DOE/OR/01-1322&D1

Soil Sampling and Analysis Plan for the Bear Creek Valley Floodplain at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee

MASTER

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ACRONYMS

AFI	area for further investigation
ANOVA	analysis of variance
AOP	analytical operating procedure
ASO	Analytical Services Organization
ASTM	American Society for Testing and Materials
BCV	Bear Creek Valley
BMAP	Biological Monitoring and Abatement Program
CLP	Contract Laboratory Program
COPCs	contaminants of potential concern
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQOs	data quality objectives
Energy Systems	Martin Marietta Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERA	Environmental Risk Assessment
ESD	Environmental Sciences Division
ESD-ATL	Environmental Sciences Division–Aquatic Toxicology Laboratory
EZ	exclusion zone
FCO	field change order
FSP	Field Sampling Plan
GC	gas chromatograph
HDPE	high-density polyethylene
HSP	Health and Safety Plan
ICP	inductively coupled plasma
ID	identification
IDW	investigation-derived waste
LCS	laboratory control standard
M&TE	measuring and test equipment
MDL	method detection limit
MS	mass spectrometry
MSD	matrix spike duplicate
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PID/FID	photoionization detector/flame ionization detector
PPE	personal protective equipment
PQLs	practical quantitation limits
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control

QAPjP	Quality Assurance Project Plan
RI	Remedial Investigation
RPD	relative percent difference
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SAS	Statistical Analysis System
SHSO	site health and safety officer
SOP	standard operating procedure
SOWs	statement of work
TCL	target compound limit
TCLP	Toxicity Characteristic Leaching Procedure
VOC	volatile organic compound
WBGT	wet bulb globe temperature
WBS	Work Breakdown Structure
%R	percent recovery

EXECUTIVE SUMMARY

This Sampling and Analysis Plan (SAP) for the Bear Creek Valley (BCV) Floodplain presents the approach and rationale for characterizing potentially contaminated soils and sediments of the Bear Creek floodplain and the impact of any contaminants on the floodplain ecosystem. It is an addendum to a previously issued document, the *Remedial Investigation Work Plan for Bear Creek (Y02-S600) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (ES/ER-19&D2), which presents background information pertaining to this floodplain investigation.

The strategy presented in the SAP is to divide the investigation into three component parts: a large-scale characterization of the floodplain; a fine-scale characterization of the floodplain beginning with a known contaminated location; and a stream sediment characterization. During the large-scale and the fine-scale characterizations, soil and biota samples (i.e., small mammals, earthworms, and vegetation) will be collected in order to characterize the nature and extent of floodplain soil contamination and the impact of this contamination on floodplain biota.

The large-scale characterization will address potential contamination on the floodplain through a screening of samples at 78 locations along 13 transects (6 locations per transect) of the floodplain. Samples from locations that exceed sampling action levels for alpha radiation, polychlorinated biphenyls (PCBs), or volatile organic compounds (VOCs) will be sent to a laboratory for an analysis of an extensive list of radiologic and chemical constituents. Samples from a subset of these locations will be collected and split for toxicity and geotechnical tests (e.g., moisture content, grain size, permeability, etc.) and, after laboratory analysis results are obtained, biota samples will be collected proximal to toxicity test sampling sites.

The fine-scale characterization will begin with an investigation of a site corresponding to the location noted in the Remedial Investigation Work Plan (ES/ER-19&D2) as an area where uranium and PCBs are concentrated in discrete strata. During this fine-scale characterization, a 1 m deep soil profile excavation will be dug into the creek berm, and individual soil strata in the excavation will be screened for alpha radiation, PCBs, and VOCs. Any layer exceeding a sampling action level for any of the three screening parameters will be sampled for laboratory analysis and thoroughly described. Following the soil profile excavation, shallow borings will be hand augered into the creek berm at 17 other locations along the floodplain different from the large-scale transect locations. Discrete strata in the borings will be compared to descriptions of contaminant-bearing strata from the soil profile excavation, and any that match the descriptions will be screened for alpha radiation, PCBs, and VOCs. Any stratum exceeding a sampling action level for any of the three parameters will be sampled and, along with a bulk soil sample from that boring, will be sent for laboratory analysis of an extensive list of radiological and chemical constituents. In addition, soil samples will be collected from these locations for toxicity and geotechnical testing. After the laboratory analysis results are received, biota samples will be collected in the vicinity of those locations.

Sediment samples will be collected at 17 depositional areas in the Bear Creek channel for the stream sediment characterization. All of the samples will be sent to a laboratory for an analysis of radiological and chemical constituents. All samples will also be tested for toxicity to surrogate benthic organisms and for geotechnical properties.

Biota samples will be collected at six locations corresponding to soil sample locations at BCV Operable Unit (OU) 1 in an effort to fully integrate the BCV floodplain investigation with the BCV remedial investigation effort. This exercise will round out the floodplain investigation by characterizing the ecological impact of contaminant source areas; soil contamination in these areas will be characterized as part of the OU 1 investigation.

1. INTRODUCTION

This Sampling and Analysis Plan (SAP) is an addendum to the *Remedial Investigation Work Plan for Bear Creek (Y02-S600) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* [Turner et al. 1991; hereafter referred to as the Remedial Investigation (RI) Work Plan]. In addition to being an addendum, this SAP represents a modification to the sampling and analysis strategy proposed in the RI Work Plan. Though the sampling strategy presented in this SAP is different from that presented in the RI Work Plan, the basic rationale for sampling Bear Creek Valley (BCV) floodplain soils and stream sediments has not changed. This rationale—based on existing data for the floodplain (Chap. 3 of the RI Work Plan)—is that, because the Bear Creek hydrologic regime has potentially been impacted by contaminant releases from numerous upstream sources at the Y-12 Plant, contaminants may have become stored in the floodplain soils and stream sediments and, therefore, the soils and sediments represent possible sources of future releases to the environment.

This SAP presents the strategy for a phased approach to soil and sediment sample collection that uses field screening methods and screening criteria in the first phase to initiate the second phase of more extensive sampling and analysis. In addition, discussions of analytical methods and project-specific Health and Safety, Quality Assurance, and Waste Management Plans are included herein.

2. SAMPLING APPROACH AND RATIONALE

2.1 OBSERVATIONAL APPROACH

The BCV floodplain soils and sediments investigation will make use of the observational approach. The use of this approach will mean flexibility for the investigation; its direction will be guided by field and laboratory results obtained during its progression. The observational approach ensures that objectives are met while at the same time uncertainties inherent in the environmental investigation are managed. The approach allows stated objectives [e.g., ensuring data sufficiency to resolve the problem(s)] to be combined with open-ended contingencies that will be finalized as the investigation develops.

The problem that is driving the BCV floodplain investigation was stated in Chap. 1 as the investigation's rationale (i.e., there is sufficient reason to expect that historical activities at the Y-12 Plant have resulted in contaminants being deposited in the floodplain). In response to this problem, decisions will have to be made that are based on the data and observations collected during the investigation. These questions will have to be answered:

- Are the floodplain soils and sediments contaminated?
- If so,
  - What are the nature and extent of contamination?
  - Is the contamination available to the biota that form the floodplain ecology?
  - What are the mechanisms for contaminant transport and deposition?

The observational approach will guide the decision-making process in the following ways:

- The investigation of the BCV floodplain will be conducted in a sequenced manner. The results of the screening analyses will be used to determine whether samples from a particular location are sent for laboratory analysis to determine the nature and extent of contamination or whether no further action will be taken for that location.
- Because screening analyses that exceed sampling action levels are expected to be directly correlated to contaminated areas in the floodplain, it will not be necessary to analyze every sample that exceeds the sampling action level during the screening activity. Therefore, a percentage of the samples, up to a stated maximum, that exceed sampling action levels will be selected for laboratory analysis.
- Results from the screening and laboratory analysis of soils will determine whether biota samples will be collected.
- The analytes for biota sample analysis will be determined by comparing the results of laboratory analyses of soil samples to predetermined benchmark concentrations for soil toxicity.

In order to direct the course of the investigation at key decision points, a sampling strategy team—comprised of personnel from the Y-12 Environmental Restoration (ER) Program; Oak Ridge National Laboratory (ORNL), Environmental Science Division (ESD); and Science Applications International Corporation (SAIC)—will be formed. When decision points are reached, the sampling strategy team will assemble and use the decision rules described in the following sections and their best professional judgment when called for.

2.2 SAMPLING OVERVIEW

The investigation of the BCV floodplain will involve sampling from two media:

- Soil/sediment samples
  - floodplain soil collected along the extent of the BCV floodplain comprising two investigations:
    1. large-scale soil characterization in which composited, shallow soil samples will be screened in the field for contaminants of potential concern (COPCs) and sent for laboratory analysis if screening results exceed sampling action levels and
    2. fine-scale soil characterization in which discrete, contaminant-bearing horizons are selectively sampled for laboratory analysis along the extent of the BCV floodplain and sent for laboratory analysis if screening results exceed sampling action levels.
  - stream sediment samples collected from the top 3 to 4 in. of sediment in the Bear Creek stream bed.
- Biota samples
  - small mammal samples collected at locations along the BCV floodplain where soil samples exceed screening criteria,
  - earthworm samples collected at locations along the BCV floodplain where soil samples exceed sampling action levels,
  - vegetation samples collected at locations along the BCV floodplain where soil samples exceed sampling action levels, and
  - the same types of biota collected at source term locations in BCV Operable Unit (OU) 1 dependent on adjacent soil boring analysis.

2.3 SAMPLING RATIONALE

The RI Work Plan identified uranium and polychlorinated biphenyls (PCBs) in the BCV floodplain soils and PCBs in stream sediments and biota as the principal COPCs. Also, because volatile organic compounds (VOCs) are included in the COPC list for the source units in BCV OU 1, they will be considered as COPCs for this investigation. A major assumption built into this SAP is that initial screening of soil for uranium, PCBs, and total VOCs will focus sampling efforts on segments of the floodplain with a greater probability of being contaminated. Sampling and laboratory analysis of soils at locations identified by the initial screening and of stream sediments will be used to determine contaminant levels within the floodplain soil column and in the Bear Creek stream bed. The results of this sampling and analysis will be used to define the nature and extent of floodplain contamination, aid in identification of the source(s) of contamination, and establish mechanisms of contaminant deposition. Additionally, the suite of analytes for the laboratory analysis of sediments and biota will be extensive (Sect. 3.1.2). These analyses will help verify the assumption that the COPCs in the BCV floodplain are uranium, PCBs, and VOCs and that the COPCs in stream sediments and biota are PCBs. These data will be used for risk assessment purposes. If, during the course of this investigation analytical results indicate that uranium, PCBs, and VOCs are not the only COPCs, the sampling strategy team will reevaluate the sampling and analysis strategy.

2.3.1 Large-Scale Characterization of Floodplain Sediments

During the large-scale characterization of floodplain soil, the vertical and horizontal extent of contamination will be evaluated. This characterization will delineate contaminated and uncontaminated regions of the floodplain and provide the information that will allow any identified contamination to be integrated over the volumetric extent of BCV floodplain soil. This integration will be important for assessing potential risk to off-site and on-site receptors and for the Feasibility Study. The large-scale characterization will involve soil toxicity testing for ecological receptors at regions of the BCV floodplain shown to be contaminated during the early, screening stage of the characterization.

Samples for the large-scale characterization will be collected from selected transects of the floodplain. Transect locations were selected to be in areas of stream deposition. These areas were identified during a site walkover on the basis of morphology (well defined creek levee and wide, flat floodplain) and were confirmed by evidence of recent flood deposits (rafted material and sandy to muddy floodplain deposits recovered using a hand-pushed coring device). Collection of samples from these transects will prevent sampling of erosional segments of the creek.

2.3.2 Fine-Scale Characterization of Floodplain Sediments

The purpose of the fine-scale characterization of floodplain soil will be three-fold. The first goal will be to pinpoint the stratigraphic locations of contaminants in the floodplain. Results of previous sampling indicate contamination may be limited to one or two discrete layers in the soil column. These layers may be 1–2 cm thick; however, the concentrations of PCBs and uranium in them may be high. The fine-scale characterization will serve to verify this conceptual model and is also important for assessing potential human and ecological risk as a result of direct contact with the potential contaminant locations. Second, the fine-scale investigation will serve to check and confirm the results of the large-scale characterization. Because the large-scale characterization will involve compositing soil from intervals as great as 16 in. (Sect. 3.1.1), it is conceivable that sampling action levels will be masked by dilution. Third, the fine-scale investigation will help determine the mechanisms for transport and deposition of contaminants in the floodplain.

2.3.3 Ecological Sampling

Ecological samples—including small mammals, earthworms, and vegetation—will be collected from a subset of sampling locations identified during the large-scale and fine-scale characterization screenings of the floodplain and soil sampling at BCV OU 1. These samples are necessary to determine if contaminants are being transferred from floodplain soil to invertebrates, vegetation, and the small mammals that form the base of the food chain. The information derived from these samples will then be used to support the ecological risk assessment.

2.3.4 Stream Sediment Sampling

Stream sediments will be analyzed in terms of an extensive analyte list and in terms of toxicity and physicochemical characteristics that affect bioavailability of the COPCs. Stream sediments are ecologically and toxicologically significant in their role as both a habitat for various benthic organisms, which are an important component of the aquatic food web, and as a sink for contaminants such as metals and hydrophobic organics.

3. FIELD SAMPLING PLAN

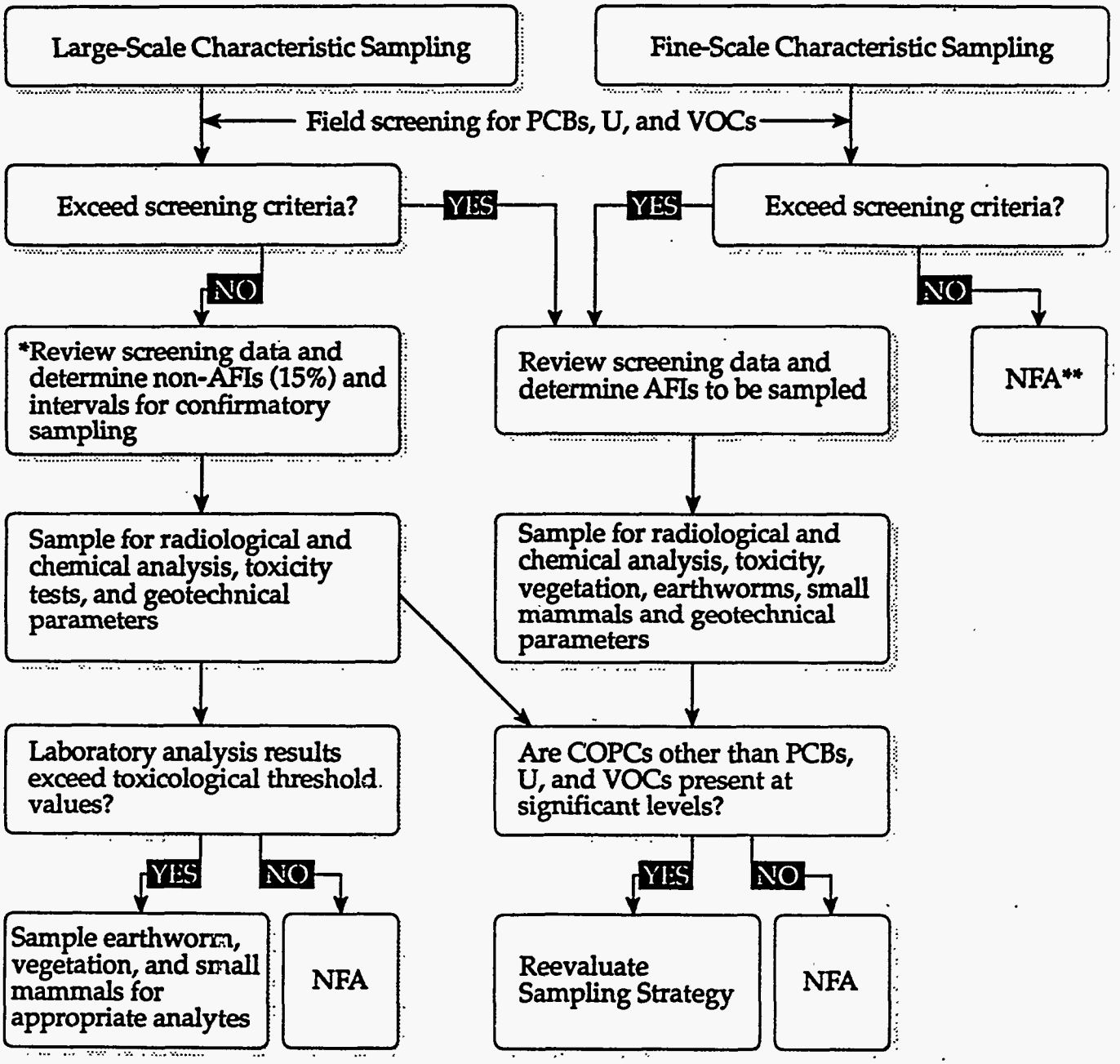
This chapter describes the approach toward sampling the different media in the BCV floodplain. All sample locations for the various media will be surveyed by a certified land surveyor, recorded on the BCV map, and marked with a stake and flagging. In addition, any location identified during the field screenings as an area for further investigation (AFI) will be staked and flagged with a unique identifier. All AFIs will be photographed by a Y-12 Plant photographer to aid in relocation of the sample locations or transects for the subsequent ecological sampling. Stream sediment sampling locations will be marked on the adjacent stream bank with supportive field notes taken to relocate the depositional area that was sampled. Figure 3.1 is a flow chart that outlines the sampling activities for the BCV floodplain investigation.

3.1 LARGE-SCALE CHARACTERIZATION OF THE BEAR CREEK VALLEY FLOODPLAIN

The large-scale characterization of floodplain soil will be conducted using a sequenced approach. Initially, the effort will involve screening soil along the length of Bear Creek beginning at BCK-12.10 and ending at the intersection between White Wing Road and Oak Ridge Turnpike (Fig. 3.2). Results of the field screening analyses will be compared with predetermined screening criteria (sampling action levels). If a screening sample from any borehole exceeds a sampling action level, that borehole location will be classified as an AFI. After the initial screening survey is complete, screening data will be reviewed by the sampling strategy team and AFIs to be sampled in more detail will be determined. Additional soil samples will be taken from the AFI, as described below, and sent for more complete radiological and chemical analysis and toxicity testing. Additional screening tests for uranium and PCBs will be conducted on a split from each sample sent for further analysis. After laboratory data are returned, biota samples will be collected from the vicinity of a subset of the AFIs, determined by the sampling strategy team based on toxicological benchmarks.

3.1.1 Floodplain Soil Screening

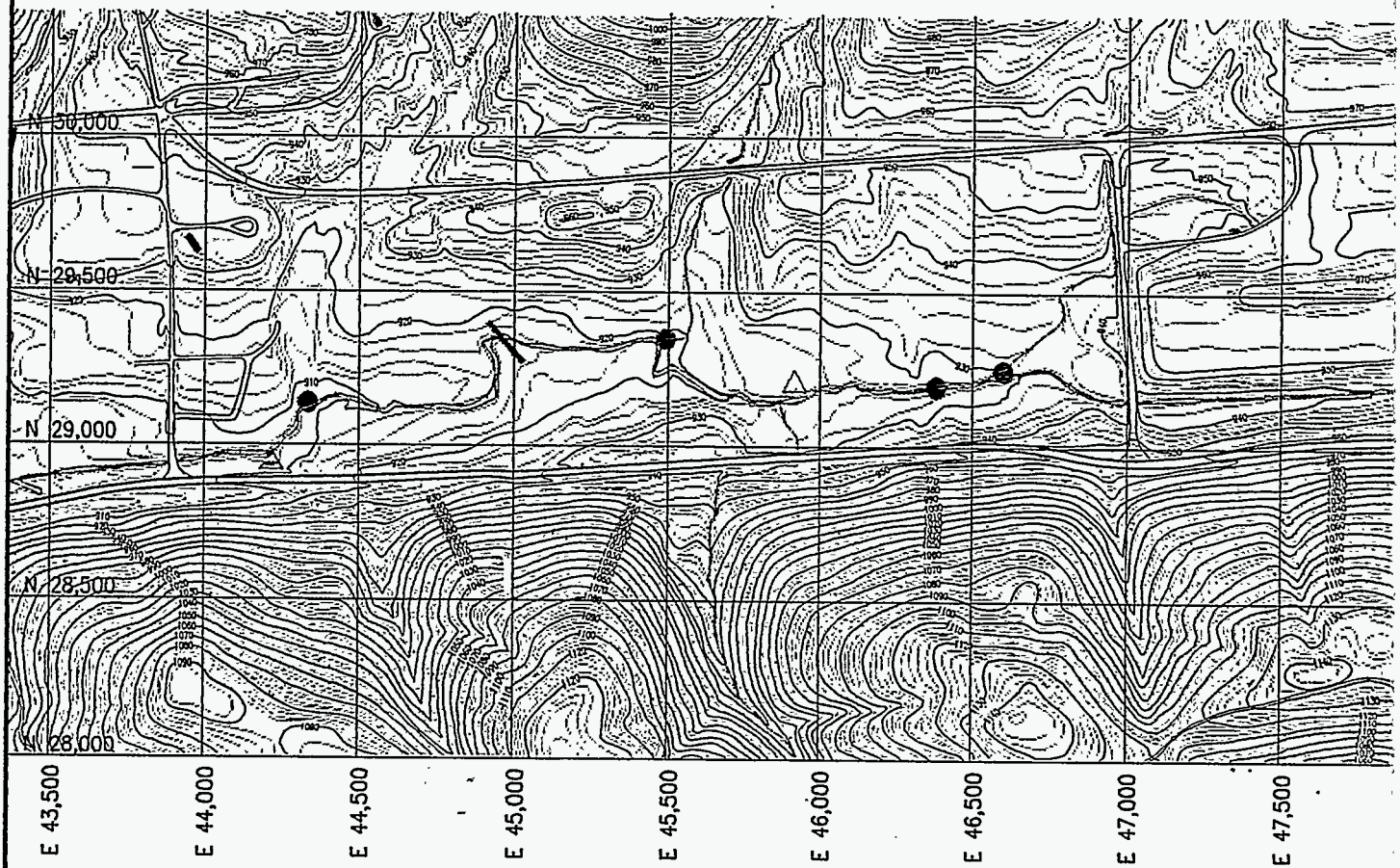
Thirteen transects in depositional areas of the BCV floodplain have been designated for sampling (Fig. 3.2). Each transect will consist of a total of six sample locations: one in the creek berms on either side of Bear Creek and two more in the backmarsh on either side of the creek (if adequate floodplain exists on both sides of creek). The backmarsh locations will be spaced evenly over the entire width of the floodplain. Each sample location will be sampled at three different depth intervals: 0–4 in., 4–16 in., and 16–32 in. below ground surface or to sampler refusal, whichever comes first. The sample collected from each interval will be homogenized and field screened for alpha radiation using an alpha scintillation detector (Sect. 6.1), PCBs using PCB field screening kits (Sect. 6.2), and VOCs using an H-Nu to detect head-space concentrations. Samples with PCB concentrations >1.0 mg/kg (the PCB sampling action level), alpha radiation greater than the sampling action level defined in Sect. 3.5.1, and/or VOC levels >5 mg/kg (based on detector resolution) will be classified as AFIs. These areas will be included in a second round of sampling, with samples from depth intervals exceeding the sampling action levels sent for laboratory radiological and chemical analysis. The PCB field screening criterion of 1.0 mg/kg corresponds to the needs of risk



*Review of data will occur as data packages arrive from the analytical laboratory. Reevaluation of the sampling strategy may occur any time during the sampling activities.

**No further action

Fig. 3.1. Bear Creek Valley floodplain sampling scheme.



