ground-water monitoring.

5.2 Ground-Water Protection Standard

The highest of the following standards will be selected for the ground-water protection standard if ground-water monitoring at any of the container storage facilities is necessary:

- . background concentrations,
- . drinking water standards,
- . proposed or draft drinking water standards,
- . maximum contaminant levels (MCLs) defined by the Safe Drinking Water Act and its subsequent amendments, and
- . discharge limits as contained in the Rocky Flats Plant Colorado Pollution Discharge Elimination System (COPDES) permit.

COPDES limits are included because ground water and surface water are interconnected at the site and it has been determined that these concentrations are protective of human health and the environment.

The highest of the above standards will be chosen since the standards have all been developed to be protective of human health and the environment and because some compounds can exceed standards protective of human health and the environment in natural background ground water.

6.0 SITE SECURITY

The existing security measures at the Rocky Flats plant include:

- . a three-strand barbed wire cattle fence surrounding the facility (Figure 1) posted to identify the land as a government reservation/restricted area,
- . a fence surrounding and guards posted 24 hours per day at two gates to the controlled area of the facility (Figure 1),
- . a 6-foot high chain link fence topped by 2 feet of three-strand barbed wire surrounding and guards posted 24 hours per day at gates to the perimeter security zone (PSZ),
- . guards patrolling the controlled area and the PSZ 24 hours per day, and
- . surveillance by security cameras 24 hours per day.

The existing security measures are sufficient to meet the requirements of 6 CCR 1007-3, Section 265.14.

The existing fences and gates are operated and maintained by the U.S. Department of Energy. Maintenance requirements will be performed by the U.S. Department of Energy, regardless of the activities at the container storage facilities.

7.0 CLOSURE CERTIFICATION

7.1 Certification Requirements

Certification of closure requirements is outlined in 6 CCR 1007-3, Section 265.115 and 40 CFR 265.115:

"When closure is completed, the owner or operator must submit to the (Department of Health/Regional Administrator) certification both by the owner or operator and by an independent registered professional engineer that the facility has been closed in accordance with the specifications in the approved closure plan."

Certification by a registered professional engineer does not guarantee the adequacy of the closure procedures and does not necessarily involve detailed testing and analyses. It implies that, based on periodic facility inspections, closure has been completed in accordance with the specifications in the approved closure plan (U.S. Environmental Protection Agency, 1981).

7.2 Activities Requiring Inspections by a Registered Professional Engineer

An independent registered professional engineer will inspect concrete decontamination activities for certification of

closure. Soil sampling activities will not be observed by the engineer certifying closure. However, field personnel will keep and sign detailed field records of soil sampling activities. The field records and the results of soil analyses will be reviewed by the engineer certifying closure.

7.3 Anticipated Schedule of Inspections by a Registered Professional Engineer

An independent registered engineer will periodically review the closure operations listed in Section 7.2 in order that a final certification of closure can be developed which states that the closure has been carried out according to the plan. The engineer will periodically obtain and review the results of chemical testing which provide a record of the progress and effectiveness of the implemented closure plan.

The independent engineer and the owner will, at the end of closure, inspect the site and certify that the closure plan was carried out as described. Prior to final certification, deficiencies noted by the engineer will be corrected. When deficiencies have been corrected, the engineer will issue a written report to the regulatory agencies certifying that

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the facility has been closed according to this closure document.

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APPENDIX 1

RESULTS OF SAMPLING OF CONTAINERS AT THE
S&W CONTRACTOR STORAGE YARD, 1985

(Rockwell, 1985b)

ANALYTICAL REPORT

ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS
P.O. BOX 464
GOLDEN, COLORADO 80401

GENERAL LABORATORY
BUILDING 881

DISTRIBUTION:

J. A. Hayden, Waste Ops 374
R. C. Baker, Waste Ops T668
J. A. Campbell, HS&E T452A
File

LAB NUMBER: M85-2210 ADDENDUM
DATE: 12-05-85
ACCOUNT NO: 389
ANALYSIS BY: S. C. Angelo

APPROVED: B. A. Medeiros
B. A. Medeiros

SAMPLE DESCRIPTION

29 waste liquids, paints, and solid samples.
Determine Flash Point, quantitate and identify volatile solvents, if present.

ANALYSIS RESULTS

Flash Point was determined by Pensky-Martens closed tester using ASTM method D93-80. Volatile solvents were determined by infrared spectroscopy.

<u>Sample</u>	<u>Flash Point (°C)</u>	<u>Volatile Components*</u>
SWP-2	25.3	acetone, toluene isopropanol
SWP-1 SWP-3 SWP-4 SWP-5 SWP-6 SWP-7 SWP-8	} Combined sample Flash point 27.8	} all had Lt. CH CO ₂
SWG-1	30.8	Lt. CH, CO ₂
SWG-2	30.8	CO ₂
SWY C-1	31.3	Lt. CH
SWY C-2	31.3	Lt. CH, CO ₂
SWY-1	26.3	Lt. CH, CO ₂
SWY-1-1	30.8	acetone, isopropanol, toluene, butyl acetate
SWY-2	32.3	Lt. CH, CO ₂ ethyl acetate, isopropanol

<u>Sample</u>	<u>Flash Point (°C)</u>	<u>Volatile Components*</u>
SWY 5-1	} Combined samples 26.3	} Each sample had Lt. CH, CO ₂
SWY 5-2		
SWY 5-3		
SWY 5-4		
SWY 5-5		
SWY 5-6		
SWY 5-7		
SWY 10-1	19.8	Lt. CH
SWY 12	22.3	
SWY 13	23.8	Toluene, Lt. CH, 2-nitropropane
SWY 14	21.8	2-nitropropane

* Lt. CH = light hydrocarbons and CO₂ = carbon dioxide.

Aerosol and solid samples were analyzed for volatile components as well as composition. For emission spectroscopy data of the solid samples see attached sheet.

<u>Sample</u>	<u>Composition</u>	<u>Volatile</u>	<u>% by weight Volatile</u>
SWY 8-1	primarily aluminum oxide with lead and calcium oxides also present.		
SWY 9-1	primarily silica (SiO ₂)	Toluene, butyl acetate CO ₂	38.6
SWY 11	Hydrated aluminum silicate compound		
SWY 2-1 (aerosol)		ethyl acetate isopropanol	
(solid)	Primarily titanium oxide and calcium carbonate organic binder hydrated silicate		

IR FILE 9015

X-Ray fluorescence data of the solid constituent of the aerosol sample SWY 2-1 are listed below. All elements are presumed to be present as oxides and normalized to 100.

<u>Elements</u>	<u>Results</u>
Ca	48%
Ti	38%
Fe	0.07%
Si	10%
Sr	0.01%
Br	0.02%

Identification of entire sample components.

<u>Sample</u>	<u>Constituents</u>	
SWP 1	TL - mineral spirits BL - water ppt. - silica (SiO ₂)	
SWP 2	TL - toluene, acetone, isopropanol, isopropyl acetate BL - water, pH 6 ppt - SiO ₂ , iron oxides	
SWP 3	All water, pH 8 ppt - ferrous sulfate, mix of resin alcohols	
SWP 4	All Water, pH 6 ppt - ferrous sulfate, iron oxides	
SWP 5	TL - mineral spirits and wood resin BL - water, pH6	
SWP 6	TL - mineral spirits BL - water, pH 7 ppt - iron oxides, ferrous sulfate, pyrite and MgO ₂	X-RAY - see attached sheet. Major elements Fe - 250% Mn - 15%
SWP 7	TL - mineral spirits, paraffinic-ester wax (e.g., Shellac wax) BL - white paint: calcium sulfate (white pigment filler) calcium carbonate (whiting)	
SWP 8	Mineral spirits	

<u>Sample</u>	<u>Constituents</u>
SWG 1	71% mineral spirits 29% paraffinic base oil
SWG 2	3.8% carbon dioxide 96.2% motor oil
SWY C-1	27.1 mineral spirits and light hydrocarbons 72.9 diesel fuel
SWY C-2	Water base solution, pH 11 possibly a cleaning fluid consisting of a phosphate (i.e., a sodium phosphate), a water dispersant and surfactant.
SWY 1	TL - mineral spirits, vegetable oil and natural resins. BL - water, pH 4
SWY 1-1	TL - mineral spirits, isopropanol, n-butyl acetate, toluene, acetone and a surface coating material (i.e., epoxy ester) BL - white paint
SWY 2	TL - small amount of paraffinic base oil floating on top of water, pH 5 ppt - mixture of metal oxides, mostly iron oxides.
SWY 5-1	Mostly water, pH 7 ppt - carbonates (i.e., potassium carbonate), ferrous sulfate and SiO ₂
SWY 5-2	Mostly water, pH 7 ppt - ferrous sulfate, pyrite and iron oxides
SWY 5-3	Mostly water, pH 8 ppt - ferrous sulfate, pyrite and iron oxides
SWY 5-4	Mostly water, pH 6 ppt - ferrous sulfate, pyrite and iron oxides
SWY 5-5	Paraffinic base oil
SWY 5-6	Mostly water, pH 7 ppt - ferrous sulfate and mix of metal carbonates (e.g., Na ₂ CO ₃ and K ₂ CO ₃)

<u>Sample</u>	<u>Constituents</u>
SWY 5-7	Mostly water, pH 7 ppt - calcium nitrate (inhibitor in lubricants)
SWY 10-1	Mineral spirits and paraffinic base oil
SWY 12	Mostly water, pH 7 ppt - iron oxides and ferrous sulfate
SWY 13	Mostly water, pH 6 ppt - iron oxides
SWY 14	Copper-silverish metallic paint

TL - top liquid layer
BL - bottom liquid layer
ppt - precipitate

Lab. Number: M85-2210

ELEMENT	SAMPLE ID		
	SWY 8-1	SWY 9-1	SWY 11
Ag	<.01	.02	<.01
Al	>10	.90	>10
Ca	>1.0	.12	<.01
Cr	<.01	.05	<.01
Fe	.04	.35	.65
K	.01	.20	.50
Li	<.01	<.01	.04
Mg	<.01	.09	.045
Mn	.01	<.01	.04
Na	.20	.15	.30
Pb	>1.0	<.01	<.01
Si	.35	>5.0	>5.0
Ti	.05	.04	.25
Zn	.015	.025	.05
Zr	<.01	.0125	<.01
P	<.01	.90	<.01

These results were determined by semiquantitative emission spectroscopy;
relative error is expected to be fifty percent.
All results are reported in % Plate No. 3092

Lab. Number: M85-2210

<u>ELEMENT</u>	<u>SAMPLE ID</u>	
	M85-2210	Swp-6 (bottom water layer)
Al	<1.0	
B	<5.0	
Be	<.10	
Ca	1.0	
Cd	<5.0	
Co	<1.0	
Cr	<1.0	
Cu	<1.0	
Fe	250	
K	<10	
Li	<1.0	
Mg	<1.0	
Mn	15	
Mo	<1.0	
Na	<16	
Ni	<1.0	
Pb	<1.0	
Si	2.0	
Sn	<5.0	
V	<1.0	
Zn	<10	

These results were determined by semiquantitative emission spectroscopy;
relative error is expected to be fifty percent.

All results are reported in µgrams/ml

Plate No. 3108-B

APPENDIX 2
SOIL CHARACTERIZATION PLAN

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1.0 INTRODUCTION

The container storage facilities requiring soil characterization under this closure plan are the:

- . PU&D container storage facilities,
- . S&W Building 980 container storage facility,
- . S&W contractor storage yard,
- . Building 885 drum storage area, and
- . Building 444/453 drum storage area.

The containers stored in the facilities requiring soil characterization were generally 55-gallon steel drums with the exception of the PU&D dumpster storage area which contained a 12-foot by 16-foot dumpster. The containerized wastes at all the container storage facilities generally consisted of waste oils, solvents and thinners. Some of the wastes had elevated metal concentrations. Low-level radioactive waste may have been present at some of the facilities. Drum samples from containers within the PU&D drum storage area, the S&W Building 980 container storage area and the S&W contractor storage area were analyzed in 1985. Results of these analyses are presented on Tables II through V and in Appendix 1 of the Container Storage Facilities Closure Plan. For more detailed descriptions of the past operations of the container storage facilities, see Sections 1.3 through 1.11 of the Container Storage

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Facilities Closure Plan. Soil sampling work has not been conducted at any of the container storage facilities to be sampled under this plan.

2.0 CONTAINERIZED LIQUIDS

Based on sample analyses from the PU&D drum storage area, the S&W Building 980 container storage facility and the S&W contractor storage yard, major portion of the containerized wastes are waste oils. Various volatile organic contaminants were found in some of the drum samples. The volatile organics included a volatile hydrocarbon solvent, freon, xylenes, and methyl alcohol. The method used in analysis of the samples did not quantify the concentration of the volatile organics within the drummed materials.

Of the metallic parameters analyzed, barium, chromium, and lead exceeded the EP toxicity levels in some of the liquids. Concentrations found in the drummed samples are summarized on Table I.

TABLE I
COMPOSITED DRUM SAMPLES
METALS TESTING RESULTS
(Rockwell, 1985a and 1985b)

<u>Constituent</u>	<u>PU&D Drums</u>	<u>S&W Building 980 Drums</u>	<u>S&W Contractor Storage Yard Drums</u>
Barium (ug/ml)	Range-<5-150 Average - 59	Range - <5-500 Average - 104	Not Analyzed
Chromium (ug/ml)	Range-<1-7 Average - 3	<1	<1
Lead (ug/ml)	Range-1 to 200 Average - 71	Range-<1-25 Average - 9	<1

The contents of the containers at the other storage facilities where soil sampling will be conducted have not been sampled and analyzed. In general, the containers are known to have contained waste oils and solvents possibly contaminated with low-level radioactivity.

3.0 INDICATOR PARAMETERS FOR SOIL SAMPLING

Analysis of drummed liquids from the PU&D drum storage area, the S&W Building 980 container storage facility and the S&W contractor storage yard and information regarding the general nature of the containerized wastes are adequate to select indicator parameters for sampling. The indicator parameters are presented in Table II.

TABLE II

SAMPLING INDICATOR PARAMETERS

1,1,1-Trichloroethane (TCA)
Trichloroethylene (TCE)
Perchloroethylene (PCE)
Carbon Tetrachloride (CCL4)
Xylenes
Total Barium
Total Chromium
Total Lead
Plutonium (Pu)
Uranium (U)

TCA, TCE, PCE and CCL4 were included because of their extensive use at the Rocky Flats Plant at various times over the plant's life. Xylenes were included because of their known presence in some of the samples taken from the PU&D drum storage area and the S&W Building 980 container storage facility. Barium, chromium and lead were chosen based on their known or suspected presence in the containerized liquids. Analyses of Pu and U were included due to the

nature of the operations at the Rocky Flats Plant. Although methyl alcohol and freon were found in some of the drum samples analyzed, they are not included as indicator parameters because the list presented in Table II should be sufficient to characterize the soils.

4.0 SOURCE/CONTAMINANT CHARACTERIZATION

4.1 Characterization of Soil Contamination in the Container Storage Facilities

Characterization of the soil contamination will be conducted in a phased assessment. The first phase of characterization will consist of visual and direct radiation surveys of each of the facilities in order to delineate areas for stratified sampling. The second phase will include soil sampling by stratified and random systematic sampling programs for indicator parameters. If contamination is identified in the Phase II assessment, a third phase will be conducted in order to further define the extent of contamination.

4.2 Phase I Surveys

The Phase I surveys, consisting of visual and direct radiation surveys, will be conducted in each of the container storage areas identified as requiring soil characterization. These surveys are intended to delineate areas within the facilities which will receive stratified sampling.

4.2.1 Visual Survey

Visual surveys were conducted at the two PU&D facilities and the two S&W facilities to identify areas that are potentially contaminated based on observable soil staining. Soils in the Building 444/453 drum storage area generally show visual signs of soil contamination. Areas of visual soil staining, with qualitative assessments of the amount of soil staining, such as slightly dark, dark and very dark, were identified. Visually stained areas may not be contaminated with hazardous constituents since:

- . the containers at these facilities generally held waste oils contaminated with solvents and possibly low-level radioactivity,
- . any solvents in the soils may have volatilized, and
- . the presence of radioactivity has not been definitively determined.

Therefore, these areas will be subjected to stratified sampling as part of the Phase II assessment.

Results of the visual surveys of the PU&D drum storage area, the S&W Building 980 container storage facility, and the S&W contractor storage yard are shown on Figures 3, 7 and 9, respectively, of the Container Storage Facilities Closure

Plan. The visual survey of the PU&D dumpster storage area indicated there was no soil staining present.

4.2.2 Direct Radiation Survey

The direct radiation survey will be conducted over the ground surface to detect measurable amounts of radioactivity. The assessment will be conducted in accordance with Rocky Flats radiation monitoring procedures (Rockwell, 1986c). At least one of the following parameters, and possibly all three, will be included in the radiological assessment:

- . gross alpha,
- . gross beta, and
- . gamma radiation.

The direct alpha survey is intended to provide the same qualitative assessment of the container storage facilities for areas of potential contamination as the visual survey. Beta surveys of the areas may be conducted for the same reasons as the alpha surveys. Both of these ionizing radiation particles are easily shielded and, therefore, gamma surveys with a Field Instrument for Detection of Low Energy Radiation (FIDLER) may prove to be the most appropriate instrument for these areas. At a minimum, a

FIDLER survey of all these sites will be conducted. Areas delineated as above background in radiation levels will have stratified sampling conducted during the Phase II assessment.

4.3 Phase II Soil Sampling

4.3.1 Introduction

Soils within each of the container storage facilities covered under this soil characterization plan will be sampled to evaluate the extent of any soil contamination.

The sampling program for each facility will include random systematic sampling and may include stratified sampling. The random systematic sampling program will include establishing grid points which will be sampled in order to evaluate the probability that a predetermined area of contamination is not present at the facility. The stratified sampling will be dependent on the results of the Phase I surveys. For both sampling methods, it is assumed the results will directly indicate if contamination is or is not present.

The major soil series over much of the Rocky Flats Plant site is the Flatirons very cobbly sandy loam. This is the soil series present at all of the outdoor container storage areas undergoing closure. This soil has a high rock fragment content ranging to 80 percent with a thick clay matrix horizon ranging up to 60 percent clay. The clay is predominantly montmorillonitic, with a high cation exchange capacity and a moderate shrink/swell potential. The top 13 inches is a very cobbly sandy loam with a permeability ranging from two to six inches per hour. From 13 to 47 inches, the soil is a very gravelly clay with a permeability range of 0.06 to 0.2 inches per hour. Below 47 inches, the soil is a sandy clay loam with a permeability that ranges from 0.6 to 2.0 inches per hour.

The above soil characteristics and the noncontinuous input of contaminants to the container storage areas currently indicates contaminated soil may be limited to the upper 13 inches of the soils. The relatively low permeability clay layer, extending from a depth of 13 to 47 inches, is anticipated to have restricted the migration of any contaminants that may have been released from container storage in these areas. Therefore, preliminary sampling and

analyses of soils will be limited to shallow soils up to 12 inches in depth.

4.3.2 Sampling Procedures

Soil sampling procedures will be the same regardless of whether random systematic or stratified sampling methods are used to identify sampling locations. At each sampling location, a one-foot deep boring will be made with hand implements or a bucket auger, depending upon soil conditions. Samples will be comprised of the composite of materials exposed over the length of the boring. Samples for volatile organic compounds will be grab samples from a depth of 12 inches within the borings.

All samples will be properly labeled, stored on ice, and delivered to an off-site laboratory for analyses and to permanent storage for holding extra samples. Detailed procedures for soil sampling are provided in Appendix A of the CEARP, Phase 2: Rocky Flats Plant, IGMP (U.S. Department of Energy, 1987b) and are reproduced in Appendix 7 of the Container Storage Facilities Closure Plan.

4.3.3 Background Soil Sampling

Nine soil borings within one background soil plot will be made and analyzed in a manner identical to the container storage facilities borings.

4.3.4 Locations and Number of Borings

Random Systematic Sampling

Within each of the container storage facilities where soil sampling will be conducted, a random systematic sampling grid will be used to determine sampling locations. The grid will be developed using published methods (Zirschky, 1984 and Gilbert, 1987). The grid points will be sampled regardless of whether they fall within areas delineated by the Phase I surveys. The intent of the random systematic sampling is to identify potential contaminant areas that are not delineated by the Phase I surveys. As samples may happen to be obtained from grid points within the potentially contaminated areas identified by the Phase I surveys, the grid sampling will also provide data for characterization of these areas. Those areas identified by the Phase I surveys which are not sampled by random

systematic sampling procedures will be sampled by stratified sampling, as discussed below.

Parameters governing the size of the random systematic sampling grid are the shape and size of the contaminated area or hot-spots of concern and the probability of finding the hot-spots. Based on the visual staining within the facilities, it appears circular hot-spots, as opposed to some other geometric shape, are the most appropriate for evaluation. The size of a potential hot-spot, at each facility, was determined by the number of drums added to the facility in a year. From past practices, drums are generally stored relatively close together, with approximately one-half of one foot between drums. Using the number of drums added per year to each of the facilities and the average spacing between drums, the area occupied by the drums was determined and an equivalent radius, L , of a potential hot-spot was calculated. For the Building 444/453 drum storage area, in which extensive soil staining is present, storage of 20 drums was assumed to define the hot-spot of concern. The number of drums and equivalent radius, L , of the potential hot-spot for four of the facilities for which soil characterization will be performed are presented on Table III.

TABLE III

HOT-SPOT RADIUS FOR SELECTED CONTAINER STORAGE FACILITIES

<u>Facility</u>	<u>Maximum Known Number of Drums Added per Year</u>	<u>Equivalent Radius, L (ft)</u>	<u>Equivalent Area, A (sq. ft.)</u>
PU&D Container Storage Facilities			
Drum Storage Area	20	6	113
Dumpster Storage Area	30 (1)	7	154
S&W Building 980 Container Storage Facility	10	4	50
Building 444/453 Drum Storage Area	20 (2)	6	113

Notes:

- (1) Assume one container was added each year and a maximum of 30 drums were placed in the container in the one-year period.
- (2) Assumed.

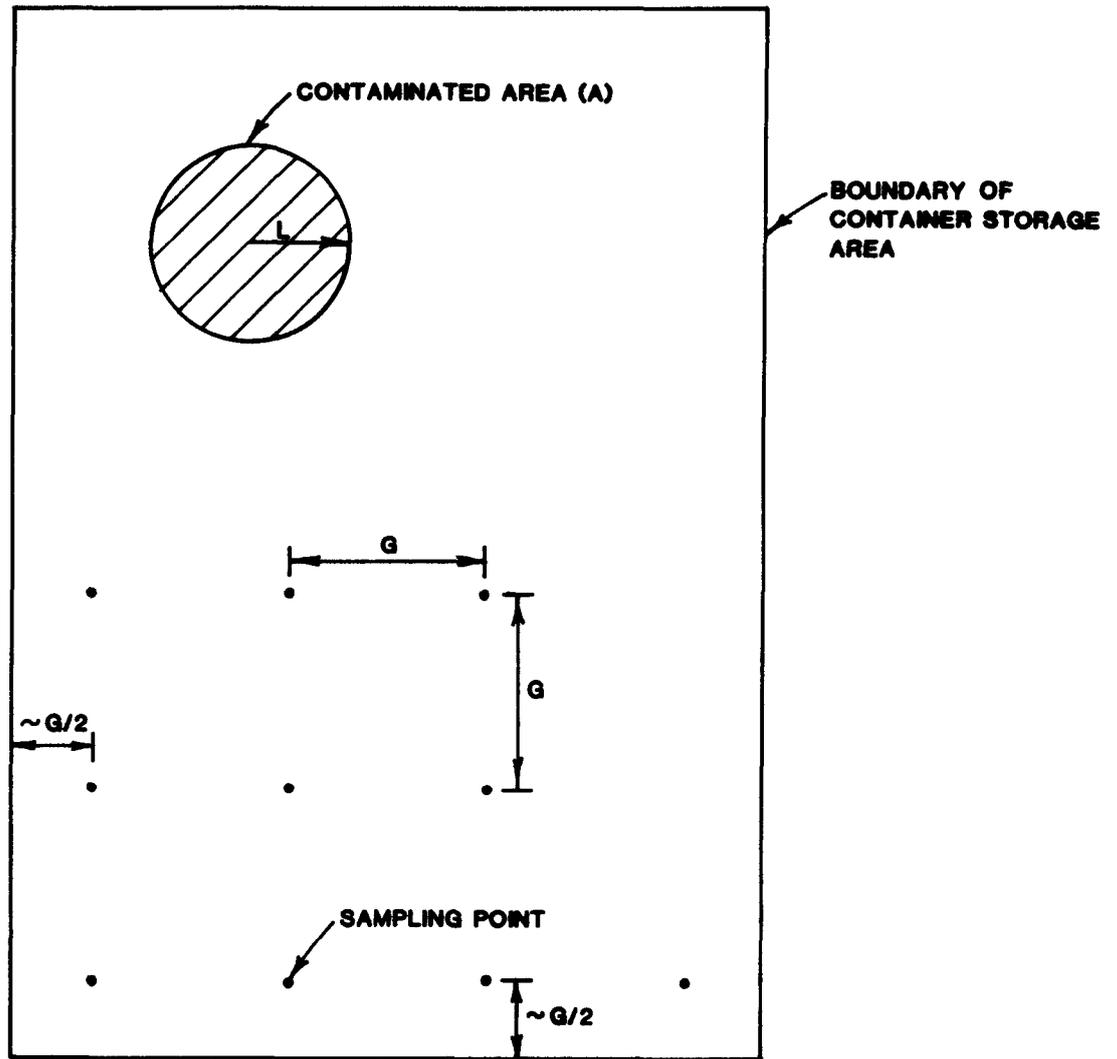
The methodology used to determine the number of samples taken at the S&W contractor storage yard and the Building 885 drum storage area is different from the four facilities presented on Table III due to their different operational history. The specific procedures used at these two facilities are discussed further below.

To select the desired probability of finding a contaminated area, several factors were evaluated. These factors were the waste characteristics, the volume of waste stored, the overall risk posed by the wastes, and the types of sampling programs selected. Based on available information, the majority of the containers stored waste oil possibly contaminated with solvents and elevated metals. The total storage capacities at each container storage facility are presented in Sections 1.3 to 1.11 of the Container Storage Facility Closure Plan. Based on the waste characteristics, the environmental risk posed by the container storage facilities is relatively low when compared with risk levels at other areas of the Rocky Flats Plant. In consideration of these factors and that the random systematic and stratified sampling will be in surveyed contaminated and uncontaminated areas, a 70 percent chance of finding a contaminated area was selected. The stratified sampling to

be conducted increases the chance of finding contamination by some unknown amount.

Using a 70 percent chance of finding a contaminated area, the procedure to be followed to determine the grid spacing is illustrated on Figure 1. The contaminated area that is under investigation, "A," is defined by the equivalent area occupied by the maximum number of drums added at each container storage facility per year. The ratio of "L" to "G," the grid spacing, is indicated to equal 0.47 (Gilbert, 1987) for a circular area with a confidence level of not hitting the target = 0.3. Using this L/G ratio, the information used to determine the grid spacing for a square sampling grid is presented on Table IV for four of the container storage facilities for which soil characterization will be conducted.

At the S&W contractor storage yard, one sample will be obtained at each of the eleven locations where materials qualifying as a hazardous waste were found in 1985. Additionally, another 16 samples, a rule-of-thumb number for sampling, will be taken randomly in areas of the S&W contractor storage yard where material storage historically



**L = EQUIVALENT RADIUS (ft.) BASED ON MAXIMUM NUMBER OF DRUMS
ADDED TO CONTAINER STORAGE FACILITY EACH YEAR**

A = EQUIVALENT AREA (sq. ft.) = πL^2

B = 0.3 (B = PROBABILITY OF NOT HITTING THE TARGET = 1-0.7)

L/G = 0.47

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Date: April 5, 1988
Revision No.: 1

TABLE IV
GRID SPACING FOR RANDOM SAMPLES

Facility	L (ft)	A (sq ft)	G (ft)	Number of Random Samples	Anticipated Number of Stratified Samples	Total Number of Samples
PU&D Container Storage Facilities						
Drum Storage Area	6	113	13	25	5	30
Dumpster Storage Area	7	154	15	4	0	4
S&W Building 980 Container Storage Facility	4	50	8	9	1	10
Building 444/453 Drum Storage Area	6	113	13	3	0	3

occurred. One sample will be taken in the one area where soil staining was observed.

At the Building 885 drum storage area, where drums were placed on concrete floors in a semi-enclosed building, samples will be taken on five-foot centers along the openings of the building to the outside. As discussed in Section 1.6 of the Container Storage Facilities Closure Plan, the drums were stored in two opposite ends of the building. On the eastern end, a length of 30 feet of the building's perimeter is not enclosed. On the western end, a maximum length of 20 feet of the building's perimeter is not enclosed. Therefore, a total of ten samples will be obtained outside Building 885. The samples will be taken one foot away from the edge of the concrete floor.

Stratified Sampling

The boring distribution for stratified sampling will be based on the results of the Phase I surveys. Each area of visual soil staining of significant size or where the direct radiation survey indicates contamination may be present will be sampled for analyses. One sample will be taken in these areas. Significant size shall be taken as a visual stain of approximate diameter similar to a 55-gallon drum. Soil

stains less than this size will be evaluated in the field based on their size, amount of visual contamination present, similarity and proximity to other soil staining. Potentially contaminated areas discerned by the Phase I surveys which cover major portions of the container storage facility and appear relatively uniform in contaminants will have additional samples obtained through the random systematic sampling.

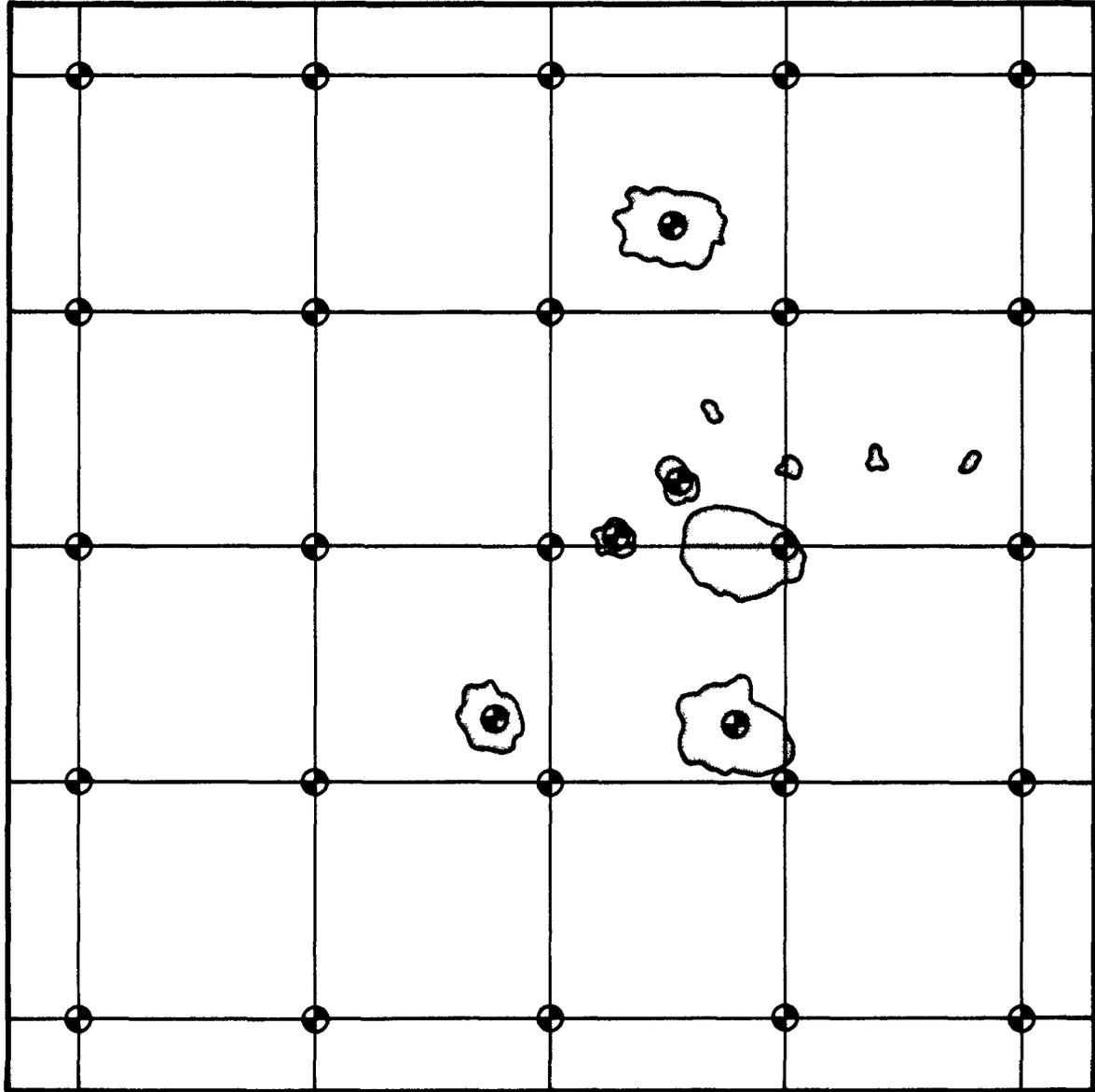
The locations of the random systematic and stratified sampling locations at the PU&D container storage facilities, the S&W Building 980 container storage facility, the S&W contractor storage yard and the Building 444/453 drum storage area are shown on Figures 2 through 6. The stratified sampling locations are based on the visual surveys that have already been conducted.

4.3.5 Quality Assurance/Quality Control

The Quality Assurance/Quality Control (QA/QC) procedures to be used for soil sampling and analyses are presented in the CEARP, Phase 2: Rocky Flats Plant, IGMP (U.S. Department of Energy, 1987b). The QA/QC Plan is reproduced in Appendix 8 of the Container Storage Facilities Closure Plan.



