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ENVIRONMENTAL MONITORING PLAN

Weldon Spring Site Remedial Action Project
Weldon Spring, Missouri

MARCH 1995 **REV. 2**

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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APPROVALS

K Meyer — 3/21/95

ES&H Manager — Date

Eric D. Conte — 03/24/95

Quality Assurance Manager — Date

[signature] — 3/25/95

Deputy Project Director — Date

James R. Powers — 3/27/95

Project Director — Date

m:\users\joanne\document\emp94\emp94.apr

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Weldon Spring Site Remedial Action Project

Environmental Monitoring Plan

Revision 2

March 1995

Prepared by

MK-FERGUSON COMPANY
and
JACOBS ENGINEERING GROUP
7295 Highway 94 South
St. Charles, Missouri 63304

for the

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ABSTRACT

The Weldon Spring Site Remedial Action Project monitoring program is designed to address pathways and constituents in a changing waste setting and to further characterize the waste units in order to model their behavior under specific conditions. Site specific criteria considered in planning pathway analyses included physical, chemical, and biological characteristics of the radionuclides and chemical contaminants detected, spatial distribution, concentrations, depth to groundwater, geology of the area, climatic conditions, how the area is used by the public and wildlife, and the proximity of contaminated sites to potential receptors.

Site features receiving surface water will be sampled, and contaminant levels will be measured. The migrating surface waters will be sampled along their courses to track their behavior until the concentrations are diluted or otherwise rendered indiscernible from background levels. Groundwater will be sampled at locations of known or potential impact to monitor the effects of remedial actions on groundwater quality and to monitor contaminant levels which may exceed water quality standards. Groundwater which surfaces at springs will also be sampled to provide a complete assessment of the groundwater system.

More intensive work-area monitoring will provide knowledge of real-time airborne emission levels. Specific locations around the site where there is concentrated human activity are considered "critical receptor" locations and will receive focused attention. Agricultural products are monitored as part of the characterization of foodstuffs and to established natural levels of radionuclides. Radionuclides in aquatic ecosystems are monitored to assess environmental conditions. This characterization, along with the determinations made during subsequent, routine biological and surface water sampling, will meet the environmental monitoring data needs of the project.

This plan is prepared to detail the environmental monitoring requirements for the project. This plan is to be reviewed annually and reissued at least every 3 years in accordance with Department of Energy Order 5400.1. Revision 2 of this document is the result of the reissuance of two NPDES permits for the project and the re-evaluation of groundwater and air monitoring programs based on activities at the site.

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1 INTRODUCTION

The Weldon Spring site is located near Weldon Spring, Missouri, 48 km (30 mi) west of St. Louis, Missouri. The site consists of an inactive uranium production facility including raffinate pits, a chemical plant, an abandoned limestone quarry, and associated vicinity properties. These areas contain chemically and radiologically contaminated materials originating from previous operations at the site.

Remediation of the Weldon Spring site is being conducted under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) and as part of the U.S. Department of Energy Environmental Restoration and Waste Management Program. The program is known as the Weldon Spring Site Remedial Action Project (WSSRAP). The major goals of the WSSRAP are to eliminate potential hazards to the public and the environment, and to the extent practicable, make surplus real property available for other uses. An environmental documentation approach has been developed that satisfies the requirements of both the CERCLA, as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and the *National Environmental Policy Act* (NEPA). The result of this process is the *Record of Decision* (Ref. 1) on ultimate disposal of the Weldon Spring site wastes which was issued in October 1993.

Department of Energy Order 5400.1, *General Environmental Protection Program*, requires the preparation of an Environmental Protection Program Implementation Plan at all Department of Energy sites. The Weldon Spring site *Environmental Protection Program Implementation Plan* (EPPIP) (Ref. 2) details the methods by which the WSSRAP will comply with this order. Because the WSSRAP is a remedial action project, the overall goal is different from that of the operating and/or production facilities for which Department of Energy Order 5400.1 was developed. Therefore, the WSSRAP EPPIP meets the intent of Department of Energy Order 5400.1 while being tailored to the unique aspects of a remedial action project. The WSSRAP has prepared this *Environmental Monitoring Plan* (EMP) to meet the requirements for Department of Energy environmental monitoring programs as specified in Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (Ref. 3), hereafter referred to as the *Regulatory Guide*.

This environmental monitoring plan is to be reviewed annually and reissued at least every three years in accordance with Department of Energy Order 5400.1. Annual reviews will be

documented and summaries of needed revisions will be transmitted to the Department of Energy along with expected dates of issuance. If during the monitoring year, significant deviations or alterations to this plan are necessary, approval by the Department of Energy will be obtained. Any deviations or alterations will also be summarized and documented in the annual site environmental report for the year of occurrence.

1.1 Purpose

Department of Energy Order 5400.1 requires the preparation of an environmental monitoring plan to define the effluent monitoring and environmental surveillance required to demonstrate compliance with applicable Federal, State, and local environmental protection laws and regulations, executive orders, and internal Department of Energy policies.

The purpose of this plan is to detail the environmental monitoring requirements at the Weldon Spring site. Environmental monitoring is performed at this site to document and quantify potential public exposure, to protect public health and safety and the environment, and to demonstrate compliance with applicable legal and regulatory requirements. The monitoring program also verifies adherence to Department of Energy environmental protection policies and supports remedial planning.

1.2 Scope

This plan describes the effluent monitoring and environmental surveillance activities that will be performed at the Weldon Spring site. These activities include monitoring of surface water, groundwater, radon, gamma exposure, air particulates, biological, and meteorological conditions. The plan also describes applicable monitoring requirements, analytical methods used, and quality assurance measures. Details and rationale regarding sampling frequencies and analytic parameters are provided. Also presented are summaries of additional programs implemented to satisfy the requirements of Department of Energy Order 5400.1, Order 5400.5, and the *Regulatory Guides* (Ref. 3). An evaluation of compliance or noncompliance with each regulatory guide criteria statement is included in Appendix A of this document. Where criteria statements are applicable to the WSSRAP, recognition of satisfying the criteria is included in the text and in Appendix A; where criteria statements are not applicable, justification for exclusion is only included in Appendix A.

1.3 Site History

In April 1941, the Department of the Army acquired 6,974 ha (17,232 acres) of land, and the Atlas Powder Company operated four of its 20 trinitrotoluene (TNT) and dinitrotoluene (DNT) explosives production lines there from November 1941 through January 1944 as part of the facility known as the Weldon Spring Ordnance Works. The remaining 16 production lines were distributed across an adjacent property which is now referred to as the U.S. Army Reserve and National Guard Training Area. By 1949, all but approximately 809 ha (2,000 acres) of this land had been transferred to the State of Missouri (August A. Busch Memorial Conservation Area and Weldon Spring Conservation Area) and the University of Missouri (agricultural land). Except for several small parcels transferred to St. Charles County, the remaining property became the Army training area.

Through a Memorandum of Understanding between the Secretary of the Army and the General Manager for the Atomic Energy Commission (AEC), 83 ha (205 acres) of the former ordnance works were transferred in May 1955 to the AEC for the construction of the Weldon Spring Uranium Feed Material Plant. Considerable explosives decontamination was performed by Atlas Powder and the Army prior to construction of the feed materials plant. Until 1966, the feed materials plant was operated as an integrated facility for the conversion of processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A small amount of thorium was also processed. Wastes generated during these operations were stored in four raffinate pits on the site.

In 1958 the AEC acquired title to the Weldon Spring Quarry from the Department of the Army. The quarry was located approximately 5.6 km (3.5 mi) south of the feed materials plant. The Army had used it earlier for disposal of wastes from the manufacture of TNT and DNT, and for disposal of TNT-contaminated rubble during operation of the ordnance works. Prior to 1942, the quarry was mined for limestone aggregate used in construction of the ordnance works. The AEC used the quarry from 1963 to 1969 as a disposal area for uranium residues and a small amount of thorium residues. But most of the material disposed of there consisted of uranium and radium contaminated building rubble and soils from the demolition of a uranium ore processing facility in St. Louis. Other radioactive materials in the quarry include drummed wastes, uncontained wastes, and contaminated process equipment.

The Weldon Spring Uranium Feed Material Plant was shut down in 1966, and in 1967 the AEC returned the facility to the Department of the Army for use as a defoliant production plant to be known as the Weldon Spring Chemical Plant. The Army started removing equipment and decontaminating several buildings in 1968, but the defoliant project was canceled in 1969 before any process equipment was installed. The Army retained responsibility for the land and facilities at the chemical plant, but the 20.6 ha (51-acre) tract encompassing the raffinate pits was transferred back to the AEC. From 1969 to 1984, the status of the Weldon Spring site did not change. The site was placed in caretaker status from 1984 through 1985, when custody of the chemical plant and quarry were transferred from the Department of the Army to the Department of Energy. In 1985, the Department of Energy proposed designating control and decontamination of the chemical plant, raffinate pits, and quarry as a major project.

A Project Management Contractor for the WSSRAP was selected in February 1986. In July 1986, a Department of Energy project office was established on site, and the contractor, MK-Ferguson and Jacobs Engineering Group, Inc., assumed control of the site on October 1, 1986. The quarry was placed on the Environmental Protection Agency Nation Priorities List (NPL) in July 1987. The Department of Energy redesignated the site as a Major Acquisition System in May 1988. The chemical plant and raffinate pits were added to the NPL in March 1989.

Under the CERCLA process, a focused *Remedial Investigation/Feasibility Study (RI/FS)-Environmental Assessment* was used to document the proposed management of the wastes in the quarry. Compared to the full-scope of the RI/FS, the focused RI/FS was appropriate for the bulk wastes since removal will decrease the threat of release of contaminants and is consistent with a permanent remedy for the entire site (Ref. 4). The NEPA/CERCLA environmental documentation process for the quarry bulk wastes is complete and remedial activities began in 1991. The first load of waste was removed from the quarry in the summer of 1993.