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0	P. HOLM	K. SWAIN	09/26/94

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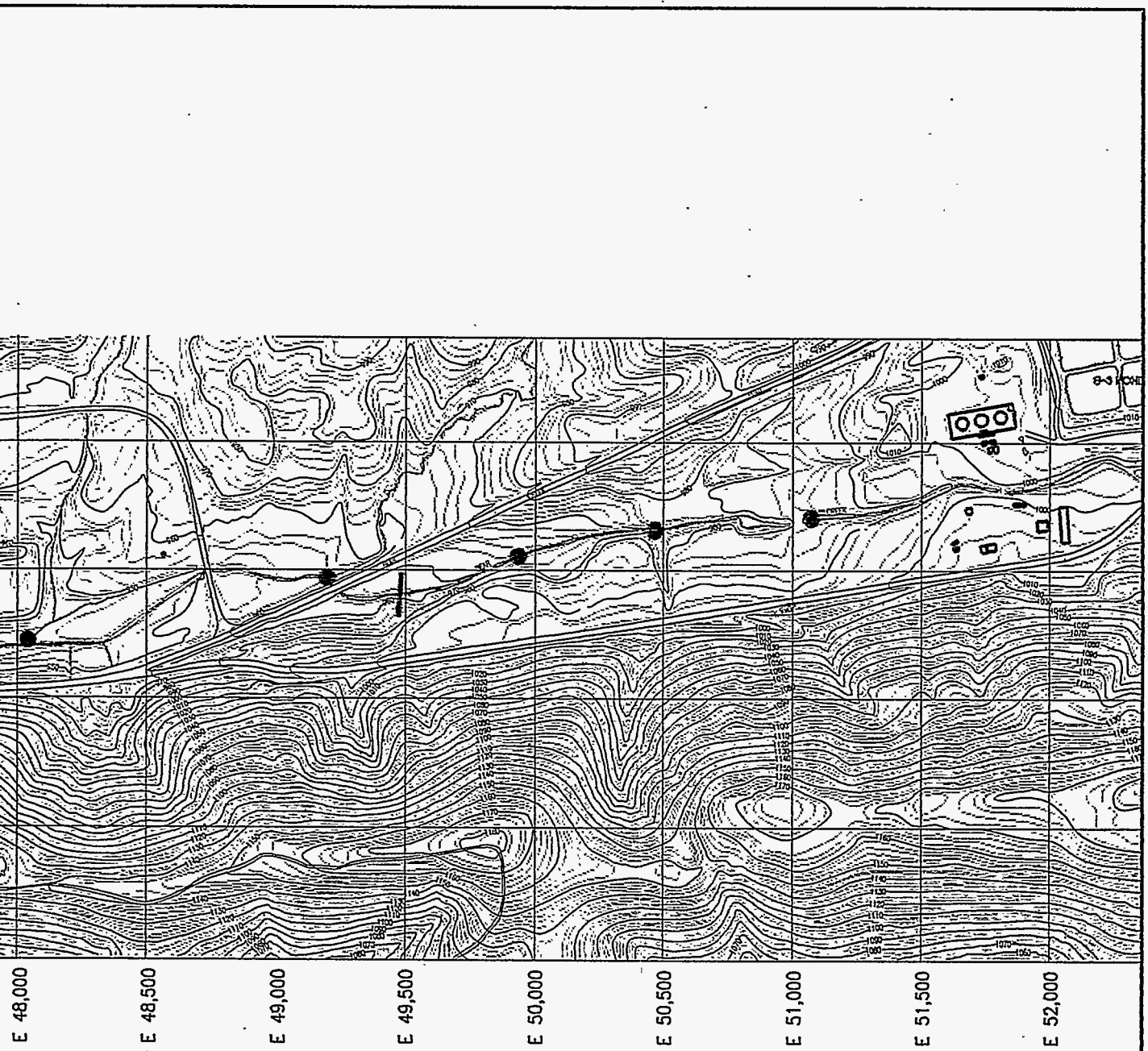
LEGEND:

PROPOSED LARGE–SCALE CHARACTERIZATION SOIL SAMPLE TRANSECT LOCATION

PROPOSED FINE–SCALE CHARACTERIZATION SOIL SAMPLE LOCATION

PROPOSED STREAM SEDIMENT SAMPLE LOCATION

Fig. 3.2. Proposed sampling l



...BEAR CREEK

Y-12 PLANT GRID

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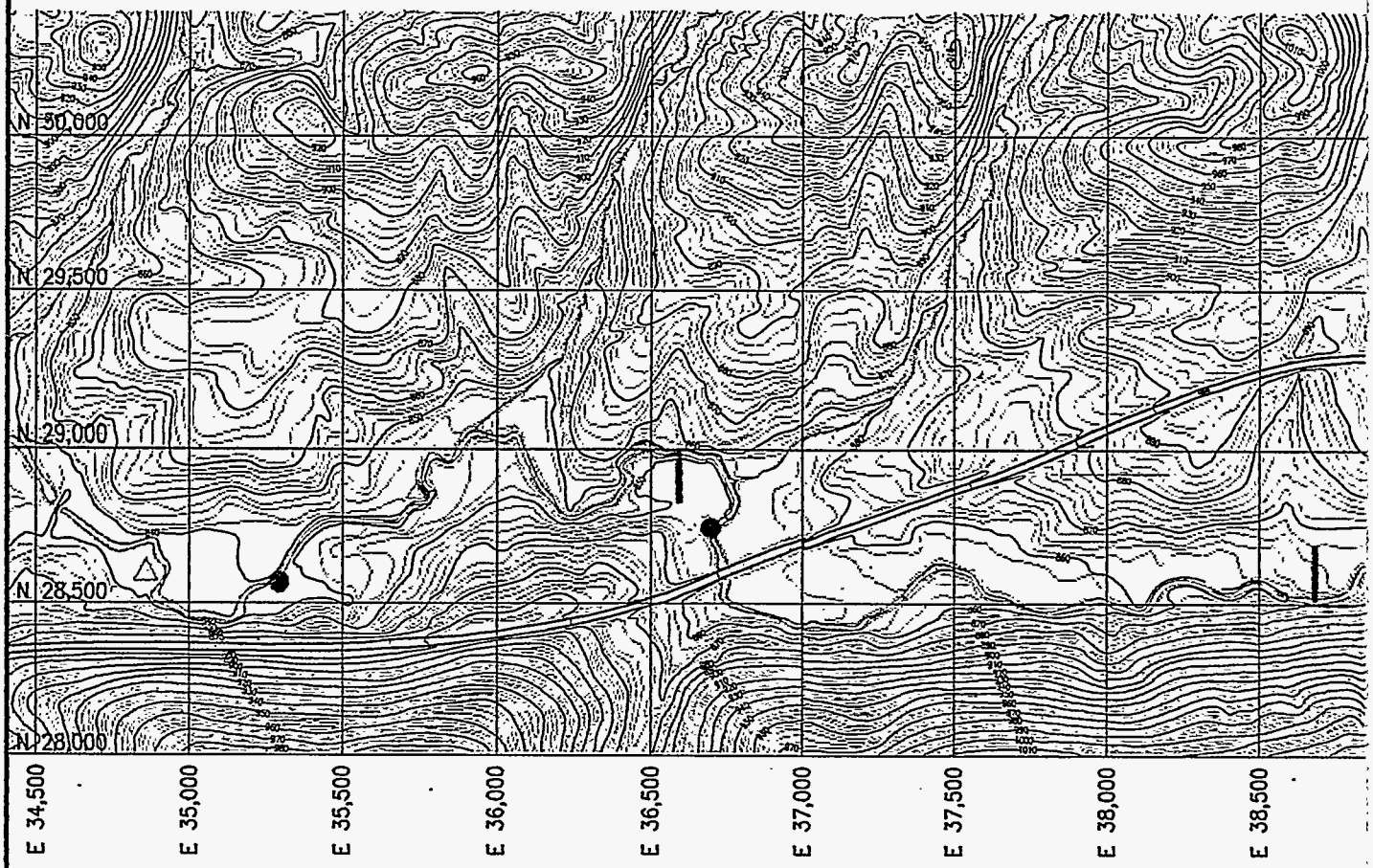
0 300 600 1200

SCALE: 1" = 600'

BEAR CREEK VALLEY
PROPOSED SOIL SAMPLE TRANSECT,
SOIL SAMPLE,
AND SEDIMENT SAMPLE LOCATIONS

cations along the extent of Bear Creek.



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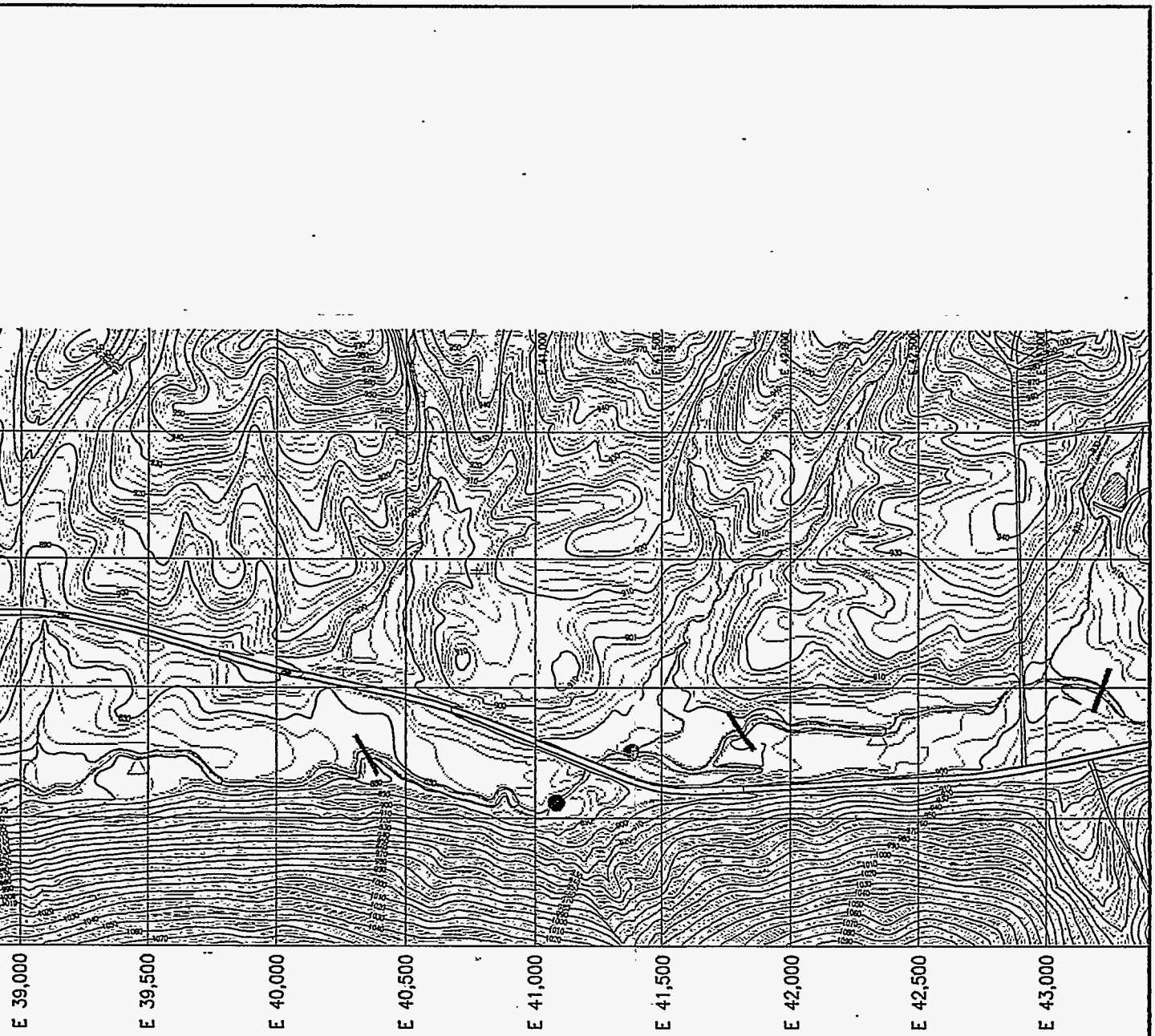
LEGEND:

PROPOSED LARGE–SCALE CHARACTERIZATION SOIL SAMPLE TRANSECT LOCATION

PROPOSED FINE–SCALE CHARACTERIZATION SOIL SAMPLE LOCATION

PROPOSED STREAM SEDIMENT SAMPLE LOCATION

Fig. 3.2 (



.....BEAR CREEK

Y-12 PLANT GRID

Science Applications International Corporation

0 300 600 1200

SCALE: 1" = 600'

BEAR CREEK VALLEY
PROPOSED SOIL SAMPLE TRANSECT,
SOIL SAMPLE,
AND SEDIMENT SAMPLE LOCATIONS

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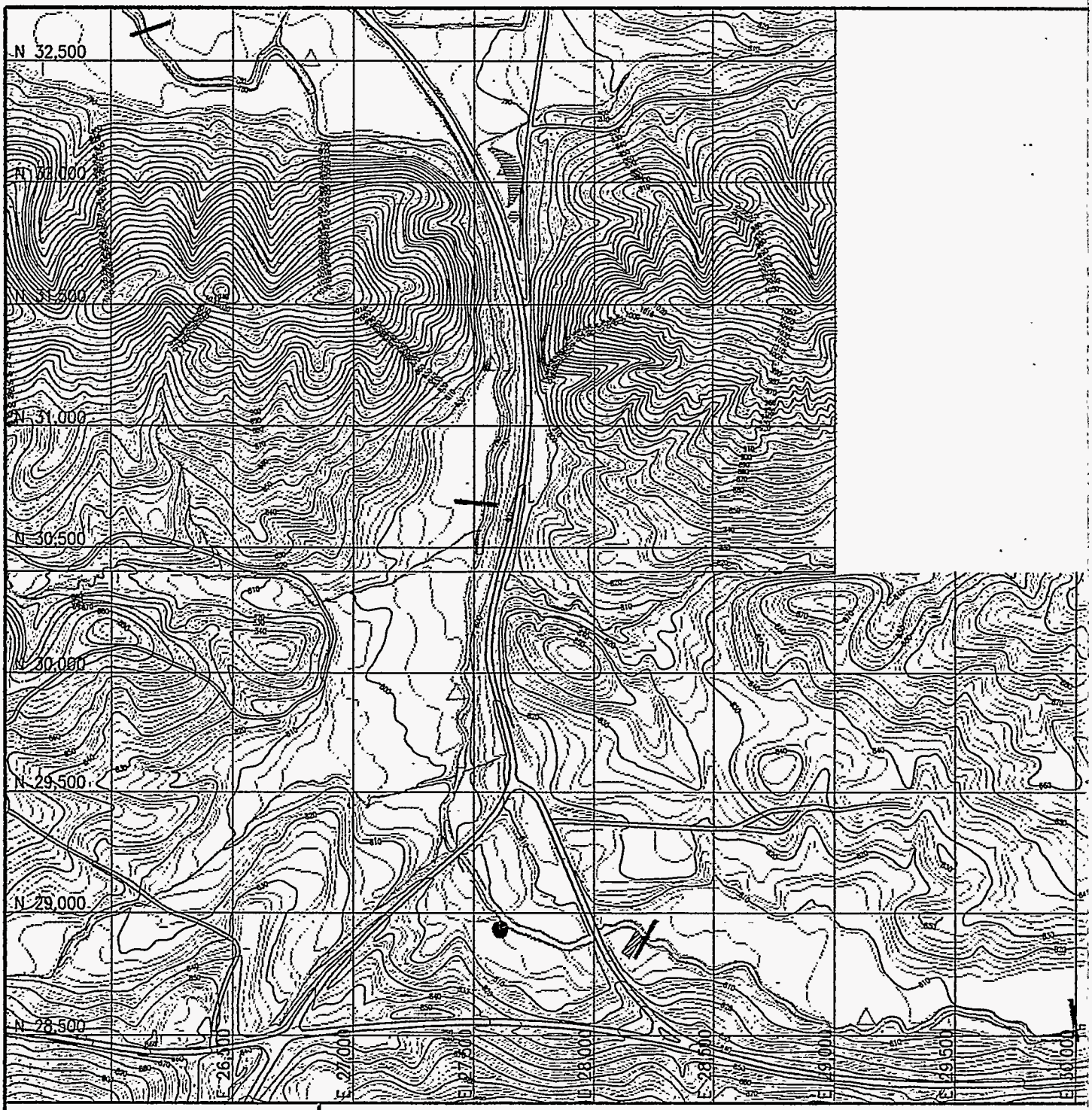

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DRAWING #	CAD FILE #	ROT. ANGLE

LEGEND:

PROPOSED LARGE-SCALE CHARACTERIZATION SOIL SAMPLE TRANSECT LOCATION

PROPOSED FINE-SCALE CHARACTERIZATION SOIL SAMPLE LOCATION

PROPOSED STREAM SEDIMENT SAMPLE LOCATION

FINE-SCALE CHARACTERIZATION TRENCH

Fig. 3.2

....BEAR CREEK
Y-12 PLANT GRID
SAIC
Science Applications International Corporation
0 300 600 1200
SCALE: 1" = 600'
BEAR CREEK VALLEY
PROPOSED SOIL SAMPLE TRANSECT,
SOIL SAMPLE,
AND SEDIMENT SAMPLE LOCATIONS

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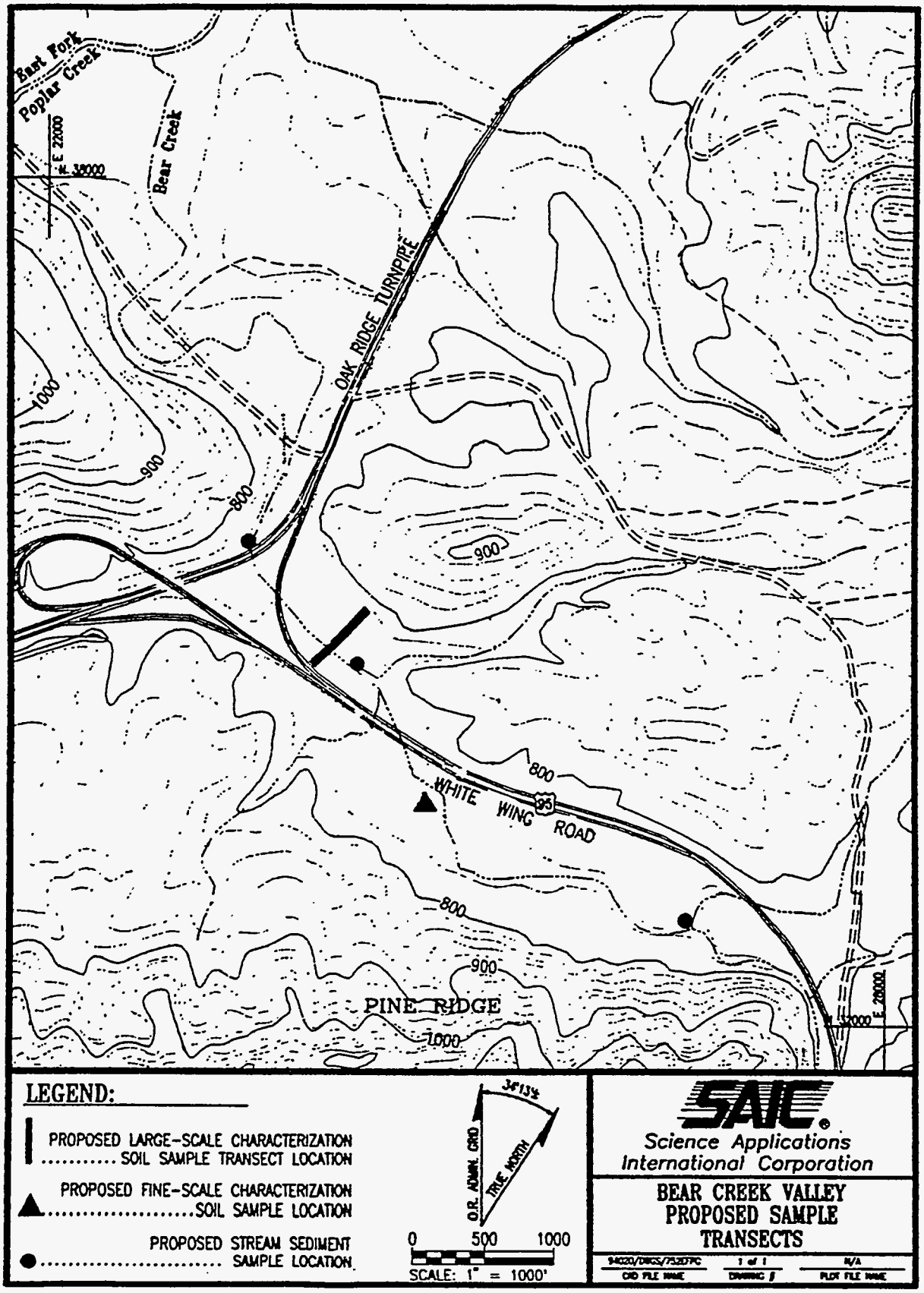


Fig. 3.2 (continued)

assessment. The radiological sampling action level will be defined as the lesser of two standard deviations or 100 cpm above an average activity determined on an uncontaminated soil (i.e., local background) of similar origin to those found in the BCV floodplain. (See Sect. 3.5.1 for details.)

3.1.2 Floodplain Soil Samples

After completion of the floodplain sample screening, sampling crews will return to the locations classified as AFIs and designated for additional sampling by the sampling strategy team. Locating these AFIs will be facilitated by reference to the BCV map, the photographs taken of the locations, and the stakes and flagging that were used to delineate the AFI during the screening effort. Those depth intervals of each designated AFI that exceed the sampling action levels will be sampled.

A maximum of 40 AFIs will be sampled and analyzed with a maximum of 3 AFIs located on one transect. The sampling strategy team will assemble when floodplain soil screening is complete to determine optimal AFIs to be sampled and analyzed. In the event that less than 40 AFIs are identified by screening, the sampling strategy team will have the option to sample more than 3 AFIs in a single transect.

Sample collection at each AFI will require an adequate number of adjacent soil collections to ensure sufficient sample volume for laboratory analysis and toxicity testing (Table 3.1). Because of the large volume of sample needed from the 0 to 4 in. and 4 to 16 in. intervals, excavation by shovel may be utilized at the discretion of the Field Team Leader. Multiple collections will be taken immediately adjacent to the location where the sampling action level was exceeded until an adequate volume of sample has been recovered. Sampling will begin by clearing the forest litter, grasses, and forbs from the ground surface. Initially, samples will be collected from the 0 to 4 in. deep interval using a manual sampler. These samples will be homogenized and the resulting sample will be split: one split will be for laboratory radiological and chemical analysis; the other split will be for toxicity testing. Roots, rocks, and invertebrates will be removed from the sample and returned to the sample location. Following sampling of the initial 0–4 in. interval, two more intervals will be sampled at each AFI, as appropriate: 4–16 in. interval and 16–32 in. interval. The 4–16 in. interval will be homogenized and split as described for the 0–4 in. interval. One split will be sent to a laboratory for more complete radiological and chemical analysis and the other split will be composited proportionally with a split from the 0–4 in. interval and homogenized for use in toxicity testing. The 16–32 in. interval will be sampled only if the sampling action level was exceeded in that interval during screening. The 16–32 in. interval will not be tested for toxicity but will be homogenized and submitted to the laboratory for more detailed radiological and chemical analyses. The analytes for chemical analysis and the isotopes whose activities will be determined during radiological analysis are listed in Table 3.2. In addition, an aliquot of each sample sent for laboratory radiological and chemical analysis will be sent to a geotechnical laboratory for analysis of moisture content, pH, particle size distribution, and organic content using American Society for Testing and Materials (ASTM) or *Methods of Soil Analysis* procedures. Data for these parameters will be used in evaluating the results of the toxicity tests.

PCB and alpha radiation field screening analyses will be performed on splits from all soil samples being sent to the laboratory for analysis. This will enable a correlation to be made between laboratory results and the newly implemented field screening techniques.

Table 3.1. Minimal volumes of BCV floodplain soil and corresponding number of adjacent collections[a] needed to satisfy laboratory analysis and toxicity testing requirements

Interval (in. below ground)	Analytical volume (liters)	Toxicity volume (liters)	Total volume needed (liters)	No. of adjacent collections needed
0–4	1.5	2.25[b]	3.75	9
4–16	1.5	6.75[b]	8.25	6
16–32	1.5	0.0	1.5	2

[a]Number of adjacent collections calculated assuming a 3-in. ID sampler will be used.
[b]Volumes are proportional to interval depths. Intervals 0–4 and 4–16 in. will be composited for one toxicity sample.

Toxicity testing will be conducted on a maximum of three samples per transect; any given transect is made up of sampling locations on both sides of Bear Creek. Sample locations for toxicity tests will be determined after a review of screening data with emphasis on PCB results. The rationale for using PCBs in preference to radioactivity or VOCs to select the toxicity test sampling locations is that PCBs are more toxic to earthworms and vegetation than radionuclides or VOCs. If no samples in a transect exceed the detection limit for the PCB screening test, then selection of samples for toxicity testing will be based on radiological results. Concern for VOCs in toxicity tests is minimal. The procedure for toxicity testing is described in Sect. 6.5. Samples to be tested for toxicity to earthworms and plants should be sieved coarsely (i.e., through a 1-cm mesh or screen) to remove pebbles, twigs, etc.

3.1.3 Confirmatory Samples

Based on the results of the floodplain screening exercise, fifteen percent (15%) of the sample locations not classified as AFIs will be selected to undergo confirmatory sampling. In addition, 50% of the confirmatory samples will be collected from the 0 to 16 in. interval, comprised of a sample from the 0 to 4 and 4 to 16 in. interval, and 50% from the 16 to 32 in. interval. Locations and intervals to be sampled will be determined by the sampling strategy team on the basis of available screening and analytical data. However, a minimum of three samples will be collected from each of the 0–16 and 16–32 in. intervals for chemical and radiological analysis. The sampling plan for the confirmatory soils will be identical to that for sampling of the AFIs (Sect. 3.1.2). Biota sampling at confirmatory locations will be conducted when the laboratory radiological or chemical analyses of soils demonstrate that toxicological benchmarks for small mammals have been exceeded (Sect. 3.1.4).

3.1.4 Small Mammal Samples

Small mammals (i.e., mice, shrews, voles) inhabiting the BCV floodplain may be exposed to elevated concentrations of contaminants. Exposure may occur through consumption of vegetation, soil invertebrates, and surface water or through incidental exposure to soil while foraging or burrowing (Suter et al. 1994). Small mammals are known to bioaccumulate a

Table 3.2. Proposed analytical parameters for soil and sediment samples collected from AFIs during the investigation at Bear Creek (modified from Turner et al. 1991)

Parameter	Method[a,b]	Estimated practical quantitation limits
ICP metals	3050	**(mg/kg)**
Aluminum (Al)		45
Antimony (Sb)		32
Arsenic (As)		53
Barium (Ba)		2
Beryllium (Be)		0.3
Cadmium (Cd)		0.1
Calcium (Ca)		10
Chromium (Cr)		1
Cobalt (Co)		7
Copper (Cu)		6
Iron (Fe)		7
Lead (Pb)		1
Magnesium (Mg)		30
Manganese (Mn)		2
Mercury (Hg)		0.2
Nickel (Ni)		15
Potassium (K)		variable
Selenium (Se)		2
Silver (Ag)		7
Sodium (Na)		29
Thallium (Tl)		40
Vanadium (V)		5
Zinc (Zn)		2
Additional elements		**(mg/kg)**
Lithium (Li)		10
Volatile organics[c]	8240[d]	**(μg/kg)**
Chloromethane		5
Bromomethane		5

Table 3.2 (continued)

Parameter	Method[a,b]	Estimated practical quantitation limits
Vinyl chloride		5
Chloroethane		5
Methylene chloride		5
Acetone		5
Carbon disulfide		5
1,1-Dichloroethene		5
1,1-Dichloroethane		5
1,2-Dichloroethene (total)		5
Chloroform		5
1,2-Dichloroethane		5
2-Butanone (MEK)		5
1,1,1-Trichloroethane		5
Carbon tetrachloride		5
Bromodichloromethane		5
1,1,2,2-Tetrachloroethane		5
1,2-Dichloropropane		5
cis-1,3-Dichloropropene		5
Trichloroethene		5
1,1,2-Trichloroethane		5
Dibromochloromethane		5
Benzene		5
trans-1,3-Dichloropropene		5
Bromoform		5
2-Hexanone		5
4-Methyl-2-pentanone (MIBK)		5
Tetrachloroethene		5
Toluene		5
Chlorobenzene		5
Ethylbenzene		5
Styrene		5

Table 3.2 (continued)

Parameter	Method[a,b]	Estimated practical quantitation limits
Xylenes, total		5
Semivolatile organics	8270[c]	**(µg/kg)**
Phenol		330
bis(2-Chloroethyl)ether		330
2-Chlorophenol		330
1,3-Dichlorobenzene		330
1,4-Dichlorobenzene		330
1,2-Dichlorobenzene		330
2-Methylphenol		330
bis(2-Chloroisopropyl)ether		330
4-Methylphenol		330
N-nitroso-di-n-propylamine		330
Hexachloroethane		330
Nitrobenzene		330
Isophorone		330
2-Nitrophenol		330
2,4-Dimethylphenol		330
bis(2-Chloroethoxy)methane		330
2,4-Dichlorophenol		330
1,2,4-Trichlorobenzene		330
Naphthalene		330
2-Chloroaniline		330
Hexachlorobutadiene		330
4-Chloro-3-methylphenol		330
2-Methylnaphthalene		330
Hexachlorocyclopentadiene		330
2,4,6-Trichlorophenol		330
2,4,5-Trichlorophenol		1600
2-Chloronaphthalene		330
2-Nitroaniline		1600

Table 3.2 (continued)

Parameter	Method[a,b]	Estimated practical quantitation limits
Dimethyl phthalate		330
Acenaphthylene		330
2,6-Dinitrotoluene		330
3-Nitroaniline		1600
Acenaphthene		330
2,4-Dinitrophenol		1600
4-Nitrophenol		1600
Dibenzofuran		330
2,4-Dinitrotoluene		330
Diethyl phthalate		330
4-Chlorophenyl phenyl ether		330
Fluorene		330
4-Nitroaniline		1600
4,6-Dinitro-2-methylphenol		1600
N-Nitrosodiphenylamine		330
4-Bromophenyl phenyl ether		330
Hexachlorobenzene		330
Pentachlorophenol		1600
Phenanthrene		330
Anthracene		330
Carbazole		10
Fluoranthene		330
Pyrene		330
Butyl benzyl phthalate		330
3,3'-Dichlorobenzidine		660
Benzo(a)anthracene		330
bis(2-Ethylhexyl)phthalate		330
Chrysene		330
Di-n-octyl phthalate		330
Benzo(b)fluoranthene		330

Table 3.2 (continued)

Parameter	Method[a,b]	Estimated practical quantitation limits
Benzo(k)fluoranthene		330
Benzo(a)pyrene		330
Indeno(1,2,3-cd)pyrene		330
Dibenzo(a,h)anthracene		330
Benzo(g,h,i)perylene		330
PCBs/pesticides	8080[f]	**(μg/kg)**
Aldrin		2.68
α-BHC		2.01
β-BHC		4.02
δ-BHC		6.03
γ-BHC (Lindane)		2.68
Chlordane (technical)		9.38
4,4′-DDD		7.37
4,4′-DDE		2.68
4,4′-DDT		8.04
Dieldrin		1.34
Endosulfan I		9.38
Endosulfan II		2.68
Endosulfan sulfate		44.2
Endrin		4.02
Endrin aldehyde		15.4
Heptachlor		2.01
Heptachlor epoxide		55.6
Methoxychlor		117.
Toxaphene		161.
PCB-1016		33
PCB-1221		33
PCB-1232		33
PCB-1242		43.5
PCB-1248		33

Table 3.2 (continued)

Parameter	Method[a,b]	Estimated practical quantitation limits
PCB-1254		33
PCB-1260		33
Herbicides	8150[g]	**(μg/kg)**
2,4-D		240
2,4-DB		182
2,4,5-T		40
2,4,5-TP (Silvex)		34
Dalapon		1160
Dicamba		54
Dichloroprop		130
Dinoseb		14
MCPA		49.8
MCPP		38.4
Cyanide	9010	**(μg/kg)**
Radiologicals		**(pCi/g)**
^{234}U, ^{235}U, ^{238}U	Alpha spectroscopy	1
^{238}Pu, ^{239}Pu, ^{240}Pu	EPA 907	15
^{228}Th, ^{230}Th, ^{232}Th	EPA 907	0.1
^{90}Sr	EPA 905	0.1
^{99}Tc	HASL 300	90
^{137}Cs	EPA 901.1	1
^{241}Am	EPA 907	15
^{243}Cm, ^{244}Cm	EPA 907	15

[a]The methods cited, unless otherwise indicated, are from the following source: *Test Methods for Evaluating Solid Wastes,* EPA Publication SW-846, Third Edition, with December 1987 Revision 1 inserts (EPA 1986b).