APPROXIMATE
SCALE: 1"=10'



LEGEND

— AREA BOUNDARY

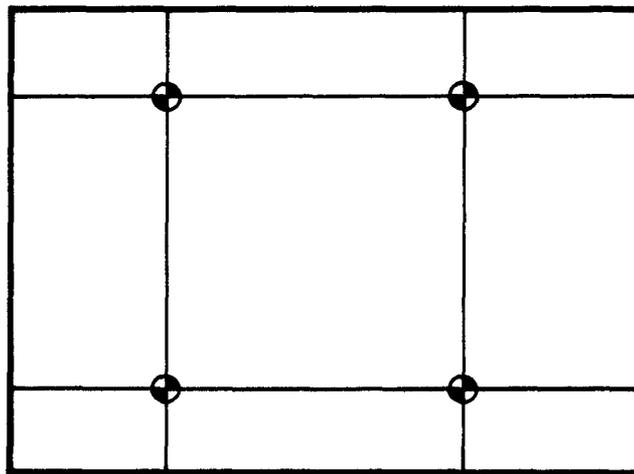
— GRID LINE

⊕ SAMPLING LOCATION

○ AREA OF SOIL STAINING



APPROXIMATE
SCALE 1"=10'



LEGEND

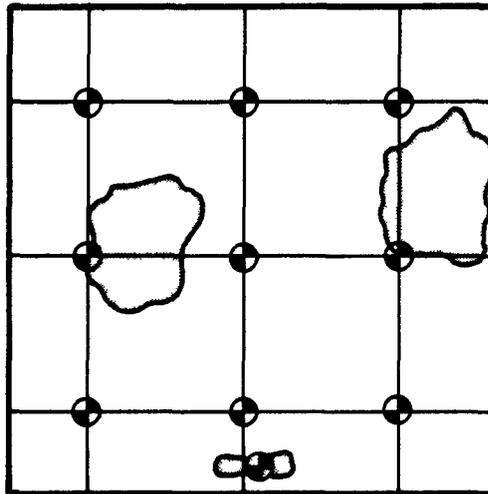
— AREA BOUNDARY

— GRID LINE

⊕ SAMPLING LOCATION



APPROXIMATE
SCALE: 1"=10'



LEGEND

— AREA BOUNDARY

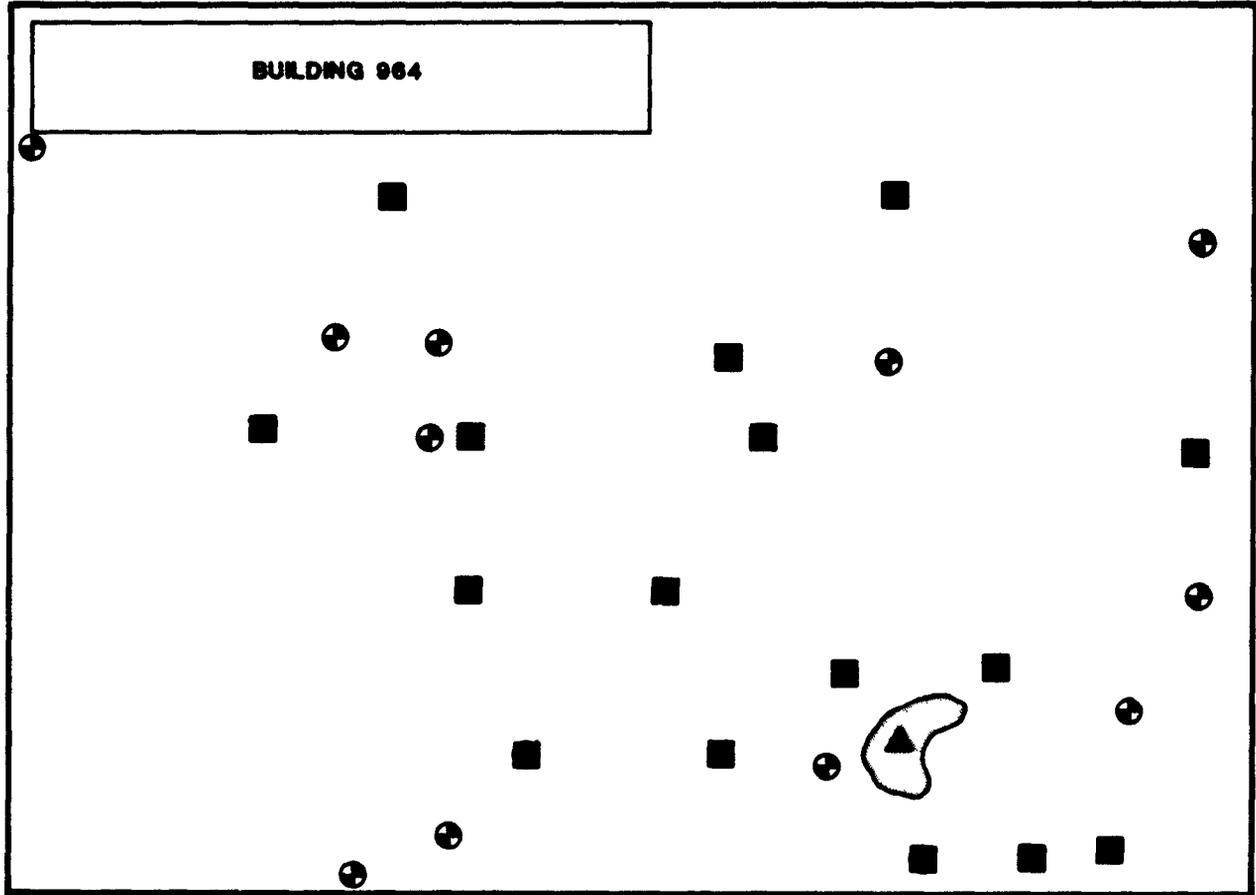
◻ AREA OF SOIL STAINING

— GRID LINE

⊕ SAMPLING LOCATION

N

APPROXIMATE
SCALE: 1"=50'

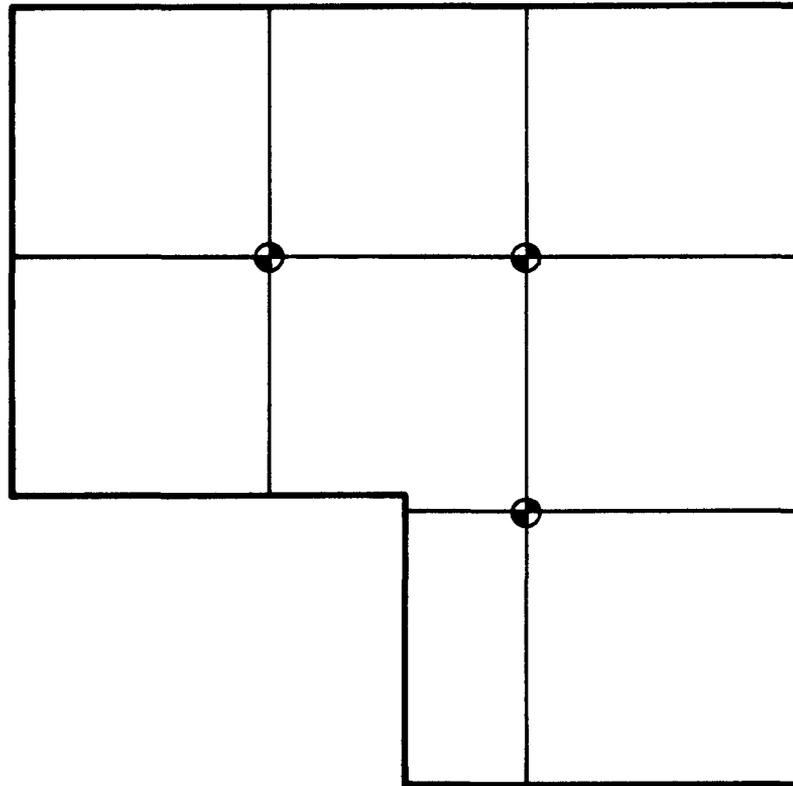


LEGEND:

- AREA BOUNDARY
- ⊕ SAMPLING LOCATION BASED ON PRESENCE OF HAZARDOUS WASTE IN 1985
- ▲ SAMPLING LOCATION BASED ON SOIL STAINING
- RANDOM SAMPLING LOCATION BASED ON HISTORICAL USE OF AREA
- ◊ AREA OF SOIL STAINING



APPROXIMATE
SCALE: 1"=10'



LEGEND:

— AREA BOUNDARY

— GRID LINE

⊕ SAMPLING LOCATION

4.4 Data Analysis

An assessment of soil contamination for each of the container facilities will be based on comparing concentrations of indicator parameters in container storage area soils with the following:

- . Metals - Average trace element concentrations in soils, as presented in "Hazardous Waste Land Treatment," Table 6.46 (U.S. Environmental Protection Agency, 1983), or average background levels determined from the background plots, whichever is more.
- . Volatile Organics -Any standards for these compounds in water, whether proposed, interim, or recommended, will be directly applied to soil. Therefore, if a standard of 0.200 ppm exists for a VOC in water, this standard will be applied to concentrations of this VOC in soil. This is a conservative standard for soils. If a standard for a VOC does not exist, then the Certified Lab Protocol (CLP) Contract Required Detection Limit (CRDL) for low soil/sediment will be used. If this CRDL is not achievable due to analytical interference, then the medium soil/sediment CRDL, which is 100 times the low soil/sediment CRDL, will be used. These limits will define the maximum allowable levels for clean soils.
- . Plutonium - The U.S. EPA, in consultation with other federal agencies, has developed interim recommendations to be used for protection of public health in areas where significant contamination by Pu and other transuranium elements exist. The recommendations are intended to provide long-term radiation protection for all exposed persons in a "critical segment of the population" and specify that both the individual and collective radiation doses should be "as-low-as-reasonably-achievable (ALARA)." These interim recommendations present a soil screening level of 0.2 microcuries of transuranium per square meter

in the upper 1 cm of soil. This represents a combined inhalation and ingestion risk of 1×10^{-6} . At activity levels greater than this, additional evaluation is recommended to determine the actual dose rates to exposed persons (U.S. Environmental Protection Agency, 1986). Assuming a soil density of 1 gm/cm^3 , this activity level translates to 20 picocuries per gram (pCi/gm) of soil. This limit will be applied to the soil sampling conducted under this soil characterization plan.

Uranium - The International Committee of Radiological Protection presents an acceptable standard of 100 millirems (mrem) of effective dose equivalent per year of exposure for long-term exposure for radionuclides from man-made sources (ICRP, 1977). The National Council on Radiological Protection (NCRP) has published soil guides for uranium, radium and lead-210 based on a dose rate of 500 mrem/year. Adjusting these guides to reflect the 100 mrem/year effective dose equivalent (reducing each guide by a factor of five) results in adjusted guides of 320 pCi of uranium per gram of soil, 8 pCi of radium per gram of soil, and 3 pCi of lead-210 per gram of soil (NCRP, 1984). Since all of these materials are found in soil, the sum of the fractions (the observed concentration divided by the concentration limit) must not exceed unity (one). The sum of the fractions technique is used by the Nuclear Regulatory Commission (NRC), U.S. DOE, and Colorado regulations when addressing mixtures. If any fraction is less than 10 percent, the material is considered non-existent for the purposes of the sum of fractions calculation. Based on the above guides, preliminary analyses will be for uranium only. If the uranium concentration exceeds 10 percent of the guide (32 pCi/gm), the radium and lead-210 concentrations in the soil sample will be determined. If the sum of the fractions is found to exceed unity, and the activity at the unit is significantly greater than the background activity for these compounds, soil removal will be used to reduce the sum of fractions to unity or less.

The use of detection limits for volatile organics in soil is quite conservative based on the results of the risk assessment performed as part of the feasibility study for the 881 Hillside (U.S. Department of Energy, 1988). The results of the risk assessment indicate acceptable soil concentrations far in excess of water standards or detection limits. The acceptable soil concentrations for six volatile organic compounds determined from information presented in the risk assessment are presented in Table V. The concentrations based on water standards or detection limits have been adopted for the purposes of ground-water protection.

The results of individual soil samples taken from the container storage facilities will be compared with the applicable criteria to determine if soil contamination exists. The soil will be considered contaminated by metals or radionuclides if the individual results exceed the applicable standard by more than two standard deviations. The soil will be considered contaminated by volatile organics if the individual results exceed the applicable standard, or if no standard exists, the detection limit of the parameter.

TABLE V

ACCEPTABLE SOIL CONCENTRATIONS FOR SELECTED PARAMETERS

<u>Parameter</u>	<u>Concentration (ug/kg)</u>
Phthalate	1,500,000
Carbon Tetrachloride	7,920
1,2-dichloroethane	11,300
1,1-dichloroethene	1,780
Perchloroethylene	20,200
Trichloroethylene	93,800

If no soil contamination is found, no further soil analyses will be performed. Those facilities where no soil contamination is found will be considered clean and closure certified.

4.5 Phase III Soil Sampling

If soil sampling indicates soil contamination is present, further soil analyses will be conducted to define the extent of contamination and to determine further actions. The additional sampling will be conducted to determine both vertical and horizontal extent of contamination and/or to identify the contamination at a 90 percent confidence level based on a statistically valid analysis. Additional background samples may be required in order to establish background levels in the differing soil horizons encountered in the container facility exploration. The vertical extent of contamination will be determined by extending borings to uncontaminated materials or to the ground-water table, whichever is shallower.

If required, the Phase III soil sampling plan will be developed and submitted to the CDH for their approval within

30 days after determining Phase III sampling is required. The Phase III soil sampling plan will be part of the revised closure plan. The Phase III soil sampling plan will follow the general guidelines presented in Appendix I-2 of the RCRA Part B Operating Permit Application (U.S. Department of Energy, 1987a).

Phase III sampling will continue until the limits of contaminated soil are identified, with the exception of those facilities covered under this closure plan that are circumscribed by a low-priority solid waste management unit (SWMU) that is not a RCRA closure site. For the units circumscribed by a low-priority SWMU, the PU&D container storage facilities and the Building 444/453 drum storage area, the Phase III sampling will cease when the horizontal limits of the RCRA closure area are reached. Any contamination beyond those limits is considered to be a part of the low-priority SWMU, and will be addressed in the ongoing CEARP activities.

APPENDIX 3

OPERATIONAL SAFETY ANALYSIS (OSA)
FOR SOIL REMOVAL

(Rockwell, 1988)

DRAFT

HSE 2.03
Page 1 of 11
Jan. 28, 1988
Replaces: 03/31/87

OPERATIONAL SAFETY ANALYSIS [OSA]

SCOPE

An OSA is required for the operations defined in this document. OSAs establish safe practices and shall be thoughtfully prepared, and thoroughly reviewed with the identified controls carefully implemented. OSAs will be reviewed at least annually.

1. GENERAL RESPONSIBILITIES

- 1.1 The Responsible User/Supervisor will.
 - 1.1.1 Assess the operations for which he/she is responsible and prepare an OSA, if required.
 - 1.1.2 Ensure the submission is complete, and follow the OSA through the entire safety review procedure.
 - 1.1.3 Secure the necessary review and approvals BEFORE initiating new operations or changes.
 - 1.1.4 Implement the OSA and all identified requirements.
 - 1.1.5 Incorporate all safety requirements specified in the OSA into the appropriate operating procedure
 - 1.1.6 Instruct involved employees on prescribed operating procedures and emergency procedures.
 - 1.1.7 Notify the HS&E Area Engineer of any change in the operations and secure a safety review prior to implementing any change[s].
- 1.2 The HS&E Area Engineer is available to assist Responsible Users/supervisors identify operations which require OSAs and to prepare new OSAs. The HS&E Area Engineer will determine, with input from Safety Analysis, if the OSA should include a Failure Mode Effects Analysis [FMEA]. The HS&E Area Engineer will review the OSA for compliance with established codes, standards, regulations, Rocky Flats Plant practices, and will conduct periodic reviews. OSAs will be audited during the annual Multi-Discipline Audit.

1.3 The Director of Health, Safety and Environment, will indicate his review and concurrence by signing the OSA Title and Approval Sheet [see Appendix B].

1.4 The Approval Authority [Director] will be satisfied that the proposed operation may be conducted safely, and will formally authorize the conduct of the operation. [see Appendix A].

1.5 Each employee participating in the operation is responsible to perform work in accordance with the requirements of the OSA.

2. WHEN REQUIRED

2.1 This review process is MANDATORY for every Rocky Flats Plant [RFP] operation with a potential risk for serious injury, radiation exposure to personnel, or damage to property or the environment. The HS&E Area Engineer will assist in the determination of the need for an OSA during the review process based on the following criteria:

2.1.1 Operations with a potential for exposing employees to radioactive or toxic materials in excess of established guides/limits.

2.1.2 Unless specifically exempted by the Director of HS&E, any operation which involves a radioactive source subject to registry per HSE 18.04, Section 5.1.

2.1.3 Any work with Occupational Safety and Health Administration or Department of Energy [DOE] defined carcinogens.

2.1.4 Operation of accelerators, x-ray machines, radiography sources, lasers, and microwave generators [other than food preparation machines].

2.1.5 Pneumatic systems with high stored energy potential, such as:

2.1.5.1 Units 6 inches and under in diameter - 100psig or greater.
Units over 6 inches and up to 24 inches in diameter - 15 psig or greater.
Units over 24 inches in diameter - 5 psig or greater.

2.1.5.2 Hydraulic pressures greater than 10,000 psig.

2.1.5.3 High voltage greater than 20 kilovolt [kV] in a vacuum.

2.1.5.4 Greater than 25 joules [J] of stored electrical energy in capacitors and capacitor banks.

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2.1.6 Any work with materials having a health hazard rating of FOUR in the Hazardous Material Handbook.

2.1.7 Work with explosives.

2.1.8 The use and storage of firearms and ammunition.

2.1.9 Operations with potential for exposing employees to environmental conditions in excess of established guides or limits [i.e., noise, heat, etc]

2.1.10 Any work involving flammable liquids as defined in HSE Manual Procedure 9.05, "Handling and Storage of Flammable Liquids for Fire Safety," Section 1.1.

2.1.11 Any operation identified as hazardous by the HSE Area Engineer, or by any HS&E discipline.

3. PROCEDURE FOR DEVELOPING AN OSA

3.1 Responsible User/Supervisor and HS&E Area Engineer: Determine the need for, and scope of each OSA. If an OSA is to be written, discuss details and depth that the OSA must contain

3.2 Responsible User/Supervisor: Write the OSA using Title and Approval Authority Sheet [Appendix B], and Procedure Sheet [Appendix C] of this Procedure. The OSA should identify: basic operations, potential hazards, and hazard controls.

All required Failure Mode & Effects Analyses [FMEAs] shall be incorporated as an addendum to the OSA.

Send completed OSA to the appropriate HS&E Area Engineer for review.

3.3 HS&E Area Engineer: Review the OSA, log in, and assign OSA number. Send copies of the OSA, with Comment Review Sheet [Appendix D] to the Area Safety Team members, along with information indicating the time and place of the HS&E review meeting. Schedule a meeting approximately 5 working days from the submittal of the OSA to the Area Safety Team.

3.4 HS&E Area Engineer and Area Safety Team: Review the OSA and the operation, with the Responsible User/Supervisor at the SITE OF THE OPERATION. Consider all hazards and ensure the hazard controls are adequate. Recommend the OSA be reviewed by a technical specialist, if appropriate, and attend the HS&E review. ALL comments must be signed and will remain as a permanent part of the OSA.

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3.5 Responsible User/Supervisor:

3.5.1 Re-write the OSA incorporating all comments from the HS&E review.

3.5.2 Return the OSA to the HS&E Area Engineer, along with all comments for review.

3.6 HS&E Area Engineer: Review the OSA and ensure all comments are present.

NOTE: If a problem arises that cannot be resolved, the OSA will be routed to the Director of Health, Safety and Environment for final resolution.

Write a cover letter to the Approval Authority highlighting areas of the OSA requiring maximum attention during implementation and use of the OSA. Send the cover letter and OSA with all comments to the Director, HS&E [alternate, Manager, HSE Area Management] for review and concurrence.

3.7 Provide the OSA title, number, Responsible User, method of information dissemination, and Approval Authority to the HSE Area Management Office.

3.8 Director of Health, Safety and Environment: Review, concur, and sign the original Title and Approval Sheet. Forward OSA package to the appropriate Approval Authority.

3.9 Approval Authority: When the approval is granted, sign original Title and Approval Authority Sheet [Appendix B] and return to the appropriate HS&E Area Engineer. If the OSA is NOT approved, return it to the Responsible User/Supervisor for necessary changes and notify the HS&E Area Engineer that the OSA has been returned to the Responsible User/Supervisor for changes.

3.10 Responsible User/Supervisor and HS&E Area Engineer: If the OSA is not approved, make the necessary changes and return the OSA to the HS&E Area Engineer for review. The HS&E Area Engineer will forward the OSA to the Area Safety Team, which will concur with the change[s] and re-submit the OSA to the Approval Authority or, if not in agreement, the OSA will be scheduled for further discussion.

If the OSA is approved, the OSA, all original comment sheets, and the original Title and Approval Sheet will be returned to HSE Area Management, for distribution to the Approval Authority, Responsible User/Supervisor, HS&E Area Engineer, and permanent repository.

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3.11 Responsible User: The Responsible User [designated by the Approval Authority and the supervisor], will be responsible for disseminating the hazards identification and control measures contained in the OSA to the involved employees. The following requirements are mandatory:

- ** Discuss OSA at DOCUMENTED safety meetings at least annually, or whenever changes occur, if more frequent.
- ** Have employees read and acknowledge by signing a sheet attached to the inside front cover of the OSA.

4. SUBSEQUENT REVIEW OF APPROVED OSAs [AT LEAST ANNUALLY]

4.1 HSE Area Management: One month in advance, HSE Area Management, will notify the Area Engineer and the Responsible User that the OSA is due for review.

4.2 Responsible User/Supervisor: Review operation and the OSA with the HS&E Area Engineer.

4.3 HS&E Area Engineer: If no significant changes have occurred, the HS&E Area Engineer will notify HSE Area Management, in writing, that the review has been completed. HSE Area Management will document and notify the Approval Authority and Responsible User that the review has been successfully completed.

4.4 During the annual review, if the User decides the OSA is acceptable for continued use, he/she will send a letter to the HS&E Area Engineer, which verifies this decision.

5. OPERATIONAL CHANGE CONTROL

5.1 Responsible User and HS&E Area Engineer: Minor changes to the OSA prior to subsequent reviews, may be approved by the Responsible User-Supervisor and the HS&E Area Engineer.

5.2 HS&E Area Engineer and Area Safety Team:

5.2.1 If a significant change has been identified by the Responsible User/Supervisor or the HS&E Area Engineer since the last review, review the OSA following the procedure outlined in Section 3.6

5.2.2 If the change requires the operation to be shutdown, the HS&E Area Engineer will notify the Responsible User/Supervisor

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5.2.3 Examples of Significant Change Are:

- ** Any change in operation altering the flow of process materials.
- ** Any addition, replacement, modification, or relocation of equipment.
- ** Any deviation in construction material[s] from the original, such as stainless steel to PVC.
- ** Any change in glovebox [e.g., sumps in floor, fire doors that block access to criticality drain].
- ** Any chemical changes or quantity changes in a process.
- ** Any relocation of a process or operation within a room building, or from building to building.
- ** Any change in a ventilation system.
- ** Any change in quantity and/or form of radioactive materials in a process or operation.
- ** Any change in temperature or pressure parameters of equipment.
- ** Any change in personnel protective equipment requirements, such as shielding, respiratory protection, eye/face protection, hand protection, etc.
- ** Any changes in construction materials used to install a wall or relocation of a wall or installation of new walls, such as dividing a room into smaller sections.

The above examples are to be used as a guide and may not cover all areas of concern. HS&E can deem a change significant based on their expertise. Therefore, judgment must be used any time that a change occurs to ensure that appropriate reviews are made.

5.3 HS&E Area Engineer: Review the OSA with the Responsible User/Supervisor to ensure that noted changes are reviewed and incorporated into the OSA as necessary. If the operation was shutdown, appropriate changes must be incorporated into the OSA and approved by the Approval Authority before the operation is permitted to proceed. Notify HSE Area Management of update.

6. AUDITS

6.1 The Area Safety Team will audit operations for compliance with OSA requirements during the annual Multi-Disciplinary Audit.

7. DEACTIVATION OF AN OSA

7.1 Responsible User/Supervisor: Notify the HS&E Area Engineer when an operation covered by an OSA has been deactivated.

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7.2 HS&E Area Engineer: The HS&E Area Engineer will, in writing, notify HSE Area Management when an OSA has been deactivated. At that time, the original OSA will be turned over to the HSE Area Engineer for retention or disposal.

8. RE-ACTIVATION OF AN OSA

8.1 Responsible User/Supervisor: Notify the HS&E Area Engineer that the OSA should be re-activated.

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APPENDIX A

APPROVAL AUTHORITIES

DIRECTOR	SUPPORT OPERATIONS
DIRECTOR	PRODUCTION OPERATIONS
DIRECTOR	QUALITY ENGINEERING & CONTROL
DIRECTOR	FINANCE & RESOURCE MANAGEMENT
DIRECTOR	PLUTONIUM OPERATIONS
DIRECTOR	HEALTH, SAFETY & ENVIRONMENT
DIRECTOR	PLANT SECURITY
DIRECTOR	SAFEGUARDS & MATERIALS MANAGEMENT

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APPENDIX B

OPERATIONAL SAFETY ANALYSIS [OSA]

OSA NUMBER _____

TITLE _____

OPERATION

Briefly describe operation covered by the OSA. The description should include a statement of principle operation; type[s] of material to be worked; statement of principle hazard[s], sequence of the operation, including location of operation, building, room; and any special conditions that should be considered

RESPONSIBILITY

_____ [Name] _____ [Position] _____ [Organization]

is responsible for this operation. It is his/her responsibility to ensure the operation is carried out in accordance with the OSA and that employees performing this operation are familiar with the document.

CHANGES

No changes will be made in this OSA without coordinating the change through the HS&E Area Engineer. He/she will determine if additional reviews and/or approvals are necessary.

CONCURRENCE

Director, HS&E [Signature] _____ Concurrence Date

APPROVAL AUTHORITY

[Type Name and Title of Approval Authority]

is the final Approval Authority for this OSA.

Approval Authority [Signature] _____ Approval Date

APPENDIX C
OPERATIONAL SAFETY ANALYSIS [OSA]

OSA # _____

TITLE _____

RESPONSIBLE ORGANIZATION

General Hazard Review & Control

Basic Job Steps

Potential Hazard

Hazard Control

APPENDIX 4
RINSATE SAMPLING METHODS

APPENDIX C-2
SAMPLING METHODS
(Shipping Regulations)

1.0 INTRODUCTION

Sampling methods used to collect hazardous wastes at the Rocky Flats Plant comply with those described in Appendix I of 6 CCR 261 (40 CFR 261). Methods were chosen for their ease in the collection of a representative sample, 6 CCR 264.13(b)(3) (40 CFR 264.13(b)(13)). Sampling location, matrix, container type and size, and accessibility were taken into consideration when assigning a sample method.

This appendix details sample collection methods, sample handling and documentation, and sample shipment.

2.0 SAMPLING PLAN

2.2 Sampling Methodology

This section presents a discussion of the general sampling procedures for a variety of waste management units.

2.2.1 Containers

The term container is used here as self-supporting receptacles designed for transporting materials. This includes drums and other mobile receptacles as opposed to stationary tanks. EPA & State regulations.

The method of sampling varies for containers depending on degree of access to the waste. Ideally, several samples will taken from

locations displaced both vertically and horizontally throughout the container. Open top containers are sampled by the three dimensional random sampling method. Closed containers with bungs or restricted openings are sampled by the two dimensional sampling method. If the container is found to have a multi-phase liquid in it, each phase is sampled separately.

Access to the container is unlimited in bags, cardboard drums, and open-headed steel drums. Two-dimensional random sampling is used in this case for liquids, slurries, sludges, and solids from powders to granules. This method involves dividing the top surface of the waste into a grid, selecting grid sections using random number tables, and sampling each selected grid point along the entire vertical profile of the waste. The surface of the container is divided into at least four equal areas. The grids on the surface are numbered from left to right, north to south when facing in a northward direction.

Open containers with non-granular larger solids such as Kimwipes and rags, are sampled using a three dimensional random sampling strategy. The surface of the waste is divided into a grid as in two dimensional random sampling. The height of the container is divided into at least two imaginary levels from top to bottom. Specific levels and grid locations are then selected for sampling using a random number table. Samples are taken in this manner until the specified sample volume has been collected.

Containers with small openings, such as drums with bungs, limit sampling to the vertical plane. In this case a sample is taken of the entire vertical profile of the waste at the point where access is allowed. Samples collected from these containers is representative if the waste is horizontally homogeneous.

3.2.2 Tanks

Tanks are considered to be immobile waste containers and include above-ground and subsurface tanks and sumps (EPA and State regulations). The obstacles encountered in obtaining a representative sample from a tank are similar to those discussed above in container sampling.

If the tank is open, the most representative set of samples is obtained using the three dimensional random sampling strategy described in Section 3.2.1. However, if it is known that vertical compositing yields a representative sample, two dimensional random sampling is adequate.

Some tanks, such as very large open tanks or closed tanks, cannot be sampled by the simple random sampling methods because access restricts sampling to a portion of the tank. Where this is the case, sufficient samples are taken where physical constraints allow to address any vertical heterogeneity of waste components in the tank. This may be accomplished by composite sampling from the outlet port of the tank as the tank is being emptied.

The sampling devices used for tank sampling vary with the size of the tank. Sampling equipment is discussed more fully in Section 3.2.

2.2.3 Process Streams

Solid or liquid waste samples are collected from the process stream prior to containerization if they are combined with other waste streams in the container or tank. In this case, a grab sample is taken by immersion or scooping the waste at one point in time. Sampling at more than one point in time is only conducted if process operations vary considerably over time.

2.2.4 Waste Piles

Waste accessibility, usually a function of pile size, is an important consideration in selecting a sampling methodology for waste piles. A smaller pile that is not homogeneous or that contains an unknown is sampled using the three dimensional simple random sampling method.

2.3 Sampling Equipment

This section describes general items needed for sampling and specific EPA approved equipment for sampling a number of waste types. A general guide to the sampling equipment to be used for each waste type is presented in Table C-2-1. Sampling methodologies and equipment may vary from the guide if those

TABLE C-2-7

MATRIX SPECIFIC SAMPLE METHODS

<u>MATRIX</u>	<u>ABBREVIATIONS</u>	<u>SAMPLE METHOD</u>
Aqueous	agu	bailer, coliwasa, dipper, pour, pump, thief, weighted bottle
Liquid	liq	bailer, coliwasa, dipper, pour, pump, thief, weighted bottle
Oil	oil	coliwasa, dipper, pour, pump, scoop, thief
Sludge	slu	scoop, shovel
Solid	sol	grab (hand, tongs, tweezers), scoop, tin snips

CONTAINMENTSAMPLE METHOD

Drum	coliwasa, thief
Tank	bailer, coliwasa, dipper, weighted bottle
Process Stream or Pipe	dipper
Waste Pile	scoop, shovel
Bottle	pour

proposed are impractical. The decision to vary from these recommended methods is made by the on-site project manager or building supervisor.

2.2.1 General Items

General equipment is needed during a sampling event to record and document sampling information, properly preserve samples, and decontaminate the outside surface of sample bottles and equipment.

These items include:

- logbook, ink pens;
- watch;
- sample containers/labels;
- sample preservatives;
- stainless steel bucket for compositing during random sampling;
- polyethylene sheeting;
- paper towels;
- HPLC/distilled water;
- pH meter/buffer solutions;
- beaker for field measurements;
- plastic squeeze bottles for decontamination of instrument probes;
- coolers with ice;
- wash bucket;
- rinse bucket;
- alkaline detergent;
- brushes;
- plastic trash bags;
- methanol;
- tap water; and
- distilled water.

3.3.2 Composite Liquid Waste Sampler (coliwasa)

The coliwasa is used to sample liquids or slurries contained in drums, shallow tanks, pits and similar containers. It consists

of a tube equipped with an end closure that can be opened while the tube is submerged in the material to be sampled. A diagram of the sampler is shown in Figure 2.3.

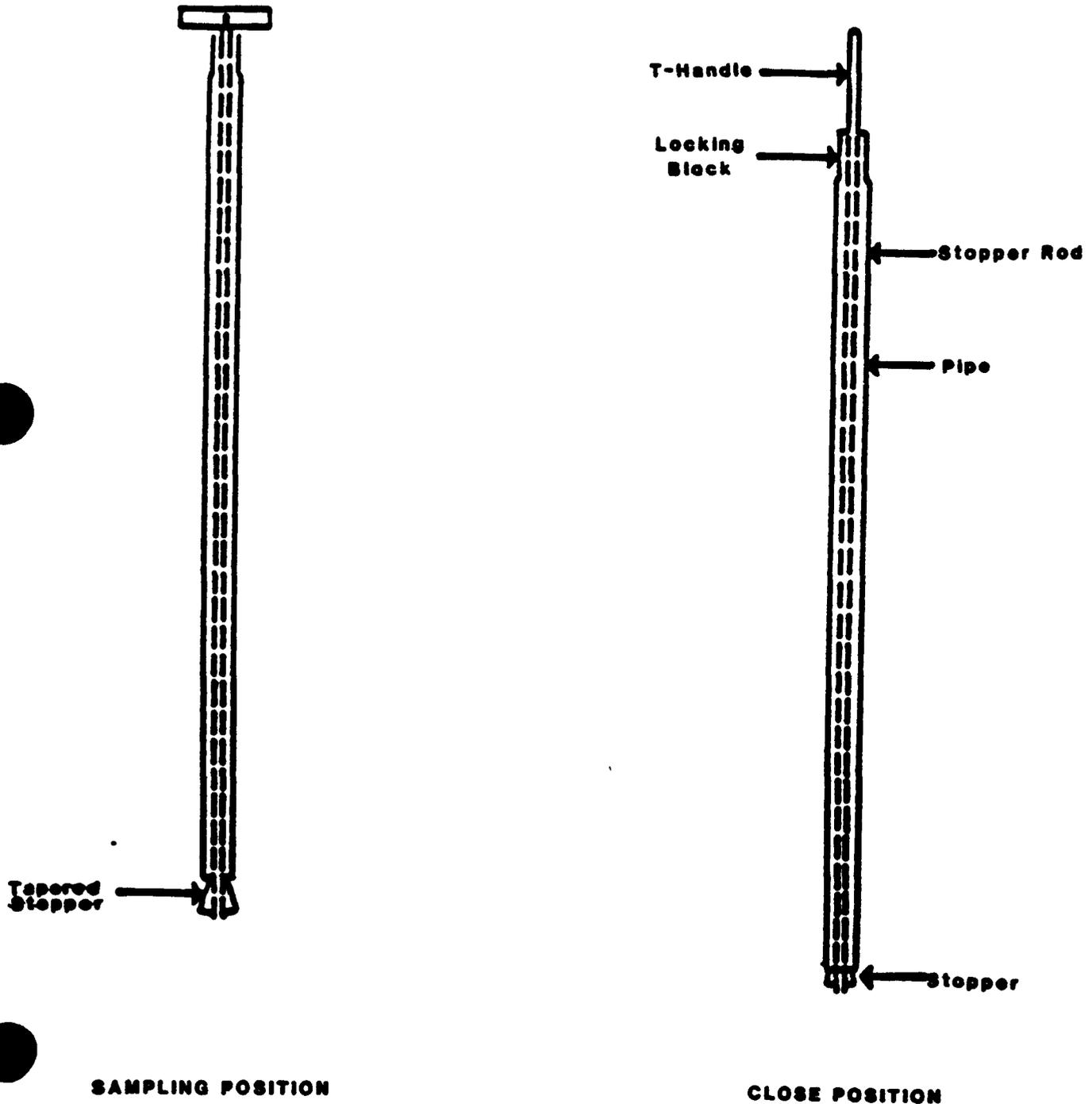
The procedure for sampling using a coliwasa is as follows:

1. Adjust sampler's locking mechanism to ensure the stopper provides a tight closure. Open sampler by placing stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.
2. Slowly lower the sampler into the waste at a rate that permits the level of liquid inside and outside the sampler to remain the same. If the level of waste in the sampler tube is lower inside than outside, the sampling rate is too fast and will produce a nonrepresentative sample.
3. When the sampler hits the bottom of the waste container, push sampler tube down to close and lock the stopper by turning the T-handle until it is upright and one end rests on the locking block.
4. Withdraw coliwasa from waste and wipe the outside with a disposable cloth or rag.

Limitations of the coliwasa include difficulty in decontamination and a prohibition on using the glass coliwassa to sample liquids that contain hydrofluoric acid.

A modification to the coliwasa described consists of a hollow glass tube with a glass insert tube that acts like a stopper. This coliwasa operates in a similar manner, where the glass insert can be lifted off the bottom of the tube when submerged in the material to be sampled. The advantage to this type of coliwasa is that it is disposable, which eliminates the possibility of cross contamination.

FIGURE 2.3
COMPOSITE LIQUID WASTE SAMPLER



2.2.3 Drum Thief

A drum thief consists of a hollow glass tube that can be used to sample liquids in drums and shallow tanks. A thief operates on a principle similar to a coliwasa. The procedure for sampling is as follows:

1. Lower the sampler slowly into the waste so that the level of liquid inside the tube remains the same as the level in the waste receptacle.
2. When the sampler touches the bottom of the container, place a thumb or stopper over the top of the tube to seal.
3. Withdraw the thief from the waste and wipe the outside with a disposable cloth or rag.
4. Place the bottom of the thief in the sample container and release the seal so that the waste in the thief flows into the sample bottle.

Like the coliwasa, a glass thief cannot be used to sample liquids that contain hydrofluoric acid. One advantage of the glass thief is that it is disposable which eliminates the possibility of cross contamination.

2.2.4 Teflon Bailer

A Teflon bailer is useful in sampling deep tanks or sumps at depth. The sampling methodology involves slowly lowering the bailer to the desired depth, then raising the bailer and collecting the sampler. Teflon is a fairly nonreactive material and can be used to sample organic and inorganic liquids. The bailer would not be effective for sampling slurries or very viscous liquids.

2.2.5 Weighted Bottle

This sampler consists of a glass or plastic bottle, sinker, stopper, and a line that is used to lower, open, and raise the bottle. The procedure to be used is as follows:

1. Assemble weighted bottle sampler.
2. Lower the sampler to directed depth and pull out the bottle stopper by jerking the line.
3. Allow bottle to fill completely as evidenced by cessation of air bubbles.
4. Raise sampler, cap, and wipe off with a disposable cloth. The bottle can serve as a sample container.

Prior to sampling using the weighted bottle, the wastes must be characterized enough to ensure that the waste will not corrode the sinker, bottle holder, or line.

2.2.6 Dipper or Ladle

A dipper consists of a glass or plastic beaker on the end of a metal or plastic pole that is used as the handle. The dipper will be used to sample liquids and slurries in tanks that cannot be sampled using any of the previous methods.