Remedial investigations were conducted at the chemical plant/raffinate pits area in 1988 and 1989 under the CERCLA RI/FS process. These investigations included characterization of the groundwater, on-site soil contamination, contaminated sediments in off-site surface drainages, lakes, surface water, and springs, and chemical and radiological contaminants in the raffinate wastes. The results of each of these investigations have been published in the *Remedial Investigation Report for the Chemical Plant Area of the Weldon Spring Site* (Ref. 5). The

Record of Decision (Ref. 1) will mark the selection of the final remediation and disposal method for the chemical plant and bulk wastes for the quarry. The *Record of Decision* was issued in September 1993.

Several small interim response actions have been conducted at the WSSRAP. Interim response actions are activities that will not change the ultimate disposal method but have been conducted to mitigate or eliminate conditions that pose immediate or potential threats to worker safety, public health, or the environment (Ref. 6). These actions have included removal of exposed friable asbestos, overhead piping, polychlorinated biphenyl (PCB) electrical equipment, power poles and wires, demolition of nonprocess buildings, isolation and capping of Ash Pond, capping of some other highly contaminated areas, and consolidation of containerized chemicals.

2 OBJECTIVES AND RATIONALE

The goal of the Weldon Spring Site Remedial Action Project (WSSRAP) is to protect and enhance the environment while protecting the public during remedial activities. The action consists of safely disposing of hazardous and radiological wastes that resulted from the operation of the Weldon Spring Uranium Feed Materials Plant and the Weldon Spring Ordnance Works. Within the overall project mission, the environmental protection program focuses on the operational activities of the project.

The WSSRAP objectives for the environmental protection program are as follows:

- To assess compliance with applicable environmental quality standards and public exposure limits.
- To measure background levels and site specific compound levels.
- To measure the effectiveness of effluent treatment and controls.
- To assess the validity and effectiveness of exposure models.
- To measure the long term buildup and assess environmental trends from site-released contaminants.
- To detect and quantify unplanned releases.

This *Environmental Monitoring Plan* describes the rationale and design criteria for the monitoring program; designates the extent and frequency of monitoring and measurements; outlines procedures for laboratory analyses, quality assurance requirements, and program implementation procedures; and preparation and disposition of related reports.

In case of deviations from this plan, either intentionally or because of circumstances outside the control of the Project Management Contractor, concurrence will be obtained from the U.S. Department of Energy. Examples include reductions of sampling frequency,

elimination of sampling locations, elimination of analyzed parameters, or use of less stringent analytical methods.

The WSSRAP environmental protection program is separated into two distinct functions: (1) effluent monitoring, and (2) environmental surveillance. Effluent monitoring assesses the quantities of substances in migration pathways from the site at its perimeter, or in pathways subject to compliance with applicable regulations (e.g., National Emissions Standards for Hazardous Air Pollutants [NESHAPs]) or permit levels and requirements (e.g., the National Pollution Discharge Elimination System [NPDES]). The environmental surveillance program generally reviews environmental media within or outside the site boundary for the presence and concentration of site contaminants to detect and/or track the migration of those contaminants. Surveillance data are used to assess the presence and magnitude of any radiological or toxicological exposures to members of the public, or to assess the effects, if any, on the local environment.

The Weldon Spring site has maintained a relatively stable configuration of its waste materials since cessation of plant operation and decontamination of some process buildings in the early 1970s. It is believed that this stability has allowed the site to achieve a rough equilibrium regarding the migration of contaminants from the site. Since the chemical plant and quarry are presently under active remediation, the nature of the waste units and their physical positions and chemical states are subject to disturbance. The monitoring program has been designed to address pathways and constituents in a changing waste setting and to further characterize the waste units in order to model their behavior under specific conditions.

The Department of Energy has defined generic performance criteria which their operations offices must use in developing their programs. The WSSRAP environmental protection program has incorporated these criteria into its monitoring program. The objective of the WSSRAP environmental monitoring program is to generate data needed to achieve regulatory compliance and assess the impact of contaminants on the public and environment. Therefore, a program must be developed to assess viable environmental pathways. The program in this plan defines a scheme of minimum data points to be collected in order to evaluate whether environmental conditions are changing, and whether site-related contaminants or activities are impacting public health or the environment. Where additional data points or density is required to verify trends or more closely evaluate environmental conditions, additional

samples may be collected that are not defined in the plan. Those samples will be collected to serve the objectives of the environmental monitoring program at the Weldon Spring site and will be consistent with the guidelines of the DOE 5400 Orders. The following section describes the pathway analysis performed by the WSSRAP to arrive at the monitoring program.

2.1 Pathway Analysis

To evaluate the potential impact on human or ecological receptors of activities at the Weldon Spring site, it is necessary to conduct a pathway analysis. Exposure pathways are identified considering the source, mechanisms of release, type and location of contaminants at the site, and the probable environmental fate (persistence, partitioning, transport, and intermedia transfer) of these contaminants and the location and activities of potentially exposed receptors. Table 2-1 identifies the matrix of factors considered in the exposure pathway screening process. The primary objective of the pathway analysis is to identify complete pathways and give reasonable assumptions about future conditions. An exposure pathway is considered complete if a link can be shown between one or more contaminant sources, through one or more environmental transport processes, to an exposure point where human or ecological receptors are present. Identification of potentially complete pathways is a qualitative judgement. Procedures used are intended to be conservative. Identification of a complete pathway does not necessarily indicate that adverse effects will occur; it indicates that the effort to monitor releases is worthwhile from the standpoint of protecting human health and the environment.

2.2 Monitoring Program Rationale

The critical pathway analyses (radionuclide and media) conducted for the WSSRAP included both the Weldon Spring Quarry and the Weldon Spring Chemical Plant and raffinate pits, and are presented in Table 2-2. These analyses were based on data developed during various characterization and monitoring studies, and from site specific criteria, site specific assumptions, and the matrix of potential exposure routes.

Site specific criteria considered in pathway analyses included physical, chemical, and biological characteristics of the radionuclides and chemical contaminants detected, spatial distribution, concentration, depth to groundwater, geology of the area, climatic conditions, how

TABLE 2-1 Potential Exposure Route Matrix

Component of Exposure Assessment	Factors to be Considered
Affected Environmental Media	Air Groundwater Surface Water Sediment Surface Soil Subsurface Soil Aquatic Biota Terrestrial Biota
Contaminant Transport Pathway	Airborne transport Groundwater migration Surface water runoff Sediment transport Infiltration Percolation Surface soil erosion Transport of aquatic biota Terrestrial biota migration
Mechanism of Release to Affected Medium	Air - Volatilization, fugitive dust emissions, gas emissions. Groundwater - Percolation, migration, losing streams. Surface water - Surface runoff, groundwater discharge, partitioning with sediment. Sediment - Sediment transport in surface runoff, fugitive dust, partitioning with surface water. Surface soil - Fugitive dust transport/deposition, surface runoff, surface disturbance. Subsurface soil - Leaching, partitioning with groundwater. Aquatic biota - Direct contact, ingestion. Terrestrial biota - Direct contact, ingestion.
Current and future receptors	Human - On-site workers, off-site workers, off-site residential, recreational. Ecological - On-site aquatic, off-site aquatic, on-site terrestrial, off-site terrestrial. Environmental - Physicochemical conditions of environmental media.
Routes of exposure by medium	Air - Inhalation, immersion Groundwater - Ingestion, dermal contact Surface water - Ingestion, dermal contact Sediment - Ingestion, dermal contact Surface Soil - Ingestion, dermal contact Subsurface soil - Ingestion, dermal contact Biota - Ingestion, dermal contact Cross Media Transfers

TABLE 2-2 Exposure Scenarios Selected for Monitoring

Receptor	Exposure Scenario	Pathway Selected for Monitoring	Rationale
Off-site Residents	Ingestion of small game animals in contact with contaminant source areas.	No	Ingestion of small game animals by residents is assumed as low due to large buffer zone of wildlife area.
	Ingestion of groundwater from well downgradient from site sources.	Yes	Potential use of groundwater as a source for drinking water by residents.
	Inhalation of particulates dispersed through wind erosion and remedial actions.	Yes	Potential inhalation of airborne particulates by nearby residents.
	Dermal contact with airborne and deposited particulates	No	Dermal contact with radiologically impacted particulates is not considered a substantial exposure mechanism.
	Ingestion of surface water and/or sediment.	Yes	Potential for ingestion due to recreational activity in off-site impacted waters.
Wildlife Area Visitors	Inhalation of particulates dispersed through wind erosion and remedial action.	Yes	Potential inhalation of airborne particulates by wildlife area visitors.
	Ingestion of game and fish inhabiting wildlife area.	Yes	Potential ingestion of game and fish inhabiting wildlife area collected during hunting season.
	Ingestion of surface water and contact with sediments while swimming or wading.	Yes	Potential exposure through ingestion of, or contact with, surface water in wildlife areas.
	Dermal contact with airborne and deposited particulates.	No	Dermal contact with radiologically impacted particulates is not considered a substantial exposure mechanism.
Terrestrial Biota (on site)	Ingestion of surface water, sediments, or vegetation, or inhalation of air particulates.	No	Previous studies have indicated no substantial uptake or risk.
Terrestrial Biota (off site)	Ingestion of surface water, sediments, or vegetation, or inhalation of air particulates.	No	Previous studies have indicated no substantial uptake or risk.
Aquatic Biota (on site)	Uptake of surface water and contact with sediments.	No	Previous studies have indicated no substantial uptake or risk.
	Ingestion of invertebrates and vegetation.	No	Previous studies have indicated no substantial uptake or risk.

TABLE 2-2 Exposure Scenarios Selected for Monitoring (Continued)

Receptor	Exposure Scenario	Pathway Selected for Monitoring	Rationale
Aquatic Biota (off site)	Uptake of surface water and contact with sediments.	Yes	Potential human consumption of game fish in contact with surface water and sediments.
	Ingestion of invertebrates and vegetation.	Yes	Potential human consumption of game fish which ingest invertebrates and vegetation.

the area is used by the public and wildlife, and the proximity of contaminated sites to potential receptors.

Site specific assumptions were as follows:

- Off-site residents have limited access to the contaminant source areas.
- Access of off-site large game animals to contaminant source areas is limited by perimeter fencing.
- Prolonged or year round use of on-site water bodies by waterfowl is limited.
- Frequency and duration of wildlife area visits per individual is low (Ref. 7).
- Consumption of game animals and fish per individual averaged over a year is low.

