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SAMPLING PLAN FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR THE GROUNDWATER OPERABLE UNITS AT THE CHEMICAL PLANT AREA AND AT THE ORDNANCE WORKS AREA, WELDON SPRING, MISSOURI (APPENDIX TO THE WORK PLAN)

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

JULY 1995 **REV. 1**

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group

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MK-FERGUSON A MORRISON KNUDSEN COMPANY Weldon Spring Site Remedial Action Project Contract No. DE-AC05-86OR21548	Rev. No. 1

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APPROVALS

Department Manager	7/25/95 Date
PDC Quality Assurance Manager	7-26-95 Date
Project Director (or Deputy Project Director)	7-31-95 Date

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Weldon Spring Site Remedial Action Project

Sampling Plan for the Remedial Investigation/Feasibility Study for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri (Appendix to the Work Plan)

Revision 1

July 1995

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U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

ABSTRACT

The *Sampling Plan for the Remedial Investigation/Feasibility Study for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri (Appendix to the Work Plan)* was developed to provide detailed sampling procedures for data required for the remedial investigation of groundwater at the Weldon Spring Ordnance Works Area and the chemical plant area at the Weldon Spring site. This plan also presents sampling procedures for the ecological investigation of Burgermeister Spring and the Southeast Drainage. Site-related contaminants for groundwater include uranium, nitroaromatics, nitrate, aluminum, antimony, arsenic, barium, cadmium, chromium, iron, lead, lithium, manganese, mercury, molybdenum, nickel, and thallium.

This sampling plan details sampling locations, frequency, and analytes, and provides the sampling procedures and analysis methods for contaminant, ecological, and hydrogeological investigations. Contaminant investigations will include the monitoring of two new wells at the chemical plant area, discrete sampling of groundwater in the Southeast Drainage, collection of groundwater samples from background wells for total uranium and specific metals, and a comprehensive sampling of groundwater wells and several springs at the chemical plant area and ordnance works area to define overall distribution of site-related contaminants.

The hydrogeological investigation will include the drilling of three additional angled boreholes at the chemical plant area, tracer tests, installation (or retrofit) of nine (seven hydrogeological, two contaminant) monitoring wells at the ordnance works area, slug and packer tests, water level measurements, and measurement of precipitation. The ecological investigation will include surveys of biotic communities, toxicity tests, and radiological and chemical analysis of surface water and sediments.

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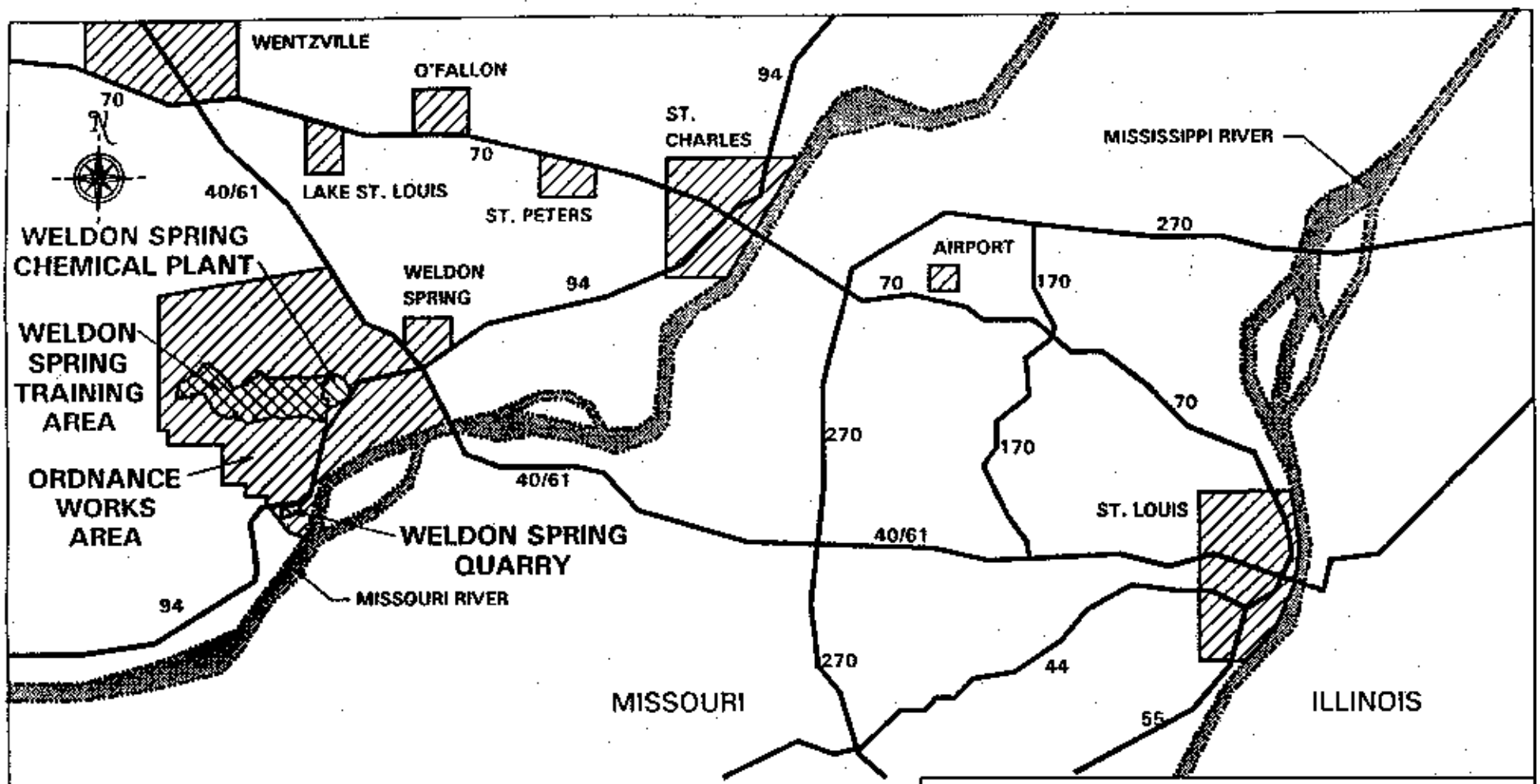
1 INTRODUCTION

The U.S. Department of Energy (DOE) and the U.S. Department of the Army, Kansas City District Army Corps of Engineers (COE) are responsible for environmental cleanup activities for groundwater at the Weldon Spring Chemical Plant and the Weldon Spring Ordnance Works areas, contaminated as a result of previous defense manufacturing activities. The Weldon Spring Ordnance Works area, located west of St. Louis, Missouri in western St. Charles County, was a former explosives production plant that encompassed 6,974 ha (17,232 acres) (Figure 1-1). Most of the explosives production facilities were located in a 670 ha (1,655-acre) portion that is currently owned by the Army and designated as the Weldon Spring Training Area (Figure 1-1) (Ref. 4). Also located within the ordnance works boundary is the Weldon Spring Chemical Plant area (Figure 1-1). The chemical plant area consists of an 88 ha (217 acre) area that was transferred to the Atomic Energy Commission (predecessor to the DOE) from the U.S. Department of the Army in 1955 for construction and operation of a uranium processing facility. Portions of trinitrotoluene lines from the explosive manufacturing facility were located in the chemical plant area. As a result of the previous ordnance works and uranium processing activities in these areas, groundwater within the ordnance works area and chemical plant area is contaminated with radionuclides, nitroaromatics, nitrate, and certain metals (Ref. 2).

This *Sampling Plan for the Remedial Investigation/Feasibility Study for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri (Appendix to the Work Plan)* describes the sampling program and procedures for the hydrogeological, contaminant, and ecological investigations to support the determination of appropriate remedial actions. The overall objectives for remedial investigation are to provide adequate characterization data on the extent and distribution of contaminants within groundwater, to provide information on the hydrogeological processes that govern contaminant mobility and migration, and to provide additional ecological characterization data for Burgermeister Spring and the Southeast Drainage.

This plan has been prepared as part of a joint effort between the DOE and the COE. The DOE is responsible for the groundwater remedial investigation/feasibility study at the chemical plant area of the Weldon Spring site and areas influenced by contaminants from the chemical



WELDON SPRING TRAINING AREA

0 4 8 MI

0 6.4 12.8 KM

SCALE

GENERAL LOCATION OF SITES

FIGURE 1-1

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/VP/036/0994	
ORIGINATOR: JR	DRAWN BY: GLN	DATE: 5/9/95	

plant area. The COE is responsible for groundwater at the ordnance works area and the Weldon Spring training area as well as areas influenced by contaminants from the ordnance works area.

A *Work Plan for the Remedial Investigation/Feasibility Study for the Groundwater Operable Units at the Chemical Plant Area and Ordnance Works Area, Weldon Spring, Missouri* (*Work Plan*) (Ref. 3) was prepared as the fundamental document for the groundwater operable units and provides information on the environmental compliance process, the environmental setting and resources at each site, the current understanding of the nature and the extent of contamination in groundwater, the conceptual site model, the preliminary risk-based screening to identify potential contaminants of concern, and the data quality objectives and requirements for the remedial investigation.

A summary of the sampling activities required for the characterization of the Groundwater Operable Units is provided in Table 1-1. Sampling activities conducted for these Groundwater Operable Units will comply with the quality assurance program developed for the Weldon Spring Site Remedial Action Project and with standard operating procedures. An overview of the quality assurance program and standard operating procedures for each operable unit is presented in Section 5 and in Appendix A.

TABLE 1-1 Summary of the Groundwater Operable Unit Remedial Investigation

Element	Data Requirement	Proposed Sampling Activity
Hydrogeological	Characterize transmissivity of the shallow aquifer in northern and western portions of chemical plant area.	Angle borings drilled in three locations and dye tracing tests.
Hydrogeological	Aquifer characterization data, hydraulic conductivity, and storativity.	Slug tests on untested wells and packer tests on all new wells.
Hydrogeological	Further define flow characteristics at the ordnance works area.	Install six new wells and one retrofit well in the ordnance area and measure water levels.
Contaminant	Define lateral extent of uranium contamination in the southeast corner of the chemical plant.	Install two new monitoring wells and sample for site-related contaminants.
Contaminant	Determine potential site contaminant concentrations in the shallow Burlington-Keokuk.	Sample background wells completed in the shallow Burlington-Keokuk for uranium and other constituents.
Contaminant	A comprehensive sampling to provide nature and extent of site-related contaminants.	Two quarters of joint sampling of groundwater wells and several springs at the chemical plant area and ordnance works.
Contaminant	Confirm site-related contaminants and concentrations.	Collect groundwater samples at selected wells.
Ecological	Identification of ecological receptors.	Survey of fish, amphibians, and benthic invertebrates to determine potential receptors of contaminants at the Burgermeister Spring and the Southeast Drainage. Determine presence of western sand darter, State Watch List species.
Ecological	Determine potential ecotoxicity of surface water and sediment.	Sampling of surface water and sediments from Burgermeister Spring and surface water from the Southeast Drainage for toxicity testing.
Ecological	Determine potential ecological impacts.	Habitat evaluation and sampling of physical quality, surface water and sediments, fish, and benthic invertebrates in Burgermeister Spring and surface water, fish and benthic invertebrates at the Southeast Drainage.

2 HYDROGEOLOGICAL INVESTIGATION SAMPLING PROGRAM

This section describes the activities proposed to satisfy the hydrogeological data requirements identified in the *Work Plan* (Ref. 3). Activities proposed to satisfy hydrogeological data requirements are:

- Drilling of three angled borings at the chemical plant area and associated tracer testing.
- Installation of eight (6 at the ordnance works area and 2 at the chemical plant area) monitoring wells.
- Retrofit of one existing U.S. Geological Survey well at the ordnance works area.
- Packer testing of the consolidated materials during rock coring activities for the angled borings and monitoring wells.
- Slug testing on several existing wells for which previous slug test data is not available.
- Water level measurements for groundwater at both the ordnance works area and the chemical plant area.
- Precipitation measurements for the ordnance works area and the chemical plant area.

The following sections provide a detailed description and associated procedures for drilling, geologic logging, and installation and development associated with monitoring wells and angle borings. Procedures are also detailed for aquifer testing, water level measurements, and precipitation measurements.

2.1 Angled Boring and Monitoring Wells

Three angled borings will be drilled at the locations shown in Figure 2-1. The borings will be drilled at a 30° angle from vertical. Emphasis will be placed on the frequency and character of vertical and horizontal discontinuities and the thickness of residuum and weathered rock zones. Angled borings will not be completed as monitoring wells. Tracer testing will be performed after the drilling has been completed as discussed in Section 2.3.3.

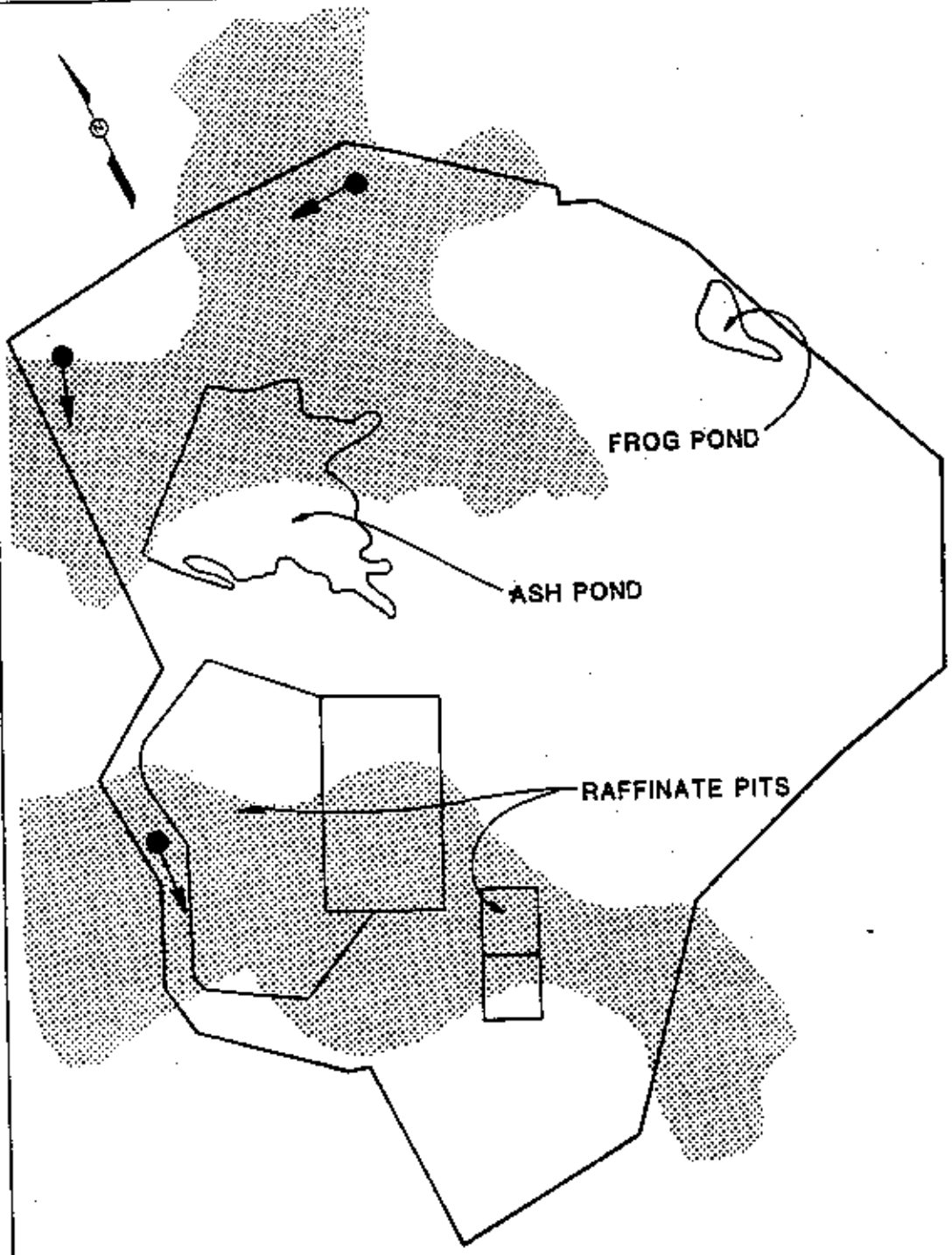
A total of eight groundwater monitoring wells will be installed. Six monitoring wells will be installed in the ordnance works area at the locations shown in Figure 2-2. The completion intervals within the Burlington-Keokuk Limestone and the associated existing well pair for the wells are summarized in Table 2-1.

TABLE 2-1 Completion Intervals for Ordnance Works Area Wells

New Monitoring Well ID	Cluster Pair	Screened Interval
MWD-107	MWS-107	Unweathered
MWS-26	MWD-5	Weathered
MWD-23	MWS-23	Unweathered
MWS-25	---	Weathered
MWD-25	---	Unweathered
MW-112	USGS-7	Pending *

* The completion interval for this well will be determined during drilling activities.

Two monitoring wells will be installed southeast of the chemical plant area at the locations shown in Figure 2-3. These wells (MW-4024 and MW-4025) will be screened in the weathered portion of the Burlington-Keokuk Limestone and south and east of MW-4020.



LOCATION AND BEARING OF PROPOSED ANGLED BOREHOLE

AREAS IN WHICH GROUNDWATER OCCURS IN RESIDUUM, OR WITHIN 10 FEET BELOW SURFACE OF BEDROCK

SCALE 0 800 FEET
0 200 METERS

LOCATIONS OF PROPOSED ANGLED BOREHOLES AND PROPOSED MONITORING WELLS

FIGURE 2-1

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/CP/098/0491	
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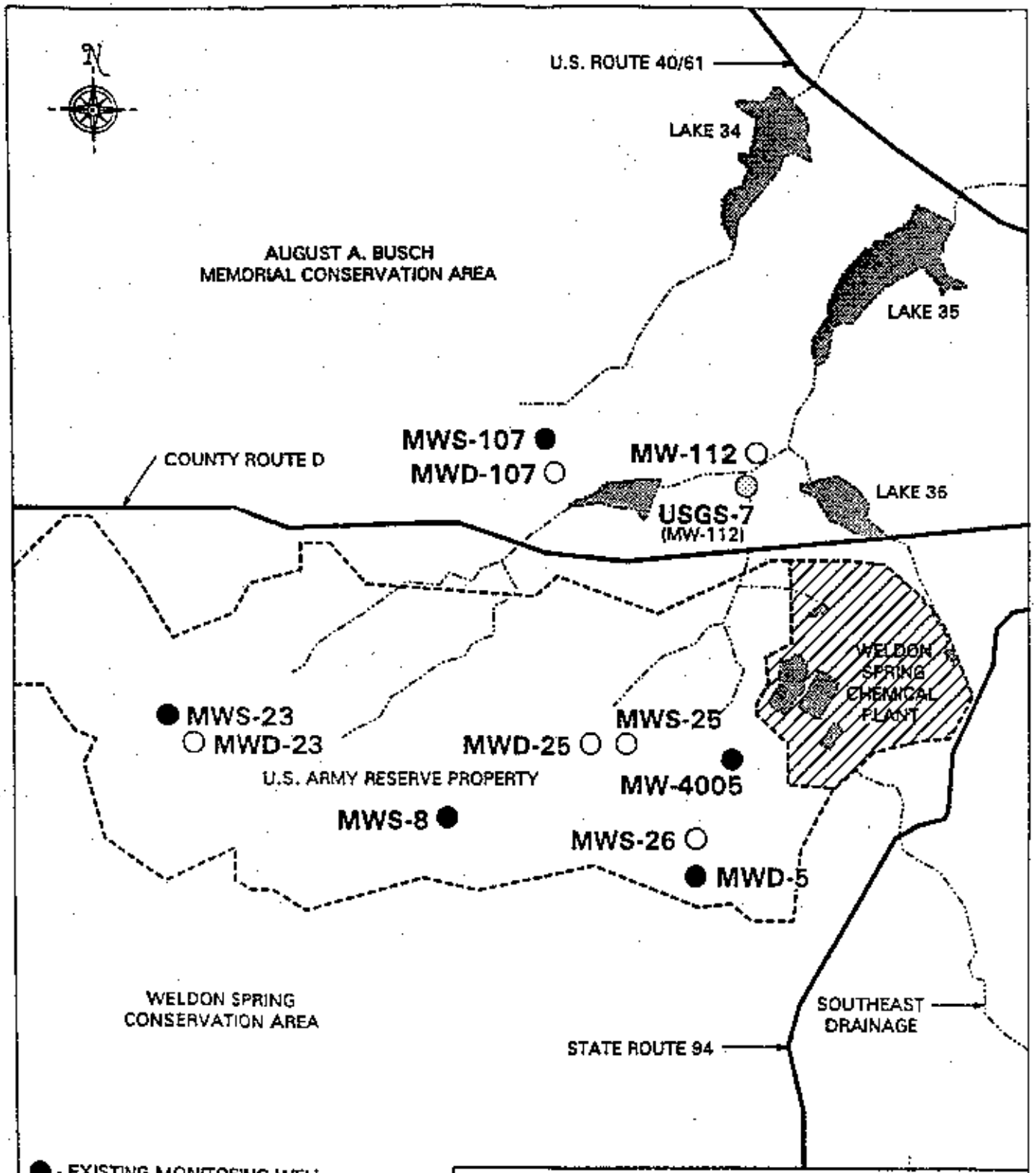


● - EXISTING MONITORING WELL

○ - NEW MONITORING WELL

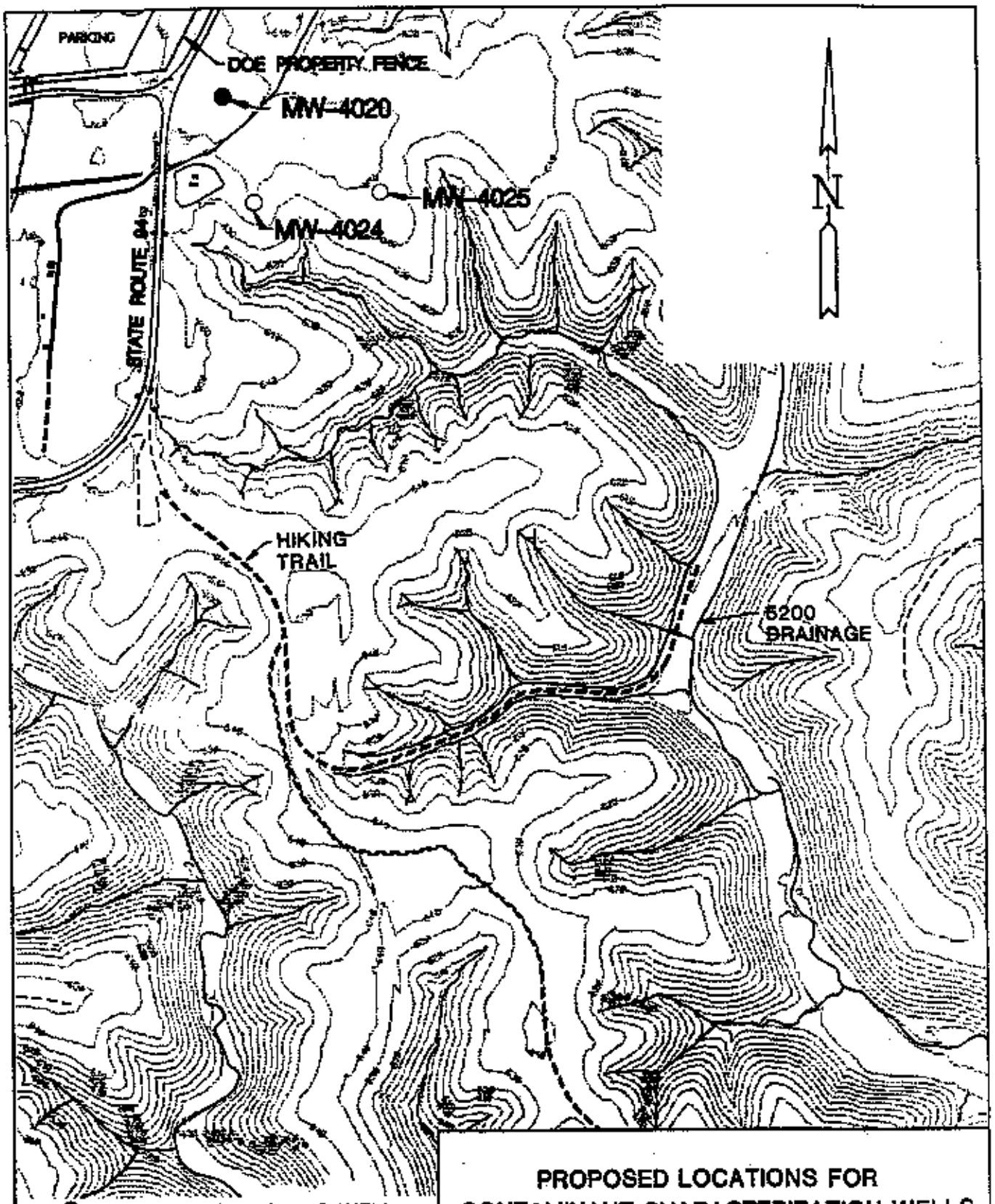
◎ - PROPOSED RETROFIT MONITORING WELL - A MONITORING INTERVAL WILL BE DETERMINED DURING CORING ACTIVITIES.