The ladle is similar to the dipper, with a shorter handle. It will be used to sample more shallow process tanks and machine reservoirs. The procedure for using either device is as follows:

1. Assemble dipper or ladle by placing beaker in clamp and fastening shut.

2. Turn the device so the mouth of the beaker faces down and insert into waste material. Turn beaker right side up when dipper is at desired depth. Allow beaker to fill completely as shown by the cessation of air bubbles.
3. Raise dipper or ladle and transfer sample to container.

Guidelines to be used in dipper and ladle sampling include not using a nonfluorocarbon plastic beaker to sample wastes containing organic material and not using a dipper with a glass beaker to sample wastes with a high pH or wastes that contain hydrofluoric acid.

2.2.7 Scoop

Scoops and shovels are used to sample granular or powdered material in bins, shallow containers, and sludges. Sampling with a scoop involves obtaining a full cross section of the waste material.

2.2.8 Pour

Wastes contained in bottles, glass or polyethylene, are poured directly into sample collection containers. Depending on "mouth" size of the bottle a funnel may be necessary.

2.3 Equipment Decontamination

Equipment is decontaminated after each use to minimize cross contamination between samples. A decontamination station is set up outside of a building prior to beginning sampling in that

building. Polyethylene sheeting forms the base of the decontamination area, which includes a detergent wash, tap water rinse, methanol rinse, distilled water rinse, and drying area. The equipment is washed by brush with an alkaline detergent, rinsed with tap water, rinsed with methanol, rinsed with distilled water, and dried with paper towels. Spent decontamination solutions and rinse waters are containerized and stored at the Rocky Flats site. The waste solutions are treated onsite by Rockwell in their process waste system. The paper towels used for drying decontaminated equipment are disposed of with the sanitary trash onsite. Appropriate disposal of the solutions are determined after review of the sample analysis data.

3.0 SAMPLE HANDLING AND DOCUMENTATION

This section describes procedures for sample handling and documentation from sample collection through receipt by the laboratory. Involved are discussions on:

1. Sample tracking system;
2. Organizational structure for sample documentation;
3. Sample identification and collection; and,
4. Documentation and chain-of-custody.

3.1 Sample Tracking System

A computerized system has been developed that provides complete

documentation of sample custody from sample collection through receipt of the samples by the laboratory. The system is capable of logging daily receipt of samples, recording field details on individual samples, and chain-of-custody.

3.2 Organizational Structure for Sample Documentation

On a daily basis the Sample Coordinator determines the number and location of samples to be collected for that date and assigns these tasks and sample numbers to the field sampling crew. The Sample Coordinator specifies proper sampling devices, sample container types, and preservation methods consistent with the analysis plan for the project.

The field sampling crew leader is responsible for recording sampling activities in detail in a field logbook and maintaining custody of the samples until they are packaged for off-site shipment or delivered to the on-site laboratory for extraction or analysis. Lab personnel enter data into the computer tracking system from the field logbooks at the end of each day. The sampling crew leader and lab personnel review data input and data reports for accuracy prior to packaging and shipping samples. Off-site shipping records are recorded by the lab personnel entering data when necessary.

3.3 Sample Collection, Decontamination, and Identification

Sample collection follows the methods and procedures described in

Section 3. The specific methods and equipment used are different for each type of sample collected. These methods are subject to change if additional information on the waste streams or possible sampling access becomes available. The decision to change sampling methods or analyses is made by the Sample Coordinator or field crew leader.

To protect sampling and laboratory personnel from potential exposure to possible hazardous or radioactive contaminants, all samples are decontaminated prior to packaging. After each sample is collected, sample containers are washed on the exterior with a detergent, rinsed with tap water, and dried with paper towels.

Decontamination solutions and rinse waters are containerized and stored with the equipment decontamination solutions. These solutions are disposed by Rockwell International in the process waste treatment system.

The data and time of collection and the sampler's initials are be entered on a preprinted bottle label that contains the following information:

1. The site name;
2. A unique sample identification number;
3. Laboratory destination;
4. Matrix;
5. Analyses requested; and
6. Time of sample collection.

All of this information is entered into the sampler's notebook, along with the chain of custody number.

3.4 Radiological Screening of Samples

Samples from uranium buildings are screened for depleted uranium content. Samples from the PSZ area are screened for plutonium and americium content. The screening is performed prior to moving the samples from the point of generation, if the content is expected to be high, or prior to the samples being received at the laboratory. A small vial containing 30-50 ml of the sample is analyzed using a lithium drifted silicon detector [SI(Li)] and a multichannel analyzer. The plutonium concentration is determined from the 17.2 keV α x-ray photo-peak. The americium concentration is determined from the 50 keV photo-peak. Uranium concentrations are determined using either a pancake Geiger-Mueller detector and scaler or from the 16.2 keV Thorium L x-ray photo-peak on the Si(Li) system.

3.5 Documentation and Chain-of-Custody

Field notebooks provide the means for recording and documenting all data collecting activities performed at a site. As such, entries is as descriptive and detailed as possible, so that a

particular situation may be reconstructed without reliance on the collector's memory.

Field notebooks are bound, with consecutively numbered pages. Each notebook is identified by a number assigned by the project manager.

The cover of the notebook contains the following information:

- o Person or organization to whom the book is assigned;
- o Book number;
- o Project name;
- o Start date; and,
- o End date.

At the beginning of the field investigation entry, the following information is recorded:

- o The date and start time;
- o All field personnel present;
- o Level of personal protection used on-site; and,
- o The signature of the person making the entry.

All field measurements made and a description of the samples collected is recorded. All entries are made in pen; no erasures is permitted. If an incorrect entry is made, the data is crossed out with a single strike mark and initialed. Entries are organized into easily understandable tables where possible. Any significant observations is also be recorded.

At each station where a sample is collected or a measurement made, a detailed description of the location of the stations is recorded. All equipment used to make measurements is also identified by preassigned equipment numbers and calibration of that equipment documented. All equipment is calibrated per the equipment instructions. The equipment used to collect samples is noted, along with other information related to the sample effort, such as:

- o The time of sampling;
- o Sample description;
- o Detailed information on the sampling procedure used;
- o Number and volume of containers.

Sample numbers are assigned prior to sampling. Duplicates, which receive separate sample number, are noted under sample description.

The day before sample collection, the Sample Coordinator or his designee contacts the data management person at the on-site lab and lists the samples to be taken the following day. The sampling crew arrives at the on-site lab the morning of the sampling and picks up bottles, bottle labels, and a chain of custody form listing the samples to be collected that day. The bottle labels are affixed to the sample bottles after sample collection and decontamination of the outside of the bottles. Any changes in samples collected or analyses to be run are

indicated on the chain-of-custody form in the field. All changes are initiated by a sampling team member.

After collection, the samples are delivered to the on-site laboratory trailers by sampling personnel and logged into the computer tracking system by laboratory personnel. The field sampling crew leader and laboratory personnel also input pertinent field information for unique samples into the tracking system. Both of the duplicate chain-of-custody records are signed by the field sampling crew leader. The original custody record is maintained at the on-site laboratory. The duplicate custody record is bound in a permanent binder and kept in the Sample Coordinator's office onsite.

3.6 Packaging, Marking, Labeling for Off-Site Shipping

Samples destined for off-site shipment are prepared in accordance with U.S.D.O.T. regulations. All samples collected during the sampling program are considered hazardous materials samples and are handled accordingly.

If the material in the sample is known or can be accurately identified, it is packaged, marked, labeled, and shipped according to the specific instructions for that material, as detailed in the U.S.D.O.T. Hazardous Materials Table 49 CFR 172.101.

For samples of hazardous substances of unknown content, the

appropriate transportation category is selected through a process of elimination from the attached Table C-2-2. While it is probable that most unknown hazardous materials samples collected will not contain radioactive materials or "Poison A" materials, it is essential that the following gradient hierarchy be considered.

If radiation survey instruments demonstrate, or reasonable probability exists, that the unknown hazardous sample is radioactive, the appropriate U.S.D.O.T. shipping regulations for "radioactive materials" must be followed. If radioactive material is eliminated, it must then be considered that the sample contains "Poison A" materials. U.S.D.O.T. defines "Poison A" as an extremely dangerous poisonous gas or liquid or such a nature that a very small amount of gas, or vapor of the liquid, is dangerous to life. Most "Poison A" materials are gases and would not be found in glass or drum-like containers. Based upon information available, a judgment must be made whether a sample from a closed container is a "Poison A."

If "Poison A" is eliminated as a shipment category, the next two classifications are "flammable" or "nonflammable" gases. Since an open container is not expected to contain a significant amount of gas, "flammable liquid" is the next applicable category. With the elimination of "radioactive materials", "Poison A", "flammable gas", and "nonflammable gas", the sample can be

TABLE C-2-2

U.S.D.O.T. HAZARDOUS MATERIALS CLASSIFICATION (40 CFR 173.2)
LISTED IN ORDER TO DESCENDING HAZARD

1. Radioactive Material
2. Poison A
3. Flammable Gas
4. Nonflammable Gas
5. Flammable Liquid
6. Oxidizer
7. Flammable Solid
8. Corrosive Material (Liquid)
9. Poison B
10. Corrosive Material (Solid)
11. Irritating Material
12. Combustible Liquid (in containers having capacities exceeding 110 gallons)
13. ORM-B (other regulated materials - Series B)
14. ORM-A (other regulated materials - Series A)
15. Combustible Liquid (in containers having capacities of 110 gallons or less)
16. ORM-E (other regulated materials - Series E)

classified as "flammable liquid" and shipped accordingly. These procedures also suffice for shipping any other samples classified below flammable liquids in the U.S.D.O.T. classification table.

For samples containing unknown material, other classifications listed below flammable liquid are generally not considered. In order to eliminate classifications which appear below flammable liquid, a flashpoint test is required. Flashpoint testing is impractical and possibly dangerous.

Thus, unless the sample is known absolutely to be a material or have a classification which is classified below flammable liquid, it is considered a flammable liquid and shipped as such.

Applying the word^g "flammable liquid" to a sample does not necessarily mean that it is in fact flammable or liquid. Rather, it prescribes the class of packaging to be used pursuant to U.S.D.O.T. regulations. This is permitted under CFR Part 172.402h. As a matter of practice, all hazardous samples are shipped as flammable liquids unless a higher hazardous materials classification applies. X

The following instructions shall apply for shipment of a flammable liquid by cargo carrying aircraft, rail car, or other common carrier.

- Collect the sample in a glass or polyethylene container no larger than 16 fluid ounces with a nonmetallic, Teflon-lined screw cap. To prevent leakage, fill the container no more than 90 percent full. If an air space

in the sample container would affect sample integrity (for example, the case of a VOA vial), place that container in a second container to meet the 90 percent requirement.

- Seal the container and place in a 2-mil thick or thicker polyethylene bag, one sample per bag. Seal the bag.
- Place the sealed bag inside metal can and cushion it with enough noncombustible, absorbent material (vermiculite, for example) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape or other positive means to secure can lid.
- Place one or more metal cans into a strong outside container such as a picnic cooler or a U.S.D.O.T. approved fiberboard box. Surround cans with noncombustible, absorbent, cushioning material for stability during transport. Total sample volume in the picnic cooler or fiberboard box shall not exceed ten gallons. A separate air bill and shipping declaration must be processed for each container or combination of containers such that the total sample volume on any air bill will not exceed ten gallons.
- Include the chain-of-custody record, properly executed, in the outside container.

The following instructions shall apply for land shipment of sample by car or truck (not by common carrier).

- The instructions above for flammable liquids shall apply.
- Sample containers are firmly secured such that they will not bounce against sides of the vehicle during transit or in the event of an accident.
- Limit shipments to 1,000 pounds or less. Under 1,000 pounds, there are no placarding requirements [40 CFR 172.504(c)(1)].

Generally, in marking and labeling of samples classified as flammable liquids, use abbreviations only where specified.

Place the following information on each paint can:

- Laboratory name and address.
- "Flammable Liquid, NOS UN1993." The designation "NOS" means "not otherwise specified." Use an approved D.O.T. label.
- "Dangerous When Wet" must be used if the material is water reactive.

Information placed on cans shall also be placed on at least one side of the outside shipping containers. If labeling is placed on more than one side, it must be affixed to all visible sides. "Cargo Aircraft Only" must be used on all outside shipping containers. Print "Laboratory Samples" and "This End Up" or "This Side Up" on top of the outside shipping container. Outside containers must also contain the state "Inside packages comply with prescribed specifications." Put upward pointing arrows on all four sides of containers.

Shipping papers must be provided for shipment of all samples (including those land carried by rental or personal car). A complete bill of lading and signed certification statement should be included. The following information should be included on the form in the order listed here:

- "Flammable Liquid, NOS UN1993."
- Net weight or net volume (weight or volume may be abbreviated) just before or just after "Flammable Liquid, NOS UN1993."
- "Limited Quantity" (or Ltd. Qty.).
- Further descriptions such as "Laboratory Samples" are allowed if they do not contradict required information.

Unknown hazardous material samples classified as flammable liquids or solids should be transported by rented or common carrier truck, railroad, or express overnight package services. They should not be transported by any passenger-carrying air transport system.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Manager (QAM) is responsible for ensuring that the following procedures are implemented during the sampling program.

4.1 Sample Collection for Quality Assurance

4.1.1 Trip Blanks

A full set of sample glassware and ^{or} plastic containers are filled with laboratory grade water prior to beginning sampling each day, taken to the sampling site, and submitted for analysis for all parameters listed for the samples collected that day. The purpose of this section is to detect containment contributions from the glassware, and/or plastic containers.

4.1.2 Field Blanks

Aqueous field blanks are prepared onsite each day sampling takes place. The field blanks are prepared by pouring laboratory

grade water through sampling equipment simulate collection of an aqueous sample. Field blanks are collected, filtered, containerized, preserved, decontaminated, and shipped as if they were environmental samples. One field blank is prepared each day for each liquid sample collection method used. Samples are analyzed for parameters in the Hazardous Substance List to screen for cross contamination during sample collection and handling.

5.1.3 Duplicate Samples

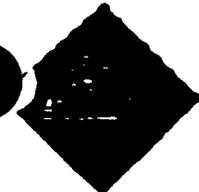
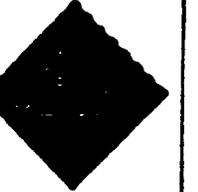
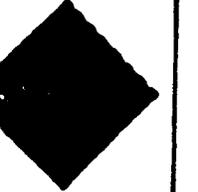
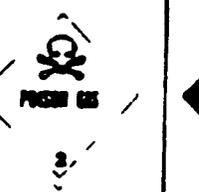
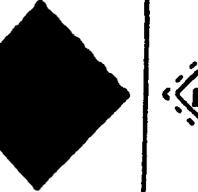
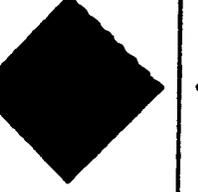
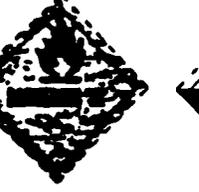
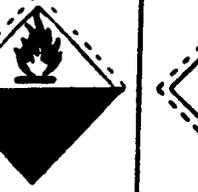
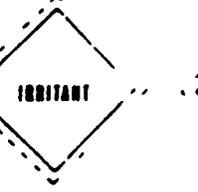
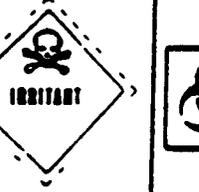
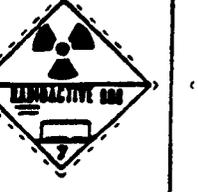
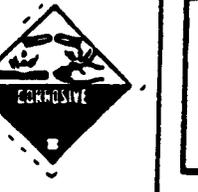
Ten percent (10%) of the waste stream samples collected are sampled twice to provide duplicate samples. The Sample Coordinator determines which waste streams will be sampled in duplicate and assigns unique sample numbers to the duplicate samples. The duplicates are collected and handled as separate samples, with decontamination of equipment between duplicates. The duplicate are used as an indicator of the representativeness of the sampling and procedure.

APPENDIX C-2-A

HAZARDOUS SUBSTANCE SAMPLES

Packaging, Marking, Labeling, and Shipping

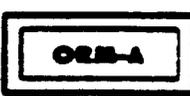
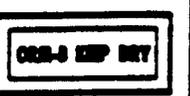
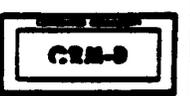
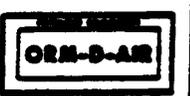
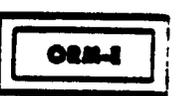
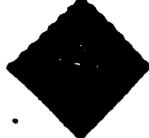
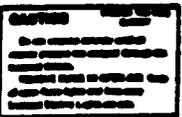
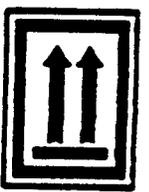
HAZARDOUS MATERIALS LABEL CHART

D.O.T. GENERAL GUIDELINES ON USE OF WARNING LABELS

1. Shipper must furnish and attach appropriate label(s) to each package of hazardous material offered for shipment unless exempted from labeling requirements. (Ref. Title 49 CFR Sec. 172.400)
2. If the material in a package has more than one hazard classification, one of which is Class A explosives, Class A poison, or Radioactive Materials, the package must be labeled for each hazard. (Ref. Title 49, CFR, Sec. 172.402(a))
3. When two or more hazardous materials, different classes are packed within the same packaging or outer enclosure, the outside of the package must be labeled for each material involved. (Ref. Title 49 CFR, Sec. 172.404(a))
4. Radioactive materials requiring labeling must be labeled on two opposite sides of the package. (Ref. Title 49 CFR, Sec. 172.403(f)).
5. Labels must not be applied to a package containing only material which is not subject to Parts 170 - 189 of this subchapter or which is exempted therefrom. This does not prohibit the use of labels in conformance with U.N. recommendations ("Transport of Dangerous Goods" (1970), or with the IMCO requirements ("International Maritime Dangerous Goods Code") (Ref. Title 48, CFR, Sec. 172.401).

HAZARDOUS MATERIALS PACKAGE MARKINGS

						
		<p style="text-align: center;">SAMPLE PACKAGE MARKING</p> <p>Proper Shipping Name ACETONE</p> <p>UN I.D. Number UN 1080</p> <p>HAZARD WARNING LABEL </p>				

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

Shipper Person Shipping Samples
Address of Shipper

Air Waybill No (Federal Express Airbill No.)

Page of Pages

Shipper's Reference Number (Work Order No.)
(optional)

Consignee
Person and Address of Lab
Receiving Samples

Two completed and signed copies of this Declaration must be handed to the operator

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for (delete non-applicable)

Airport of Departure
(City Shipping From)



CARGO AIRCRAFT ONLY

Airport of Destination: City Shipping To

Shipment type: (delete non-applicable)

NON-RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification

Proper Shipping Name	Class or Division	UN or ID No.	Quantity	Country and type of packing	Packing Inst.	Authorisation
Flammable Liquid Numbers	Flammable Liquid	UN1993	1 Cooler at (Cooler Capacity) gallons	Limited Quantity	173.118	
	Cargo Aircraft Only					

Additional Handling Information
- 172.402h

This shipment prepared according to: 48CFR IATA Regulations ICAO Regulations

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labelled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.

Name/Title of Signatory
(Name, Title)
Place and Date
(City Shipping From, Date)
Signature
(see warning above)

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

<p>Shipper Person Shipping SCBA (Full) Address of Shipper</p>	<p>Air Waybill No (Federal Express Airbill No.) Page of Pages Shipper's Reference Number (optional) (Work Order Number)</p>
--	---

Consignee
 Person and Address of Party
 Receiving SCBA

Two completed and signed copies of this Declaration must be handed to the operator

WARNING
 Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for (state non-applicable)	Airport of Departure (City Shipping From)		
<table border="1"> <tr> <td style="text-align: center;"> <input checked="" type="checkbox"/> PASSENGER AIRCRAFT ONLY </td> <td style="text-align: center;"> <input type="checkbox"/> CARGO AIRCRAFT ONLY </td> </tr> </table>	<input checked="" type="checkbox"/> PASSENGER AIRCRAFT ONLY	<input type="checkbox"/> CARGO AIRCRAFT ONLY	Airport of Destination (City Shipping To)
<input checked="" type="checkbox"/> PASSENGER AIRCRAFT ONLY	<input type="checkbox"/> CARGO AIRCRAFT ONLY		

Shipment type: (state non-applicable)
NON-RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification						
Proper Shipping Name	Class or Division	UN or ID No.	Subsidiary Risk	Quantity and type of packing	Packing Inst.	Authorizations
Air, Compressed	Non-Flammable Gas Cargo Aircraft Only	UN1002		(# of) Cylinders At 5,000 lbs.	173.302	

Additional Handling Information

This shipment prepared according to: 49CFR IATA Regulations ICAO Regulations

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labeled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.	Name/Title of Signatory (Name, Title) Place and Date (City Shipping From, Date) Signature (see warning above)
---	---

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

<p>Shipper Person Shipping OVA Address of Shipper</p>	<p>Air Waybill No (Federal Express Airbill No.) Page of Pages Shipper's Reference Number (Work Order Number) <small>(optional)</small></p>
--	---

<p>Consignee Person and Address of Party Receiving OVA</p>	
---	--

Two completed and signed copies of this Declaration must be handed to the operator

TRANSPORT DETAILS

This shipment is within the limitations prescribed for <small>(delete non-applicable)</small> <input checked="" type="checkbox"/> PASSENGER AIRCRAFT <input checked="" type="checkbox"/> AIRCRAFT <input checked="" type="checkbox"/> AIRCRAFT <input type="checkbox"/> CARGO AIRCRAFT ONLY	Airport of Departure (City Shipping From)
---	--

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

Airport of Destination: (City Shipping To)	Shipment type: <small>(delete non-applicable)</small> <input checked="" type="checkbox"/> NON-RADIOACTIVE <input type="checkbox"/> RADIOACTIVE
--	---

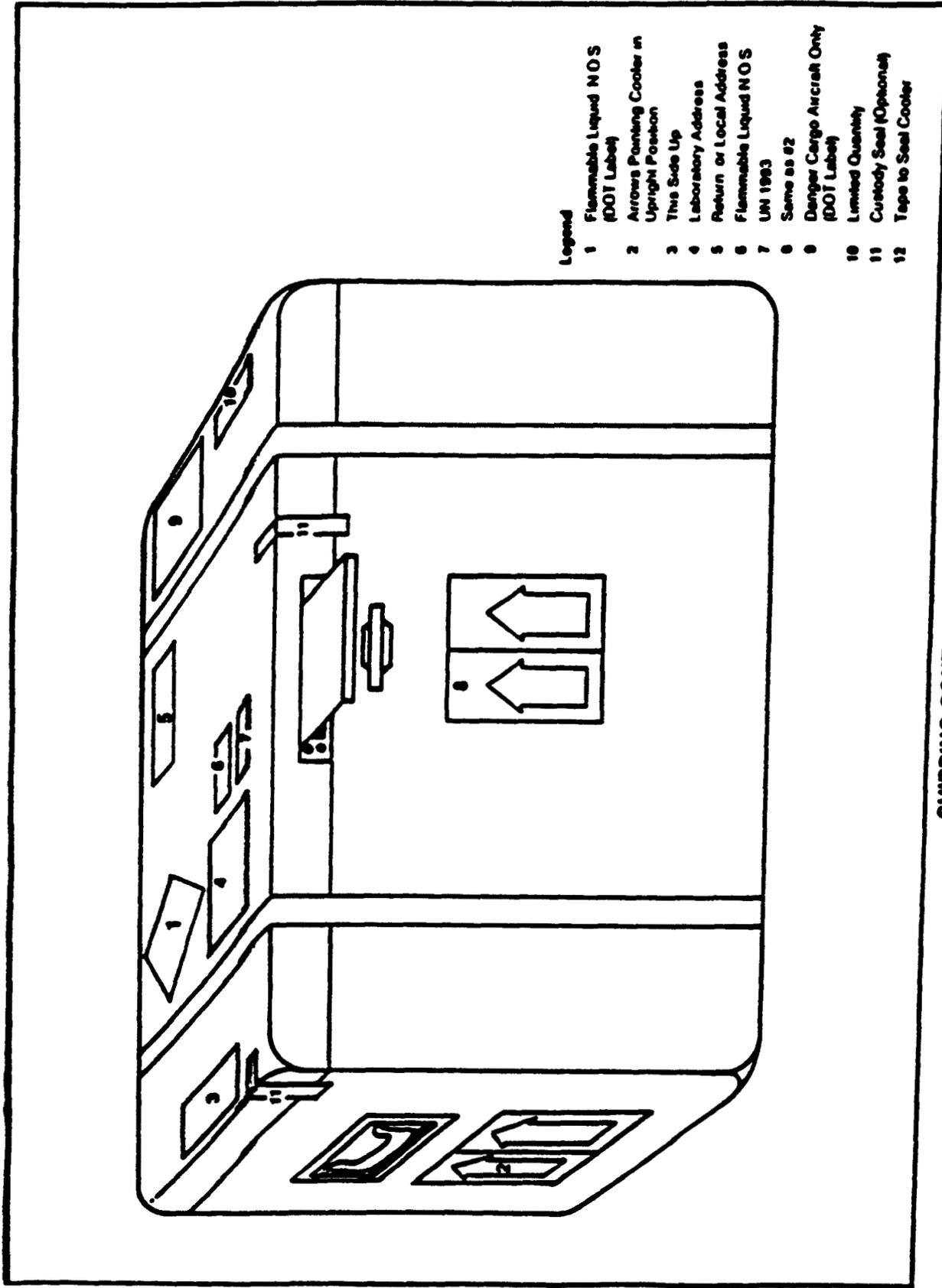
NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification						
Proper Shipping Name	Class or Division	UN or ID No.	Subsidiary Risk	Quantity and type of packing	Packing Inst.	Authorizations
Hydrogen	Flammable Gas Cargo Aircraft Only	UN1049		1 Cylinder at 5,000 lbs. See DOT Exemption Attached	173.304	

Additional Handling Information
 DOT Exemption / DOE-E-7607

This shipment prepared according to: 49CFR IATA Regulations ICAO Regulations

<p>I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labelled, and are in all respects in the proper condition for transport by air according to the applicable international and National Government Regulations.</p>	<p>Name/Title of Signatory (Name, Title) Place and Date (City Shipping From, Date) Signature <small>(see warning above)</small></p>
---	--



Legend

- 1 Flammable Liquid NOS (DOT Label)
- 2 Arrows Pointing Cooler in Upright Position
- 3 This Side Up
- 4 Laboratory Address
- 5 Return or Local Address
- 6 Flammable Liquid NOS UN 1993
- 8 Same as #2
- 9 Danger Cargo Aircraft Only (DOT Label)
- 10 Limited Quantity
- 11 Custody Seal (Optional)
- 12 Tape to Seal Cooler

SHIPPING CONTAINER LABEL PLACEMENT

APPENDIX C-2-B
SHIPPING OF RADIOACTIVE MATERIALS

From: THE HEALTH PHYSICS AND RADIOLOGICAL HANDBOOK
Bernard Schleien and Michael S. Terpilak
Nuclson Lectern Associates, Inc., 1984.

Shipping of Radioactive Materials

This chapter is intended to be a comprehensive guide to the more prominent and basic regulatory requirements for the safe transportation of radioactive materials. Information is included on the shippers' requirements for limitation of activity content of packages, packaging, labeling, shipping documentation and control of radiation and contamination.

Basic guidance also is included on the handling of transport incidents and emergencies during the transport of radioactive materials.

The tables and illustrations in this chapter are directed toward the practical. The references listed in the bibliography are extensive, and should be consulted for a more detailed discussion of the information in this chapter. A great deal of the basic information contained herein is based on a Federal USDOT training publication which reviews the transport regulations for radioactive material. (Pamphlet "A Review of the DOT Regulations for Transportation of Radioactive Material," Revised Fall 1983)

Table 12.1 Regulatory Organizations And Sources

Statutory authority to regulate safety in the transport of radioactive materials is vested principally in two Federal Agencies -- the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC). The U.S. Postal Service also has established rules for certain very small mailable quantities of radioactive material. Pursuant to the Transportation Safety Act of 1974 ("Transportation Safety Act of 1974", as amended, Public Law 93-633, 88 Stat. 2156, 49 USC 1808, Jan. 3, 1975) and earlier legislation, (The Department of Transportation Act of October 15, 1967, Public Law 90-670 Stat. 937, 49 USC 1657) the DOT is the Federal agency charged with the overall responsibility to regulate shippers and carriers of all types of hazardous materials in interstate and foreign commerce. Under its authority of the Atomic Energy Act of 1954 ("The Atomic Energy Act of 1954," as amended, Public Law 83-703, 68 Stat. 919, 42-USC Chapter 23) and the Energy Reorganization Act of 1974 ("Energy Reorganization Act of 1974," as amended, 42 USC 5841), the NRC regulates the use, possession and transfer (including transportation) of licensed byproduct, source and special nuclear material.

In certain Agreement States*, the state regulates the use, possession and intra-state transportation of byproduct and source materials licensed by the state. Common and contract carriers however are exempted from licensing to the extent that they possess, transport or store licensed material delivered by a licensee for transport. Because of the overlapping and duplicative authority to regulate transport of radioactive materials, the NRC and DOT have accomplished a written Memorandum of Understanding, ("Transportation of Radioactive Materials; Memorandum of Understanding", Federal Register, (44 FR 38690), July 2, 1979), intended to avoid duplicative effort and conflicts.

Table 12.1. Sources of Federal Regulations Transportation of Radioactive Materials

Title 49 Department of Transportation's Hazardous Materials Regulations, (49 CFR Part 100-77 "Hazardous Regulations" of the US Department of Transportation, Revised as of Oct. 1)
Parts 180-177 and 178-179.

Main Headings

- 49 CFR 106 - Rulemaking Procedures
- 49 CFR 107 - Hazardous Materials Program Procedures
- 49 CFR 171 - General Information, Regulations and Definitions

*States which have entered into an agreement with the NRC pursuant to Section 274 of the Atomic Energy Act of 1954, as amended, under which the NRC has relinquished to such States the majority of its regulatory authority over source, byproduct, and special nuclear materials in quantities not sufficient to form a critical mass.

**Table 12.1. Sources of Federal Regulations
Transportation of Radioactive Materials
(continued)**

49 CFR 172 - Hazardous Materials Table and Hazardous
Materials Communications Regulations
49 CFR 173 - Shippers-General Requirements for Shipments
and Packagings
49 CFR 174 - Carriage by Rail
49 CFR 175 - Carriage by Aircraft
49 CFR 176 - Carriage by Vessel
49 CFR 177 - Carriage by Public Highway
49 CFR 178 - Shipping Container Specifications

**Title 10 U.S. Nuclear Regulatory Commission (10 CFR Part 71, "Packaging and
Transportation of Radioactive Material." Revised annually as of January 1)**

10 CFR 71 - Packaging and Transportation of Radioactive Material

**Title 39 Postal Service (US Postal Service Publication No. 6, Dec. 1975
"Radioactive Material, as amended by US Postal
Bulletin, June 30, 1983, pages 2-5.)**

**Domestic Mail Manual, U.S. Postal Service Regulations, Part 124.
(Postal Regulations for Transport of Radioactive Matter are
published in U.S. Postal Service Publication #6, December 1975 and
in the U.S. Postal Manual and in the U.S. Postal Manual.)**

Table 12.2 Definition of Radioactive Material

For purposes of transportation, radioactive materials having a specific activity not exceeding two nanocuries per gram (0.002 $\mu\text{Ci/gm}$) are not subject to regulation in transportation. This is, however, a "de minimus" level which applies only to transportation. For purposes of licensing during use and possession, such materials may still be subject to regulation by NRC or an Agreement State.

Safety during the transport of radioactive material is achieved principally by the use of proper packaging, considering the type, quantity and form of the material, and by limitation of the level of radiation from the material. Much less reliance is placed on operational or carriers controls. In establishing the proper type of packaging and activity content limitation within the package, the following factors must therefore be considered:

- a. the type of material, e.g., the radionuclide;
- b. the quantity of radioactivity; and
- c. the form of the material, e.g., whether in:
 1. Special form; or
 2. Normal (non-special) form.

Special Form and Normal Forms of radioactive material are illustrated in Figure 12.1.

Table 12.3 Quantity Limits and Packaging

After considering the type, quantity, and form of the radioactive material, the appropriate packaging and limitation of the activity content of such packaging can then be established. Packaging types generally fall within one of the following broad types:

Type A (Figure 12.2)
Type B (Figure 12.2)
Excepted or exempt
Strong Tight

Table 12.4 A_1/A_2 System for Limiting Package Activity Content

Prior to July 1983, the regulations utilized a "transport group" system to establish activity content limits of packages. Under the old system, each radionuclide was assigned to one of seven transport groups. The activity limit of that material in normal form was the limit for the group, which was based on the most radioactive member of the group. For special form materials, the Type A limit was the same for all nuclides -- 20 curies. After the A_1/A_2 system each radionuclide is assigned an A_1 and A_2 value. The A_1 limit, based on external radiation considerations is the type A limit for that nuclide in special form. The A_2 limit, based on radiotoxicity, is its limit in Type A packaging, when in normal form. The A_1/A_2 values are used to derive limits for excepted (limited) quantities, radioactive articles (devices), and low specific activity (LSA) materials. Quantities exceeding A_1 or A_2 are Type B. The table below lists typical A_1/A_2 limits for several common nuclides.

Table 12.4 Examples of A_1/A_2 Limits

Symbol of Radionuclide	Element and Element Number	A_1 (Ci) (Special Form)	A_2 (Ci) (Normal Form)
^{14}C	Carbon (6)	1000	60
^{137}Cs	Cesium (55)	30	10
^{99}Mo	Molybdenum (42)	100	20
^{235}U	Uranium (92)	100	0.2
^{226}Ra	Radium (88)	10	0.05
^{201}Pb	Lead (82)	20	20
^{239}Pu	Plutonium (94)	2	0.002
^{35}S	Sulfur (16)	1000	60
^{60}Co	Cobalt (27)	7	7
^{90}Sr	Strontium (38)	10	0.4
^{241}Am	Americium (95)	8	0.008
^{192}Ir	Iridium (77)	20	10

Table 12.5 Types of Packaging

Figure 12.2 is an illustration of "Typical Type A Packaging Schemes." Type A packaging is that which must be designed in accordance with the applicable general packaging requirements as prescribed in the regulations (Sections 173.24, 173.411, 173.412), and which must be adequate to prevent the loss or dispersal of its radioactive contents and to maintain its radiation shielding properties if the package is subjected to normal conditions of transport. The regulations prescribe (Section 173.465) the performance criteria to simulate normal and rough handling conditions of transport. Typically, the Type A packaging prescribed in the regulations is the performance-based DOT Spec. 7A (Section 178.350) Type A general packaging for which each shipper must make his own assessment and certification of the particular package design against the performance requirements. The regulatory framework, therefore, provides for the use of Type A packaging without prior specific approval by DOT of the package designs via the use of DOT Spec. 7A performance specifications. Additionally, foreign-made Type A packages are acceptable internationally, provided they are so marked as Type A and comply with the requirements of the country of origin. It should be noted that the shipper of each DOT Spec. 7A is required to maintain on file for at least one year after the latest shipment, and be prepared to provide to DOT a complete certification and supporting safety analysis demonstrating that the construction methods, packaging design, and materials of construction are in compliance with the specification (see Section 173.415). The information in this file must show, through any of the methods given in Section 173.461, that all the requirements of Sections 173.24, 173.463 and 173.465 are met. The file must also relate the contents of the package(s) being shipped to the contents which were used for testing purposes.

Except for a limited number of specification Type B packagings (e.g., DOT-6M) described in the DOT regulations, all Type B package designs require PRIOR APPROVAL of the U.S. Nuclear Regulatory Commission or Department of Energy (DOE). (See Section 173.471 for standard requirements and conditions pertaining to NRC approved packages and Section 173.7 for DOE certified packages.)

"Type B Packages," "Highway Route Controlled Quantities," and "Fissile Radioactive Materials" present more unusual and specific problems for packaging and carrier's operational controls. These materials are additionally controlled by the specific packaging standards as promulgated by the Nuclear Regulatory Commission in Title 10 CFR Part 71. Operational and administrative requirements for "highway route controlled quantities" (formerly called "large quantities") are prescribed in 173.403 and 177.825.

