LOGSHEET FOR FIELD CHANGES TO CONTROLLED DOCUMENTS

Change Number	Date	Document Number	Document Title	Section/Page Modified	Description of Change (s)	Resp. Manager Approval	Compliance Approval	ESH&Q Approval	Rad. Eng. Approval	Quality Assurance	Completion of ADM 2.01 Checklist	Completion of SES/USQD Checklist
2	10/18/99	RFI/RIMS-97-084 Rev. 1	Final SAP for the 903 Pad, Lip Area + Am Zone	i, ii, v, 8, 15, 41, 44, 45	Incorporate Agency request to sample Wetland Area in Am Zone adjacent to SW053	S.M. Gar	NA	NA		J.H. Moore	yes	yes

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STANDARD OPERATING PROCEDURES - (Cont.)

NUMBER	PROCEDURE TITLE
1-50000-ADM-12.01	Control of Measuring and Test Equipment
3-21000-ADM-17.01	Quality Assurance Records Requirements
1-C88-WP1027-NONRAD	Non-Radioactive Waste Packaging
1-M12-WO4034	Radioactive Waste Packaging Requirements
4-C77-WO-1101	Solid Radioactive Waste Packaging
1-C80-WO-1102-WRT	Waste/Residue Traveler Instructions
PADC-96-00003	WSRIC for OU Operations, Version 6.0, Section No. 1
1-PRO-079-WGI-001	Waste Characterization, Generation, and Packaging
RMRS/OPS-PRO.064	Pond and Reservoir Bottom Sediment Sampling

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1.0 INTRODUCTION

The purpose of this Sampling and Analysis Plan (SAP) is to estimate the volume of soils exceeding the Rocky Flats Environmental Technology Site (RFETS) Cleanup Agreement (RFCA) Action Level Framework (ALF) Tier I Soil Action Levels or other action levels identified as being protective of surface water for radionuclides and volatile organic compounds (VOCs) at the 903 Drum Storage Area (903 Pad, Individual Hazardous Substance Site [IHSS] 112), the 903 Lip Area (Lip Area, IHSS 155), and the Americium Zone (Figure 1.1). The 903 Pad, Lip Area, and Americium Zone are located in the Buffer Zone Operable Unit (OU). The scope of this SAP also includes the surface soils of OU No.1, 881 Hillside, which have been administratively incorporated into the Buffer Zone OU (DOE, 1995b). The Buffer Zone OU has been designated for restricted open space land use.

In 1996 the Actinide Migration Expert Panel was formed to review existing data on actinide migration at RFETS and make recommendations for future work. Panel recommendations included developing a conceptual model for actinide transport, based on a thorough understanding of chemical and physical processes; investigating the long-term impacts of actinide geochemical mobility on remedial requirements; and evaluating the protectiveness of the RFCA soil action levels to surface water quality. This SAP has incorporated data interpretations from the Actinide Migration Expert Panel presented in the *Summary of Existing Data on Actinide Migration at the Rocky Flats Environmental Technology Site* (DOE, 1997a). Based on modeling currently being performed by the Actinide Migration Expert Panel, revisions to this SAP may be necessary. **However, measurement techniques purported in this SAP provide adequate sensitivity to identify soils exceeding much lower soil action levels than those currently stipulated by RFCA, should the Actinide Migration Expert Panel conclude that soil action levels be lowered to protect surface waters.**

The Americium Zone is defined as the general area located outside the 903 Pad and Lip Area within the RFETS boundaries that have been impacted by past waste disposal and/or cleanup activities associated with the 903 Pad and 903 Lip Area. The Americium Zone exhibits americum-241(^{241}Am) activities above background levels as defined by the *Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program*

west of well 06691 and off the western edge of the 903 Pad. At this location, observed carbon tetrachloride levels ranged from 122 to 4,800 µg/L.

Because of the complex nature of DNAPL transport and fate, DNAPL may often be undetected by direct methods leading to incomplete site assessments and inadequate remedial designs (EPA, 1992). A guide for estimating the potential for a DNAPL source at a site includes assessing if concentrations of DNAPL-related chemicals in groundwater are greater than 1 percent (%) of the pure phase solubility of the DNAPL compound (EPA, 1992).

Table 1.1 provides a comparison of the pure phase aqueous solubility and concentrations of DNAPL compounds detected in groundwater at or near the 903 Pad. The comparison indicates that tetrachloroethene and carbon tetrachloride have been detected in groundwater samples at 10% and 12% of their aqueous solubilities, respectively. Based on the results of this comparison and known historical site uses, there is a high potential for DNAPL and VOC contaminants above the Tier I soil action levels beneath the 903 Pad.