NOT TO SCALE

PROPOSED LOCATIONS FOR HYDROGEOLOGICAL CHARACTERIZATION WELLS

FIGURE 2-2

REPORT NO.:	DOE/OR/21548-445	DGN/MT NO.:	A/VP/039/0994		
ORIGINATOR:	JB	DRAWN BY:	GLN	DATE:	5/15/95



● EXISTING MONITORING WELL
○ PROPOSED MONITORING WELL

500 0 500

GRAPHIC SCALE
1"= 500'-0" (152.40m)

PROPOSED LOCATIONS FOR CONTAMINANT CHARACTERIZATION WELLS FOR THE CHEMICAL PLANT AREA

FIGURE 2-3

REPORT NO.	EXHIBIT NO.	
DOE/OR/21548-445	A/VP/020/0494	
ORIGINATOR	DRAWN BY	DATE
JB	BC	5/15/95

2.1.1 Drilling Activities

Drilling methods were evaluated with respect to the anticipated types of geologic materials, previous site experience, and the relative advantages and disadvantages of each method. The following drilling methods will be employed:

- Hollow-stem augering (unconsolidated materials)
- Water rotary drilling (rock coring and rock reaming)
- Air rotary drilling (rock reaming)

Precautions will be taken at all times during drilling operations to prevent the contamination or cross-contamination of all wells and borings. Potential contaminants include, but are not limited to, oils, greases, hydraulic fluids, fuels, and contaminated soils. The following general precautions will be taken to minimize the effects of drilling on the subsurface environment:

- All drilling equipment and tools will be decontaminated prior to drilling activities and between locations.

- All drilling will be performed with circulation of in-line air or potable water as a coolant/lubricant. Other additives shall not be used. Filtering of air shall be required.

- Only Teflon tape or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Oils, greases, or pipe dope shall not be used on threads, drilling rods, downhole hammer bits, or other downhole tools. No hydrocarbon-based oils or greases shall be used on rotary table slides or other open, lubricated surfaces of the drill rig.

2.1.1.1 Hollow-Stem Auger Drilling. Hollow-stem auger drilling will be used in unconsolidated materials. This method is required to advance a borehole to a minimum diameter of 15 cm (6 in.). The following precautions and requirements will apply to hollow-stem auger drilling operations:

- Samples will be collected continuously or at predetermined intervals using split spoon samplers or other continuous sampling equipment if directed by the field geologist.

- All samples will be collected during auger advance.

- A plug may be used depending on the sampling method selected.

- Potable water may be used during augering operations to assist in advancement or retrieval of samplers.

2.1.1.2 Rock Coring. Rock coring will be used in consolidated materials to obtain samples of the rock units for lithologic, mineralogic, and hydrologic characteristics. Coring will be accomplished using conventional rotary or wire-line methods in accordance with American Society for Testing and Materials (ASTM), Standard Method D-2113, *Practice for Diamond Core Drilling for Site Investigation*. The following precautions and requirements will apply to rock coring operations:

- Rock coring activities will be performed through temporary casing to prevent the caving or sloughing of the unconsolidated materials into the boring and to facilitate in the circulation of water during rock coring/reaming activities.

- A diamond-impregnated core bit and split inner barrel will be used. The core obtained will be the standard diameter of approximately 5 cm (2 in.).

- Samples will be collected by continuous coring from the top of the bedrock to the specified depth.

- Each core run will be no more than 3 m (10 ft) in length. Variance in length will be determined in the field by the field geologist.

2.1.1.3 Air or Water Rotary Drilling. Air or water rotary drilling will be used in consolidated materials following coring operations and prior to well installation. Rotary drilling

is required to ream boreholes to a minimum diameter of 16 cm (6.25 in.) for single-cased wells. The following precautions and requirements will apply to rotary drilling operations:

- Rotary drilling activities will be performed through temporary casing to prevent the caving or sloughing of the unconsolidated materials into the boring and to facilitate in the circulation of water during rock coring activities. Reaming will be performed through the hollow-stem augers.

- The type of air compressor, compressor lubricating oil, and daily consumption will be specified and recorded in the daily logbook. This information may be required for evaluation in the event that suspect constituents, possibly related to drilling operations, are detected in groundwater samples.

- Air-line oil filters will be used and maintained in accordance with the manufacturer's recommendations. This maintenance activity will be recorded in the daily logbook. Air filters will be changed on a regular basis.

- Air usage, including pressures used, will be fully described on boring logs and in the daily logbook. Information in the daily logbook will also include, but not be limited to, equipment description, manufacturer, model, frequency of oil filter changes, and evaluations of system performances.

2.1.2 Cuttings and Fluids Handling

All cuttings generated and not retained for geological analysis or otherwise used, and all fluids generated as a result of drilling operations or development will be managed in accordance with site-specific procedures. For activities associated with the chemical plant, these materials will be handled in accordance with Procedure RC-30 - *Monitoring Well Waste Management* (Appendix A). For activities associated with the ordnance works, these materials shall be distributed on the ground surface near the well in accordance with Corp of Engineers standard operating procedures.

2.1.3 Geologic Logging

A qualified geologist or geological engineer shall prepare a lithologic log of the unconsolidated and rock portions of each boring, in accordance with Procedure ES&H 4.4.7s, *Soil and Rock Core Borehole Logging* and Appendixes F and G of the *Chemical Data Acquisition Plan* (CDAP) (Ref. 4) (Appendix A). To facilitate selection of screened intervals for the monitoring wells, particular emphasis will be placed on recording lithology, stratigraphic features, and discontinuities that could affect contaminant transport.

Boring logs shall be completed in the field during drilling activities. The dates of the start and completion of any boring shall be recorded. The drilling equipment used shall be generally described with such information as the manufacturer, model, drilling method(s), and boring diameter(s). The names of the drilling contractor and field geologist shall also be recorded.

During logging of unconsolidated materials, the following information will be recorded:

- Sequential boundaries shall be recorded and when depths are estimated, the degree of accuracy shall be noted.
- Depths shall be recorded in feet and tenths of feet. Reference shall be made to the ground surface.
- Soil descriptions shall be in accordance with the Unified Soil Classification (USC) system.
- The description shall include, but not be limited to, the USC symbol and classification name, color, grain size, plasticity, moisture content, and mineralogy.
- The percent recovery shall be calculated and recorded for each sampling interval.
- The first subsurface water encountered shall be indicated.

During logging of consolidated materials, the following information will be recorded:

- Sequential boundaries shall be recorded, and when depths are estimated, the degree of accuracy shall be noted.
- Depths shall be recorded in feet and tenths of feet. Reference shall be made to the ground surface.
- Rock descriptions shall include, but not be limited to, rock type, color (based on Geological Society of America Rock Color Chart), discontinuities (tightness, smoothness, fillings, staining, orientation, voids, etc.), primary and secondary mineralogy, degree of weathering, grain size, alteration, hardness, reaction to hydrochloric acid, and formation name.
- Intervals of core loss and probable reasons for loss shall be noted on the log.
- The percent recovery shall be calculated and recorded for each core run.
- The coring or drilling time per foot of drilling shall be periodically determined and recorded.
- The percent drilling fluid recovery shall be determined and recorded.

2.1.4 Core Storage

The cores will be placed in premanufactured wood boxes designed to hold 3 m (10 ft) of core. The rock core will be clearly labeled to indicate proper orientation, both vertically and with adjacent pieces of core, core interval, core loss, and depth of sample interval. Core losses will be noted by marked wooden blocks showing the approximate depth and length of the loss zone. Unconsolidated, friable, or clayey sections of core will be placed in clear plastic sheeting, glass jars, core tubing, or sealable bags, and will be stored with any competent core in the core boxes. Rock cores will be handled in general accordance with ASTM D-2113, regarding storage and transportation. Rock cores will be retained at each respective site.

2.1.5 Field Logbook

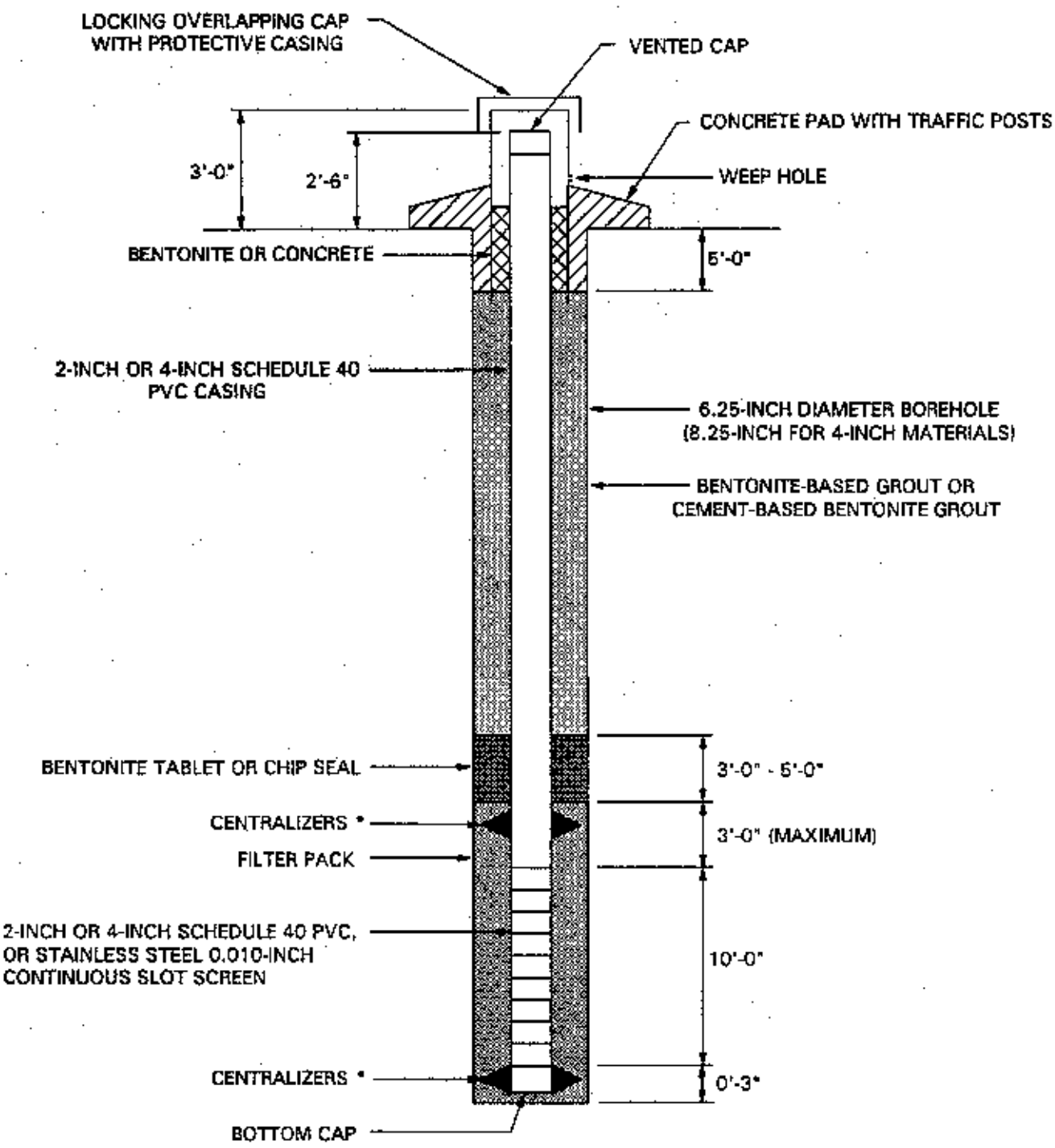
During all drilling activities, the field geologist will also maintain a daily logbook that will permit a recreation of drilling operations. The logbook will contain information not recorded on approved forms and may include, but not be limited to, grout density, monitoring of drilling operations, recording of water losses/gains, groundwater elevation measurements, and field change justifications and notifications. All well installation activities and measurements will be recorded in the daily logbook. Logbook maintenance shall be performed in accordance with Procedure ES&H 1.1.4s, *Logbook Procedure* and in the CDAP (Ref. 4), Section 5.5.1, Field Notebook Documentation (Appendix A).

2.1.6 Monitoring Well Construction

Monitoring well installation will begin as soon as practical (at a maximum of 48 hours) after drilling and coring activities are completed. All activities will be performed in accordance with 10 CSR 23, *Missouri Well Construction Rules*. The security and integrity of the borehole and the well during installation will be maintained by providing suitable barriers, tamper-detection seals, or if possible, locks to prevent unauthorized access. After beginning well installation, operation will not be stopped for extended breaks, at the end of the regular work shift, or at dark until the bentonite or bentonite cement seal has been placed above the filter pack. Figure 2-4 illustrates the typical monitoring well design, and monitoring wells will be constructed according to the following specifications and procedures:

- Prior to well installation, the borehole will be cleaned of cuttings by circulating air or water through the borehole.

- The well casing will be new, threaded, flush-jointed, stainless steel (316L) or Schedule 40 polyvinyl chloride (PVC) with a nominal 5 cm (2 in.) inside diameter. All well casings will conform to or exceed the requirements of ASTM F-480, *Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios*.



* NOTE: CENTRALIZERS CAN BE PLACED AT EITHER TOP OR BOTTOM OF SCREEN OR BOTH.

NOT TO SCALE

TYPICAL MONITORING WELL CONSTRUCTION

FIGURE 2-4

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/PI/042/0393	
ORIGINATOR: JDC	DRAWN BY: GLN	DATE: 8/8/95	

- A continuous slot, flush-jointed well screen will be used. The well screen will be constructed of 5 cm (2 in.) stainless steel/Schedule 40 PVC. Slot size shall be 0.25 mm (0.010 in.). Wells will have screen lengths of 3 m (10 ft).

- Well screen and well casing sections will be stainless steel or Schedule 40 PVC with a 5 cm (2 in.) nominal inside diameter and will be joined by threaded, flush-jointed couplings to form straight, water-tight unions. No solvents or glue will be used in the construction of wells.

- The well screen will have a threaded, stainless steel or Schedule 40 PVC bottom cap, not to exceed 0.15 m (0.5 ft) in length, securely attached to provide a tight seal. The well casing shall have a top cap.

- The following information shall be recorded to the nearest 0.03 m (0.1 ft) in the logbook and on the well completion record: total depth of boring, total length of casing, depth to top and bottom of well screen and filter pack, and bentonite seal interval (top and bottom). Measurements will be made from the ground surface.

- Each screen/casing assembly will be centered in the borehole using stainless steel centralizers.

- The wells will be installed through hollow stem augers through the overburden.

- The well assembly will be lowered onto approximately 7.6 cm (3 in.) of filter pack material. Filter pack materials will be placed in the borehole with a tremie pipe. Filter pack material will consist of clean, medium- to coarse-grained (70% retained by a No. 40 mesh sieve), well-rounded, uniform silica sand that is free of surface oxides. Filter pack will be added to the annulus to a height not to exceed 1 m (3 ft) above the screen. A weighted tape will be used to continuously tag the top of the filter pack, in order to ensure accurate placement. The source of the filter pack and gradational curves shall be provided.

- An annular seal will be constructed by placing 15 cm (6 in.) lifts of 6.3 mm to 9.5 mm (1/4 in. - 3/8 in.) bentonite tablets or bentonite chips, specifically designed for sealing purposes, to a height of at least 1 m (3 ft) and no greater than 1.5 m (5 ft) above the filter pack. If seal is placed above the groundwater surface, tablets will be hydrated by the addition of at least 5 liters (1.3 gal) of potable water after placement of each 15 cm (6 in.) of lift. The seal (if above the groundwater surface) will be allowed to sufficiently hydrate (typically for 12 to 24 hours) before placement of the bentonite grout annular seal.

- The remaining annular space will be filled with a high-solids, bentonite-based grout or cement-based grout with bentonite additives (maximum of 3% bentonite by weight) to within 1.5 m (5 ft) of the surface using a side-discharge, tremie-pipe. The grout will be specifically designed for use in monitoring well construction. The grout will be mixed by jetting or mixing, according to the manufacturer's instructions regarding weights and measures, and will be circulated through the rig mud pump. This ratio will be properly documented in the field logbook. The grout mix must achieve a minimum weight of 1.1 kg/liter (9.4 lb/gal) prior to placement. Grout weight will be verified through the use of a mud balance. Grout will be allowed to set at least 24 hours before installation of the protective casing. Grout specification will meet the requirements of ASTM D-5092, *Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers*.

- All measurements and thicknesses including total depth of hole, filter pack thickness, and depth to top of bentonite seal will be checked and recorded using a weighted tape. Depths will be made from the ground surface.

- The casing will be cut off approximately 0.75 m to 0.9 m (2.5 ft to 3 ft) above the ground surface.

- Locking protective casings will be installed at each well. A vent hole, not to exceed 3 mm (1/8 in.) in diameter, shall be drilled in the side of the protective casing directly above the contact with concrete pad. A concrete pad, sloped to drain away from the well with minimum dimensions of 0.75 m (30 in.) by 0.75 m (30 in.) by

0.15 m (6 in.), will be installed. A minimum of 24 hours will have elapsed prior to placement of the concrete surface structure above the annular seal. A brass monument will be set in the protective pad. At least three protective posts will be installed to guard against damage from vehicles.

- After well installation, the top-of-casing elevation, ground elevation, and the coordinates of each well will be surveyed by a licensed surveyor. Top-of-casing and ground elevations will be to the nearest 0.003 m (0.01 ft). Horizontal control will be within 0.15 m (0.5 ft).

2.1.7 Monitoring Well Development

Wells installed during this investigation will be developed in a manner consistent with criteria set forth in 10 CSR 23, *Missouri Well Construction Rules*. All development activities will be documented. The following guidelines will be used during well development activities:

- Development will not commence until at least 48 hours after the well casing has been grouted in place.

- Development methods will provide alternating cycles of mechanical surging and evacuation through the well screen and filter pack to remove soil and rock particles. Mechanical surging may be performed through the use of bailers, pumps, or surge blocks. Airlift devices will not be used for development purposes.

- Three times the volume of water lost during drilling and development activities will be removed from the well.

- Development will be considered complete when the following conditions have been met: (1) three consecutive well volume samples yield conductivity and dissolved oxygen measurements that have stabilized to within 10%, (2) three consecutive well volume samples yield pH measurements that have stabilized to within ± 0.5 standard units, (3) three consecutive well volume samples yield temperature measurements that have stabilized to within $\pm$ 1°C, and (4) if the water remains visibly turbid,

development shall continue for a minimum of 4 hours or until turbidity does not exceed 50 NTUS.

Water generated during well development will be handled as outlined in Section 2.1.2.

2.1.8 Borehole Abandonment

Angled borings and monitoring well locations that are unuseable will be plugged in accordance with 10 CSR 23-4.080, *Plugging of Monitoring Wells*. The borehole will be filled from the bottom of the boring by placing a bentonite-additive cement grout or a high-solids bentonite grout specifically designed for sealing boreholes using a tremie pipe. The ratio of clay grout to fresh potable water will be consistent with manufacturer's instructions, with respect to weights and measures. This ratio shall be verified in the field using a mud balance and shall be recorded.