Type B Packaging (see Figure 12.2), must meet the general packaging requirements and all of the performance standards for Type A packages. In addition, it must withstand certain serious accident damage test conditions. After the tests, there must be only limited loss of shielding capability and essentially no loss of containment. The performance criteria which the package designer must use to assess Type B packaging against these empirically established accident damage test conditions of transport are prescribed in the Nuclear Regulatory Commission regulations (10 CFR 71.73) and include the following:

1. A 30-foot free drop onto an unyielding surface.
2. A puncture test which is a free drop (over 40 inches) onto a six-inch diameter steel pin.
3. Thermal exposure at 1,475°F for 30 minutes.
4. Water immersion at 3 ft. depth for eight hours (for fissile materials packaging only).
5. Water immersion at 50 ft. for eight hours.

Table 12.6 Limited Quantities, Instruments and Articles

The A_1 and A_2 values are also used as a basis for defining the package quantity limits for limited quantities and both the item and package limits for radioactive instruments and articles, as illustrated below. Packages containing materials within these quantity limits are excepted from some of the requirements which apply to Type A packages. These exceptions include not having to provide specification packaging, shipping papers, certification, marking or labeling. However, there are a number of conditions which the limited quantity, instrument or article must meet. They include:

1. Activity limits per package and, if appropriate, per instrument or article;
2. The materials must be packed in strong, tight packages that will not leak ANY of the radioactive material during conditions normally incident to transportation;
3. The radiation level at any point on the external surface of the package cannot exceed 0.5 millirem per hour;
4. The external surface of the package must be free of significant removable contamination;
5. For instruments or articles, the radiation level at 4 inches from any point on the surface of the unpackaged instrument or article may not exceed 10 millirem per hour; and
6. A prescribed description of the contents on a document which is in or on the package or forwarded with it.

Table 12.6

Limited Quantities, Instruments and Articles (continued)

Nature of Contents ^{1/}	Instruments and Articles		Materials
	Instrument and article limits ^{1/}	Package limits	Package limits
Solids			
Special form	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Other forms	$10^{-2}A_2$	A_2	$10^{-3}A_2$
Liquids			
Tritiated water < 0.1 Ci/liter	-	-	1,000 curies
0.1 Ci to 1.0 Ci/l	-	-	100 curies
> 1.0 Ci/liter	-	-	1 curie
Other liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gases			
Tritium ^{2/}	20 curies	200 curies	20 curies
Special form	$10^{-3}A_1$	$10^{-2}A_1$	$10^{-3}A_1$
Other forms	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A$

^{1/} For mixture of radionuclides see Section 173.433(b).

^{2/} These values also apply to tritium in activated luminous paint and tritium absorbed on solid carriers.

Refer to Sections 173.421 through 173.424 for the complete requirements pertaining to these materials.

The U.S. Postal Service has revised its rules (U.S. Postal Service Publication No. 6, Dec. 1975 as amended June 30, 1983.) for mailable radioactive materials. The mailable amounts of material are now (since July 1983) one-tenth the values listed above. Other additional restrictions apply to mailable materials and the Postal Regulations should be consulted for complete specifications.

Table 12.7 Low Specific Activity (LSA) Materials

The levels of radioactive materials packaging and methods of limiting activity contents during transport, as described previously except for the "de minimus" definition of .002 uCi/gm all have one common characteristic, e.g., limitation by total activity content of the package. There is another extremely important transport classification for radioactive materials, e.g., "Low Specific Activity", or "LSA" which is controlled and limited principally on a specific activity, e.g., activity per unit of weight basis. Historically the LSA category was originally developed and premised on a basis of imposing less stringent packaging and shipment requirements on radioactive materials deemed to pose much less risk and were presumably "inherently safe". The categories of LSA have generally included solids, limited either on the specific activity basis or by name, tritiated water and surface contaminated objects. Looking at the most significant of these categories further; i.e., solids:

Solid LSA materials are limited to those in which the activity must be essentially uniformly distributed and in which the estimated average concentration per gram of material does not exceed:

1. 0.0001 millicurie of radionuclides for which the A_2 quantity is not more than 0.005 Curies;
2. 0.005 millicurie of radionuclides, for which the A_2 quantity is more than 0.05 Curies, but not more than 1 curie; or
3. 0.3 millicurie of radionuclides for which the A_2 quantity is more than 1 curie.

In the original derivation of LSA limits for solids in the international regulations, inhalation of dispersed airborne material was considered, and for modeling purposes it was assumed that the airborne materials at a very dusty (10 mg/m³) concentration was inhaled at the breathing rate of 2 m³/h for a one-half hour exposure resulting in a 10 mg uptake. Little reliance was placed therefore on packaging requirements per se. More recently, the modeling and assumptions for solid LSA materials have been under extensive reexamination by IAEA as well as DOT/NRC. It is anticipated that in the future proposed changes to LSA requirements will be published, aimed principally at establishing more realistic models so as to control hazards of beta-emitting as well as Gamma-emitting materials. It is likely that future regulations for LSA may include limitations on activity of such materials in packages, as well as more precise packaging prescriptions.

Solid LSA wastes include a very wide range of fuel cycle, industrial and institutional wastes; contributing a major portion of the materials which are transported from waste generator facilities to the commercial low level waste burial sites.

Shipment Requirements for LSA Materials

Under the DOT regulations in 49 CFR, the specific shipment requirements for LSA materials depend upon the type of vehicle involved in the shipment:

- o Nonexclusive use shipments - "essentially Type A packages"

The first method, "nonexclusive use" transportation, requires that the material be transported in essentially a Type A package. "Essentially a Type

A" package means a package that must survive the physical tests, such as the drop and compression tests for Type A packages - but which is expected from some of the general Type A requirements. The actual test requirements are found in Section 173.465. Although the packages are excepted from certain design requirements, their integrity must be equal to a Type A.

o Exclusive use - "strong, tight package"

LSA materials which are transported by conveyances assigned for the "exclusive use" of the consignor may be shipped in packages that are of less rigorous construction. Users of the exclusive use provision MUST ENSURE that there will be no loading or unloading of the material except under the direction of the consignee or consignor. The limitation on loading and unloading, plus the requirement that the material be in exclusive use, safely allows the exception from certain packaging test requirements. Exclusive use LSA, therefore, is allowed to be made in the so-called "strong, tight package."

There are no specific test requirements for the strong, tight packages. However, a performance criteria must be met — there can be no release of radioactive content during transportation and like any other package of hazardous material, the requirements of Section 173.24 must be met. Materials which are consigned as exclusive use LSA shipments MUST have the packages marked "Radioactive LSA." And the vehicle on which they are being transported MUST be placarded with the RADIOACTIVE MATERIAL placard.

Certified Type A Packages for LSA

In general, approval of Type A package designs, by a regulatory agency is not usually required. The shipment of Type A quantities of radioactive material is more frequently made in designs conforming to DOT Specification 7A. This specification is based solely on the performance test requirements of the regulations. Shippers utilizing such packagings are however required to maintain documentation of the results of their safety analyses of the design against the regulatory criteria.

A major exception to the above involves shipments by USNRC licensees of LSA materials in packages wherein the activity exceeds a Type A quantity. Ordinarily, under DOT regulations, LSA materials are not limited only on the basis of specific activity of the material, and not on total package activity. However, due to the provisions of 10 CFR Part 71, the shipment of LSA in packages where the quantity exceeds Type A requires the use of certified Type A packaging. This certification is obtained by submittal of an application which addresses the results of the evaluation of the package against the Type A conditions, e.g., normal conditions of transport. Effectively therefore, Type B quantities of LSA material are required to be in NRC-certified Type A packagings. This exception is extremely important to fuel cycle waste shipment considerations. The NRC has certified several dozen such Type A designs for LSA shipments. These are listed in the NRC Directory of certified packages. (NUREG-0383 "Directory of Certificates of Compliance for Radioactive Material Packagings," revised annually in three volumes). They each are similar in design and appearance to Type B packages (see Figure 12.2), but are not required to be subjected to the Type B tests.

Table 12.8 Fissile Radioactive Materials

In addition to considerations for the radioactivity content, a shipper of radioactive materials which are also fissile, i.e., capable of sustaining a nuclear chain reaction, such as enriched uranium, plutonium, or U-233; must take account in the packaging design certain additional requirements which are intended to ensure against accidental nuclear criticality during transport of the material. These specific criteria and requirements are addressed in DOT and NRC regulations. Again, as in the case of Type B non-fissile package designs, only a few "DOT Specification" packages for fissile radioactive materials are listed in 49 CFR, e.g., DOT-6L, DOT-6M, and DOT 20PF. Other designs which have been specifically approved and certified by NRC are listed in the NRC Directory of Certified Packages. (NUREG-0383 "Directory of Certificates of Compliance for Radioactive Material Packaging," revised annually in three volumes). For purposes of control of nuclear safety during transport, each design is assigned a "fissile Class" number of 1, 2, or 3, which is an indication of the degree of control to be exercised during transport to assure nuclear safety of the shipment. These controls are listed in the Table below.

Table 12.8
Shipment Controls for Fissile Radioactive Materials
(Section 173.455)

-
1. Fissile Class I - Packages may be transported in unlimited numbers (Transport Index^a is based only on external radiation levels).
 2. Fissile Class II - Number of packages limited by aggregate maximum of transport indexes of 50 (50 unit rule). No single package may exceed a transport index of 10. Transport index shall be based on criticality or external radiation level basis, whichever is most restrictive.
 3. Fissile Class III - Shipments of packages which do not meet the requirements of Fissile Class I or II. Controlled by specific arrangements between the shipper and carrier. (See Section 173.457(b)).
-

^a Exposure rate in mrem/h at three feet from external surface of package.

Table 12.9 Radiation Limits

The regulations set limits on the external radiation on packages and in some cases on the vehicles transporting radioactive materials packages. These limits, which depend upon whether the packages are transported as non-exclusive use (mixed freight) or as exclusive use, are listed below:

Table 12.9 Radiation Level Limits (173.441)

Packages Transported As Non-Exclusive Use:

At Surface: 200 mrem/hour

At 1 meter from package surface: 10 mrem/hr.

Packages Transported As Exclusive Use

At package surface: 1000 mrem/hour (in closed transport vehicle only)
200 mrem/hour (un open vehicle)

At 2 meters (6.6 ft.) from lateral surfaces of vehicle: 10 mrem/hour

In occupied area of vehicle: 2 mrem/hour

At outer surfaces of transport vehicle: 200 mrem/hour.

Table 12.10 Contamination Limits (173.443)

Regulatory limits are also set for the allowable removable surface contamination on packages, as measured on wipe (smear) samples. These limits are listed below:

Table 12.10 Removable External Radioactive Contamination Limits
Removable External Radioactive Contamination Limits

Contaminant	Maximum permissible limits	
	uCi/cm ²	dpm/cm ²
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates	10 ⁻⁵	22
All other alpha emitting radionuclides	10 ⁻⁶	2.2

In applying the limits of this table and the assessment of the surface contamination of a package, sufficient measurements (wipes) must be taken in the most appropriate location of a package surface so as to yield a representative assessment of the non-fixed contamination levels. Averaging of wipe samples may be done only within any given 300 cm² area that is wiped. For packages transported as exclusive use, the removable contamination should not exceed ten times the levels prescribed here. Each transport vehicle used to transport packages with these higher units must be surveyed after use. Before release for other use, the vehicle must not be returned to service until the non-fixed contamination levels meet the above limits.

Table 12.11 Communications Requirements

The regulations contain a number of "communications" requirements which are intended to convey certain hazard characteristic information to package handlers, carrier personnel, receivers, and the general public. These requirements include warning labels, vehicle placarding, and shipping paper descriptions.

Warning Labels (172.403)

Each package of radioactive material, unless excepted, must be labeled on two opposite sides, with a distinctive warning label. Each of the three label types bears the unique trefoil symbol (Figure 12.3). The label alerts persons that the package contains radioactive materials and that the package may require special handling. A label with an all white background color indicates that the external radiation level is low and no special handling is required. If the upper half of the label is yellow, the package may have an external radiation level or fissile properties requiring consideration during transportation. If the package bears a yellow label with three stripes, the transport vehicle must be placarded RADIOACTIVE. Placarding is discussed in more detail below. The criteria which the shipper must consider in choosing the appropriate label are listed below:

Other package labels are illustrated in figures 12.4 and 12.5.

A vehicle placard is shown in figure 12.6 and its placement illustrated in figure 12.7.

For all labels, vertical bars on each label are in red. Each label is diamond-shaped, four inches on each side, and has a black solid-line border one-fourth inch from the edge. The background color of the upper half (within the black line) is white for the "I" label. It is yellow for the "II" and "III" labels.

Table 12.6
Radioactive Materials Packages Labeling Criteria
Section 172.403

Transport Index ^a (T.I.)	Radiation Level at Package Surface (RL)	Fissile Criteria	Label Category ^b
N/A	RL ≤ 0.5 millirem per hour (mrem/h)	Fissile Class I No Fissile Class II or III	White - I
T.I. ≤ 1.0	0.5 mrem/h < RL ≤ 50	Fissile Class I, Fissile Class II with T.I. ≤ 1.0, No Fissile Class III	Yellow - II
1.0 < T.I.	50 mrem/h < RL	Fissile Class II with 1.0 < T.I., Fissile Class III	Yellow - III

^a Exposure rate in mrem/h at three feet from external surface of package.

^b Any package containing a "Highway Route Controlled Quantity" (173.403) must be labeled as Radioactive Yellow - III.

Table 12.12 Shipping Papers

Like any shipment of regulated hazardous materials in commerce, each shipment of radioactive material must be accompanied by a properly completed and shipper-certified shipping paper (also known as bill of lading, air bill, cargo manifest, etc.) For limited quantities and excepted radioactive articles, this shipping paper/certificate may be a specially worded notice which may be on or on the package (i.e., packing list), or separately accompanying the shipment. The elements of information which must be included, as applicable, on shipping papers includes:

- (1) Proper shipping name from Section 172.101;
- (2) Hazard class (see Section 172.202(a)(2)), hazard class from Column 3, Section 172.101, except when the hazard class is contained in the shipping name;
- (3) Identification number (see Section 172.202(a)(3) from Column 3A, Section 172.101);
- (4) Net quantity of material by weight or volume as stated in Sections 172.202(a)(4) and (c). For most radioactive materials packages, it is not required to list the weight or volume. The requirements of Section 172.203~~(a)~~ provide better indications of potential hazards and controls required. These requirements include the package contents as measured in curies and the transport index. A listing of weight or volume measurements for radioactive materials is usually needed only for establishing transportation charges;
- (5) Radionuclide(s) contained in package (abbreviations are allowed). For a mixture of radionuclides, only those radionuclides which comprise 1% or more of the total activity in the package must be listed;

- (6) Physical and chemical form of material, or statement that the material is "special form" (if it is special form). A generic description of material, such as protein, carbohydrate, enzyme, or organic salt, is authorized if exact chemical form is difficult to specify;
- (7) Activity in curies (Ci), millicuries (mCi), or microcuries (uCi). If the package contains a "Highway Route Controlled Quantity," those words must also be shown on the shipping papers;
- (8) Category of RADIOACTIVE labels applied to package;
- (9) Transport index of the package if labeled RADIOACTIVE Yellow-II or RADIOACTIVE Yellow-III;
- (10) The information required in Section 172.203(d)(I)(vi) must be included if the shipment is "fissile" radioactive material;
- (11) The identification markings shown on the package must appear on the shipping paper if the package is approved and certified by the Nuclear Regulatory Commission or the Department of Energy, OR is certified by DOT or other National Competent Authority for international shipment.
- (12) Other information as required by the mode of transportation or subsidiary hazard of the material. (See Section 172.203).

The regulations require that certain specific descriptive information must be included on shipping papers. While there is no specification for shipping paper format, the first three entries of the description must be in a specific order (see above). Other descriptive information is allowed, such as the functional description of the product. However, other information must not confuse or detract from the required descriptions of the hazardous materials.

Table 12.12
Most Commonly Used Shipping Names for Radioactive Material^a
(From Hazardous Materials Table, Section 172.101)

Radioactive Material, Limited Quantity, n.o.s. ^b	UN 2910
Radioactive Material, Instruments, <u>and</u> Articles ^c	UN 2911
Radioactive Material, Fissile, n.o.s.	UN 2918
Radioactive Material, Low Specific Activity <u>or</u> LSA, n.o.s.	UN 2912
Radioactive Material, Special Form, n.o.s.	UN 2974
Radioactive Material, n.o.s.	UN 2982
Uranium Hexafluoride, Fissile (<u>Containing more than 1% U-235</u>)	UN 2977
Uranium Hexafluoride, Low Specific Activity	UN 2978

^aRefer to Section 172.101 for other proper shipping names.

^bn.o.s. means "not otherwise specified."

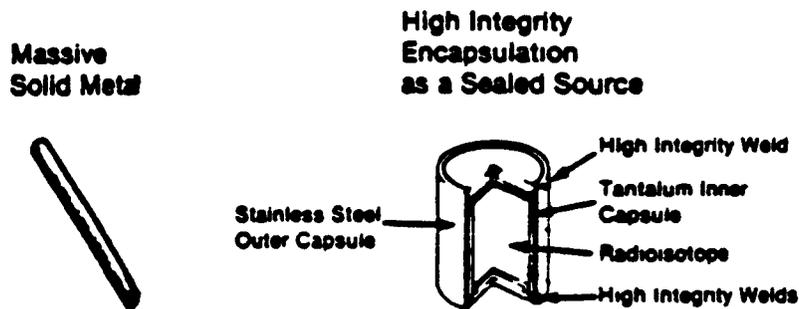
^cUnderlined words are not part of the proper shipping name.

Figure 12.1 Forms of Radioactive Materials for Transport
From: A Review of the Department of Transportation (DOT)
Regulations For Transportation of Radioactive Material
(Summer 1980)

"Special Form" R.A.M. (173.403 (2) and 173.469 (a))

May Present a Direct Radiation Hazard if Released From Package, but Little Hazard Due to Contamination

"Special Form" R.A.M. May Be "Natural" Characteristic, i.e., Massive Solid Metal, or "Acquired" Through High Integrity Encapsulation



Normal Form Radioactive Materials 49 CFR 173.403(s)

Normal Form Materials May Be Solid, Liquid or Gaseous and Include any Material Which Has Not Been Qualified as Special Form

Type A Package Limits are A₂ Values

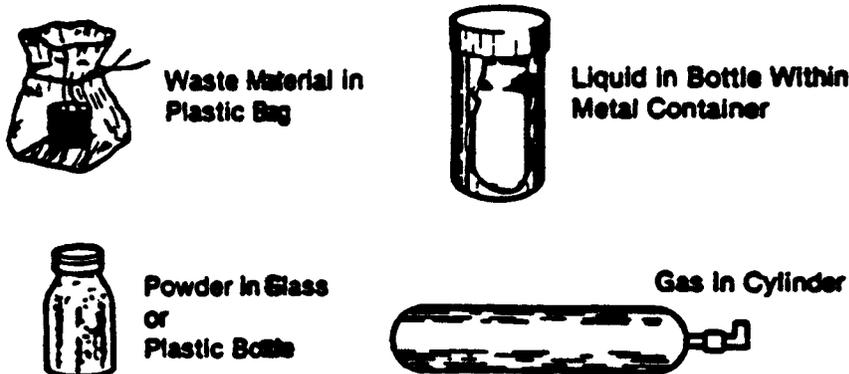


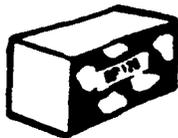
Figure 12.2. Types of Packaging
(From A Review of the Department of
Transportation (DOT) Regulations for
Transportation of Radioactive Materials
(Summer 1980))

Type A

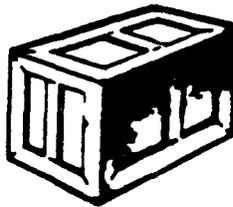
All packaging design is directed at preventing the release of the radioactive contents and damage to the radiation shielding so that a severe radiological hazard will not develop. Because of the smaller quantities of material permitted in Type A packages, accidents that might cause damage to such packages would not be likely to result in serious radiation hazards. Therefore such packaging must only withstand moderate degrees of stress. These include conditions of heat, cold, reduced air pressure, vibration, impact, water, drop, penetration, and compression. The majority of radioactive material shipments are made in Type A packages.

TYPICAL TYPE A PACKAGING

**PACKAGE MUST WITHSTAND NORMAL CONDITIONS [173.398(B)]
OF TRANSPORT ONLY WITHOUT LOSS OR DISPERSAL OF THE
RADIOACTIVE CONTROL CONTENTS.**



FIBERBOARD BOX



WOODEN BOX



STEEL DRUM

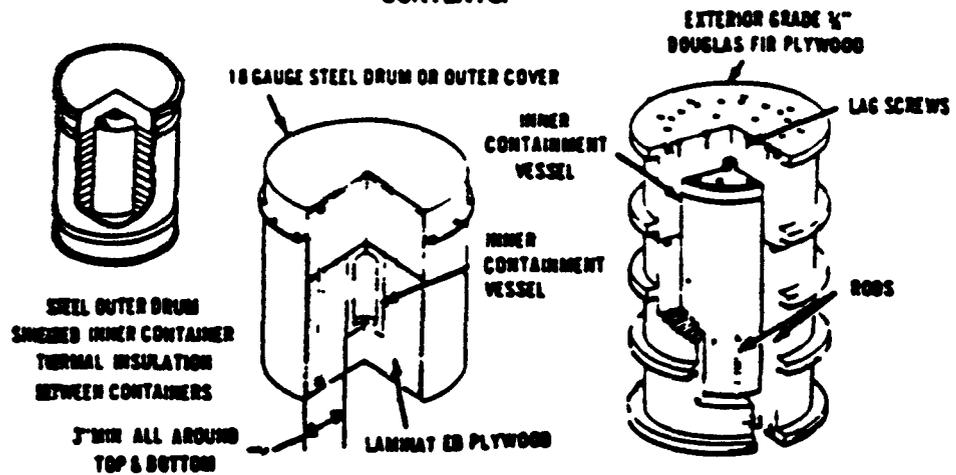
**TYPICAL SCHEMES
DOT SPECIFICATION 7A**

Figure 12.2 (Continued)

Type B

Type B packages are designed for transport of greater quantities of material. Since the potential for hazard resulting from damage to this type of package would be greater than that from a Type A package, there are additional structural design requirements. In addition to meeting standards for Type A packages, Type B packaging must withstand puncture, drop, thermal, and water immersion stresses that might be experienced under actual or hypothetical transportation accident conditions.

TYPICAL TYPE B PACKAGING SCHEMES
PACKAGE MUST STAND BOTH NORMAL (173.398(B)) AND
ACCIDENT (173.398(C)) TEST CONDITIONS WITHOUT LOSS OF
CONTENTS.



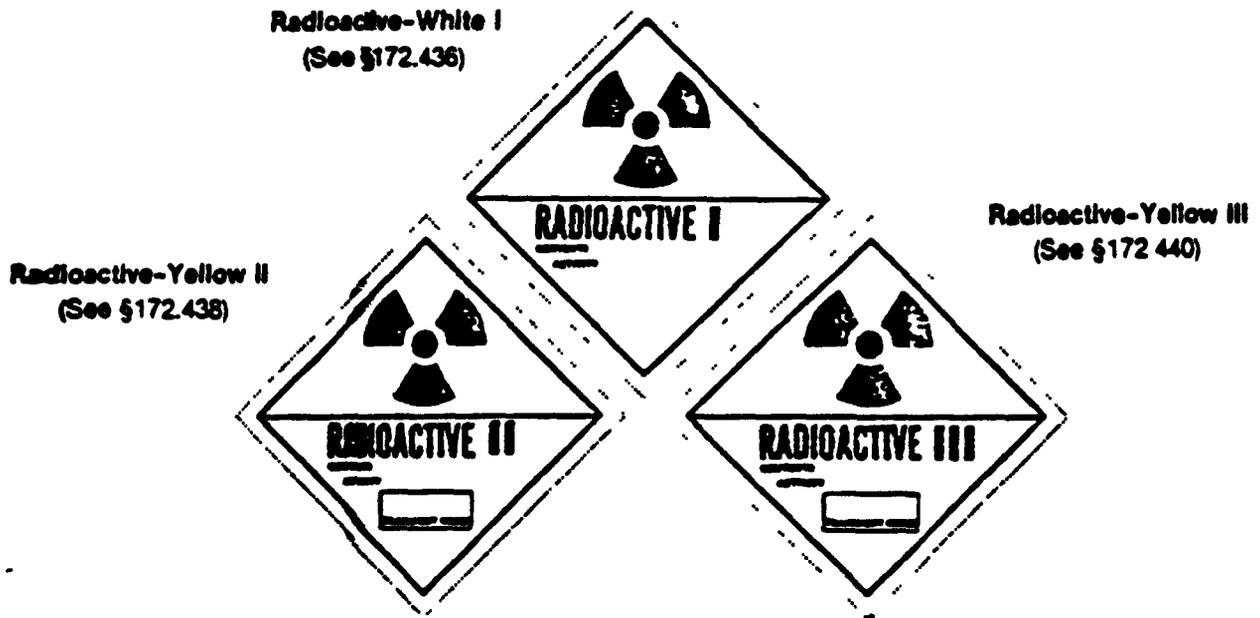
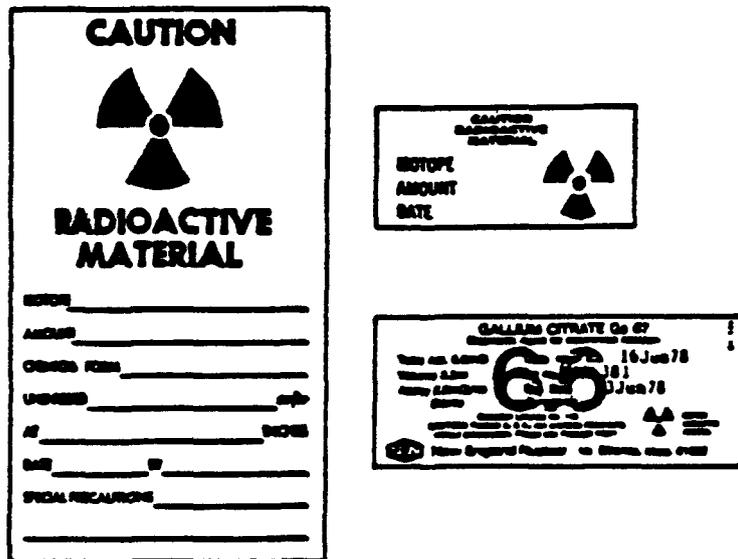


Figure 12.3 Labels Required on Exterior Package

Three different labels are used on packages for radioactive material (see above). The required label is usually determined by the external radiation level or, in some cases, the type and quantity of radionuclide within the package (see Labeling Criteria table). Package labels must specify the radionuclide (contents) and quantity (curies). In addition, Yellow II and Yellow III labels contain the transport index, which is equal to the maximum radiation level at 3 feet from the package or, for packages containing fissile material, the degree of nuclear safety control required.

Figure 12.4 Radioactive Material Warning Labels
(From DOT/RSPA/MTB-79/8)

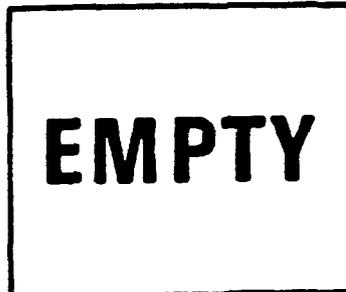
All packages of radioactive material, with the exception of those containing Limited Quantities or Low-Specific-Activity materials (which would present no severe hazard if involved in an accident), must bear two identifying warning labels affixed to opposite sides of the outer package. Limited shipments do not require outer package labeling; however, they, like all shipments of radioactive material, must have standard yellow and magenta radiation warning labels on the inner containers.



Warning Labels

Figure 12.5 Empty Label
(From DOT/RSPA/MTB-79/8)

Reusable shipping containers are frequently transported in an empty, but possibly internally contaminated condition. When in transit, these containers must bear the EMPTY label shown below. There is minimal hazard from containers displaying this label.



Typical label required to indicate empty shipping container.

Figure 12.6 Vehicle Warning Placards
(From DOT/RSPA/MTB-79/8)

Placards

The carrier must apply the RADIOACTIVE placard to the transport vehicle (rail or highway) if ANY radioactive material package on board bears a "Radioactive YELLOW-III" label (Section 172.440). The format for the placard is illustrated in Figure 12.7. The requirements for placarding are in Section 172.504 and Table 1 footnotes of that Section.

Figure 12.6



(The background color for the black trefoil in the upper half of this 12" x 12" placard is yellow.)

Vehicles transporting ANY package which contains a highway route controlled quantity must display the above placard upon the square white background with black border as specified in Section 172.507.

For shipments of LSA materials in exclusive-use vehicles, the shipper is required to placard the transport vehicle, even though the packages of LSA within the vehicle are excepted from labeling requirements.

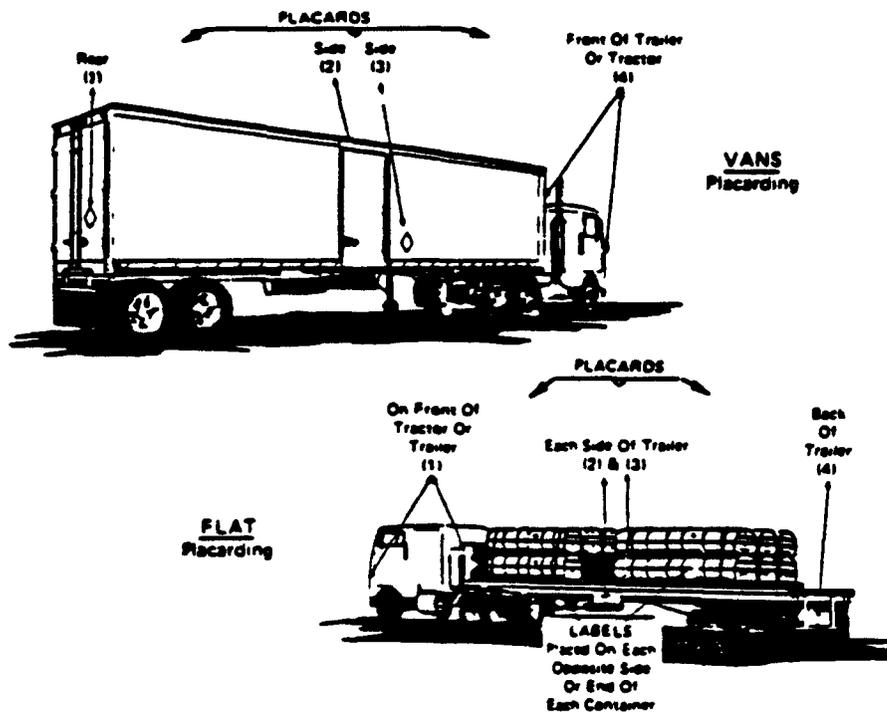
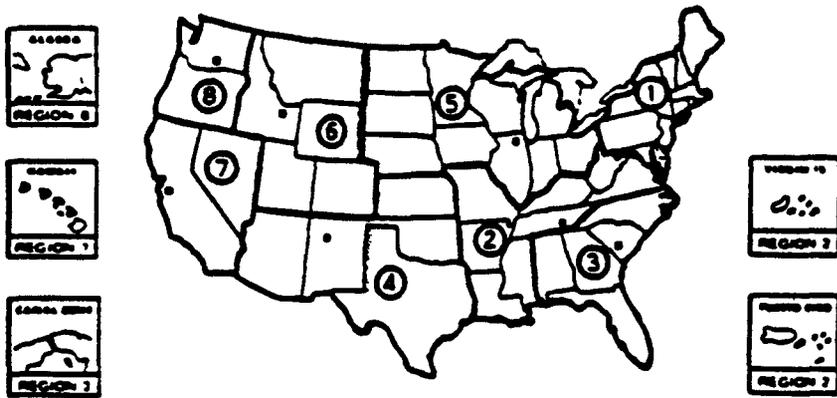


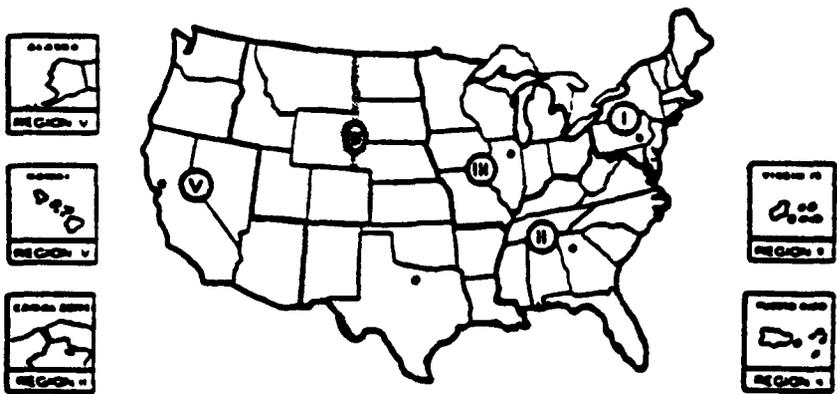
Figure 12.7 Diagrammatic representation of placard location on vans and flatbed trucks (From DOI/RSPA/MTB-81/4)

Figure 12.7 is a guide to placement of placards on motor vehicles. Where placards are impractical, i.e., on aircraft or water vessels, they are not required to be displayed.



Regional Coordinating Office	Post Office Address	Telephone
1 Breakhaven Area Office	Upper, L.I., New York 11973	(516) 345-2200
2 Oak Ridge Operations Office	P.O. Box E, Oak Ridge Tennessee 37830	(615) 576-1006 or (615) 525-7885
3 Savannah River Operations Office	P.O. Box A, Aiken S.C. 29801	(803) 725-3333
4 Albuquerque Operations Office	P.O. Box 5400 Albuquerque N.M. 87115	(505) 264-4667
5 Chicago Operations Office	9885 Cass Ave. Argonne Illinois 60439	(312) 972-4800 Off Duty Mrs. (312) 972-5731
6 Idaho Operations Office	P.O. Box 2108 Idaho Falls, Idaho 83401	(208) 525-1515
7 San Francisco Operations Office	1327 Broadway Oakland California 94612	(415) 273-4237
8 Richland Operations Office	P.O. Box 550 Richland Washington 99352	(509) 942-7381

Figure 12.8 Department of Energy regional coordinating offices for radiological assistance and geographical areas of responsibility.



Address	Telephone	
	Daytime	Nights/Holidays
Region I Office of Inspection and Enforcement, USNRC 631 Park Avenue, King of Prussia, Pennsylvania 19406	(215) 337-1150	(215) 337-1150
Region II, Office of Inspection and Enforcement, USNRC 230 Peachtree Street, N.W., Suite 818, Atlanta, GA 30303	(404) 528-4803	(404) 528-4803
Region III Office of Inspection and Enforcement, USNRC 799 Roosevelt Road, Glen Ellyn, Illinois 60137	(312) 858-2680	(312) 858-2680
Region IV, Office of Inspection and Enforcement, USNRC 611 Ryan Plaza Drive, Suite 1000, Arlington, Texas 76012	(817) 334-2841	(817) 334-2841
Region V Office of Inspection and Enforcement, USNRC 1990 N. California Blvd., Suite 202, Walnut Creek Plaza Walnut Creek, California 94596	(415) 486-3141	(415) 486-3141

Figure 12.9 United States Nuclear Regulatory Commission regional offices.

APPENDIX 5
RINSATE ANALYTICAL METHODS

C-5 ANALYTICAL METHODS

It is the intention to perform the required analytical work on site at Rocky Flats Plant. The analytical laboratories have developed a series of in-house procedures referred to as "L-Procedures." The guidelines for developing and maintaining quality control within the procedures is described in Section C-7. Where appropriate, procedures presented in SW-846 are followed. Rocky Flats reserves the right to send samples offsite for analysis or to substitute equivalent methods.

Table C-4 shows the methods used in analyzing nonradioactive wastes. Slightly different methods are used for low-level contaminated wastes. These procedures are presented in Table C-5. The methods used for fingerprint analysis are shown in Table C-6.