Radionuclide contamination in groundwater was investigated by reviewing groundwater monitoring well sample results from 1991 to 1995. Groundwater in one well, 09091 (Figure 1.2), contains ^{241}Am and $^{239/240}$Pu activity in excess of Tier I action levels for groundwater. Tier I action levels for ^{241}Am and $^{239/240}$Pu are 14.5 pCi/L and 15.1 pCi/L, respectively. Well 09091 has maximum activities of 354.6 pCi/L of ^{241}Am and 46.5 pCi/L of $^{239/240}$Pu. Uranium isotopes have not been detected in excess of their respective background activities in groundwater samples collected over this period.

1.2.4 Surface Water

Radionuclide contamination in surface water was evaluated by reviewing surface water monitoring results from 1989 to 1995 from surface water sampling station SW053, located in the Americium Zone (Figure 1.2). Radionuclide concentrations in surface water from SW053 exceed surface water ALF standards for Woman Creek for total uranium, ^{241}Am, and $^{239/240}$Pu. Exceedances were also observed for the VOCs PCE, TCE, and carbon tetrachloride. However, no sediment or soil samples were collected from SW053 during the previous RFI/RI characterizations. The HPGe *in situ* survey was unable to collect survey measurements in the wetland or the hummocky landslide topography north of the wetland.

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1.3 Geologic Setting and Contaminant Summary

The surficial geology in the Investigation Area consists of Quaternary alluvium, colluvium and slump deposits along with artificial fill, soil and debris deposits, and disturbed soil. The surficial deposits overlie bedrock which consists of weathered claystone and minor bedrock sandstones of the Cretaceous Arapahoe and Laramie Formations. Surficial deposits consist of sandy clay and clayey gravel. Soil developed over the alluvium is rocky and sandy in contrast to the clayey soils developed over the claystone bedrock.

Table 1.1 Comparison of Pure Phase Aqueous Solubility with Concentrations in Groundwater Samples - Selected VOCs

Compound	Pure Phase Aqueous Solubility at 25°C (mg/L)	Highest Concentration Detected in Groundwater (mg/L)	Ratio Groundwater/Aqueous Solubility (%)
Carbon Tetrachloride	793	100.0	12.6
Chloroform	7,920	49.0	0.62
cis-1,2-dichloroethene	3,500	2.9	0.83
Methylene Chloride	13,000	35.0	0.27
Tetrachloroethene (PCE)	200	20.0	10.0
Trichloroethene (TCE)	1,100	4.6	0.42

[1] = EPA, 1996. Soil Screening Guidance: Technical Background Document

Artificial fill is present directly beneath the 903 Pad and on the surface of the Lip Area as a result of previous remediation activities. In November 1968 "slightly contaminated" soil was graded from outside the fence at the 903 Pad into the fenced area to be capped. In September of 1969 a base coarse material (artificial fill) overlay, soil sterilant, and asphalt primer were placed over the 903 Pad as a "containment barrier." The asphalt pad was constructed in October of 1969 and is reportedly 7.6 cm (3 in) thick. The thickness of the base coarse materials beneath the 903 Pad is assumed to be approximately 20 cm (8 in). In February 1970, operations were initiated to apply additional fill (base coarse) over the Lip Area due to surficial radiological contamination. This fill material ranges from 2 cm (0.8 in) to 13 cm (5.1 in) (DOE, 1995a).

The surficial soil contaminants of concern are $^{239/240}$Pu and ^{241}Am (DOE, 1995a). $^{239/240}$Pu is relatively insoluble and tends to be strongly absorbed to fine grained soil particles. The OU2 RFI/RI (DOE, 1995a) states that 90% of the ^{241}Am and $^{239/240}$Pu activities are concentrated in the upper 15 cm (6 in) of the soil. While there is a tendency for ^{241}Am and $^{239/240}$Pu activities to decrease with increasing distance from the source area, isolated areas in the Americium Zone show higher activities than the 903 Pad and Lip Area.