The monitoring programs described in the following subsections were designed with specific knowledge of the active pathways and the pathway analyses performed. Each media-specific monitoring and analysis program follows a general rationale.

2.2.1 Surface Water

Surface water is influenced by three general mechanisms. It is impacted by:

- Water that flows from the site and carries with it site-source contaminants. Small quantities of water migrate from the site on a regular basis due to human influenced activities such as discharge of treated effluent from the administration building.

- Contaminants resuspended from sediments on site and in stream channels.

- Discharge of contaminated groundwater to surface water receptors from springs in the area.

Site features receiving surface water are sampled and contaminant levels are measured. The migrating surface waters are subsequently sampled along their courses to track their behavior until the concentrations are diluted or otherwise rendered indiscernible from background levels.

2.2.2 Groundwater

The hydrology and hydrogeology of the Weldon Spring site have been extensively studied, and separate regimes have been identified for the chemical plant and raffinate pits and the quarry based on spatial separation and differing geology. The present conceptual model of the hydrogeologic regime at the chemical plant and raffinate pits incorporates the activity of diffuse flow through the fractured limestone and the influence of discrete groundwater movement through solution enlarged fractures and conduits. Monitoring wells are used to monitor the influence of site contaminants on the groundwater. Converging conduits transport diffuse flow to discrete flow, and then to the springs previously mentioned. Appropriate monitoring of the resurging water at those springs monitors the secondary mechanism of groundwater movement from the site.

The present conceptual model of the hydrogeologic regime for the Weldon Spring Quarry incorporates the fractured flow described above and flow through the porous media of the Missouri River alluvium. Monitoring wells are used to monitor the influence of the site contaminants on the bedrock adjacent to the quarry and alluvial groundwater.

2.2.3 Air and Atmospheric Migration

Air pathway and atmospheric migration of contaminants and radiation constitute a broad set of exposure pathways. Characterization studies indicate that the only significant sources of airborne contamination from site-related wastes lie within the boundaries of the chemical plant and raffinate pits and quarry. As remedial activities begin to disturb source areas, the potential for increased airborne emissions will increase. More intensive site-specific and work area monitoring will provide knowledge of real-time airborne emission levels.

Airborne particulates, radionuclides, and atmospheric radiation released from both the chemical plant and quarry source areas must pass the facility boundaries before migrating to uncontrolled or public access areas. Site perimeter monitoring will be utilized to detect and monitor the migration of radioactivity detectable at the facility boundaries. Finally, specific locations around the site where there is concentrated human activity are considered "critical receptor" locations and will receive focussed attention.

2.2.4 Soil and Sediment

Soils and sediments on and around the Weldon Spring site have been, and in some locations continue to be, receiving contaminants from the site. The soil is generally in a stable condition and, although it might act as a long term source for groundwater and surface water contamination, soil in itself does not pose a dynamic contaminant front that would require routine monitoring. Soils and associated contamination that are disturbed during remedial activities may be mobilized by surface water runoff or be dispersed in the air and migrate from the site. Therefore, the surface water monitoring program will monitor levels of suspended and settleable solids to assess the quantities of materials leaving the site. The air monitoring program, combined with air modeling when appropriate, will assess potential impacts to off-site receptors.

For the purposes of this plan, sediments are those solid materials that are mobilized by surface water flow and which accumulate to some discernable depth in and along the stream channels and lake basins. Sediments have been characterized during remedial investigations of the Weldon Spring site and Weldon Spring Quarry. That characterization, along with the

determinations made during subsequent, routine biological and surface water sampling, will meet the environmental monitoring data needs of the project.

2.2.5 Biological Media

Biological factors, such as the animal and plant vectors in a biouptake chain, will be sampled to assemble and provide surveillance of the environmental and potential human pathways. Biouptake sampling of fish at surrounding wildlife areas has been conducted since 1987. Game animals are sampled when specimens become available, but dose estimates are calculated on the basis of concentrations in surface water and soil. Agricultural products are monitored as part of the characterization of foodstuffs and to established natural levels of radionuclides. Radionuclides in aquatic ecosystems are monitored to assess environmental conditions by using benthic invertebrates as indicators of water quality.

3 ENVIRONMENTAL SURVEILLANCE

The environmental surveillance program for the Weldon Spring Site Remedial Action Project (WSSRAP) is based on pathway analysis for possible exposure routes and receptors in accordance with Department of Energy Order 5400.1 and 5400.5 and the *Regulatory Guide* (Ref. 3). Exposure routes requiring surveillance are air, surface water, groundwater, and biological media. Radiological concentrations obtained for samples of these media are used to estimate public dose and to provide compliance data for applicable environmental regulations.

The environmental surveillance program for each medium is based on the applicable regulations, the hazard potential of the contaminants, the amount and concentration of the contaminants, and the impacts to the environment. Sampling locations, frequency, and analyses required to determine the ambient environmental levels for each medium are summarized in the following sections.

3.1 Surface Water Surveillance Program

Surface water samples will be collected from locations that are known to be, or potentially could be impacted by the Weldon Spring Chemical Plant and raffinate pits or the Weldon Spring Quarry. Because of the differing topography and hydrologic conditions at the chemical plant and the quarry, surface water sampling programs for each of these areas are described separately. In previous *Environmental Monitoring Plans*, the monitoring of springs was included as part of the surface water monitoring program. As of 1992, the WSSRAP has incorporated spring monitoring under the groundwater monitoring program, consistent with the draft U.S. Environmental Protection Agency guidance for groundwater monitoring in karst terrains. The data on contaminants in spring water will be more directly correlated to levels in the groundwater near the site as measured using conventional groundwater monitoring techniques.

3.1.1 Surface Water Evaluation

A surveillance program, which includes monitoring potentially impacted surface water, has been established to determine the distribution of radiochemical and chemical contaminants that have migrated from the Weldon Spring site. The extent of the surface water environmental

surveillance program is based upon applicable regulations, hazard potential, concentration of effluents, public interest, and the nature of potential or actual impacts on surface water. The environmental surveillance program for surface water will be conducted in accordance with the requirements of Department of Energy Orders 5400.1, 5400.5, and the *Regulatory Guide* (Ref. 3).

3.1.2 Surface Water Monitoring Program at the Weldon Spring Chemical Plant and Raffinate Pits

Surface water draining from the chemical plant area transports both dissolved and suspended contaminants from waste materials distributed about the site. Seven monitoring locations have been chosen to provide data necessary to monitor the impact of contaminants delivered to downgradient streams and water features. The locations of the monitoring points and the purpose for monitoring are described in the following sections. The U.S. Department of Energy, in cooperation with the Missouri Department of Natural Resources - Division of Geology and Land Survey and the United States Geological Survey, has established a detailed profile of the complex hydrogeologic system that influences the flow of surface water from the site.

3.1.2.1 Rationale. The chemical plant area is located on the Missouri-Mississippi River surface water drainage divide. The topography is gently undulating and generally slopes northward to the Mississippi River. Streams do not cross the properties, but incipient drainageways convey surface water runoff to off-site streams. Most surface drainage from the chemical plant area discharges to an intermittent stream in the Army Reserve Training Area to the west via Ash Pond or other smaller streams body, as shown in Figure 3-1. Discharges from these locations combine near St. Charles County Road D and flow northward into Schote Creek, which in turn enters Dardenne Creek, which finally discharges into the Mississippi River. An additional surface drainage system ultimately reaching the Mississippi River drains the northeastern site area through Frog Pond. A storm water sewer system that drains land surfaces from the northern portion of the buildings area, also discharges into the Frog Pond. The Frog Pond drainage enters Lake 36 in the August A. Busch Conservation Area. Lake 36 in turn discharges into Lake 35 which ultimately discharges into Schote Creek.

Storm water runoff from the southern portion of the chemical plant flows southeast to the Missouri River by way of the Southeast Drainage. In the past, infiltration and inflow of storm water into the abandoned process and sanitary sewers drained to the Southeast Drainage. These sewers now terminate at pump stations and the water is pumped to the site water treatment plant. The sewer lines downstream of the lift stations have either been removed or plugged.

3.1.2.2 Monitoring Locations. All features monitored by the surface water surveillance program are situated on the north (Mississippi River) side of the drainage divide. Waters requiring contaminant monitoring to the south of this divide are monitored by the effluent monitoring or the quarry groundwater monitoring programs. The routine monitoring locations are numbered from SW-2001 through SW-2005, SW-2007, SW-2012, and SW-2016. Locations SW-2008 and SW-2009 (Burgermeister Spring and Overflow Spring) were transferred to the groundwater surveillance program in 1991 and have been given different location identifiers. Location SW-2015, the Materials Staging Area basin, was added in 1992, but was transferred to the NPDES program in 1994. Frog Pond (SW-2011) and Ash Pond (SW-2010) were deleted in 1994, because the discharges from these ponds exit the chemical plant through NPDES permitted outfalls and are monitored under that program. The four raffinate pits (SW-3001 through SW-3004) were deleted in 1994 because these waters are being treated in the site water treatment plant and, therefore, are monitored under treatment plant operations sampling.

Sampling locations SW-2001, at the confluence of Schote and Dardenne creeks, and SW-2016, downstream of SW-2001 at the intersection of Dardenne Creek and County Highway N, monitor any contribution of site derived contaminants to Schote and Dardenne creeks. Locations SW-2002 through SW-2005 and SW-2012 monitor the three lakes in the August A. Busch Memorial Conservation Area that lie within the basin that receives runoff from the chemical plant site.

3.1.2.3 Monitoring Schedule. All surface water locations retained in the monitoring program will be monitored according to the schedule in Table 3-1. Samples will be collected for total uranium on a semiannual basis to monitor potential changes in the conditions. Other site-derived contaminants have remained below water quality standards at these locations and were removed from the monitoring schedule.

TABLE 3-1 Weldon Spring Chemical Plant Surface Water Monitoring Program

Location	Total Uranium
SW-2001	S
SW-2002	S
SW-2003	S
SW-2004	S
SW-2005	S
SW-2012	S
SW-2016	S

S = Semiannually

3.1.3 Surface Water Monitoring Program for the Weldon Spring Quarry

Nine surface water monitoring locations near the quarry have been chosen for routine monitoring to investigate and document whether surface waters near the quarry might pose a risk to human health or the environment due to influence of the wastes in the quarry and contaminated groundwater migrating into surface waters near the quarry.