[b]The detection limits presented represent those established by the laboratory for the analytical method indicated.

[c]Samples will be submitted for VOA analysis only if screening by H-Nu indicates VOAs are present in larger- and finer-scale characterization. VOA analysis will be conducted on all confirmatory samples.

[d]This is for volatile organic compounds (VOCs) in soil/sediment samples using the protocol for VOC analysis. Sample practical quantitation limits (PQLs) are highly matrix-dependent. The PQLs are provided for guidance and may not always be achievable. PQLs are established for a wet-weight basis. Detection will usually be at or below the values specified.

Table 3.2 (continued)

[e]Medium soil/sediment PQLs for semivolatile target compound list (TCL) are 60 times the individual low soil/sediment PQL. Specific PQLs are highly matrix-dependent. The PQLs are provided for guidance and may not always be achievable. PQLs listed for soil/sediment are based on wet weight. Limits calculated on a dry-weight basis will be higher.

[f]Medium soil/sediment PQLs for pesticides and PCBs are 15 times the individual low soil/sediment PQL. Specific quantitation limits are highly matrix-dependent. The quantitation limits listed in the table are provided for guidance and may not always be achievable. PQLs for soil and sediment are based on wet-weight values; detection limits are calculated on dry weight.

[g]Specific quantitation limits are highly matrix-dependent. The quantitation limits listed in the table are provided for guidance and may not always be achievable. PQLs for soil and sediment are based on wet-weight values; detection limits are calculated on dry weight.

variety of contaminants from contaminated environments (Talmage and Walton 1991). Talmage and Walton (1991) found a general relationship between concentrations of contaminants in soil or food and concentrations in tissues of several species, especially for nonessential heavy metals such as Cd, Pb, and Hg. The primary objective of this study was to determine the degree of bioaccumulation of contaminants in small mammals in Bear Creek sites and the potential for accumulation or biomagnification into higher trophic levels.

The presence and chemical body burdens of small mammals along the BCV floodplain will be determined by trapping and analyzing a sufficient number (3–5 animals, depending upon availability). In order to help correlate the results of the small mammal analyses with those of the floodplain soils, sampling will be done only in the vicinity of AFIs where sampling action levels were exceeded in the 0–16 in. interval and from those confirmatory sample locations described in Sect. 3.1.3. The sampling strategy team will review data including toxicological benchmarks (Sect. 3.1), background soil levels, and toxicity test results and determine what analytes the small mammal samples will be analyzed for at each sample site. Because of the relatively large ranges of mice, only one trapping system will be set up per sampling transect with identified AFIs. Only animals from the *Peramyscus*, *Reithrodotomys*, and *Microtus* genera will be collected in order to compare these data with results from reference sites.

Toxicological benchmarks for small mammals were calculated by assuming that the most significant exposure is to mice ingesting soil and contaminated vegetation. Vegetation accumulates contaminants from soil at rates that are characteristic of the contaminants. Soil-to-plant uptake factors (B_v) have been determined or assumed for most inorganics by Baes et al. (1984) and NCRP (1989). The former authors used literature values to compare plant tissue concentrations to soil concentrations of contaminants whenever they were available; otherwise, values of B_v were derived from the general chemical properties of the analytes and solubility and transport properties of similar chemicals. The authors presented a single uptake factor for all vegetative tissue, even though contaminants are likely to be transported less to fruits and seeds than to leaves and stems. The biological availability of ions in soils varies with soil structure and composition. However, detailed information on the effects of soil composition and structure on plant uptake of inorganics is not available. The uptake of organic chemicals by plants is inversely related to the octanol-water partitioning coefficient of the chemicals (Travis and Arms 1988). Biotransfer factors from soil to vegetation for organics were calculated as described by Travis and Arms (1988). The amount of soil consumed daily was taken from Beyer, Connor, and Gerould (1994). Contaminant screening dose values were taken from Opresko, Sample, and Suter (1994). The equation used to calculate the toxicity benchmark in soil was:

$$CS = SD/((SI + B_v) \times VI \times C) ,$$

where

- CS = toxicity benchmark concentration in soil
- SD = screening dose for mice (Opresko, Sample, and Suter 1994)
- SI = daily fraction of diet as soil = 0.02 (Beyer, Connor, and Gerould 1994)
- B_v = soil-to-plant uptake factor, dry weight basis
- VI = daily vegetation ingestion, wet weight basis = 0.169 g (Opresko, Sample, and Suter 1994)
- C = conversion factor, wet-weight to dry-weight for vegetation = 0.25 (Baes et al. 1984).

Soil screening benchmark values for biota are listed in Table 3.3. Locations where soil samples have contaminant concentrations equal to or greater than those listed in Table 3.3 are candidates for further toxicological testing and biota sampling.

3.1.5 Earthworm Samples

Earthworms will be collected at the locations of AFIs where sampling action levels were exceeded in either sample interval from 0 to 16 in. and from those confirmatory sample locations described in Sect. 3.1.3. The sampling strategy team will review numbers of contaminants and their distributions throughout the floodplain after soil analysis data are returned to determine the maximum number of earthworm sample sites and the optimal site locations. A minimum of three sample locations will be identified to provide statistically defensible data. However, no more than two earthworm collections will occur at a given transect. Thus, if all six sample locations at a particular transect exceed the sampling action levels for either PCBs or uranium (Sect. 3.1.1), only two will be selected for earthworm sampling. These will be two of the sites selected for toxicity testing. Earthworms will be analyzed only for those analytes that exceed their toxicological benchmark values in the soil.

3.1.6 Vegetation Samples

Vegetation samples will be collected in the vicinity of AFIs where earthworm samples were collected. A sufficient sample for chemical analysis will be collected at each sample location. Vegetation will be analyzed only for those analytes that exceed their toxicological benchmark values in the sediment.

3.2 FINE-SCALE CHARACTERIZATION OF THE BEAR CREEK VALLEY FLOODPLAIN

The fine-scale characterization of the BCV floodplain will be based on the observation made at location BCK 4.70 that the two primary contaminants, uranium and PCBs, are concentrated near the creek's berm and within discrete strata in the floodplain. (See Table 3.21 of the RI Work Plan.) To confirm this observation and to characterize the extent to which it holds over the whole floodplain, the following characterization strategy has been devised. In addition to defining the locations of contaminants in the soil column, this characterization effort will serve to confirm the findings of the large-scale characterization effort and provide information for understanding the mechanisms for contaminant transport and deposition. If, during the course of this investigation, laboratory results indicate uranium and PCBs are not the only COPCs, the sampling strategy team will reevaluate the sampling and analysis strategy.

The investigation will begin at BCK 4.70 with a hand-dug, sediment profile excavation into the floodplain in the vicinity of coring sites W1 and W2. (See Fig. 3.24 and Table 3.21 of the RI Work Plan.) Excavation dimensions will be 3 × 1 × 1 m. Photographs will be taken of the excavation walls and discrete sediment layers will be flagged and demarcated. Discrete layers will then be sampled and screened for alpha radioactivity, PCBs, and VOCs as in the large-scale characterization. If any layer exceeds the sampling action levels for either alpha radiation, PCBs, or VOCs, then sufficient sample for radiological and chemical analysis (Table 3.2) will be collected from that layer where it is exposed in the walls of the excavation. In addition, that layer will be described in sufficient detail to be able to recognize a layer of

Table 3.3. Soil screening values for biota

Analytes	Screening dose (mg/kg/day)	Plant uptake factor (mg/kg)	Soil screening concentration (mg/kg)
	Inorganics		
Aluminum	1.38E+01	4.00E-03	1.37E+04
Antimony	8.96E-01	2.00E-01	9.70E+01
Arsenic	9.03E-01	8.00E-02	2.15E+02
Barium	8.77E+01	1.00E-02	6.96E+04
Beryllium	1.06E+01	4.00E-03	1.05E+04
Cadmium	1.37E+00	5.50E-01	5.72E+01
Calcium	NA	3.50E+00	NA
Chromium (VI)	5.29E+01	7.50E-03	4.58E+04
Cobalt	1.38E+02	8.00E-02	3.29E+04
Copper	2.67E+02	5.00E-02	9.08E+04
Iron	NA	4.00E-03	NA
Lead	1.29E+02	1.00E-02	1.02E+05
Magnesium	NA	1.00E+00	NA
Manganese	1.42E+03	4.00E-01	8.05E+04
Mercury	1.03E-01	3.00E-1	7.66E+00
Nickel	6.45E+02	5.00E-02	2.19E+05
Niobium	NA	2.00E-02	NA
Potassium	NA	2.50E-02	NA
Selenium	5.38E-01	2.50E-02	2.85E+02
Silver	NA	2.00E-01	NA
Sodium	NA	7.50E-02	NA
Thallium	1.21E-01	4.00E-03	1.20E+02
Thorium	NA	8.50E-04	NA
Vanadium	3.07E+00	5.50E-03	2.87E+03
Zinc	2.58E+03	4.00E-01	1.46E+05
	Organics		
Acenaphthene	1.25E+02	2.10E-01	1.30E+04
Acenaphthylene	NA	2.10E-01	NA
Acetone	1.61E+02	5.33E+01	7.20E+01

Table 3.3 (continued)

Analytes	Screening dose (mg/kg/day)	Plant uptake factor (mg/kg)	Soil screening concentration (mg/kg)
Aldrin	3.23E+00	1.11E-02	2.47E+03
alpha-BHC	NA	1.04E-01	NA
Anthracene	NA	2.68E-02	NA
Aroclor-1016	3.12E+01	2.94E-02	1.51E+04
Aroclor-1221	NA	1.63E-01	NA
Aroclor-1242	1.56E+00	1.84E-02	9.69E+02
Aroclor-1248	3.88E-01	1.70E-02	2.50E+02
Aroclor-1254	8.46E-01	1.14E-02	6.41E+02
Aroclor-1260	NA	2.27E+00	NA
Benzene	1.89E+02	2.24E-02	1.06E+05
Benzo(a)anthracene	NA	5.62E-02	NA
Benzo(a)pyrene	7.17E+00	6.17E-03	6.52E+03
Benzo(b)fluoranthene	NA	2.56E-03	NA
Benzo(g,h,i)perylene	NA	4.31E-03	NA
Benzo(k)fluoranthene	NA	3.20E+00	NA
beta-BHC	6.45E+00	6.36E-02	1.84E+03
Bis(2-chloroethyl)ether	NA	1.22E+00	NA
Bis(2-chloroisopropyl)ether	NA	3.35E-02	NA
Bis(2-ethylhexyl)phthalate	1.31E+02	3.82E-02	5.38E+04
Bromodichloromethane	NA	8.19E-01	NA
Bromoform	NA	4.68E-01	NA
Bromomethane	NA	2.74E+01	NA
2-Butanone	2.86E+04	6.69E-02	7.82E+06
Butyl benzyl phthalate	NA	1.73E-02	NA
Carbazole	NA	2.19E+00	NA
Carbon Disulfide	NA	1.02E+00	NA
Carbon Tetrachloride	2.58E+02	2.64E-01	2.16E+04
2-Chloroaniline	NA	NA	NA
Chlorobenzene	NA	1.55E-02	NA
Chlordane	3.28E+01	2.47E-01	2.92E+03

Table 3.3 (continued)

Analytes	Screening dose (mg/kg/day)	Plant uptake factor (mg/kg)	Soil screening concentration (mg/kg)
Chloroethane	NA	.2.81	NA
Chloromethane	NA	2.98E+00	NA
4-Chloro-3-methylphenol	NA	1.62E-01	NA
2-Chloronaphthalene	NA	2.22E+00	NA
2-Chlorophenol	NA	5.72E-01	NA
4-Chlorophenyl phenyl ether	NA	4.38E-02	NA
Chrysene	3.19E+03	5.72E-03	2.96E+06
2,4-D	NA	NA	NA
2,4-DB	NA	NA	NA
4,4-DDD	NA	1.05E-01	NA
4,4-DDE	NA	1.58E-02	NA
4,4-DDT	1.29E+01	NA	NA
delta-BHC	NA	1.37E-02	NA
Dibenzo(a,h)anthracene	3.23E+03	1.61E-01	4.24E+05
Dibenzofuran	NA	4.16E-02	NA
Dibromochloromethane	NA	6.19E-01	NA
1,2-Dichlorobenzene	NA	1.11E-01	NA
1,3-Dichlorobenzene	NA	1.11E-01	NA
1,4-Dichlorobenzene	NA	1.10E-01	NA
3,3'-Dichlorobenzidine	NA	2.19E+00	NA
1,1-Dichloroethane	NA	2.40E+00	NA
1,2-Dichloroethane	3.77E+02	5.40E+00	1.66E+03
1,1-Dichloroethylene	4.84E+02	5.87E-01	1.90E+04
1,2-Dichloroethylene	3.24E+02	5.40E+00	1.42E+03
2,4-Dichlorophenol	NA	NA	NA
Dichloroprop	NA	NA	NA
1,2-Dichloropropane	NA	4.81E-01	NA
1,3-Dichloropropene	NA	9.77E-02	NA
Dieldrin	3.22E-01	7.54E-01	9.91E+00
Diethyl phthalate	3.29E+04	NA	NA

Table 3.3 (continued)

Analytes	Screening dose (mg/kg/day)	Plant uptake factor (mg/kg)	Soil screening concentration (mg/kg)
Dimethyl phthalate	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA
2,6-Dinitrotoluene	NA	1.86E-04	NA
Di-n-octyl phthalate	NA	3.13E-01	NA
Endosulfan I	2.42E+00	NA	NA
Endosulfan II	2.42E+00	NA	NA
Endosulfan Sulfate	NA	1.51E-02	NA
Endrin	6.59E-01	NA	NA
Endrin Aldehyde	NA	NA	NA
Ethylbenzene	NA	2.60E-01	NA
Fluoranthene	8.87E+01	3.22E-02	4.05E+04
Fluorene	8.87E+01	1.49E-01	1.25E+04
gamma-BHC (Lindane)	1.29E+02	1.34E-01	1.99E+04
Heptachlor	1.29E+01	1.54E-01	1.77E+03
Heptachlor Epoxide	NA	1.54E-01	NA
Hexachlorobutadiene	NA	2.40E-02	NA
Hexachlorocyclopentadiene	NA	NA	NA
Hexachloroethane	NA	NA	NA
2-Hexanone	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	6.17E+00	NA
Isophorone	NA	1.45E-03	NA
MCPA	NA	NA	NA
MCPP	NA	NA	NA
Methoxychlor	6.45E+01	NA	NA
Methylene Chloride	9.43E+01	1.89E+00	1.17E+03
2-Methylnaphthalene	NA	5.87E-02	NA
4-Methyl-2-pentanone	4.03E+02	2.56E+00	3.72E+03
2-Methylphenol	NA	9.08E+00	NA
4-Methylphenol	NA	NA	NA

Table 3.3 (continued)

Analytes	Screening dose (mg/kg/day)	Plant uptake factor (mg/kg)	Soil screening concentration (mg/kg)
Naphthalene	NA	1.13E-01	NA
2-Nitroaniline	NA	4.43E-01	NA
3-Nitroaniline	NA	NA	NA
4-Nitroaniline	NA	NA	NA
Nitrobenzene	NA	NA	NA
2-Nitrophenol	NA	NA	NA
4-Nitrophenol	NA	NA	NA
N-nitroso-di-n-propylamine	NA	NA	NA
N-nitrosodiphenylamine	NA	6.77E+00	NA
Pentachlorophenol	NA	NA	NA
Phenanthrene	NA	2.64E-02	NA
Phenol	NA	1.43E+00	NA
Pyrene	5.37E+01	1.02E-01	1.05E+04
Styrene	NA	4.80E+01	NA
Tetrachloroethylene	2.04E+02	5.78E-01	8.12E+03
Toluene	1.86E+02	NA	NA
Toxaphene	1.29E+02	NA	NA
1,2,4-Trichlorobenzene	NA	1.08E+00	NA
1,1,1-Trichloroethane	7.54E+03	NA	NA
1,1,2-Trichloroethane	NA	NA	NA
Trichloroethylene	5.02E+00	1.89E-01	5.72E+02
2,4,5-Trichlorophenol	NA	NA	NA
2,4,6-Trichlorophenol	NA	1.45E+00	NA
Vinyl Acetate	NA	2.16E+00	NA
Vinyl Chloride	2.74E+00	4.50E+00	1.44E+01
Xylenes	1.48E+01	1.75E-01	1.80E+03

NA = data not available.

similar type and origin in shallow samples along the floodplain. Characteristics that will be included in the description are color, relative amounts of coarse, fine and organic material; depth in the profile; and general descriptions of overlying and underlying layers.

After characterization of the sediment profile excavation at BCK 4.70 is complete a modified version of it will be used to investigate the BCV floodplain between BCK 1.0 and BCK 11.09. Seventeen locations in the floodplain have been selected for this part of the fine-scale characterization effort (Fig. 3.2). A soil sample will be taken on or proximal to the berm to a depth equal to the bottom of the creek channel, or a maximum of 1 m or until sampler refusal, whichever comes first. The different layers in the sample will be inspected for similarities to those recognized as contaminant-bearing layers during the sediment profile characterization at BCK 4.70. Any layers that match the physical descriptions will be screened for alpha radiation, PCBs, and VOCs. If any layer exceeds the sampling action levels for a COPC (Sect. 3.1.1) then sufficient sample (Table 3.1) will be collected from the layer for laboratory analysis of the radiological and chemical constituents presented in Table 3.2. In addition, the sample location will be classified as an AFI and the location will be investigated as described for AFIs beginning with Sect. 3.1.2. This will include soil samples for chemical and radiological analysis, toxicity tests, and biota samples for ecological testing.

3.3 BEAR CREEK STREAM SEDIMENT CHARACTERIZATION

Whole sediment samples on Bear Creek and from tributaries and springs that feed Bear Creek will be collected in the field from specified locations (Fig. 3.2) and analyzed for the constituents presented in Table 3.2. In addition, the sediment samples will be tested at the Environmental Sciences Division Aquatic Toxicology Laboratory (ESD-ATL) for toxicity to surrogate benthic invertebrates. Sample splits will be sent to a second laboratory for bulk sediment characteristics. The data obtained from these toxicity tests will be used in the BCV-Environmental Risk Assessment (ERA) as one of several lines of evidence to evaluate the ecological condition of BCV. Seventeen locations have been identified along Bear Creek for sediment sample collection (Fig. 3.2).

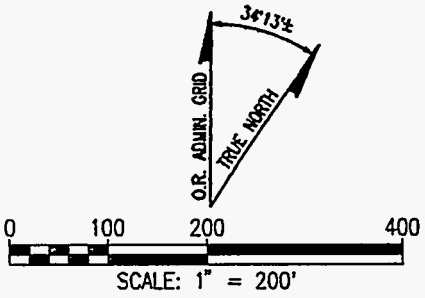
3.4 SOURCE TERM ECOLOGICAL CHARACTERIZATION

In order to completely characterize the full ecological impact of any potential contaminants it will be necessary to investigate the impact of potential source areas. A major proportion of the source areas for the Bear Creek drainage reside in OU 1. The RI for OU 1 will be conducted during the fall of 1994, prior to the investigation of the BCV floodplain described here. Hence, by the time the BCV floodplain investigation is under way, many source soil samples will have been collected and sent to the laboratory for radiological and chemical analysis. In order to correlate ecological sampling with the OU 1 soil sampling effort, six sampling locations have been identified from the OU 1 sampling plan for ecological sample collection (Fig. 3.3). Ecological source term sampling will be conducted at each of the six soil sample locations. The sampling strategy team will review available soil data from adjacent soil borings sampled during BCV OU 1, toxicological benchmarks (Sect. 3.1), and site accessibility to determine types of ecological sampling appropriate for each site. No intrusive sampling will be conducted in the capped sections of the Burial Grounds. A split

Fig. 3.3. Proposed sour

LEGEND:

- 3 ..... PROPOSED BCV OU1 SOIL BORING LOCATION
- ▲ .. PROPOSED SOURCE TERM ECOLOGICAL SAMPLING LOCATION



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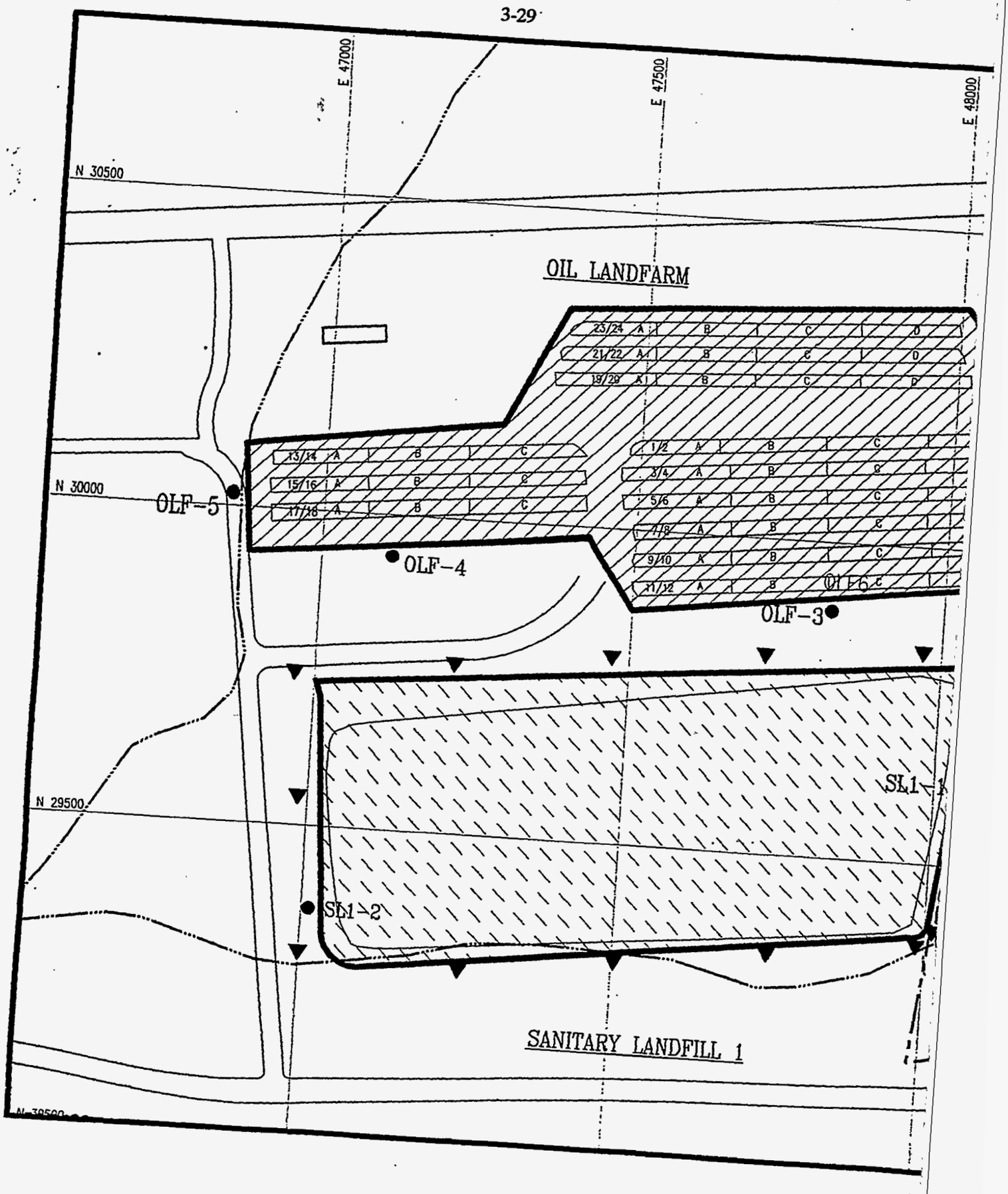
BEAR CREEK VALLEY OPERABLE UNIT 1 S-3 SITE

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM	K. SWAIN	9/28/94

XREFERENCES	PLOT FILES
/94003/XREF/BASE2 /94020/XREF/MANGAREA	94020/PLOT/752SMPA

93044	/DWGS/752SMPA	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

term ecological sample locations.