2.2 Equipment Decontamination

Equipment used in drilling operations and sample collection and materials used in well construction will be decontaminated according to the following guidelines:

- Drilling equipment and tools will be decontaminated with a hot water, high pressure washer upon arrival at the site, between boreholes, and before departure from the site. Equipment and tools will be allowed to air dry after cleaning. Working areas of the drill rig will be decontaminated between boring locations. All gross materials shall be removed from the rig and tires between each location. Pumps and hoses will be flushed with potable water between locations. Equipment and tools will be stored in a manner that maintains the cleanliness of the equipment.

- Continuous samplers, split spoons, and other sampling equipment will be washed between samples in accordance with Procedure ES&H 4.1.3, *Sampling Equipment Decontamination* or CDAP, Appendix F-1, Decontamination Procedures (Appendix A) and allowed to air dry prior to sample collection.

- All well screens, casings, caps, and outer casings will be cleaned using a hot water, high pressure washer and will be allowed to air dry prior to installation. Cleaned materials will be stored in a manner that maintains cleanliness. A manufacturer's Certificate of Cleanliness shall be accepted in lieu of hot water, high pressure washing, contingent upon inspection and approval of prepackaged and sealed materials.

- All well development tools and equipment will be cleaned using a hot water, high pressure washer and will be allowed to air dry prior to initial use and between well locations. Cleaned materials will be stored in a manner that maintains cleanliness.

Water and other wastes generated during decontamination activities will be handled as outlined in Section 2.1.2.

2.3 Aquifer Testing

Aquifer characteristic testing to be outlined in this plan are slug tests, packer tests, and tracer tests.

2.3.1 Slug Tests

Slug tests will be conducted on several existing wells that do not have previous testing data. These wells are summarized in Table 2-2.

TABLE 2-2 Well Locations Proposed for Slug Testing

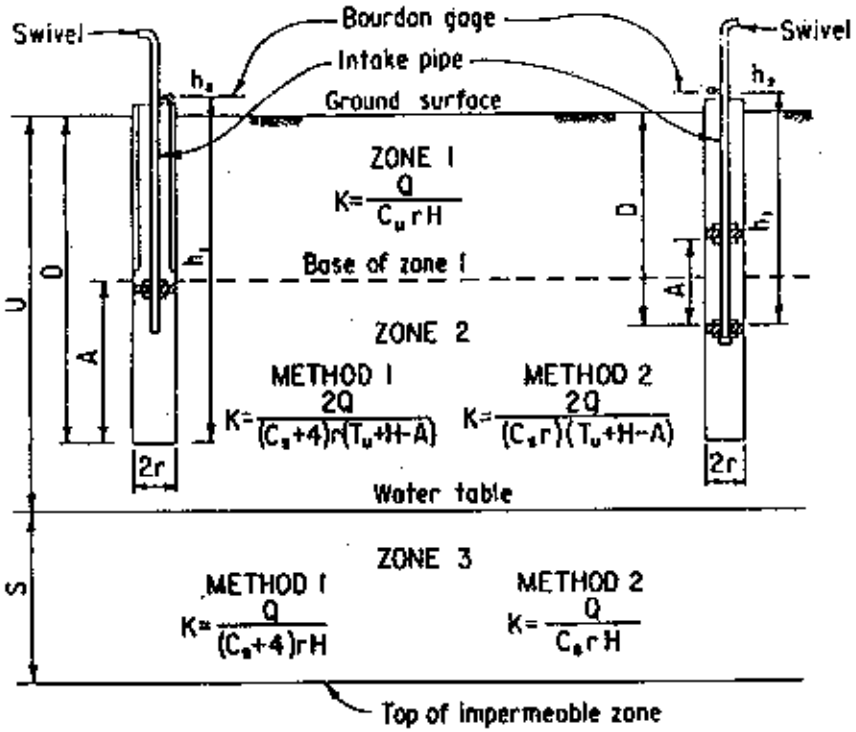
Chemical Plant Area					Ordnance Works Area
MW-2001	MW-2012	MW-2035	MW-2040	MW-3023	MWS-21
MW-2003	MW-2014	MW-2036	MW-2041	MW-3026	MWS-22
MW-2007	MW-2017	MW-2037	MW-2042	MW-4002	MWV-22
MW-2010	MW-2032	MW-2038	MW-2043	MW-4003	MWV-24R
MW-2011	MW-2034	MW-2039	MW-2044	MW-4007	MWS-24

Slug tests will be performed in accordance with Procedure ES&H 4.3.2s, *Single Well Hydraulic Conductivity Testing* (Appendix A) or ASTM D-4044, *Test Method for Instantaneous Change in Head for Determining Hydraulic Properties of Aquifers*. Both rising and falling headtests will be performed on each well. Standard pressure transducers and data loggers will be used to obtain water level measurements as recommended in ASTM D-4050, *Test Method for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems*.

2.3.2 Packer Tests

Packer tests will be performed during drilling of all angled borings and in the bedrock sections of all monitoring wells. Packer tests will be performed and data analyzed as described in the *Groundwater Manual* (Ref. 5) and *Determination of Rock Mass Permeability* (Ref. 6). A schematic that details the configuration of the system and defines the applicable equations and variables is presented in Figure 2-5. The tests will be performed as outlined:

- Testing will be performed as drilling progresses to the desired depth.
- Testing intervals will be 3 m (10 ft) in the weathered portion of the bedrock and may vary from 3 m to 6 m (10 ft to 20 ft) in the unweathered portion of the unit.
- The test intervals will be isolated using a single packer system.
- Water flow and pressure will be monitored through the use of a flow meter and pressure gauge, respectively.
- Three to five tests of differing pressure will be performed on each test interval. Pressures are to start lower, increase, and return to starting pressures. All tests will be 5 minutes in duration.



SOURCE: U.S DEPARTMENT OF INTERIOR (1977)

K = coefficient of permeability, feet per second under a unit gradient
Q = steady flow into well, ft^3/s
$H = h_1 + h_2 - L$ = effective head, ft
h_1 (above water table) = distance between Bourdon gage and bottom of hole for method 1 or distance between gage and upper surface of lower packer for method 2, ft
h_1 (below water table) = distance between gage and water table, ft
h_2 = applied pressure at gage, 1 lb/in^2 = 2.307 ft of water
L = head loss in pipe due to friction, ft; ignore head loss for Q<4 gal/min in $1\frac{1}{4}$-inch pipe; use length of pipe between gage and top of test section for computations
$X = \frac{H}{T_u}(100)$ = percent of unsaturated stratum
A = length of test section, ft
r = radius of test hole, ft
C_u = conductivity coefficient for unsaturated materials with partially penetrating cylindrical test wells
C_s = conductivity coefficient for semi-spherical flow in saturated materials through partially penetrating cylindrical test wells
U = thickness of unsaturated material, ft
S = thickness of saturated material, ft
$T_u = U - D + H$ = distance from water surface in well to water table, ft
D = distance from ground surface to bottom of test section, ft
a = surface area of test section, ft^2; area of wall plus area of bottom for method 1; area of wall for method 2
Limitations:
$Q/a \leq 0.10$, $S \geq 5A$, $A \geq 10r$, thickness of each packer must be $\geq 10r$ in method 2

PERMEABILITY TEST SET UP FOR SATURATED AND UNSATURATED BEDROCK

FIGURE 2-5

REPORT NO.: DOE/OR/21348-445		EXHIBIT NO.: A/PI/050/0392	
ORIGINATOR: LMK	DRAWN BY: SRS	DATE: 1/5/95	

- Prior to recording flow into the formation under each pressure, the boring will be allowed to stabilize.

- The pressures used will typically range from 0.70 kg/cm^2 to 2.8 kg/cm^2 (10 psi to 40 psi). Greater pressures can be used deeper in the boring, but are not required. The general rule is that the overburden applies 0.07 kg/cm^2 (1 psi) of pressure per foot of depth.

2.3.3 Tracer Tests

Tracer tests will be performed after drilling of each angled boring at the chemical plant site (Figure 2-1). Intervals for testing will be determined based on packer test results and observations made in the field regarding fractures, voids, broken zones, and water loss zones. This testing will be performed as outlined:

- The tracer dye will be injected at the predetermined depth by grouting the bottom of the boring. All grout mixtures will be performed as outlined in Section 2.1.8. The dye will be injected followed by potable water to promote movement of the tracer slug. Between 7.5 to 11 liters (2 to 3 gallons) of dye will be injected into each selected interval.

- Several types of dye are possible, and determination of the types used will be made after analysis of the baseline samples from the resurgence points.

- To minimize the potential for contamination of sampling equipment and detectors from the dye, the following should be considered:

  - Handling of the dye should not occur on the same day as detector placement, or if this is not possible, the dye should not be handled by the same person who will be placing or collecting the detectors.

  - Dyes should be sealed in a secondary container during transportation to the injection site.

- Dyes should not be stored in the same location as the detectors, sampling equipment, or sample containers.

Monitoring for the dye will be done through the use of charcoal and cotton packets. Packets are made of 20 cm by 20 cm (8 in. by 8 in.) nylon screen folded in half and sealed at the edges. Approximately 33 cu cm (2 cu in.) of activated charcoal or cotton material are contained within the screen. Packets will be placed at two springs in the Burgermeister Spring Branch (SP-6301 and SP-6303) and one spring below this area (SP-6306) (Figure 3-3). Placement and collection of the packets is outlined as follows:

- The packets will be staked in place to prevent movement in the stream channel and to allow for placement of subsequent packets at the same location within the spring. Placement will be made in areas where flow can be determined visually.

- Packets will be changed out every 48 to 72 hours for the first 4 weeks of the study and then weekly for the last 8 weeks.

- Packets will be retrieved from the spring and placed directly into clean, resealable plastic bags. Only one set should be placed in each bag. Packets will be retrieved from the spring using clean, disposable gloves and new gloves will be used at each sampling location to prevent cross-contamination between packets.

- The following information shall be written directly onto the sample bag using a permanent marker: Sample ID, date and time of collection, and personnel. Sample IDs will be identified in accordance with Procedure ES&H 4.1.1, *Numbering System for Environmental Samples and Sampling Locations*.

- Packets should be protected from direct sunlight.

Baseline fluorescence will be determined at each of the springs. Several sampling events of 2 day duration and 7 day duration will be performed to simulate actual sampling durations. Baseline samples will be placed and collected as outlined above.

2.3.4 Water Level and Precipitation Measurements

Groundwater elevation measurements will be made to the nearest one hundredth of a foot (0.01) in accordance with Procedure ES&H 4.4.2s, *Groundwater Levels Monitoring and Well Integrity Inspections* (Appendix A) on all wells at both the chemical plant area and ordnance works area. Water levels will be made in conjunction with the joint sampling event and will be obtained prior to any sampling event. All wells will be measured within a 72-hour period.

Site-specific precipitation monitoring results will be obtained from the site meteorological station maintained in accordance with Procedure ES&H 4.8.3s, *The WSSRAP Meteorological Monitoring Station* (Appendix A). Hourly measurements and daily totals will be available for use.

3 CONTAMINANT SAMPLING PROGRAM

This contaminant sampling program has been developed to characterize the extent and distribution of contaminants in groundwater for the remedial investigation of the Groundwater Operable Units.

Data objectives have been designed to obtain characterization data as defined by the requirements presented in the *Work Plan* (Ref. 3). The sampling objectives are to:

- Collect groundwater samples from all Weldon Spring Ordnance Works and Weldon Spring Chemical Plant monitoring wells and several springs during May and August of 1995 and analyze for site-related contaminants.
- Collect groundwater samples from selected monitoring well locations and analyze for specific metals.
- Collect groundwater samples to determine the horizontal extent of uranium contamination in the southeast portion of the chemical plant area.
- Collect groundwater samples from the western portion of the Weldon Spring Training Area to provide background concentration ranges for potential site contaminants.
- Collect groundwater samples in the Southeast Drainage using discrete sampling techniques, to determine the presence of uranium, nitroaromatics, and selected metals.

3.1 Sampling Activities

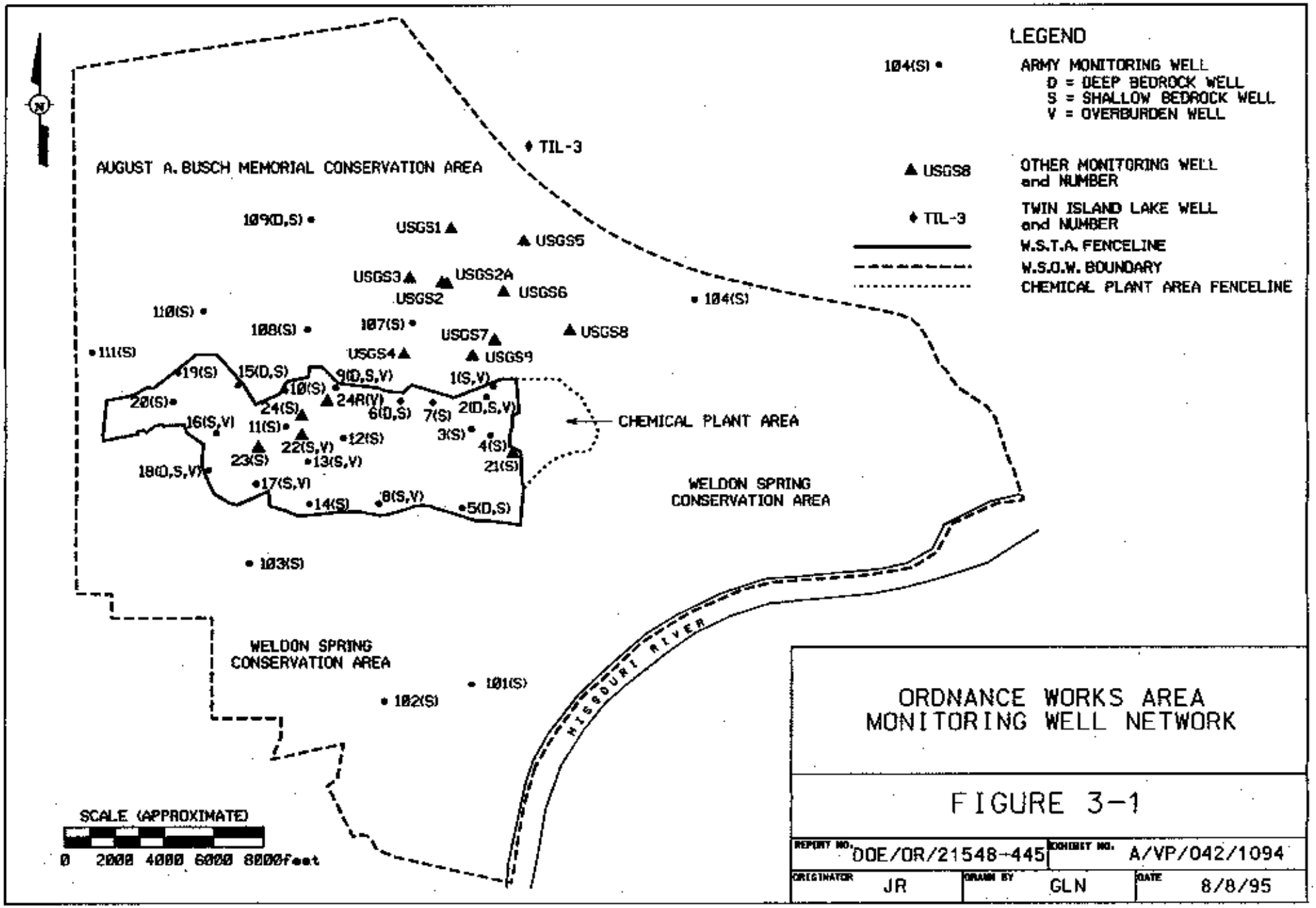
3.1.1 Comprehensive Sampling Effort

As part of the remedial investigation, the U.S. Department of Energy (DOE) will lead an interagency comprehensive sampling effort (DOE and Corps of Engineers) to provide an overall view of the distribution of potential site contaminants. This comprehensive sampling

effort will be conducted in May and August of 1995. All field sampling methods will be unified and will follow applicable DOE procedures. All procedures related to groundwater sampling are presented in Appendix A. Static water level measurements will be taken during a two-day period from all wells at the start of each sampling effort and prior to sampling each well. Measurements will be obtained as described in Procedure ES&H 4.4.2, *Groundwater Level Monitoring and Well Integrity Inspections*. Filtered and unfiltered samples will be obtained for metals, and all other parameters will be unfiltered. Samples will be filtered according to Procedure ES&H 4.5.8, *Water Sample Filtering*. All groundwater samples will be collected in accordance with Procedure ES&H 4.4.1, *Groundwater Sampling*.

Sampling locations include all wells in the ordnance works area and chemical plant area monitoring well networks, as shown in Figures 3-1 and 3-2. Table 3-1 provides the sampling schedule for the comprehensive effort. Spring sampling locations include SP-5101, SP-5201, SP-5303, SP-5402, SP-5501, SP-5504, SP-5601, SP-5602, SP-5605, SP-5612, SP-6301 (Burgermeister Spring), SP-6303, SP-6306, SP-6501, and SP-6601. Figure 3-3 presents the locations of these springs.

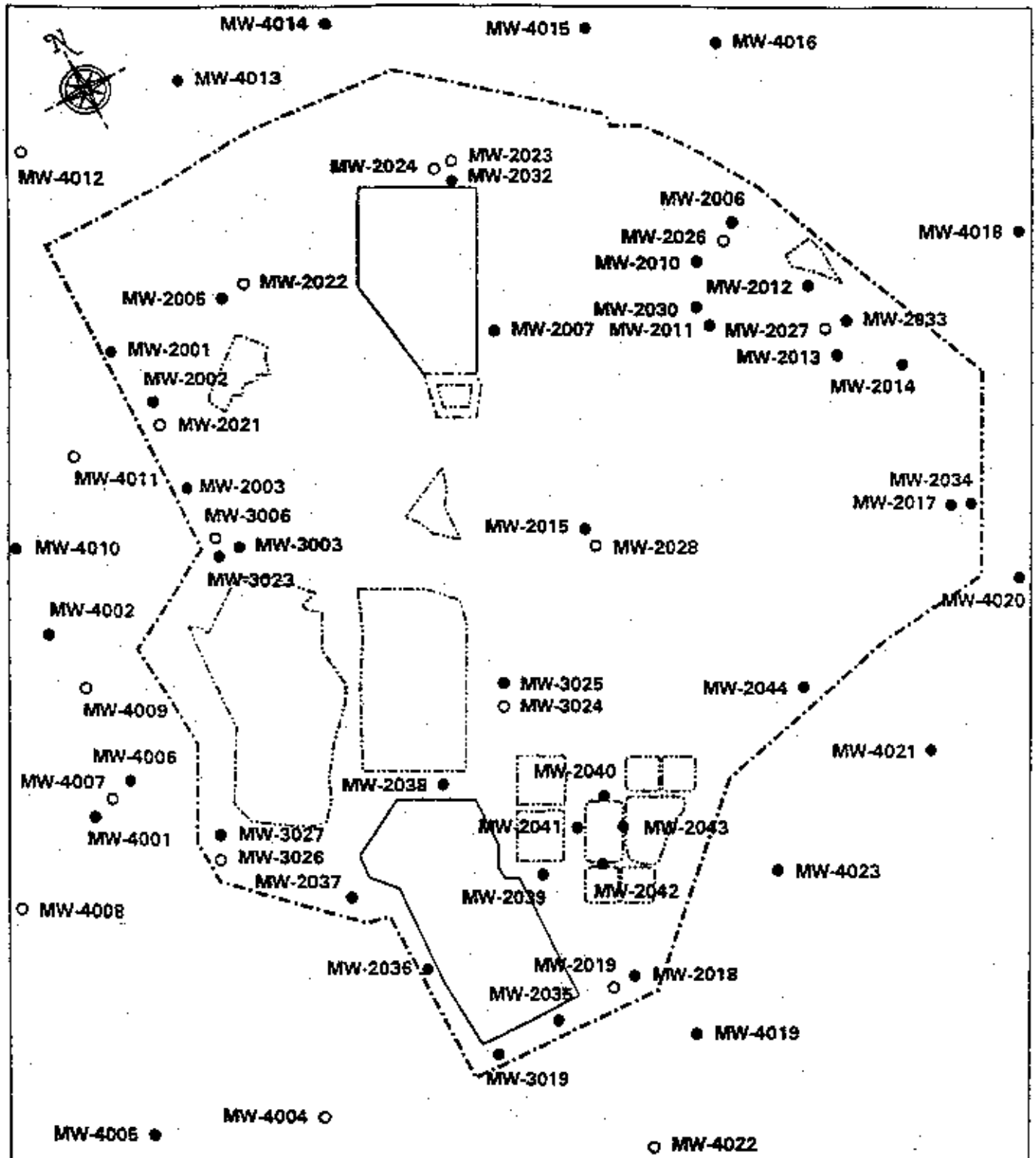
All groundwater samples will be analyzed for radiological and chemical parameters identified as site-related contaminants and listed in Table 3-2. Data from wells located on the western portion of the ordnance works area (MWS-13, MWS-23, MWS-111 [weathered zone] and MWD-105, MWD-106, MWS-108 and MWD-109 [unweathered zone]) will be considered for use in determining background concentrations for uranium and metals. Use of data from additional wells on the ordnance works/training area will be determined pending the results of the first comprehensive sampling event. Standard operating procedures (SOPs) related to monitoring well purging, groundwater sample collection, sample identification and preservation requirements, and chain of custody procedures, are discussed in Section 3.2. Table 3-5 presents sample container size, preservative requirements, and holding times for each parameter to be analyzed.