3.1.3.1 Rationale. The quarry is located on the northern bluff of the Missouri River valley. Surface water within the quarry collects in the quarry pond, which acts as a sump and intercepts groundwater. There is no direct surface water runoff from the quarry; however, movement of contaminated groundwater from the fractured bedrock of the quarry through the fine-grained alluvium to the Femme Osage Slough has resulted in elevated uranium levels in the slough water. The slough is directly impacted by contaminated groundwater migrating from the quarry; therefore, it is routinely monitored. Also, samples from the Femme Osage Creek and Little Femme Osage Creek are collected routinely to provide baseline data for those locations to monitor for impact.

3.1.3.2 Monitoring Locations. Monitoring locations SW-1001, SW-1002, and SW-1014 (see Figure 3-2) monitor Little Femme Osage Creek at points upstream and down

stream of the quarry. Six sampling locations, SW-1003 through SW-1005, SW-1007, SW-1009, and SW-1010, are distributed along the Femme Osage Slough west of, adjacent to, and east of the quarry. These locations within the slough were chosen to provide representative data for areas that are potentially impacted by the quarry contamination. The quarry pond, SW-1008, was deleted in 1994 because this location is monitored under the quarry water treatment plant operations. The Missouri River was monitored under the surface water program, to obtain baseline water quality data for water treatment plant operation activities. In 1994, locations SW-1011, SW-1015 and SW-1016 were deleted from the National Pollution Discharge Elimination System monitoring program.

3.1.3.3 Monitoring Schedule. Surface water bodies near the Weldon Spring Quarry which have been established as background, or are potentially affected by the quarry, include the Femme Osage Slough, Femme Osage Creek, and Little Femme Osage Creek. These water bodies will be sampled as shown in Table 3-2.

All locations will be monitored bimonthly or quarterly for total uranium due to the fluxuations in concentrations as a result of changing slough levels and groundwater static water levels, and the potential impact of surface water contaminants on groundwater south of the slough. This will allow trends to be identified in addition to maintaining a surveillance of uranium in surface water bodies near the quarry. Locations SW-1003 through SW-1005 will be monitored quarterly for nitroaromatic compounds because they are downgradient from the area of greatest nitroaromatic groundwater contamination. The remainder of the locations were deleted in 1994 because sufficient historic data is now available and there is no potential impact from source areas.

TABLE 3-2 Weldon Spring Quarry Surface Water Monitoring Analytical Program

Location	Parameters	
	Total Uranium	Nitroaromatic Compounds
SW-1001	Q	NS
SW-1002	Q	NS
SW-1003	B	Q
SW-1004	B	Q
SW-1005	B	Q
SW-1007	Q	NS
SW-1009	Q	NS
SW-1010	Q	NS
SW-1014	Q	NS

B Bimonthly
Q Quarterly
NS Not Sampled

3.2 Groundwater Surveillance Program

Groundwater samples will be collected from locations known to be impacted, or potentially impacted, in the chemical plant area and the quarry area. Due to the differing hydrology and hydrogeology of the two areas, these groundwater monitoring programs are discussed separately.

Groundwater beneath several waste storage facilities at both the chemical plant and quarry is monitored to comply with the intent of 40 CFR 246, Subpart F and 10 CSR 25.7, Subpart F. A separate monitoring program has been established for these facilities and is outlined in Section 3.2.5.

3.2.1 Groundwater Evaluation

Groundwater within and around the chemical plant and quarry has been radiologically and chemically characterized through sampling and analyses. A surveillance program that includes monitoring potentially impacted groundwater has been established to monitor

radiological and chemical conditions. The extent of the groundwater environmental surveillance program has been determined based upon applicable regulations, hazard potential of effluents, quantities and concentrations of effluents, public interest, and the potential or actual impacts on groundwater. The environmental surveillance program for groundwater will be conducted in accordance with the requirements of the Department of Energy Orders 5400.1, 5400.5, and the *Regulatory Guide* (Ref. 3).

3.2.1.1 Groundwater Characterization. Potential exposure pathways were determined based on the sampling of groundwater within, and near, the chemical plant and the quarry. Chemical and radiological characterization of the groundwater was provided through the implementation of work plans, sampling plans, and other characterization plans. These plans were approved by the Department of Energy and the U.S. Environmental Protection Agency, and included environmental monitoring, sampling locations, procedures, equipment, frequency and analysis required, minimum detection limits, and levels of quality assurance/quality control. Evaluation of the characterization data and potential exposure pathways provided the basis for the groundwater environmental surveillance program described in this monitoring plan.

In addition to the chemical/radiochemical characterization, changes in the static groundwater level are monitored either manually or with dedicated transducers. Manual readings are taken during sampling events and monthly during the well inspections. Dedicated transducers are installed in certain wells to document the static water level fluctuations on a daily basis. This documentation will be used in more focused investigations as outlined in Section 3.2.2.3.

3.2.1.2 Parameter Categories. The following radiological and chemical parameter categories will be monitored in groundwater at either the quarry or the chemical plant since similar contaminant constituents are present at both areas:

- Total Uranium (U): Uranium is a contaminant of concern at both the quarry and the chemical plant due to both the purification process of uranium and raffinate storage at the chemical plant and the disposal of uranium contaminated materials and process wastes at the quarry. Uranium is monitored to assess the potential for exposure to the public and the environment and to assess migration in the groundwater system and contamination levels in the aquifer.

- Radiochemical Parameters (R): The radiological parameters consisting of gross alpha, Th-230, Th-232, Ra-226, and Ra-228 are monitored at both the quarry and the chemical plant due to their presence in uranium residues at each site. These parameters are monitored to assess the potential for exposure to the public and the environment and to assess migration in the groundwater system and contamination levels in the aquifer.

- Nitroaromatic Compounds (N): Nitroaromatic compounds are contaminants of concern at both the quarry and the chemical plant due to the previous production of trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Weldon Spring Ordnance Works and the disposal of TNT/DNT contaminated materials at the quarry. Groundwater at both sites will be monitored for 1,3,5-TNB; 1,3-DNB; 2,4,6-TNT; 2,4-DNT; and 2,6-DNT. Groundwater will also be qualitatively evaluated for degradation products of the nitroaromatic compounds at both the chemical plant and the quarry.

- Sulfate-Nitrate-Alkalinity (I): Both nitrate and sulfate are contaminants of concern due to their presence as residual products during the uranium purification process at the chemical plant and in the production of nitroaromatics at the ordnance works. Both nitrate and sulfate levels are elevated in the raffinate pits and at some groundwater locations at the chemical plant. Elevated sulfate levels were observed in monitoring wells adjacent to the quarry and in the alluvium north of the Femme Osage Slough. Monitoring of nitrate at the quarry was discontinued in 1993 because there was no evidence of notable groundwater contamination. Nitrate and sulfate provide potentially important constraints on the areal extent of contaminated plumes because these parameters generally behave as conserved elements in the groundwater system (i.e., they are not strongly impacted by sorption, precipitation, or degradation reactions). Alkalinity is monitored to verify general groundwater quality and to determine whether conditions exist to sustain the elevated levels of contaminants.

- Geochemical Characterization (G): This group of parameters includes an extensive list of anions, cations, and metals that are not routinely monitored by the WSSDAP. These analyses are conducted as part of the pre-operational characterization of groundwater at both sites. Characterization data are required to evaluate groundwater

quality and contaminant migration. These parameters are to be monitored for a limited period of time at both the chemical plant and quarry.

3.2.1.3 Groundwater Estimated Release Quantities and Public Doses. It is the objective of the groundwater monitoring program at both the chemical plant and the quarry to collect sufficient data to estimate the approximate quantity of radionuclides released along a given migration route. This information will be used to calculate the public dose to hypothetical groundwater users. At present, no wells within a 1.6 km (1 mi) radius of the chemical plant site are actively pumped as water supplies. Wells outside that area have been sampled in the past and have shown no evidence of radionuclide contamination from the WSSRAP. Those private wells will continue to be routinely sampled and analyzed as part of an independent program by the Missouri Department of Health. The results are also made available for review by the WSSRAP staff.

Presently, eight drinking water production wells are located within a 1.6 km (1 mi) radius of the quarry. The data collected from the quarry area and the St. Charles County well field will allow an assessment to be made on whether the quarry wastes present an increased incremental risk to users of that water. No measurable increases in uranium or chemical contaminant levels above background have been seen at the well field to date.

3.2.2 Groundwater Monitoring Program for the Weldon Spring Quarry

3.2.2.1 Geology and Hydrogeology. The geology of the quarry area is generally separated into upland overburden, Missouri River alluvium, and bedrock. The Missouri River alluvium and bedrock units produce groundwater, and it is within these units that the groundwater is monitored. General descriptions of each unit follow.

The unconsolidated upland material overlying bedrock consists of up to 9.2 m (30 ft) of silty clay soil and loess deposits. A residual soil is present in some areas between the silty clay and the bedrock; however, the upland soils near the quarry are generally not saturated and are not monitored.

The sediments comprising the alluvium along the Missouri River vary from clays, silts, and sands, to gravels, cobbles, and boulders. The maximum alluvium thickness near the quarry

is approximately 31 m (100 ft). The alluvium is truncated at the erosional contact with Paleozoic bedrock bluffs. The alluvium thickness increases dramatically with distance from the bluffs. Silts and clays with minor amounts of sand are the primary sediments between the bluffs and the Femme Osage Slough. The thick, water-producing sands and gravels of the alluvial aquifer give way to fine-grained organically rich overbank deposits beneath the Femme Osage Slough. The potentiometric surface of the alluvial aquifer fluctuates in response to pumping of the St. Charles County production wells and the stage of the Missouri River, which indicates that the Missouri River is the primary recharge source for the alluvial aquifer.