TABLE C-4

ANALYTICAL METHODS FOR NON RADIOACTIVE WASTES

<u>Analyte</u>	<u>Instrument</u>	<u>Method</u>
HSL Inorganic	ICP	
	Extraction aqu.	3010
	Extraction solids	3050
	Analysis	6010
HSL Inorganic	AA	3000 series
	Extraction solids	7000 series
HSL Volatile	GC-MS	8240
HSL Base/Neutral/Acid	GC-MS	
	Extraction liqu/liqu	3510
	Extraction soxhlet	3540
	Extraction sonication	3550
	Analysis	8270
Pesticides and PCB	Analysis	8080
EP Toxicity		1310
EPTOX Leachate	AA	7000 series
Reactivity: Cyanide		7.3.3.2 and 9010
Hydrogen Sulfide		7.3.4.2
Corrosivity	pH meter	9040
Ignitability	Setaflash	D 3278-82
	IR-Gas-Sniff	L-6211

TABLE C-5
ANALYTICAL METHODS FOR LOW LEVEL WASTES

Analyte	Instrument	Method
HSL Inorganic	ICP	
	Extraction aqu.	3010
	Analysis	6010
	except Na, K, Hg and Se	
	Sodium	7770
	Potassium	7610
	Mercury	7470
Selenium	Sodium Boro- hydride	
HSL Volatile and HSL Base/Neutral/Acid	Extraction	*
HSL Volatile	GC-MS	8240
HSL Base/Neutral/Acid	GC-MS	8270
EP Toxicity		1310
EPTOX Leachate	ICP	6010
Reactivity: Cyanide		7.3.3.2 w/ Draeger tube
Sulfide		7.3.4.2
Corrosivity	pH meter	9040 9045
Ignitability	Pensky-Martens	1010 (ASTM D93-80)

* As described in: "Preparation of Radioactive Mixed Waste Samples for Measurement of RCRA Organic Compounds."

TABLE C-6

ANALYTICAL METHODS FOR FINGERPRINT ANALYSIS

<u>Test</u>	<u>Method</u>
Appearance	Physical identification, color, viscosity, phases and odor
pH	Electrode on pH paper
Combustibility	Match test or Pensky Martens closed cup tester
Specific Gravity	Hydrometer
Miscibility	50/50 mixture with water
Reactivity	50/50 mixture with water or other waster
Chlorinated Solvents	Test kit or Beilsten test
PCB	Test kit
Cyanide	Draeger tube
Total Alpha	L-6114 Aqueous L-6194 Oils

APPENDIX 6

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

C-7 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Quality Engineering and Control, an organization not associated with Waste Management Operations, has the responsibility for quality assurance. This organization will be responsible for (1) reviewing analytical results bias to determine validity of the information, (2) conducting and documenting periodic system and performance audits, (3) use of blind or performance samples in the sampling/analysis process, (4) documenting observed problems with recommendations directly to Waste Operations for resolution and, (5) ensuring that the requirements of the Quality Laboratories Quality Assurance Program are implemented, periodically (at least annually) reviewed and revised as appropriate.

Quality Engineering and Control is responsible for ensuring that the following procedures are implemented during the sampling and analysis program for waste characterization (Section C-2).

C-7.1 Sample CollectionC-7.1.1 Trip Blank

A full set of sample containers glassware or plastic will be filled with laboratory grade water prior to beginning sampling each day, taken to the sampling site, and submitted for analysis as a routine sample. Sample analysis is performed for the sum of all the analytes required for samples for the day of the trip

blank. The purpose of this sample is to detect contaminant contributions from the glassware, and/or plastic containers.

Trip blanks will not be taken when such activities will increase personnel chemical or radioactive exposure above ALARA levels. This applies to samples taken in glove boxes or other controlled atmosphere environments.

C-7.1.2 Field Blanks

Field Blanks will consist of laboratory-grade water exposed to the sampling environment. A container of water will be opened at the sampling location, opened and poured into the sample containers utilizing the appropriate sampling devices. The sampling devices will be decontaminated prior to obtaining the field blank following the same procedure as used for a routine field sample. Field Blanks will be taken every time a field sampling procedure is changed, when the sampling personnel are changed, or once for every 20 routine field samples, whichever is more frequent. This frequency may be decreased when disposable sampling equipment is used.

Field blanks will not be taken when such activities will increase personnel chemical or radioactive exposure above ALARA levels. This applies to samples taken in glove boxes or other controlled atmosphere environments.

Field Blanks will be assigned a sample number similar to that of a routine field sample. The identification of field samples will

not be known to the laboratory analyst.

C-7.1.3 Field Duplicates

Ten percent (10%) of the waste stream samples collected will be sampled twice to provide duplicate samples. The field sampling team will use a random procedure to determine when duplicates will be taken. Duplicates will be assigned a number similar to that of a routine sample and submitted blind to the analytical laboratory. The duplicates are collected, handled, and analyzed as separate samples (including decontamination of sample collection equipment between collections). The duplicate is an indicator of the representativeness of the sampling procedure.

C-7.2 Laboratory QA/QC Program

This subsection of the Quality Assurance/Quality Control Program briefly describes the organization and guidelines used to produce reliable analytical data in the RFP Quality Laboratories. A more detailed and comprehensive presentation of the Quality Laboratories' organization and quality assurance guidelines may be found in the QL Quality Assurance Program

C-7.2.1 Organization

The ultimate responsibility for the generation of reliable laboratory data rests with the laboratory management. Laboratory

management is vested with the authority to effect those policies and procedures to ensure data of acceptable quality.

Laboratory management, as well as the Quality Assurance Coordinator and the Laboratory Quality Assurance/Quality Control Officer are ultimately responsible for the implementation of the established policies and procedures. They possess the authorities commensurate with their responsibilities for the day-to-day enforcement and monitoring of laboratory activities.

Laboratory management has the following responsibilities:

- 1) Direct implementation of the Quality Assurance Program.
- 2) Ensuring that their personnel are adequately trained to perform analyses.
- 3) Ensure that equipment and instrumentation under their control are calibrated and functioning properly.
- 4) Review and perform subsequent corrective action on internal and external audits.

The Quality Assurance Coordinator and the Laboratory Quality Assurance/Quality Control Officer have the following responsibilities:

- 1) On-going review of individual Quality Assurance procedures.
- 2) Providing assistance in the development and implementation of specific quality assurance plans for special analytical programs.
- 3) Coordination of internal and external quality assurance audits.
- 4) Coordination of Quality Assurance training.

- 5) Review special project plans for consistency with organizational requirements and will advise laboratory management and Waste Operations of inconsistencies.
- 6) Overall coordination of the Quality Laboratories' Quality Assurance Program manual.
- 7) Review procedures and QA plans of any outside laboratory.

C-7.2.2 Sample Management

An organized, efficient sample management system is a necessary and critical foundation on which analyses of samples are based. Sample management includes document creation, bottle preparation, sample preservation, sample receipt, sample storage, chain-of-custody documentation, reporting, sample and records retention. Sample management is practiced as specified in L-Procedure L-6002, "Sample Administration - General Laboratory."

Sample bottles will be prepared by the laboratory and made available to the sampling team. The bottles will be prepared according to the analysis plan procedures and will include sample preservatives appropriate to the analytes and matrices of concern.

Samples received at the laboratories are inspected for integrity, and any field documentation is reviewed for accuracy and completeness.

Chain-of-custody and sample integrity problems are noted and recorded during sample log-in. Waste Operations is informed of

any deficiencies and will advise the laboratory on the desired disposition of the samples.

As each sample is received by the laboratory, it is assigned a unique sequential sample number which will identify the sample in the laboratory's internal tracking system. References to a sample in any communication will include the assigned sample number.

C-7.3 Analytical System

C-7.3.1 Instrument Maintenance

Instruments will be maintained in accordance with the manufacturer's specifications. More frequent maintenance may be dictated dependent on operational performance. Instrument logs will be maintained to document the date and type of any maintenance performed, and rationale for maintenance.

Contracts on major instruments with manufacturers and service agencies, may be used to provide routine preventive maintenance and to ensure rapid response to emergency repair service.

C-7.3.2 Instrument Calibration

Before any instrument can be used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which the various instruments are calibrated is dependent on the particular instrument and the

intended use of the instrument. All sample measurements will be made within the calibrated range of the instrument. After calibration, satisfactory instrument response is verified by use of calibration check standards. Failure to confirm concentrations of such standards will result in recalibration of the instrument. All data on calibration and standards will be kept in the operating log of the instrument.

C-7.3.3 Personnel Training

Prior to conducting analyses on an independent basis, analysts are trained by experienced personnel in the complete performance of an analytical method. The analyst is required to independently generate data on several methods and/or matrix spikes to demonstrate proficiency in that analytical method. The type of data to be generated will be dependent on the analytical method to be performed. Results of this "certification" are then reviewed for adequacy.

Since method blanks and method spikes are required routine samples in every lot of samples analyzed, performance on a day-to-day basis can be monitored by comparison with the original and cumulative data on similar samples. Laboratory management and the laboratory Quality Assurance/Quality Control Officer are responsible for ensuring that samples are analyzed by only competent analysts.

C-7.3.4 Analytical Methods

All analytical measurements are made using methodology appropriate for the specific purpose and performed according to a plan individually developed and optimized for each situation. The requirements of each problem are studied and thoroughly understood before hand, in order to ensure that the measurements planned will be adequate both in kind, number, and quality. All measurements are made using standard methods, methods with peer recognition, methods developed in the specific laboratory, or those mandated by outside requirements. No method will be used for data output purposes until it is known to be applicable and competence has been acquired in its use. If or when it appears that available techniques are not adequate to solve a particular problem, the requester of the services is usually informed of any preliminary investigations or research required, including estimated costs in terms of laboratory time.

To control routinely employed analytical laboratory analyses and avoid errors leading to unsatisfactory results, formal procedures are written to provide direction for those doing the work. Instructions for performing most routine analytical laboratory operations are provided in L-Procedures, also known as Analytical Laboratory Procedures. L-Procedures are developed and written by the Quality Laboratories' technical staff and apply to routinely performed analytical work.

These procedures are reviewed prior to approval by laboratory

management and are subject to periodic audits. The L-Procedures for analytical methods are usually adaptations of SW-846. L-Procedures also cover other standard operating practices such as sample handling protocols, security procedures, and nuclear accountability practices. L-Procedures for analytical methods perform the following functions:

- 1) Describe operations, materials, and equipment required.
- 2) Serve as training guide for indoctrination and education of personnel.
- 3) Identify potential hazards, safety requirements, and safeguards considerations associated with the procedure.
- 4) Describe calibration and standardization procedures.
- 5) Describe techniques for quality assessment of data (e.g., measurement control samples, replicate measurements, etc.).
- 6) Describe sample preparation and handling.
- 7) Describe data handling and calculations, including statistical analysis of the data and reporting of uncertainties.
- 8) Provide a format or model for report generation if appropriate.

For non-routine analysis investigations that are encountered infrequently, written procedures are not generated. The analytical methodology, in these cases, is based upon the analyst's knowledge and skill. The data from such work are supported by documentation of good laboratory practices and data verification steps.

The control of written procedures and the policies for changing

procedures are defined in Procedure L-1000. Master copies of all qualified procedures are maintained by the managers of the laboratory groups to which the procedures apply. Working copies of approved procedures are distributed to the responsible managers and technical staff members.

C-7.3.5 Reference Materials

If possible, primary reference materials will be obtained from the National Bureau of Standards (NBS) or the U.S. Environmental Protection Agency (EPA). In the absence of available reference materials from these organizations, other reliable sources may be sought. When available reference materials will be used for instrument calibration, quality control spikes, and/or performance evaluations. Secondary reference materials may be used for these functions provided that they are traceable to an NBS standard or have been compared to an NBS standard within the laboratory.

C-7.3.6 Reagents

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

C-7.3.7 Corrective Actions

When an analytical system is deemed to be questionable or out-of-

control at any level of review, corrective action is taken. If possible, the cause of the out-of-control situation is determined, and efforts are made to bring the system back into control. Demonstration of the restoration of a reliable analytical system will normally be accomplished by generating satisfactory calibration and/or quality control sample data. The major consideration in performing corrective action is ensuring that only reliable data are reported from the laboratory.

C-7.4 Data Management

C-7.4.1 Data Collection

In addition to the data collected in the field and recorded on the chain-of-custody forms, data describing the processing of samples will be accumulated in the laboratory and recorded.

Laboratory records may contain:

- Date and time of processing
- Sample numbers
- Project (optional)
- Analyses or operation performed
- Calibration data
- Quality control samples included
- Dates of Analysis
- Concentrations/dilutions required
- Instrument readings
- Special observations
- Analyst's signature

C-7.4.2 Data Reduction

Data reduction is performed by the individual analysts and consists of calculating results in samples from the raw data

obtained from the measuring instruments. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved in obtaining a sample that can be measured.

Copies of all raw data and the calculations used to generate the final results will be retained in the laboratory to allow reconstruction of the data reduction process at a later date.

C-7.4.3 Data Review

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews are performed prior to submission of data to the laboratory management or designee.

Laboratory management or designee will review the data for consistency and validity with other generated data and determine if program requirements have been satisfied. Unusual or unexpected results will be reviewed, and a determination will be made as to whether the analysis should be repeated.

The Quality Assurance/Quality Control Officer independently conducts a complete review of results from randomly selected samples to determine if laboratory and program quality

assurance/quality control requirements have been met. Discrepancies will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures.

C-7.4.4 Data Archiving

The laboratory will maintain on file all of the raw data, laboratory notebooks, and other pertinent documentation. This file will be maintained at the laboratory for a period of time consistent with RFP requirements.

Data retrieval from archives may be handled only with the approval laboratory management.

C-7.4.5 Data Reporting

All data will be reported in a format approved by Laboratory Management and the Laboratory QA/QC officer. Data reports will include the following information:

- Waste ID Number
- Laboratory Sample Number
- Sample Date
- Extraction Date (if appropriate)
- Analysis Date

- For each Analyte:
 - Parameter
 - Units
 - Value
 - Detection Limit
 - Flags (where appropriate)
 - Counting error (for radioactive parameters)
- Laboratory Blank Results
- Laboratory Spike Results

When errors are detected in laboratory results, subsequent reports will clearly designate which results have been revised.

C-7.5 Special Measurement - Control Programs

In addition to internal laboratory Quality Assurance and Quality Control Programs, formal measurement control programs have been established and are administered by groups outside the laboratory. These programs provide for additional measurement quality assurance for data.

C-7.5.1 Sample Exchange Programs

There are three special sample exchange programs in place which are administered independent of the Rocky Flats operation. They are:

- a) The Environmental Monitoring Surveillance Laboratory Exchange Program provides for radiological analysis control among approximately 200 environmental laboratories nationwide.
- b) The U.S. Geological Survey Exchange Program addresses environmental pollutant monitoring parameters. This program involves 40 government agency laboratories.

- c) The Environmental Protection Agency QA Laboratory Performance Evaluation Study is a quality assurance compliance check for the National Pollutant Discharge Elimination System (NPDES). Compliance with this program assures continuation of the DOE Discharge Permit for Rocky Flats Plant waste discharge. The Rocky Flats Plant Health, Safety, and Environment Department administers this program for the plant and is responsible for reporting all data.

C-7.6 Standards Laboratory Measurement Control Programs

C-7.6.1 Analytical Measurement Control

The Standards Laboratory administers two formal measurement control systems for analytical laboratory measurements. The two systems, designated the Measurement Control System (MCS) and the Interactive Measurement Evaluation and Control System (IMECS), differ only in the method of collecting data. The MCS involves manual transcription of data that are eventually entered on a one-time basis into a computer program that produces one specific report. IMECS involves on-line computer data collection into a database management system and is capable of producing a variety of user-specified reports. (For more details on the MCS, refer to Standards Laboratory Procedure L-25. The IMECS is documented in Introduction to IMECS and Measurement Control.)

Regardless of the method of data collection, the Standards Laboratory prepares control samples for a variety of laboratory analyses, including analyses for accountable materials, nuclear safety measurements, and environmental analyses. The control

samples are submitted to the appropriate laboratories on a predetermined schedule. The control samples are analyzed in the laboratory at the specified frequency and results are either reported to the Standards Laboratory or are entered directly into the IMECS via a local computer terminal.

The Standards Laboratory is responsible for monitoring and enforcing compliance with the measurement-control systems. Measurement-control deviation reports are issued by the Standards Laboratory for all control samples that are past due and for all control results that exceed specified limits. The various Quality Laboratories are required to respond in writing to these noted deviations within one week of receipt of the notice. Deviation reports for accountable materials are further reviewed by the Rocky Flats Plant Safeguards group. All records are maintained by the Standards Laboratory.

Formal measurement-control reports are produced monthly by both systems. These reports are distributed to the laboratories involved as well as to the Rocky Flats Safeguards group and to DOE. Additionally, in the case of IMECS, the formal reports include control charts for each individual measurement control program. IMECS also provides a variety of reports, tables, and plots on demand since it is an on-line database management system.

C-7.6.2 Weight Measurement Control

Within the Quality Laboratories, balances that are used for critical applications requiring certified accuracy and precision are included in the Weight MEASUREMENT Control Program. The Standards Laboratory supplies balance users with certified check weights. Balance operators must make periodic check weighings on their balances in accordance with the Standards Laboratory Procedure M1307, "Weight Measurement Control Check Weight Procedure." Data is either recorded on specially provided data entry forms or is entered directly into the Weight Measurement Control Program in the IMECS. The Standards Laboratory maintains all records on the check weights and the Weight Measurement Control Program.

C-7.6.3 Performance and System Audits

Quality assurance audits will be conducted during the sampling and analysis program as mandated by the QL Quality Assurance Program. The audits are a key mechanism for ensuring the technical and procedural accuracy of hazardous waste and environmental sampling and analysis. A field audit will be performed periodically in accordance with an established schedule.

Specific system audits of deliverables, field notebooks, calculations, and data entry will be conducted by the Quality

Assurance Coordinator throughout the year at random, unscheduled intervals.

Specific audits will be planned, organized, and clearly defined before they are initiated. Auditors will identify non-conformances or deficiencies, report and document, initiate corrective action through appropriate channels, and follow up with a compliance review.

Annually, or more frequently if appropriate, a quality assurance audit will be performed in accordance with an established schedule by the Quality Assurance Coordinator. A report will be prepared that summarizes any deviations from approved plans or procedures and their impacts on results.

C-7.6.4 Field Audits

For randomly selected sites where samples are collected, an unannounced audit, investigating conformance with QA/QC procedures will be performed during a randomly selected performance period. A written report on the results of this audit, along with a notice of non-conformance (if necessary), will be submitted to management.

C-7.6.5 Corrective Action

After each audit, auditors will identify non-conformances in a written non-conformance notice and initiate corrective action. The non-conformance notice will describe any non-conforming conditions and sets a date for response and corrective action. A

written response outlining the proposed corrective action is required. Follow-up review will be performed as necessary to confirm that the corrective actions have been implemented.

APPENDIX 7
SOIL SAMPLING PROCEDURES

APPENDIX A

1. DRILLING AND SAMPLING

1.1. PURPOSE

To provide procedures for borehole drilling and sampling

1.2. DEFINITIONS

- **Monitor Wells:** Two-inch wells designed for monitoring water levels and groundwater quality
- **Alluvial Wells:** Monitor wells completed in surficial materials (Rocky Flats Alluvium, colluvium, or valley fill alluvium).
- **Bedrock Wells.** Monitor wells completed in saturated sandstone of the Arapahoe or Laramie Formations.
- **Piezometers:** Two-inch wells completed in claystone of the Arapahoe or Laramie Formations for monitoring water levels.
- **Surface Casing** Casing set and grouted through surficial materials in bedrock wells to prevent interconnection of shallow and deep flow systems.

1.3. RESPONSIBILITY

The Rockwell International CEARP Manager is responsible for the drilling and sampling program.

The Subcontractor Site Manager is responsible for direct supervision of drilling and sampling. The Subcontractor Site Manager will report daily to the Rockwell International CEARP Manager on drilling and sampling progress including any problems encountered implementing the field program.

The Field Team Leader is responsible for supervision of drilling, verification of drilled depths, and approval of the Driller's daily logs. The Field Team Leader is also responsible for sample collection, handling, and field screening.

The Driller is responsible for operating and maintaining the rig and auxiliary equipment, for keeping a clean and safe working environment, and for assisting the Field Team Leader with sampling.

1.4. EQUIPMENT AND MATERIALS

- Drilling rig with auger, rotary tricone, and diamond coring systems
- Water truck
- Rod trailer
- Maintenance and access vehicles
- Miscellaneous drilling equipment
- Volatile organic-free water
- Electric well sounder
- Glass jars and lids
- Labels
- Core boxes
- Plastic wrap
- Pipe wrenches
- Rock hammer
- Pocket knife
- Hand lens
- Tape measure divided in tenths of a foot
- Dropper bottle of hydrochloric acid
- Protractor
- Marking pens and pencils
- Field notebook
- Log of boring form

1.5. PROCEDURES

1.5.1. Alluvial Wells

- (1) Alluvial wells will be drilled with hollow stem augers where practical. Boulders in the Rocky Flats Alluvium may prohibit the use of hollow stem augers, in which case alternative drilling methods such as tricone rotary will be used. Sampling through surficial materials will be performed by continuous sampling through the hollow stem augers (with split tube inner barrel) or by split spoon, depending on the materials.
- (2) Alluvial wells will be drilled approximately one to three feet into bedrock. They will be terminated after confirming the presence and lithology of bedrock.

- (3) The hole diameter will be a minimum of four inches. The use of hollow stem augers eliminates the need for drilling fluids; however, some volatile organic-free water may be used if hole stability is a problem. In no event will mud or foaming agents be used.

1.5.2. Bedrock Wells

- (1) Bedrock wells will be augered and rotary drilled through surficial materials and weathered bedrock as described above.
- (2) Upon penetration of unweathered bedrock, steel surface casing will be set and neat cement grout will be placed in the annulus through a tremie pipe or by pushing a plug of cement through the surface casing. The surface casing will be approximately 6 in. in diameter.
- (3) Grout will be neat Type I or Type II Portland cement, mixed with volatile organic-free water at a mix ratio of 6 to 9 gal. of water per 94-lb bag of cement. Grout will be allowed to set at least twenty-four hours before drilling resumes.
- (4) The hole will proceed through bedrock by rotary coring (size NX or larger), using bentonite mud, volatile organic-free water, air mist (air and volatile organic-free water), or filtered air.
- (5) Drilling will progress into bedrock until at least 3 ft of saturated sandstone within a 10-ft interval of bedrock is encountered, or until the well is approximately 100 ft deep. Wells may be drilled deeper than 100 ft to fully penetrate a sandstone.
- (6) After drilling through sufficient sandstone thickness (as defined above), the hole will be cleaned and stabilized for packer testing.
- (7) Geophysical logging may be performed in some holes after packer testing.
- (8) After packer testing and geophysical logging are completed, the hole will be reamed, if necessary, to a minimum of 4 in. for well installation.

1.5.3. Sampling and Logging

- (1) The Driller will provide either continuous samples from a split tube sampler, split-spoon samples, rotary cuttings, or NX core, depending on the drilling method.
- (2) As drilling progresses, the Field Team Leader will confirm sample depths with the Driller, describe the samples, and field screen the sample for organic or radioactive contamination. Descriptions and screening results will be recorded in the field notebook and on a log of boring form. The Field Team Leader will also note the depth at which groundwater is encountered.
- (3) Sample descriptions will include the following items as appropriate:
 - Borehole designation
 - Time and date
 - Interval footage and recovered footage
 - Name of unit and/or brief rock name
 - Characteristic structures of the unit
 - Fossils
 - Lithologic description
 - Nature of contacts
 - Water content
 - Organic and radioactive field screening results.
- (4) Auger and rotary cuttings will be bottled in glass jars and labeled. Intervals designated for chemical analyses will be placed in jars and stored on ice in coolers. These samples will be delivered to the onsite laboratory, if an onsite laboratory is used, within 3 hours of collection.
- (5) Core continuous split tube samples, and split-spoon samples will be wrapped with clear plastic to prevent rapid drying and cracking and placed in NX or NC size core boxes as appropriate. Wooden blocks will be inserted in the boxes at the beginning and end of runs to mark footages and will indicate lost core zones. Core boxes will be labeled and stored.
- (6) The Driller will keep a daily log detailing footage drilled, material used, and stand-by time. The Field Team Leader will keep an independent record of drilling activities in the field notebook to verify the daily logs. One copy of the daily logs will be submitted to the Subcontractor Site

**Manager and Rockwell International CEARP Manager by the Field Team
Leader on a weekly basis.**

1.6. RECORDS

- Log of boring
- Driller's daily logs
- Field notebook

ATTACHMENT 2

Lower Limits of Detection

The detection limits presented were calculated using the formula in NRC Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow

$$LLD = \frac{4.66 \sqrt{\frac{BKG}{DUR}}}{(2.22) (Eff) (CR) (SR) (e^{-xt}) (Aliq)},$$

Where

- LLD = Lower Limit of Detection in pCi per sample unit
- BKG = Instrument Background in counts per minute (cpm)
- DUR = Duration of sample counting in minutes
- Eff = Counting efficiency in cpm/disintegration per minute (dpm)
- CR = Fractional radiochemical yield
- SR = Fractional radiochemical yield of a known solution
- x = The radioactive decay constant for the particular radionuclide
- t = the elapsed time between sample collection and counting

In that LLD is a function of many variables including sample matrix, sample volume, and other factors, the limits presented are only intended as guides to order-of-magnitude sensitivities and, in practice, can easily change by a factor of two or more even for the conditions specified

Table 3 4. Analysis Plan for Radiological Analysis for Soils/Sediments

Analyte	Method*	Detection Limit**	Sample Container	Sample Size (g)	Preservations	Holding Time (days)	Reporting Units
Gross alpha/beta	1,2,3,4,6,7,8,9	Gross a = 4 pCi/g Gross b = 10 pCi/g	G, 1 L	0 1	NA	NA	pCi/g
Pu 239	10,11	0 3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Am 241	11,12	0 3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Isotopic U	1,3,4,7,8,9	U-233 + 234 = 0 3 pCi/g U 238 = 0 3 pCi/g	G, 1 L	1	NA	NA	pCi/g
Sr 90	1,3,4,8	1 pCi/g	G, 1 L	1	NA	NA	Pci/g

*See Attachment 1
**See Attachment 2

ATTACHMENT I

Method References

- 1 US Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No EMSL-LY-0539-1, Las Vegas, NV, US Environmental Protection Agency
- 2 American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed, Washington, DC, Am Public Health Association
- 3 US Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No EPA-600/4-75-008 Cincinnati US Environmental Protection Agency
- 4 Harley, J H, ed, 1975, HASL Procedures Manual, HASL-300, Washington, DC. US Energy Research and Development Administration
- 5 Misaqi, Fazlilleh L, Monitoring Radon-222 Content of Mine Waters Informational Report 1026, US Department of Interior, Mining Enforcement and Safety Administration, Denver, CO, 1975
- 6 "Radioassay Procedures for Environmental Samples," 1967, USDHEW, Section 7 2 3
- 7 "Handbook of Analytical Procedures," USAEC, Grand Junction Lab 1970, page 196.
- 8 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, US Environmental Protection Agency, Cincinnati, Ohio 45268
- 9 "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," USGS Book 5, Chapter A5, 1977
- 10 "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979
- 11 "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium and Americium," by E H. Essington and B J Drennon, Los Alamos National Laboratory, a private communication
- 12 "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.

ATTACHMENT 2

Lower Limits of Detection

The detection limits presented were calculated using the formula in NRC Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg 21, and follow

$$LLD = 4.66 \frac{BKG^{1/2}}{DUR (2.22) (Eff) (CR) (SR) (e^{-xt}) (Aliq)}$$

Where

- LLD = Lower Limit of Detection in pCi per sample unit
- BKG = Instrument Background in counts per minute (cpm)
- DUR = Duration of sample counting in minutes
- Eff = Counting efficiency in cpm/disintegration per minute (dpm)
- CR = Fractional radiochemical yield
- SR = Fractional radiochemical yield of a known solution
- x = The radioactive decay constant for the particular radionuclide
- t = the elapsed time between sample collection and counting

In that LLD is a function of many variables including sample matrix, sample volume, and other factors, the limits presented are only intended as guides to order-of-magnitude sensitivities and, in practice, can easily change by a factor of two or more even for the conditions specified.

Table 3.5 Hazardous Substance List (HSL) and Contract Required
Detection Limits (CRDL)**

Volatiles	CAS Number	Detection Limits*	
		Low Water ^a ug/L	Low Soil/Sediment ^b ug/Kg
1 Chloromethane	74-87-3	10	10
2 Bromomethane	74-83-9	10	10
3 Vinyl Chloride	75-01-4	10	10
4 Chloroethane	75-00-3	10	10
5 Methylene Chloride	75-09-2	6	5
6 Acetone	67-64-1	10	10
7 Carbon Disulfide	75-15-01	5	5
8 1,1-Dichloroethene	75-35-4	5	5
9 1,1-Dichloroethane	75-35-3	5	5
10 trans-1,2-Dichloroethene	156-60-5	5	5
11 Chloroform	67-66-3	5	5
12 1,2-Dichloroethane	107-06-2	5	5
13 2-Butanone	78-93-3	10	10
14 1,1,1-Trichloroethane	71-55-6	5	5
15 Carbon Tetrachloride	56-23-5	5	5
16 Vinyl Acetate	108-05-4	10	10
17 Bromodichloromethane	75-27-4	5	5
18 1,1,2,2-Tetrachloroethane	79-34-5	5	5
19 1,2-Dichloropropane	78-87-5	5	5
20 trans-1,3-Dichloropropene	100061-02-6	5	5
21 Trichloroethene	79-01-6	5	5
22 Dibromochloromethane	124-48-1	5	5
23 1,1,2-Trichloroethane	79-00-5	5	5
24 Benzene	71-43-2	5	5
25 cis-1,3-Dichloropropene	10061-01-5	5	5
26 2-Chloroethyl Vinyl Ether	110-75-8	10	10
27 Bromoform	75-25-2	5	5
28 2-Hexanone	591-78-6	10	10
29 4-Methyl-2-pentanone	108-10-1	10	10
30 Tetrachloroethene	127-18-4	5	5
31 Toluene	108-88-3	5	5
32 Chlorobenzene	108-90-7	5	5
33 Ethyl Benzene	100-41-4	5	5
34 Styrene	100-42-5	5	5
35 Total Xylenes	100-42-5	5	5

Table 3 5 (Continued)

Semi-Volatiles	CAS Number	Detection Limits*	
		Low Water ^c ug/L	Low Soil/Sediment ^d ug/Kg
36 N-Nitrosodimethylamine	62-75-9	10	330
37 Phenol	108-95-2	10	330
38 Aniline	62-53-3	10	330
39 bis(2-Chloroethyl) ether	111-44-4	10	330
40 2-Chlorophenol	95-57-8	10	330
41 1,3-Dichlorobenzene	541-73-1	10	330
42 1,4-Dichlorobenzene	106-46-7	10	330
43 Benzyl Alcohol	100-51-6	10	330
44 1,2-Dichlorobenzene	95-50-1	10	330
45 2-Methylphenol	95-48-7	10	330
46 bis(2-Chloroisopropyl ether	39638-32-9	10	330
47 4-Methylphenol	106-44-5	10	330
48 N-Nitroso-Dipropylamine	621-64-7	10	330
49 Hexachloroethane	67-72-1	10	330
50 Nitrobenzene	98-95-3	10	330
51 Isophorone	78-59-1	10	330
52 2-Nitrophenol	88-75-5	10	330
53 2,4-Dimethylphenol	105-67-9	10	330
54 Benzoic Acid	65-85-0	50	1600
55 bis(2-Chloroethoxy) methane	111-91-1	10	330
56 2,4-Dichlorophenol	120-83-2	10	330
57 1,2,4-Trichlorobenzene	120-82-1	10	330
58 Naphthalene	91-20-1	10	330
59 4-Chloroaniline	106-47-8	10	330
60 Hexachlorobutadiene	87-68-3	10	330
61 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
62 2-Methylnaphthalene	91-57-6	10	330
63 Hexachlorocyclopentadiene	77-47-4	10	330
64 2,4,6-Trichlorophenol	88-06-2	10	330
65 2,4,5-Trichlorophenol	95-95-4	50	1600
66 2-Chloronaphthalene	91-58-7	10	330
67 2-Nitroaniline	88-74-4	50	1600
68 Dimethyl Phthalate	131-11-3	10	330
69 Acenaphthylene	208-96-8	10	330
70 3-Nitroaniline	99-09-2	50	1600

Table 35 (Continued)

Semi-Volatiles	CAS Number	Detection Limits*	
		Low Water ^c ug/L	Low Soil Sediment ^d ug Kg
71 Acenaphthene	83-32-9	10	330
72 2,4-Dinitrophenol	51-28-5	50	1600
73 4-Nitrophenol	100-02-7	50	1600
74 Dibenzofuran	132-64-9	10	330
75 2,4-Dinitrotoluene	121-14-2	10	330
76 2,6-Dinitrotoluene	606-20-2	10	330
77 Diethylphthalate	84-66-2	10	330
78 4-Chlorophenyl Phenyl ether	7005-72-3	10	330
79 Fluorene	86-73-7	10	330
80 4-Nitroaniline	100-01-6	50	1600
81 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
82 N-nitrosodiphenylamine	86-30-6	10	330
83 4-Bromophenyl Phenyl ether	101-55-3	10	330
84 Hexachlorobenzene	118-74-1	10	330
85 Pentachlorophenol	87-86-5	50	1600
86 Phenanthrene	85-01-8	10	330
87 Anthracene	120-12-7	10	330
88 Di-n-butylphthalate	84-74-2	10	330
89 Fluoranthene	206-44-0	10	330
90 Benzidine	92-87-5	50	1600
91 Pyrene	129-00-0	10	330
92 Butyl Benzyl Phthalate	85-68-7	10	330
93 3,3'-Dichlorobenzidine	91-94-1	20	660
94 Benzo(a)anthracene	56-55-3	10	330
95 bis(2-ethylhexyl) phthalate	117-81-7	10	330
96 Chrysene	218-01-9	10	330
97 Di-n-octyl Phthalate	117-84-0	10	330
98 Benzo(b)fluoranthene	205-99-2	10	330
99 Benzo(k)fluoranthene	207-08-9	10	330
100 Benzo(a)pyrene	50-32-8	10	330
101 Indeno(1,2,3-cd)pyrene	193-39-5	10	330
102 Dibenz(a,h)anthracene	53-70-3	10	330
103 Benzo(g,h,i)perylene	191-24-2	10	330

Table 35 (Continued)

Pesticides	CAS Number	Detection Limits*	
		Low Water ^c ug/L	Low Soil/Sediment ^f ug/Kg
104 alpha-BHC	319-84-6	0.05	8.0
105 beta-BHC	319-85-7	0.05	8.0
106 delta-BHC	319-86-8	0.05	8.0
107 gamma-BHC (Lindane)	58-89-9	0.05	8.0
108 Heptachlor	76-44-8	0.05	8.0
109 Aldrin	309-00-2	0.05	8.0
110 Heptachlor Epoxide	1024-57-3	0.05	8.0
111 Endosulfan I	959-98-8	0.05	8.0
112. Dieldrin	60-57-1	0.10	16.0
113 4,4'-DOE	72-55-9	0.10	16.0
114 Endrin	72-20-8	0.10	16.0
115 Endosulfan II	33213-65-9	0.10	16.0
116 4,4'-DDD	72-54-8	0.10	16.0
117 Endrin Aldehyde	7421-93-4	0.10	16.0
118 Endosulfan Sulfate	1031-07-8	0.10	16.0
119 4,4'-DDT	50-29-3	0.10	16.0
120 Endrin Ketone	53494-70-5	0.10	16.0
121 Methoxychlor	72-43-5	0.5	80.0
122 Chlordane	57-74-9	0.5	80.0
123 Toxaphene	8001-35-2	1.0	160.0
124 AROCLOR-1016	12674-11-2	0.5	80.0
125 AROCLOR-1221	11104-28-2	0.5	80.0
126 AROCLOR-1232	11141-16-5	0.5	80.0
127 AROCLOR-1242	53469-21-9	0.5	80.0
128 AROCLOR-1248	12672-29-6	0.5	80.0
129 AROCLOR-1254	11097-69-1	1.0	160.0
130 AROCLOR-1260	11096-82-5	1.0	160.0

^aMedium Water Contract Required Detection Limits (CRDL) for Volatile HSL
Compounds are 100 times the individual Low Water CRDL

^bMedium Soil/Sediment Contract Required Detection Limits (CRDL) for Volatile
HSL Compounds are 100 times the individual Low Soil/Sediment CRDL

^cMedium Water Contract Required Detection Limits (CRDL) for Semi-Volatile HSL
Compounds are 100 times the individual Low Water CRDL

^dMedium Soil/Sediment Contract Required Detection Limits (CRDL) for Semi-
Volatile HSL Compounds are 60 times the individual Low Soil/Sediment CRDL.