ORDNANCE WORKS AREA
MONITORING WELL NETWORK

FIGURE 3-1

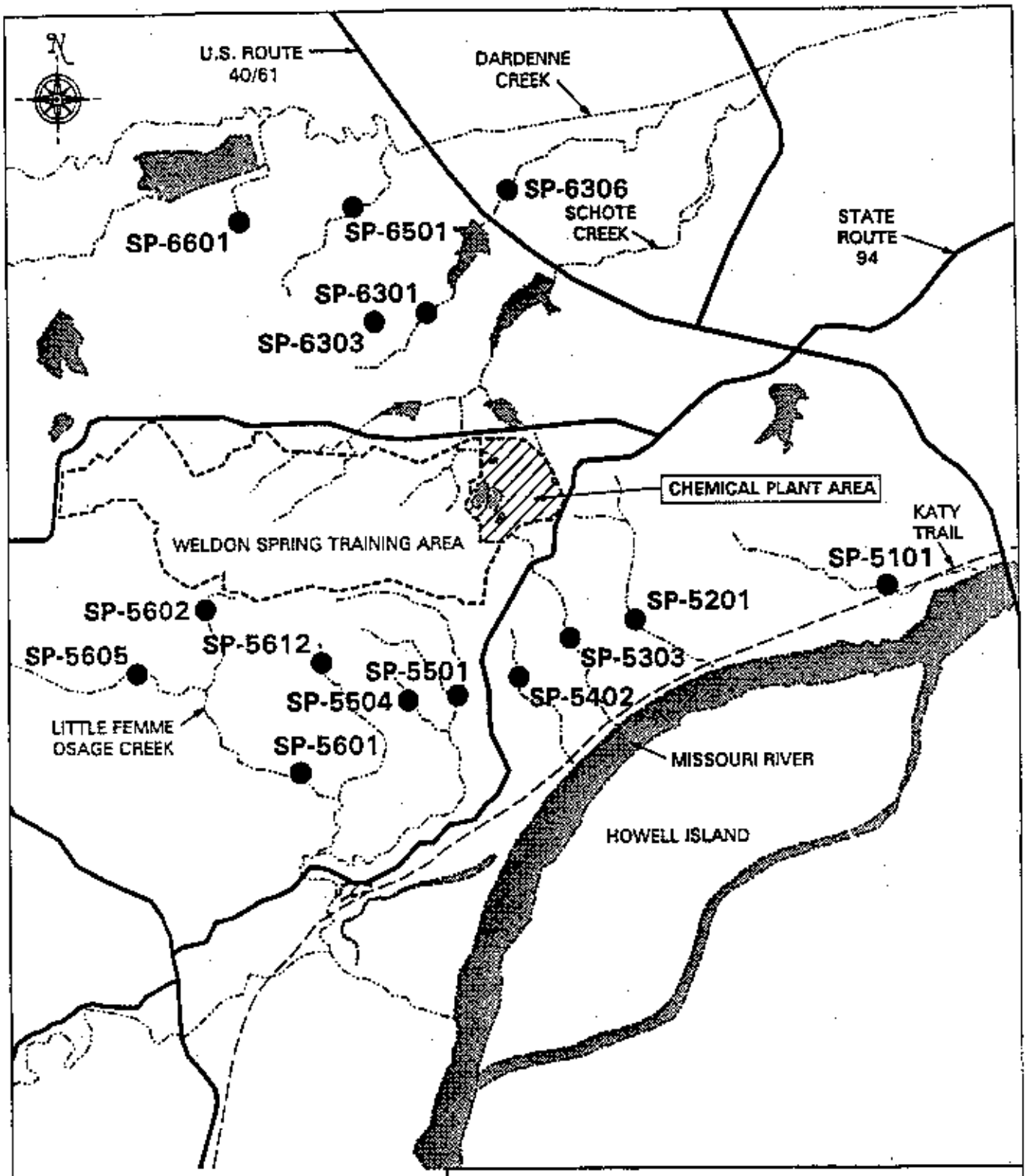
REPORT NO. DOE/OR/21548-445		DOCUMENT NO. A/VP/042/1094	
ORIGINATOR JR	DRAWN BY GLN	DATE 8/8/95	



CHEMICAL PLANT AREA
MONITORING WELL NETWORK

FIGURE 3-2

REPORT NO.: DOE/OR/21548-445		DOCUMENT NO.: A/CP/087/0993	
ORIGINATOR: RC	DRAWN BY: GLN	DATE: 5/15/95	



● - SPRING

0 1 MI
0 1.6 KM
SCALE

SPRING MONITORING LOCATIONS
FOR COMPREHENSIVE SAMPLING EFFORT

FIGURE 3-3

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/VP/040/1094	
ORIGINATOR: JR	DRAWN BY: GLN	DATE: 5/9/95	

TABLE 3-1 Comprehensive Sampling Schedule

MAY 1995				
5/1	5/2	5/3	5/4	5/5
MW-2001 MWD-02 MW-2002 MWS-02 MW-2003 MWV-02 MW-2033 MWD-18 MW-2027 MWS-18 MW-2013 MWV-18	MW-2005 MWD-09 MW-2023 MWS-01 MW-2024 MWV-01 MW-2032 MWS-12 MW-2034 MWD-15 MW-2017 MWS-15 MW-2014 MWS-19 MW-2021 MWS-09 MW-2012 MWV-09 MW-3003 MWD-06 MW-3006 MWS-06 MW-3023 MWS-07	MW-2040 MWV-08 MW-2042 MWS-08 MW-2043 MWD-05 MW-4003 MWS-05 MW-4004 MW-4005	MW-2041 MW-2015 MWS-23 MW-2028 MWV-24R MW-3027 MWS-03 MW-3026 MWS-04 MW-2030 MWS-21	
5/8	5/9	5/10	5/11	5/12
		MW-3024 USGS-1 MW-3025 USGS-2A MW-2035 MWD-105 MW-2007 MWS-105	MW-2008 USGS-3 MW-2019 USGS-4 MW-4001 MWS-110 MW-4006 MWS-111	MW-4002 TIL-3 MW-4010 MWS-104 MW-4011 MWS-20 MW-4007 MWS-26
5/15	5/16	5/17	5/18	5/19
MW-2026 USGS-5 MW-2010 USGS-6 MW-2038 MWD-109 MW-3019 MWS-109	MW-2036 USGS-8 MW-2037 USGS-9 MW-2039 MWD-107 MW-2044 MWS-107	MW-2022 MWS-101 MW-2011 MW-102 MW-3019 MWS-103 MW-4018 MWS-108	MW-4014 MWD-112 MW-4015 MWS-112 MW-4016 MWD-106 MW-4012 MWS-106	MW-4020 MWS-22 MW-4021 MWV-22 MW-4023 MWD-25 MW- 4019 MWS-25
5/22	5/23	5/24	5/25	5/26
MW-4022 MWS-13 MW-4008 MWV-13 MW-4009 MWS-17 MW-4013 MWV-17	MW-4024 MWS-11 MW-4025 MWD-23	SP-5101 SP-5501 SP-5201 SP-5504 SP-5303 SP-6301 SP-5402 SP-6501	SP-5601 SP-6303 SP-5602 SP-6306 SP-5605 SP-6601 SP-5612	

TABLE 3-1 Comprehensive Sampling Schedule (Continued)

AUGUST 1995				
8/1	8/2	8/3	8/4	8/7
MW-2001 MWD-02 MW-2002 MWS-02 MW-2003 MWV-02 MW-2033 MWD-18	MW-2005 MWD-09 MW-2021 MWS-09 MW-2012 MWV-09 MW-3003 MWD-06	MW-2023 MWS-01 MW-2024 MWV-01 MW-2032 MWS-12 MW-2034 MWD-15	MW-2040 MWD-25 MW-2042 MWS-25 MW-2043 MWV-08 MW-4003 MWS-08	MW-2041 MWD-23 MW-2015 MWS-23 MW-2028 MWV-24R MW-3027 MWS-03
8/8	8/9	8/10	8/11	8/17
MW-2018 MWD-109 MW-2019 MWS-109 MW-2035 MWD-107 MW-4012 MWS-107	MW-4002 MWD-112 MW-4011 MWS-112 MW-4010 MWD-108 MW-4015 MWS-106	MW-3015 MWS-110 MW-3024 MWS-111 MW-2038 TIL-3 MW-4020 USGS-5	MW-4025 MWD-105 MW-2026 MWS-105 MW-2010 MWS-101 MW-2006 MWS-102	MW-3019 MWS-104 MW-2036 USGS-1 MW-2037 USGS-2A MW-4008 USGS-4
8/18	8/16	8/14	8/15	8/21
MW-2039 MWS-13 MW-2044 MWV-13 MW-2022 MWS-14 MW-2011 MWS-11	MW-4001 MWS-17 MW-4006 MWV-17 MW-4007 MWS-20 MWS-16	SP-5101 SP-5501 SP-5201 SP-5504 SP-5402 SP-6301 SP-5303	SP-5601 SP-6303 SP-5602 SP-6306 SP-5605 SP-6501 SP-5612 SP-6601	MW-2027 MWS-18 MW-2013 MWV-18 MW-3006 MWS-06 MW-3023 MWS-07
8/22	8/23	8/24	8/25	8/28
MW-2017 MWS-15 MW-2014 MWS-19 MW-4004 MWD-05 MW-4005 MWS-05	MW-3026 MWS-04 MW-2030 MWS-21 MW-4013 MWS-108 MW-4014 UGSG-3	MW-4016 USGS-9 MW-4018 USGS-6 MW-4021 MWS-26 MW-4023	MW-4019 MWS-103 MW-4022 USGS-8 MW-4009 MW-4024	MW-2007 MWS-22 MWV-16 MWS-10 MWV-22

3.1.2 Selected Parameter and Well Sampling

Additional characterization data will be obtained during the comprehensive sampling effort and may be required during the fourth quarter of 1995. Two well locations will be analyzed for specific volatile organic compounds (VOAs) during the August sampling event. WSTA-MWS-5 will be sampled and analyzed for toluene and WSOW-MWS-104 will be sampled and analyzed for carbon disulfide.

Pending the results of the comprehensive sampling effort, additional data may be required from selected monitoring well locations during the 4th quarter of 1995. If necessary, the list of sample locations and parameters is shown in Table 3-3. This additional round of sampling will be conducted by the DOE.

TABLE 3-2 Analytical Parameters for Comprehensive Sampling

		Select Wells/Parameters	
Uranium	Nitroaromatics:	Toluene[b]	WSTA-MWS9
Aluminum	2,4-DNT[a]	Carbon Disulfide[b]	WSOW-MWS104
Antimony	2,6-DNT[a]		
Arsenic	4-Amino-2,6-DNT[a]		
Barium	2-Amino-4,6-DNT[a]		
Cadmium	2,4,6-TNT[a]		
Chromium	1,3,5-TNB[a]		
Copper	1,3-DNB[a]		
Iron	Nitrobenzene		
Lead	m-Nitrotoluene		
Lithium	o-Nitrotoluene		
Manganese	p-Nitrotoluene		
Mercury			
Molybdenum			
Nickel			
Selenium			
Silver			
Thallium			
Nitrate			
Chloride[b]			
Fluoride[b]			
Sulfate[b]			

a DNT = dinitrotoluene; TNT = trinitrotoluene; TNB = trinitrobenzene
DNB = dinitrobenzene

b sampling during August event

TABLE 3-3 4th Quarter Sampling Requirements For The Groundwater Operable Units

Monitoring Well Location	Parameters[a]
MW-2012[b]	Manganese
MW-2030	Iron, Manganese
MW-2032	Iron, Manganese
MW-2033	Iron, Manganese
MW-2037	Lithium, Manganese
MW-2038	Lithium, Manganese
MW-2039	Antimony
MW-2040	Molybdenum
MW-2041	Manganese
MW-3025	Manganese
MW-3027	Antimony
MW-4001	Antimony
MW-4006	Antimony
MW-4012	Molybdenum
MW-4016	Molybdenum, Iron
MWS-18	Sulfate

(a) These constituents, following the comprehensive sampling effort, have been elevated in at least one sampling round in the given well. The monitoring wells listed will have less than 6 samples available for the given constituent, so additional data may be needed. For iron and manganese, the additional samples may be required to determine the concentration relationship between filtered and unfiltered samples.

(b) Well MW-2012 is being used as a replacement for abandoned Well MW-4017, which had one elevated manganese concentration (97 $\mu g/l$) in an unfiltered sample.

3.1.3 Southeast Drainage Discrete Groundwater Sampling

Discrete groundwater samples will be obtained from the lower portion of the Southeast Drainage to determine the presence of uranium, nitroaromatics, and those metals identified as potential site contaminants in Table 3-2. Based on the amount of water obtained at each location, the requested analysis will be prioritized in terms of obtaining uranium data, then

nitroaromatic data,and then metals. Six locations have been selected for discrete groundwater sampling as shown on Figure 3-4. A groundwater sample will be taken within 10 ft of the stream at each location, with a 10 ft spacing between each location. Specific locations will be defined in the field, based on equipment accessibility. No SOPs have been developed for discrete sampling, therefore, details are provided below.

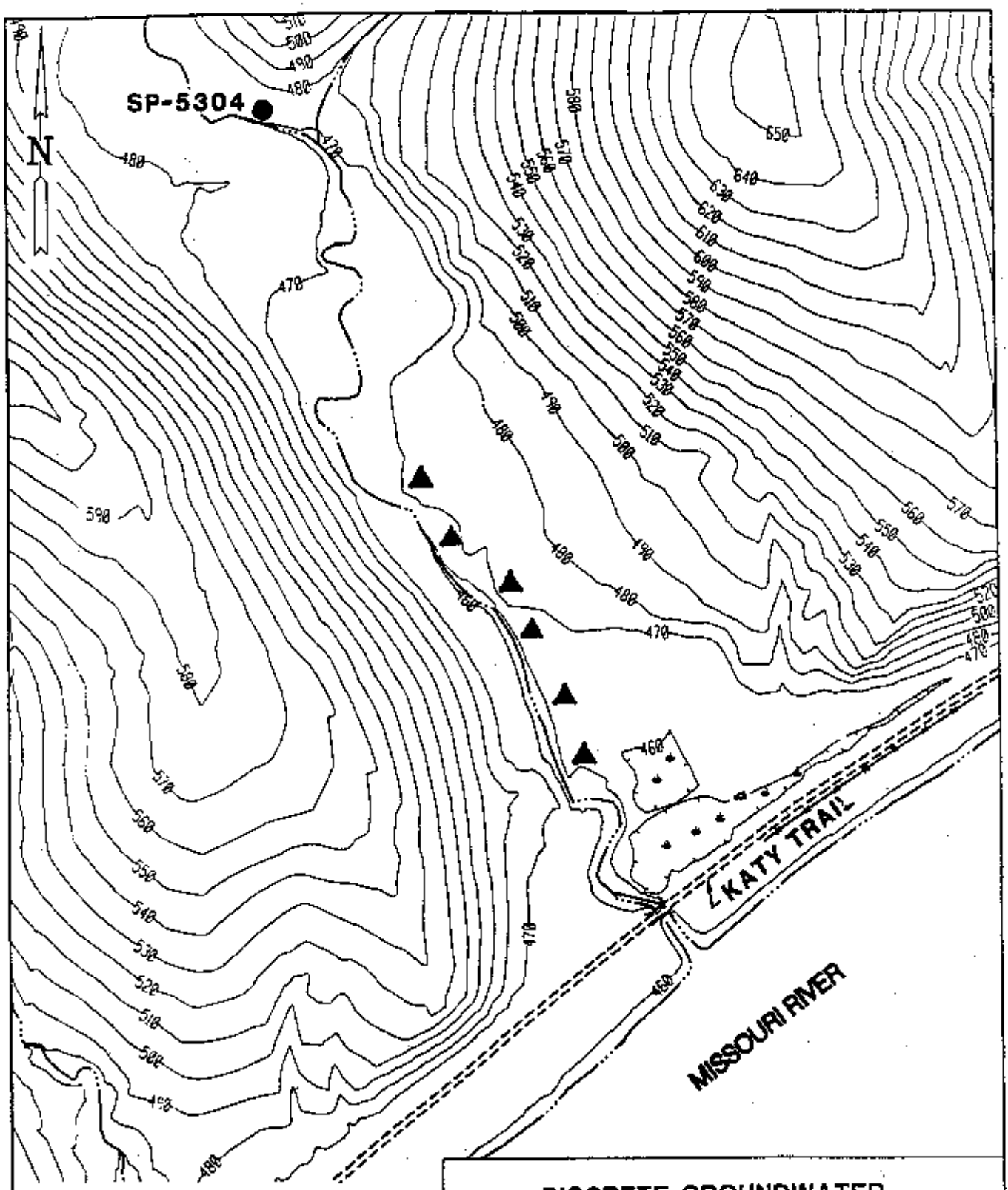
An all-terrain vehicle drill rig equipped with a hollow stem auger will be used to obtain groundwater samples. Boreholes will be advanced using the hollow stem auger with a continuous sampler for soil sampling. After each 5 ft sample interval, the continuous sampler will be opened and examined for moisture in the soils. When moisture is detected, the auger will be pulled back approximately 2 ft to allow water to enter the borehole. A waiting time of at least 15 minutes should elapse to allow sufficient water to enter the borehole. A representative sample will then be collected. Any holes created will be plugged according to Procedure ES&H 4.4.4s/2, *Subsurface Monitoring Device Plugging and Abandonment Procedure*. All groundwater sampling activities will be conducted in accordance with applicable ES&H procedures described in Section 3.2.

3.2 Standard Operating Procedures

The SOPs in the following sections will be complied with for all characterization activities specified in the Sampling Plan. These SOPs are included in Appendix A.

3.2.1 Field Logbooks

Water levels, sample locations, water temperatures, and other physical parameters will be recorded in the field. The standard operating procedure for logbook entry and maintenance is detailed in Procedure ES&H 1.1.4, *Logbook Procedure*. All logbooks used for field activities shall be bound and constructed of waterproof paper. Field logbooks shall be used to record all activities, occurrences, conditions, data, and other information not recorded on the SOP form (i.e., Groundwater Sampling Field Data Form). All field logbooks shall be signed and dated upon completion of each field day's activity and retained as quality assurance records by the DOE.



▲ SAMPLE LOCATION

200 0 200

GRAPHIC SCALE
1" = 200'-0" (60.39m)

DISCRETE GROUNDWATER SAMPLING LOCATIONS SOUTHEAST DRAINAGE

FIGURE 3-4

REPORT NO. DOE/OR/21548-445		EXHIBIT NO. A/VP/018/0494	
ORIGINATOR JR	DRAWN BY CRM	DATE 5/9/95	

3.2.2 Field Equipment Calibration

Physical parameters collected in the field, such as water temperature, conductivity, and pH, will be measured using standard field instruments. DOE Procedures ES&H 4.5.1, *pH and Temperature Measurement in Water*, ES&H 4.5.2, *Specific Conductance Measurement in Water*, and ES&H 4.5.9, *Operation and Calibration of YSI Flowthrough Cell System*, include specific steps for equipment calibration. These procedures also require that equipment calibrations be documented using specific calibration forms or by documenting calibrations in field logbooks, in accordance with the specific calibration procedure.

3.2.3 Field Measurements

Prior to groundwater sample collection, specific field measurements will be taken. These measurements include temperature, pH, redox potential (Eh), and conductivity. DOE procedures for obtaining these measurements are provided in the following: ES&H 4.5.1, *pH and Temperature Measurement in Water*, ES&H 4.5.2, *Specific Conductance Measurement in Water*, ES&H 4.5.5, *Measurement of Specific Ions in Water,* and ES&H 4.5.9, *Operation and Calibration of YSI Flowthrough Cell System*. These measurements are initially taken after removing one well volume. Wells are then pumped again and the measurements taken a second time. If the parameters are found to be within 10% of each initial measurement, the well is considered stable and ready for sampling. If 10% is not reached, then the water is removed until stability is achieved. All field measurements will be taken and recorded on the appropriate sample collection forms, which are included in the SOPs (Appendix A). All field measurements will be performed in situ or on unpreserved samples. Monitoring probes will not be placed in sample bottles containing samples for laboratory analysis.

3.2.4 Sample Identification

All groundwater samples collected under this sampling plan will be identified according to Procedure ES&H 4.1.1, *Numbering System for Environmental Samples and Sampling Locations*.

The chemical plant area identification number consists of three discrete parts as shown in example GW-2020-S195. The first two codes in the sample identification number are used to indicate the environmental matrix sampled. The sample letter identifiers applicable to this sampling plan are: GW for groundwater samples and SP for spring. The second part of each identification number is a unique four-character sample location identifier. Groundwater monitoring wells and spring locations are documented on an Environmental Sampling Location Identification form. Nonpermanent locations (discrete sampling in the Southeast Drainage) will be identified by completion of a Nonstandard Environmental Sampling Identification form. The third portion of the identification number identifies the sample collection date by a code signifying semiannual samples (S195). This code system will be used for the comprehensive sampling event (S195 = May; S295 = August). The discrete groundwater sampling and any additional fourth quarter sampling will be identified by the month, day and year (071595).

For the comprehensive sampling effort, the ordnance works area sample identification numbering system will be identical to that described above except for the first two codes. All ordnance works samples will be designated with an MW prefix, as shown in example MW-D002-S195. D002 represents training area well MWD-2.

3.2.5 Quality Control Samples

Quality control (QC) samples will be collected to ensure consistent and accurate performance of sample collection and laboratory analysis. DOE Procedure ES&H 4.1.4, *Quality Control Samples for Aqueous and Solid Matrices: Definitions, Identification Codes, and Collection Procedures*, defines the types of QC samples that shall be collected, the recommended collection frequency, and the collection procedure. Table 3-4 summarizes the quality control samples that will be collected to support the comprehensive field sampling effort. A set of QC samples is scheduled to be collected on each of the following days, May 3rd, May 8th, May 11th, and May 16th for the first event, and August 3rd, August 8th, August 11th, and August 16th for the second sampling event. Table 3-5 lists the sample collection requirements (container, volume, etc.) for the QC samples.