Bedrock at the Weldon Spring Quarry consists of three distinct Ordovician formations: the Kimmswick Limestone, the limestone and shale of the Decorah Group, and the Plattin Limestone in descending order. The Kimmswick Limestone is a coarsely crystalline limestone with numerous near vertical solution-enlarged joints. The Decorah Group consists of interbedded limestone and green shale; it is approximately 9.2 m (30 ft) thick, and is horizontally fractured. The Plattin Limestone is a thinly bedded limestone about 31 m to 38 m (100 ft to 125 ft) thick.

3.2.2.2 Rationale. Chemical and radiological wastes in the quarry are of particular concern because of their proximity to the St. Charles County well field located approximately 0.8 km (0.5 mi) to the south. Well field protection is a sensitive issue for the public, the Department of Energy, and other regulatory agencies. The Department of Energy has issued a number of orders providing direction on the assessment of exposure to the public, including directions for protection from radiation and chemicals where applicable. The groundwater monitoring program at the quarry and well field has been designed to provide the necessary data to accomplish the following objectives:

- Protect public health and the environment. This objective includes assessing whether present contaminant levels exceed State or Federal water quality standards, Department of Energy derived concentration guidelines, or background levels at the quarry and the St. Charles County well field, and monitoring concentration levels of contaminants which exceed these criteria.

- Provide information on the effects of quarry dewatering and bulk waste removal

- Perform spatial and temporal trend analyses.

- Develop additional baseline geochemical information for assessment of the interaction of the groundwater with contaminants and the surrounding environment. This characterization will facilitate assessment of contaminant transport, possible oxidation/reduction of contaminants across the Femme Osage Slough, and possible changes in the oxidation or reduction state of the groundwater due to remediation activities in the quarry.

3.2.2.3 Monitoring Locations. Currently, 35 wells, including eight municipal production wells, four county-owned monitoring wells, and 23 Department of Energy monitoring wells are screened within the alluvial material located between the quarry and the Missouri River (see Figures 3-3 and 3-4). Five of the wells, MW-1035 through MW-1037, MW-1040, and MW-1041, are located west of the quarry to monitor the immediate area around the quarry water treatment plant equalization basin. As of 1994, these wells will be monitored under a separate program discussed in Section 3.2.4. Six wells, MW-1006 through MW-1009, MW-1014, and MW-1016, are located between the quarry and the slough to monitor contaminant migration south of the quarry within the alluvium. Monitoring wells MW-1010, MW-1011, and MW-1017 through MW-1024 are located south of the slough within the alluvium and are monitored to enable detection of contaminants south of the slough. St. Charles County monitoring wells RMW-1 through RMW-4 are monitored to provide an early warning of contaminant migration toward the county production wellfield, if this should occur. The eight county municipal wells, PW-2 through PW-9, are also monitored to guard against quarry contaminants affecting the quality of the municipal well field water supply.

Currently, 15 Department of Energy monitoring wells are screened within either the Kimmswick-Decorah or Plattin Formations to monitor contaminants near the quarry within the bedrock. Monitoring wells MW-1002, MW-1004, MW-1005, MW-1012, MW-1013, MW-1015, MW-1026, MW-1027, MW-1029, MW-1030, MW-1032, and MW-1034 were installed to monitor contaminants within the Kimmswick-Decorah Formations surrounding the quarry. Monitoring wells MW-1028, MW-1031, and MW-1033 are located south of the quarry, within the Plattin Limestone to determine if vertical contaminant migration through the fracture system has occurred.

For the bedrock comprising the quarry and the alluvial materials south and west of the quarry, monitoring wells MW-1034 (bedrock) and MW-1035 (alluvium) have been determined to be upgradient for the assessment of groundwater quality in these materials. In 1992, eight groundwater monitoring wells were installed in the Darst Bottom area approximately 1.6 km (1 mi) southwest of the St. Charles County Well Field. These wells were installed by the U.S. Geological Survey to study the upgradient characteristics of the Missouri River alluvium in the vicinity of the quarry. Analyses of the groundwater from those wells have been used by the WSSRAP as background values for the well field area. Subsequent analyses by the U.S. Geological Survey are provided to WSSRAP for this purpose.

Four dedicated transducers with electronic recording capacity are currently monitoring the static water levels in monitoring wells south and west of the quarry. These are wells MW-1004, MW-1005, MW-1027, and MW-1040. Readings are taken every 24 hours to correlate with dewatering activities and significant precipitation events. The transducer in MW-1040 will measure the static water level with respect to the base of the leachate collection system following significant precipitation and/or flooding events.

3.2.2.4 Monitoring Schedule. Two separate groundwater monitoring programs have been developed for the quarry to monitor specific areas according to the levels of contaminant impact, public concern, and regulatory guidelines. The monitoring programs are as follows:

- The Weldon Spring Quarry and Department of Energy monitoring wells north and south of the Femme Osage Slough.

- The St. Charles County well field and water treatment plant.

The first program is summarized in Table 3-3. This program was developed to monitor contaminant migration and the effects of quarry dewatering and bulk waste removal, which began in mid-1993. This program consists of monthly, bimonthly, or quarterly sampling of certain monitoring wells for total uranium and chemical parameters. The frequency of sampling for each location is based on the distance of the well from the source or migration pathway and the level of understanding of contaminant levels necessary to properly characterize the contaminant condition. All monitoring wells will be sampled at least annually for radiochemical

TABLE 3-3 Weldon Spring Quarry Groundwater Monitoring Program Summary

Location	Total Uranium		Ra-226, Ra-228, Th-230, and Th-232	Nitroaromatic Compounds	Sulfate	Geochemical
	Off-site Analysis	KPA				
MW-1002	Q	M	Q	M	Q	-
MW-1004	Q	M	Q	M	Q	Q
MW-1005	Q	M	Q	M	Q	-
MW-1006	S	B	Q	B	Q	Q
MW-1007	S	B	Q	B	Q	Q
MW-1008	S	B	Q	B	Q	Q
MW-1009	S	B	Q	B	Q	Q
MW-1010	S	Q	S	NS	S	-
MW-1011	S	Q	S	NS	S	-
MW-1012	S	Q	S	NS	S	-
MW-1013	S	B	Q	Q	Q	-
MW-1014	S	B	Q	Q	Q	-
MW-1015	S	B	Q	Q	Q	Q
MW-1016	S	B	Q	Q	Q	Q
MW-1017	S	B	S	Q	Q	Q
MW-1018	S	B	S	Q	Q	-
MW-1019	S	B	S	Q	Q	-
MW-1020	S	B	S	Q	Q	-
MW-1021	S	B	S	Q	Q	-
MW-1022	S	B	S	Q	Q	-
MW-1023	S	B	S	Q	Q	Q
MW-1024	S	Q	S	Q	Q	-
MW-1026	S	Q	S	S	S	-
MW-1027	S	S	S	Q	Q	Q
MW-1028	S	Q	S	Q	Q	-
MW-1029	S	B	Q	Q	Q	Q
MW-1030	Q	B	Q	Q	Q	Q

TABLE 3-3 Weldon Spring Quarry Groundwater Monitoring Program Summary (Continued)

Location	Total Uranium		Ra-226, Ra-228, Th-230, and Th-232	Nitroaromatic Compounds	Sulfate	Geochemical
	Off-site Analysis	KPA				
MW-1031	Q	B	Q	Q	Q	-
MW-1032	Q	B	S	Q	Q	-
MW-1033	Q	B	S	Q	Q	-
MW-1034	S	Q	S	S	Q	-
MW-1038	S	Q	S	NS	Q	-
MW-1039	S	Q	S	NS	Q	-

B Bimonthly
M Monthly
Q Quarterly
S Semi-annual
NS Not sampled
Geochemical Al, Ar, Ba, Br, Ca, Cl, Cr, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, NO_3, P, Pb, S (sulfide), SiO_2, Se, Sr, V, Zn, TOC

parameters and qualitatively analyzed for nitroaromatic degradation products. Monthly sampling of certain monitoring wells monitors the effects of dewatering activities and bulk waste removal. Total uranium samples will be collected quarterly, or semiannually, for off-site analysis; however to provide verification of stable total uranium levels at critical locations, samples will be analyzed utilizing an on-site KPA. If major changes in uranium concentrations are observed at any locations with the on-site KPA, then data from these locations will be confirmed by off-site analysis.

The second program monitors the St. Charles County well field and the associated potable water treatment plant. Active production wells and the St. Charles County RMW-series monitoring wells are to be sampled quarterly and semiannually for selected parameters. Table 3-4 presents the analytical parameters and sampling frequency of these wells. This portion of the monitoring program has been developed by representatives of the Department of Energy and the Missouri Department of Natural Resources. Any deviation from this program will be summarized in the WSSRAP annual site environmental report.

TABLE 3-4 St. Charles County Well Field Sampling Program Summary

Monitoring Locations	Parameters						
	Total Uranium*	Ra-226, Ra-228, Th-230, and Th-232	Gross Alpha	Nitroaromatic Compounds	Metals		Sulfate
					As	Be	
MW-1024	Q	S	Q	Q	Q	Q	Q
RMW-1	Q	S	Q	Q	Q	Q	Q
RMW-2	Q	S	Q	Q	Q	Q	Q
RMW-3	Q	S	Q	Q	Q	Q	Q
RMW-4	Q	S	Q	Q	Q	Q	Q
PW-2	Q	S	Q	Q	S	S	S
PW-3	Q	S	Q	Q	S	S	S
PW-4	Q	S	Q	Q	S	S	S
PW-5	Q	S	Q	Q	S	S	S
PW-6	Q	S	Q	Q	S	S	S
PW-7	Q	S	Q	Q	S	S	S
PW-8	Q	S	Q	Q	S	S	S
PW-9	Q	S	Q	Q	S	S	S
Raw water	Q	S	Q	Q	S	S	S
Treated water	Q	S	Q	Q	S	S	S

A Annual
Q Quarterly
S Semiannual
* KPA analysis will also be performed quarterly.

The well field monitoring program includes sampling both untreated and treated water from the St. Charles County water treatment plant. Gross alpha analysis will be performed on a quarterly basis. This portion of the monitoring program satisfies the portion of the *Regulatory Guide* (Ref. 3) and Department of Energy Order 5400.5 requiring the monitoring of affected or potentially affected public drinking water supplies as defined in 40 CFR Part 141.26. The quarterly gross alpha values will be averaged and presented in the annual environmental report. Above-normal and outlier quarterly values will be responded to by implementation of procedure

ES&H 1.1.7, *Reporting Above Normal Values from Environmental Monitoring Networks*. Possible responses include validation of the reported value and resampling of the monitoring location. All values not disqualified as being non-natural will be included in the annual average.