E 47000
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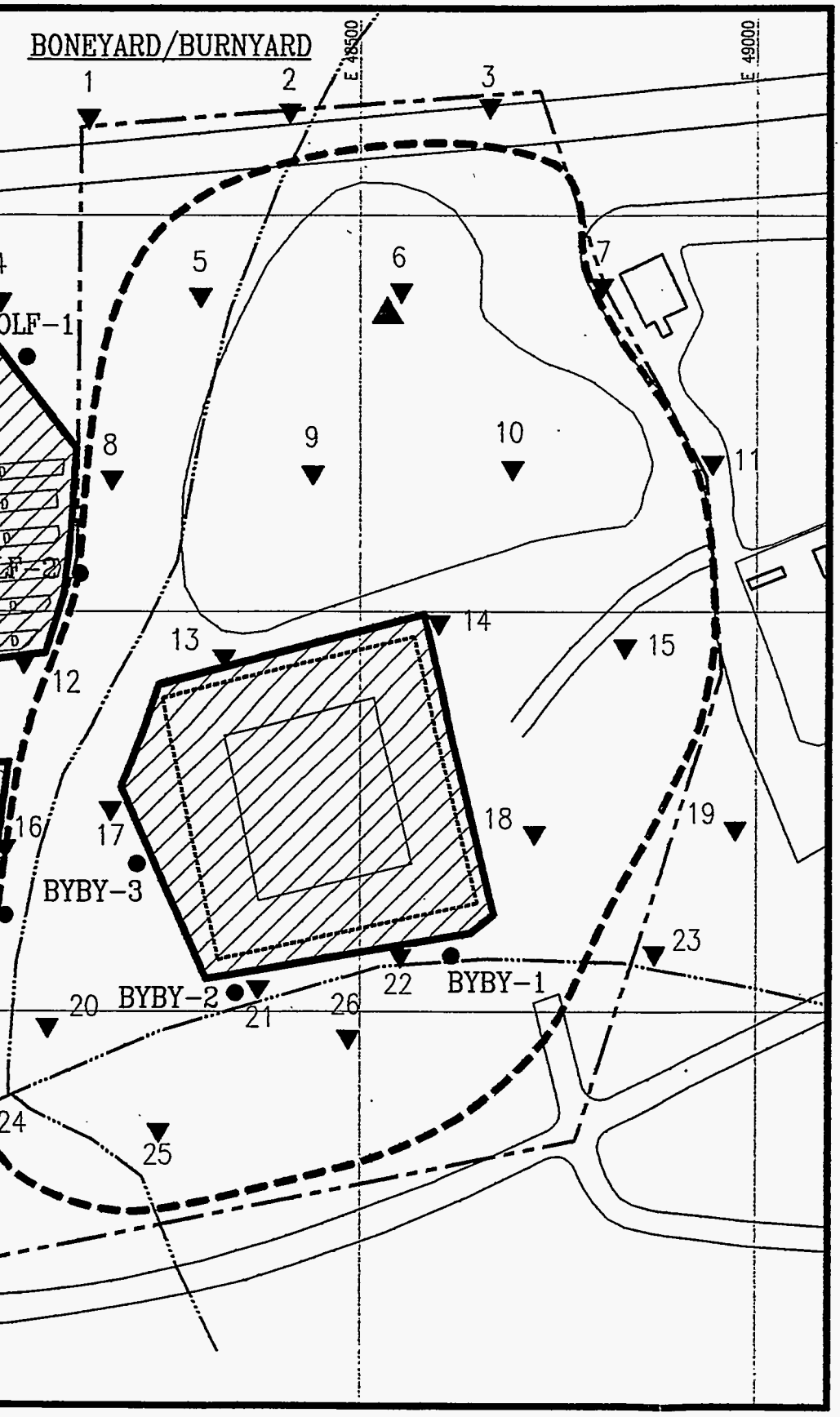
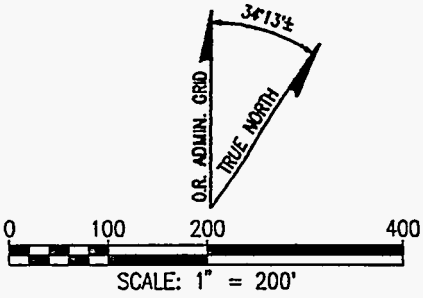
E 48000
N 30500
OIL LANDFARM
23/24
21/22
19/20
13/14
15/16
17/18
1/2
3/4
5/6
7/8
9/10
11/12
N 30000
OLF-5
OLF-4
OLF-3
SL1-1
N 29500
SL1-2
SANITARY LANDFILL 1

Fig. 3.3



LEGEND:

- ▲ PROPOSED ECOLOGICAL SAMPLE LOCATION
- ●3 PROPOSED BCV OU1 SOIL BORING LOCATION
- ▼ PROPOSED BCV OU1 SURFACE SOIL SAMPLE



Science Applications International Corporation

OIL LANDFARM SANITARY LANDFILL 1 BONEYARD/BURNYARD

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM	K. SWAIN	9/28/94

XREFERENCES	PLOT FILES
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99020	/DWGS/752SMPB	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

ontinued)

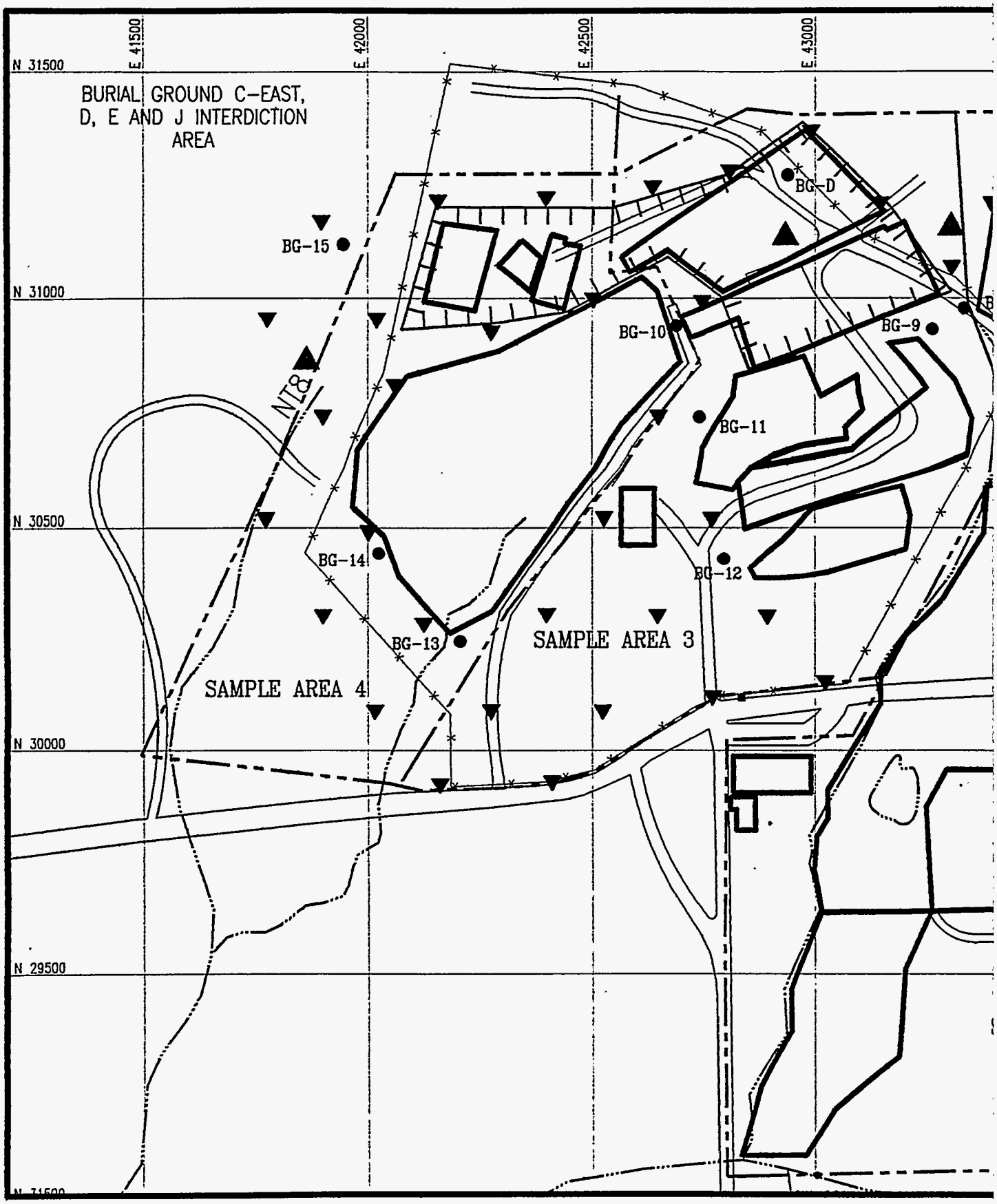
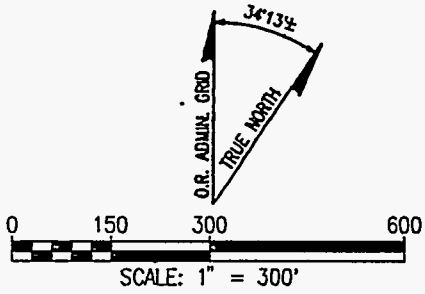

E 41500
E 42000
E 42500
E 43000
N 31500
N 31000
N 30500
N 30000
N 29500
BURIAL GROUND C-EAST,
D, E AND J INTERDICTION
AREA
BG-D
BG-15
BG-10
BG-9
BG-11
BG-14
BG-12
BG-13
SAMPLE AREA 3
SAMPLE AREA 4
NT&

Fig. 3.3

LEGEND:

- PROPOSED SOURCE TERM ECOLOGICAL SAMPLE LOCATION
- PROPOSED BCV OU1 SURFACE SOIL OR SEDIMENT SAMPLE
- BG-1 PROPOSED BCV OU1 SOIL BORING LOCATION



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BEAR CREEK VALLEY OPERABLE UNIT 1 BURIAL GROUNDS

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM	K. SWAIN	9/28/94

XREFERENCES	PLOT FILES
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94020	/DWGS/752SMPC	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

(continued)

from all ecological characterization samples collected from the source term areas will be submitted for geotechnical analysis. Ecological sample collection will be conducted as described above for the large-scale characterization investigation (Sect. 3.1).

3.5 REFERENCE SAMPLES AND VALUES

It is important to establish reference radiological screening activities and reference concentrations for the full list of analytes (Table 3.1) against which the results of the sample analyses for the BCV floodplain investigation can be compared. To do this, it will be necessary to go outside the BCV floodplain to collect a number of different types of samples.

3.5.1 Floodplain Soil Screening Reference Samples

Soil screening during the large-scale and fine-scale characterizations will involve PCB, radiometric, and VOC screening techniques. The reference value for PCBs is set to satisfy risk assessment needs. The reference value for alpha radiation will be determined by locating 10 sites outside of the BCV floodplain but within geologic and soil units similar to those of the floodplain. The best locations for these will be along tributaries to Bear Creek that do not drain waste disposal sites. Reference samples will be taken at three locations at each of these sites for a total of 30 measurements. The analytical procedure that will be used is presented in Sect. 6.1. The reference value used for comparison purposes will be the upper ninety-five percent (95%) confidence level arithmetic average of all of the readings from all of the sites.

3.5.2 Floodplain Soil Radiological and Chemical Reference Values

The reference values against which soil radiological and chemical analyses will be compared will come from the Background Soil Characterization Project (DOE/OR/01-1136) for soils of similar type and origin. These reference values will be for inorganic elements and compounds and radionuclides only. This is based on the assumption that the organic analytes are not naturally occurring and, therefore, do not have reference concentrations.

3.5.3 Ecological Reference Samples

A reference sample of small mammals, earthworms, and vegetation will be taken from areas outside the BCV floodplain but in soil similar to those found in the floodplain. Locations for each type of sample will correspond to one of the locations from which the soil reference values were determined by the Background Soil Characterization Project (Sect. 3.5.2). Samples will be collected in accordance with the procedures described in Sects. 1.3.1.4 through 1.3.1.6 and Sects. 1.4.2 through 1.4.4.

3.5.4 Stream Sediment Reference Samples

Three stream sediment samples will be collected from Bear Creek or its tributaries for chemical and radiological analysis from areas not affected by contamination. The three samples will be composited in equal amounts for sediment toxicity testing. If suitable locations cannot be found on Bear Creek, samples will be collected from Hinds Creek and/or Grassy Creek for reference purposes. The samples will be collected in accordance with the

procedures described in Sect. 3.3 and Sect. 4.5. The sediment reference samples will be analyzed for the full radiological and chemical suite (Table 3.1).

3.6 ESTIMATED NUMBER OF SAMPLES

The estimated number of all types of samples is presented in Table 3.4. Many of the estimates are based upon the following assumptions:

- For the large-scale characterization there will be 13 transects with 6 shallow sample locations per transect (total of 78 locations) and 3 sampled intervals per sample location.
- A maximum of 40 AFIs will be designated for further analysis.
- There will be 17 locations for the fine-scale characterization.
- Two soil strata per location will match the indicator criteria for contaminated layers in the fine-scale characterization.
- A minimum of three biota samples, excluding small mammals, will be collected from large-scale and fine-scale characterization sites combined.
- Stream sediment samples will be collected from 17 locations and every sample will be fully analyzed.
- Confirmatory samples will be recovered from 15% of the large-scale characterization sample locations that did not exceed screening criteria.

3.7 SCHEDULE OF PROPOSED FIELD ACTIVITIES

Figure 3.4 presents a schedule of the primary field activities that have been discussed in the preceding sections. The schedule assumes a start date in late fall of 1994 such that sampling of stream sediment and floodplain soils will occur during periods of active sediment transport. Scheduled activities also emphasize biota collection in peak biological activity in the spring for use in ecological risk assessment.

Table 3.4. Maximum/minimum number of samples that will be collected as a result of the implementation of the BCV floodplain SAP

Medium	Parameter	No. of sites	No. of samples	Duplicates	Field blanks	Rinsates	Trip blanks	Total
			Large-scale[a]					
Soil	Rad, PCB, VOC screen	78/78	234/354[b]					234/354
	Full suite rad and chemical	0/40	0/120	0/6	0/2	0/6	0/10	0/146
	Toxicity test	3[c]/39	3[c]/39					3[c]/39
	Geotechnical	3[c]/26	3[c]/26					3[c]/26
Biota	Mice	0/13	0/13					0/13
	Earthworms	3[c]/26	3[c]/26					3[c]/26
	Vegetation	3[c]/26	27/234					27/234
			Confirmatory[d]					
Soil	Full suite rad and chemical	0/18	0/18	0/1		0/1	0/3	0/23
	Toxicity test	3[c]/6	3[c]/6					3[c]/6
	Geotechnical	3[c]/6	3[c]/6					3[c]/6
Biota	Mice	0/12	0/12					0/12
	Earthworms	3[c]/6	3[c]/6					3[c]/6
	Vegetation	3[c]/6	27/54					27/54

Table 3.4 (continued)

Medium	Parameter	No. of sites	No. of samples	Duplicates	Field blanks	Rinsates	Trip blanks	Total
				Fine-scale				
Soil	Rad, PCB, VOC screen	0/17	0/85[e]					0/85[e]
	Full suite rad and chemical	0/17	0/51	0/3		0/3	0/5	0/62
	Toxicity test	3[c]/17	3[c]/17					3[c]/17
	Geotechnical	3[c]/17	3[c]/17					3[c]/17
Biota	Mice	0/17	0/17					0/17
	Earthworms	3[c]/17	3[c]/17					3[c]/17
	Vegetation	3[c]/17	3[c]/153					3[c]/153
				Stream Sediment				
Sediment	Full suite rad and chemical	NA/17	NA/17	1		1	5	NA/24
	Toxicity test	NA/17	NA/17					NA/17
	Geotechnical	NA/17	NA/17					NA/17
				Reference				
Soil	Soil radiologicals	30	30					30
Stream Sediment	Chemical and radiologicals	3	3					3

Table 3.4 (continued)

Medium	Parameter	No. of sites	No. of samples	Duplicates	Field blanks	Rinsates	Trip blanks	Total
	Sediment toxicity	3	1 (composite)					1
	Geotechnical	3	1 (composite)					1
Biota	Mice	3	3					3
	Earthworms	3	3					1
	Vegetation	2	18					18

NA = Not applicable.

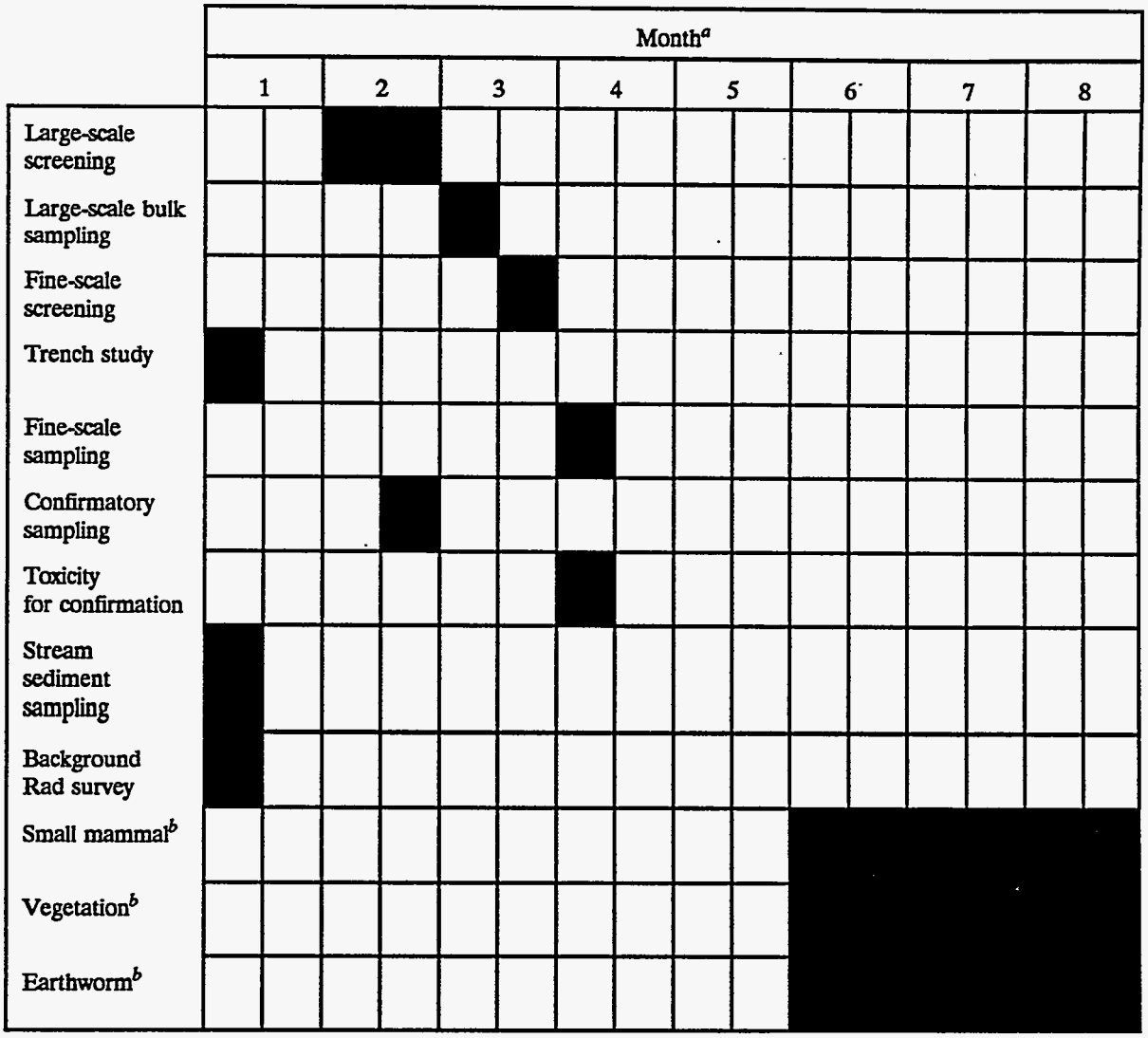
[a]Large-scale characterization and sample numbers are derived by assuming all large-scale characterization samples exceeded sampling action levels for a minimum and none exceeded sampling action levels for a minimum sample number.

[b]The minimum includes 234 initial screenings plus maximum number of confirmatory samples (36 from 12 sites) that will be screened for comparison to laboratory data. The maximum includes 234 initial screenings plus the maximum number of samples (120) that will be screened for comparison to laboratory data. Only PCB and uranium screens will be conducted on samples sent to the laboratory.

[c]A minimum of three (3) sites will be sampled for earthworm, vegetation, toxicity testing, and geotechnical parameters from large-scale, confirmatory, and fine-scale sampling combined.

[d]Confirmatory sample numbers are derived assuming all samples exceeded the sampling action level in the large-scale characterization sampling for a minimum and none exceeded for a maximum.

[e]This is the maximum number derived assuming 2 layers per site will be initially screened and all 17 sites will be resampled as AFIs requiring 51 additional screening tests.



[a]The schedule assumes the NTP will be issued in late fall.
[b]All biota sampling must be conducted between April 15 and August 31.

Fig. 3.4. Field activity schedule.

4. SAMPLING PROCEDURES

4.1 FLOOD PLAIN SEDIMENT SAMPLING

All soil sampling for the Bear Creek Valley investigation will be conducted using media-specific standard operating procedures (SOPs) when applicable, provided, or approved by Y-12 Plant ER and consistent with the Martin Marietta Energy Systems, Inc. (Energy Systems), document ESH/Sub/87-21706/1, *Environmental Surveillance Procedures, Quality Control Program* (Kimbrough, Long, and McMahon 1990). Any necessary deviations from the SOPs will be documented on an FCO form as outlined in the Field Quality Assurance Project Plan for this SAP (Chap. 7).

Soil sampling in the floodplain will be conducted using a 3-in. manual sampler (hand auger or corer) in accordance with Energy Systems procedures (Kimbrough, Long, and McMahon 1990). Additional technical procedures to be used during the course of the Bear Creek floodplain investigation are presented in Table 4.1.

4.2 SMALL MAMMAL SAMPLING

Small mammals will be collected using snap traps or Sherman live traps at locations to be selected based on the results of the floodplain soil screening analysis of the Bear Creek watershed. A maximum of one sample location per transect will be sampled. The sampling strategy team will determine the location after soil sample analyses have been conducted. Traps will be baited with peanut butter and oats and checked daily.

Determination of age, sex, body measurements (weight, tail length, head/body/length), and species of small mammals shall be performed. Whole-body samples shall be washed with a nonionic shampoo to remove external contamination and thoroughly rinsed with deionized water. Samples will be stored at −20°C in a freezer before submission for laboratory analysis.

4.3 EARTHWORM SAMPLING

The procedure for earthworm collection will be to use a mustard solution (Gunn 1992) as an expellant (Bechtel 1994). This technique is nonintrusive, minimizes personnel exposure to contaminants, and is not as labor intensive as hand sorting. Samples will be taken by forcing a 50 × 50 cm stainless steel frame ~10 cm into the sediment. Three to 6 L of a mustard and water suspension will be slowly applied to the surface within the frame using a watering can to obtain even spread and minimal ponding. Surfacing earthworms will be collected using forceps until no additional worms emerge from the soil (~20 to 25 min).

Upon collection, each worm will be rinsed in the field with deionized water (to remove soil and expellant), placed in a sealed petri dish, and placed in a cooler. It is essential that all worms be kept moist, intact, and alive, and that handling be minimized. Parameters recorded for each earthworm will include sample location, sample site, date collected, weight (to be measured in the laboratory), presence of clitellum (girdle), and general physical condition,

Table 4.1 Technical procedures to be used in the course of BCV floodplain investigation

Procedure number	Subject activity	Issue date	Revision
	Soil sampling		
ESP 303-1	Soil sampling with a spade and scoop	8/30/88	0
ESP-303-2	Soil sampling with an auger	9/1/88	0
TP-303-8	Subsoil sampling with a JMC backsaver soil sampling system	10/2/91	1
	Stream sampling		
ESP-304-1	Sediment sampling procedures: stream beds	10/29/90	1
	Biota sampling		
TP-309-9	Terrestrial vegetation sampling collection	5/8/92	0
TP-309-3	Terrestrial small mammal sampling	10/15/91	0
K-901-1062	Terrestrial subsurface macroinvertebrate collection	9/14/94	0

including overt signs of lesions or other abnormalities. In addition, a running total of earthworms collected since the time expellant was added (in 2-min intervals) should be recorded.

All worms will be maintained in the laboratory for 3 d to allow voiding of intestinal tract contents (depuration). Depurate collected from the earthworms will be composited by sample location. All samples (worm and depurate) will be analyzed for the radiological and chemical parameters that will be identified from the results of the soil analyses at their corresponding locations.

4.4 VEGETATION SAMPLING

Vegetation collected will include tree foliage, herbaceous ground cover (i.e., grasses and forbs), and woody browse plants [e.g., Japanese honeysuckle (*Lonicera japonica*)]. Vegetation will be collected from the same locations as earthworms. As availability permits, three samples of each vegetation type will be collected at each location (for a maximum of nine samples per location). Leaves from a given tree will be counted as a single sample. Ground cover and woody browse will each be sampled by compositing both leaves and stems at each sampling point.

Vegetation samples will be rinsed with deionized water in the laboratory to remove external contamination, air dried, and stored at −20°C in a freezer before submission for laboratory analysis. Vegetation samples may be ground to a fine, homogeneous powder using a sample mill, or the analytical laboratory may perform homogenization.

4.5 STREAM SEDIMENT SAMPLING

All stream sediment sampling for the Bear Creek Valley investigation will be conducted using media-specific SOPs when applicable, provided or approved by Y-12 Plant ER and consistent with the Energy Systems document ESH/Sub/87-21706/1, *Environmental Surveillance Procedures, Quality Control Program* (Kimbrough, Long, and McMahon 1990), and the U.S. Environmental Protection Agency (EPA) document, *Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual* (EPA 1991). Any necessary deviations from the SOPs will be documented on an FCO form as outlined in the Field Quality Assurance Project Plan for this SAP (Chap. 7).

Specifically, stream sediment sampling in Bear Creek will be conducted using a 1-L, hand-operated, Ponar-style dredge. Sampling will be conducted in accordance with Energy Systems procedure ESP-304-1 (Kimbrough, Long, and McMahon 1990). Additional information for stream sediment sampling procedures using the Ponar dredge can be found in SOP-29 of the ESD Toxicology Laboratory Quality Assurance Manual—Collection of Surface Sediment Samples. Other technical procedures to be used during the course of the Bear Creek floodplain investigation are presented in Table 4.1.

One 2-L sample volume will be collected at each designated sampling site. In the field, large gravel and debris will be removed from the whole sediment samples that will be homogenized. One 0.5-L split portion (for toxicity testing) will be placed into labeled 0.5-L, high-density polyethylene (HDPE) sample containers on ice. The other 1.5-L split portion (for bulk analysis) will be placed into containers with volumes appropriate for use in laboratory analysis and stored on ice. All samples will be shipped on ice to either the laboratory for chemical and radiological analysis or to the ESD-ATL for toxicity testing. In addition, each sample will be sent to a geotechnical laboratory for analysis of moisture content, pH, particle size distribution, and organic content using ASTM or *Methods of Soil Analysis* procedures.

5. DOCUMENTATION

Field documentation will be maintained throughout the investigation in various types of documents and formats, including the site logbook, field logbooks, sample labels, sample tags, chain-of-custody forms, and field data sheets. The following general guidelines for maintaining field documentation will be implemented:

- All entries will be written clearly and legibly using nonerasable, indelible black ink.
- Corrections will be made by marking a single line through the error that does not obliterate the original entry. Corrections will be dated and initialed.
- Dates and times will be recorded using the format "mm/dd/yy" for the date and the military (i.e., 24-h) clock to record the time.
- Zeros will be recorded with a slash (/) to distinguish them from letter "O"s.
- No documents will be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require correction.