TABLE 3-4 Field Quality Control Sample Summary

Quality Control Sample Type	Frequency	Purpose
Matrix Spike/Matrix Spike Duplicate or Matrix Duplicate	*1 per 20 samples or 1 per 14 days	Assess matrix and possible intralaboratory variability
Blind Duplicate/Secondary Duplicate	1 per month	Assess matrix and interlaboratory variability
Replicate	1 per 20 samples	Assess matrix and intralaboratory variability
Equipment Blank (nondedicated equipment only)	1 per 20 samples	Assess effectiveness of decontamination at wells with non-dedicated sampling equipment.
Distilled Water Blank **	1 per month	Assess quality of distilled water
Field Blank**	1 per month	Assess impact of ambient conditions on samples
Trip Blank	2 per VOC shipment	Assess VOC contamination introduced during transportation or laboratory handling

* Whichever is of higher frequency.
** Collected together on the same day.

Quality control samples are further identified by a two or three-character suffix added to the sample identification number (as described in Section 3.2.4). The quality control samples are identified based on their purpose: duplicate/split samples-DU, field replicate-FR, matrix spike-MS, matrix spike duplicate-MSD, equipment blank-EB, field blank-FB, and water blank-WB. A trip blank will be used when shipping the VOA samples from the August event. All Sample Identification Forms will be kept as permanent quality assurance records.

3.2.6 Sample Collection, Preparation, and Preservation

All samples taken for the chemical plant area and the ordnance works area will be collected in certified-clean plastic or amber bottles as appropriate for analysis. Table 3-5 lists the sample collection requirements for each parameter and media. All water samples will be preserved according to Table 3-5, after collection and during shipment to the analytical laboratories. All samples will be packed in ice to maintain a temperature of 4°C (39.2°F).

Sample preparation and packaging will conform to the standard operating procedures detailed in Procedure RC-19s, Hazardous Material/Sample Transportation Activity (HMSTA)

TABLE 3-5 Sample Collection Requirements

Analysis Name	Media Type	Sample Container Size/Type	Preservative	Holding Time	Minimum Volume Required	MS/MD or DU Volume Required
Nitroaromatics	Water	1 liter amber glass	4°C (ICE)	5 days; actual extraction/holding times variable; samples should be shipped immediately upon collection	1000 ml	1000 ml
Metals, Individual	Water	1 liter plastic	Nitric Acid (HNO_3) to a pH < 2	6 months	250 ml	1000 ml
Nitrate[a]	Water	250 ml plastic	Sulfuric Acid (H_2SO_4) to a pH <2	28 days	100 ml	300 ml
Chloride	Water	250 ml plastic	4°C (ice)	28 days	100 ml	300 ml
Fluoride	Water	250 ml plastic	4°C (ice)	28 days	100 ml	500 ml
Sulfate	Water	250 ml plastic	4°C (ice)	28 days	100 ml	500 ml
Uranium	Water	500 ml plastic	Nitric Acid (HNO_3) to a pH <2	6 months	100 ml	500 ml
Volatiles	Water	2-40 ml glass vials	Hydrochloric acid to a pH <2 and 4°C (ice)	10 days	160 ml	160 ml

a Actual extraction/analysis holding times are variable. Samples should be shipped immediately after collection.

Operations. All samples will be prepared for shipment by sealing the bottles with tape and properly labeling and tagging samples. Sufficient space in all bottles should be allowed, except volatile organic analyses, to compensate for pressure and temperature changes that may be incident to transportation (approximately 10% of the container volume). All samples will be shipped and analyzed within the holding times established by the analytical methods (Table 3-5).

All samples obtained from the chemical plant controlled area will be surveyed at the chemical plant Access Control area for radiological contamination control. Exit survey forms will be obtained (in accordance with RC-19). A copy of the results will be provided to the HMSTA personnel. If survey results indicate radiation above background, Access Control personnel will remove nonfixed radiation in accordance with current acceptable practice and will

acquire further radiological data from the Radiation Laboratory. This data will be forwarded to the HMSTA.

3.2.7 Chain-of-Custody

Chain-of-Custody Forms will be maintained for all environmental samples collected. The chain-of-custody procedure is detailed in Procedure ES&H 4.1.2 and specific procedures established to ensure that samples are not tampered with or altered prior to sample analysis.

Chain-of-custody is maintained by use of Chain-of-Custody Seals and Chain-of-Custody/Authorization Forms. The person collecting each sample shall be responsible for the care and custody of the sample until it is transferred or properly disposed of. All transfers are documented on the Chain-of-Custody Forms, which shall consist of the signature of the releasing party, the signature denoting acceptance of the samples, and the date and time of transfer.

Prior to shipment to analytical laboratories, all sample containers shall be checked against the Chain-of-Custody Form. Chain-of-Custody Forms will be signed and taped to the inside of the shipping container. Then the shipping container shall be sealed using signed and dated Chain-of-Custody Seals. Upon arrival at the analytical laboratory, sample shipment containers shall be inspected to ensure that custody seals are not damaged, tampered with, or missing. Any problems shall immediately be reported to the DOE laboratory coordinator. Copies of Chain-of-Custody Forms will be returned from the laboratories to note that the shipments arrived intact, complete, and untampered with. After samples have been analyzed and disposed of, the responsible party will complete the Chain-of-Custody Form.

All chain of custody documents will become permanent quality assurance records.

3.2.8 Sampling Equipment Decontamination

All sampling equipment will be decontaminated according to Procedure ES&H 4.1.3, *Sampling Equipment Decontamination*. Prior to collecting a water sample, nondedicated sampling equipment must be decontaminated according to the following steps:

- *Equipment.* Remove all visible contamination with clean tap water. If this is not effective, use a clean soft cloth or sponge or use pressurized water to clean equipment. If required, a brush may be used to clean stainless steel or metal equipment but not plastic equipment, which may be scratched by the brush. After cleaning equipment with tap water, triple rinse equipment with distilled water.

- *Hoses.* Pump clean tap water through hoses. If necessary, use pressurized tap water. After cleaning hoses with tap water, pump three volumes of distilled water through hoses.

- *Probe tips and meters.* Triple rinse with distilled water.

- Collect sample according to the specific procedure for the sample type, which may include decontaminating equipment prior to collecting sample.

- Rinse all sample collection equipment with clean tap water followed by distilled water. Store equipment in clean containers.

Disposal of decontamination water at the chemical plant area will follow Procedure RC-18, *Handling and Disposition of Site Generated Waste*. According to this procedure, decontamination water collected from wells located on the chemical plant area will be placed in a strong tight container with a secure lid. This water will be released at the decontamination pad at the end of the sampling day. Decontamination water from wells located on the ordnance works area will be discharged to the ground surface at the well site.

All equipment and tools will be decontaminated between sample collections and upon arrival at the site. Equipment and tools will be stored during sampling activities to maintain cleanliness. This may include use of plastic sheeting, boxes, or other appropriate methods.

4 ECOLOGICAL INVESTIGATION

Ecological investigations are required at Burgermeister Spring and the Southeast Drainage as part of the Groundwater Operable Units at the Weldon Spring Chemical Plant area. The ecological investigations for these drainages will help determine whether impacts exist as a result of the presence of contaminated media in the drainages. Site-related contaminants for Burgermeister Spring have been identified as uranium, nitroaromatics, nitrate, chromium, arsenic, lead, mercury, selenium, and silver. Site-related contaminants for Southeast Drainage have been identified as uranium, nitroaromatics, nitrate, chromium, copper, lead, manganese, silver, and zinc. Ecological data requirements as discussed the Work Plan (Ref. 3) will be fulfilled by the following sampling activities:

- Surface water samples shall be collected for chemical and radiological analysis and for toxicity testing at four locations at Burgermeister Spring, at two locations at Southeast Drainage and at background Spring 6501 in Drainage 6500 and background Spring 5406 in Drainage 5400. Sediment samples shall also be collected for chemical and radiological analysis and for toxicity testing for the locations at Burgermeister Spring and at background Spring 6501.

- The U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) (Ref. 7) Method II macroinvertebrate (benthic) assessment and habitat assessment shall be conducted at four locations at Burgermeister Spring, four locations in Drainage 6500, at two locations at Southeast Drainage, and at two locations in background Drainage 5400.

- The EPA RBP V method habitat assessment and fish community assessment (using electrofishing methods) shall be conducted at four locations at Burgermeister Spring, four locations in Drainage 6500, at two locations at Southeast Drainage, and at two locations in background Drainage 5400.

- Macroinvertebrate tissue samples shall be collected and prepared for tissue analysis at four locations at Burgermeister Spring and Spring 6501 at Drainage 6500. Fish tissue samples shall be collected and prepared for tissue analysis from four locations

at Burgermeister Spring and Spring 6501 in the 6500 drainage, at two locations in the Southeast Drainage, and at background Spring 5406.

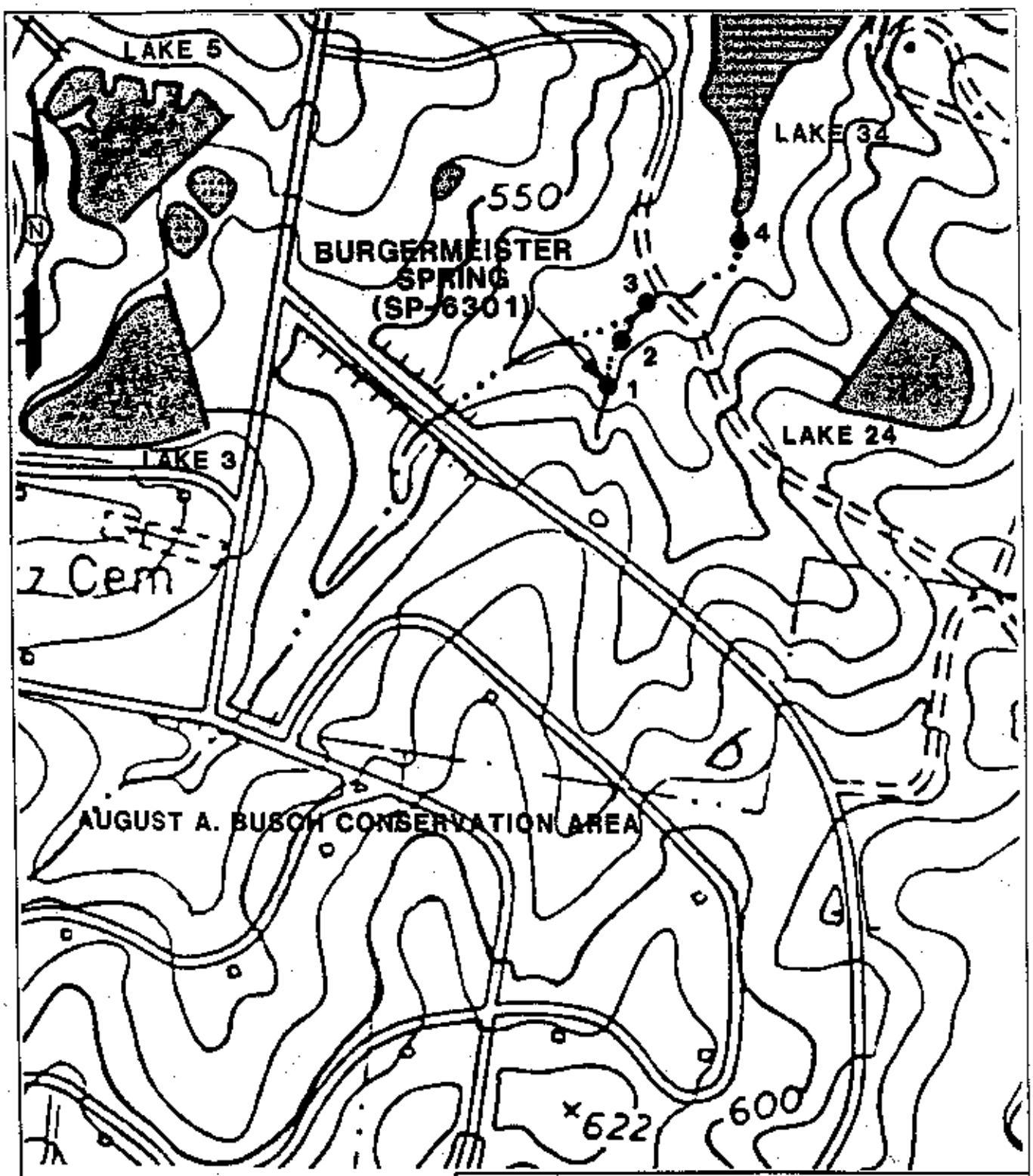
Sampling activities shall be conducted in four areas: in two study areas, Burgermeister Spring and the Southeast Drainage and at two background areas, Drainage 6500 and Drainage 5400. The locations of these areas are shown in Figure 4-1 through Figure 4-4. A total of 12 sampling locations have been defined for the four areas. At Burgermeister Spring and Drainage 6500, four study locations have been selected for sampling and are shown in Figures 4-1 and 4-2. Two study locations have been selected for sampling at the Southeast Drainage and two locations at background Drainage 5400 as shown in Figures 4-3 and 4-4.

Each sampling activity listed above shall be conducted during two separate calendar periods. These periods shall be late spring (May) and late summer (August/September). Late spring sampling events shall be taken during high flow periods or periods induced by precipitation (1/2 in. or greater). Late summer samples shall be taken at low flow conditions, representing undiluted groundwater flow, and therefore, shall be collected no sooner than one week following a precipitation event.

4.1 Surface Water and Sediment Sampling

Surface water and sediment samples shall be collected for contaminant analysis and toxicity testing at study and background locations as indicated on Figures 4-1 and 4-2. Surface water samples shall be collected for contaminant analysis and toxicity testing at locations as shown in Figures 4-3 and 4-4. One surface water sample and one sediment sample shall be used for contaminant analysis at each respective location. One surface water sample and one sediment sample from each respective location shall be used for toxicity testing. Additional sampling of surface water and/or sediments shall be performed for additional toxicity testing. Samples will be collected during two sampling periods.

In situ water quality information shall be measured at each sampling location. Parameters to be measured are dissolved oxygen, temperature, pH, conductivity, and flow rate. Meters shall be calibrated prior to use, and measurements shall be taken according to Procedures ES&H 4.5.1; 4.5.2, and 4.5.6 (Appendix A). Measurements shall be made at the spring, riffle, and



● - SAMPLE LOCATION

0 500 1000

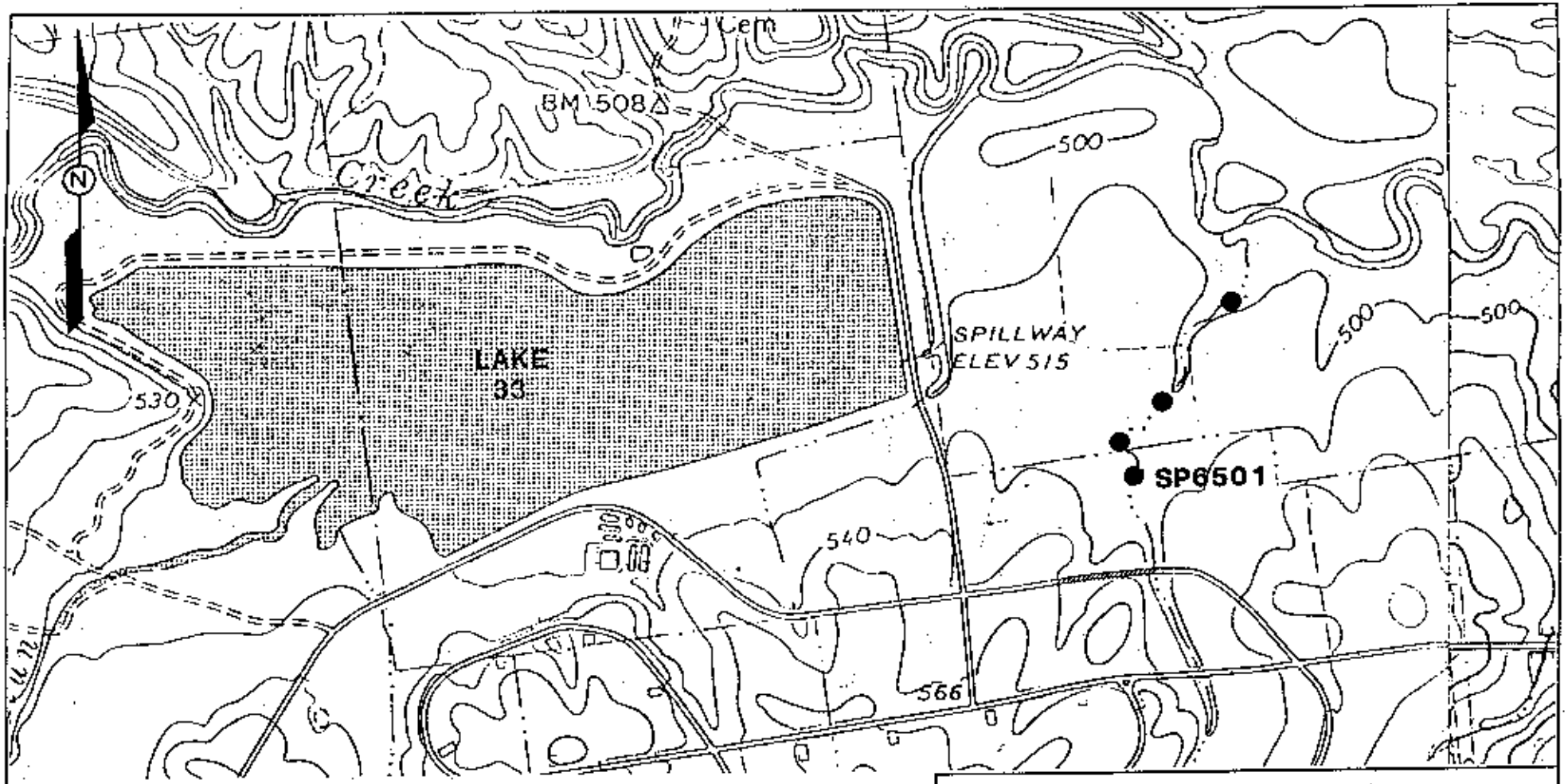
SCALE FEET

SOURCE: USGS TOPO

ECOLOGICAL SAMPLING LOCATIONS
BURGERMEISTER SPRING

FIGURE 4-1

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/VP/021/0494	
ORIGINATOR: JR	DRAWN BY: GLN	DATE: 12/28/94	