Quality control samples (including duplicate, matrix spike, field blank, equipment blank, and water blank samples) are not included in this schedule, but are collected in compliance with procedure ES&H 4.1.4s. Sampling frequency, collection methods, and sample handling protocols for quality control samples are discussed in Section 7, Quality Assurance.

3.2.3 Groundwater Monitoring Program for the Weldon Spring Chemical Plant and Raffinate Pits

Groundwater monitoring is required by DOE 5400.1 and the *Regulatory Guide* (Ref. 3) to identify and document pre-operational conditions and monitor the effects of Department of Energy operations on groundwater quality, and to demonstrate compliance with applicable Federal and State laws and regulations. Groundwater monitoring has been conducted at the chemical plant since the first quarter of 1987. The program has been adjusted yearly to accommodate changes in laws and regulations, specific project needs, and the requirements of the *Comprehensive Environmental Response, Compensation and Liability Act-National Environmental Policy Act* (CERCLA) and the National Environmental Policy Act (NEPA).

Seventy-two groundwater wells have been chosen for routine monitoring to investigate and document the locations and migration of contaminants that may pose a risk to human health and the environment.

3.2.3.1 Geology and Hydrogeology. Geology at the chemical plant, raffinate pits, and vicinity properties may be divided into two major units based on gross lithologic characterization: the unconsolidated glacial and residual soils and the underlying bedrock. The unconsolidated material consists of topsoil, loess, glacially derived sediments, and residuum. On average, the glacial soils are silty clays with minor amounts of gravel. The unconsolidated materials, which are present at depths ranging from 6 m to 15 m (20 ft to 50 ft), are usually not saturated and thus are not monitored.

Saturated conditions are generally first encountered in the Burlington-Keokuk Limestone, the underlying bedrock unit. The Burlington-Keokuk Limestone is composed of two different lithologic zones: a shallow weathered zone underlain by an unweathered zone.

The weathered zone is typically a grayish-orange to yellowish-gray, argillaceous limestone containing up to 60% chert, which occurs as discrete nodules or interbedded lenses. The weathered limestone is a low-yield, semi-confined, heterogeneous, anisotropic aquifer that is fractured and susceptible to natural solution processes. Within the confines of the chemical plant, the uppermost aquifer generally exhibits diffuse flow properties; however, discrete flow zones may be present in saturated, highly weathered bedrock and in the saturated residuum which fills paleochannels.

The unweathered or competent portion of the Burlington-Keokuk Limestone is thinly to massively bedded, gray to light gray, finely to coarsely crystalline, styolitic and fossiliferous. Fracture densities are significantly lower in the unweathered zone as compared to the weathered zone.

In contrast to the quarry, which is located near a poorly drained area, the chemical plant site straddles a topographic high. Thus site soils are well drained with minimal accumulation of organic material. These conditions foster relatively oxidizing conditions in the unconsolidated materials and upper bedrock units beneath the chemical plant, whereas, potentially reducing conditions are present in the quarry environs. Redox conditions are an important control on the mobility and stability of many species that are potential contaminants at these two locations.

3.2.3.2 **Rationale**. Groundwater flow and contaminant transport mechanisms at the chemical plant, raffinate pits, and vicinity properties differ from those at the quarry because of differences in the geologic environments of these two locations. Site geologic conditions are briefly described in the following section. At the chemical plant and environs, the aquifer generally exhibits diffuse flow properties that are overlain by zones of fracture or conduit flow. To accommodate these two flow mechanisms, the groundwater surveillance program includes analyses of water from monitoring wells, which typically sample the diffuse component of flow, and from springs, which represent the resurgence point for discrete or conduit flow paths.

The groundwater monitoring program at the chemical plant is designed to provide the necessary data to accomplish the following objectives, outlined in Department of Energy Order 5400.1, Chapter IV, Section 3 and Section 5, Part b:

- Ensure protection of public health and the environment. Included in this objective are (1) evaluating whether contaminants of concern, as determined in the draft remedial investigation for the site, are present at levels exceeding maximum contaminant levels (MCLs) or assumed background concentrations which are being determined by the U.S. Geological Survey at uncontaminated wells located in the immediate vicinity of the chemical plant and raffinate pits, and (2) monitoring concentration levels of contaminants which exceed these criteria.

- Develop a baseline for studying long-term and short-term effects of source removal, which is to be conducted as part of CERCLA-NEPA activities slated to begin in 1994. At least one year of baseline data taken quarterly will be required to provide adequate information for future comparisons.

- Develop a pre-operational baseline for studying the effects of the equalization basin associated with the wastewater treatment plant and on-site construction activities associated with site remediation.

- Perform spatial and temporal trend analyses.

3.2.3.3 Monitoring Locations. Currently, 63 Department of Energy monitoring wells are utilized for the environmental surveillance program (see Figure 3-5). Nine of the Department of Energy monitoring wells were installed in late 1992 to monitor impacts of the equalization basin at the site water treatment plant and the temporary storage area on the quality of the uppermost aquifer. Background water quality characteristics for the chemical plant area have been determined by the U.S. Geological Survey (Ref. 27).

Fifty Department of Energy wells monitor the upper, weathered portion of the shallow aquifer. The remaining 13 wells monitor the deeper, unweathered portion of the aquifer. In late 1993, three open-hole Department of Energy wells (MW-2020, MW-3008, and MW-3009) were retrofitted to shallow wells (MW-2044, MW-3025, and MW-3022, respectively) and deep

wells (MW-3024 and MW-3026, respectively) were drilled adjacent to wells MW-3025 and MW-3027. As site remedial activities progress and site development occurs, some wells will require abandonment due to conflicts with land use. In each instance, an evaluation of the data requirements from that location will be conducted and a determination of well replacement will be performed.

3.2.3.4 **Monitoring Schedule.** For most locations, the 1995-1996 groundwater monitoring program for the WSCP reflects a significant reduction in sampling frequency and the number of analyses performed (see Table 3-5). The RCRA monitoring program will remain unchanged as will characterization monitoring for new wells.

The reduced monitoring schedule is justified for this period because characterization monitoring is complete at most wells, groundwater chemistry has remained relatively constant, and site conditions are not expected to change substantially over the next 2 years. Increased monitoring will be instituted when disposal cell construction and raffinate pit removal begin as these activities will alter the site and are likely to result in changes to groundwater conditions.

Previous Characterization

The quality of groundwater in most WSCP monitoring wells has been well studied. Routine monitoring for uranium, nitrate, sulfate and nitroaromatic compounds has been conducted since 1987. In addition to these analyses, water quality (geochemical) parameters have been measured in at least six independent samples for most locations.

Evaluation of the monitoring data has shown that the distribution and concentration of contaminants in the groundwater beneath the WSCP area have remained relatively constant over the last seven years. Statistical analysis of contaminant concentrations was conducted for the 1993 ASER to evaluate seasonal variations and trends in the groundwater. Seasonal effects were not detected in the data and only a limited number of trends were identified. Less than half of these trends were positive (i.e., indicating increasing concentrations). Of the positive trends, few were steep (i.e., indicative of significant changes in concentrations) and most occurred in wells with low levels of contamination. Upward uranium trends were not observed at any location.

TABLE 3-5 Weldon Spring Chemical Plant Monitoring Program Summary

	Total Uranium	Radionuclides	Nitroaromatic Compounds	Anions	
			Full Analysis	NO_3	SO_4
Weldon Spring Chemical Plant Monitoring Wells					
MW-2001	A	NS	A	A	NS
MW-2002	A	NS	A	A	NS
MW-2003	A	NS	A	A	NS
MW-2004	A	NS	A	A	NS
MW-2005	A	NS	A	A	NS
MW-2006	A	NS	A	A	NS
MW-2007	A	NS	A	A	NS
MW-2008	A	NS	A	A	NS
MW-2009	A	NS	A	A	NS
MW-2010	A	NS	A	A	NS
MW-2011	A	NS	A	A	NS
MW-2012	A	NS	A	A	NS
MW-2013	A	NS	A	A	NS
MW-2014	A	NS	A	A	NS
MW-2015	A	NS	A	A	NS
MW-2017	A	NS	A	A	NS
MW-2018	A	NS	A	A	NS
MW-2019	NS	NS	NS	NS	NS
MW-2021	NS	NS	NS	NS	NS
MW-2022	NS	NS	NS	NS	NS
MW-2023	NS	-NS	NS	NS	NS
MW-2024	NS	NS	NS	NS	NS
MW-2025	NS	NS	NS	NS	NS
MW-2026	NS	NS	NS	NS	NS
MW-2027	NS	NS	NS	NS	NS
MW-2028	NS	NS	NS	NS	NS

TABLE 3-5 Weldon Spring Chemical Plant Monitoring Program Summary (Continued)

	Total Uranium	Radionuclides	Nitroaromatic Compounds	Anions	
			Full Analysis	NO_3	SO_4
MW-2029	NS	NS	NS	NS	NS
MW-2030	A	NS	A	A	NS
MW-2032	A	NS	A	A	NS
MW-2033	A	NS	A	A	NS
MW-2034	A	NS	A	A	NS
MW-2044	A	A	A	A	NS
Weldon Spring Raffinate Pits Monitoring Wells					
MW-3003	A	A	A	A	NS
MW-3006	NS	NS	NS	NS	NS
MW-3019	A	A	A	A	NS
MW-3023	A	A	A	A	NS
MW-3024	A	A	A	A	NS
MW-3025	A	A	A	A	NS
MW-3026	A	A	A	A	NS
MW-3027	A	A	A	A	NS
Vicinity Property Monitoring Wells					
MW-4001	A	NS	A	A	NS
MW-4002	A	NS	A	A	NS
MW-4003	A	NS	A	A	NS
MW-4004	NS	NS	NS	NS	NS
MW-4005	A	NS	A	A	NS
MW-4006	A	NS	A	A	NS
MW-4007	NS	NS	NS	NS	NS
MW-4008	NS	NS	NS	NS	NS
MW-4009	NS	NS	NS	NS	NS
MW-4010	A	NS	A	A	NS