Table 35 (Continued)

^cMedium Water Contract Required Detection Limits (CRDL) for Pesticide HSL
Compounds are 100 times the individual Low Water CRDL
^fMedium Soil/Sediment Contract Required Detection Limits (CRDL) for Pesticide
HSL compounds are 60 times the individual Low Soil/Sediment CRDL

*Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, as required by the contract, will be higher.

**These are the EPA detection limits under the Contract Laboratory Program. Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

**Table 3 6. Elements Determined by Inductively Coupled
Plasma Emission or Atomic Absorption Spectroscopy**

<u>Element</u>	<u>Contract Required Detection Level^{1,2} (ug/L)</u>
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cesium	200
Molybdenum	40
Strontium	200
Cyanide	10

Note: Detection limits in soil/sediment are numerically equivalent to those listed above with concentration units of mg/kg

¹Higher detection levels may also be used in the following circumstances

If the sample concentration exceeds two times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the contract required detection limit. This is illustrated in the example below

Table 36 (Continued)

For lead

Method in use - ICP

Instrument Detection Limit (IDL) = 40

Sample Concentration = 85

Contract Required Detection Limit (CRDL) = 5

The value of 85 may be reported even though instrument detection limit is greater than required detection level. The instrument or method detection limit must be documented.

²These CRDL are the instrument detection limits obtained in pure water met using the procedure in Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.

4 SAMPLING PROCEDURES

Procedures for collecting samples and for performing all related field activities are described in detail in Appendix A of the IGMP/CSPCP Sampling Plan. Adherence to these procedures will be confirmed by the CEARP Quality Assurance Officers (Rockwell International and subcontractor) by quality assurance audits.

5. SAMPLE CUSTODY

CEARP field custody procedures are described in Section 7.2 of the IGMP/CSPCP Sampling Plan. Laboratory custody procedures for the analytical laboratories are described in Appendix A.

6. CALIBRATION PROCEDURES AND FREQUENCY

Standard commercial calibration procedures will be used by the analytical laboratories, as specified in Appendix A

Calibration of equipment used to perform geotechnical testing will be in accordance with that specified in the ASTM Method D 422-63 for hydrometer and sieve analyses (Annual Book of ASTM Standards, Volume 04 08, 1984) The equipment calibrations, including those for ovens, thermometers and balances, shall be done at a minimum of every six months and prior to large scale testing.

Field instruments will be calibrated according to procedures presented in Appendixes A and B of the IGMP/CSPCP Sampling Plan. A calibration log book will be assigned to each field instrument, and all calibrations will be documented in the log books

7. ANALYTICAL PROCEDURES

Laboratory analyses will follow methods described in Tables 3 1, 3 2, 3 3, and 3 4. Deviation from those methods, if required, will be presented in the SSMPs.

8. DATA REDUCTION, VALIDATION, AND REPORTING

Analytical laboratories will provide results to the Rockwell International CEARP Manager, the Subcontractor Project Manager, and Quality Assurance Officers. These data will include results and documentation for blanks and duplicates, matrix spikes, and forms summarizing analytical precision and accuracy.

Analytical data, including quality control sample analysis, will be entered into the technical data base. The analyses will be grouped into lots, with quality control samples associated with a particular lot. The analyses of quality control samples will be compared to theoretical known concentrations of those samples. If analyses do not meet acceptance criteria, the analytical laboratory may be asked to re-analyze the samples for parameters which do not exceed holding times. Analyses which cannot meet acceptance criteria, will be labelled as unacceptable. All parameter-specific values for a lot in which the quality control analyses did not meet acceptance criteria, will be removed from the technical data base.

Acceptance criteria for analyses of parameters for quality control samples (knowns) will be based on the theoretical known value furnished by the laboratory that prepared the sample. The theoretical known value is stated as a range of values. The analysis of the sample must be within the stated range of the theoretical known plus or minus 10% of the range. An exception is analyses at or near the limit of detection. If the lower limit of the range of the theoretical known value is less than twice the limit of detection, an acceptable analysis includes the range from the limit of detection to the upper limit of the theoretical range, plus 10%.

Analytical reports from a field laboratory, if used, and the geotechnical laboratory will include all raw data, documentation of reduction methods, and related quality assurance/quality control data. These data will be assessed by verification of reduction results and confirmation of compliance with quality assurance/quality control requirements.

Raw data from field measurements and sample collection activities used in project reports will be appropriately identified. Where data have been reduced or summarized, the method of reduction will be documented.

The Quality Assurance Officers will review results of Quality Control-acceptance evaluations and will document acceptance or non-acceptance of data. The Quality Assurance Officers will maintain records of quality control-acceptance tests. These records will be subject to independent audit, which may include Los Alamos National Laboratory.

9. INTERNAL QUALITY CONTROL PROCEDURES

Internal quality control procedures for the laboratory are those specified in Appendix A. These specifications include types of audits required (e.g., sample spikes, surrogate spikes, reference samples, controls, and blanks), frequency of audits, compounds to be used for sample spikes and surrogate spikes, and quality control acceptance criteria for audits.

The quality control checks and acceptance for data from a field laboratory if used, and the geotechnical laboratory are described above in Sections 3.2 and 3.3. Quality control procedures for field measurements (pH, conductivity, and temperature) are limited to checking the reproducibility of the measurement in the field by obtaining multiple readings and/or by calibrating the instruments (where appropriate). Quality control of field sampling will involve collecting field duplicates and blanks.

10. PERFORMANCE AND SYSTEMS AUDITS

For each activity where samples are collected, a performance audit investigating conformance with quality control procedures will be conducted (Appendix A) at the discretion of the Rockwell International CEARP manager, Subcontractor Project Manager, and Quality Assurance Officers. This audit will be scheduled to allow oversight of as many different field activities as possible. This audit will be performed by the Quality Assurance Officers or their designees. A written report of the results of this audit, along with a notice of nonconformity (if necessary), will be submitted to the following individuals:

- Rockwell International CEARP Manager
- Subcontractor Project Manager
- Subcontractor Site Manager

At least one systems audit will be performed during the project. The audit will verify that a system of quality control measures, procedures, reviews, and approvals was established for all activities and is being used by project personnel. It will also verify that the system for project documentation is being used and that all quality control records, along with required quality control reviews, approvals, and activity records are being maintained. A standard checklist for systems audits will be used. The systems audit will be conducted by the Quality Assurance Officers and/or Los Alamos National Laboratory. A final report will be prepared which summarizes any deviations from approved methods and their impacts on the project results.

After consultation with the CEARP Manager (and Subcontractor Project Manager), the Quality Assurance Officers may schedule systems audits of the participating laboratories. At a minimum, the systems audit would include inspection of laboratory notebooks, control sheets, logsheets, computer files, and equipment calibration and maintenance records. If scheduled, system audits will be executed by individuals identified in Section 2.3 of this document.

Performance and systems audits of analytical laboratories will be scheduled and executed by the laboratory Quality Assurance Officers. Performance audits are conducted at least semiannually.

11. PREVENTIVE MAINTENANCE

This section applies solely to field equipment. Preventive maintenance will be addressed by checks of equipment prior to initiation of field operations, to allow time for replacement of malfunctioning equipment. The Subcontractor Site Manager will be responsible for implementing and documenting these procedures on a weekly basis during the period of use.

12. LABORATORY DATA ASSESSMENT PROCEDURES

Analytical data from laboratories is assessed for accuracy, precision and completeness by the laboratory Quality Assurance Officers, using standard procedures

Assessment of data generated by analytical laboratories is initiated and continued at three administrative levels. The bench chemist directly responsible for the test knows current operating acceptance limits. He/she can directly accept or reject generated data and consult with his/her immediate supervisor for any corrective action. Once the bench chemist has reported the data as acceptable, he/she initials the report sheet. Any out-of-control results are flagged and a note is made as to why the results were reported.

The chief chemist receives the data sheets and reviews the quality control data that accompanied the sample run. After checking the reported data for completeness and quality control results, the chief chemist either initials the report sheet or sends it back to the bench chemist for rerunning of samples. The Quality Control Coordinator reviews data forwarded to him/her as acceptable by the chief chemist. Any remaining out-of-control results that, in the opinion of the Quality Control Coordinator, do not necessitate rerunning of the sample, are flagged, and a memo is written to the data user regarding utility of the data. Data generated from all analyses are given a final review by the laboratory Quality Assurance Officers.

13. CORRECTIVE ACTION PROCEDURES

The Quality Assurance Officers and their audit teams will prepare a report describing the results of the performance and/or system audits. If unacceptable conditions (e.g., failure to have/use procedures), unacceptable data, nonconformity with the quality control procedures, or a deficiency are identified, the Quality Assurance Officers will notify the Rockwell International CEARP Manager of the results of the audit in writing. They will also state if the nonconformity is of significance for the program and recommend appropriate corrective actions. The Rockwell International CEARP Manager will be responsible for ensuring that corrective is developed and initiated and that, if necessary, special expertise not normally available to the project team is made available. The subcontractor will be responsible for carrying out corrective actions. The subcontractor will also ensure that additional work is not performed until the nonconformity is corrected. Corrective action may include

- reanalyzing the samples if holding time permits,
- resampling and reanalyzing,
- evaluating and amending the sampling and analytical procedures, and
- accepting the data and acknowledging its level of uncertainty

The Rockwell International CEARP Manager will be responsible for ensuring that corrective action was taken, and that it adequately addressed the nonconformity.

After corrective action is taken, the Quality Assurance Officer responsible for the audit will document its completion in a written report. The report will indicate any identified findings, corrective action taken, follow-up action, and final recommendations. The report will be sent to the Rockwell International CEARP Manager. Project staff will be responsible for initiating reports on suspected nonconformities in field activities and deliverables or documents.

14. QUALITY ASSURANCE REPORTS

The Rockwell International CEARP Manager will rely on written reports, memoranda documenting data assessment activities, performance and systems audits, nonconformity notices, corrective action reports, and quality assurance notices to enforce quality assurance requirements. The Los Alamos National Laboratory will be issued a written quality assurance report at the end of each stage of site characterization (remedial investigation) by the Rockwell International CEARP Manager.

Records will be maintained to provide evidence of quality assurance activities. Proper maintenance of quality assurance records is essential to provide support for evidential proceedings and to assure overall quality of the investigation. A quality assurance records index will be started at the beginning of the project. All information received from outside sources or developed during the project will be retained by the project team. Upon termination of an individual task or work assignment, working files will be processed for storage as quality assurance records. Upon termination of the project, complete documentation records (for example, chromatograms, spectra, and calibration records) will be archived as required by DOE Order 1324 2A (Records Deposition). The Rockwell International CEARP Manager and the Los Alamos National Laboratory CEARP Rocky Flats Plant Team Leader will be responsible for ensuring that the Quality Assurance records are being properly stored and that they can be retrieved.

15. REFERENCES

DOE 1986b. "Comprehensive Environmental Assessment and Response Program Phase 1. Draft Installation Assessment Rocky Flats Plant," US Department of Energy unnumbered draft report, April 1986

APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

1. LABORATORY QA/QC PROGRAM

This appendix to the quality assurance/quality control plan describes the organization and procedures used to produce reliable analytical data. These procedures are applicable to performing chemical, radiological, and geotechnical analyses on waste or environmental samples as appropriate.

The ultimate responsibility for the generation of reliable laboratory data rests with the laboratory management. Laboratory management is vested with the authority to establish those policies and procedures to ensure that only data of the highest attainable caliber are produced. Laboratory management, as well as the laboratory Quality Assurance/Quality Control Officer are responsible for the implementation of the established policies and procedures.

Laboratory management has the following responsibilities

- direct implementation of the quality assurance program,
- ensure that their personnel are adequately trained to perform analyses,
- ensure that equipment and instrumentation under their control are calibrated and functioning properly, and
- review and perform subsequent corrective action on internal and external audits.

The Quality Assurance/Quality Control Officer has the following responsibilities

- on-going review of individual quality assurance procedures,
- providing assistance in the development and implementation of specific quality assurance plans for special analytical programs,
- coordination of internal and external quality assurance audits,
- coordination of quality assurance training,
- review of special project plans for consistency with organizational requirements and advising laboratory management of inconsistencies, and
- overall coordination of the laboratories' quality assurance program manual.

1.2. SAMPLE MANAGEMENT

On notification of the sampling and analyses effort, the laboratory will create a file to maintain records associated with the activity. In addition to administrative information, requests for sample containers, preservatives, and required analyses will be included in the file.

Sample bottles will be prepared by the laboratory and made available to the sampling team. The bottles will be prepared according to the analysis plan procedures and will include sample preservatives appropriate to the analytes and matrices of concern. Addition of preservatives to sample shall be recorded on chain-of-custody forms.

Samples received at the laboratories will be inspected for integrity, and any field documentation will be reviewed for accuracy and completeness.

Chain-of-custody and sample integrity problems will be noted and recorded on the chain-of-custody forms during sample log-in. Chain-of-custody forms and deficiency notices will be maintained in the file. Any deficiencies will be brought to the attention of the Rockwell International CEARP Manager who will advise the laboratory on the desired disposition of the samples.

Each sample that is received by the laboratory will be assigned a unique sequential sample number which will identify the sample in the laboratory's internal tracking system. References to a sample in any communication will include the assigned sample number.

Samples will be stored in a locked refrigerator at 4°C. The temperature of the storage refrigerators will be monitored and recorded daily by the sample custodian. Sample fractions and extracts will also be stored under these same conditions.

1.3. ANALYTICAL SYSTEMS

1.3.1. Instrument Maintenance

Instruments will be maintained in accordance with manufacturers' specifications. More frequent maintenance may be dictated dependent on operational performance. Instrument logs will be maintained to document the date, type, and reason for any maintenance performed.

Contracts on major instruments with manufacturers and service agencies may be used to provide routine preventive maintenance and to ensure rapid response to emergency repair service.

1.3.2. Instrument Calibration

Before any instrument is used, it will be calibrated using known reference materials. All sample measurements will be made within the calibrated range of the instrument. A record of calibration will be kept in an equipment log.

1.3.3. Personnel Training

Prior to conducting analyses on an independent basis, analysts will be trained by experienced personnel in the complete performance of the analytical method. Analysts may require training at instrument manufacturers' training courses. The analyst will be required to independently generate data on several method and/or matrix spikes to demonstrate proficiency in that analytical method. The type of data to be generated will be dependent on the analytical method to be performed. Results of this "certification" will be reviewed by laboratory management for adequacy.

Method blanks and method spikes will be required in every lot of samples analyzed, thus performance on a day-to-day basis can be monitored. Laboratory management and the Laboratory Quality Assurance/Quality Control Officer are responsible for ensuring that samples are analyzed by only competent analysts.

1.4. ANALYTICAL METHODS

1.4.1. Gas Chromatography/Mass Spectroscopy

Mass spectrometers will be tuned on a daily basis to manufacturer's specifications with FC-43. In addition, once per shift (8 hours) these instruments will be tuned with decafluorotriphenylphosphine (DFTPP) or 4-bromo-fluorobenzene (BFB) for semi-volatiles or volatiles, respectively. Ion abundance will be within the window dictated by the requirements of the specific protocols. Once an instrument has been tuned, initial calibration curves for analytes (appropriate to the analyses to be performed) will be generated for at least three solutions containing known concentrations of authentic standards of compounds of concern.

The calibration curve will bracket the anticipated working range of analyses.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

During each operating shift, a midpoint calibration standard will be analyzed to verify that the instrument responses are still within the initial calibration determinations. The calibration check compounds will be those analytes used in the EPA contract laboratory program's multicomponent analyses (e.g., priority pollutants and hazardous substances list) with the exception that benzene will be used in place of vinyl chloride (volatiles) and di-n-octyl phthalate will be deleted from the semi-volatile list.

The response factor drift will be calculated and recorded. If significant (>30%) response factor drift is observed, appropriate corrective action will be taken to restore confidence in the instrumental measurements.

All GC/MS analyses will include analyses of a method blank, a method spike, and a method spike duplicate in each lot of samples. In addition, appropriate surrogate compounds specified in EPA methods will be spiked into each sample. Recoveries from method spikes and surrogate compounds will be calculated and recorded on control charts to maintain a history of system performance.

Duplicate samples will be analyzed for analytical lots of twenty (20) or more samples

Audit samples will be analyzed periodically to compare and verify laboratory performance against standards prepared by outside sources.

1.4.2. Gas Chromatography and High Performance Liquid Chromatography

Gas chromatographs and high performance liquid chromatographs will be calibrated prior to each day of use. Calibration standard mixtures will be prepared from appropriate reference materials and will contain analytes appropriate for the method of analysis.

Working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of three concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentrations must be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be obtained, additional standards must be analyzed to define the calibration curve. A midpoint calibration check standard will be analyzed each operating shift (8 hours) to confirm the validity of the initial calibration curve. The check standard must be within twenty (20) percent of the initial response curve to demonstrate that the initial calibration curve is still valid.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory. The method spikes will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery of the spikes, precision will be measured by the reproducibility of method spikes.

1.4.3. Atomic Absorption Spectrophotometry

Atomic absorption spectrophotometers will be calibrated prior to each day of use.

Calibration standards will be prepared from appropriate reference materials, and working calibration standards will be prepared fresh weekly. The working standards will include a blank and a minimum of five concentrations to cover the anticipated range of measurement.

Duplicate injections will be made for each concentration. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples. Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory and will be introduced at a frequency of one per analytical lot or five (5) percent of the samples, whichever is more. The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery of the spikes. The recovery must be within the range of 75-125 percent to be considered acceptable.

Precision will be measured by the reproducibility of both method spikes. Results must agree within twenty (20) percent in order to be considered acceptable.

1.4.4. Spectrophotometric Methods

Spectrophotometers will be calibrated prior to each day of use. Calibration standards will be prepared from reference materials appropriate to the analyses being performed, and working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of "known" versus "found" concentration will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to the analysis of samples.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

Accuracy will be measured by the percent recovery of the spikes. The recovery must be in an acceptable range (based on EPA data for the method of interest) in order to be considered acceptable. Precision will be measured by the reproducibility of both method spikes.

Results must agree within acceptable limits (based on EPA data) in order to be considered acceptable.

1.5 REFERENCE MATERIALS

Whenever possible, primary reference materials will be obtained from the National Bureau of Standards (NBS) or the U.S. Environmental Protection Agency (EPA). In absence of available reference materials from these organizations, other reliable sources may be sought. Reference materials will be used for instrument calibrations, quality control spikes, and/or performance evaluations. Secondary reference material

may be used for these functions provided that they are traceable to an NBS standard or have been to an NBS standard within the laboratory

1.6. REAGENTS

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

1.7. CORRECTIVE ACTIONS

When an analytical system is deemed to be questionable or out-of-control at any level of review, corrective action will be taken. If possible, the cause of the out-of-control situation will be determined, and efforts will be made to bring the system back into control. Demonstration of the restoration of a reliable analytical system will normally be accomplished by generating satisfactory calibration and/or quality control sample data. The major consideration in performing corrective action will be to ensure that only reliable data are reported from the laboratory. The Rockwell International CEARP Manager will be informed of the problem and all corrective actions taken.

1.8. DATA MANAGEMENT

1.8.1. Data Collection

All data will be recorded in laboratory notebooks. Laboratory notebooks will contain

- Date and time of processing
- Sample numbers
- Project
- Analyses or operation performed
- Calibration data
- Quality control samples included
- Concentrations/dilutions required
- Instrument readings
- Special observations
- Analyst's signature.

Copies of laboratory notebooks will be provided to the Rockwell International CEARP Manager on request.

1.8.2. Data Reduction

Data reduction will be performed by the individual analysts. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved

For those methods utilizing a calibration curve, sample responses will be applied to the linear regression line to obtain an initial raw result which will be factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained, to minimize rounding errors, and results will not normally be expressed in more than two (2) significant figures.

Copies of all raw data and the calculations used to generate the final results will be retained in the laboratory file to allow reconstruction of the data reduction process at a later date. Copies of these records will be provided to the Rockwell International CEARP Manager on request.

1.8.3. Data Review

System reviews will be performed at all levels. The individual analyst will review the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews will be performed prior to submission of data to the laboratory management.

Laboratory management will review data for consistency and validity to determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, etc.) will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, laboratory management, will recalculate selected results to verify the calculation procedure. Any abnormalities will be brought to the attention of the Rockwell International CEARP Manager.

The Quality Assurance Officer will independently conduct a complete review of results from randomly selected samples to determine if laboratory and program quality assurance/quality control requirements have been met. Deviations from requirements will be reported to the laboratory management and Rockwell International CEARP Manager for resolution.

Non-routine audits may be performed.

1.8.4. Data Reporting

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blanks data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures.

Data will be reported in units commonly used for the analyses performed. Concentrations in liquids will be expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices will be expressed in terms of weight per unit weight of sample (e.g., micrograms per grams).

Reported detection limits will be those specified by the analytical method.

1.8.5 Data Archiving

The laboratory will maintain on file all of the raw data (including calibration data), laboratory notebooks, and other pertinent documentation. This file will be maintained at the laboratory for a period of time consistent with Rocky Flats Plant's requirements. At the end of that time frame, all these records will be given to Rocky Flats Plant.

2. PERFORMANCE AND SYSTEM AUDITS

Quality assurance audits will be conducted. System audits will be conducted at random, unscheduled intervals at least annually

Audits will be planned, organized, and clearly defined before they are initiated. Auditors will identify nonconformances or deficiencies. These will be reported and documented so that corrective actions can be initiated through appropriate channels. Corrective actions will be followed up with a compliance review. A report on each audit will be sent to the Rockwell International CEARP Manager.

2.1. FIELD AUDITS

Unannounced field audits, investigating conformance with QA/QC procedures, will be performed. A typical checklist for this type of audit is shown in Table A-1. A written report on the results of this audit will be submitted to the Rockwell International CEARP Manager.

2.2. CORRECTIVE ACTION

After each audit, auditors will identify nonconformances in a written nonconformance notice and initiate corrective action through the Rockwell International CEARP Manager. The nonconformance notice will describe any nonconforming conditions and set a date for response and corrective action(s). The Subcontractor Project Manager will prepare a written proposal for corrective action for review and approval by the Rockwell International CEARP Manager. When approved, the proposed corrective action(s) will be implemented. Follow-up review will be performed by the auditor to confirm that the corrective actions have been implemented.

Table A 1 Field Audit

Project _____

Site Manager _____

Site Location _____

Field Team Leader _____

Auditor _____

Date _____

Audit Question Yes No Comment/Documentation

- 1 Was a site-specific sampling and analytical plan followed?
- 2 Was a field team leader appointed?
- 3 Was the site health and safety coordinator present?
- 4 Were field team members familiar with the sampling plan?
- 5 Was a briefing held offsite, before any site work was begun, to acquaint personnel with sampling equipment and assign field responsibilities?
- 6 Was the daily briefing and safety check conducted?
- 7 Was a completed "Site Personnel Protection and Safety Evaluation Form" read and signed by all visitors and personnel entering the site?
- 8 Was a field notebook assigned to the field team leader?
- 9 Were entries made in the field notebook?
10. Were sampling stations located correctly?
- 11 Did the number and location of samples collected follow the site-specific sampling plan?

Table A.1 (Continued)

Project _____

Site Manager _____

Site Location _____

Field Team Leader _____

Auditor _____

Date _____

<u>Audit Question</u>	<u>Yes</u>	<u>No</u>	<u>Comment/Documentation</u>
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12 Were samples identified as described in the site-specific sampling plan?

13 Were samples collected following procedures specified in the site-specific plan?

14 Was a chain-of-custody form filled out for all samples collected? Were all sample transfers documented?

15 Were samples preserved as specified in the site-specific sampling plan?

16 Were the number, frequency, and type of samples (including blanks and duplicates) collected as described in the site-specific sampling plan?

17 Were the number, frequency, and type of measurements and observations taken as specified in the site-specific sampling plan?

18 Were blank and duplicate samples properly identified?

19 Was a record maintained of calibration of field equipment?

20 Was field equipment calibrated as required?

Table A.1 (Continued)

Project _____ Site Manager _____
 Site Location _____ Field Team Leader _____
 Auditor _____ Date _____

Audit Question Yes No Comment/Documentation

- 21. Have any procedures been revised?
- 22. Are revisions to procedures adequately documented?
- 23. Was the document log for chain-of-custody records and other sample traffic control forms maintained?
- 24. Have any accountable documents been lost?
- 25. Did drilling and well construction follow procedures outlined in the sampling plan?
- 26. Were the activities being conducted compatible with the environmental conditions?

2. MATERIALS DESCRIPTION

2.1. PURPOSE

To provide procedures for field descriptions of surficial and bedrock materials.

2.2. RESPONSIBILITY

The Field Team Leader is responsible for describing core and samples following this work procedure

2.3. EQUIPMENT AND MATERIALS

- Log of boring
- Field notebooks
- Clipboard
- Rulers
- Rock-color chart, Geological Society of America
- Waterproof pens
- Colored pencils
- Protractor
- Hand lens
- Dropper bottle of hydrochloric acid
- Rock hammer
- Grain-size chart/scale

2.4. PROCEDURES

(1) All surficial materials and bedrock samples will be described using the following sequence of parameters:

- Footage
- Sample type
- Percent recovery
- General material type
- Color
- Structural characteristics
- Grain sizes
- Composition of grains
- Degree of sorting
- Grain shapes
- Minor characteristics

- Degree and nature of cementation
- Moisture content

Procedures for describing each of these parameters are presented below

- (a) Footage: Depth of sample interval.
- (b) Sample Type: Continuous drive, cuttings, core, or split spoon.
- (c) Percent Recovery Percent of sample recovered from borehole
- (d) General Material Type Clay, clayey sand, sandy clay, Silt, sand, gravel, sand and gravel, shale, sandstone, or siltstone
- (e) Color: Color of samples will be described by comparing samples with a standard color chart. Either a Munsel soil color chart or USGS standard color chart will be used. Colors will be described from moistened samples. Any color abbreviations shall follow those set by the standard color chart used.
- (f) Structural Characteristics: This parameter describes bedding and other primary features of the sample, including: nature of bedding (e.g., massive, tabular, lenticular, laminated, graded, or even), primary features within beds or other structures (e.g., grading, laminations, cross bedding, channeling, distorted flow banding, and inclusions), and characteristic secondary features (e.g., cleavage, prominent weathering effects, and fracturing) (Compton 1962)
- (g) Grain Size Grain sizes will be classified according to the Wentworth scale (Dresser Atlas 1982). The percentage of each grain size will be denoted by the following descriptive terms.

Descriptive Term	Percentage
Trace	1-10%
Some	10-20%
Adjective (sandy, silty, etc.)	20-35%
"And"	35-50%

- (h) Composition of Grains: Composition of grains will be described by using the major or dominant grain component first, followed by

minor component percentages or the appropriate descriptive term (Compton 1962).

- (i) Degree of Sorting: The degree of sorting is a measure of particle size uniformity. It will be visually estimated in the field using sorting charts (Dresser Atlas 1982).
- (j) Grain Shapes (Roundness): Roundness is the degree of a clastic particle abrasion and is reflected in the sharpness of its edges and corners. Grain shapes will be determined visually in the field using grain shape charts (Dresser Atlas 1982).
- (k) Minor Characteristics: Minor and/or unusual characteristics of a sample will be noted in the description including weathering.
- (l) Degree and Nature of Cementation: The degree of cementation will be recorded as uncemented or unconsolidated, poorly cemented or consolidated, or well cemented, based on visual inspection. The nature of calcium carbonate will be determined based on the reaction of samples to dilute hydrochloric acid. The intensity of the hydrochloric acid reaction will be described as no reaction, weak reaction, or strong reaction.
- (m) Moisture Content: A general qualitative description will be used to describe moisture content.

Dry: No discernible moisture present

Damp. Enough moisture present to darken the color of the sample, but does not feel moist to the touch.

Moist. Sample feels moist to the touch.

Wet: Visible water is present.

- (2) Geologic descriptions of core will follow the same procedures as outlined above. Additional records required for core are: the cored (run) interval, the footage of recovered core and percent recovery, and the Rock Quality Designation (RQD) of the cored interval. RQD is the percent of sound core recovered in pieces greater than four inches in length (Deere 1964).

2.5 RECORDS

- Field Notebooks
- Log of Boring

2.6. REFERENCES

Compton, R R., 1962, *Manual of Field Geology*. John Wiley and Sons, Inc., New York, 378 pp

Deere, D U., 1964, *Technical Description of Rock Cores for Engineering Purposes: Rock Mechanics and Engineering Geology*, Vol. 1, pp. 16-22.

Dresser Atlas, 1982, *Well Logging and Interpretation Techniques*. Dresser Atlas, Inc, 228 pp

3. FIELD SCREENING FOR TOTAL ORGANIC COMPOUNDS IN SOIL SAMPLES

3.1. PURPOSE

To field screen soil samples for volatile organic compounds

3.2. RESPONSIBILITY

The Field Team Leader is responsible for field screening of samples following this work procedure

3.3. EQUIPMENT AND MATERIALS

- Field notebooks
- Log of boring
- Adhesive labels
- Waterproof pen
- Sample bottles (500-ml amber glass) with lids
- Photoionization detector (PID)
- Organic vapor analyzer (OVA)

3.4. PROCEDURES

- (1) Approximately 50 to 100 ml of soil will be placed in 500-ml amber glass jars, and an equal amount of deionized water will be added to the jar. The jar will then be shaken and allowed to stand for 30 minutes allowing organic compounds to volatilize.
- (2) The sample jars will be labeled with the date, time, borehole number, sample depth, and Field Team Leader's.
- (3) Field screening of the samples for total organic vapor concentrations will be conducted using an OVA and a PID. The instruments will be calibrated to the volatile organic compounds of concern at each site (Roffman et al. 1986).
- (4) The lid of the sample jar will be opened slightly and the probes of the instruments will be placed inside the jar. Values registered on each instrument will then be recorded in the field notebook. The

date and time of the reading, the borehole number, and the sample depth will also be recorded in the field notebook and log of boring.

3.5. RECORDS

Field notebooks
Logs of borings

3.6. REFERENCES

Roffman, H. K., M. D. Neptune, J. W. Harris, A. Carter, and T. Thomas, Field Screening for Organic Contaminants in Samples from Hazardous Waste Sites, 1986. Abstract from: Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater-Prevention, Detection, and Restoration, Houston, Texas, 8 p.

4. LABELING AND STORAGE OF SAMPLES

4.1. PURPOSE

To provide procedures for labeling and storage of boxed cores and jarred samples.

4.2. DEFINITIONS

- Storage Facility: The location where boxed cores and/or jarred samples will be stored without freezing.

4.3. RESPONSIBILITY

The Field Team Leader is responsible for labeling and storage of all samples.

4.4. EQUIPMENT AND MATERIALS

- Labeling Pens
- Adhesive Labels
- Inventory Sheets
- Field Notebook

4.5. PROCEDURES

- (1) Label core boxes and sample jars in the field as samples are collected. All samples will be labeled with
 - (a) location
 - (b) borehole designation
 - (c) date
 - (d) depth
 - (e) box or jar number
 - (f) total number of boxes or jars for the borehole
 - (g) Field Team Leader initials

Check that all information is correct before leaving the field with samples.

- (2) Transport samples to storage facility.

- (3) Place samples in storage facility. Samples should be stacked in order by hole number and in neat and orderly arrangement for accessibility. All samples from each well should be placed in one location, and the labels should be visible.

4.6. RECORDS

- Field Notebook

5. DECONTAMINATION OF DRILLING, TESTING, AND SAMPLING EQUIPMENT

5.1. PURPOSE

To provide procedures for equipment decontamination.

5.2. DEFINITIONS

Equipment: Augers, drill pipe, bits, sampling devices, tools, tremie pipe, packers, water pipe, geophysical logging equipment, casing, electric well sounders, pumps, and all other miscellaneous equipment used in drilling, sampling, testing, logging, installing, and developing monitor wells.

Decontamination: Decontamination is the process of cleaning equipment to avoid transport of contamination.

5.3. RESPONSIBILITY

The Field Team Leader is responsible for supervising and approving the decontamination cleaning of equipment

The Driller is responsible for cleaning all drilling, sampling and well construction equipment and assisting the geophysicist in cleaning geophysical probes and cables.

5.4. EQUIPMENT AND MATERIALS

- Portable Steam Cleaner
- Brushes and Buckets
- Organic-free Water
- Alkaline Detergent

5.5. PROCEDURES

5.5.1. Drilling and Well Installation Equipment

- (1) Decontaminate all drilling equipment before starting the first borehole.

- (2) Upon termination of a borehole, decontaminate all drilling, packer testing, and geophysical logging equipment as well as stainless steel well casing and screen.
- (3) Decontamination will include:
 - (a) a rinse with the steam cleaner using organic-free water;
 - (b) scrubbing with brushes using a solution of organic-free water and an alkaline detergent, and
 - (c) a final rinse with the steam cleaner using organic-free water.
- (4) Cover drilling equipment with a clean sheet of plastic after it is decontaminated. Install wet casing and screen in the borehole.
- (5) Decontaminate all equipment and tools used in well installation.
- (6) Before moving to the next drill site, decontaminate the wireline cable by pulling it off the drum to the appropriate length. Also decontaminate the rig table and mast.

5.5.2. Sampling Equipment

- (1) Decontaminate all sampling equipment before collecting the first sample and after each sample collected.
- (2) Decontamination will include:
 - (a) scrubbing with brushes using a solution of organic-free water and an alkaline detergent; and
 - (b) a rinse with organic-free water (a steam cleaner may be used)
- (3) Decontaminate the electric well sounder probe and cable before and after measuring water levels.
- (4) Decontaminate pumps and pump line exteriors before and after pumping a monitor well. Decontaminate the internal system of pumps and tubing by pumping at least 1 tubing volume of organic free water through the pump.

(5) Discard bailer rope after each use. Attach new polypropylene rope to the bailer at each well.

5.6. RECORDS

- Field Notebook

8. WELL INSTALLATION

8.1. PURPOSE

To provide procedures for monitor well construction and installation.

8.2. DEFINITIONS

Monitor Well: Two-inch well designed for monitoring water levels and groundwater quality

Alluvial Well Monitor well completed in surficial materials (Rocky Flats Alluvium, colluvium, or valley fill alluvium).

Bedrock Well Monitor well completed in saturated sandstone of the Arapahoe or Laramie Formations.

Piezometers Two-inch well completed in claystone of the Arapahoe or Laramie Formations for monitoring water levels.

8.3. RESPONSIBILITIES

The Subcontractor Site Manager is responsible for selecting completion intervals and well designs. Completion intervals and well designs will be approved by the Rockwell International CEARP Manager prior to well construction.

The Field Team Leader is responsible for supervision and documentation of well completions.

The Driller will assemble and install all materials.

8.4. EQUIPMENT AND MATERIALS

- Schedule 5 Type 316 stainless steel casing
- Schedule 5 Type 316 stainless steel wire wrap screen
- Type 316 stainless steel centralizers
- Bentonite pellets
- Appropriate filter pack
- Neat Type I or II Portland cement

- Concrete mix
- Organic-free water
- Five-gallon buckets
- Tremie pipe
- Hoses and pump
- Shovel
- Trowel
- Protective surface casing
- Padlock
- 100-ft tape measure divided in tenths of a foot with a weight on the end
- Electric well sounder
- Well construction summary data sheets
- Field notebook

8.5. PROCEDURES

- (1) Pull all augers and drill pipe from borehole. If borehole stability is a problem, the wells may be completed inside the hollow stem augers.
- (2) Decontaminate drilling equipment and casing.
- (3) Measure depth to water and design well construction.

Alluvial Wells The screened interval in alluvial wells will extend from approximately 1 ft below the top of bedrock to 2 to 5 ft above the water table. A filter pack designed for the grain size of the formation will be placed around the screened interval and will not extend more than 2 ft above the top of the screened interval. A 1-ft-thick bentonite seal will be placed above the filter pack, and the annulus will be tremie grouted with neat Portland Type I or II cement to the surface. Cement may be poured from the surface if the cemented interval is within 5 ft of the surface. A locking steel protective casing will be placed over the well, and a concrete surface pad, approximately 3 ft in diameter, will be poured around the surface casing. The pad will be sloped so as to drain away from the well.

Bedrock Wells Bedrock monitor wells will be screened across the entire interval of saturated sandstone with a minimum screened interval of 5 ft. Filter pack, bentonite, cement grout, protective casing, and a concrete pad will be placed as described above.