– MDOC ROAD PARKING FOR DRAINAGE ACCESS

0 1000 2000 FT

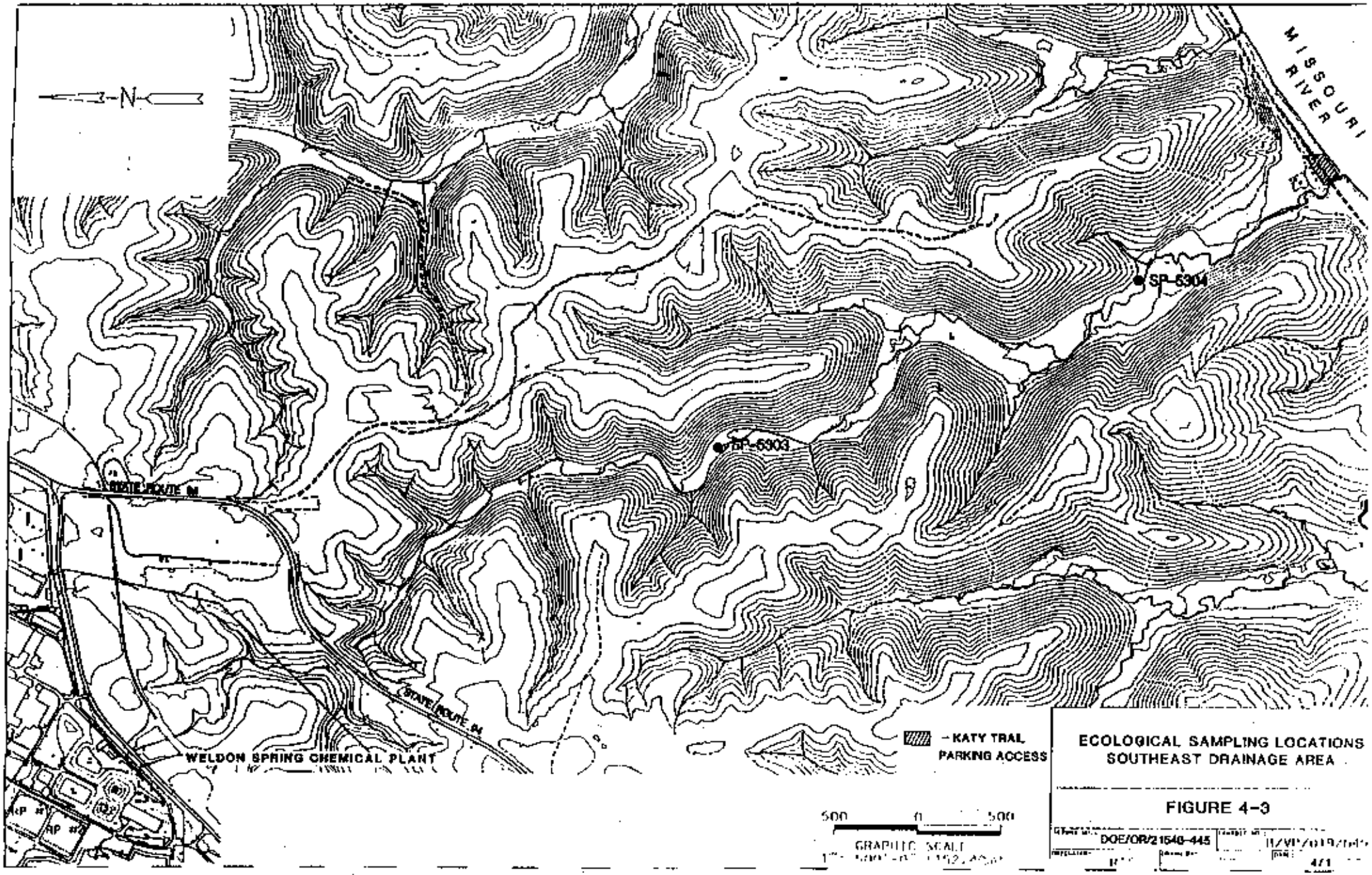
0 304.8 609.6 M

SCALE

ECOLOGICAL SAMPLING LOCATIONS; BACKGROUND SPRING (6500 DRAINAGE) FOR BURGERMEISTER SPRING

FIGURE 4-2

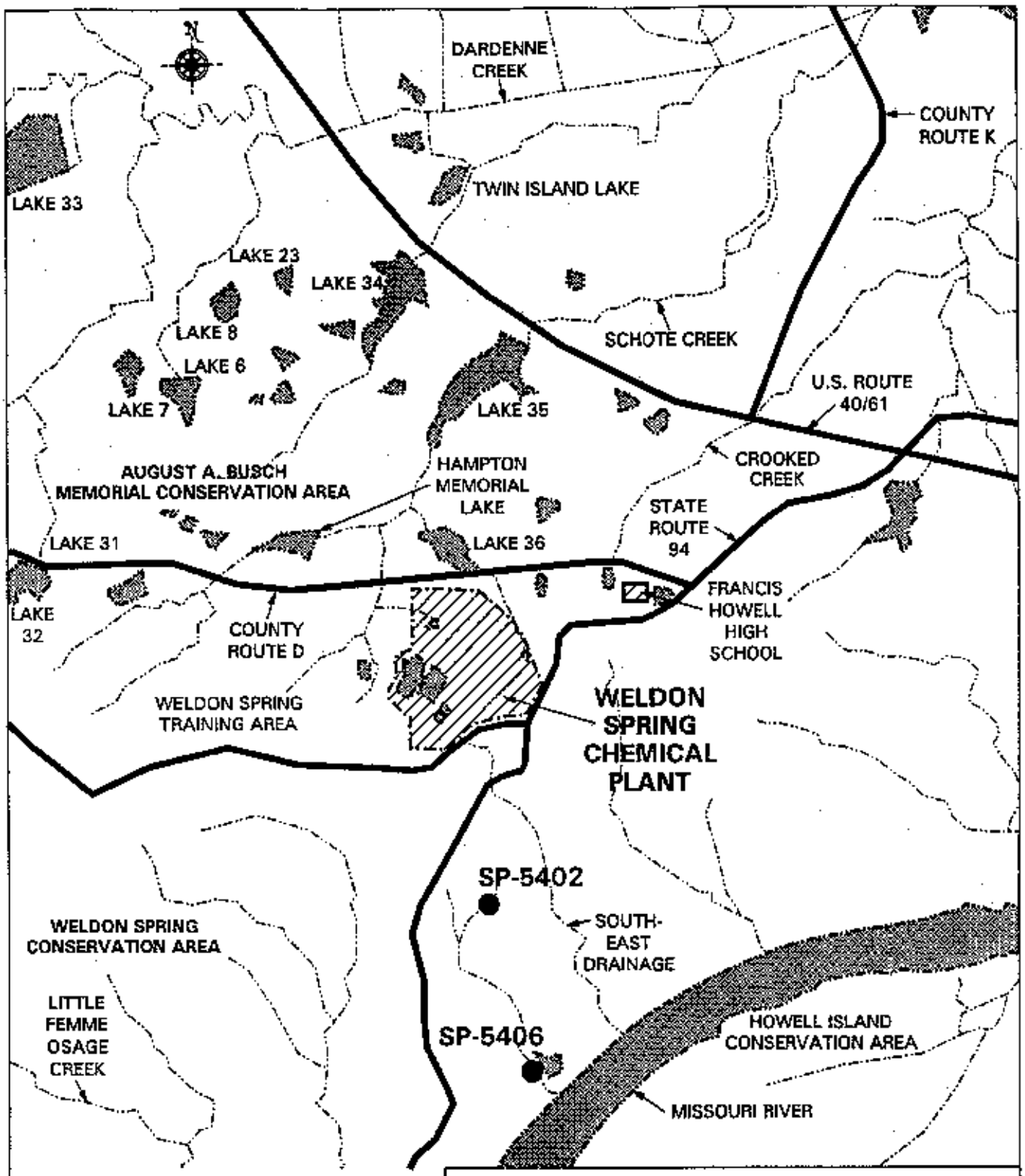
REPORT NO: DOE/OR/21548-445		EXHIBIT NO: A/VP/034/0894	
ORIGINATOR JR	DRAWN BY: SRS	DATE: 7/10/95	



ECOLOGICAL SAMPLING LOCATIONS
SOUTHEAST DRAINAGE AREA

FIGURE 4-3

DOE/OR/21548-445



DRAINAGE 5400 BACKGROUND SAMPLING FOR SOUTHEAST DRAINAGE

FIGURE 4-4

REPORT NO.: DOE/OR/21548-445		EXHIBIT NO.: A/VP/008/0295	
ORIGINATOR: JLP	DRAWN BY: GLN	DATE: 8/8/95	

downstream pool areas just below the water's surface and recorded as separate measurements. In situ water quality information shall be measured prior to collecting surface water samples, which shall be collected prior to sediment sample collection. Surface water samples shall be collected at each location using clean sample containers of the type as indicated in Table 4-1. Containers shall be filled to approximately 5.1 cm (2 in.) below the water surface. All data shall be recorded on the physical characterization/water quality field sheet (Appendix B). Water samples will be analyzed for Burgermeister Spring for uranium, nitroaromatics, nitrate, arsenic, lead, chromium, mercury, selenium, and silver. Water samples will be analyzed for the Southeast Drainage for uranium, nitroaromatic, nitrate, chromium, copper, lead, manganese, silver and zinc.

One sediment sample will be taken during the water sample event from depositional areas within each designated sample location. Sediment samples shall be collected using an Eckman or petite Ponar dredge. For the location, a representative grab sample, composed of a minimum of three separate grab samples shall be collected, mixed, and a representative aliquot shall be taken for analysis. Sediment shall be qualitatively examined in the field for substrate type using the following designations: clay, silt, fine sand, coarse sand, pebble, gravel, rubble, cobble, boulder, and detritus. The primary substrate type shall be recorded first with secondary characteristics noted second (e.g., silt with clay and detritus). All sediment collection information shall be recorded on the physical characterization/water quality field sheet (Appendix B). When collecting multiple sediment grab samples, from each of the study and background areas, sampling shall begin at the farthest downstream point and progress upstream. All sediment sampling devices shall be decontaminated between sampling locations. Equipment shall be decontaminated before each sample type is collected according to Procedure ES&H 4.1.3, *Sampling Equipment Decontamination*. Equipment shall be washed with soap and water to remove visible contamination. After all visible contamination is removed, rinse with clean water, and then triple rinse with clean distilled water. All residues and wash water wastes must be containerized and transferred to the Weldon Spring Site Remedial Action Project (WSSRAP) Waste Management Group for disposal. Decontamination shall be documented in the field logbook.

Additional surface water and sediment samples will be collected for toxicity tests. Samples shall be collected as described above. Additional surface water and/or sediment

samples may be collected dependent upon the results of the first level toxicity tests (acute). Tests shall be completed within 3 days of initial sampling. If acute toxicity is observed, serial acute toxicity tests shall be performed. If acute toxicity is not observed, chronic toxicity tests shall be performed. Additional samples shall be collected within 10 days of acute testing completion. Surface water and sediment samples collected for acute and chronic toxicity testing shall be stored, preserved, and shipped according to the requirements defined in Table 4-1. Toxicity samples shall be analyzed in accordance with Table 5-3.

All chemical, radiological, and toxicological analyses shall be conducted by the Contractor's off-site laboratory. Transfer of custody of samples shall be conducted in accordance with Procedure ES&H 4.1.2. Chain-of-Custody Forms to be used for all sampling activities are shown in Procedure ES&H 4.1.2. and Appendix A.

Quality control (QC) samples will be collected for chemical and radiological analysis in addition to designated location samples. A minimum of one set of quality control samples shall be collected per sample medium (sediment and water) during each sampling period. These quality control samples include duplicate, field replicate, and equipment blank samples for sediment and surface water; and matrix spike and matrix spike duplicate samples for sediment samples. QC samples shall be collected in accordance with Procedure ES&H 4.1.4 and the *Sample Management Guide* (Ref. 8).

4.2 Biotic Surveys

4.2.1 Habitat Assessment and Macroinvertebrate Sampling

The EPA RBP II (Ref. 7) shall be used to assess macroinvertebrate communities at each area and location, as specified in Figures 4-1 through 4-4. The habitat assessment is included as part of Protocol II and shall also be conducted at each location.

At each location, the habitat assessment shall be conducted as detailed in the RBP manual. The habitat assessment shall include evaluation of the main drainage channel, the stream bank, and the immediate drainage area. Physical characteristics collected for the habitat assessment shall include extent of erosion, non-point-source pollution, stream width and depth,

TABLE 4-1 Ecological Sample Collection Requirements

Analysis	Media Type	Sample Container Size/Type	Preservative	Holding Time	Minimum Sample Volume or Weight Required	Quality Control Sample Volume Required
Chemical - Nitroaromatics	Water	1 liter amber glass	4° Celsius (ICE)	5 days[a]	1000 ml	1000
	Sediment	250 ml amber glass wide-mouth			1000 cc	
Chemical - Metals, Individual[c]	Water	1 liter plastic 250 ml	Nitric Acid (HNO_3) to a pH < 2	6 months	250 ml	1000
	Sediment	amber glass wide-mouth	4° Celsius (ICE)		1000 ccc	
Chemical - Nitrate	Water	250 ml plastic bottle	Sulfuric Acid (H_2SO_4) to a pH < 2	28 days	100 ml	300 ml
	Sediment	250 ml plastic jar	4° Celsius (ICE)		500 cc	1000
Radiological - Uranium	Water	500 ml plastic bottle	Nitric Acid (HNO_3) to a pH < 2	6 months	100 ml	500 ml
	Sediment	250 ml plastic jar	4° Celsius (ICE)		500 cc	1000
Toxicity - Acute / Serial Acute	Water	2 liter plastic cube	4° Celsius (ICE)	36 hours	6.5 liter 12.4 liter	nr
	Sediment	5 liter plastic bucket		14 days	5 liter	nr
Toxicity - Chronic	Water	2 liter plastic cube	4° Celsius (ICE)	36 hours	45 liter[b]	nr
	Sediment	5 liter plastic bucket		14 days	5 liter	nr
Tissue Analysis	Macro-invertebrates	25 ml glass	4° Celsius (ICE)	1 month	2.7 grams	2.7 grams
	Fish	1 gallon plastic bag and double-bagged		6 months	10 grams and 2 individuals	10 grams and 2 indiv.

nr = not required

a Actual extraction/analysis holding times are variable. Samples should be shipped immediately after collection.

b Fifteen liters will be submitted to the laboratory for initial test setup and renewal water on Day 2. An additional collection of fifteen liters will be made by the subcontractor. Fifteen liters will be collected for Day 3 tests and again on Day 5 for test for use as renewal water.

c For reference only: metals include arsenic, chromium, lead, mercury, selenium, and silver.

high water marks, velocity, channelization, canopy cover, sediment odors, oils and deposits, and inorganic and organic substrate types. All information shall be recorded on the Physical Characterization/Water Quality Field Data Sheet (Appendix B).

Water quality information collected as part of the surface water sampling in Section 4.1 shall be used for the habitat assessment. These parameters include temperature, dissolved oxygen, pH, and conductivity. Additional water quality information shall be collected for the habitat assessment including stream type, water odors and oils, and turbidity. All water quality information shall be recorded on the Physical Characterization/Water Quality Field Data Sheet (Appendix B).

Habitat parameters shall be collected at each location during each sampling period, and shall include instream habitat, channel morphology, bank features, riparian vegetation, substrate, cover, embeddedness, velocity, and depth regime. All information shall be recorded on the Habitat Assessment Field Sheet (Appendix B).

RBP Method II shall be conducted to assess the biological community at each location (Figure 4-1 and 4-2). Macroinvertebrates shall be collected at riffle/run habitats within each sampling location using a surber and a kick net. A kick net will be used to collect macroinvertebrates from two 1 m^2 (10.8 ft^2) areas, and a surber shall be used to collect macroinvertebrates from two 0.09m^2 (1 ft^2) areas, which shall constitute one macroinvertebrate sample for the location. Samples shall be collected at areas of fast and slow current. At sampling locations where riffles do not exist, run areas with cobble or gravel substrate shall be used. A coarse particulate organic matter (CPOM) sample as described in the RBP manual, shall also be collected at each location. Each riffle/run sample shall be processed separate from the CPOM samples.

Macroinvertebrate samples collected at each location shall be sorted and enumerated during processing to obtain a 100-count organism subsample as described in RBP Method II (Ref. 7). All remaining organisms and any sample residue shall be preserved for quality control. All organisms in the subsample shall be identified as to family, enumerated, and recorded on the Biosurvey Field Data Sheet (Appendix B). All organisms in the subsample shall also be classified according to the functional feeding group, as presented in the RBP manual, enumerated, and recorded on the Biosurvey Field Data Sheet (Appendix B).

The CPOM samples taken at each location shall be processed according to RBP Method II (Ref. 7). Individuals shall be classified as shredders and non-shredders, enumerated by

classification, and recorded on the Biosurvey Field Data Sheet (Appendix B). Any sample residue shall be preserved for quality control processing.

A representative sample of macroinvertebrates shall be retained for tissue analysis. A minimum of 2.7 g of sample mass is required for invertebrate tissue analysis. Samples shall be collected, preserved, and stored according to requirements specified in Table 4-1. Samples shall be analyzed for Burgermeister Spring for uranium, nitroaromatics, nitrate, arsenic, chromium, lead, mercury, selenium, and silver. Tissue samples for Southeast Drainage shall be analyzed for uranium, nitroaromatics, nitrate, chromium, copper, lead, manganese, silver, and zinc. Sample collection shall be documented using the Biological Sample Collection Form as shown in Appendix B and identified in accordance with Procedure ES&H 4.1.1. All tissue analyses shall be conducted by the off-site contracted laboratory according to the Data Quality Requirements list in Table 5-2. Transfer of custody of samples shall be documented on the Chain-of-Custody form as shown in Appendix A and in accordance with Procedure ES&H 4.1.2.

4.2.2 Fish Sampling

The RBP Method V (Ref. 7) shall be used to assess fish communities at each location specified on Figures 4-1 through 4-4. Fish surveys shall focus on determining the presence or absence of *Ammocrypta clara*, the western sand darter, a State Watch List species. Fish shall be sampled using nonfatal electrofishing methods as used for the RBP V Method. Due to the limited access to each area, portable electrofishing units will be used for all locations.

At each sampling location, a 100 m (328 ft) reach shall be established for electrofishing. Block nets shall be placed at each end of the 100 m (328 ft) reach. The survey shall include sampling of all habitats represented within designated 100 m (328 ft) reach, and will ideally consist of at least one spring (if present), one riffle, one run, and one pool.

Electrofishing shall be conducted for a minimum period of 15 minutes at each location, or until 100 to 200 individuals are collected. Even if the sample area of 100 m (328 ft) overlaps individual sample locations, sampling shall be conducted for a specified period. All fish stunned by the electrofishing unit shall be quickly netted using a dip net. All captured specimens shall

be placed in a small holding tank (e.g., 5-gallon bucket with stream water) until identification and enumeration is conducted.

All fish (not just game fish) collected shall be identified and enumerated by species in the field according to methods presented as part of RBP Protocol V. All fish less than 20 mm (1 in.) in length shall not be included in the sample recording. If no fish larger than 20 mm (1 in.) are collected, then these fish will be recorded. Fish shall be identified as to species, sorted, and separated into adults and juveniles by size, and then total numbers and weights recorded on Fish Field Collection Data Sheet (Appendix B). Juvenile fish may be enumerated and weighed by group. Fish shall also be evaluated for physical anomalies such as eroded fins, excessive mucus, parasites, or tumors. All field collection information shall be recorded on the Fish Field Collection Data Sheet (Appendix B). Reference specimens of each species from each site shall be preserved in 10% formalin or other appropriate preservative, labeled, and stored.

A representative sample of fish specimens shall be retained for tissue analysis. A minimum of 10 g or two individuals shall be collected, enumerated, prepared, and preserved according to Table 4-1. Samples from Burgermeister Spring will be analyzed for uranium, nitroaromatics, nitrate, arsenic, chromium, lead, mercury, selenium, and silver. Tissue samples from the Southeast Drainage will be analyzed for uranium, nitroaromatics, nitrate, chromium, copper, lead, manganese, silver, and zinc. All sample collections shall be documented using the Biological Sample Collection Form as shown in Appendix B. All tissue analyses shall be conducted according to data quality requirements listed in Table 5-2. Chain of custody of samples shall be completed on the Chain-of-Custody form, as shown in Appendix A and in accordance with Procedure ES&H 4.1.2.

At each location, fish surveys conducted as part of the RBP Method V shall include sampling for the western sand darter, *Ammocrypta clara*. Suitable habitat within each location shall be sampled for this species. Suitable habitats are described as areas with sandy bottoms, quiet margins of stream channels, and shallow backwaters (Ref. 11). All individuals collected shall be examined to identify potential individuals of the species, *Ammocrypta clara*. Personnel conducting fish surveys shall be required to review and know identifying characteristics of this species prior to field surveys. No species listed on the Federal or State endangered or threatened species lists shall be killed for reference collection. If the species *Ammocrypta clara*

identified, field photographs shall be taken and State conservation officials shall be notified. Field photographs shall be instant processing photographs, and photographs shall be taken of the specific identifying characteristics.

Based upon observations made at each location during the assessment of habitat, water quality, and the fish biosurvey, a determination shall be made as to whether an impairment exists. If an impairment is determined, an Impairment Assessment Sheet (Appendix B) shall also be completed for the location, according to the RBP Method V.

5 QUALITY ASSURANCE

Remedial investigation activities for the Groundwater Operable Units at the chemical plant area and the ordnance works area will comply with the quality assurance program developed for the Weldon Spring Site Remedial Action Project (WSSRAP). The WSSRAP has developed the *Project Management Contractor Quality Assurance Program* (Ref. 9) in accordance with U.S. Department of Energy (DOE) Order 5700.6C. This program addresses sections of the American Society of Mechanical Engineers NQA-1 1989, *Nuclear Quality Assurance Program* and the U.S. Environmental Protection Agency (EPA) QAMS-005/80, *Quality Assurance Management Staff Quality Assurance Project Plan.* A plan has been developed specifically for environmental activities, and will be used for the Groundwater Operable Unit at the chemical plant area, and is entitled *Environmental Quality Assurance Project Plan* (EQAPjP) (Ref. 10). The EQAPjP ensures that all environmental activities conducted at the WSSRAP are performed in accordance with EPA QAMS-005/80. The U.S. Army Corps of Engineers (COE) has conducted a review of the EQAPjP and has approved the document for use for the groundwater operable unit at the ordnance works area. The quality assurance program is further supported by the use of standard operating procedures (SOPs), data quality requirements, data validation and verification and data interpretation methods.

The *Sample Management Guide* (Ref. 8) summarizes standard operating procedures and data quality requirements developed for use in the collection and analysis of environmental data, guidance in developing investigation-specific data quality objectives, data quality review programs conducted to ensure data integrity and validity, and administrative procedures adopted by the WSSRAP to manage the use of environmental data.

Data quality requirements (DQRs) have been established for environmental data. DQRs are qualitative and quantitative statements that specify characteristics of the data required to support decisions during remedial action activities and identify specific goals for WSSRAP data, including precision, accuracy, and completeness. The WSSRAP DQRs are standard in their application and are used as a guideline for the project.

Standard operating procedures (SOPs) have been developed to provide consistency in sample collection methodology and documentation of environmental activities. SOPs include

procedures for sample collection and identification and for data quality review. SOPs are issued as controlled copies and are reviewed annually. The procedures are updated as necessary.

5.1 Standard Operating Procedures

SOPs have been identified for use in sampling activities associated with environmental characterization for the Groundwater Operable Unit and are listed in Table 5-1 and included in Appendix A.

TABLE 5-1 Standard Operating Procedures for Characterization Activities for the Groundwater Operable Units

WSSRAP Procedure Number	Procedure Title
ES&H 1.1.4	Logbook Procedure
ES&H 4.1.1	Numbering System for Environmental Samples and Sampling Locations
ES&H 4.1.2	Chain of Custody
ES&H 4.1.3	Sampling Equipment Decontamination
ES&H 4.1.4	Quality Control Samples for Aqueous and Solid Matrices: Definitions, Identification Codes, and Collection Procedures
ES&H 4.3.2	Single Well Hydraulic Conductivity Testing
ES&H 4.4.1	Groundwater Sampling
ES&H 4.4.2	Groundwater Level Monitoring and Well Integrity Inspections
ES&H 4.4.4	Subsurface Monitoring Device Plugging and Abandonment Procedure
ES&H 4.4.5	Soil/Sediment Sampling
ES&H 4.4.7	Soil and Rock Core Borehole Logging
ES&H 4.5.1	pH and Temperature Measurement in Water
ES&H 4.5.2	Specific Conductance Measurement in Water
ES&H 4.5.5	Measurement of Specific Ions in Water
ES&H 4.5.6	Measurement of Dissolved Oxygen in Water
ES&H 4.5.8	Water Sample Filtering
ES&H 4.5.9	Operation and Calibration of YSI Flowthrough Cell System

TABLE 5-1 Procedures Applicable to Characterization Activities at the Chemical Plant Area the Weldon Spring Site (Continued)

WSSRAP Procedure Number	Procedure Title
ES&H 4.8.3	The WSSRAP Meteorological Monitoring Station
ES&H 4.9.1	Environmental Monitoring Data Verification
ES&H 4.9.2	Environmental Monitoring Data Validation
ES&H 4.9.3	Data Review Procedure for Surface Water, Groundwater, and Soils
RC-18	Handling and Disposition of Site-Generated Wastes
RC-19	Hazardous Material/Sample Transportation Activity (HMSTA) Operations
RC-30	Monitoring Well Waste Management
CDAP, Appendix F-1	Soil/Bedrock Boring Procedures for Well Installation
CDAP, Appendix F	Decontamination Procedures
CDAP, Appendix G	Borehole Logging Requirements
CDAP, Appendix G	Well Construction Diagrams
CDAP, Appendix G	Well Development Documentation
CDAP, Section 5.5.1	Field Notebook

CDAP (Ref. 4)

5.2 Data Quality Requirements

5.2.1 Analytical DQRs

The data quality objective process helps ensure that the right type and quality of information is collected and that the study design efficiently supports the decision-making process. This process includes ensuring that the samples collected are analyzed at adequate detection limits and by adequate methods to serve risk assessment needs. In addition, all laboratories contracted by the DOE will be required to conform to approved analytical methods and quality assurance and control procedures.