5.1 FIELD LOGBOOKS

An integral part of the quality assurance/quality control (QA/QC) plan for the field activities will be to maintain accurate and complete field records and to collect appropriate field data forms. This will be accomplished by establishing a field logbook to be kept by the Field Team Leader. The primary purpose of the logbook is to document each day's field activities, the personnel on each sampling team, and any administrative occurrences, conditions, or activities that may have affected the field work or data quality of any environmental samples for any given day. The field logbook will be a bound book with a hard cover and sequentially numbered pages. The location, the names of the company or companies performing the field sampling, the client, and the contract number for the work being performed will be listed on its front cover. Each logbook will contain, as a minimum, a title page, a table of contents, task team activity log sheets, and sample log sheets. The title page of each logbook will provide the following information: project title, work site, contract number, task order, project manager, telephone number, site location start date, and end date.

The field logbook will contain as a minimum the following information:

- day, date, time arrived on site;
- temperature and weather conditions;
- names and titles of personnel present on site;
- name, title, and organization affiliation of any visitor who entered the site during the day;
- arrival time of any subcontractors on site;
- any unusual occurrences encountered during sampling;

- number of duplicate samples, number of split samples, laboratory to which split samples were sent, references to field logbook(s) or field forms that contain more specific field information for any tasks;
- decontamination iterations, equipment decontaminated, and procedures used;
- specific comments relative to any problems that occurred during the day's activities, the final resolution of any problems, and the anticipated impact on the outcome of the field investigation or on data quality;
- a record of telephone calls (incoming and outgoing) pertaining directly to the decision-making process of the field investigation, along with the outcome of each conversation, and a reference to the telephone log to obtain more specific information on the call;
- page numbers of sample log sheets that correspond to that day's activities;
- notations of equipment used to prepare equipment QC; and
- any other information the Field Team Leader deems necessary to fully document the sampling activities.

In addition to the requirements for documentation shown in the previous list, general requirements for logbooks include the following:

- Unused logbook pages will be marked with a diagonal line drawn from corner to corner.
- All information blocks on field collection forms will be completed.
- If any section of a form is not used, a line will be drawn through the unused section and the area dated and initialed.
- Security of the logbooks will be maintained by storing them in a secured (i.e., locked) area when not in use.
- A backup copy (i.e., photocopy) of daily entries will be maintained and stored separately from the original logbook.

The field logbook will also contain an equipment calibration log sheet for each instrument to document the proper use, maintenance, and calibration of all field testing equipment used during the field sampling. Calibration log sheets within the logbooks will supplement the master calibration log maintained for all field instrumentation. Before using field equipment, the Field Team Leader will inspect and document approval of the use of the field testing equipment by initialing the equipment calibration sheet. The team member using, maintaining, or calibrating the instrument will document his/her actions on the calibration log sheet in the field logbook when calibration is performed and will record the instrumentation identification (ID) number on the log sheet.

One, two-sided sample log sheet will contain sample-specific information for each field sample collected, including field QC samples. Generally, sample log sheets will be preprinted from the data management system with the following information:

- project name and number;
- sample ID number;

- sampling location, station code, and description;
- sample medium or media;
- sample type;
- analysis;
- preservative; and
- volume.

In addition, all specific analytical requests will also be preprinted from the data management system and will include the following for each analytical request:

- analysis/method,
- container type,
- number of containers,
- container volume,
- preservative (type/volume), and
- destination laboratory.

During sample collection, a field team member will record the remaining required information and sign and date each sample log sheet. The following information will be recorded for each sample:

- whether or not the sample was collected;
- date and time of collection;
- name of the collector;
- collection methods and/or procedures;
- all required field measurements and measurement units;
- instrumentation documentation, including the date of last calibration;
- adherence to or deviation from the procedure or the sampling and analysis plan;
- weather conditions at the time of sample collection;
- activities in the area that could impact subsequent data evaluation;
- general field observations that could assist in subsequent data evaluation;
- sample documentation and transportation information, including unique chain-of-custody form number, air bill number, and container lot number; and
- all relevant and associated field QC samples (for each sample).

If preprinted sample log sheets are not used, all information will be recorded manually. A member of the sampling team other than the recorder will perform a QA review of each sample log sheet and document the review by signing and dating the log sheet. Notations of deviations will be initialed by the Field Team Leader as part of his/her review of the logbook.

5.2 SAMPLE IDENTIFICATION, NUMBERING, AND LABELING

Each sample will be identified by a pressure-sensitive, gummed label placed on the sample container at the time of collection. In addition to the sample label, a sample container tag will be firmly attached to the sample container with string, waterproof tape, or rubber bands to provide evidence and a permanent record of samples received at the analytical laboratory. Generally, sample labels and tags will be preprinted with information from the data management system and will contain the following information:

- sample ID number;
- project number;
- sampling location, station code, and description;
- sample medium;
- sample type;
- type or types of analysis required;
- preservative;
- volume; and
- destination laboratory.

A field sampling team member will complete the remaining information during sample collection:

- name of collector,
- date and time of collection,
- radiological screening information, and
- comments.

Furthermore, when samples are collected, a pressure-sensitive, gummed sample seal will be attached to the sample containers in such a way that it will be necessary to break the seal to open the sample container. These seals will ensure that should any tampering occur between sample collection and analysis, the tampering will be detectable. All samples designated for shipment that leave the sampler's custody will have a sample seal affixed.

If preprinted sample labels and tags are not used, all information will be recorded manually during sample collection. The recorder will sign and date all entries made on sample labels, tags, and seals, and a member of the sampling team other than the recorder will perform an independent QA review of the entries and document the review in the field logbook with his or her signature and the date.

The following briefly summarizes the sample ID plan. It will provide a basis for understanding the sample designations and can be used as a stand-alone section for those dealing with the data and sample ID numbers.

In order to support the data management requirements specified in the EPA Contract Laboratory Program (CLP) statements of work (SOWs), sample IDs will be limited to 15 characters. The first seven characters will be the project ID obtained from the Work Breakdown Structure (WBS) system, and the second eight characters will be the sample number. While this may appear to be a limitation, the data management system provides an additional data field to describe specific sample ID information. Adhering to the CLP SOW requirements will facilitate the overall data reporting and ensure the integrity of project-derived data. Sample ID numbers will be coded to enable identification of the location, sample pattern, media, and depth.

- Sample location—A single character or digit will be used to identify the sampling location within the specific study area. This position of the sample ID will be keyed to descriptive text specifically identifying the location.
- Sample station/boring—Three digits will be used to identify the specific sampling station within the sampling location (i.e., sample location number) mentioned in the previously listed item. This position of the sample ID will be keyed to descriptive text. This field will identify the station.
- Sample media—A single digit will be used to identify the type of medium being sampled. This position of the sample ID will be keyed to descriptive text identifying the sample medium.

  A single digit will be used to designate sequential sample numbers.

5.3 SAMPLE CHAIN-OF-CUSTODY

Chain-of-custody procedures will document sample possession from the time of collection, through all transfers of custody, to receipt at the laboratory and subsequent analysis. Chain-of-custody records will accompany each packaged lot of samples; the laboratory will not accept samples for analysis without a correctly prepared chain-of-custody record. A sample will be considered under custody if it is (1) in the possession of the sampling team, (2) in view of the sampling team, or (3) transferred to a secured (i.e., locked) location.

The Field Team Leader is responsible for reviewing and ensuring the accuracy and completeness of the chain-of-custody form and for the custody of the collected samples in the field until they have been properly transferred to the Shipping Coordinator, who is responsible for sample custody until the samples are properly packaged, documented, and released to a courier or directly to the analytical laboratory. If samples are not immediately transported to the analytical laboratory, they will remain in the custody of the Shipping Coordinator and will be refrigerated, with custody seals affixed. Keys to the secure area will be kept by the Field Team Leader or designee.

A carbonless, multicopy chain-of-custody form will be used for this project. Each chain-of-custody form will be identified by a unique number located in the upper right hand corner, which will be recorded on the sample log sheet at the time of sample collection. Each chain-of-custody form will contain the following information:

- the ID for each sample;
- the collection data for each sample;
- the number of containers of each sample;
- a description of each sample (environmental matrix/field QC type);
- analyses required for each sample;
- method of shipment;
- special handling requirements;
- date and time of shipment, if relevant; and
- blocks to be signed as custody is transferred from one individual to another.

In addition, the airbill number and temperature in the cooler will be recorded in the comments section, as appropriate. The original chain-of-custody form will be sealed in a reclosable plastic bag and taped to the inside of the cooler lid, and copies will be retained for the Data Coordinator and the Field Team Leader's records.

At each point of transfer, the individuals relinquishing and receiving custody of the samples sign in the appropriate blocks and record the date and time of transfer. When the laboratory sample custodian receives the samples, he or she will document receipt of the samples, record the time and date of receipt, and note the condition of the samples (e.g., cooler temperature, whether the seals are intact) in the comments section. The laboratory will then forward the following to the project Data Coordinator:

- a cover memo stating sample receipt date and any problems noted at the time of receipt;
- the original signed chain-of-custody form; and
- a report showing the field sample ID, the laboratory ID, and the analyses scheduled by the laboratory for each sample.

5.4 SAMPLE SHIPMENT

Samples shipped for CLP analyses will be packaged in thermally insulated, rigid containers, according to U. S. Department of Transportation (DOT) specifications 172, Subparts B, C, and D; Subparts A and B of Part 173; and 173.510. Sample containers will be placed in the shipping container with blue ice and absorbent packing for liquids or Styrofoam packing for solids. The completed chain-of-custody form will be placed inside the shipping container unless otherwise noted. The container will then be sealed.

Procedure ESP-800, *Packaging Environmental Samples for Transportation,* will be followed in the preparation and packaging of samples. In general, sample containers will be packed according to the following:

- Custody tape will be wrapped over the neck and cap of each container.
- Glass sample containers will be wrapped with plastic insulating material to prevent contact with other sample containers or the inner walls of the container.

- Logbook entries, sample tags and labels, and chain-of-custody forms with sample data collection information and names of all persons handling the sample in the field will be completed before packaging.
- Samples, coolant blanks, and trip blanks will be placed in a thermally insulated cooler along with ice packed in reclosable plastic bags. After the cooler is filled, the appropriate chain-of-custody form will be placed in the cooler in a reclosable plastic bag attached to the inside of the cooler lid.
- The temperature of the coolant blank will be recorded before the sealing of the cooler.
- Samples will be classified according to DOT regulations pursuant to Title 49 *Code of Federal Regulations.* All samples will be screened for radioactivity so that DOT limits of 2 μCi/mL for liquid waste and 2 μCi/g for solid waste are not exceeded.

5.5 FIELD PLANNING MEETING

A field planning meeting will be conducted before work begins at the site so that all involved personnel will be informed of the requirements of the field work associated with the project. Additional planning meetings will be held whenever new personnel join the field team or if the scope of work changes significantly. Each meeting will have a written agenda and attendees must sign an attendance sheet that will be maintained in the project files and on site. The following will be discussed at these meetings:

- objectives and scope of the field work,
- project and site-specific health and safety,
- equipment and training needs,
- field operating procedures,
- required QC measures, and
- documents covering on-site field work.

5.6 READINESS CHECKLIST

Before implementation of the field program, the Quality Assurance Project Plan (QAPjP) and Field Sampling Plan (FSP) will be reviewed to identify all field activities and materials required to complete the activities. An SAIC-prepared readiness checklist will be reviewed to ensure that all activities required for project readiness have been accounted for on the list and will be considered in the assessment of project readiness. The following activities must appear on the checklist and be considered in project readiness:

- task deliverables,
- required approvals and permits,
- personnel availability,
- training and indoctrination,
- field equipment,

- sampling equipment,
- site facilities and equipment, and
- health and safety equipment.

Before field work begins, appropriate Energy Systems personnel will concur that readiness has been achieved.

6. SAMPLE AND TOXICITY ANALYSIS

6.1 FLOODPLAIN SOIL RADIOMETRIC FIELD SCREENING ANALYSIS

Field screening for radioactivity will be done with an alpha scintillation detector having a suitable portable ratemeter/scaler. An instrument setup similar to the Ludlum model 43-1-1 detector with the model 2223 portable alpha/beta scaler/ratemeter is the instrument of choice. Samples will be collected and composited and an aliquot will be placed in a stainless steel bowl. The bowl will be placed inside of a box constructed of 2.54-cm-thick lead walls having an opening for the detector probe. Alpha counting will take place over a 10-min period.

6.2 FLOODPLAIN SOIL PCB SCREENING ANALYSIS

Field screening for PCBs will be done with commercially available PCB field detection devices. After sample collection and compositing, an aliquot will be taken for field screening analysis. The procedure will follow the manufacturer's instruction.

6.3 LABORATORY RADIOLOGICAL ANALYSIS

All laboratories performing analyses for the investigation will be required to hold a current Nuclear Regulatory Commission (NRC) license for handling radioactive materials. In addition, all laboratories will be audited and accepted by the Energy Systems Analytical Project Office before field mobilization.

When available and appropriate for the sample matrix, EPA methods will be used. When EPA methods are not available or are not appropriate, other nationally recognized methods such as the U.S. Department of Energy (DOE) and ASTM methods will be used. The following standardized procedure manuals are recommended references for radiological analysis:

- EPA-600/4-80-032, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water;*
- EPA SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods;*
- EPA 520/5-84-006, *Eastern Environmental Radiation Facility Radiochemistry Procedures Manual;* and
- HASL-300, *DOE Environmental Measurements Laboratory Procedure Manual.*

If a laboratory has adapted a method from one of these standardized procedure manuals or other nationally recognized sources, the laboratory's procedure will be evaluated to ensure equivalency before being approved for use. Sample pretreatment methods (i.e., leaching, dissolution) will be selected to correspond to the sample matrix type. Sediment samples will undergo total dissolution through a combination of ashing and acid digestion. Sediment samples collected during the field effort will be submitted for laboratory analysis of the suspected radionuclide COPCs, gamma scan, and total activity (^{241}Am to be determined by gamma scan).

Table 3.2 (Sect. 3.1.2) summarizes sample and analysis requirements for radiological analytical parameters. The estimated instrument detection limits presented are the target levels that will be required of the laboratory. Analysis of concentrations at these limits will be distinguishable from the background 95% of the time. However, net results and uncertainties will be reported for all analyses. Soil and sediment samples to be analyzed for radionuclides require no preservation and have holding times of 6 months.

6.4 LABORATORY CHEMICAL ANALYSIS

Laboratory analyses of soil and sediment samples (Table 3.2) will be performed by laboratories participating in the EPA CLP using methods presented in Table 3.2. Sample holding times are discussed in the QAPjP.

6.5 FLOODPLAIN SEDIMENT TOXICITY TESTING

The Ecotoxicology Laboratory will estimate sediment toxicity using the earthworm *Eisenia foetida* and the plant *Arabidopsis thaliana*. The earthworm test uses as endpoints survival, growth, and reproduction; the *A. thaliana* test uses as endpoints seed germination and growth (increase in shoot mass). These tests will be conducted according to SOPs. The two test procedures were used successfully to support the Portsmouth Gaseous Diffusion Plant baseline ERA (Wicker, Gibbs, and Stewart 1994).

Samples that are sent to ESD for toxicity testing will be screened for radiological contaminants by Health Physics personnel. If the level of contamination is sufficiently low (i.e., alpha <300 dpm), the samples will be tested for toxicity using existing SOPs. Samples that are deemed above the level of human-health concern may not be tested if appropriate facilities are not available. Only full-strength sediment samples (i.e., no dilutions) initially will be evaluated for toxicity. If any of the samples shows strong evidence for toxicity, additional tests using dilutions of the sediment may be conducted to provide a more quantitative estimate of sediment toxicity. The confirmatory tests, based on dilutions, will be initiated only upon agreement of Y-12 Plant ER Division management. If dilutions are required and authorized, they will be prepared using soil from a reference site deemed to be appropriate based on results of prior tests.

All toxicity tests will be conducted by appropriately trained laboratory personnel in accordance with QA procedures established by the Biological Monitoring and Abatement Program (BMAP) Quality Assurance Program (QAP-2). Training documentation will be maintained by the Principal Investigator or his designee, and will be made available to Y-12 Plant ER upon request.

Toxicity tests will be initiated <96 h after samples have been delivered to the laboratory for testing. Depending upon the number of samples to be tested, sampling and testing may need to be conducted in two or more "runs." If more than one "run" is required, the reference site will be resampled and retested during the second run to ensure direct comparability of results among runs. All sediment characterization and toxicity testing activities for this project are contingent on the availability of adequate health, safety, and disposal procedures and facilities as deemed necessary by the ESD Aquatic Toxicology Laboratory.

Earthworm survival, growth and reproduction, and *Arabidopsis* seed germination and shoot biomass will be assessed in comparisons with negative controls and soil samples collected from reference sites. The results of the tests will be evaluated statistically by analysis of variance (ANOVA), using methods similar to those described in the Portsmouth Gaseous Diffusion Plant baseline ERA (Wicker, Gibbs, and Stewart 1994).

Results of tests will be evaluated statistically by ANOVA. Organism response in each site sample will be compared to response in the reference site sample. Documentation of the results of the tests and statistical analyses will be provided to the Y-12 Plant ER. This information will include, but is not limited to, copies of the following:

- toxicity test data log sheets,
- chain-of-custody forms,
- reference toxicant test data, and
- copies of Statistical Analysis System (SAS) programs and analysis output.

Data summaries of test results and test sample end points will be provided to the Y-12 Plant ER staff within 60 calendar days after the tests have been completed. The method of data transmittal will be a hard copy to the Y-12 Plant ER. The Y-12 Plant ER will provide guidance to ESD Ecotoxicology Laboratory personnel for submittal of documentation.

The Ecotoxicology Laboratory will use ORNL-registered laboratory notebooks to record test data.

The floodplain sediment toxicity tests conducted by the Ecotoxicology Laboratory will follow QA/QC guidelines established for the BMAP Quality Assurance Program.

Periodic internal surveillances in accordance with BMAP QAP-3 and QAP-4 will be conducted to verify compliance with established procedures. Surveillances may include seed counts, incubator temperature checks, soil-weight checks, food-weight checks, repeat weights of earthworms, and verification of data entries and calculations, as appropriate for ensuring valid and accurate results from the tests. The appropriate number or proportion of samples or end points to be rechecked and the parameters selected to ensure validity and accuracy of the data will be determined following consultation with the BMAP's QA Coordinator.

After testing is complete, the sample residues will be transferred to Y-12 Plant ER personnel for appropriate disposal.

6.6 STREAM SEDIMENT TOXICITY TESTING

In an effort to minimize the variability inherent in sediment toxicity tests, standardized methods for assessing freshwater sediment toxicity are being developed. EPA is considering using *Chironomus tentans* and *Hyalella azteca* as standard whole freshwater sediment toxicity test organisms. As of yet, EPA has not provided guidance on pore water toxicity testing. Many investigators have also used *Daphnia magna* as a test organism for both pore water toxicity and sediment elutriate toxicity tests. This organism is an epibenthic organism that is potentially sensitive to contaminants leached from sediments into the overlying water column.

Whole sediment toxicity will be evaluated using *Daphnia magna* (survival and reproduction end points; ESD-ATL Quality Assurance Program SOP-22) and either *Chironomus tentans* (survival and growth end points; ESD-ATL Quality Assurance Program SOP-35) or *Hyalella azteca* (survival end point; ESD-ATL Quality Assurance Program SOP-21). All procedures are based on guidelines outlined in ASTM *Standard Guide for Conducting Sediment Toxicity Tests with Freshwater Invertebrates* (E 1383-90). No pore water extraction or toxicity testing will be done. All sediment toxicity testing activities for this project are contingent on the availability of adequate health and safety procedures and facilities as deemed necessary by the ESD Aquatic Toxicology Laboratory. No sediment dilution tests will be done.

Results of tests will be evaluated statistically by ANOVA. Organism response in each site sample will be compared with the response in the reference site sample. Documentation of the results of the tests and statistical analyses will be provided to the Y-12 Plant ER. This information will include, but is not limited to, copies of the following:

- toxicity test data log sheets,
- chain-of-custody forms,
- reference toxicant test data, and
- copies of SAS programs and analysis output.

Data summaries of test results and test sample end points will be provided to the Y-12 Plant ER staff within 60 calendar days after the tests have been completed. The method of data transmittal will be a hard copy to the Y-12 Plant ER. The Y-12 Plant ER will provide guidance to ESD Ecotoxicology Laboratory personnel for submittal of documentation.

The Ecotoxicology Laboratory will use ORNL registered laboratory notebooks to record test data.

Upon completion of the toxicity tests, sediment samples in original sample containers and associated rinse water will be returned, along with original chain-of-custody forms, to the Y-12 Plant sampling group for disposal activities.

Environmental Restoration Quality Assurance Project Plan for the SAP for the Bear Creek Valley Floodplain (Sediment Investigation at the Y-12 Plant)

Technical Support Contractor Program Manager	Date
Technical Support Contractor Officer	Date
DOE ER Program Manager	Date
DOE ER Division QA Program Manager	Date
Energy Systems ER Site Program Manager	Date
Energy Systems ER Site Project Manager	Date
Energy Systems ER Site Quality Assurance Specialist	Date

7. QUALITY ASSURANCE PROJECT PLAN

7.1 QA OBJECTIVES

QA objectives for data collection are developed from Data Quality Objectives (DQOs) established for BCV OU 1. The DQOs were developed using guidance contained in *Data Quality Objectives Process for Superfund* [EPA/540/6-93/071 (EPA 1993)].

A QC program for analytical data develops information that can be used to accomplish the following:

- Evaluate the accuracy and precision of analytical data to establish their quality.
- Indicate the need for corrective actions when a comparison with existing regulatory or program criteria or data trends shows that activities must be changed or monitored to a different degree.
- Determine the effect of corrective actions.

Because the laboratory for this project has not yet been specified, the QC criteria included herein should be considered minimum requirements. When the laboratory or laboratories have been specified, the QC requirements defined herein will be communicated to those facilities in analytical services' statements of work. Any minor changes to these requirements will be documented and approved through the variance system. Requirements for analytical documentation for the selected laboratory will be field screening support and summary analytical deliverable support.

The QA objectives for all analytical data are to obtain reproducible, precise, and accurate measurements consistent with the intended use of the data and the limitations of the sampling and analytical procedures. The reasons for QC are (1) to screen out data of unacceptable degrees of precision or accuracy and (2) to obtain data that will accomplish the objectives of this project. This QAPjP specifies the documentation and QA requirements applicable to these data; they are specified in Sect. 7.9.

7.1.1 Field Laboratory Analysis Data Quality Parameters

The DQOs for the plan determine the types and quality of field laboratory analysis and data quality parameters that will be required. Guides to measurements typical of the QC for field screening and field analytical support follow.

The collection and field screening/analysis of environmental samples are used for surface soil samples analysis of metals and PCB. These methods will provide field analytical support data. Additionally, field screening data will be generated by other field screening methods described in the remainder of this section.

Field Screening Support. Field screening support is used to generate field screening data that will be used to determine the extent of contamination at a site, to provide real-time health and safety monitoring, to allow screening/optimization of sampling, and to acquire qualitative measurements of ambient conditions. Analytical parameters typically specified for field screening data collection include the following:

- measurement of ambient temperature (soil/water/air),
- measurement of electrical conductivity (soil/water),
- measurement of pH (soil/water),
- measurement of salinity (water),
- measurement of dissolved oxygen (water),
- total organic vapor concentration [photoionization detector/flame ionization detector (PID/FID)] (air/soil/gas), and
- radiological monitoring (alpha/beta/gamma) (soil/air/equipment/personnel).

Calibration of field screening instrumentation, in accordance with the manufacturer's instructions as appropriate for the media and analytes of concern, is required before and upon completion of daily sampling. Positive response verification checks will be performed by the health and safety officer, the field team leader, or a designee on these instruments for every 20 samples or every 4 h, whichever is more frequent. These checks consist of exposing the instrument to a source analyte (e.g., exposing a PID to a volatile organic source) and verifying a response. If no response is obtained, corrective action will be taken and documented and the instrument recalibrated. Results of calibration and response checks will be recorded in the instrument logbook.

Personnel responsible for using and/or maintaining particular instruments must maintain a log of calibration/response check procedures and performance. The field team leader will inspect the logs, which will become part of the project records. Each operator must be trained in the proper use of the instruments, be familiar with their operation, be able to interpret data from them, and be able to produce documentation certifying these skills. This documentation will facilitate comparability between samples.

QC field screening support for sampling conducted during the investigation is met by the following:

- sampling procedures;
- site surveillance;
- utilization of standard sampling and monitoring devices;
- personnel training;
- documentation of sampling location, method, and media;
- reporting of results in appropriate units;
- consistent utilization of types of screening/monitoring instruments; and
- maintenance of measuring and test equipment (M&TE) and M&TE records.

Field Analytical Support. Field analytical support is used to provide real-time data for ongoing field activities, to identify samples for laboratory analysis, and to allow for a phased approach to sampling. Analytical parameters, instrumentation, and media typically specified for field analytical support data collection may include the following:

- VOC analysis (soil/water);
- inorganic compound analysis (mobile lab) (soil/water/air);
- pesticide/PCB and dioxin/furan analysis (soil); and
- special applications (e.g., down-hole monitoring, geotechnical applications).

Calibration of field analytical instrumentation, in accordance with the manufacturer's instructions as appropriate for the media and analytes of concern, is required before and upon completion of the daily analyses or as required by the appropriate EPA-recommended methodology. Documentation and QC procedures for field analyses are instrument- and analyte-specific.

QC field analytical support for field analysis conducted during the investigation is met by the following:

- sampling procedures;
- site surveillance;
- utilization of standard sampling and monitoring devices;
- personnel training;
- documentation of sampling location, method, and media;
- reporting of results in appropriate units;
- consistent use of types of screening/monitoring instruments; and
- stringent control limits for the daily QC checks.

7.1.2 Analytical Laboratory Data Quality Parameters

Analytical laboratory data will be generated for environmental samples to provide confirmed identification and quantification of organic and inorganic compounds and radionuclides in each sampled media. Analytical methods that may be used include EPA CLP, SW-846, and others as long as the QC information that is appropriate is being reported and delivered.

Summary Analytical Deliverable Support. Summary analytical support is used to provide confirmed identification and quantification of contaminants to determine the extent of contamination, to determine the presence or absence of contaminants with required detection limits, and to confirm the results of field screening and field analyses. Analytical parameters and media typically specified for this type of data documentation include:

- organic compound analysis (soil/water/air),
- inorganic compound and elemental analysis (soil/water/air),
- radionuclide analysis (soil/water/air), and
- toxicity characteristic leaching procedure (TCLP).

Laboratory QC procedures will follow requirements specified in the appropriate EPA-recommended methodologies. Analytical protocols include calibration runs, surrogate standards, and laboratory control standards. External QA is employed in the form of field blanks, replicate and duplicate samples, and blind spikes, which may be submitted with the samples. Documentation requirements depend on the laboratory and type of analysis performed.

Accuracy, precision, and method detection limit (MDL) information is provided by adherence to SW-846 and/or EPA CLP.

Laboratories performing analyses must maintain a record of instrument calibration and QA/QC results. Such records may become part of the project records. Each operator must be trained in the proper use of the instrument, be familiar with the instrument's operation, be able to interpret data from the instrument, and have documentation certifying these skills.