TABLE 3-5 Weldon Spring Chemical Plant Monitoring Program Summary (Continued)

	Total Uranium	Radionuclides	Nitroaromatic Compounds	Anions	
			Full Analysis	NO_3	SO_4
MW-4011	A	NS	A	A	NS
MW-4012	NS	NS	NS	NS	NS
MW-4013	A	NS	A	A	NS
MW-4014	A	NS	A	A	NS
MW-4015	A	NS	A	A	NS
MW-4016	A	NS	A	A	NS
MW-4017	A	NS	A	A	NS
MW-4018	A	NS	A	A	NS
MW-4019	A	NS	A	A	NS
MW-4020	A	NS	A	A	NS
MW-4021	A	NS	A	A	NS
MW-4022	A	NS	A	A	NS
MW-4023	A	NS	A	A	NS

A Annual
S Semiannual
Q Quarterly
NS Not sampled
Radionuclides Ra-226, Ra-228, Th-228, Th-230, Th-232, gross alpha, and gross beta
Nitroaromatic Compounds 1,3,5-TNB; 1,3-DNB; 2,4,6-TNT; 2,4-DNT; 2,6-DNT and Nitrobenzene
Geochemical Parameters Set 1: Ba, Ca, Cl, Fe, K, Li, Mg, Mn, Na
Set 2: Al, As, Br, Cr, Hg, Mo, Ni, P, Pb, SiO_2, Se, Sr, V, Zn, TOC

Based upon the information presented above the 1995 groundwater monitoring program for the Weldon Spring Chemical Plant is summarized as follows:

- Uranium and nitrate will be measured annually in weathered zone wells and impacted unweathered zone wells.

- Waste storage facilities wells will be sampled quarterly and analyzed for the constituents described in Section 3.2.4 and listed in Table 3-6.

- Burgermeister Spring, which monitors off-site migration of contaminated groundwater, will be analyzed quarterly for uranium, nitrate, and the abbreviated geochemical list and semiannually for nitroaromatic compounds.

- New wells will be monitored quarterly for contaminants of concern, geochemical parameters, and nitroaromatics until characterization monitoring is complete, that is when a total of six data points has been collected for each location.

- Wells in the unweathered zone which have not historically shown contamination will not be sampled during 1995, but will be reviewed again in 1996.

3.2.4 Groundwater Monitoring of the Waste Storage Facilities

Groundwater monitoring wells have been placed around three waste management units: the quarry and site water treatment plant equalization basins, and the temporary storage area (see Figures 3-3 and 3-5). These wells were installed to detect monitoring parameters in the uppermost water unit beneath these storage facilities in order to comply with the requirements of 40 CFR 264, Subpart F, and 10 CSR 25.7, Subpart F. The monitoring parameters were derived from previous evaluations performed and documented in the *Engineering Evaluation/Cost Analysis for the Proposed Management of Contaminated Water in the Weldon Spring Quarry* (Ref. 8) and the *Baseline Risk Evaluation for Exposure to Bulk Waste at the Weldon Spring Quarry, Weldon Spring, Missouri* (Ref. 9).

The detection monitoring program will consist of quarterly and annual monitoring of selected parameters. A summary of the monitoring locations, the corresponding waste management unit, and the schedule of sampling is shown in Table 3-6. In conjunction with these analyses the groundwater surface elevation at the time of each sampling event will be measured.

Concentrations at the monitoring wells will be compared with baseline for each well. If there is statistically significant evidence of contamination at the monitoring wells, a program of increased monitoring and/or evaluation of the liners of the basins or storage areas will be

TABLE 3-6 Waste Storage Facility Monitoring Program

Monitoring Locations	Parameters							
	Total* Uranium	Radiochemical	Anions	Metals	Nitroaromatic Compounds	PCBs	PAH	Pesticides
Quarry Water Treatment Plant Equalization Basin								
MW-1035	Q	A	Q	Q	Q	A	A	A
MW-1036	Q	A	Q	Q	Q	A	A	A
MW-1037	Q	A	Q	Q	Q	A	A	A
MW-1040	Q	A	Q	Q	Q	A	A	A
MW-1041	Q	A	Q	Q	Q	A	A	A
Site Water Treatment Plant Equalization Basin								
MW-2040	Q	A	Q	Q	Q	A	A	A
MW-2041	Q	A	Q	Q	Q	A	A	A
MW-2042	Q	A	Q	Q	Q	A	A	A
MW-2043	Q	A	Q	Q	Q	A	A	A
Temporary Storage Area								
MW-2035	Q	A	Q	Q	Q	A	A	A
MW-2036	Q	A	Q	Q	Q	A	A	A
MW-2037	Q	A	Q	Q	Q	A	A	A
MW-2038	Q	A	Q	Q	Q	A	A	A
MW-2039	Q	A	Q	Q	Q	A	A	A

A	Annually
Q	Quarterly
Radiochemical	U-234, U-238, Ra-226, Ra-228, Th-230, and Th-232
Anions	Nitrate, sulfate, chloride, and fluoride
Metals	As, Ba, Cd, Cr, Pb, Hg, and Se, (toxicity [RCRA] metals)
PCBs	polychlorinated biphenyls
PAH	Polynuclear aromatics hydrocarbons
Pesticides	Endrin, lindane, methoxychlor, toxaphene, 2,4-D and 2,4,5-TP Silvex
*	KPA analysis will also be performed quarterly.

initiated. Statistical treatment of data is discussed in Section 6. If groundwater protection standards are exceeded, corrective action plans will be evaluated on an individual basis.

3.2.5 Groundwater Monitoring at Springs

The groundwater flow system beneath the chemical plant, raffinate pits, and vicinity properties comprises both diffuse and discrete flow components; therefore, a complete groundwater monitoring program must include sampling at conventional groundwater monitoring wells near the contaminant sources and at springs. Springs in the vicinity of the site have been monitored since 1987, beginning with the Department of Energy and Project Management Contractor broad-based Phase I spring and seep characterization, which involved 30 springs and seep features within a 3.2 km (2-mi) radius of the site. The springs and seeps were inventoried and sampled at varying flow rates. The springs impacted by the site were identified, and a program of regular monitoring was established for those springs. Through that program and additional studies conducted by the Department of Energy, contractor, and the Missouri and U.S. Geological Surveys, the flow characteristics of the springs and their recharge basins were determined.

3.2.5.1 Monitoring Locations. As a result of the early characterization results, investigations by the Missouri Department of Natural Resources on shallow groundwater movement (Ref. 32), and the subsequent annual monitoring at select locations, sufficient data have been collected to understand the basic mechanics and contaminant levels in the springs of concern. For the 1995 monitoring year, only Spring SP-6301 (Burgermeister Spring) will be monitored regularly. SP-6301 (Figure 3-6) exhibits recognizable contribution from contaminated groundwater from the Weldon Spring site throughout the year and is believed to be a local discharge point for contaminated groundwater from beneath the site. For that reason, it is a key monitoring location for identifying changes in groundwater contamination conditions from the site and will allow the project to document improvements in groundwater contamination conditions as remedial actions at the site proceed.

The Burgermeister Spring branch receives site-contaminated ground and surface water. Although the Weldon Spring site is not located in Valley 6300, it is connected to this drainage by losing streams that travel along subterranean conduits and emerge at springs in the Burgermeister Spring branch. The most prominent location is Burgermeister Spring (SP-6301), a perennial spring that discharges site-contaminated water during high and low flow periods. High flow is dominated by a surface water component, whereas low flow is dominated by a groundwater component. Spring 6306, located downstream of Busch Lake 34 and downstream

of Burgermeister Spring, also contains uranium. Considerable evidence suggests that Lake 34 is a plausible source for the uranium in Spring 6306. However, there is also evidence of a possible connection with Busch Lake 35, which is located in the same drainage as the Weldon Spring site and also has elevated uranium levels.

Springs SP-5303, SP-5304, and SP-6306 will not be sampled during 1995, since sufficient data have been collected to characterize the contamination conditions, and no substantial changes in conditions will occur on the project area during 1995 which are expected to modify the contaminant conditions during this period. The project will review the monitoring needs at these locations as remedial actions progress.

3.2.5.2 Monitoring Program. Burgermeister Spring will be monitored at low flow, which is defined hereafter as seasonal base flow, or the stage of spring discharge when not influenced by active surface water runoff from local land surfaces. Low flow samples are intended to monitor the undiluted groundwater component of flow. To meet this criterion, low flow samples will be collected no sooner than one week following the conclusion of a precipitation event of sufficient intensity to cause surface runoff. To provide a direct comparison with groundwater collected from monitoring wells, low flow samples will not be filtered.

Burgermeister Spring, will also be sampled at high flow. In contrast to low flow, high flow is induced by precipitation events. During high flow, discharge is dominated by surface run off. Only contaminants of concern will be measured during high flow. These samples will not be filtered.

The monitoring schedule for Burgermeister Spring is presented in Table 3-7.

TABLE 3-7 Spring Monitoring Program

Spring	Q1	Q2		Q3	Q4	
	Low	Low	High	Low	Low	High
SP-6301	U,I,G,N	U,I,G	U,I	U,I,G,N	U,I,G	U,I

U Uranium, total
I Inorganic Anions (nitrate and sulfate)
G Geochemical Parameters (see Table 3-5, Sets 1 and 2 with chloride)
N Nitroaromatic compounds

wastes. During high flow, this spring is impacted by surface runoff from the site, whereas contaminated groundwater from beneath the site is predominant during low flow. The contaminants of concern will be monitored during high and low flow conditions to assess the influence from surface water and groundwater sources on water quality. Geochemical samples will be collected at low flow on a quarterly basis to provide a basis for comparison with site groundwater. Characterization of SP-6301 at both high and low flow stages throughout the remediation period should provide a valuable measure of potential changes in environmental conditions.