Data quality requirements for both Groundwater Operable Units are defined to obtain appropriate analytical methods and detection limits. These requirements include human health

risk and ecological risk needs. For each parameter, the analytical method, detection limits, analytical precision, and accuracy guidelines have been selected as shown in Table 5-2. Data quality requirements that differ for ecological risk assessments needs have been identified, and additional detection limits are provided in Table 5-2.

5.2.2 Toxicological DQRs

Surface water and sediment samples collected at each ecological sampling location (Section 4) shall be used to determine if media are toxic to biota and to provide applicable dose-response information. Toxicity tests shall be conducted in accordance with the prescribed methods on four test organisms as described in Table 5-3.

If the results of the acute toxicity tests indicate that mortality is significant at the 0.05 level, surface water and/or sediment shall be collected and serial dilution tests shall be performed. Serial acute toxicity tests shall determine the LC50, if attainable, or the highest concentration at which survival is not significantly different from the control (no-observed-adverse-effect concentration, or NOAEC). LC50 is the estimated percent concentration of the sample that is lethal or sublethal to 50% of the test organisms.

The serial dilution tests shall be performed in accordance with the stated method for acute toxicity (Table 5-3). Analysis shall be performed on 100% sample (i.e., no dilution), 50% sample, 25% sample, 12.5% sample, and 6.25% sample. Surface water samples shall be diluted using a clean source of water adjusted to mimic the surface water sample in pH, temperature, dissolved oxygen, hardness, conductivity, alkalinity, ammonia, and chlorine. Sediment samples shall be diluted in a similar fashion using a clean source of silica/sand.

If mortality is not noted during the acute toxicity tests, or if mortality is not significant at the 0.05 level, surface water and/or sediment shall be collected and chronic toxicity tests on these samples will be performed in accordance with the appropriate method listed in Table 5-3. The parameters measured in the chronic toxicity tests shall be survival and growth. If 10% or greater mortality is noted in the laboratory control group, for any of the tests conducted the test will be considered acceptable.

TABLE 5-2 Data Quality Requirements for the Data Analysis: Methods, Detection Limits, and Precision and Accuracy Requirements

			Sediment/DQRs			Water DQRs		
Category	Analytical Parameter	Analytical Method[b]	LLD soil µg/g[b]	Precision[a] (soil)	Accuracy[a] (soil)	LLD[b] µg/l	Precision[a] (water)	Accuracy[a] (water)
Field Measurements	pH	ES&H 4.5.1 *	NA	NA	NA	NA	20	NA
	Temperature	ES&H 4.5.1 *	NA	NA	NA	NA	20	NA
	Conductivity	ES&H 4.5.2 *	NA	NA	NA	NA	20	NA
	Redox potential	ES&H 4.5.9 *	NA	NA	NA	NA	20	NA
	Dissolved Oxygen	ES&H 4.5.6a	NA	NA	NA	NA	20	NA
Off-Site Radiological Measurements (off-site laboratory analyses)	Uranium, total	EPA 908.0	1 pCi/g	50	30	1 pCi/l	20	20
	Biotic tissue		0.001 pCi/g	60	50			
Nitroaromatic Compounds	TNT	GC/ECD	0.006	50	50	0.03	20	20
	2,4-DNT	GC/ECD	0.006	50	50	0.03	20	20
	2,6-DNT	GC/ECD	0.002	50	50	0.01	20	20
	1,3,5-TNB	GC/ECD	0.006	50	50	0.03	20	20
	1,3-DNB	GC/ECD	0.018	50	50	0.09	20	20

TABLE 5-2 Data Quality Requirements for the Data Analysis: Methods, Detection Limits, and Precision and Accuracy Requirements (Continued)

			Sediment/DQRs			Water DQRs		
Category	Analytical Parameter	Analytical Method[b]	LLD soil µg/g[b]	Precision[a] (soil)	Accuracy[a] (soil)	LLD[b] µg/l	Precision[a] (water)	Accuracy[a] (water)
Nitroaromatic Compounds (Continued)	Nitrobenzene	GC/ECD	0.006	50	50	0.03	20	20
	2-Nitrotoluene (o-NT)	GC/ECD	NA	NA	NA	0.03	20	20
	Aminodinitrotoluenes	GC/ECD	NA	NA	NA	0.03	20	20
	Nitrotoluenes, total	GC/ECD	NA	NA	NA	0.03	20	20
	3-Nitrotoluene (m-NT)	GC/ECD	NA	NA	NA	0.03	20	20
	4-Nitrotoluene (p-NT)	GC/ECD	NA	NA	NA	0.03	20	20
	2-Amino-4,6-dinitrotoluene (2-Amino-DNT)	GC/ECD	NA	NA	NA	0.03	20	20
	4-Amino-4,6-dinitrotoluene (4-Amino-DNT)	GC/ECD	NA	NA	NA	0.03	20	20
Miscellaneous	Lithium	EPA 200.7	0.5	50	50	5	20	20
	Mo	EPA 200.7	0.4	50	50	4	20	20
	Nitrate	300.0/353.1	50	50	50	10 mg/l	20	20

TABLE 5-2 Data Quality Requirements for the Data Analysis: Methods, Detection Limits, and Precision and Accuracy Requirements (Continued)

			Sediment/DQRs			Water DQRs		
Category	Analytical Parameter	Analytical Method[b]	LLD soil µg/g[b]	Precision[a] (soil)	Accuracy[a] (soil)	LLD[b] µg/l	Precision[a] (water)	Accuracy[a] (water)
Miscellaneous (Continued)	Fluoride	EPA 300	NA	NA	NA	1 mg/l	20	20
	Sulfate	EPA 300	NA	NA	NA	200 mg/l	20	20
	Chloride	EPA 300	NA	NA	NA	200 mg/l	20	20
CLP-Metals	Arsenic-GW	CLP	NA	NA	NA	2	As required by CLP	
	Arsenic-Eco	CLP	1	As required by CLP		10	As required by CLP	
	Chromium-Eco	CLP-ICP	1	As required by CLP		10	As required by CLP	
	Lead-GW	CLP-AA	NA	NA	NA	3	As required by CLP	
	Lead-Eco		0.1	As required by CLP		10	As required by CLP	
	Mercury-GW	CLP-CV	NA	NA	NA	0.2	As required by CLP	
	Mercury-Eco	CLP-CV	0.1	As required by CLP		2.0	As required by CLP	
	Nickel	CLP-AA	4	As required by CLP		40	As required by CLP	
	Zinc	CLP-ICP	2	As required by CLP		20	As required by CLP	
	Silver-GW	CLP-ICP	NA	NA	NA	10	As required by CLP	
	Silver-Eco	CLP-ICP	1	As required by CLP		8	As required by CLP	
	Selenium-GW	CLP-AA	NA	NA	NA	30	As required by CLP	

TABLE 5-2 Data Quality Requirements for the Data Analysis: Methods, Detection Limits, and Precision and Accuracy Requirements (Continued)

			Sediment/DQRs			Water DQRs		
Category	Analytical Parameter	Analytical Method[b]	LLD soil µg/g[b]	Precision[a] (soil)	Accuracy[a] (soil)	LLD[b] µg/l	Precision[a] (water)	Accuracy[a] (water)
CLP Metals (Continued)	Selenium-Eco	CLP-AA	0.5	As required by CLP		3	As required by CLP	
	Thallium	CLP-AA	0.1	As required by CLP		1	As required by CLP	
	Antimony	CLP-AA	0.5	As required by CLP		4	As required by CLP	
	Iron	CLP-ICP	NA	NA		100	As required by CLP	
	Manganese	CLP-ICP	NA	NA		15	As required by CLP	
CLP VOAs	Carbon disulfete and toluene	CLP-GC/MS	NA	NA	NA	10	As required by CLP	
Other parameters not listed		TBD	TBD	50	50	TBD	20	20

TBD To be determined
NA Not applicable
LLD Lower limit of detection.
(a) Accuracy criteria reflect the maximum ± deviation from 100% recovery. Precision criteria reflect the maximum relative percent difference between duplicate values.
(b) Detection limits and/or methods may vary with each laboratory and assume a dilution factor of 1.0. The soil detection limits assume 100% solids content.

TABLE 5-3 Ecological Toxicity Methods

Test Organism	Duration	*Acute Surface Water	*Accute Whole Sediment
Daphnia magna or *D. pulex* (<24 hours old)	48 hour static non-renewal	EPA/600/4-90-027	ASTM E 1383-94a
Hyalella azteca (total length 2-3 mm)	96 hour static renewal	EPA/600/4-90-027	ASTM E 1383-94a
Pimephales promelas (≤14 days old)	96 hour static renewal	EPA/600/4-90-027	EPA/600/4-90-027 (modified)
Rana sphenocephala (≤14 days old)	96 hour static renewal	ASTM E 1192-88, or ASTM E 729-88	EPA/600/4-90-027
Test Organism	**Duration**	**Chronic Surface Water**	**Chronic Whole Sediment**
Daphnia magna or *D. pulex* (<24 hours old)	7 days static renewal	EPA/600/4-89-001 (modified	ASTM E 1383-94a
Hyalella azteca (total length 2-3 mm)	7 days static renewal	EPA/600/4-89-001 (modified)	ASTM E 1383-94a
Pimephales promelas (≤14 days old)	7 days static renewal	EPA/600/4-89-001 (modified)	EPA/600/4-89-001
Rana sphenocephala (≤14 days old)	7 days static renewal	EPA/600/4-90-027 (modified)	EPA/600/4-89-001

* The methods listed for acute toxicity will be used for serial dilution tests if acute toxicity is observed.

5.3 Data Documentation, Validation, and Reporting

The WSSRAP quality assurance program for environmental data specifies numerous initiatives for each aspect of data documentation, reduction, validation, and reporting. The *Sample Management Guide* (Ref. 8) is a specific program-level plan that provides the foundation for collecting, verifying, validating, and managing data. This plan also includes a summary of sample collection procedures, data verification and validation requirements, database administration, and data archival. All sampling activities under this plan will be conducted in accordance with the *Sample Management Guide*.

All data received from analytical laboratories are subjected to data verification upon arrival from the laboratory. The data verification process is detailed in Procedure ES&H 4.9.1, *Environmental Monitoring Data Verification* and consists of a preliminary review of the quality-impacting aspects of sampling, analysis, andreporting. A preliminary data review is also conducted that assists in identifying analytical problems with data or identifies unusual concentrations that may require further action. This review is conducted according to ES&H 4.9.3, *Data Review Procedure* and is further discussed in Section 5.4. The verification process also ensures that any discrepancies are properly addressed and that resultant changes are documented. Data are available for use after data verification is complete.

Data validation is performed by the DOE, independent of the analytical laboratory. The data validation process is detailed in Procedure ES&H 4.9.2 (Appendix A). Data validation consists of two primary functions, review of the analytical process, and assessment of data quality. The analytical process consists of reviewing all records related to sample integrity, sample preparation, and the analytical measurement systems, and comparing data to the method-specific criteria and site-specific data quality requirements that ensure that data quality is evaluated based on the end use of the data. For the chemical plant area, approximately 10% of all analytical data are validated. Validation methods actually review more than 10% of the analytical data, by requiring validation of each analytical lot (group of samples analyzed), effectively validating a much larger percentage of the database. This is accomplished by reviewing information affecting data quality (i.e., instrument calibration) that is the same for all samples in an analytical lot.

The final step involves comparing results to the method criteria and data quality requirements (Table 5-2). Qualifiers are attached to validated data records. This allows data users to assess the quality of the data without a detailed knowledge of the analytical processes.

5.4 Data Assessment and Interpretation of Chemical and Radiological Data

Data received from the analytical laboratories are reported as nondetects (<DL) with the detection limit identified, or as detected values, or as uncensored data. Data reported as uncensored data are data with concentrations measured at less than the required detection limit of the analytical methods or instrumentation. If uncensored data are not available, one-half the detection limit is used for calculating averages in nondetect data. The EPA recommends the use of this value for statistical manipulation of data when the percentage of nondetects in the data set is small and uncensored data are not available (Ref. 18).

Review of all new data is conducted prior to use according to the Procedure ES&H 4.9.3s (Appendix A). This procedure defines statistical summary methods to compare new data with historical data, evaluation of potential outliers (artificial or natural), review of quality control data, and documentation of the data review.

When new data are received from the laboratory, they are reviewed against a statistical summary of historical data for the same location for each parameter. The summary is based on trimmed datasets and Gaussian statistics. The datum is ranked relative to the tolerance intervals, which are defined by the trimmed mean (μ) ± 3 standard deviations (σ). Although some datasets may not follow a Gaussian (normal) distribution, this approach provides a conservative means for identifying extreme values (potential outliers), and it is simple to use. The outlier identification procedure is used to recognize datapoints that might require further investigation and/or those marked with data qualifiers. Data qualifiers assist the user in identifying data that are potentially limited in their use, as determined by the user or the task.

The relative percent difference is calculated for all duplicate/replicate samples. If data values differ by more than 20%, the data are qualified to indicate the lower level of precision. Blank samples are also reviewed to determine if detectable quantities are present on any

parameter. This method may indicate a contaminated blank sample that could impact sample results. These data are potentially subject to limited use as determined by the user.

Laboratory quality control data, where provided, are also evaluated. Method blanks are laboratory samples that reflect all aspects of the analytical process, including sample preparation and analysis. Similar to field blank samples, concentrations for all parameters should be less than the detection limit in the method blank. If a given parameter is detected in the method blank, all other analyses for that parameter, with values less than five times the blank value in the same data packet, should be considered suspect (Ref. 12).

Control samples are standards analyzed by the laboratory. When recoveries are reported relative to the accepted value, they should be within the range of 80% to 120%. Data are also checked against the Chain-of-Custody Form to determine if the samples are labelled properly and if the specified analyses were performed.

5.5 Ecological Data Assessment

Data analysis and interpretation techniques for the habitat, macroinvertebrate and fish surveys as part of the ecological investigation shall include assessment methods and products as described in the Rapid Bioassessment Protocol Manual for Protocols II and V (Ref. 7).

All Physical Characterization/Water Quality Field Data Sheets and Habitat Assessment Field Data Sheets shall be completed properly and completely and in accordance with the RBP methods. Each location, at Burgermeister Spring Drainage and Drainage 6500, and each sampling event, shall be rated and a total score obtained. The total score obtained for each location shall be compared to the similar background location, and a ratio will be obtained. A habitat assessment category/classification shall be documented for each location. A cumulative score shall also be obtained and compared to the cumulative score for the respective background location. A ratio or percent comparability shall also be calculated for cumulative score. Impairment assessment forms shall be completed if biological impairment is determined. Interpretations shall summarize habitat assessment, impairments, observations or problems associated with each location, with each area as a whole, and with each study area in comparison to the background location.

Macroinvertebrate data collected from each location shall be reviewed using eight biological metrics as presented in the RBP Manual for Method II (Ref. 7). The metrics to be calculated shall include taxa richness; family biotic index; ratio of scraper/filtering collectors; ratio of Ephemeroptera, plecoptera, trichoptera (EPT) and chironomid abundances; percent contribution of dominant family; EPT index; community similarity index; and ratio of shredders to total individuals.

Each metric result from each location for Burgermeister Spring shall be given a score based on percent comparability to the background location (Drainage 6500). Scores shall be totaled and compared to the total metric score for the background location, and a percent comparison shall be calculated. The percent comparison score shall be classified according to the RBP Manual to biological condition category. The percent comparison shall also be calculated for all locations at each study area and compared to the cumulative score for the background location. Data interpretation shall summarize the macroinvertebrate community assessment, observations, or problems associated with each location, with each area as a whole, and with each study area in comparison to the background location.

Basic interpretations shall also be made and consideration should be given to particular pollution indicator species, biological community assessment, the potential impacts realized and their potential source(s), and recommendations for future monitoring.

Fish data collected from each location shall be reviewed using 12 biological metrics as presented in the RBP Manual for Method V. The metrics to be calculated shall include number of native species, number of darter or benthic species, number of sunfish or pool species, number of sucker or long-lived species, number of intolerant species, proportion of green sunfish or tolerant individuals, proportion of omnivorous individuals, proportion of insectivores, proportion of top carnivores, total number of individuals, proportion of hybrids or exotics, and proportion with disease or anomalies.

Each metric result from each location for Burgermeister Spring shall be given a score based on percent comparability to the background location (Drainage 6500). Southeast Drainage locations will not be analyzed in this manner. Scores shall be totaled and compared to the total metric score for the background location and a percent comparison calculated. The percent

comparison score shall be classified according to the RBP manual to biological condition category. The percent comparison shall also be calculated for all locations at each study area and compared to the cumulative score for the background location. Data interpretations shall summarize the fish assessment, observations, or problems associated with each location, with each area as a whole, and with each study area in comparison to the background location. Consideration shall also be given to particular pollution indicator species, fish assessment, the potential impacts realized, and their potential sources.

6 GLOSSARY

Acute toxicity	The measurement of the biological effect (death) associated with exposure to contaminated or hazardous compounds.
Aquifer	A water-bearing layer of permeable rock or soil that will yield water to wells in usable quantities. Confined aquifers are usually at higher than hydrostatic pressure and are isolated from the atmosphere at the point of discharge by impermeable geologic formations. Unconfined aquifers are exposed to atmospheric pressure through openings in the overlying materials (vadose zone).
Auger	A rotary drilling device used to drill borings through unconsolidated materials in which the cuttings are mechanically removed from the bottom of the boring without the use of fluids.
Background levels	Naturally occurring chemical and radioactive concentrations in the soil, surface water, and groundwater within a specific geographic region.
Bedrock	Solid lithified or crystalline (lattice structure with molecular bonds) rock that underlies unconsolidated surficial materials.
Biouptake	Route of intake related to storage, transport, and metabolism within an organism.
Borehole	A cylindrical hole made by drilling into soil or rock.
Coarse particulate organic matter	Decomposing vascular plant material from a variety of forms: leaves, twigs, bark. Aquatic invertebrate habitat including shoreline areas and leaf pack areas where shredding-type species are found.

Conductivity	A measure of the ability of water to conduct an electric current. Conductivity is typically proportional to the concentration of dissolved solids and is measured in μmhos/cm at 25°C.
Conduits	An underground feature formed by the dissolution of carbonate rock material filled with water under hydrostatic pressure.
Core-loss	Portions or segments of geologic sample lost during drilling, due to noncohesive physical properties or the absence of geologic media, as in the case of voids and fractures.
Data validation	A systematic review of data using laboratory analytical records to assess laboratory performance in accordance with the defined analytical methods.
Data verification	A nonanalytical review of sample data and associated documentation to ensure that samples are preserved, shipped, maintained, and analyzed in accordance with established data quality requirements defined by this sampling plan and standard operating procedures developed for the Weldon Spring Site Remedial Action Project.
Dissolved oxygen	The mass of free oxygen dissolved in water and measured in mg/liter. In groundwater, free oxygen is consumed in reactions with minerals and organic matter in the unsaturated and saturated zones.
Fracture	A break in a rock formation due to structural stress. Fractures may occur as faults, shears, joints, or planes of cleavage.
Genus	A category in the hierarchy of plant and animal classification, intermediate in rank between family and species.
Groundwater	Water within the zone of saturation beneath the ground surface.

Grout	A mortar combined with water and bentonite to provide a matrix for sealing a borehole or the annular space of a monitoring well.
Hydraulic conductivity	The rate of flow (measured in gallons per day or centimeters per second) of groundwater through a unit cross-sectional area under a unit hydraulic gradient in a unit of time, at a specific temperature. Synonym - permeability coefficient.
LD-50	Measurement used in toxicity tests; the concentration dose of a chemical or mixture in a medium which is estimated to be lethal to 50% of the test organisms within a specific time period; median lethal concentration.
Lithology	The study of the physical character of a rock based on such characteristics as color, mineralogic composition, and grain size.
Logging	The method or technique by which subsurface formations are characterized, relative to depth, lithology, and stratigraphy and are presented graphically by measurements or observations during drilling of soils and/or bedrock.
Matrix spike	An aliquot of sample to which a known amount of a compound has been added (spiked). This aliquot is analyzed and compared with an unspiked aliquot. From this comparison, the percent recovery is determined. Matrix spike samples are used to evaluate the accuracy of measurements.
Metrics	Biological parameter that measures a component of the community structure and that has a different range of sensitivity to pollution stress.
Overburden	All materials, such as loose soil, sand, and gravel, that lie above bedrock.
pH	A measure of the relative acidity or alkalinity of a solution, with neutral equal to a pH of 7. The negative $\log_{10}$ of the hydrogen ion activity in a solution.

Potentiometric map	A subsurface contour map showing the elevation of a potentiometric surface of an aquifer, an imaginary surface representing static water level (piezometric surface) in an unconfined aquifer or the total head of groundwater as defined by the level to which water will rise in a well for a confined aquifer.
Retrofit	Modification of open-hole wells by installation of a filter pack, screen, and casing, to monitor a specific geologic interval; increasing or reducing borehole depth may be included in this process.
Riffle	Area of a river, stream, or creek that is characterized by steep surface gradients that result in high velocity flow.
Rock quality designation (RQD)	The ratio of the cumulative length of rock core pieces greater than 4 in. in length to the total length of the core interval. Expressed as a percentage or decimal fraction of one or less.
Seine	Sampling apparatus constructed of twine or nylon netting and used to collect fish.
Shredder	Functional classification of aquatic insects based upon feeding mechanism. Feeds on decomposing organic matter.
Species	A group of plants or animals that may interbreed and produce fertile offspring.
Stratigraphy	The science of characteristics and attributes of rocks as beds or layers of homogeneous or gradational rock material; the interpretation in terms of mode of origin and geologic history of rock strata; the arrangement of strata as to geographic position and chronological order of sequence.
Stream sinuosity	The morphology of a stream, river, or creek characterized by natural curving and bending of channel.