Comprehensive Analytical Deliverable Support. Comprehensive analytical support conforms to the EPA CLP for performing routine analytical services for analyses of all types of media. Deliverable protocol provides confirmed identification and quantification of contaminants to determine the extent of contamination and the presence or absence of contaminants with low required detection limits. QC provides documented data for risk assessment and remedial investigations. Analytical specifications and media that may require comprehensive analytical deliverables include:

- Hazardous Substance List organic compound analysis (soil/water/air),
- priority pollutant inorganic compounds and elemental analysis (soil/water/air),
- radionuclide analysis (soil/water/air), and
- TCLP.

Laboratory QC procedures will follow requirements specified in the current EPA SOW revision for CLP methodologies. Methods not included in the CLP will be expanded to meet CLP-type requirements. All raw data will be submitted. CLP routine analytical services protocols are very specific concerning QA/QC requirements and data package documentation. Routine analytical services deliverable packages contain information on initial and continuing calibration, gas chromatograph/mass spectrophotometer tuning, surrogate percent recovery, matrix spike duplicates (MSDs), and spectra for every sample and blank. External QA is employed in the form of field blanks and replicate and duplicate samples submitted with the samples.

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are described in Sect. 7.9.2. Routine analytical services documentation is sufficient to allow qualified personnel to review, verify, and validate analytical results and to assess data quality.

Comprehensive documentation will be maintained as part of the project records. Chemists must be trained in the proper use of the instrument, be familiar with the instrument's operation, be able to interpret data from the instrument, and be able to produce documentation certifying these skills.

7.2 SAMPLE COLLECTION PROCEDURES

Surface soil and sediment sampling are proposed for this project. Characterization efforts will focus on depositional areas of Bear Creek. Prior to commencing field activities, a readiness review will be conducted by SAIC following SAIC QAAP 2.2. Energy Systems will conduct a readiness review following ER/C-P1610.

A field procedures manual will be prepared and controlled by SAIC and approved by Energy Systems Y-12 ER project manager, Y-12 ER quality assurance specialist, SAIC project manager, and SAIC QA/QC officer. The procedures manual will include procedures from Energy Systems *Environmental Surveillance Quality Control Program*, ES/ESH/INT-14, Rev. 4 (Kimbrough, Long, McMahon 1990); Energy Systems *ERWM Programs Intersite Procedures Manual*, ES/ER/INT-26/R1, and the SAIC *Field Technical Procedures Manual*. The Energy Systems procedures will be modified, as necessary, and submitted for Y-12 ER approval for ESP procedures with modifications and site/project specifications on the cover sheet in front of each procedure.

7.2.1 Soil Sampling

Soil sampling will be conducted in accordance with the ESP-303 series and SAIC procedures (Table 4.1).

7.2.2 Sediment Sampling

Sediment sampling will be conducted in accordance with the ESP-304 series (Table 4.1).

7.2.3 Field Measurement of Physical Parameters

Field measurement of physical parameters will be conducted in accordance with the ESP-307 series and/or SAIC procedures. Due to the wide variety and case-specific application of these types of instrumentation, each procedure will include manufacturer's instructions for specific instrument operation and maintenance procedures.

7.2.4 Sample Compositing and Special Sample Collection Procedures

Sample compositing and specialized sample collection procedures will be conducted in accordance with ESP-308 series or SAIC procedures.

7.3 SAMPLE PREPARATION AND ANALYSIS PROCEDURES

7.3.1 Sample Containers, Sample Preservatives, and Holding Times

The selection criteria for appropriate sample containers, sample preservatives, and holding times shall be in accordance with ESP-701. Types of sample containers and sample preservation methods used will be documented in the sampling logbook. Field and laboratory records will indicate the sample holding time before analysis (Table 7.1).

Table 7.1 Sample holding times, sample containers, sample preservation, and minimum sample size

Parameter	Matrix	Holding time[a] (from time of collection)	Container	Preservative[b]	Sample size[c]
Volatile organics	Soil	14 d	4-oz glass jar with Teflon-lined cap	Cool to 4°C	50 g
Extractable organics (semivolatile organics, or pesticides/PCBs)	Soil	14 d, extraction 40 d, analysis	8-oz glass jar with Teflon-lined cap	Cool to 4°C	100 g
Metals (other than mercury)	Water, soil	180 d 180 d	1-L poly bottle 8-oz plastic jar	HNO_3 to pH <2	900 mL 80 g
Mercury	Water, soil	28 d 28 d	Same containers as for metals	HNO_3 to pH <2 Cool to 4°C	100 mL 10 g
Cyanide	Water, soil	14 d 14 d	500-mL poly 1-L poly bottle 8-oz plastic jar	Water NaOH to pH > 12, Cool to 4°C	1000 mL 10 g
Radionuclides	Water, soil	180 d 180 d	4-L cubitainer 8-oz poly jar	HNO_3 to pH < 2	4 L 100 g
Soil moisture content	Soil	14 d	Polyethylene, glass	4°C	10 g
Percent organic matter, particle size, cation exchange capacity, ignitability, corrosivity, reactivity	Soil	28 d	Polyethylene, glass	4°C	100 g

[a]Holding times are consistent with CLP validation guidelines.
[b]Dissolved metals require filtration before pH adjustment.
[c]Additional sample must be collected for matrix spike/matrix spike duplicate samples or matrix spike/duplicate.
[d]Anions include chloride, sulfate, and fluoride.
[e]Miscellaneous includes TSS (7-d hold time), TDS (7-d hold time), alkalinity (14-d hold time), and turbidity (48-h hold time).

Sample Packaging and Transportation. Handling, shipping, and storage of samples and data resulting from field activities will adhere to custody (Sect. 7.4) and will ensure the integrity for analytical purposes is maintained. The procedures required to properly package, ship, handle, and store containers of environmental samples are described in ER/C-P2302.

Decontamination of Equipment and Devices. Decontamination of sample containers and sampling devices will be performed according to ESP-801, Sect. VI, C, pages 19 and 20. Sampling equipment will be decontaminated before use and between sampling locations/ intervals. Each decontamination activity will be recorded in the field logbook. Equipment used during field activities, including drilling equipment, soil sampling equipment, and field test equipment will be decontaminated in accordance with ESP-802.

Sample Identification and Traceability. Each environmental sample collected during these investigations will be assigned a unique sample identifier, which will be permanently affixed to the sample container and recorded in the field logbook and on the chain-of-custody form. The identifiers used for samples will be established and maintained in accordance with ESP-501.

Identification systems will ensure traceability of samples to the appropriate source. Sample identification shall be transferred to each subdivision when the sample is split.

Site Surveying. Site surveying will be conducted to establish location and elevation of sampling points in relation to the appropriate plant or site grid. A licensed surveyor will be contracted to perform this effort.

Field Variance System. Procedures cannot fully encompass all conditions encountered during a field investigation. Variances from operating procedures, the work plan, the sampling and analysis plan, and/or health and safety plan will, therefore, likely occur and must be documented on an FCO form following ER/C-P1719 and noted in the appropriate logbooks. The Y-12 ER project manager may give verbal approval for the field change, if the risk issue is minor, until the FCO is reviewed and categorized. If a variance is anticipated (e.g., due to a change in field instrumentation), the applicable procedure should be modified and the change noted in the field logbooks.

Any variances from the health and safety plan must be approved by the health and safety officer. Copies of the field change order forms and a field change order log will be maintained by the sampling teams until the fieldwork is complete. Field change order forms and log will be included in the project file and the subcontractor's Central Records Facility.

Routine (minor) FCO will be completed in the field, noted on the FCO log, then routed through the FCO coordinator for delivery to the Energy Systems Y-12 ER project manager and QA specialist for signature approval. A verbal approval from the Y-12 ER project manager or designee will be noted in the field logbook.

Emergency or urgent (major) FCOs will be delivered to the Y-12 ER project manager and QA specialist for immediate signature approval, then forwarded to the FCO coordinator.

7.3.2 Analytical Procedures

Environmental samples collected during this project will be analyzed for potential contaminants of concern using EPA-approved methods where applicable (Table 3.2).

The approved methods and protocols that may be used by the analytical laboratory are provided in the following documents:

- *Test Methods for Evaluating Solid Wastes* (EPA 1986a);
- *Methods for Chemical Analysis of Water and Wastes* (EPA 1983);
- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980);
- *Eastern Environmental Radiation Facility Radiochemistry Procedure Manual* (EPA 1984);
- *CLP SOWs for Organics and Inorganics* (EPA 1990b,c);
- 40 *CFR* 136;
- 40 *CFR* 141.30;
- 40 *CFR* 136;
- APHA, *Standard Methods for the Analysis of Water and Wastewater*; and
- *EML Procedures Manual,* HASL-300 (Krey and Beck 1992).

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is greater than zero. The MDL actually achieved in a given analysis varies depending on instrument sensitivity and interferences. Contracts will be established with analytical laboratories to analyze environmental samples collected during these investigations. Each contract laboratory that analyzes samples will provide quantification limits for each constituent analyzed.

Laboratory equipment QA/QC will be drawn from the supporting laboratory's QA plan(s).

7.4 SAMPLE CUSTODY

7.4.1 Field Documentation

An integral part of the QA/QC plan for the field activities will be to maintain current, accurate, and complete field records including logbooks, chain-of-custody forms, and airbills. Field logbooks (e.g., field health and safety, site activity, M&TE, decontamination, sampling management logbook for each activity) shall be of hardcover construction. All information pertinent to field activities will be recorded. Each page must be signed and dated. Entries in the logbooks or on the data forms will be made in water resistant black or blue ink and will include the information specified in ESP-501, Sect. VII, Part D methodologies. Corrections must be marked out with a single line, dated, and initialed. Field logbooks will be copied once a week with the copies remaining in the SAIC offices. When the fieldwork is complete, copies will be made of the completed logbooks, the copies will be entered into the SAIC Control

Records Facility and the project file, and a copy will be forwarded to the Y-12 ER project manager.

Appropriate field data forms will be prepared. No blank spaces should appear on completed forms. If information requested is not applicable, the space shall be marked N/A.

Chain-of-custody procedures require documentation of sample possession from the time of collection to time of disposal. These procedures allow the possession and handling of samples from the time of collection through analysis and final disposal to be traced.

Samples will be accompanied by the original completed chain-of-custody form. Should a sample be split, another copy will remain with the sample. As the samples are transferred, the present custodian and the new custodian will complete the required sections of the record as well as note any discrepancies. This chain-of-custody form will remain with the sample from the field while it is being transported to the laboratory, and it will be checked upon receipt at the laboratory. The laboratory will retain a copy of the form, and the original will be sent to the designated subcontractor personnel. This original will be routed to the Central Records Facility and used in the final analytical report.

Field Custody Procedures. Sample custody will be initiated at the time of sample collection. Field samples will be identified by sample tags and appropriate labels. Descriptions of sampling activities and sample identification data will also be recorded in field logbooks. Field chain-of-custody forms containing the same information will be completed for each set of samples. A line item on the sample chain-of-custody form will be completed for each sample, and the sampling technician will confirm by signature the completeness of the information on the form. Each individual who assumes responsibility for the samples will sign and date the chain-of-custody form.

Field custody procedures include the following steps:

- Before sampling begins, the QA/QC Officer or designee, will instruct sampling personnel on the chain-of-custody and sample labeling procedures, as necessary.
- A chain-of-custody form, which corresponds to the sample identification label, will be initiated in the field for each sample.
- Each time sample custody is transferred, the person relinquishing the sample and the new custodian will sign the chain-of-custody form and note the date and time.
- The analyses to be performed for each sample will be recorded on the chain-of-custody form accompanying the samples to the laboratory.
- The field team leader will confirm that proper custody procedures are followed during the fieldwork and that results were documented in the appropriate field logbooks.

7.4.2 Shipping Custody Procedures

Sample custody will be maintained by personnel until custody is transferred to a common carrier/air freight company, if applicable. Shipments sent by common carrier/air freight will have a bill of lading/air bill accompanying them with the original chain-of-custody form packed in the containers. These bills will be maintained as permanent records, and the air bill number will be noted on the chain-of-custody form. The common carrier/air freight company delivers

samples and transfers custody to particular analytical laboratories, where their intralaboratory chain-of-custody procedures will be in effect. If the Y-12 Plant Analytical Services Organization (ASO) is used to analyze the samples, the samples will be delivered by a sample team member to the ASO.

7.4.3 ASO Custody Procedures

Upon receipt at the ASO, each sample identification will be compared to the information contained on the chain-of-custody form. If discrepancies exist, appropriate notes (signed and dated) will be made on the chain-of-custody form and the project manager or designated person will be notified.

At receipt and initial inspection of samples and accompanying forms, the following items will be checked:

- seals and tapes on the transportation container to verify that they are unbroken;
- sample containers in the transportation container to ensure that they are intact and at correct temperature;
- external activity with radiation survey instruments and smear surfaces for removal of contaminants;
- pH of preserved samples (except volatile organic analytes);
- identification on the sample bottles to verify that it corresponds to the entire description on the chain-of-custody form; and
- number of sample containers received to verify that it is equal to the number of samples listed on the chain-of-custody form(s).

If there are discrepancies, the project manager or designee will be called immediately to rectify them. Discrepancies will be recorded on appropriate forms and incorrect information will be marked out with a single line, initialed, and corrected.

Once samples are in the possession of the ASO, their internal chain-of-custody and sample handling procedures will be followed. If samples are to be shipped from one laboratory to another, proper chain-of-custody and packaging procedures will be maintained. Anticipation of reanalysis requires proper preservation of samples following analysis. Samples requiring refrigeration will remain refrigerated.

Sample Labeling. Sample labels and tags will contain sufficient information to identify the sample in the absence of other documentation. The label and tag will be directly affixed to the sample container, will be completed with black water resistant ink, and will follow ESP-501.

In the event samples arrive damaged or custody seals are broken, a nonconformance report will be initiated. The project manager will be advised and will make a decision as to the fate of the nonconforming sample(s) and initiate corrective actions. The laboratories will retain tags in their project files.

7.5 CALIBRATION PROCEDURES AND FREQUENCY

All M&TE will be calibrated against certified equipment and/or standards having known valid traceability to nationally recognized standards. M&TE shall be calibrated, adjusted, and maintained at prescribed intervals and/or before use. If no nationally recognized standards exist, the basis for calibration will be documented.

7.5.1 Field Instrument Calibration Procedures and Frequency

A list of all M&TE to be used, along with a schedule for calibration, will be prepared before initiating fieldwork. Field instrumentation will be calibrated according to the procedures specified in the manufacturer's operating manual or more frequently should the conditions dictate it for the particular instrument. Instrument logbooks or notebooks will be established and maintained by the cognizant field team members, field team leader, or the health and safety officer, as appropriate.

7.5.2 Laboratory Instrument Calibration Procedures and Frequency

Laboratory equipment will be calibrated according to the procedures specified in the analytical methods and in the operating manual for the particular instrument. Calibration frequency will be based on the analytical methods employed, type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience.

For those cases for which analyses are governed by EPA CLP protocols, the calibration frequencies and procedures as designated in the CLP routine analytical services SOW will be followed. In this scenario, the calibration requirements in the CLP routine analytical services SOW take precedence.

For laboratory equipment, Class A volumetric glassware will be used to prepare calibration standards, bench standards, samples for analysis, etc. Class A glassware may be purchased with known accuracy per ASTM specifications.

It should be noted that other nonanalytical instrumentation (such as thermometers) must be properly maintained and calibrated. The temperatures of ovens and refrigerators used in sample handling will be recorded and the control limits defined. If these limits are not met, corrective action will be required. All calibration and maintenance records will be kept with the equipment if practical. Otherwise, they will be maintained by the laboratory QA personnel.

7.5.3 Equipment Categories

Calibrated equipment will be uniquely identified by using either the manufacturer's serial number or other means. All equipment will be categorized as one of the following:

- Category A—Casual devices and systems (e.g., rulers, tape measures, graduated cylinders) that are not to be calibrated in service (i.e., not calibrated other than by the manufacturer).

- Category B—Routine devices and systems (e.g., balances, spectrophotometers) that are to be included in a regular calibration recall program.
- Category C—Field experiment devices and systems (e.g., pH meters, turbidimeters) that are to be calibrated before, during, and after use.

The appropriate category decal with the identification number and the due date of the next calibration will be attached to the equipment. If this identification is not possible, records traceable to the equipment will be readily available for reference.

7.5.4 Calibration Failures

Scheduled periodic calibration of equipment will not relieve personnel of the responsibility of employing properly functioning equipment. If an individual suspects an equipment malfunction, he/she should remove the device from service, initiate a nonconformance report, tag it so it is not inadvertently used, and notify project management. If equipment is found to be out of calibration, the appropriate project management personnel will evaluate and document (in the instrument logbook) the validity of previous inspection or test results and the acceptability of similar equipment previously inspected or tested. The responsible supervisor will ensure the devices that are out of calibration are (1) tagged or segregated from other equipment and (2) disposed of or not used until they are calibrated. Any equipment that is consistently found to be out of calibration will be repaired or replaced. Any such action should be recorded in the instrument logbook or notebook.

All standards used for equipment calibration will be traceable to the EPA, National Institute of Standards and Technology, or a commercially available certified standard. The source of the standard used must be documented in a calibration logbook.

7.5.5 Calibration Records

Calibration data will be recorded in the instrument logbook or notebook. The information will include the date, operator, signature, and standard that was used. Records will be prepared and maintained for each piece of calibrated equipment to indicate that established calibration procedures have been followed. The appropriate project management personnel will ensure that records of calibration data are kept current. Records for field equipment used will be maintained by the field team leader and the health and safety officer and kept in the project files. Records for laboratory equipment used will be maintained by the laboratory supervisor and kept in the project files.

7.6 PREVENTIVE MAINTENANCE PROCEDURES/SCHEDULES

Any equipment (an inclusive term for tools, gauges, instruments, and other items that require specific preventive maintenance) will be serviced and documented as specified by the manufacturer's recommended schedule.

All service will be performed by qualified and trained individuals. The operators are responsible for seeing that the equipment is scheduled for service, serviced, and properly maintained. Properly maintained equipment helps reduce unnecessary downtime.

A complete list of equipment will be developed by the operator, and the parts or replacement equipment will be immediately available (either from the supplier/manufacturer or on site). Having replacement equipment or critical spare parts available minimizes downtime.

The implementation of a preventive maintenance program depends on the specific instruments and equipment used for the field. SAIC will ensure a preventive maintenance program that includes the following:

- a list of the instruments and equipment that are included in the program, including backup alternatives;
- the frequency of maintenance, taking into consideration the manufacturer's recommendations and/or previous experience with the equipment. The frequency should be stated in terms, including monthly and quarterly;
- each instrument in the program provide the following:
  - external service contracts,
  - items to be checked and/or serviced during maintenance, and
  - directions for performing maintenance (if external service is not provided, or if directions are not stated in the manufacturer's instrument manuals).

Preventive maintenance will be documented. A file will be maintained for each instrument at the SAIC office. The instrument file should include the following, at a minimum:

- external service contracts;
- a checklist of items to be serviced and directions for maintenance or manufacturer's instrument manuals;
- a record of periodic maintenance; and
- comments noting any replacement of parts, observed deterioration, etc.

Equipment used throughout the laboratory must be controlled through a calibration program. Calibration of analytical balances must be performed by a trained and qualified instrument technician using weights traceable to National Institute of Standards and Technology specifications. The gas chromatograph/mass spectrophotometer instruments must be calibrated, tuned, and operated in accordance with EPA CLP protocol OLM01.8 (EPA 1990c), which also meets the criteria specified in other EPA documents and the *Federal Register*. The ICP, atomic adsorption spectroscopy, gas chromatograph, and similar instruments must be calibrated and operated in accordance with requirements of the procedure being employed. The calibration of all equipment must be performed or verified with each analysis run, and the record of calibration for each analysis must be maintained as a permanent record. Any deviation from the calibrations required by the appropriate EPA method must be approved using an FCO that is authorized by the SAIC project chemist, the Y-12 ER QA specialist, and the Y-12 ER project manager.

Volumetric glassware must be used to prepare calibration standards, bench standards, and samples for analysis; therefore, the glassware used for these preparations must be of known

accuracy. The glassware must be purchased in accordance with federal and ASTM specifications.

The standards used for instrument calibration, internal controls, bench standards, spike solution, and traceability of sample analyses to these specific standards must be documented.

7.7 DATA REDUCTION AND REPORTING

Data reduction and reporting will be in accordance with the *Environmental Restoration Quality Program Plan*, ES/ER/TM-4/R3 (Energy Systems 1993). The data reduction will follow the guidelines of the EPA CLP SOWs (EPA 1990b, 1990c) and the *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1990a). Generally, results must be expressed to two significant figures. The results for nonaqueous samples must be expressed on a dry weight basis in milligrams per kilogram, micrograms per kilogram, or micrograms per gram. The moisture content of samples must also be reported.

Table 7.2 depicts data set deliverables for summary and comprehensive documentation. In addition to following field and laboratory documentation and QA/QC procedures, data may be verified using a variety of computerized checks for reasonableness. These procedures will ensure that data are entered, encoded, manipulated in a consistent way, and available in a usable format.

7.7.1 Field Data Reduction and Reporting

Data collected during field activities will be evaluated by checking the procedures used and comparing the data to previous measurements. The QA/QC officer or designee and appropriate field personnel will be responsible for checking field QC sample results to ensure that field measurement and sampling protocols have been observed. These reviews will check date and time sampled, preservation, SOPs, calibration method and frequency, and chain-of-custody documentation.

Reviewers are responsible for ensuring that data reduction calculations are documented and checked by qualified personnel. Specific calculations used for data reduction may also be included.

7.7.2 Laboratory Data Reduction

In general, the analyst will process the data, either manually or by inputting the data into a computer. All computerized programs used to reduce and analyze data should be in compliance with software QC (Energy Systems 1990) and appropriate Energy Systems procedures. For manually processed data, all the steps in the computation must be provided, including equations used and the source of input parameters such as response factors, dilution factors, and calibration constants. If calculations are not performed directly on the data sheet or chromatogram, the calculations must be provided on company letterhead paper and attached to the data sheets. All pages of the calculations must be signed and dated by the analyst performing the calculations.

Table 7.2 Data set deliverables for summary and comprehensive documentation[a]

Method requirements	Deliverables
Requirements for all methods	
Holding time information and methods requested	Signed chain-of-custody forms
Discussion of laboratory problems	Case narratives
LCS with results on control charts (run with each batch of samples processed)	Control charts
Organics	
Sample results	CLP Form 1 or equivalent
Surrogate recoveries. Surrogates to be used in volatiles, semivolatiles, pesticides/PCBs. For volatiles by GC, surrogate names should reflect the appropriate surrogate used	CLP Form 2 or equivalent
Matrix spike/spike duplicate (will be 1 spike and spike duplicate per 20 samples of similar matrix)	CLP Form 3 or equivalent
Method blank data	CLP Form 4 or equivalent
GC/MS tuning for volatiles/semivolatiles	CLP Form 5 or equivalent
GC/MS initial calibration data for volatiles/semivolatiles	CLP Form 6 or equivalent
Pesticide/PCB calibration data if calibration factors are used	CLP Form 9 or equivalent
For volatiles by GC, initial calibration data:	
If calibration factors are used	CLP Form 8D or equivalent, with five columns for multilevel calibration factors
If a calibration curve is used	A plot of the calibration curve is required and a linear regression determination, with flagged correlation coefficient, if it is less than 0.995
For volatiles by GC, continuing calibration data; if calibration factors are used, calibration factors and their percent differences from the initial calibration must be reported; retention time (RT) windows and analyte RTs for the analytes must be included on this form	CLP Form 9 or equivalent
GC/MS continuing calibration data:	CLP Form 7 or equivalent
No chromatograms or mass spectra are presented for calibration; these data should be filed in the laboratory and available if problems arise in reviewing/validating the data	
GC/MS internal standard area data	CLP Form 8 or equivalent

Table 7.2 (continued)

Method requirements	Deliverables
Second column confirmation for all GC work when compounds are detected above reporting limits	CLP Form 10 or equivalent for all positive hits
Complete copy of all laboratory raw data information [i.e., chromatograms, bench notes, etc. (Comprehensive Documentation)]	Raw data
Metals	
Sample results	CLP Form 1 or equivalent
Initial and continuing calibration	CLP Form 2 or equivalent
Method blank taken through digestion (1 per 20 samples of same matrix)	CLP Form 3 or equivalent
ICP interference check sample	CLP Form 4 or equivalent
Spike sample recovery (1 per 20 samples of similar matrix)	CLP Form 5A or equivalent
Postdigestion spike sample recovery for ICP metals (only done if predigest spike recovery exceeds CLP limits)	CLP Form 5B or equivalent
Postdigestion spike for graphite furnace atomic absorption	Recovery noted on raw data
Duplicates (one per 20 samples will be split and digested as separate samples)	CLP Form 6 or equivalent
LCS	CLP Form 7 or equivalent
Standard addition. The decision process outlined in CLP (p. E-3) will be used to determine when standard additions are required	CLP Form 8 or equivalent
Holding times	CLP Form 10 or equivalent
Complete copy of all laboratory raw data information [bench notes, computer printouts, etc. (Comprehensive Documentation)]	Raw data
Wet chemistry	
LCS (one/batch)	Control charts
Method blank (one/batch)	Report result
Sample results	Report result
Spike/spike duplicate	Percent recovery and percent RPD
Continue calibration check	Recovery and percent difference
Complete copy of all laboratory raw data information [strip chart graphs, calculation sheets, run logs, etc. (Comprehensive Documentation)]	

Table 7.2 (continued)

Method requirements	Deliverables
Radiochemical analysis	
Sample results	Report results
Initial calibration	Efficiency determination
Efficiency check	Percent difference from calibration
Background determinations	Report results
Minimum detectable activity	Report results
Method blank	Report results
Spike recovery results	Spike added and percent recovery
Internal standard results	Standard added and percent recovery
Duplicate results	Report results and percent RPD
Self-absorption factors (α, β)	Report factors
Complete copy of all laboratory raw data information [instrument run logs, bench notes, instrument output, etc. (Comprehensive Documentation)]	Raw data

[a]LCS = laboratory control standard, CLP = contract laboratory program, PCB = polychlorinated biphenyl, GC = gas chromatograph, MS = mass spectrometry, ICP = inductively coupled plasma.

For data input by an analyst and processed using a computer, a copy of the input must be kept and uniquely identified with the project number and other pertinent information as necessary. The samples to which the data processing refers must be clearly stated, and the input must be signed and dated by the analyst performing the input.

When processing data acquired through the use of instrumentation, the analyst must verify that the correct project, sample numbers, calibration constants, response factors, units, and numerical values used for detection limits are present.

After required chemical analyses have been completed, the samples will be maintained at a temperature of 4°C for at least 2 weeks after expiration of the appropriate holding time. The laboratory will be responsible for disposal of all laboratory-generated wastes. Upon the receipt of written notification from the subcontractor's project manager, the laboratory will return unused sample portions to the project.

7.8 QC CHECKS

7.8.1 Field QC Checks

The number of required QC samples per site is based on a set minimum percentage. The number of QC samples to be collected may change from site to site; however, the types of field QC samples remain constant. The types of QC samples are trip blanks, equipment rinsates, field blanks, and field duplicates.