Piezometers. Deep boreholes which do not encounter sufficient sandstone thickness after drilling through 70 ft of claystone with an average hydraulic conductivity of 5×10^{-7} centimeters per second will be completed as piezometers with two-inch, Schedule 80, threaded and flush jointed, polyvinylchloride (PVC) casing. Ten ft of machine slotted casing will be placed at the base of the casing string. The remainder of the well completion will be as discussed above for alluvial monitor wells.

- (4) Calculate the amount of filter pack, bentonite, and cement that will be required for well construction.
- (5) Weld end cap on the bottom of the well screen with a stainless steel welding rod, and thread the casing string together.
- (6) Place centralizer in the center of the screened interval, and determine its location on the casing string to the nearest 1/100th foot.
- (7) Measure the length of the screened interval and the blank casing to the nearest 1/100th ft.
- (8) Measure total depth of the open borehole. If the bottom of the borehole is below the base of the screen, backfill it with bentonite pellets or tremie cement grout to the base of the screen. If the open borehole is backfilled with grout, allow it to set for 24 hours before well completion. Measure total depth of the open borehole again.
- (9) Place casing string in open borehole. Place slip-on cap on top of the casing string. Measure stick up to determine total well depth. Check well design for correct total depth.
- (10) Slowly pour filter pack into borehole annulus, making sure it is evenly distributed around the well casing. Gently shake the casing as filter pack is added to avoid bridging of the filter pack. Measure depth to the top of the filter pack after each bag is added. Make more frequent measurements as filter pack approaches the top of the screened interval.

- (11) Record the final depth to the top of the filter pack on well construction summary sheet. Record amount of filter pack used in the field notebook.
- (12) Pour bentonite pellets into borehole annulus, making sure they are evenly distributed around the well casing.
- (13) Measure depth to the top of the bentonite seal and record on well construction summary sheet. Record amount of bentonite used in the field notebook.
- (14) If the bentonite pellets are above the water table, add 1 to 2 gal. of organic-free water to the hole. Allow the bentonite to swell for approximately 15 minutes before grouting to the surface.
- (15) Mix neat Type I or II Portland cement (as directed by the Subcontractor Site Manager) at a mix ratio of 6 to 9 gal. of water per 94-lb bag of cement.
- (16) Place tremie pipe in borehole annulus and attach appropriate hoses and pump
- (17) Pump grout down borehole annulus. Pour grout from the surface if the cemented interval is within 5 ft of the surface. Record amount of cement used in field notebook.
- (18) Measure final stick-up of well casing and record on well construction summary sheet
- (19) Set protective surface casing over stainless steel well casing.
- (20) Allow grout to set for 24 hr.
- (21) Place form for concrete surface pad around well casing.
- (22) Mix concrete and pour surface pad around well casing. Slope pad away from the well with a trowel.
- (23) Weld well number on protective surface casing.

8.6. RECORDS

- Well Construction Summary
- Field notebook

9. WELL DEVELOPMENT

9.1. PURPOSE

To provide procedures for well development.

9.2. DEFINITIONS

Well Development: Well development is the process by which fines from the formation and/or filter pack are removed from the vicinity of the well bore in order to increase the efficiency of the well (UOP Johnson Division 1975).

9.3. RESPONSIBILITY

The Subcontractor Site Manager is responsible for determining which method of development will be used. Well development methods will be approved by the Rockwell International CEARP Manager prior to well development.

The Field Team Leader is responsible for well development.

The Driller will be responsible for supplying an air compressor with an air filter if the well is developed by the air lift method.

9.4. EQUIPMENT AND MATERIALS

- Electric well sounder
- Tape measure calibrated in tenths of feet
- Stainless steel pump*
- Air compressor*
- Teflon bailer*
- Bailer rope*
- PVC drop pipe*
- Gasoline powered generator*
- One liter beaker
- Watch
- Calculator
- Well development summary sheets
- Field notebook

*NOTE. The use of these materials will depend on the method of well development selected.

9.5. PROCEDURES

The well will be developed by pumping, bailing, or air-lifting. Pumping is the preferred method of well development and will be used wherever possible. Air-lifting is less desirable because the potential exists for oils from the air compressor to enter the wells, but may be necessary to adequately stress the wells. An air filter will be used if air-lifting is necessary. Bailing is not an efficient method of well development because of the low flow rates induced by bailing. Bailing will only be done in the event of pump failure and to remove sediments in the bottom of the casing.

- (1) Decontaminate all equipment prior to well development.
- (2) Measure the water level in the well.
- (3) Record the water level on the water level data sheet. Record the date, time, well, and development methods on the well development summary sheet.

9.5.1. Pumping

Well development by pumping will be accomplished by means of a two-inch stainless steel piston pump. The pump will be lowered to approximately 1 ft above the bottom of the well. The well will then be pumped until ten casing volumes of water have been removed from the well, until the well water is clear, or until 4 h have elapsed. The pump will be raised 2 ft at periodic intervals until the entire screened interval is developed.

9.5.2. Air Lifting

Well development by air lifting will be accomplished by using an air compressor and 1-in. PVC air line. An air filter will be attached to the air line from the air compressor to prevent the introduction of compressor oils or other foreign materials into the well.

The 1-in. PVC air line will be lowered until within approximately 2 ft of the bottom of the well. The air line from the air compressor will then be attached to the top section of PVC pipe. The well will then be developed by the introduction of

compressed air into the well for approximately fifteen minutes, or until a column of water is removed from the well. The well will then be allowed to recover and another column of water discharged to the surface. This process will be repeated until 10 casing volumes of water have been removed from the well, until the produced water is clear, or until 4 h have elapsed. At periodic intervals, the air line will be raised 2 ft until the entire screened interval is developed.

9.5.3. Bailing

Well development by bailing will be accomplished using a Teflon bailer and small diameter polypropylene bailing rope. Water, formation and/or filter pack materials will be removed from the well by bailing until 10 casing volumes of water have been removed from the well, until the well water is clear, or until 4 h have elapsed. The bailing rope will be discarded following well development.

9.6. RECORDS

- Well development summary sheets
- Field notebook

9.7. REFERENCES

Johnson, E. E., Inc., *Groundwater and Wells - A Reference Book for the Water-Well Industry*, 1980, Johnson Division, UOP, Inc, Saint Paul, Minnesota, 440 p

11. WELL PURGING

11.1. PURPOSE

To provide procedures for well purging.

11.2. DEFINITIONS

Casing Volume: The casing volume is the volume of water standing inside the casing, i.e., the distance between the water level and the bottom of the casing (length of the water column in the well) multiplied by the inner cross-sectional area of the casing

Well Purging: Purging is the removal of sufficient water from the well so that representative formation waters enter the well and can be sampled. Purging will consist of removing three casing volumes.

11.3. RESPONSIBILITY

The Subcontractor Site Manager is responsible for selecting well purging methods. Well purging methods will be approved by the Rockwell International CEARP Manager prior to purging.

The Field Team Leader is responsible for purging wells prior to sampling

11.4. EQUIPMENT AND MATERIALS

Wells will be purged using dedicated bladder pumps, dedicated Teflon bailers, or portable sampling pumps. Because of the various purging methods, some or all of the following equipment will be needed.

- Bladder pump
- Oil-less air compressor
- Stainless steel piston pump
- Polypropylene rope
- Large container of known volume
- Deionized water
- Watch
- Calculator

- Pencil
- Field Water Quality Data Sheet
- Field notebook

11.5. PROCEDURES

11.5.1. Calculations

- (1) Calculate the casing volume using the formula

$$\text{Casing volume (gallons)} = (\text{TD} - \text{WL}) \cdot (\text{A}),$$

where

TD	=	total depth of the well from ground surface (ft),
WL	=	depth to water from ground surface (ft),
A	=	cross sectional area of the well (gallons/ft),
	=	0.163 for a 2-in. well,
	=	0.367 for a 3-in. well,
	=	0.652 for a 4-in. well, and
	=	1.468 for a 6-in. well.

Note that total depth and depth to water must be measured from the same datum. The total depth of the casing is usually reported as depth below ground surface and the depth to water is measured from the top of the inner casing. In order to correct the depth to water measurement, subtract the height of casing above ground from the depth to water measured from the top of casing.

- (2) Multiply the casing volume by three. This is the volume of water to be purged.
- (3) Record calculations in the field notebook and on Field Water Quality Data Sheet.

11.5.2. Purging

Remove three casing volumes of water from the well using the pump, the dedicated Teflon bailer, or the portable sampling pump. Regardless of the methods used to purge the well, record the total volume purged and the time when purging begins and ends.

Dedicated Pump System. The dedicated pump system will consist of an air-actuated bladder pump with downward flow checking valves on the inlet to the inside of the bladder and on the tubing above the outlet from the inside of the bladder. Air is delivered to the outside of the bladder and pressure is maintained long enough that the bladder is compressed and water inside it is forced into the discharge tubing. Water is kept from exiting the bottom of the pump by the lower check valve. The air pressure is vented to surface through the same pressurizing tube (requiring a time dependent on length of tubing, required air pressure, and depth of submergence of the pump). Water forced into the discharge tubing is held by the upper check valve. The cycle is repeated until discharge reaches the surface and purging begins. Because of this pumping mechanism, the discharge is delivered to the surface in cyclic slugs, but the pressurizing air is never in contact with the water.

The upper check valve has a small-diameter bypass so that water in the discharge tubing will drain back into well and not freeze.

- (1) Attach compressor to Pump Pressure Inlet on controller (use oil-less compressor to protect pneumatic logic components inside controller).
- (2) Connect red air hose between well cap and Pump Supply on controller.
- (3) Position Refill and Discharge knobs to center position (12 o'clock) and start compressor. Record the time at the start of pumping in the field notebook.
- (4) Set gas pressure level to a pressure sufficient to lift the column of water in the discharge tubing plus 30 psi, but do not exceed 125 psi total.
- (5) Adjust Discharge knob so that venting occurs at the end of the slug discharge.
- (6) Decrease Refill cycle time until volume discharged in each cycle begins to decrease. If decrease is immediate, lengthen both Refill and Discharge cycle times and repeat steps 5 and 6.
- (7) Measure volume produced in a container of known volume (e.g., plastic trash can or plastic bucket).

- (8) Continue pumping until the appropriate volume has been purged. Record time at end of pumping as well as the total volume pumped in the field notebook and on the Field Water Quality Data Sheet.
- (9) Measure and record water level at the end of pumping.

Bailing

- (1) Put on surgical gloves. New cotton gloves may be worn over the surgical gloves if desired.
- (2) Place a sheet of plastic over the casing. Cut a hole in the plastic for the casing and spread sheet on ground around the well. The plastic and equipment should be arranged in such a manner to enable the samplers to do all work while standing on the plastic.
- (3) Attach new polypropylene rope to bailer inspect the check valve, top bail, knot, and rope. Do not allow bailer or rope to contact anything but clean plastic. If any components are loose or damaged, replace them. Decontaminate equipment if any new parts are used.
- (4) Lower bailer into well, fill with water, and hoist to surface, coiling the rope into the hands.
- (5) Empty bailer into a container of known volume (e.g., 5-gal. bucket).
- (6) Continue bailing until appropriate volume has been purged, as determined by volume in container.
- (7) Record volume purged in the field notebook and on Field Water Quality Data Sheet.

Portable Pump

- (1) Decontaminate the pump and sufficient tubing by scrubbing with an alkaline detergent solution followed by a deionized water rinse. Pump at least one tubing volume of deionized water through the pump.

- (2) Place decontaminated pump approximately 1 ft above the bottom of the well.
- (3) Place up-hole end of the discharge line in container of known volume (e.g., plastic trash can or 5-gal. bucket).
- (4) Connect compressor to pump controller
- (5) Turn on compressor and pump appropriate volume as measured in container
- (6) Record purged volume on the Field Water Quality Sheet.
- (7) After collecting the sample, decontaminate pump by scrubbing all tubing that has been pulled off the reel and the pump itself with an alkaline detergent solution and rinsing with deionized water. Pump at least one tubing volume of deionized water through the pump

11.6. RECORDS

- Field water quality sampling and analysis form
- Field notebook

11.7. REFERENCES

US Environmental Protection Agency, 1986, *Hazardous Waste Groundwater Task Force Protocol for Groundwater Evaluation*, Office of Solid Waste and Emergency Response, Washington, DC, DIR 9080.0-1

12. GROUNDWATER SAMPLING

12.1. PURPOSE

To provide procedures for groundwater sample collection.

12.2. RESPONSIBILITIES

The Subcontractor Site Manager is responsible for assigning specific wells to be sampled. The sampling schedule will be approved by the Rockwell International CEARP Manager prior to implementation.

The Field Team Leader is responsible for sampling monitor wells, field water quality measurements, and transportation of samples to the onsite laboratory

12.3. EQUIPMENT AND MATERIALS

- Sample bottles provided by on-site laboratory
- Thermometer inscribed in degrees Centigrade
- pH meter
- Portable electrical conductivity meter
- Field notebook

12.4. PROCEDURE

- (1) Pick up sample bottles, cooler, blue ice packs, sample labels, and chain-of-custody form at the laboratory
- (2) Pre-label bottles before leaving the laboratory. Place sample bottles on ice
- (3) Produce the sample with the same device used to purge the well.
- (4) Collect the sample immediately after purging if possible. If the well is essentially dry after pumping, measure the water level in the well on a periodic basis (approximately every three hours). Collect the volatile organic samples within three hours of purging. Collect the rest of the samples as soon as there is sufficient volume in the well to sample as soon as there is sufficient volume in the well to fill the sample bottles (approximately 4

gallons). Attempt to collect an aliquot for field tests and laboratory analysis (in that order) 24 hours after purging even if there is insufficient water in the well to fill all sample bottles.

- (5) Produce sufficient sample for performance of four field water quality tests (two 500 milliliter beakers - one for temperature and conductivity and one for pH). Perform one field water quality test before sampling, two during sampling, and one after sampling following procedures in this document.
- (6) Rinse each bottle with formation water directly from the pump discharge or bailer. Fill the bottle about one-quarter full, cap the bottles, and rinse both bottle and cap with a swirling motion. Discard rinse water. Immediately fill bottle with sample, cap, complete label, rinse bottle exterior with deionized water, place in plastic bag, and return bottle to cooler. Remove only one bottle from the cooler at a time for filling.
- (7) After rinsing the volatile organics vials and caps with sample, fill each vial to overflowing with sample. Carefully place the cap on the vial so that air is not captured, and tighten. Invert the vial and tap lightly. If bubbles are observed, repeat the process.
- (8) Record time of sampling on Field Water Quality Sheet and in field notebook. Also note weather conditions and any other observations (e.g., insufficient sample to fill all bottles, bottles broken, etc.).
- (9) Complete chain-of-custody form and indicate analyses to be performed in the laboratory.
- (10) Deliver samples to the on-site laboratory within 3 hours of collection for filtration and/or preservation of appropriate bottles.

12.5. RECORDS

- Field water quality and analysis sampling form
- Field notebook

12.6. REFERENCES

U.S. Environmental Protection Agency, 1986, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*, Office of Solid Waste and Emergency Response, Washington, D.C.

13. FIELD MEASUREMENTS

13.1. PURPOSE

To provide procedures for field measurements made at the site of monitor wells and surface water stations.

13.2. DEFINITIONS

Field Measurements: These measurements consist of temperature, pH, conductivity, dissolved oxygen, organic vapors, and qualitative observations of color and odor

13.3. RESPONSIBILITY

The Field Team Leader is responsible for measurement of field parameters.

13.4. EQUIPMENT AND MATERIALS

The equipment used for field measurements has been selected based on proven durability in field applications; however, field equipment is still rather fragile. Equipment should be kept spotlessly clean at all times and protected from temperature extremes. Conductivity meters and pH meters will be calibrated daily following the manufacturers' instructions. All other instruments will be calibrated weekly. Each instrument will have its own calibration log book, and all calibrations will be documented. The following equipment is normally used:

- Thermometer inscribed in degrees Centigrade
- pH Meter - with calibration buffer solutions
- Portable electrical conductivity meter - with calibration
- Standard solutions
- Photoionization Detector (PID)
- Organic Vapor Analyzer (OVA)
- Deionized water
- Pencil
- Field Water Quality Sheets
- Field notebook
- Calibration notebooks

13.5. PROCEDURE

13.5.1. Temperature Measurement

Immerse the thermometer bulb in a beaker filled with sample. Make the measurement immediately after sampling so that the temperature will not have time to change. Read the thermometer while it is still immersed, to the nearest degree Centigrade, and record the reading in the field notebook and on the Field Water Quality Data Sheet. Rinse the thermometer with deionized water and put it away.

Calibrate the thermometer on a weekly basis against a National Bureau of Standards certified thermometer. Document calibrations in the calibration log book.

13.5.2 pH Measurement (VWR Scientific 1976)

- (1) Turn on meter.
- (2) Check battery.
- (3) Place partially filled 50-milliliter beakers containing pH 4 and pH 7 buffer solutions into a water bath (well water) to maintain the temperature of the buffers as close as possible to the temperature of the well water. The water bath will need to be refilled periodically with water removed from the well.
- (4) Remove boot from electrode.
- (5) Rinse electrode with deionized water. Be sure any salts are removed.
- (6) Immerse bulb in pH 7 buffer.
- (7) Adjust using calibration knob to read 7.
- (8) Rinse electrode with deionized water.
- (9) Immerse bulb in pH 4 buffer.
- (10) Adjust using temperature knob to read 4 (this is a span adjustment and not a true temperature correction).

- (11) Measure the temperature of the buffers using a thermometer, following the procedures described previously. Be sure to rinse the thermometer with deionized water between solutions.
- (12) Collect some sample in a beaker (rinse the beaker with sample)
- (13) Rinse the thermometer with deionized water, and measure the temperature of the sample. If the buffer solutions are not at the same temperature as the samples, put fresh formation water in the water bath, allow time for temperature equalization, and repeat the calibration procedure.
- (14) Rinse the electrode in deionized water.
- (15) Immerse the bulb in the sample.
- (16) Read the pH to the nearest tenth of a pH unit. Stir the sample with the electrode to hasten reading stability.
- (17) If the pH is greater than 7, re-calibrate using the pH 10 buffer instead of the pH 4. Perform steps 5 through 16 above. If most samples have pH values greater than 7, pH 10 buffer should be routinely substituted for pH 4.
- (18) Record the pH reading on the data sheet and in the field notebook. Document calibrations in the calibration log book.
- (19) Rinse the electrode with deionized water and replace plastic boot.
- (20) Turn off meter.

13.5.3 Conductivity Measurement (YSI 1976b)

- (1) With conductivity meter off, check zero position. Adjust if necessary.
- (2) Switch to red line and adjust.
- (3) Calibrate meter against standard solutions and record calibrations in the calibration log book.

- (4) Collect a sample in a beaker (rinse beaker with sample before collecting)
- (5) Rinse probe with deionized water.
- (6) Immerse probe in the sample.
- (7) Switch to temperature. Record the temperature on Field Water Quality Sheet and in field notebook (may be different from earlier temperature measurement).
- (8) Switch to conductivity and record both the needle reading and scale knob setting. Do not perform any calculations. Record the two values on the Field Water Quality Sheet and in field notebook.
- (9) Turn meter off.
- (10) Remove probe from sample and rinse with deionized water.
- (11) Rinse beaker with deionized water.

13.5.4. Dissolved Oxygen Measurement (YSI 1976a)

- (1) Place meter in intended operating position. Do not move without calibrating.
- (2) With meter off, adjust meter to zero using center screw.
- (3) Switch meter to zero and adjust to zero with zero knob.
- (4) Switch meter to full scale and adjust to "15" on ppm scale using full scale knob.
- (5) Attach probe to the meter and wait 15 min to polarize probe.
- (6) Perform air calibration:
 - Switch to calib O2 position;
 - Place the probe in moist air (small calibration bottle with a few drops of water) and allow 10 min for temperature stabilization (can be same as polarization wait); and

- Set meter to local altitude (6,000 ft amsl) using calib knob -- be sure reading is steady;

Calibrate meter against standard solutions (on a weekly basis). Document calibrations in calibration log book.

- (7) Place probe in sample and stir by raising and lowering the probe about 1 ft per s. Allow probe to equilibrate to sample temperature and dissolved oxygen.
- (8) Turn switch to temp and read temperature from lower scale.
- (9) Set O2 solubility factor dial to observed temperature, using the salinity index scale on the dial (salinity determined using SCT meter - each bar on index represents 5,000 ppm chloride concentration).
- (10) Turn switch to read O2 and read dissolved oxygen value in ppm directly from the meter.
- (11) Turn off meter, rinse probe with deionized water, add a few drops of deionized water to the sponge in the probe holder, and return probe to holder.

13.5.5. Photoionization Detector Measurements (HNU Systems 1975)

- (1) Remove plate on the top half of the case by pulling up on the two fasteners. The extension tube and battery charger are located under this plate.
- (2) Attach extension tube to the end of the probe.
- (3) Check to see if the instrument's function switch is in the "OFF" position.
- (4) Install the 12 pin interface connector for the probe into the connector on the instrument box by carefully matching the alignment key of the probe connector to the slots in the box connector. Twist the connector in a clockwise manner until a distinct snap and lock is felt.
- (5) Check the battery supply by turning the function switch to the "BATT" position. The meter needle should deflect to the far right or well within

the green zone (NOTE: The battery check indicator will not function unless the probe is attached). If the needle is below or just in the green zone or the red LED light is on, the battery should be recharged.

- (6) To zero the instrument, turn the function switch to the "STANDBY" position and rotate the "ZERO" potentiometer until the meter reads zero. This is an electronic zero adjustment. Calibration gases are not needed.
- (7) Turn the function switch to the selected scale. There should be a humming sound emanating from the probe. This is the fan which pulls air into the probe. A blue glow should be seen through the end of the probe. Do not stare at this glow, as it is an ultraviolet light source which can damage the eyes. An overall check can also be done by passing a magic marker past the tip of the probe. This should generate a reading or jump of the needle.
- (8) Place the function switch in the 0 - 20-ppm range for the most sensitive monitoring.
- (9) Before entering a work area, determine the background concentration. This concentration should be used as a reference to readings made in the work area. Under no circumstances should one attempt to adjust the "ZERO" or "SPAN" adjustments while the instrument is being used in the work area (NOTE: When using the 0 - 20 ppm range, background concentrations up to 1.0 ppm are common in clean environments. This reading is generated internally by the instrument and should be referred to as zero ppm)
- (10) Take PID readings in the headspace of a well before making water level measurements. Condensation and dust on the lamp can interfere with proper readings. PIDs do not function well during precipitation events or sudden temperature changes which can fog up the lamp.
- (11) Record all readings in the field notebook.

13.5.6. Organic Vapor Analyzer Measurements (Foxboro Analytical)

- (1) Remove top cover of the instrument.
 - (2) Move the INSTR switch to ON and allow five minutes for warm up
 - (3) Set the audible alarm to a predetermined level by turning the PUMP switch to ON. Adjust the meter pointer to the desired alarm level using the CALIBRATE ALARM (zero) knob. Turn the ALARM LEVEL ADJUST knob on the back of the readout assembly until the audible alarm comes on. Adjust speaker volume with VOLUME knob. The instrument is then preset to activate the alarm when the organic vapor level exceeds that of the setting.
 - (4) Move the CALIBRATE switch to 10X and adjust the meter reading to zero with the CALIBRATE ADJUST (zero) knob.
 - (5) Ensure the PUMP switch is ON and observe the SAMPLE FLOW RATE indicator. The flow rate should be approximately 2 units.
 - (6) Open H2 TANK VALVE one turn and observe the reading on the H2 TANK PRESSURE indicator (approximately 150 psi of pressure is needed for each hour of operation).
 - (7) Open H2 SUPPLY VALVE one-half to one turn and observe the reading on the H2 SUPPLY PRESSURE indicator.
- Caution:** Do not leave H2 SUPPLY VALVE open when the pump is not running, as this will allow hydrogen to accumulate in the detector chamber.
- (8) Confirm that meter is still reading zero (readjust if required).
 - (9) Depress the igniter button. There will be a slight "pop" as the hydrogen ignites, and the meter pointer will move upscale of zero. Do not depress igniter button for more than 6 seconds. If burner does not ignite, let instrument run for several minutes and try again.

- (10) Move instrument to an area representative of the "lowest ambient background concentration" to be surveyed. Move the CALIBRATE switch to 1X and adjust the meter to read 1 ppm with the CALIBRATE ADJUST (zero) knob.
- (11) If the alarm level is to be set above background levels, turn the ALARM LEVEL ADJUST knob on the back of the readout assembly until it activates slightly above background.
- (12) Set the CALIBRATE switch to the desired range.
- (13) Using one hand operation, survey the areas of interest while observing the meter and/or listening for the audible alarm indication.
- (14) Record readings in the field notebook.

13.5.7. Color and Odor

Record any observations regarding the general condition of the samples. Especially note color, turbidity and odor.

13.6. RECORDS

- Field water quality data sheets
- Field notebook

13.7. REFERENCES

Foxboro Analytical Century Systems Portable Organic Vapor Analyzer Instructions and Service Manual.

HNU Systems Inc., 1975, Instruction Manual for Model PI101 Photoionization Analyzer.

VWR Scientific, 1976, Care and Feeding of the Mini and Digital pH Meters, Model 47.

Yellow Springs Instrument Co., 1976a, Instruction Manual, YSI Model 51B Dissolved Oxygen Meter.

Yellow Springs Instrument Co., 1976b, Instructions for YSI Models 33 and 33M S-C-T Meters.

14. WATER LEVEL MEASUREMENTS

14.1. PURPOSE

To provide procedures for measuring water levels in monitor wells and piezometers.

14.2. DEFINITIONS

Electric Water Level Sounder: An electric water level sounder is a device to measure the depth from a reference point (usually top of casing) to the water level in a well. The sounder consists of a two-wire cable on a reel with a double electrode tip. The reel houses a battery and voltmeter (or other device such as a light or buzzer) so that electrical continuity is indicated between the electrodes when submerged. The cable is graduated, indicating the length of cable in the well (Todd 1980).

14.3. RESPONSIBILITY

The Field Team Leader is responsible for water level measurements and accurate recording of data.

14.4. EQUIPMENT AND MATERIALS

- Electric water level sounder
- Deionized water
- Extra batteries
- Tape measure graduated in hundredths of feet
- Watch
- Pencil
- Photoionization Detector (PID)
- Field Water Quality Data Sheet
- Water Level Data Sheet
- Field notebook

14.5. PROCEDURES

- (1) Record well location, identification number, date, time, and Field Team Member initials in field notebook and on data sheets.

- (2) Check headspace of the well for any organic vapors with a PID Record reading in field notebook.
- (3) Decontaminate electrode on sounder and sufficient length of cable by washing with an alkaline detergent solution and rinsing with deionized water so that only clean cable enters the well.
- (4) Turn on sounder, check battery, and lower cable into well until the presence of water is indicated.
- (5) Hold wire so thumb and index finger are touching the top of casing when probe just enters the water (alarm will sound). Use the north rim of the inner casing for the depth to water reference point.
- (6) Raise cable until alarm stops (i.e., probe is just above water level) Lower cable until alarm sound again. Check to see if thumb and index finger are at the same location as before.
- (7) Still holding the cable at the measurement point, pull an arm's length of cable from the well. With other hand, push the zero end of tape measure against thumb, holding the measurement point, and measure distance to the first downhole graduation on the cable. Measure to the nearest 1/100th of a foot.
- (8) Record the time, cable and tape measure readings in the field notebook. Transfer readings to the Field Water Quality Data Sheet and the Water Level Data Sheet.
- (9) Coil the downhole cable into hands to minimize contamination of the entire sounder.
- (10) Decontaminate all of the cable that was downhole plus 5 ft by washing with an alkaline detergent solution and rinsing with deionized water. Decontaminate equipment between wells and at the end of each day.
- (11) Wrap sounder in clean plastic after decontaminating.

14.6. RECORDS

- Water level data sheets
- Field notebook

14.7. REFERENCES

Todd, David Keith, 1980, Subsurface Investigations of Groundwater; *in* *Groundwater Hydrology*, Second Edition, John Wiley and Sons, Inc., New York, pp. 434-435

APPENDIX 8

QUALITY ASSURANCE/QUALITY CONTROL
PROCEDURES FOR SOIL CHARACTERIZATION

**DEPARTMENT OF ENERGY
ALBUQUERQUE OPERATIONS OFFICE
ENVIRONMENT, SAFETY AND HEALTH DIVISION
ENVIRONMENTAL PROGRAMS BRANCH**

**COMPREHENSIVE ENVIRONMENTAL ASSESSMENT
AND RESPONSE PROGRAM**

**PHASE 2:
ROCKY FLATS PLANT
INSTALLATION GENERIC MONITORING PLAN
(Comprehensive Source and Plume Characterization Plan)**

QUALITY ASSURANCE/QUALITY CONTROL PLAN

February 1987

DRAFT

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QUALITY ASSURANCE/QUALITY CONTROL PLAN

1. INTRODUCTION

CEARP Phase 2 consists of CEARP Phase 2a, Monitoring Plan, and CEARP Phase 2b, Site Characterization (Remedial Investigation). This Quality Assurance Quality Control (QA/QC) Plan is one component of the Monitoring Plan for Rocky Flats Plant. The Monitoring Plan typically consists of five parts: Synopsis, Sampling Plan, Technical Data Management Plan, Health and Safety Plan, and Quality Assurance/Quality Control Plan. Because of the Compliance Agreement made by the State of Colorado, Environmental Protection Agency, and the DOE, this Monitoring Plan also includes a Feasibility Study Plan. The Synopsis provides a discussion of the current situation and serves as an introduction to the other plans.

CEARP uses a three-tiered approach in preparing the monitoring plans: the CEARP Generic Monitoring Plan (CGMP) (DOE, 1986b), the Installation Generic Monitoring Plan (IGMP), and the Site-Specific Monitoring Plans (SSMPs). The CGMP Quality Assurance/Quality Control (QA/QC) Plan provides the generic guidelines and procedures that will be employed during CEARP Phase 2 site characterization (remedial investigation) to ensure the reliability of data collected at CEARP sites. It is intended to establish a general quality assurance/quality control policy and to provide the framework for more specific quality assurance/quality control requirements to be employed at each installation and at each site. This IGMP Quality Assurance/Quality Control Plan provides installation generic information and procedures, whereas the SSMPs will provide site-specific detail regarding locations, types and number of samples.

This IGMP is the Comprehensive Source and Plume Characterization Plan required by the Compliance Agreement. Therefore, the acronym used to refer to this plan is IGMP/CSPCP.

According to DOE policy, DOE activities shall maintain programs of quality assurance (DOE Order 5700 6B). In the area of environmental protection, quality assurance plans must be integrated with the DOE implementation of CERCLA (DOE Order 5480 14).

CEARP Phase 2b site characterizations (remedial investigations) will be implemented using procedures to assure that the precision, accuracy, completeness, and representativeness of data are known and documented. At a minimum, this will include adherence to the CEARP CGMP, IGMP/CSPCP, and SSMP Quality Assurance/Quality Control Plans, and may include preparation of written Quality Assurance/Quality Control Plans covering each aspect of the project performed.

This IGMP/CSPCP Quality Assurance/Quality Control Plan presents the organization, objectives, functional activities, and specific quality assurance and quality control activities associated with the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. The Quality Assurance/Quality Control Plan is designed to achieve specific data quality goals for CEARP Phase 2b site characterizations (remedial investigations). Appendix A includes the quality assurance protocols for all laboratory services to be provided under CEARP Phase 2b site characterizations (remedial investigations).

A brief description of the CEARP Phase 2b site characterization (remedial investigation) and background can be found in the Synopsis. For a more in-depth background description, see the CEARP Phase 1 report.

2. PROJECT ORGANIZATION AND RESPONSIBILITY

Project organization and responsibility are divided among DOE, Los Alamos National Laboratory, and Rockwell International as described below. Los Alamos National Laboratory has the primary responsibility to implement CEARP under the guidance of DOE-Albuquerque Operations Office. However, operational responsibilities have been assigned to Rockwell International at Rocky Flats Plant for the site characterizations (remedial investigations). The DOE-Rocky Flats Plant Area Office is responsible for the function of the Rocky Flats Plant. Because of this responsibility, the DOE-Rocky Flats Plant Area Office will provide additional guidance to its contractor, Rockwell International, in implementation of the CEARP Phase 2b site characterizations (remedial investigations).

Project organization is shown in Figure 2.1. The responsibilities of the various personnel can be divided into operational, laboratory, and quality assurance responsibilities, as follows:

2.1. OPERATIONAL RESPONSIBILITIES

Assistant Secretary for the Environment The DOE Assistant Secretary for the Environment appoints Headquarters investigation boards and establishes the scope of Headquarters investigations (DOE Order 5484.1). DOE-wide Environmental Surveys and Audits originate from the Assistant Secretary.

Environmental Surveys and Audits Headquarters Environmental Survey Teams have been directed to conduct one-time environmental surveys and sampling of DOE facilities. These surveys are independent of CEARP activities at Rocky Flats Plant, but data from survey team sampling will be utilized in the CEARP characterization of Rocky Flats Plant. A Headquarters environmental survey team visited the Rocky Flats Plant site in 1986. The results of the survey will be used as an internal management tool by the Secretary and Undersecretary of DOE.

Audits are a function of the Office of the Assistant Secretary for the Environment. Audit teams provide quality control for the implementation of environmental monitoring at DOE facilities. Although independent of CEARP, audit teams complement CEARP activities by providing additional quality assurance.

DOE-Albuquerque Operations Office Environmental Programs Branch The DOE-Albuquerque Operations Office, Environmental Programs Branch, is responsible for overseeing all environmental programs within DOE-Albuquerque Operations and conducting special assessments such as CEARP

DOE-Rocky Flats Area Office The DOE Rocky Flats Area Office is responsible for the missions of the Rocky Flats Plant, including environmental protection. The DOE Rocky Flats Area Office oversees the integration of Rocky Flats Plant resources with CEARP activities at Rocky Flats Plant

Rockwell International Rockwell International, as prime contractor to DOE, provides support to DOE in accomplishing the mission of Rocky Flats Plant, including environmental protection. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant

Los Alamos National Laboratory Los Alamos National Laboratory manages the CEARP program, providing direction, oversight and review, and preparing final reports

2.2. ANALYTICAL LABORATORY RESPONSIBILITIES

Analytical laboratory responsibilities include performing analytical services, and providing quality assurance. Rockwell International will perform the CEARP Phase 2b site characterizations (remedial investigations) at Rocky Flats Plant. This IGMP/CSPCP provides guidance for quality assurance programs to be implemented by

- field laboratory operations
- analytical laboratories
- geotechnical laboratories
- radiological laboratories

2.3 QA RESPONSIBILITY

Quality assurance responsibilities are to monitor and review the procedures used to perform all aspects of site characterizations (remedial investigations), including data collection, analytical services, data analysis, and report preparations. Primary responsibility for project quality rests with the Rockwell International CEARP Manager. Ultimate responsibility for project quality rests with DOE.