Substrate	The substance or nutrient on or in which an organism lives and grows or the surface to which a fixed organism is attached.
Species richness	The total number of genera or species collected in a sample. A measurement that reflects the health of the ecological community.
Tolerance value	Classification or value assigned to a family or species indicative of its ability to inhabit polluted environments.
Uncensored data	Actual measurements that are below the specified limit of detection. These numbers are accompanied by significant uncertainty and may assume negative values.
Unconsolidated materials	Sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either at the surface or at depth.
Unweathered	Rocks that have not undergone physical or chemical changes, such as crumbling or surface pitting, or destructive processes due to exposure to the atmosphere and its agents at or near the earth's surface.
Vadose zone	Water occurring in the zone of aeration. The unsaturated region of soil between the ground surface and the zone of saturation.
Water table	The static water level surface of a body of an unconfined aquifer. The surface in a groundwater body at which the pore water pressure is equal to that of the atmosphere. For a confined aquifer, it is the imaginary surface along which the water pressure is equal to the atmospheric pressure.
Weathered	Rocks that have undergone physical or chemical changes, such as crumbling or surface pitting, or destructive processes due to exposure to the atmosphere and its agents at or near the earth's surface.

7 REFERENCES

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3. Argonne National Laboratory. *Work Plan for the Remedial Investigation/Feasibility Study - Environmental Assessment for the Groundwater Operable Unit at the Weldon Spring Site*, Preliminary Draft. DOE/OR/21548-567. Prepared for the U.S. Department of Energy, Weldon Spring Site Remedial Action Project, St. Charles, Missouri, by the Environmental Assessment Division. September 1994.

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9. MK-Ferguson Company and Jacobs Engineering Group. *Project Management Contractor Quality Assurance Program*, Rev. 1. DOE/OR/21548-333. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. November 1994.

10. MK-Ferguson Company and Jacobs Engineering Group. *Environmental Quality Assurance Project Plan*, Rev. 1. DOE/OR/21548-352. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO. July 1993.

11. Pflieger, William L. *The Fishes of Missouri*. Published by Missouri Department of Conservation. 1975.

12. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual (Part A)*, Vol. 1, Interim Final, EPA\540\1-89\002. Washington, D.C. December 1989.

APPENDIX A
Standard Operating Procedures

MORRISON KNUDSEN CORPORATION

MK-FERGUSON GROUP

SET I.D.049

INTER-OFFICE CORRESPONDENCE

DATE: June 28, 1995

TO: Charles Bowers

FROM: Jim Meier

SUBJECT: **QUICK CHANGE TO ES&H PROCEDURE 4.4.1 GROUNDWATER SAMPLING**

The following change should be made to ES&H procedure 4.4.1, in the Exhibit 2 table.

Original:

The Exhibit 2 table has the preservative for volatiles as "4 degrees (ice)".

Revision:

The Exhibit 2 table should have the preservatives for volatiles as "ice and HCL to pH<2".

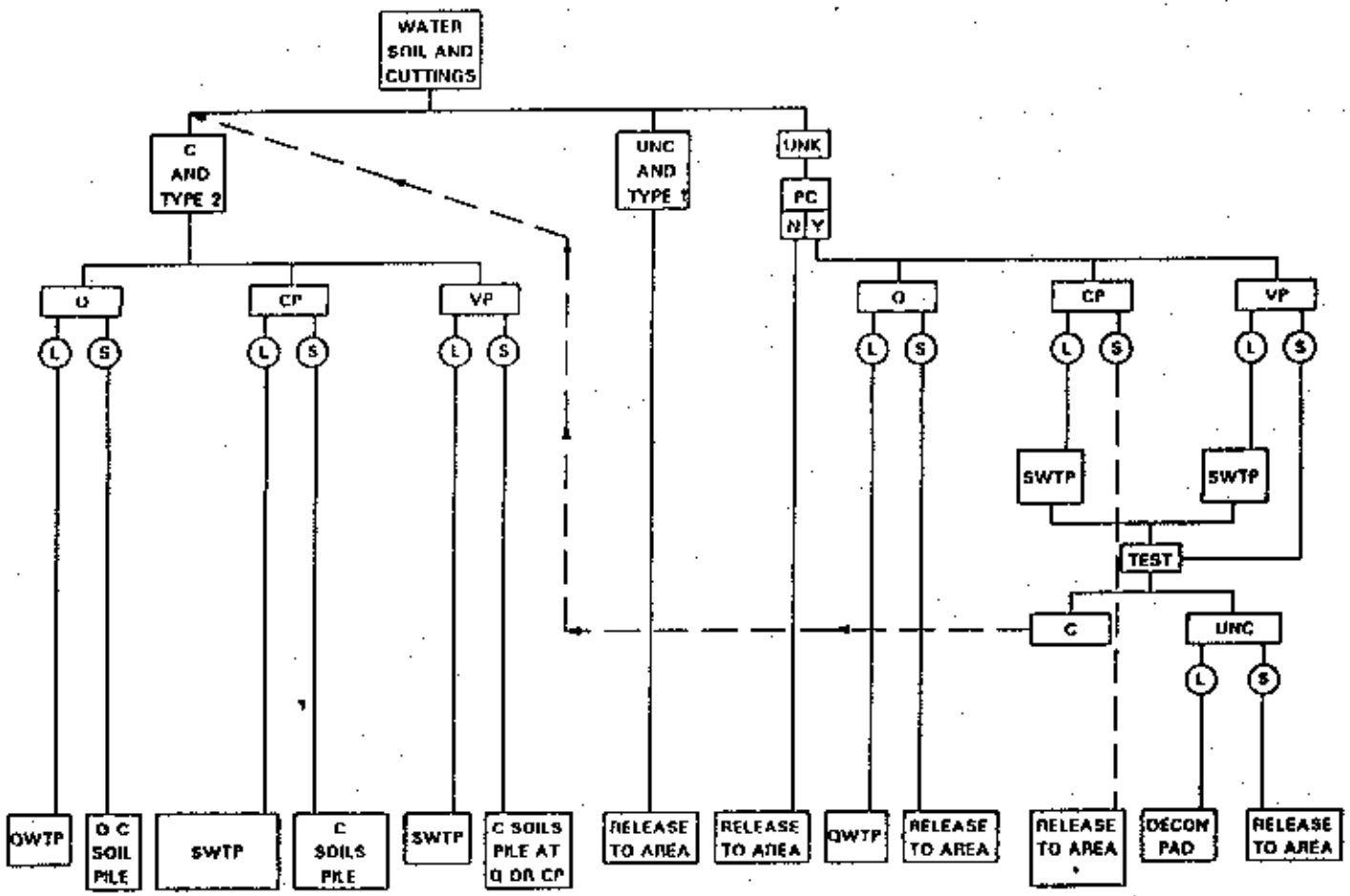
If you have any comments about this revision, provide them to the Jim Meier within 45 days. If the ES&H Department receives no comments by August 14, 1995, the procedure will be revised to incorporate the changes specified in this IOC and forwarded to management for approval. No further opportunity for review or comment will be provided at this time.

MQ/jn

ES&H Manager — Date 6/29/95

Project Quality Manager — Date 06/30/95

Deputy Project Manager — Date 6/30/95



* - RELEASE TO AREA ONLY IF AREA IS ALREADY CONTAMINATED. OTHERWISE PLACE AT CONTAMINATED SOILS PILE.

LEGEND

UNC - UNCONTAMINATED
UNK - UNKNOWN
C - CONTAMINATED
L - LIQUID
S - SOLID
Y - YES
N - NO
CP - CHEMICAL PLANT
VP - VICINITY PROPERTY
Q - QUARRY
TYPE 1 WATER (SEE EXHIBIT 1)
TYPE 2 WATER (SEE EXHIBIT 1)
PC - POTENTIALLY CONTAMINATED
SWTP - SITE WATER TREATMENT PLANT OR 434 DECON PAD SUMP
QWTP - QUARRY WATER TREATMENT PLANT OR QUARRY DECON PAD SUMP

WELL SPOILS FLOW CHART

EXHIBIT 2

REPORT NO.:		EXHIBIT NO.:	A/P1/131/0892
ORIGINATOR: JJD	DRAWN BY: GLN	DATE: 3/22/95	

APPENDIX B
Biological Field Sheets

B-1 Physical Characterization/Water Quality Field Data Sheet
B-2 Habitat Assessment Field Sheet
B-3 Biosurvey Field Data Sheet
B-4 Fish Field Collection Data Sheet

B-1 Physical Characterization/Water Quality Field Data Sheet

PHYSICAL CHARACTERIZATION

RIPARIAN ZONE/IN-STREAM FEATURES:

Predominant Surrounding Land Use:

Forest Field/Pasture Agricultural Residential Commercial Industrial Other _____

Local Watershed Erosion: None Moderate Heavy

Local Watershed NPS Pollution: No evidence Some Potential Sources Obvious Sources

Estimated Stream Width _____m Estimated Stream Depth: Riffle _____m Run _____m Pool _____m

High Water Mark _____m Velocity _____ Dam Present: Yes _____ No _____ Channelized: Yes _____ No _____

Canopy Cover: Open Partly Open Partly Shaded Shaded

SEDIMENT/SUBSTRATE:

Sediment Odors: Normal Sewage Petroleum Chemical Anaerobic None Other _____

Sediment Oils: Absent Slight Moderate Profuse

Sediment Deposits: Sludge Sawdust Paper Fiber Sand Relict Shells Other _____

Are the undersides of stones which are not deeply embedded black? Yes No

Inorganic Substrate Components			Organic Substrate Components		
Substrate Type	Diameter	Percent Composition in Sampling Area	Substrate Type	Characteristic	Percent Composition in Sampling Area
Bedrock			Detritus	Sticks, Wood, Coarse Plant Materials (CPOM)	
Boulder	> 256-mm (10 in.)				
Cobble	64-256-mm (2.5-10 in.)				
Gravel	2-64-mm (0.1-2.5 in.)		Muck-Mud	Black, Very Fine Organic (FPOM)	
Sand	0.06-2.00-mm (gritty)				
Silt	.004-.06-mm				
Clay	<.004-mm (slick)		Marl	Grey, Shell Fragments	

WATER QUALITY

Temperature _____C Dissolved Oxygen _____ pH _____ Conductivity _____ Other _____

Instrument (s) Used _____

Stream Type: Cold water Warm Water

Water Odors: Normal Sewage Petroleum Chemical None Other _____

Water Surface Oils: Slick Sheen Globs Flecks None

Turbidity: Clear Slightly Turbid Turbid Opaque. Water Color _____

WEATHER CONDITIONS

PHOTOGRAPH NUMBER

OBSERVATIONS AND/OR SKETCH

B-2 Habitat Assessment Field Sheet

Habitat Parameter	Category: Excellent	Good	Fair	Poor
1. Bottom substrate/ available cover	Greater than 50% rubble, gravel, submerged logs, undercut banks, or other stable habitat. 16-20	30-50% rubble, gravel or other stable habitat. Adequate habitat. 11-15	10-30% rubble, gravel or other stable habitat. Habitat availability less than desirable. 6-10	Less than 10% rubble gravel or other stable habitat. Lack of habitat is obvious. 0-5
2. Embeddedness	Gravel, cobble, and boulder particles are between 0% and 25% surrounded by fine sediment 16-20	Gravel, cobble, and boulder particles are between 25% and 50% surrounded by fine sediment 11-15	Gravel, cobble, and boulder particles are between 50% and 75% surrounded by fine sediment 6-10	Gravel, cobble, and boulder particles are over 75% surrounded by fine sediment 0-5
3. ≤.15 cms (5 cfs) → Flow, at rep. low flow	Cold >0.05 cms (2 cfs) Warm >0.15 cms (5 cfs) 10-20	0.03-0.05 cms (1-2 cfs) 0.05-0.15 cms (2-5 cfs) 11-15	0.01-0.03 cms (.5-1 cfs) 0.03-0.05 cms (1-2 cfs) 6-10	<0.01 cms (.5 cfs) <0.03 cms (1 cfs) 0-5
or >0.15 cms (5 cfs) → Velocity/depth	Slow (<0.3 m/s), deep (>0.5 m); slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present. 16-20	Only 3 of the 4 habitat categories present (missing riffles or runs receive lower score than missing pools). 11-15	Only 2 of the 4 habitat categories present (missing riffles/runs receive lower score). 6-10	Dominated by one velocity/depth category (usually pool). 0-5
4. Channel alteration	Little or no enlargement of islands or point bars, and/or no channelization. 12-15	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. 8-11	Moderate deposition of new gravel, coarse sand on old and new bars; pools partially filled w/silt; and/or embankments on both banks. 4-7	Heavy deposits of fine materials, increased bar development; most pools filled w/silt; and/or extensive channelization. 0-3
5. Bottom scouring and deposition	Less than 5% of the bottom affected by scouring and deposition. 12-15	5%-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools. 8-11	30%-60% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools. 4-7	More than 50% of the bottom changing nearly yearlong. Pools almost absent due to deposition. Only large rocks in riffle exposed. 0-3
6. Pool/riffle, run/bend ratio (distance between riffles divided by stream width)	5-7. Variety of habitat. Deep riffles and pools. 12-15	7-15. Adequate depth in pools and riffles. Bends provide habitat. 8-11	15-25. Occasional riffle or bend. Bottom contours provide some habitat. 4-7	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. 0-3

Habitat Assessment Field Sheet (Continued)

Habitat Parameter	Category			
	Excellent	Good	Fair	Poor
7. Bank stability	Stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problem. 9-10	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods. 6-8	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential during extreme high flow. 3-5	Unstable. Many eroded areas. Side slopes >60% common. "Raw" areas frequent along straight sections and bends. 0-2
8. Bank vegetative stability	Over 80% of the stream bank surfaces covered by vegetation or boulders and cobble. 9-10	50%-79% of the stream bank surfaces covered by vegetation, gravel, or larger material. 6-8	25%-49% of the stream bank surfaces covered by vegetation, gravel, or larger material. 3-5	Less than 25% of the stream bank surfaces covered by vegetation, gravel, or larger material. 0-2
9. Stream side cover	Dominant vegetation is shrub. 9-10	Dominant vegetation is of tree form. 6-8	Dominant vegetation is grass or forbes. 3-5	Over 50% of the stream bank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. 0-2
Column Totals	____	____	____	____
	Score _____			

B-3 Rapid Bioassessment Protocol III

Biosurvey Field Data Sheet

RELATIVE ABUNDANCE OF AQUATIC BIOTA

Periphyton	0	1	2	3	4	Slimes	0	1	2	3	4
Filamentous Algae	0	1	2	3	4	Macroinvertebrates	0	1	2	3	4
Macrophytes	0	1	2	3	4	Fish	0	1	2	3	4

0 = Absent/Not Observed 1 = Rare 2 = Common 3 = Abundant 4 = Dominant

MACROBENTHOS QUALITATIVE SAMPLE LIST (Indicate Relative Abundance R = Rare, C = Common, A = Abundant, D = Dominant)

Porifera	Anisoptera	Chironomidae
Hydrozoa	Zygoptera	Plecoptera
Platyhelminthes	Hemiptera	Ephemeroptera
Turbellaria	Coleoptera	Trichoptera
Hirudinea	Lepidoptera	Other
Oligochaeta	Sialidae	
Isopoda	Corydalidae	
Amphipoda	Tipulidae	
Decapoda	Empididae	
Gastropoda	Simuliidae	
Bivalvia	Tabanidae	
	Culicidae	

Rare < 3 Common 3-9 Abundant > 10 Dominant > 50 (Estimate)

CPOM SAMPLE FUNCTIONAL FEEDING GROUPS (Indicate No. of Individuals Representing Group)

Shredders	Total Org. in Sample

Observations

B-4 Fish Field Collection Data Sheet

Drainage _____ Date _____

Sampling Duration (min) _____

Sampling Distance (m) _____ Sampling Area (m^2) _____ Crew _____

Habitat Complexity/Quality (excellent good fair poor very poor)

Weather _____ Flow (flood bankfull moderate low)

Gear Used _____ Gear/Crew Performance _____

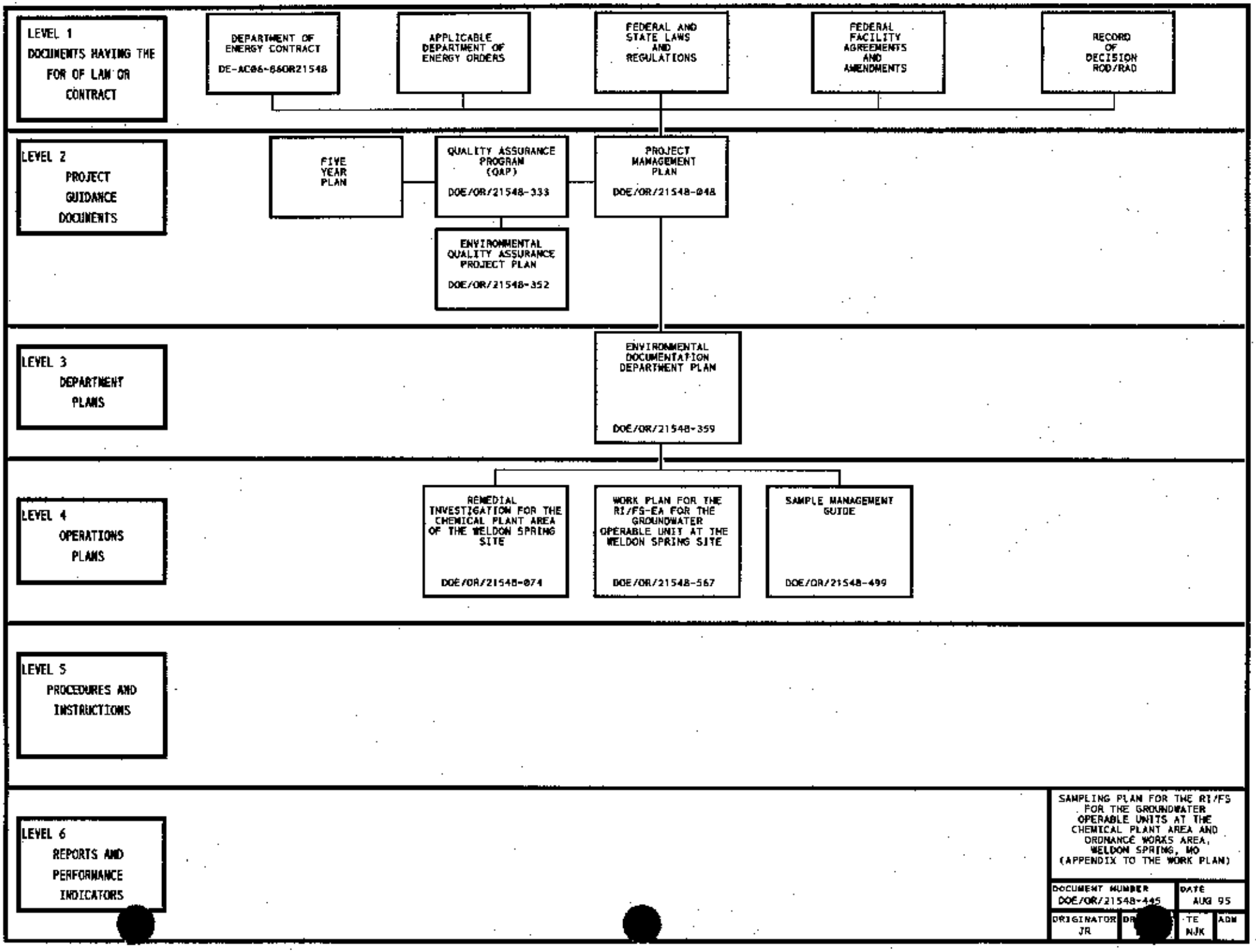
Comments _____

Fish (preserved) Number of Individuals _____ Number of Anomalies _____

Genus/Species	Adults No.	Adults Wt.	Juveniles No.	Juveniles Wt.	Anomalies(*) No.

(*) Discoloration, deformities, eroded fins, excessive mucus, excessive external parasites, fungus, poor condition, reddening, tumors, and ulcers

APPENDIX C
Document Hierarchy


LEVEL 1
DOCUMENTS HAVING THE FOR OF LAW OR CONTRACT
DEPARTMENT OF ENERGY CONTRACT
DE-AC06-86OR21548
APPLICABLE DEPARTMENT OF ENERGY ORDERS
FEDERAL AND STATE LAWS AND REGULATIONS
FEDERAL FACILITY AGREEMENTS AND AMENDMENTS
RECORD OF DECISION ROD/RAD
LEVEL 2
PROJECT GUIDANCE DOCUMENTS
FIVE YEAR PLAN
QUALITY ASSURANCE PROGRAM (QAP)
DOE/OR/21548-333
PROJECT MANAGEMENT PLAN
DOE/OR/21548-048
ENVIRONMENTAL QUALITY ASSURANCE PROJECT PLAN
DOE/OR/21548-352
LEVEL 3
DEPARTMENT PLANS
ENVIRONMENTAL DOCUMENTATION DEPARTMENT PLAN
DOE/OR/21548-359
LEVEL 4
OPERATIONS PLANS
REMEDIAL INVESTIGATION FOR THE CHEMICAL PLANT AREA OF THE WELDON SPRING SITE
DOE/OR/21548-074
WORK PLAN FOR THE RI/FS-EA FOR THE GROUNDWATER OPERABLE UNIT AT THE WELDON SPRING SITE
DOE/OR/21548-567
SAMPLE MANAGEMENT GUIDE
DOE/OR/21548-499
LEVEL 5
PROCEDURES AND INSTRUCTIONS
LEVEL 6
REPORTS AND PERFORMANCE INDICATORS
SAMPLING PLAN FOR THE RI/FS FOR THE GROUNDWATER OPERABLE UNITS AT THE CHEMICAL PLANT AREA AND ORDNANCE WORKS AREA, WELDON SPRING, MO (APPENDIX TO THE WORK PLAN)
DOCUMENT NUMBER
DOE/OR/21548-445
DATE
AUG 95
ORIGINATOR
JR
TE
NJK
ADM