In defining the number of field blanks required, it is important to note that a sampling event is from the time sampling personnel arrive at the site until personnel leave for more than 24 h. For example, sampling personnel go to a site for 10 d, conduct soil borings, and install groundwater wells. During this visit, soil and water samples are collected. The crew leaves the site for 2 months and later returns to collect another set of groundwater samples over a 3-d period. Two sampling events have occurred: a 10-d event and a 3-d event.

Trip Blanks. Trip blanks are used to detect contamination by VOCs during sample shipping and handling. Trip blanks are 40-mL VOA vials of analyte-free water that are generally filled in the laboratory, transported to the sampling site, and returned to the laboratory with VOA samples. Trip blanks are not to be opened in the field. One trip blank is to accompany each cooler containing VOA samples. Each trip blank is to be stored at the laboratory with associated samples and analyzed with those samples. Trip blanks are only analyzed for VOCs. Trip blanks are also sent with soil samples; however, because the blanks cannot be analyzed through the use of soil methods, they are analyzed and reported as water samples.

Field Blanks. Field blanks are samples of the potable water source and analyte-free water that are used in the decontamination and cleaning of equipment used in sample collection. Analyte-free water will be sampled per lot number. The decontamination potable water source will be sampled once in each event.

Equipment Rinsates. Equipment rinsates are samples of analyte-free water passed through decontaminated sampling equipment. They are used as a measure of decontamination process effectiveness. Equipment rinsates will be collected at a rate of 5% of the samples collected per matrix per event (i.e., 1 to 20 samples collected equals 1 equipment rinsate; 21 to 40 samples collected equals 2 equipment rinsates). Matrices for this purpose are considered to be soils, sediments, groundwater, and surface water. Equipment rinsates are analyzed for the same analytes as the associated samples. Equipment rinsates are reported as water samples.

Field Duplicates. Additional samples may be taken near the field sample co-located to determine total measurement error variance. Samples submitted for VOA will not be homogenized. Field duplicates will be taken at the rate of one for every 20 samples.

7.8.2 Laboratory QC Procedures

To ensure data quality, laboratory quality control samples, data review, and data validation are used to measure the quality of the sampling and analysis process. A quality control operation or component is only useful if it can be measured or documented. The components of analytical QC that are defined in this section are related to the analytical

batch or to those samples that are analyzed together with the same method sequence, the same lots of reagents, and the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition. All QC data and records specified in this section will be reported as part of the data deliverables package. These procedures will be performed at least once with each analytical batch with a minimum of 1 per 20 samples.

The types of laboratory QC samples are method blanks, LCSs (blank spikes), MSs, MSDs, and duplicates. These samples are defined in the following sections. More detailed ER requirements are found in *Requirements for Quality Control of Analytical Data* (DOE 1990).

Method Blanks. Method blanks are used to determine the existence and magnitude of possible contamination encountered during sample preparation and analysis. They consist of analyte-free water for water samples and clean sand or soil for soil samples if available. They are carried through the entire analytical procedure with the samples. At least one method blank must be prepared with each batch of samples. A batch cannot exceed 20 samples and is determined by the number of samples of similar matrix that can be processed simultaneously through the entire preparation process. Analysis is performed for the same analytes as those associated with the respective environmental samples.

Matrix Spikes/Matrix Spike Duplicates. An MS is an aliquot of a sample spiked with known quantities of analytes and subjected to the entire analytical procedure. It is used to indicate the appropriateness of the method for the matrix by measuring recovery. An MSD is a second aliquot of the same sample as the MS with known quantities of compounds added. The purpose of the MSD, when compared to the MS, is to determine method precision. Precision is the measure of the reproducibility of a set of replicate results among themselves or the agreement among repeat observations made under the same conditions. MSs and MSDs will be performed per 20 samples of similar matrix.

Duplicate Samples. Duplicate samples are identical splits of individual samples that are analyzed by the laboratory to test for method reproducibility or precision. These samples are split in the laboratory during sample preparation. Duplicates are used mainly for inorganic analysis, while MSDs are used for organics. Duplicates will be performed per 20 samples of similar matrix.

Surrogate Spikes. A surrogate spike is prepared by adding a pure compound to a sample before extraction. The compound in the surrogate spike should be of a similar type to that being assayed in the sample. The purpose of a surrogate spike is to determine the efficiency of recovery of analytes in the sample preparation and analysis. The percent of recovery of the surrogate spike is then used to gauge the total accuracy of the analytical method for that sample.

Laboratory Control Sample. The laboratory will use an LCS system to monitor sample preparation and analysis.

The laboratory will employ an LCS program that monitors sample preparation and analysis. The LCS program will be monitored through the use of control charts. The purpose of this program is to demonstrate that the laboratory process for sample preparation and analysis is in control. This type of program is required for all ER Waste Management projects.

An LCS is a laboratory blank with a known amount of analyte(s) added or a commercially available standard consisting of known analyte concentrations representative of the contaminants to be determined. Analytes selected for spiking should be representative of the compound class. It is suggested that the following criteria be followed:

- For VOCs and semivolatile organic compounds the method blank surrogate standards can be used as the LCS. All surrogates in the method blank must be monitored on control charts.
- For pesticides, at least two target compounds are added to a blank other than the method blank. These compounds are monitored on control charts.
- For PCBs, at least one target Aroclor is added to a blank other than the method blank. The compound is monitored on a control chart. If pesticides and PCBs are both being determined, it is recommended that a single LCS with both pesticide and PCB spikes be used.
- For metals determined by ICP, an LCS must be monitored by means of control charts for at least three metals.
- For metals determined by atomic absorption (graphite furnace atomic absorption, furnace atomic absorption, and cold vapor atomic absorption), an LCS must be monitored by means of a control chart for each element.
- For wet chemical and radiochemical methods, an appropriate LCS for each method must be used (e.g., for cyanide, a control standard of sodium cyanide from a source other than that used for calibration may be spiked into water and analyzed with the water samples). The value for the control is monitored on the control chart.

The LCS matrix should be comparable to the sample matrix (i.e., analyze water control samples when water samples are analyzed).

In the LCS, problems encountered with matrix effects and sample nonhomogeneity will be minimized through the use of blank water and well characterized soil. This information, used in conjunction with sample MS recoveries, can aid in determining whether an out-of-control condition is due to laboratory problems or matrix problems.

Five percent of the samples will be LCSs, which may vary depending upon analytical method.

7.9 DATA VALIDATION PROCEDURES

7.9.1 ASO Data Verification and Validation

Data verification/validation is a systematic process for evaluating a body of data against a defined set of criteria to provide assurance that the data are adequate for their intended use. The evaluation process consists of data screening, range checking, auditing, verification, flagging, and quality evaluation. Specifically, data will be evaluated per derived DQO requirements. This will include review of sample custody forms, photocopied pages of laboratory notebooks, and data forms completed by laboratory staff, including sample weights, dilutions, laboratory data reduction, instrument logs, and raw data, as necessary. The final task

report will certify that the data have been verified/validated and qualified in accordance with the defined process.

Analytical data generated during and following field activities will be reviewed by the laboratory(s) and reported per the systematic requirements identified and defined in Sect. 7.3. The analytical laboratory(s) will not perform data verification/validation. Verification /validation is independent of the analytical laboratory data review.

Data validation will be consistent with the specifications as outlined in *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program* (ES/ER/TM-16). All project data will be evaluated to ensure a complete, consistent, and usable project data set.

Data Validation Approach. Data validation will be performed to ensure that the precision and accuracy of the analytical data are adequate for their intended use. Because the greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement, validation will be performed only to the level necessary to minimize the potential of using false positive or false negative concentrations in the decision-making process (i.e., to ensure accurate identification of detected versus nondetected compounds).

All deliverables will be verified to ensure completeness and compliance with the laboratory statement of work. A minimum of 10% of project data will be evaluated by data validation criteria consistent with the guidelines in ES/ER/TM-16 related to a comprehensive data deliverable. The 10% subset of the project data will be selected with respect to sample medium, analytical method, analytical laboratory, and project schedule (i.e., sample data packages will be selected throughout the project). The remaining 90% of the project data will be validated based on an adjusted set of ES/ER/TM-16 summary data deliverable validation criteria as described in the following section.

Data Validation Rationale. The data validation criteria listed below have been determined as critical in the evaluation of analytical data usability. These are a subset of the comprehensive ES/ER/TM-16 data validation criteria that, based on analytical process knowledge, contribute significantly to the qualification and associated uncertainty of the reported results. Evaluation of this subset will allow identification of potential false positive or negative results. Because these criteria are associated with random rather than systematic error, they require evaluation throughout the analytical measurement process. They cannot be comprehensively determined by reviewing only a portion of the data. Consistent with the data quality requirements as defined in the DQOs and based on the above rationale, all project data and associated QC must be evaluated on these criteria and qualified as per the outcome of the review. The criteria by which the data will be evaluated are discussed in this section.

The data validation categories to be evaluated are as follows.

Organics	Inorganics	Radiochemistry
Holding times	Holding times	Holding times
Blanks	Blanks	Blanks
Surrogate recovery	Laboratory control sample	Laboratory control sample

Organics	Inorganics	Radiochemistry
Internal standards	Furnace atomic absorption QC	Sample specific chemical or tracer recovery
Calibration	Calibration	Calibration
Sample reanalysis		
Secondary dilutions		
Case narrative	Case narrative	Case narrative

While the categories just listed are those that most impact the determination of data usability, it is also necessary to evaluate whether any systematic errors are occurring during the analytical process that could adversely affect the sample results. Therefore, some portion of the data must be evaluated against the additional criteria. Because the laboratory(s) will be reviewed, audited, and approved based on extensive selection criteria prior to providing analytical support to the project and because they will be subject to periodic audits during the project, selection of a minimum of 10% of the data packages for complete ES/ER/TM-16 validation will adequately identify any systematic problems. The 10% subset of data packages will be selected across media, methods, laboratories, and time to ensure an adequate sampling of the process. If a systematic problem is discovered in the 10% subset, additional data packages will be reviewed based on the problem criterion to determine the extent of and resolve the problem. This approach to validation will result in a minimum of 10% of the data packages being validated to comprehensive ES/ER/TM-16 criteria and the remaining 90% of the data packages being reviewed based on adjusted ES/ER/TM-16 validation criteria.

7.9.2 Adjusted Data Validation Criteria

Holding Times. Evaluation of holding times ascertains the validity of results based on the length of time from sample collection to sample preparation or sample analysis. Verification of sample preservation must be confirmed and accounted for in the evaluation of sample holding times. The evaluation of holding times is essential to establishing sample integrity and representativeness. Concerns regarding physical, chemical, or biochemical alteration of analyte concentrations can be eliminated or qualified through this evaluation.

Blanks. The assessment of blank analyses is performed to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks apply to any blank associated with the samples, including field, trip, equipment, and method blanks. Contamination during sampling or analysis, if not discovered, results in false positive data.

Surrogate Recovery. System monitoring compounds are added to every sample, blank, MS/MSD, and standard. They are used to evaluate extraction, cleanup, and analytical efficiency by measuring recovery on a sample-specific basis. Poor system performance as indicated by low surrogate recoveries is one of the most common reasons for data qualification. Evaluation of surrogate recovery is critical to the provision of reliable sample-specific analytical results.

Calibration. The purpose of initial and continuing calibration verification analyses is to verify the linear dynamic range and stability of instrument response. Relative instrument response is used to quantitate the analyte results. If the relative response factor is outside acceptable limits, the data quantification is uncertain and requires appropriate qualification.

Internal Standards. Internal standards are utilized to evaluate and compensate for sample-specific influences on the analyte quantification. They are evaluated to determine whether data require qualification due to excessive variation in acceptable internal standard quantitative or qualitative performance measures. For example, a decrease or increase in internal standard area counts for organics may reflect a change in sensitivity that can be attributed to the sample matrix. Because quantitative determination of analytes is based on the use of internal standards, evaluation is critical to the provision of reliable analytical results.

Sample Reanalysis. When instrument performance-monitoring standards indicate an analysis out-of-control, the laboratory is required to reanalyze the sample. If the reanalysis does not solve the problem (i.e., surrogate compound recoveries are outside the limits for both analyses), the laboratory is required to submit data from both analyses. An independent review is required to determine which is the appropriate sample result.

Secondary Dilutions. When the concentration of any analyte in any sample exceeds the initial calibration range, a new aliquot of that sample must be diluted and reanalyzed. The laboratory is required to report data from both analyses. When this occurs, an independent review of the data is required to determine the appropriate results to be used for that sample. An evaluation of each analyte exceeding the calibration range must be made, including a review of the dilution analysis performed. Results chosen in this situation may be a combination of both the original results (i.e., analytes within initial calibration range) and the secondary dilution results.

Laboratory Control Samples. The LCS serves as a monitor of the overall performance of the analytical process, including sample preparation, for a given set of samples. Evaluation of this standard provides confidence in or allows qualification of results based on a measurement of process control during each sample analysis.

Furnace Atomic Absorption QC. Duplicate injections and furnace post-digestion spikes are evaluated to establish precision and accuracy of individual analytical determinations. Because of the nature of the furnace atomic absorption technique and because of the detailed decision tree and analysis scheme required for quantitation of the elements, evaluation of the QC is critical to assuring reliable analytical results.

Sample-Specific Chemical or Tracer Recovery. Laboratory performance on individual samples subject to chemical process and separation is established by means of spiking with tracer quantities of other radioisotopes of the same element or carrier quantities of an inactive isotope of the same or a chemically similar element. This process is analogous to surrogate or internal standard recovery, dependent on the analyte and method being evaluated, and is a common reason for data qualification.

7.9.3 Project Data Quality Assessment

The data quality indicator parameters, PARCC, will be used to evaluate data quality and quantity. Reviewers are responsible for ensuring that data reduction calculations follow appropriate data calculation procedures, are documented, and are checked by qualified personnel. Specific calculations used for data reduction will also be included.

Both qualitative and quantitative criteria are used as indicators of the quality of the data. In determining data usability, especially in the decision-making process, the integrity and authenticity of the data must be evaluated and the analytical uncertainty must be determined. These parameters will be evaluated for the entire project data set.

The following procedures will be used to assess data precision, accuracy, and completeness. These equations apply to both field and laboratory measurements.

Precision. Precision is defined as the reproducibility or degree of agreement between duplicate measurements under a given set of conditions. The closer the measurements approach each other, the more precise the measurement. The level of precision is determined by calculating the relative percent difference (RPD) between the two measurements using the following equation:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100\%,$$

where

S = analyte concentration of the original sample and
D = analyte concentration of the duplicate sample.

Precision is determined using MS/MSD analyses. The laboratory will select one sample in twenty to split into three aliquots. The first aliquot will be analyzed routinely for the parameters of interest; the other two aliquots will be spiked with known quantities of the parameters of interest before analysis. The RPD between the two spike results will be calculated and used as an indication of the precision of the analyses performed.

When the analyte of interest provides a measurable quantity without spiking, precision determinations can be obtained through duplicate analysis comparisons. Field duplicate samples are evaluated as an indication of overall precision. This evaluation measures variability introduced during both field sampling and laboratory analysis.

Analytical precision goals for the proposed radiochemical and inorganic parameters will be ~20 RPD. Goals for analytical precision for organic parameters will be those identified in the analytical methods for specific analytes. In general, these range up to 25 RPD (volatile organics) and 50 RPD (semivolatile organics) in soils. If analytical precision goals are exceeded, a determination will be made through the data validation process relative to the useability of that information.

Accuracy. Accuracy is defined as the degree of difference between measured values and the true values. Sampling accuracy will be maximized by adhering to the QAPjP. All procedures used will be documented as SOPs or Analytical Operating Procedures (AOPs). Analytical measurement accuracy is evaluated through implementation of analyte matrix spike or standard reference material determinations. The following equation will be used to calculate percent recovery (%R):

where

$$\%R = \frac{A_r - A_o}{A_f} \times 100\%,$$

A_r = total compound or element concentration detected in the spiked sample,
A_o = concentration of the compound or element detected in the unspiked sample, and
A_f = concentration of the compound or element added to the sample.

For situations in which a standard reference material (SRM) is used rather than or in addition to MS analyses, the following equation will be used:

$$\%R = \frac{C_m}{C_{srm}} \times 100\%,$$

where

C_m = measured concentrate of SRM and
C_{srm} = actual concentration of SRM.

A recovery of 100% is equivalent to 100% accuracy. Values varying from 100% may indicate a sample matrix effect and a false reading. A periodic program of sample spiking is required (e.g., 1 MS and 1 MSD per 20 samples).

The proposed radiochemical and inorganic accuracy goals for this investigation will be 80% to 120% as expressed in recovery of known analytical spikes into the sample media. Analytical accuracy goals for organic parameters will be those identified in the CLP analytical methods for specific analytes.

In general, volatile organic compound spike recoveries range between 60% and 150% in soils, while semivolatile organic compound spike recoveries range between 20% and 140%. In the event analytical accuracy goals are exceeded, a determination will be made through the data validation process relative to the usability of those data.

Representativeness. Representativeness expresses the relative degree to which the data depict the characteristics of a population, parameter, sampling point, process condition, or environmental condition. The objective of this study is to accurately represent the chemical concentrations of target analytes.

Representative samples for this investigation will be acquired through implementation of approved sampling and analytical procedures that will generate data representative of the sampling point location. Sampling procedures are designed to minimally impact the sample obtained, so that conditions representative of the sampling location will be maintained. Analytical methods will be selected that most accurately represent the true concentration of the parameter of interest. The accumulation of QC procedures and information (i.e., RPD

values, blank QC concentrations, MS percent recoveries, etc.) employed for a given analysis combine to exhibit the representativeness of the data generated.

The goal for representative sample data will therefore be met through the proper documentation of field and analytical protocols. If these procedures and methods cannot be implemented, the appropriate corrective action documentation will encompass the impact on the representativeness of the information. When review of the data and documentation determines that the data are nonrepresentative, the information will be qualified in its use or will not be used by the project. Statistical formulas may be implemented to further define sample population, parameter, or process characteristics relative to representativeness.

Completeness. Completeness is the measure of the amount of data obtained from a measurement process that achieves the project goals compared to the amount of data planned to be obtained by the project.

The following are three measures of completeness determined for this investigation.

Sample collection:

$$Completeness = \frac{Number\ of\ sample\ points\ sampled}{Number\ of\ sample\ points\ planned} \times 100\%.$$

Field measurements:

$$Completeness = \frac{Number\ of\ valid\ field\ measurements\ made}{Number\ of\ field\ measurements\ planned} \times 100\%.$$

Laboratory analysis:

$$Completeness = \frac{Number\ of\ valid\ laboratory\ measurements\ made}{Number\ of\ laboratory\ measurements\ planned} \times 100\%.$$

Completeness goals established for this project for sample collection and field measurements are 95%. If these goals are not met, the necessity for resampling will be determined on a case-by-case basis. The completeness goal for laboratory analysis for this project is 90% overall. For critical data points, which consist of background sample locations, the completeness goal for sample collection, field measurements, and laboratory analysis is 100%. If review of the data and documentation determines that the data are incomplete, the impact relative to the project objectives will be assessed and documented.

To complete the intent of this project, all data will be validated against the reduced Level C criteria, with a minimum of 10% of the data validation being completed at Level D, to determine its useability. For determination of completeness in this project, all data not flagged as rejected by the validation process will be considered valid.

Additional formulas and statistically generated data may be utilized to further define data set completeness.

Comparability. Comparability expresses the confidence with which one data set can be compared with another. Comparability of the data generated in this investigation will be obtained through the implementation of the identified protocols for sampling and analysis of samples. Use of traceable reference materials as laboratory standards, expression of results in standard concentration units, and successful participation by the laboratories in external performance evaluation programs will enable the data produced through this investigation to be compared with future data sets, if required.

7.10 AUDITS AND SURVEILLANCES

Audits are performed to review and evaluate the adequacy of field and laboratory performance and to ascertain whether the QA/QC plan is being completely and uniformly implemented. Planned and scheduled audit will be performed to verify compliance with all aspects of the QA program and to determine the program's effectiveness. Energy Systems audits will be conducted in accordance with ESS-QA-18.0 and ESP-QA-18.1. An SAIC audit may be conducted in accordance with SAIC QAAP 18.1 and will be performed by personnel who do not have direct responsibility for performing the activities being audited.

Surveillance activities include monitoring and observing documents and work activities to provide an effective real-time means of evaluating the adequacy and effectiveness of methods for achieving quality and for assessing the quality of final results. Energy Systems surveillances will follow ER/Y-I1600. SAIC surveillances will be conducted in accordance with SAIC QAAP 18.3 and will identify the root cause on any NCR issued.

At least one surveillance will be scheduled to include observation of all procedures implemented.

Field surveillances will be conducted to assess technical and quality activities including sampling, instrumentation use, equipment decontamination, sample shipment, and field record maintenance.

7.11 CORRECTIVE ACTION

Energy Systems corrective actions to audit/surveillance findings and nonconformances will be managed in accordance with ESS-QA-16.0, 16.1, 16.2, 16.3, 16.4 and ESS-QA-15.0 and 15.1. SAIC corrective actions to audit/surveillance findings and nonconformances will be managed in accordance with SAIC QAAP 15.1 and 16.1. The Y-12 ER project manager will be notified when a nonconformance is documented and furnished a copy as soon as possible. Copies of nonconformances and their dispositions will be forwarded to the Y-12 ER project manager for placement in the Y-12 ER Records Center. Nonconformance reports issued as a result of an audit or surveillance will identify the root cause of the problem.

7.12 QA REPORTS TO MANAGEMENT

All QA records concerning the project (e.g., internal and external correspondence, sampling and analysis plan, QAPjP, field logbooks and forms, chain-of-custody forms, data packages, audit reports, surveillance reports, nonconformance reports, corrective action reports, etc.) will be submitted to the Central Records Facility for dual storage and retrieval.

Environmental Restoration Health and Safety Plan for the SAP for the Bear Creek Valley Floodplain (Sediment Investigation at the Y-12 Plant)

Technical Support Contractor Program Manager	Date
Technical Support Contractor Field Team Leader	Date
Site Health and Safety Officer	Date
Energy Systems ER Site Program Manager	Date
Energy Systems ER Site Project Manager	Date

8. HEALTH AND SAFETY PLAN

This Health and Safety Plan (HSP) addresses the performance of investigation field work on the BCV Floodplain Sampling Investigation. The purpose of this plan is to establish site-specific health and safety requirements to be followed by all personnel involved in conducting on-site work for this project. The field work will be conducted in accordance with relevant DOE and Y-12 Plant Safety and Health Standards and the SAIC Environmental Compliance and Health and Safety Program. Section 8.1 is a checklist that presents condensed site hazards and controls. This section is designed to be read and easily understood by all project personnel.

The levels of protection and the procedures specified in this plan are based on the best information available from historical data and preliminary evaluations of the area. Therefore, these are the minimum health and safety requirements to be observed by all personnel engaged in this project. Unforeseen site conditions or changes in scope of work may warrant a reassessment of protection levels and controls. All adjustments that result in decreases in protective measures must have prior approval of the relevant Y-12 Health and Safety office, the Y-12 ER project manager, and the SAIC Health and Safety manager. Such changes will be approved and documented through the issuance of field change orders.

The field phases of this project will begin in late summer or early fall 1994 and should be completed in late fall. The field crew will consist of 5 to 15 personnel. These personnel will include SAIC and subcontractor employees. An SAIC field team leader will be on site at all times and will be in charge of SAIC personnel and SAIC subcontractor personnel.

8.1 SITE HEALTH AND SAFETY CHECKLIST

8.1.1 Site Description

This plan addresses the full extent of Bear Creek Valley Floodplain. Contamination is suspected to have originated and been transported from the BCV source OUs 1 and 2. The units in BCV OU 1 were used for the disposal of waste oils, mop water, uranium-contaminated materials, thorium-contaminated materials, mercury-contaminated material, acids, salts, solvents, asbestos debris, and other contaminated material. In most cases open earthen trenches were filled and either burned or buried. The S-3 ponds were treated with acid and lime for bioremediation. The ponds were drained and filled with soil, then paved to create a parking lot. The units in BCV OU 2 are areas of contaminated fill and spoil areas.

Disposal records indicate a wide assortment of hazardous and nonhazardous materials have been disposed of in the various disposal facilities. Much of the disposal material was contaminated debris. Records indicate that flammable and reactive materials were exposed to the atmosphere (emptied from containers or containers were ruptured) and were burned or reacted prior to burial.

Prior sampling of Bear Creek floodplain sediments and stream sediments indicated elevated concentrations of uranium and PCBs.

The planned tasks include subsurface sediment sampling, surface sediment sampling, stream sediment sampling, and equipment decontamination. Chemical and radiological exposures will be limited to materials that may have migrated from the disposal sites.

8.1.2 Site Organization

The project personnel are organized to assure clarity of responsibility for health and safety tasks. The Y-12 project manager is responsible for the overall coordination and performance of the project. The SAIC Health and Safety manager is responsible for reviewing site health and safety plans, determining if proposed plan changes meet relevant health and safety requirements, and verifying that on-site project execution provides a safe and healthy work environment through on-site audits. The site Health and Safety officer is responsible for monitoring site health and safety, verifying the hazards of planned work, making health and safety decisions, and reporting unexpected hazards and noncompliance with the health and safety program to the field team leader, the project manager, and the health and safety manager. The SAIC field team leader is responsible for on-site enforcement of the health and safety plan and coordination of SAIC activities during any emergencies. The SAIC project manager is responsible for assuring that the appropriate personnel and equipment are available to perform site work safely. These personnel are the following: Y-12 project manager, Judy A. Hodgins, (615) 576-2368; SAIC Health and Safety manager, Steve Davis, (615) 481-4755; SAIC SHSO and alternates, Paul Eldridge, Mike Crenshaw, Steve Davis, (615) 481-2348; SAIC project manager, Peter Salpas, (615) 481-4747;
SAIC team leader, Ken Swain, (615) 481-4712.

8.1.3 Tasks

The following planned tasks are indicated with a Y, and tasks that will not be performed are indicated with an N.

1. Y Groundwater sampling
2. N Test pit excavation
3. Y Geophysical surveying
4. N Penetrometer testing
5. Y Monitoring well installation
6. Y Surface water sampling
7. N Land clearing
8. Y Land surveying
9. Y Radiation surveying
10. Y Equipment decontamination
11. Y Soil boring/sampling
12. Y Surface soil sampling
13. N Air sampling
14. N Drum sampling
15. N Biota sampling
16. N Sludge sampling

8.1.4 Task-specific Hazard Evaluation and Controls

This section presents task-specific hazard evaluations and controls. The hazard evaluations are organized into general categories such as physical hazards, electrical hazards, etc. A numerical ranking of 0 to 4 is used to indicate the presence and probability/severity of a hazard. These rankings are: 0—that hazard is not posed by the planned tasks at this site or the impact of that hazard is insignificant; 1—the worst case potential for exposure is less than relevant action limits and the potential for a serious injury is very low even without controls; 2—the worst case potential for exposure is less than threshold limit values and the potential for a serious injury is low and controllable with standard operating procedures; 3—the worst case potential for exposure is greater than the threshold limit values and the potential for a serious injury is moderate and controllable with specific controls; 4—a high probability of encountering that hazard and a high probability for a serious adverse outcome if nothing is done to control the hazard. The final part of this section presents task specific hazard controls based on these hazard evaluations.