Subsurface soil contaminants of concern include carbon tetrachloride, tetrachloroethene, trichloroethene, ^{241}Am and $^{239/240}$Pu (DOE, 1995a). VOC concentrations observed in groundwater indicate that a DNAPL may be present beneath the 903 Pad area. The exact

Table 3.4 Subsurface Soil - Field Program

Area	Number of Boreholes	REAL Samples	Duplicate Samples	Rinse Samples	Trip Blanks (VOC only)	Total Samples
903 Pad	25 - Radiological Investigation	150	8	8	0	166
903 Pad	12- VOC Investigation	72 (rad) [1] 72 (VOC)[2]	4 4	4 4	0 12 (est.)	80 92
Lip Area	25-Radiological Investigation	100	5	5	0	110
Lip Area	1 - VOC Investigation	6 (rad) [1] 6 (VOC) [2]	1 1	1 1	0 1	8 9
Americium Zone	3-Radiological Investigation	6	1	1	0	8

[1] - Borehole samples collected for radiochemistry during the VOC investigation.
(est.) - estimated
[2] - Boreholes samples collected for VOC analysis during the VOC investigation.
Approximately 373 samples will be collected for radiological screening analysis for Department of Transportation shipping requirements.

Table 3.5 Subsurface Soil - Analytical Program

Analytical Method	Analytes	Container	Preservative	Holding Time
Radiological Screen	Gross Alpha/Gross Beta	125-ml wide mouth glass or poly jar for soil, 40-ml glass for water	None	6 months
Alpha Spectroscopy	Plutonium-239/240, Americium-241, Uranium Isotopes	125-ml wide mouth glass or poly jar for soil, 1-gl poly for water	None for soil, HNO_3 for water	6 months
SW-846 Method 8260A	Volatile Organic Compounds	120-ml capped core, 125-ml wide mouth glass jar. Teflon lined closure.	Cool, 4° C	14 days
SW-846 Method 8260A (DNAPL, Trip and Rinse Blanks)	Volatile Organic Compounds	3 x 40-mL glass, Teflon lined septa cap.	Cool, 4° C HCl, pH<2	14 days

SW-846 (EPA, 1986), Test Methods for Evaluating Solid Waste.

to either a total depth of 0.92 m (3.0 ft) or 0.31 m (1.0 ft) past the depth where the FIDLER indicates less than 5,000 cpm, whichever is greater. Samples will be collected at approximately 15 cm (6 in) intervals below the asphalt or as appropriate to differentiate the sample interval between asphalt, artificial fill material, and natural soils. This will be done to prevent potential

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dilution of the natural soil sample below the artificial fill material. Borings and core will be checked by engineer's tape for total depth and recovery. If necessary the borings will be overdrilled to a depth of 1.2 m (4 ft) to ensure recovery of the suspected contamination interval from 30.5 cm (12 in) to 61 cm (24 in). Samples for radiological screening will be collected as a composite sample from the radiological sample consisting of approximately 60 grams of soil into approximately one half of the 125 ml wide mouth sample jar. The samples will be screened for alpha, beta/gamma, and VOCs using portable field instruments. If VOCs are detected above 10 parts per million by field instrumentation at any sampling location, the VOC subsurface soil sampling program, as described in Section 3.2, will be implemented to characterize contamination at that location.

Subsurface soil samples for radiochemical analysis will also be collected for the VOC subsurface investigation as described in Section 3.2. Soil samples will be collected from 12 initial and approximately eight "step-out" boreholes on the 903 Pad and one borehole east of well 07191 in the Lip Area. Figure 3.4 presents the location of the VOC investigation boreholes. Soil samples for radiochemical analysis will be collected immediately above the interval where the VOC sample is collected.

Lip Area - A total of twenty-five boreholes are proposed to be completed over the Lip Area where artificial fill was placed in 1970 and where surface soils were remediated in 1976, 1978, and 1984. A systemic grid design for sampling the area was chosen as discussed in Section 2.6. Some judgment was used for grid placement, for the purpose of biasing selected nodes within previous soil removal areas. Of the 25 borings, one boring will be completed in the 1976 remediation area, four borings will be completed in the 1978 remediation area, and three borings placed in the proximity of the 1984 remediation area. Up to six additional boreholes may be placed as necessary to complete the grid based on analytical results equal to or greater than Tier I soil action levels.

This sampling program, a systematic grid design, was spaced and superimposed over the area to collect samples of the artificial fill as well as the natural soil underlying the fill material based on the grid (Figure 3.3). Portions of surface soil plots PT015, TP016, PT019, PT020, PT028, and PT029 are located within the Lip Area. Portions of the 903 Pad are located in Plots PT015,

PT016, PT019, PT020 which will be characterized under the 903 Pad subsurface radiological investigation.