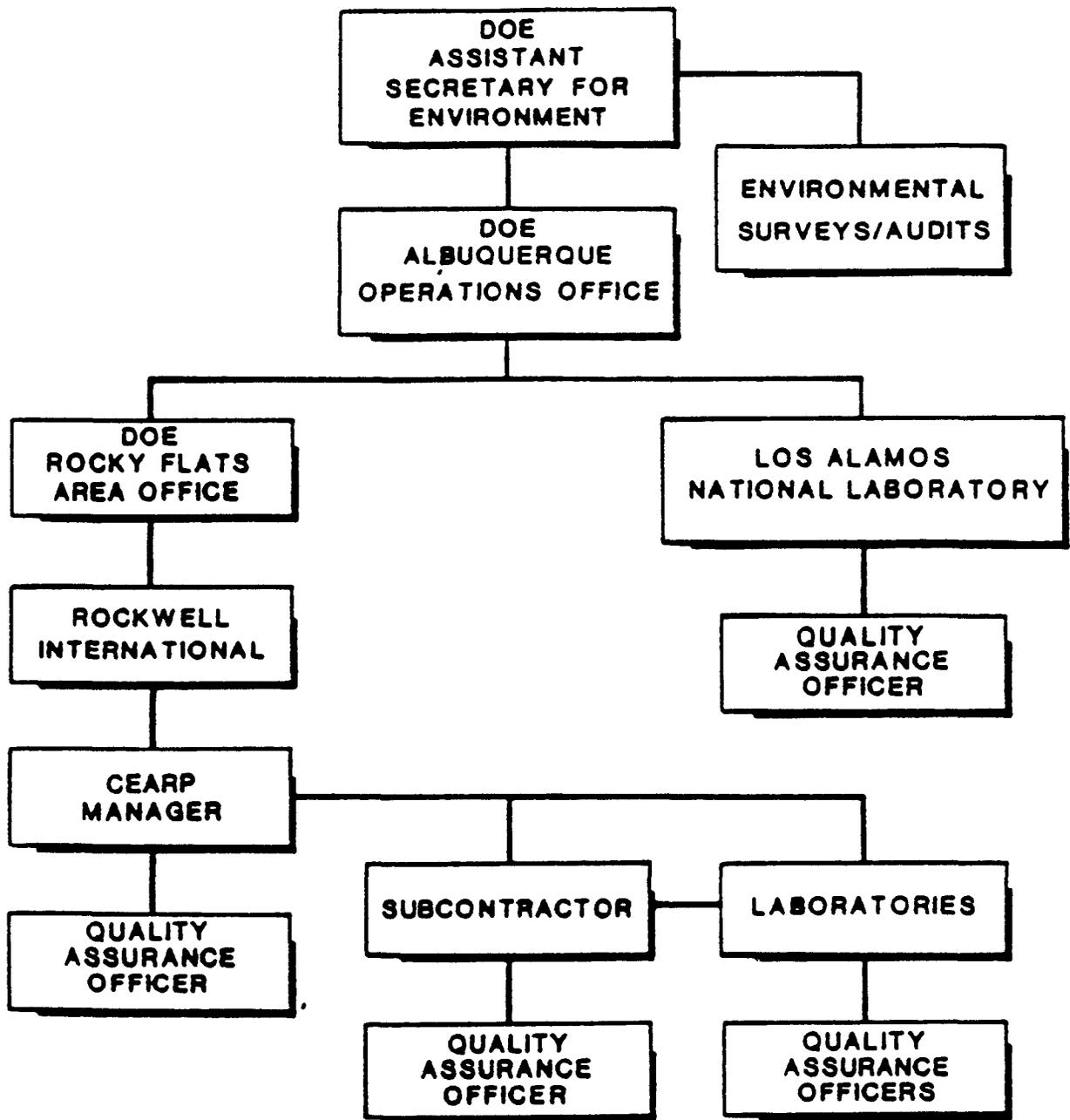


Figure 2.1 Quality Assurance/Quality Control Organization Chart.

3 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall quality assurance objective is to develop and implement procedures for field sampling, field testing, chain of custody, laboratory analysis, and reporting that will assure quality as specified in DOE orders governing quality assurance and environmental protection. Specific procedures to be used for sampling, chain-of-custody, audits, preventive maintenance, and corrective actions are described in other sections of this IGMP Quality Assurance/Quality Control Plan. The purpose of this section is to define quality assurance goals for accuracy, precision and sensitivity of analysis, and completeness, representativeness, and comparability of measurement data from all analytical laboratories. Quality assurance objectives for field measurements are also discussed.

For some field activities, samples will not be collected, but measurements will be taken where quality assurance concerns are appropriate (e.g., field measurements of pH, temperature, and elevations). The primary quality assurance objective in activities where samples are not collected is to obtain reproducible measurements to a degree of accuracy consistent with their intended use and to document measurement procedures.

3.1. REGULATORY AND LEGAL REQUIREMENTS

Data used to evaluate compliance with the National Interim Primary Drinking Water Standards, State of Colorado water-quality standards, or water-quality criteria for agricultural or industrial use will have method detection limits as specified by the analytical method used, as appropriate.

3.2. LEVEL OF QUALITY ASSURANCE EFFORT

Field duplicates, field blanks, and trip blanks will be taken and submitted to the analytical laboratories to provide a means to assess data quality resulting from field sampling. Duplicate samples will be analyzed to check for sampling reproducibility. Field and trip blanks will be analyzed to check for procedural contamination and/or ambient site conditions that are causing sample contamination. Trip blanks will be analyzed to check for contamination during packaging and shipment.

Because volatile organic compounds are a class of contaminants most likely to be introduced to the sample by the sample container, there will be one trip blank per batch of samples designated for volatile organic compound analysis (shipping container). There will be one duplicate and one field blank for every 10 investigative samples collected. For laboratory organic analysis, matrix spikes and matrix spike duplicates will be used. The general level of quality assurance effort for organic analysis will be one matrix spike and one matrix spike duplicate prepared for every 20 samples of similar concentration and/or similar sample matrix, whichever is greater. In addition to field check samples, water samples of known concentration traceable to either EPA or NBS standards will be prepared for inorganic and radiological analyses. The general level of quality assurance effort for inorganic analyses will be one duplicate known sample and one duplicate field sample for every 10 investigative samples to check analytical reproducibility.

Soil samples selected for geotechnical testing will include one field duplicate for each 20 analyses being performed, if possible, but will not include blanks.

The groundwater, surface water, and soil samples collected at Rocky Flats Plant during CEARP Phase 2 will be analyzed using the analytical methods specified in Tables 3.1, 3.2, 3.3, and 3.4. The level of laboratory quality assurance effort will correspond to the procedures outlined in Appendix A.

3.3. ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSES

The fundamental quality assurance objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the quality control acceptance criteria of the analytical protocols. Sensitivities required for analyses of radionuclides, organics, metals, and other inorganic compounds, in both aqueous and solid matrices will be the detection limits shown in Tables 3.1, 3.2, 3.3, 3.4, 3.5, and 3.6. Achieving these detection limits depends on the sample matrix. Highly contaminated samples requiring dilution will have detection limits higher than those detected.

The accuracy of field laboratory measurements of groundwater and surface water pH will be assessed through pre-measurement calibrations and post-measurement verifications using at least two standard buffer solutions. The two measurements must each be within +0.05 standard units of buffer solution values. Precision will be

assessed through replicate measurements of every tenth sample. The standard deviation of four replicate measurements must be less than or equal to 0.1 standard units (The electrode will be withdrawn, deionized-rinsed and re-immersed between each replicate. The calibration and verification will be done before the first replicate and after the last replicate.) The instrument used will be capable of providing measurements to 0.01 standard units.

The geotechnical and field data will be considered accurate if the quality assurance criteria with respect to equipment, solutions, and calculations are met, and if adherence to appropriate methods can be documented during a systems audit.

3.4. COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

The laboratories will provide data meeting quality control acceptance criteria as described in Appendix A. Laboratories will provide completely valid data (IGMP/CSPCP QA/QC Plan, Section 8), the reasons for any variances from 100 percent completeness will be documented in writing.

3.5. FIELD MEASUREMENTS

Measurement data will be generated in many field activities. These activities may include, but are not limited to, the following:

- using geophysical surveys
- documenting time and weather conditions
- locating and determining the elevation of sampling stations
- measuring pH, conductivity, and temperature of water samples
- qualitative organic vapor screening of solid samples using a photoionization detector (PID) or an organic vapor analyzer (OVA)
- measuring water levels in a borehole or well
- standard penetration testing
- calculating pumping rates
- verifying well-development and presampling purge volumes
- performing hydraulic conductivity tests

The general quality assurance objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data through the documented use of standardized procedures. Procedures for performing these activities and standardized formats for documenting them are presented in the CGMP and IGMP/CSPCP Sampling Plans. These procedures may be incorporated by reference (EPA methods) or included as appendices. Standardized formats for documenting data collection are included in the Technical Data Management Plan.

Table 3 1 Analysis Plan for Aqueous Samples*

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
HSL Volatile	Ref 1	X ³	40 ml vial (2) w/teflon lined silicone rubber septum	40 ml	Cold, 4°C ⁹	14	ug/L
HSL Base/Neutral/Acid ¹	Ref. 2	X ³	Amber G, 1L	1 L	Cold, 4°C ⁹	7/40 ⁷	ug/L
HSL Pesticide/PCB	Ref 3	X ³	Amber G, 1L	1 L	Cold, 4°C ⁹	7/40	ug/L
HSL Inorganic ²	EPA 200.7 ⁸	X ³	P, G, 1L	1 L	pH<2, w/HNO ₃ ⁹	180	ug/L
Cyanide	EPA 335 ⁸	X ³	P, G, 1L	0.5 L	pH>11, w/NaOH ⁹	14	ug/L
pH ⁴	EPA 150 1 ⁸	0.1 pH unit	P, G	N/A	None	Field Meas	pH unit
Sp Conductivity ⁴	EPA 120.1 ⁸	1	P, G	N/A	None	Field Meas.	umho/cm
Temperature ⁴	EPA 170 1 ⁸	0.1	P, G	N/A	None	Field Meas	°C
Diss Oxygen ⁴	EPA 360 1 ⁸	0.5	G	N/A	None	Field Meas	mg/l
TDS	EPA 160 ⁸	5	P, G 1L	0.1 L	Cold 4°C ⁹	7	mg/l
TSS	EPA 160 ⁸	10	P, G 1L	0.1 L	Cold 4°C ⁹	7	mg/l
Total Phosphate	EPA 365 4 ⁸	0.01	P, G 1L	1 L	Cold 4°C, pH<2 ⁹ w/H ₂ SO ₄	28	mg/l

Table 3 1 (Continued)

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
Chloride, Sulfate	EPA 352.2 ⁸ 375.2 ⁸	5	P, G, 1L	1 L	Cold 4°C ⁹	28	mg/l
Carbonate/Bicarbonate ⁵	S M 403 ⁶	10	P, G, 1L	1 L	Cold 4°C ⁹	14	mg/l
Nitrate	EPA 300.0 ⁸	5	P, G, 1L	1 L	Cold 4°C ⁹	2	mg/l
Hexavalent Chromium	S M. 3128 ⁶	0.01	P, G, 1L	1 L	Cold 4°C ⁹	1	mg/l

¹The HSL Base/Neutral/Acid fractions analytical parameters are the HSL semivolatiles.

²Includes Cesium, Molybdenum, Strontium which are non HSL metals.

³See Tables 3 5 and 3.6.

⁴Field Measurements

⁵These are reported as carbonate and bicarbonate alkalinity

⁶Standard Methods for Examination of Water and Wastewater, 15th Edition

⁷7 days to extraction, analysis within 40 days of extraction

⁸Methods for Chemical Analysis of Water and Wastes, 1983, EPA 600/4 79 020.

⁹All samples with the exception of VOA's will be filtered within 4 hours of sample collection, and preservatives added to the filtrate as specified. All samples will be kept at 4°C until delivered to the laboratory.

^{*}The SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples

Method References

- Ref 1 Method 624 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4 82 057 plus additions, 1984
- Ref. 2 Method 625 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4 82 057 plus additions, 1984
- Ref 3 Method 608 "Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water," EPA 600/4 82 057 plus additions, 1984

Table 3 2 Analysis Plan for Soil/Sediment/Waste Samples*

Analyte	Method	Detection Limit	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
HSL Volatile	Ref 2	X ²	40 ml vial (2) w/teflon lined silicon rubber septa	5	Cold, 4°C	14	ug/kg
HSL Base/Neutral/Acid	Ref 3	X ²	Amber G, 1 l	10 30	Cold, 4°C	7/40 ³	ug/kg
HSL Pesticide/PCB	Ref. 4	X ²	Amber G, 1 L	10 30	Cold, 4°C	7/40 ³	ug/kg
HSL Inorganic ¹	Ref 5	X ²	P G, 1 L	200	Cold, 4°C	180	mg/kg
Reactivity	Ref. 6	Ref 8	Amber G	-	Cold 4°C	N/A	ug/l
EP Toxicity	Ref 7	Ref 9	Amber G	100 g	Cold 4°C	N/A	ug/l in leachate
Chloride	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Sulfate	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Nitrate	EPA 300 0 ⁵	60 ug/g ⁶	G, 1 L	20	Cold, 4°C	N/A	mg/kg
Cyanide	Ref 1	X ²	G, 1 L	200	Cold, 4°C	14	mg/kg
Hexavalent Chromium	S M 312b ⁷	1 ug/g ⁶	G, 1 L	100	Cold 4°C	1	mg/kg

¹ Includes Cesium, Molybdenum, and Strontium which are non HSL metals.

² See Tables 3.5 and 3.6

³ Extract within 7 days, analysis within 40 days of extraction

⁴ Reported as dry weight, % moisture reported separately

⁵ Soil/Sediments will be leached with Laboratory Reagent Water (20 g soil to 50 ml water) and water extract analyzed using referenced procedure
⁶ Methods for Chemical Analysis of Water and Wastes, 1983, EPA 600/4 79 020

Procedure reference

Table 3.2. (Continued)

⁶These are estimated detection limits.

⁷Soil/sediment will be leached with Laboratory Reagent Water (5 g soil and 100 ml of water) by shaking for 2 hours, and the water extract filtered and subsequently analyzed. This is in accordance with method 312B in Standard Methods for Examination of Water and Wastewater, 15th Edition.

*The SSMP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

Method References

- Ref. 1. Method 9010 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 2. Method 8240 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 3. Method 8270 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 4. Method 8080 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 5. Method 6010 or 7000 Series Methods - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 6. Method 9010, 9030 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.
- Ref. 7. Method 1310 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised April 1984.

Table 3 3 Analysis Plan for Radiological Analysis for Aqueous Samples

Analyte	Method*	Detection Limits**	Sample Container	Sample Volume	Preservations	Holding Time (days)	Reporting Units
Gross alpha/beta	1,2,3,4,6,7,8,9	Gross alpha = 2pCi/L	P, 1 gal	0.2 L	HNO ₃ to pH <2	180	pCi/L
Tritium	1,2,3,8	400 pCi/L	G, 100 ml	0.008 L	No preservation	NA	pCi/L
Pu 239	10,11	0.3 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L
Am 241	11,12	0.4 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L
Isotopic U	1,3,4,7,8,9	U-233 + 234 = 0.6 pCi/L U 238 = 0.6 pCi/L	P, 1 gal	0.500 L	HNO ₃ to pH <2	180	pCi/L
Sr 90	1,3,4,8	1 pCi/L	P, 1 gal	1.000 L	HNO ₃ to pH <2	180	pCi/L

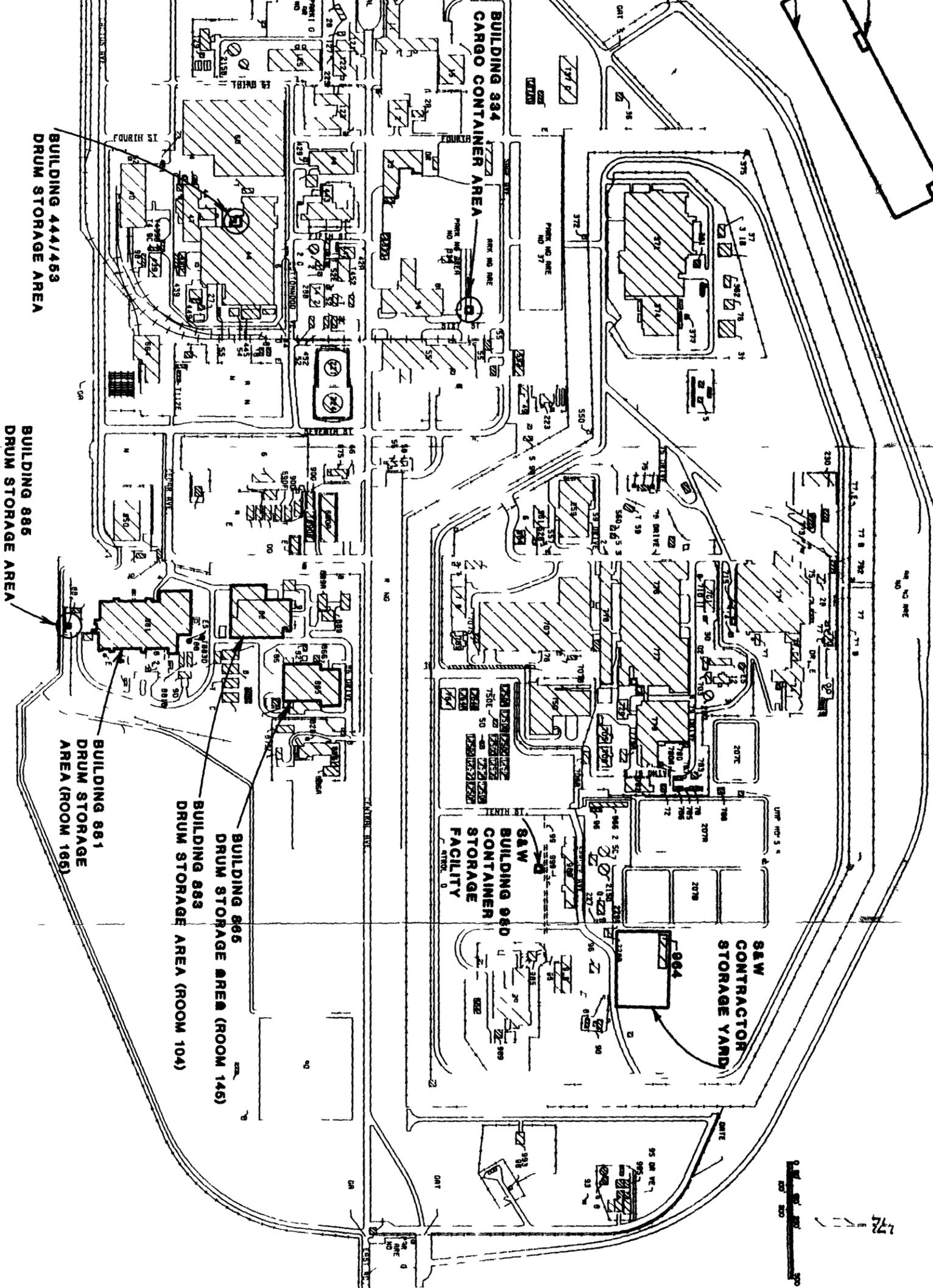
*See Attachment 1
**See Attachment 2

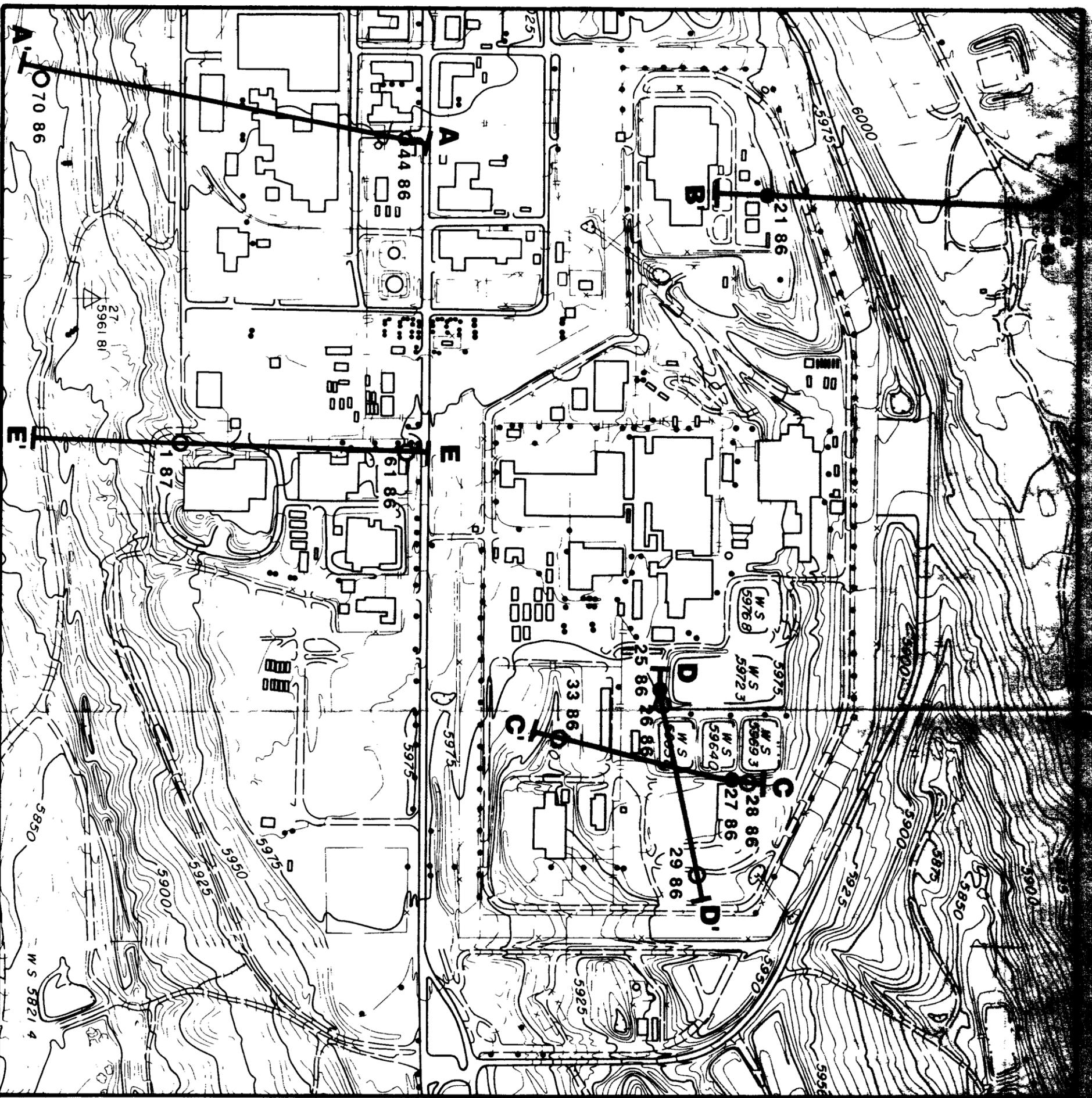
ATTACHMENT I

Method References

- 1 U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No EMSL-LY-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency
- 2 American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985 Standard Methods for the Examination of Water and Wastewater, 16th ed, Washington, D.C., Am Public Health Association
- 3 U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No EPA-600/4-75-008. Cincinnati: U.S. Environmental Protection Agency
- 4 Harley, J. H., ed, 1975, HASL Procedures Manual, HASL-300, Washington, D.C., U.S. Energy Research and Development Administration
- 5 Misaqi, Fazlallah L., Monitoring Radon-222 Content of Mine Waters Informational Report 1026, U.S. Department of Interior, Mining Enforcement and Safety Administration, Denver, CO, 1975
- 6 "Radioassay Procedures for Environmental Samples," 1967, USDHEW, Section 723
- 7 "Handbook of Analytical Procedures," USAEC, Grand Junction Lab 1970, page 196
- 8 "Prescribed Procedures for Measurement of Radioactivity in Drinking Water." EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268
- 9 "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," USGS Book 5, Chapter A5, 1977
- 10 "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979
- 11 "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium and Americium," by E. H. Essington and B. J. Drennon, Los Alamos National Laboratory, a private communication
- 12 "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.

PUAD DUMPSTER STORAGE AREA
PUAD STORAGE YARD
PUAD DRUM STORAGE AREA

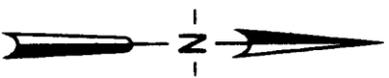




EXPLANATION

- 14 86 Bedrock Well
- 35 86 Alluvial Well

Contour Interval = 5 feet



Scale 1 = 500

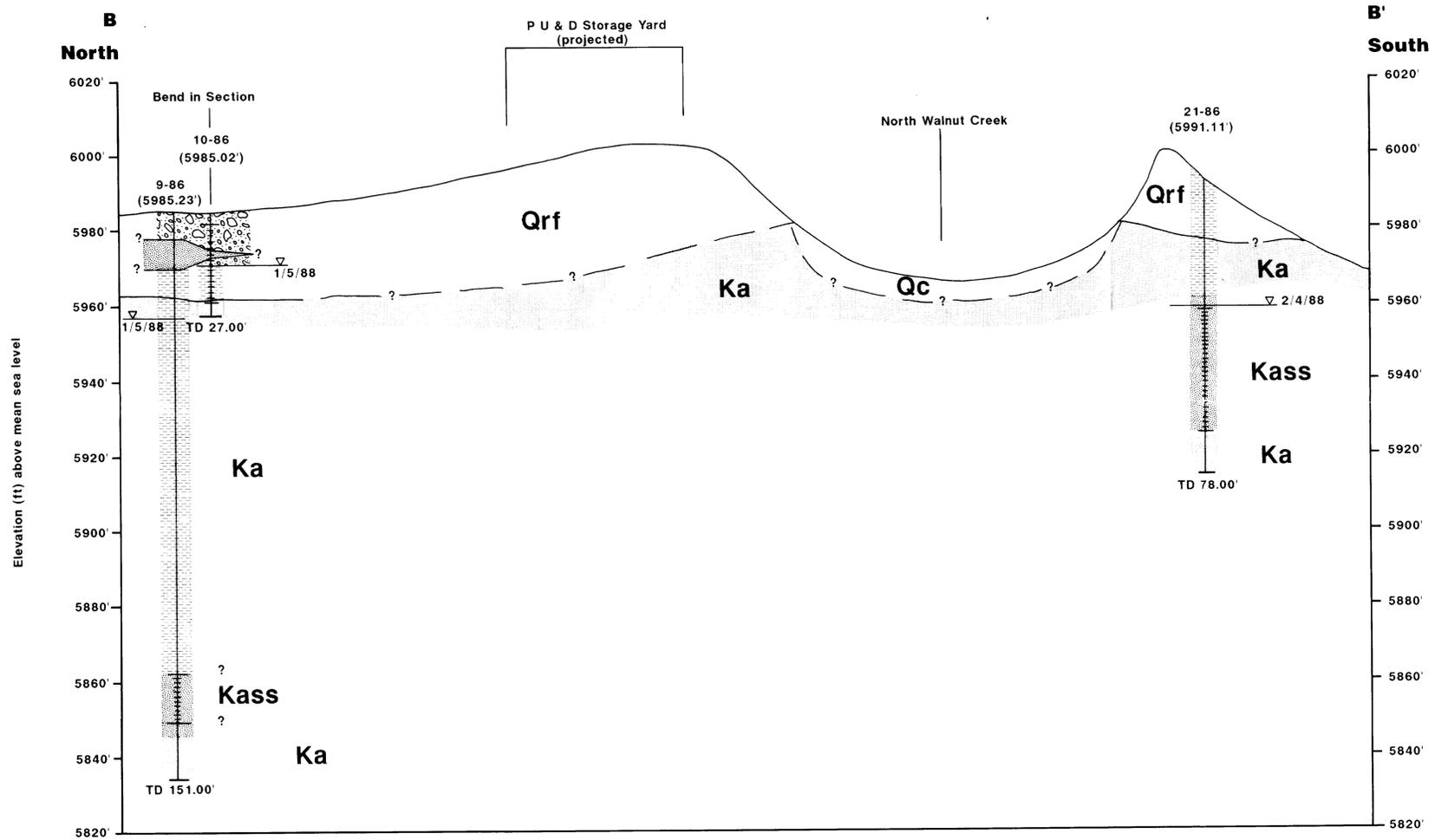
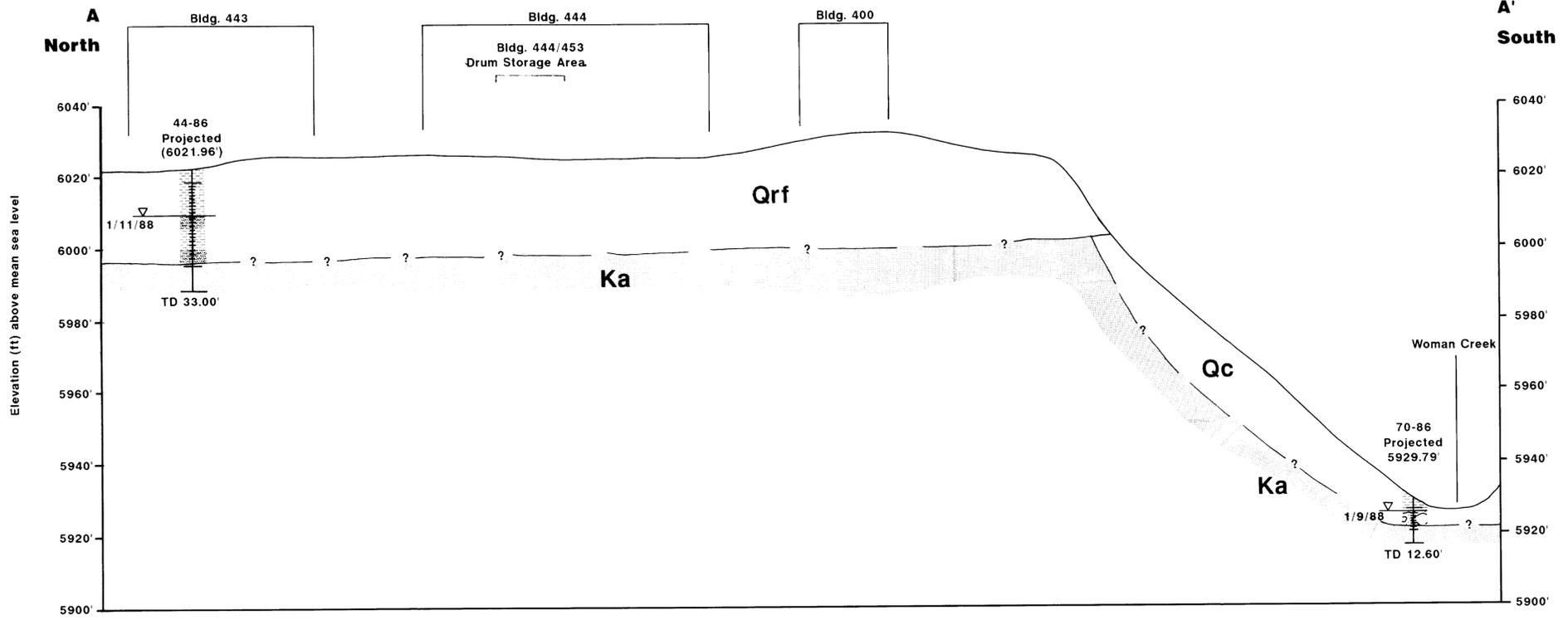


215 Union Boulevard
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ROCKWELL INTERNATIONAL
Rocky Flats Plant
Golden Colorado

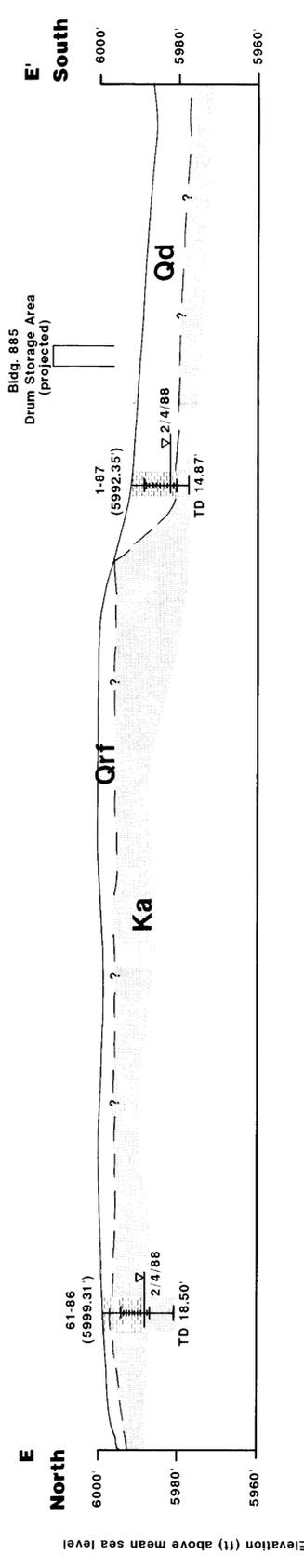
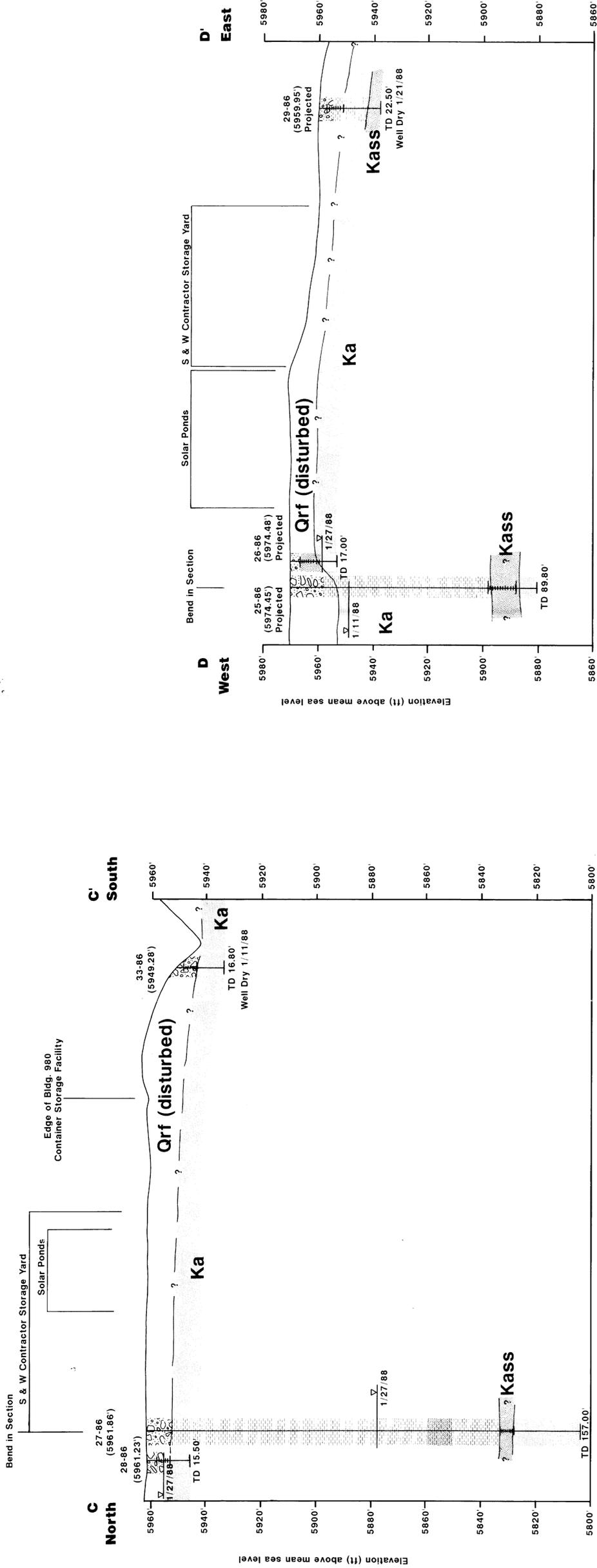
Figure 4

CROSS SECTION LOCATION MAP



EXPLANATION

<p>Scale: 1"=20'</p> <p>0 100</p> <p>Scale: 1"=100'</p> <p>Vertical Exaggeration = 5x</p>	<p>2-87 BH3-87 5930.56'</p> <p>Well/Borehole Identification</p> <p>Ground Surface Elevation (surveyed)</p> <p>Water Level</p> <p>Geologic Contact (Querried where inferred, Dashed where approximately located.)</p> <p>Screened Interval</p> <p>Total Depth Drilled</p>	<p>QUATERNARY</p> <p>Qt Terrace</p> <p>Qd Disturbed Ground</p> <p>Qc Colluvium</p> <p>Qrf Rocky Flats Alluvium</p> <p>Qal Alluvium</p> <p>CRETACEOUS</p> <p>Ka Arapahoe Formation (Claystone)</p> <p>Kass Arapahoe Formation (Sandstone)</p>	<p>Clay</p> <p>Clayey Sand or Sandy Clay</p> <p>Cobbles and/or Gravel</p> <p>Sand and/or Sandstone</p> <p>Sand and Gravel</p> <p>Silt or Siltstone</p> <p>Claystone</p>



EXPLANATION

- QUATERNARY**
- Terrace
 - Disturbed Ground
 - Colluvium
 - Rocky Flats Alluvium
 - Alluvium
 - Arapahoe Formation (Claystone)
 - Arapahoe Formation (Sandstone)
- WELL BOREHOLE IDENTIFICATION**
- Well Borehole Identification
 - Ground Surface Elevation (surveyed)
 - Water Level
 - Geologic Contact (Querried where inferred, Dashed where approximately located)
 - Screened Interval
 - Total Depth Drilled
- CLAY**
- Clay
 - Clayey Sand or Sandy Clay
 - Cobbles and or Gravel
 - Sand and or Sandstone
 - Sand and Gravel
 - Silt or Siltstone
 - Claystone

Scale: 1" = 20'
 Scale: 1" = 100'
 Vertical Exaggeration = 5x