The planned tasks are divided into five groups based on similarities in potential hazards. These groups consist of the following:

- monitoring well installation and soil boring/sampling,
- surface soil sampling, and
- equipment decontamination.

The hazard evaluations for each of these groups are presented under each category of hazard.

Physical hazards

Tasks: Soil Boring/Sampling

2	Heat Stress	0	Enclosed Space	0	Ergonomic Hazards
1	Cold Stress	0	Explosive/Flammable	2	Heavy Lifting
0	Noise	0	Oxygen-deficient	1	Tripping/Falling
0	Confined Space	0	Electrical Equipment	0	Vibration

Tasks: Surface Soil Sampling

2	Heat Stress	0	Enclosed Space	0	Ergonomic Hazards
2	Cold Stress	0	Explosive/Flammable	2	Heavy Lifting
0	Noise	0	Oxygen-deficient	1	Tripping/Falling
0	Confined Space	0	Electrical Equipment	0	Vibration

Tasks: Land Surveying

1	Heat Stress	0	Enclosed Space	0	Ergonomic Hazards
1	Cold Stress	0	Explosive/Flammable	0	Heavy Lifting
0	Noise	0	Oxygen-deficient	1	Tripping/Falling
0	Confined Space	0	Electrical Equipment	0	Vibration

Tasks: Equipment Decontamination

2	Heat Stress	0	Enclosed Space	0	Ergonomic Hazards
1	Cold Stress	1	Explosive/Flammable	2	Heavy Lifting
2	Noise	0	Oxygen-deficient	1	Tripping/Falling
0	Confined Space	0	Electrical Equipment	0	Vibration

Safety/construction hazards

Tasks: Boring/Sampling

0	Trenching	0	Excavating	0	Heavy Equipment
0	Hoisting/Rigging	0	Elevated Work	0	Welding/Cutting
0	Ladders	0	Underground hazards	0	Overhead hazards

Tasks: Surface Soil Sampling

0	Trenching	0	Excavating	0	Heavy Equipment
0	Hoisting/Rigging	0	Elevated Work	0	Welding/Cutting
0	Ladders	1	Underground hazards	0	Overhead hazards

Tasks: Land surveying

0	Trenching	0	Excavating	0	Heavy Equipment
0	Hoisting/Rigging	0	Elevated Work	0	Welding/Cutting
0	Ladders	0	Underground hazards	0	Overhead hazards

Tasks: Equipment Decontamination

0	Trenching	0	Excavating	0	Heavy Equipment
0	Hoisting/Rigging	0	Elevated Work	0	Welding/Cutting
0	Ladders	0	Underground hazards	0	Overhead hazards

Chemical hazards

Table 8.1 lists the potential chemical exposures.

Tasks: Soil Boring/Sampling

1	Volatile organic	1	Inorganics	1	Carcinogens
1	Corrosive	1	Reproductive toxicant	1	Mutagens/Teragens
1	Metals	0	Asbestos	0	Other

Table 8.1. Chemical hazards

Chemical	TLV/PEL/Activity or DAC/STEL/IDLH[a]	Health effects/ potential hazard[b]	Chemical and physical properties[c]	Exposure route(s)
Corrosive and reactive materials (exact materials unknown)	TLV: unknown STEL: unknown IDLH: unknown	Irritation, potential reactivity	Unknown	Inhalation Ingestion Contact
Isopropyl alcohol (used for sampling equipment decontamination)	TLV: 400 ppm STEL: 500 ppm IDLH: 12000 ppm	Irritation, dizziness	Colorless liquid with rubbing alcohol odor; FP 53° F; IP 10.10 eV	Inhalation Ingestion Contact
Perchloroethylene (and other chlorinated solvents)	TLV: 50 ppm STEL: 200 ppm IDLH: 500 ppm	Classified by NIOSH as a carcinogen, eye irritation, dizziness	Colorless liquid with chloroform odor; FP NA; IP 9.32 eV	Inhalation Ingestion Contact
PCBs	TLV: 0.5 mg/m^3 STEL: NA IDLH: 5 mg/m^3	Classified by NIOSH as a carcinogen, eye irritation, acne-form dermatitis	Usually mixed with oil as dark liquid; FP NA; IP NA; VP 0.00006 mm	Inhalation Absorption Ingestion Contact
Uranium (isotope unknown)	2 x 10^{-11} μCi/mL (representative)	Carcinogenic, mutagenic, teratogenic	Variable, depends on compound	Inhalation Ingestion Absorption Injection

[a]From 1993-1994 Threshold Limit Values, 1990 NIOSH Pocket Guide to Chemical Hazards, and ICRP 30.

[b]From 1990 NIOSH Pocket Guide to Chemical Hazards.

Notes: CNS = central nervous system; CVS = central vascular system; DAC = derived air concentration; FP = flashpoint; GI = gastrointestinal tract; IDLH = immediately dangerous to life and health; IP = ionization potential; LEL = lower explosive limit; NA = not available; PEL = permissible exposure limit; SOL = solubility; STEL = Short-term exposure limit; TLV = threshold limit value; TWA = time weighted average; UEL = upper explosive limit; VP = vapor pressure.

Tasks: Surface Soil Sampling

2	Volatile Organic	1	Inorganics	1	Carcinogens
0	Corrosive	1	Reproductive toxicant	1	Mutagens/Teragens
0	Metals	0	Asbestos	0	Other

Tasks: Land Surveying

1	Volatile Organic	0	Inorganics	1	Carcinogens
0	Corrosive	1	Reproductive toxicant	1	Mutagens/Teragens
0	Metals	0	Asbestos	0	Other

Tasks: Equipment Decontamination

1	Volatile Organic	1	Inorganics	1	Carcinogens
0	Corrosive	1	Reproductive toxicant	1	Mutagens/Teragens
0	Metals	0	Asbestos	0	Other

Ionizing radiological hazards

Tasks: Land surveying, equipment decontamination, soil boring/sampling, and surface soil sampling.

0	Radiation	0	High radiation	0	Very high radiation
1	Contamination	0	High contamination	0	Fixed contamination
1	Soil contamination	0	Airborne radioactivity	0	

Biological/vector hazards

Tasks: Land surveying, equipment decontamination, soil boring/sampling, and surface soil sampling.

2	Wildlife	2	Plants	0	Medical Waste
0	Bacterial	2	Parasites	2	Ticks

Sanitation

Tasks: Land surveying, equipment decontamination, soil boring/sampling, and surface soil sampling.

4	Need toilets	4	Need washing facilities

Illumination

Tasks: Land surveying, equipment decontamination, soil boring/sampling, and surface soil sampling.

0	Inadequate Lighting

Task-specific hazard controls

This section presents task-specific hazard controls. The tasks are organized into groups based on similar hazards and controls, as shown in Table 8.2.

8.1.5 General Hazard Controls

A complete description of general hazard controls is given in the following text.

Engineering controls

Chemicals brought on site will be in their original containers and an MSDS will accompany each chemical. The MSDS will be readily available to site workers for review. Chemicals in secondary containers will have a diamond label affixed to the containers with the information as required by Y-70-208.

Training

Table 8.3 gives a complete description of training requirements.

Medical surveillance

All on-site workers will be enrolled in a medical surveillance program to comply with the requirements of 29 *CFR* 1910.120. The frequency of medical examinations will be at least annually for routine site workers (100 or more hours on site each year) and at least bi-annually for auditors, managers, etc. who spend <100 h on site each year.

Site control

Exclusion zones (EZ) will be established around any operation where access control is needed to protect personnel from chemical, physical, or radiological hazards, or control the spread of contamination. Only authorized personnel will be allowed to enter. EZs will be established around tasks, such as surface soil sampling, if unauthorized personnel have ready access to the sample area or if the sample collection will take more than 1 h. EZs will be large enough to preclude injury or unacceptable exposure to anyone outside the EZ. No eating, drinking, using tobacco, chewing gum, or applying cosmetics will be permitted in the EZ. Workers in EZs will abide by a "buddy system."

Decontamination and contamination control

Where an EZ is established to prevent the spread of contamination, a contamination reduction zone (CRZ) will also be established and personnel and equipment exiting the exclusion zone will be verified free of contamination, appropriately decontaminated, or packaged to prevent the spread of contamination (equipment) and decontaminated at a central decontamination facility. Equipment decontamination will consist of washing with detergent and water or steam cleaning. Where the exclusion zone is established to prevent the spread of chemical or radiological contamination, protective clothing will be doffed (consistent with standard health physics requirements) prior to entering the support zone. Personnel decontamination will consist of at least a field wash of hands and face before eating

Table 8.2 Task-specific hazard controls

Step	Hazard	Controls
Surface soil sampling (manual-samples operation, sample processing)		
1. Sample collection and packaging	General physical hazards (slips, falls)	Safety shoes, safety glasses if full-face respirator not used, work gloves as appropriate
	Exposure to chemicals	Level D Minimal contact
	Animal hazards (bees, ticks, wasps, snakes)	Pants taped to boots or tucked into socks Visual observation for snakes
	Temperature extremes	Consumption of electrolyte replacement fluid Compliance with ESS-IH-134 Frequent breaks when temperature exceeds 80°F
	Radiation	Compliance with radiation work permit PPE as required for area Decontamination (as required) Minimize contact
Equipment decontamination (hot water washing, soap and water washing, isopropanol washing)		
1. Washing	Release of contaminants to the environment during cleaning	Containment system dependent on contaminant levels
	Exposure to chemicals	Safety glasses or goggles, nitrile or PVC outer gloves, latex inner gloves, Tyvek or company coveralls
	Temperature extremes	Consumption of electrolyte replacement fluid Compliance with ESS-IH-134 Frequent breaks when temperature exceeds 80°F
	Radiation	Compliance with radiation work permit PPE as required for area Decontamination (as required) Minimize contact
2. Isopropanol rinse	General physical hazards (slips, falls, equipment handling)	Level D; Safety glasses or goggles, hard hats if overhead hazards are present, nitrile or polyvinyl chloride (PVC) gloves, safety shoes, field work clothes
	Release of contaminants to the environment during cleaning	Rinse performed in plastic tubs and rinsate collected for appropriate disposal

Table 8.2 (continued)

Step	Hazard	Controls
	Fire/explosion (isopropyl alcohol)	Control of ignition sources Control of flammable materials (quantities limited to single day use) ABC fire extinguisher Flammables stored in flammables cabinet if more than 10 gal
	Exposure to chemicals	Safety glasses or goggles, Tyvek or company coveralls
	Temperature extremes	Consumption of electrolyte replacement fluid Compliance with ESS-IH-134 Frequent breaks when temperature exceeds 80°F
	Radiation	Compliance with radiation work permit PPE as required for area Decontamination (as required) Minimize contact

Notes: PPE = personal protection equipment; PVC = polyvinyl chloride; WBGT = wet bulb globe temperature.

or drinking. A clean support zone will surround the CRZ, and all eating, drinking, and smoking will take place in this zone. The EZ and CRZ will be clearly delineated by barricade tape and/or radiological control rope and signs. A designated entry and exit point will be established and marked.

Level D decontamination. Employees will wash face and hands prior to eating or drinking.

Level C decontamination. If the protective clothing is not contaminated (or suspected to be contaminated) and all monitoring instruments are measuring no more than background levels of contaminants in the breathing zone, decontamination will consist of washing the face and hands prior to eating or drinking. If protective clothing is contaminated (or suspected to be contaminated), a sequential "step-off" decontamination (doffing) process will be used in the CRZ. This will be followed by washing the hands and face.

Radiological doffing/decontamination. Radiological protective clothing doffing and personnel decontamination will follow established Y-12 Plant Health Physics protocols for the relevant area and task.

8.1.6 Personal Protective Equipment

Level D

Level D will be used for nonintrusive and intrusive tasks that pose no significant chemical exposure hazard. Task-specific hazards may require the modification of these basic requirements. See the Task-specific hazard controls section.

Table 8.3 Training requirements

Training	Worker	Supervisor	Site visitor (unescorted)	Site visitor (escorted)
General Employee Training	✓	✓	✓	✓
SARA/OSHA (40 h)	✓	✓	×	×
SARA/OSHA (24 h)	×	×	✓	×
SARA/OSHA Annual Refresher (8 h)	✓	✓	✓	×
SARA/OSHA Supervisors Training (8 h)	×	✓	×	×
General Hazard Communication Training (Contained in 40 or 24 h)	✓	✓	✓	×
Respiratory Protection (required only if respirators are worn; contained in 40 h)	✓	✓	✓	✓
Pre-entry Briefing	✓	✓	✓	✓
Site-specific Hazard Communication (contained in site access briefing)	✓	✓	✓	✓
Safety Briefing (daily and whenever conditions or tasks change)	✓	✓	×	×
Defensive Driving on Non-paved Surfaces* Module #10791	✓	✓	×	×

✓ = Required
× = Not required
* = Required for drivers only

Tasks: Land surveys, equipment decontamination, soil and sediment sampling—"Y" indicates that the item is required, "N" indicates that the item is not required, and "C" indicates that the SHSO may require this item on a contingency basis, depending on the specific hazards of the task.

Clothing:	N	Company coverall	C	Tyvek	N	Other
	N	Saranex	N	PVC	Y	Field clothes
Head:	C	Hard hat	Y	Safety glasses	C	Goggles
	C	Splash shield	C	Ear plugs	N	Other

Hard hats will be worn only around overhead hazards. Ear plugs will be used if noise levels exceed 85 dBA. Splash shields will be worn if any task presents a splash hazard to the face.

Gloves:	C	Nitrile	C	PVC	N	Neoprene
	C	Latex	N	Vinyl	N	Other

Chemical protective gloves will be required for some tasks.

Footwear	Y	Steel-toed leather	C	Chemical overboots
	N	Steel-toed rubber	N	Other

Action levels for changes. The SHSO will upgrade the required protection to Level C if the air monitoring action levels are exceeded or will add specific items such as PVC gloves if evidence of significant unanticipated exposure hazards is observed.

Level C

Level C may be used as a contingency in the event that PID readings in the breathing zone are >5 ppm, mercury vapor readings are >0.025 mg/m^3, or radiological readings above 100 cpm/100 cm^2 alpha or readings above 500 cpm/100 cm^2 may require upgrade to level C.

Tasks: "Y" indicates that the item is required, "N" indicates that the item is not required, and "C" indicates that the SHSO may require this item on a contingency basis, depending on the specific hazards of the task.

Respirator:	Y	Half-face	C	Full-face

Full- or half-face respirators with organic vapor, acid gas, and HEPA cartridges will be worn.

Clothing:	Y	Company coverall	C	Polyethylene Tyvek		Other
	C	Saranex Tyvek	N	PVC		

Polyethylene or saranex Tyveks may be required.

Head:	C	Hard hat	Y	Safety glasses	C	Goggles
	N	Splash shield	C	Ear Plugs	N	Other

Hard hats will be worn only around overhead hazards. Ear plugs will be worn in any area where noise levels exceed 85 dBA. Safety glasses will be worn if a full-face respirator is not used.

Gloves:	Y	Nitrile	C	PVC	N	Vinyl
	Y	Latrex	C	Work	N	Other
	N	Neoprene				

PVC or nitrile gloves will be worn over latex inner gloves. Work gloves will be added over these gloves if tasks present a cut or abrasion hazard.

Footwear:				
	Y	Steel-toed leather	C	Chemical overboots
	C	Steel-toed PVC	N	Other

Footwear will consist of steel-toed PVC boots or steel-toed leather boots with chemical-resistant overboots.

Current plans do not call for Level B for any task.

8.1.7 Monitoring Requirements

Direct reading instruments

Table 8.4 assigns the direct reading instruments for the various tasks.

8.1.8 Emergency Preparedness

The Plant Shift Superintendent will be contacted (911 from a plant phone or 574-7172 from a cellular phone) in the event of any site emergency. The Plant Shift Superintendent will coordinate and supply emergency services such as ambulance, emergency medical care, firefighting, security, and hazardous materials response. Additional emergency telephone numbers are: Y-12 Plant Guard Department, 574–7272; Y-12 Plant Medical, 574–1577; Y-12 Plant Industrial Hygiene, 576–7182; Y-12 Plant Health Physics, 574–3547; Y-12 Plant Industrial Safety, 574–1562; Methodist Medical Center of Oak Ridge, 481–1190.

Table 8.4 Direct reading instruments to be used during the performance of field activities

Instruments	Task(s)	Frequency	Action limits/responses
Alpha meter	5, 11, 12	Sample removal	≥100 cpm/100 cm^2
Beta/gamma meter	5, 11, 12	Sample removal	≥500 cpm/100 cm^2
PID	5, 11, 12	Continuous	>1 ppm (breathing zone); benzene detector tube
			>5 ppm (breathing zone); level C
			>20 ppm (stop work); reduce concentration
Mercury (Jerome)	5, 11, 12	Greater than once per 10 min	>0.025 mg/m^3; stop work; reassess
Other (specify)			

The SHSO will perform the following pre-emergency tasks before starting field activities:

- Locate nearest plant telephone and alarm station (Bear Creek Road entrance to SL1).
- Confirm and post emergency telephone numbers.
- Post site map of work areas marked with evacuation route and hospital.
- Inventory and check out on-site emergency equipment and supplies.

8.1.9 Emergency Equipment

Y	First aid kit(s)	Y	Emergency eyewash	Y	Cellular phone or radio
Y	Fire extinguisher(s)	N	Deluge shower	N	Other

8.2 EMERGENCY PREPAREDNESS

Emergency actions are tailored according to whether investigative activities are being conducted on sites in noncontaminated areas, on sites that have been designated as radiologically contaminated, or on sites that have been surveyed and may contain hazardous substances.

8.2.1 Emergency Actions For Noncontaminated Areas

In the event of an accident involving actual or suspected personal injury, the Field Team Leader will perform the following steps in the order shown here:

- Initiate emergency first aid, if necessary.
- Contact the Y-12 Plant Shift Superintendent.
- Obtain transportation for injured personnel (e.g., driller's service truck, SHSO vehicle, escort vehicle, ambulance), if required. A medical exam will be required after each accident that potentially exposes personnel to hazardous substances above the allowable limits or that results in injuries, other than minor first aid injuries, that might result in lost work days or reassignment of the injured worker.
- Initiate necessary corrective measures to abate any unsafe conditions.
- Withdraw uninjured site personnel to a safe distance from the accident scene until the SHSO determines that it is safe for work to resume.
- Contact the Y-12 Plant ER project manager.

Personnel should not enter an area to attempt a rescue if their own lives would also be threatened because of inadequate personal protection (e.g., clothing, self-contained breathing apparatus). The SHSO will ensure that all employees can be rescued from any area of the site that they are allowed to enter and is responsible for developing any special decontamination procedures for injured personnel if necessary.

Emergency planning will include establishing a procedure for evacuation from the site in case of a natural or man-made catastrophe. For work sites inside the Y-12 Plant, contractor and subcontractor personnel will assemble at the designated assembly point or where instructed by the Plant Shift Superintendent in the event of a plant emergency.

8.2.2 Emergency Actions Within Contaminated Areas

If personal injury or exposure of personnel to radiological contamination, suspected hazardous chemicals, vapors, or particulates occurs within a contaminated site, the following emergency procedures will be applied.

Personnel Injury in the Exclusion Zone. All site personnel will assemble at the decontamination line. The rescue team will enter the exclusion zone (if required) to remove the injured person to the boundary.

- The SHSO or other qualified person will evaluate the nature of the injury. If the injury is determined not to be an immediate threat to life, the injured person will be decontaminated to the extent possible before being moved to the support zone. If the injury is determined to be an immediate threat to life, decontamination procedures will be postponed until the injured person stabilizes.
- The Y-12 Plant Shift Superintendent will be contacted for an ambulance, and the designated medical facility will be notified (if required). No person will re-enter the exclusion zone until the cause of the injury or symptoms is determined.

PPE Failure. If any site worker experiences a failure or alteration of PPE that affects the protection factor, that person and his/her buddy will immediately leave the work area for a safe location. Re-entry will not be permitted until the equipment has been repaired or replaced. Rescue operations from toxic atmospheres will be conducted by persons wearing either self-contained breathing apparatus or suitable air-line respirators with escape bottles.

First Aid. At least one person on site will be certified in first aid and cardiopulmonary resuscitation (CPR). Workers trained and certified in first aid and CPR will render first aid and will attempt to stabilize any ill or injured worker needing assistance. Life support techniques such as CPR and treatment of life-threatening problems such as bleeding, airway obstruction, and shock will be given top priority. All on-site emergency assistance, including medical assistance, will be obtained as rapidly as possible by calling 911 or the Plant Shift Superintendent at 574-7172.

Spill Response. Site personnel will respond and contain any nonemergency spill such as hydraulic fluid or small quantities of decontamination fluid. Site personnel will not perform emergency response to significant spills such as large quantities of fuels. The Plant Shift Superintendent will be contacted for emergency response and site personnel will withdraw from the area.

8.2.3 On-site Communications

On-site communication is required. For emergency communication, the SHSO will use one of the following communication methods:

- mobile radio,
- mobile telephone,
- nearest plant or guard house telephone, or
- fire pull-station.

Environmental Restoration Waste Management Plan for the SAP for the Bear Creek Valley Floodplain (Sediment Investigation at the Y-12 Plant)

Technical Support Contractor Program Manager	Date
Technical Support Contractor Field Team Leader	Date
Site Health and Safety Officer	Date
Energy Systems ER Site Program Manager	Date
Energy Systems ER Site Project Manager	Date

9. WASTE MANAGEMENT PLAN

9.1 SCOPE

The objectives of this Waste Management Plan for the Bear Creek Floodplain Sampling are to specify requirements for managing wastes generated as a result of investigation activities and to estimate the volume of waste that will be generated.

The Bear Creek Floodplain Sampling Waste Management Plan will include management of soil, protective clothing, stream sediment, and decontamination water wastes. Table 9.1 outlines the ER Waste Management Plan Checklist for BCV Floodplain. Investigation-derived wastes (IDW), waste types, waste categories, estimated generation volumes, and expected contaminants for each waste stream are provided in Table 9.1.

Decontamination procedures will be established to support equipment decontamination and reduce the potential for cross contamination during sampling activities. All equipment and personnel will be scanned for radioactive contamination before leaving a sampling location. Equipment exhibiting radioactive contamination will be decontaminated at the sampling location where it was used before being moved to another location or returned to the temporary decontamination area. All equipment at each borehole location will be subjected to preliminary cleaning to remove surface dirt or mud that otherwise might be tracked to other areas of the Y-12 Plant.

Soil cuttings will be generated during the collection of samples. Soil cuttings will be generated when the hand auger is used to collect samples. These soil cuttings will be scanned for radiological and volatile organic contamination using field screening instruments. Soil cuttings will be returned to the borehole from which they came in accordance with CERCLA guidance (*Guide to Management of Investigation-Derived Waste*, EPA Publication 9345-03FS, April 1992).

Boreholes will be abandoned by filling the borehole with soil cuttings. Excess soil cuttings will be mounded on top of the borehole to alleviate any settling and/or spread around the borehole. Extra materials will not be added to the collection area to bring it up to grade.

Decontamination water will be collected for each transect and will be poured onto the ground adjacent to each transect off of the floodplain. The water will be poured at a rate that will prevent pooling or runoff. Decontamination water for fine-scale locations will be poured on the ground at an approved central location off of the floodplain. The isopropyl alcohol used as a rinse during decontamination will be contained separately from the decontamination water and allowed to evaporate.

9.2 LABORATORY ANALYTICAL SAMPLES

The analytical laboratory will be subcontracted directly by SAIC. The disposal of any laboratory-generated waste and excess sample material will be the responsibility of the subcontracted laboratory and will be disposed of at an approved off-site facility. Documentation of an NRC license to handle the material will be provided by the laboratory and a contract to dispose of the material will be in place. If the on-site laboratory facility is used, all sample material will be returned to the associated sample location by the sampling team.

Table 9.1. Environmental Restoration Waste Management Project Plan

General project information	
Project name:	Bear Creek Operable Unit 1 Remedial Investigation Project
Plant:	Y-12 Plant
Organization:	Environmental Restoration Division/Remedial Investigation Subcontractor
Responsible project manager:	Judy Hodgins, Y-12 Environmental Restoration Program
Expected start/completion date:	August 1, 1994/June 29, 1996
Project description (brief):	Remedial Investigation to collect surface and subsurface samples
Project participants (for waste management interface only):	Waste generator: RI subcontractor Waste handler: Y-12 ER Division Waste transporter: WTSD Interim waste storage: RI subcontractor Permanent waste storage: WTSD Waste treatment: WTO Waste disposal: Y-12 sanitary landfill and/or WTSD

Waste stream general information

Waste stream	Category	Contaminant	Available analysis	Volume (ft or gal)	Packaging	2109#
Waste Stream 1 Unused soil will be returned to the borehole from which it came. The upper 4 ft of each borehole will be grouted. Any remaining soil will be kept on site	LLW	Depleted and enriched uranium, nitrates, metals, acids, bases	None required	1.8 m^3 (60 ft^3)	None	None required
Waste Stream 2 Decontamination water (uncontaminated will be returned to AOC; only contaminated will be contained)	LLW	Depleted and enriched uranium, nitrates, metals, acids, bases	CSTI required field screening for rad	418 L (110 gal)	Poly tanks or drums	Yes
Waste Stream 3 PPE (clothing)	Sanitary (Dumpster)	Same as Waste Stream 1	Field screening for rad	1.35 m^3 (45 ft^3)	None	None required
Waste Stream 4 Purge water	LLW	Same as Waste Stream 2	Same as Waste Stream 2	(2000 gal)	Poly tanks or drums	Yes

Table 10.1 (continued)

Waste stream handling	
Transport across public access roads Road involved: DOT regulations to be applied: Reportable quantities of anticipated DOE regulated hazardous material (if required):	☐ Yes ☑ No N/A ☐ Yes ☑ No N/A
Waste storage requirements 90-day storage area (waste handler must obtain 90-day permit from the Environmental Compliance Department) Location: Capacity: Waste acceptance criteria requirements: Responsible organization: Permitted (or interim status) storage Location: Capacity: Waste acceptance criteria requirements:	☐ Yes ☑ No ☐ N/A ☐ Yes ☑ No ☐ N/A
Identification of potential treatment options Location: Capacity: Responsible organization: Special waste acceptance criteria requirements:	
Identification of potential disposal options Location: Capacity: Responsible organization: Special waste acceptance criteria requirements:	SLF 5 WTSD N/A

Table 10.1 (continued)

Waste minimization and reduction techniques to be implemented	
Segregation: ✓ Decontamination: Compaction: ✓ Solvent substitution: Sludge dewatering: Section of PPE: ✓ Other:	In field pretreatment: Waste handling: ✓ Material recylcing (solvents, containers): Material reuse (solvents, wash waters): Cutting fluids recovery: Section of equipment:
Description of special techniques and expected effectiveness:	
General project information (continued)	
Prepared by:	Science Applications International Corporation
Date:	June 14, 1994
Reviews: ER Waste Management Coordinator: Plant Waste Coordinator: (Certifies Acceptance into Waste Management)	_____ _____

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