Soil borings located in the Lip Area and subsurface soil samples will be collected utilizing Geoprobe® or conventional hollow-stem auguring techniques. Soils will be continuously cored to either a total depth of 0.61 m (2 ft) or 0.31 m (1 ft) past the depth where the FIDLER indicates less than 5,000 cpm, which ever is greater. Samples will be collected at approximately 15 cm (6 in) intervals or as necessary to differentiate the sample interval between artificial fill material and natural soils. This will be done to prevent potential dilution of the natural soil sample below the artificial fill material. Borings and core will be checked by engineer's tape for total depth and recovery. If necessary the borings will be overdrilled to a depth of 0.9 m (3 ft) to ensure recovery of the suspected contamination interval from 15.25 cm (6 in) to 30.5 cm (12 in). Samples for radiological screening will be collected as a composite sample from the radiological sample consisting of approximately 60 grams of soil into approximately one half of the 125 ml wide mouth sample jar. The samples will be screened for alpha, beta/gamma, and VOCs using portable field instruments. Radiological contamination is suspected from ground surface to a depth of 28 cm (11 in) based on the radiological results from Soil Profile Pit TR08.

It should be noted that if subsurface soils in the Lip Area are determined to exceed Tier I soil action levels in areas where artificial has been placed, surface soils will be assumed (for alternative analysis purposes) to also be contaminated and will require the same remedial treatment as the subsurface soils. This assumption is based on operation difficulties associated with the removal of the surface soils without introducing subsurface contaminants to them, and the probability that the surface soils in the Lip Area have been impacted by radionuclides. Detailed surface soil characterization (i.e., HPGe surveys) will not be performed in portions of the Lip Area where subsurface soils are determined to exist above Tier I action levels.

Americium Zone – Surface and subsurface soil samples will be collected in the wetland area of the Americium Zone to determine the depth of radiological contamination associated with the surface water radiological exceedances observed in SW053 (Figure 3.5). Soil borings located in the wetland and soil samples will be collected utilizing slide hammer driver corer as described in RMRS/OPS-PRO-.085, Pond and Reservoir Bottom Sediment Sampling. Soils will be continuously cored to a total depth of 0.46 m (1.5 ft). Samples will be collected at approximately 15 cm (6 in) intervals to a depth of 0.31 m (1 ft).

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3.2 *VOC Investigation*

Investigation of VOC contamination at the 903 Pad will begin with the highest areas of groundwater contamination and in the Lip Area where the anomalous PCE soil gas results, east of borehole 07191, were observed. Figure 3.4 shows the proposed borehole locations for the VOC investigation. Table 3.4 provides the proposed number of boreholes to be completed and the number of samples to be collected by area. Table 3.5 provides the analytical program for subsurface soil samples collected for the VOC investigation.

Subsurface soil sampling at the 903 Pad will be implemented near existing groundwater monitoring wells 06691, and 08891 using an upgradient radial placement geometry with the well location serving as the downgradient location. Boreholes will be located 20 ft to the north, south, and west of well locations 06691, and 08891. Six boreholes will be placed along the west to northwest side of the 903 Pad on the basis of aerial photographs with drum storage and surface staining (Figure 3.4). These locations will utilize the same grid spacing/locations from the subsurface radiological investigation from Figure 3.3. The number of boreholes required to investigate the VOC contamination at the 903 Pad are based on the initial 12 boreholes. Approximately eight additional "step-out" boreholes may be required to characterize contamination at the 903 Pad.

The soil gas anomaly in the Lip Area at the southeast corner of the 903 Pad adjacent to borehole 07191 will be evaluated. One borehole will be spotted with a center 20 ft east and 10 ft south of borehole location 07191. VOC contamination was not detected in subsurface soil samples from borehole 07191.

Boreholes will be advanced from the ground or asphalt surface either to a depth of 0.31 to 0.62 m (1 to 2 feet) below the top of bedrock or 0.31 to 0.62 m (1 to 2 feet) below the vertical extent of VOC contamination (based on field instruments), whichever is greater. Samples will be collected at 1.22 m (4 ft) intervals below ground surface, or at intervals where VOCs are detected with field instrumentation. The VOC sample will be collected from approximately the lower 15 cm (6 in) interval and the radiological sample will be collected from the 15 cm (6 in) interval

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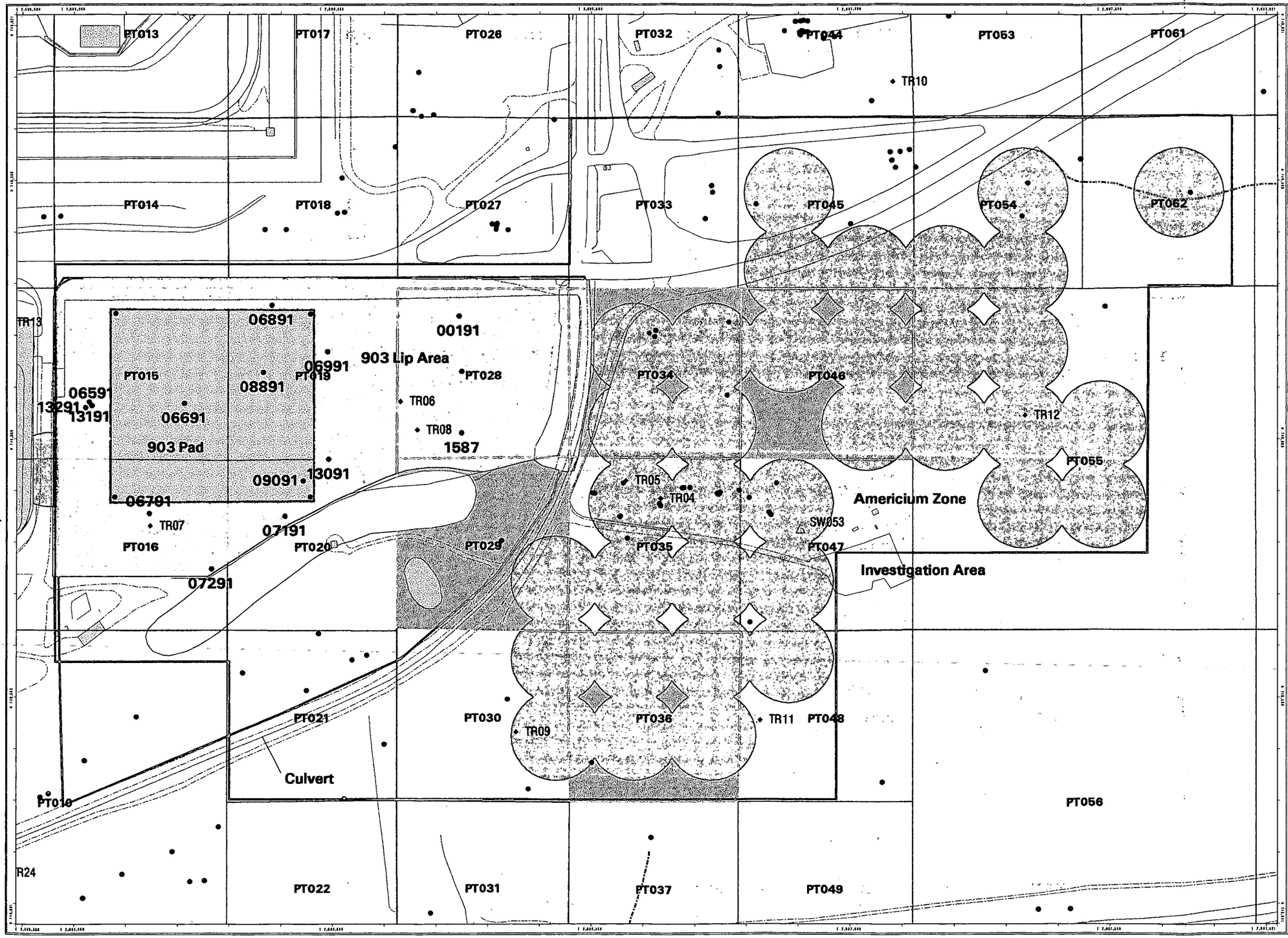
Sampling and Analysis Plan for the Site Characterization at the 903 Drum Storage Area, 903 Lip Area and Americium Zone

Investigation Area Location Map

Figure 1.2



EXPLANATION

- HPGe 150 foot FOV Circles (above 10pCi/g Am-241)
- Plots above Tier I Action Levels
- Groundwater Well Locations
- Soil profile Sampling Sites
- Surface Water Sampling Location
- 1976 Soil Removal Area (approx)
- 1978 Soil Removal Area (approx)
- 1970 Soil Fill Area (approx)
- 1984 Soil Fill Area (approx)

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSI, Las Vegas.
Digitized from the orthophotographs, 1/95
HPGe data from Ron Reiman, Gamma Survey Group, Safeguard Measurements, EG&G Rocky Flats, Inc. June 1994

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Scale = 1 : 2270
1 inch represents approximately 189 feet

0 100 200m

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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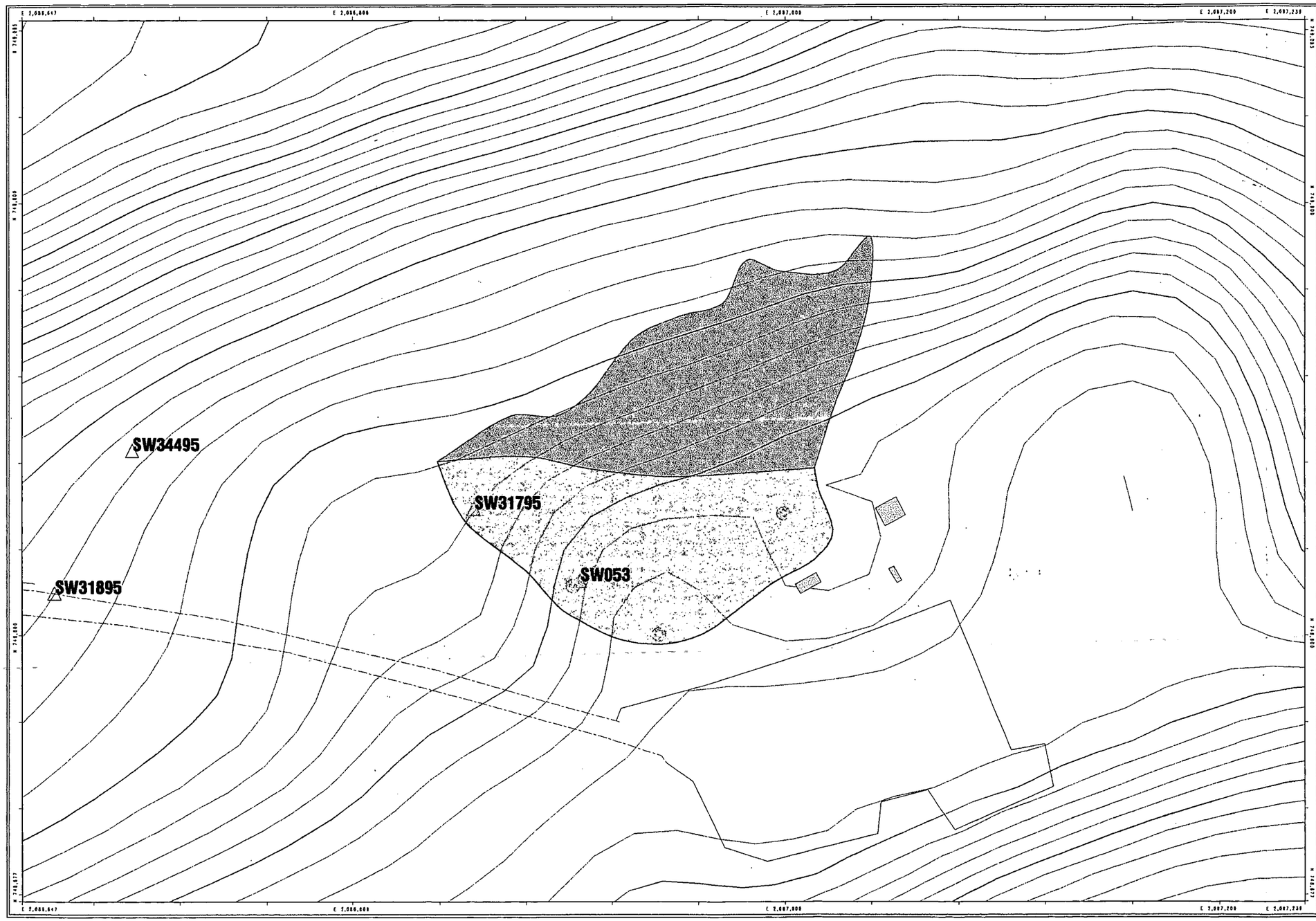

Sampling and Analysis Plan for the
Site Characterization at the
903 Pad Drum Storage Area, 903 Lip Area
and Americium Zone

Wetland Area
Radiological Sampling Locations
Figure 3.5

EXPLANATION

- Surface Water Sampling Location
- Proposed Soil Boring Location

Wetland Features

- Hummocky Topography (Landslide)
- Wetland (Ephemeral Spring)

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (2-Foot)
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 600
1 inch represents 50 feet

15 0 30 60ft

State Plane Coordinate Projection
Colorado Central Zone
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