3.3 External Radiation Exposure Environmental Surveillance Monitoring

The external radiation exposure environmental surveillance program at the Weldon Spring site is designed to monitor potential external exposure points at the chemical plant, raffinate pits, quarry perimeter, vicinity properties, and at off-site locations where the potential for exposure of the general public to gamma radiation is highest. Gamma radiation is emitted by nearly all the radionuclides of the U-238 and Th-232 decay series, and these radionuclides are found in above-background concentrations on the site.

In addition, the environment contains naturally occurring radioactive substances which emit gamma radiation. Terrestrial radiation sources are natural radioactive elements in the environment. Cosmic radiation is high-energy radiation that originates in outer space and filters through the atmosphere to reach the earth's surface. Together, these two sources account for

natural background gamma radiation. Terrestrial radiation levels depend largely on the soil composition, and cosmic radiation levels depend on elevation above sea level.

3.3.1 Weldon Spring Site Monitoring Locations

The choice of locations for external monitoring stations was based on the characteristics of both the chemical plant and quarry. External gamma exposure to the public as a result of fugitive dust emissions from the site is an unrealistic exposure pathway. This conclusion is based on the fact that the primary radioactive contaminant is uranium, and three air monitoring programs have been established to ensure airborne concentrations at the perimeters are maintained at near background levels. If there is an airborne emission from the site, it will be intermittent and contain low concentrations of radionuclides. Thus, this pathway is not expected to result in measurable external exposure to the general public. In addition, there are no high energy accelerators, industrial X-ray, or large isotopic radiation sources at either the chemical plant or quarry. The only potential for external exposure to the general public results from contaminated soils at the chemical plant, raffinate pits, quarry, and vicinity properties.

Gamma radiation at the Weldon Spring site perimeters will be monitored at 11 locations using thermoluminescent dosimeters (TLD)s. Seven monitoring stations will be located around the perimeter fence of the chemical plant (Figure 3-7), and four stations will be located along the quarry perimeter fence (Figure 3-8). This represents a decrease of five monitoring locations at the chemical plant perimeter and four monitoring locations at the quarry perimeter. The justification for reduction in the monitoring locations is based on that since 1986 the statistical analysis of the TLD results, has indicated that at the 95% confidence level there was no reason to suspect that gamma radiation at the monitoring stations was greater than background. These locations are summarized in Table 3-8.

Spacing of the monitoring stations around the perimeters of the chemical plant and quarry is based on the relative potential for external exposures. The perimeter of the quarry, which has the shortest distances between monitoring stations, is the most accessible to the general public. In addition, the contaminated materials within the quarry are at some points less than 46 m (150 ft) from the perimeter. The intervals between monitoring stations at the chemical plant near the temporary storage area are similar to those at the quarry. Transport of material presently at the quarry to the temporary storage area began in mid-1993. In some places the

TABLE 3-8 Gamma Radiation (TLD) Monitoring Locations

Station	Location	Station	Location
Chemical Plant Area			
TD-2003	North perimeter of site	TD-3001	Northwest of Raffinate Pit 4
TD-2004	Northeast corner of site	TD-3003	South of Raffinate Pit 4 and west of TSA
TD-2005	Southeast of administration building	TD-3004	South of TSA
TD-3005	Southeast of TSA		
Quarry Area			
TD-1002	Northeast corner of quarry	TD-1006	West perimeter of quarry
TD-1004	South perimeter of quarry	TD-1009	North perimeter of quarry
Off-site and Background			
TD-4001	Busch Conservation Area	TD-4007	Residence west of quarry
TD-4002	Army site guard house	TD-4008	Katy Trail south of quarry
TD-4003	Francis Howell High School	TD-4009	Daniel Boone Elementary School, New Melle
TD-4005	West of Army site		

temporary storage area perimeter is less than 31 m (100 ft) from the chemical plant perimeter. The monitoring stations are placed at wider intervals along the remainder of the chemical plant perimeter because in this area, potential for external exposure to the general public is less.

3.3.2 Off-Site Monitoring Locations

Six off-site monitoring stations (Figures 3-9 and 3-10), as well as two of the perimeter stations (Figure 3-7), will be used to assess gamma radiation exposure rates at locations near the chemical plant where members of the general public abide or reside. Francis Howell High School, TD-4003, and the Busch Conservation Area headquarters, TD-4001, were selected as monitoring locations because they have the largest populations near the chemical plant. The State of Missouri Highway Department, TD-2004; the Army Reserve guard house, TD-4002; and the WSSRAP administration building, TD-2005; are the closest locations to the chemical plant where members of the general public abides or resides.

A monitoring station was placed near a residence, TD-4007 (Figure 3-8), because the individuals who reside there have an assumed continuous exposure time. The location at the Femme Osage Slough vicinity property, TD-4008, was chosen because it is near the Katy Trail, which has the largest population group that visits the site vicinity, and it is used by individuals who fish from the Femme Osage Slough.

3.3.3 Background Monitoring Locations

Two monitoring stations are used to measure background gamma radiation exposure rates (Figures 3-9 and 3-10). These locations are TD-4005 and TD-4009. This represents a decrease from five monitoring stations in previous years. In 1989, background gamma radiation exposure rates were measured in each of the three distinct geological regions in the vicinity of the Weldon Spring site. These regions are the dissected glacial till deposits, the alluvial deposition of the Missouri River, and the Salem Plateau. Statistical analysis of the data from these measurements indicated that at the 95% confidence level there was no reason to suspect a difference in the gamma exposure rates between the three geological regions. Since there was no reason to suspect a difference, an average of the results of the two background locations is used to estimate the background gamma radiation exposure rate.

Monitoring station TD-4005 is within 6 km (4 mi) from the chemical plant and the quarry. Monitoring station, TD-4009, is approximately 13 km (8 mi) from the chemical plant and 11.3 km (7 mi) from the quarry (Figure 3-10). The *Regulatory Guide* (Ref. 3) suggests that background stations should be located at least 10 km to 15 km (6 mi to 9 mi) from a site. Although TD-4005 is at a lesser distance, they are at appropriate distances with respect to the site. As mentioned, the site will not render external radiation exposures as a result of airborne emissions. There are no high energy accelerators, or industrial X-ray or large isotopic radiation sources at either the chemical plant or quarry; thus, the distances of the background stations from the chemical plant, raffinate pits, quarry, and vicinity properties are more than sufficient to attenuate the gamma radiation from contaminated soils.

3.3.4 Radiological Measurements

Measurements with a pressurized ion chamber as suggested in the *Regulatory Guide* (Ref. 3) will not be made at monitoring stations used in previous years. Because the TLDs

integrate gamma exposure for 13 weeks, the TLDs actually provide a better means of identifying natural occurring anomalies than would a short term pressurized ion chamber measurement.

Results of previous TLD measurements are consistent with yearly background gamma exposures made by the Project Management Contractor and other Department of Energy contractors around the site. The monitoring stations at the quarry are located in the controlled area near contaminated soils and material. Any above background results detected by these stations are due to the proximity of the monitoring stations to the contaminated soils. Because previous TLD measurements are consistent with background exposure rates performed by the contractor and others, and are within the expected range for the altitudes of the stations, it is concluded that no naturally occurring anomalies are present. Thus, pressurized ion chamber measurements are not necessary.

The quality control measures that will be implemented for environmental TLDs include spiked and duplicate detectors. At least two duplicate TLDs will be deployed, one at the quarry and one at the chemical plant. The TLDs will be exchanged and retrieved in accordance with the appropriate standard operating procedures (SOPs), and field sheets will be used to document placement, retrieval, and unusual occurrences. Chain-of-Custody forms will also be filled out as specified in the appropriate SOPs. The data received from vendors will be reviewed and anomalies will be identified and investigated. In addition, TLDs will be performance tested, deployed, and stored according to ANSI-N545-1975. The environmental TLD used for monitoring ambient gamma radiation is comprised of 25% calcium sulfate dysprosium ($CaSO_4$:Dy) in a Teflon matrix. The dosimeters will be encased in black polyethylene bags which will be placed in plastic holders with copper shielding. The copper shielding is necessary to correct for over-response of the dosimeter at low energies. The dosimeters will be exchanged quarterly.

3.4 Biological Monitoring Program

Biological monitoring requirements are designated in Department of Energy Orders 5400.1, 5400.5, and the Regulatory Guide (Ref. 3). The Department of Energy Order 5400.1 requires environmental programs to monitor contaminant levels in biota.

Remedial activities in process at the quarry and chemical plant could potentially result in the release of contaminants to the environment. Work practices are incorporated into remedial actions to avoid releases, and programs have been established to evaluate the effectiveness of these practices. Environmental monitoring at the WSSRAP has been designed to focus on effluent monitoring to detect, characterize, and report unplanned releases; therefore, ecological studies are conducted to assess baseline conditions in the environment, such as lakes and streams.

3.4.1 Past Studies

Characterization studies conducted prior to 1990 examined the level and extent of contaminants in the environment. These studies involved sampling of surface waters, soils, and sediments. Primary exposure routes for biota were examined, although these studies were not designed to assess ecological conditions. The main purpose of these studies was to examine the contaminants in relation to their potential for human exposure. Nevertheless, some information can be applied to the Department of Energy monitoring requirements and the CERCLA ecological assessment process.

In 1987, the first biouptake study was conducted by measuring concentrations of metals, polychlorinated biphenyls (PCBs), and radionuclides in fish. No fish were found in the raffinate pits or in the quarry pond; however, sunfish were found in Frog Pond. No PCBs were found in fish from off-site locations, but detectable concentrations of metals were found in some fish samples taken from these locations. Small game mammals were sampled in 1988, and no radionuclides were detected in these samples. Waterfowl were sampled from Raffinate Pit 4 during 1990. Results showed detectable levels of radionuclides in organ, bone, and flesh samples. One white-tailed deer was sampled in 1991, and radionuclides were detected in some bone, organ, and flesh samples.

Since 1992, more emphasis has been placed on characterizing ecological conditions on site and at vicinity properties receiving effluent from the Weldon Spring site. The aquatic biological investigation characterized the physical properties of lakes and streams in the area and in biological organisms found within the aquatic habitats. Data from electrofishing surveys and stocking practices were compiled to define fish populations in vicinity lakes and to examine their influences on other organisms within the lakes.

Population surveys for deer located within the chemical plant and raffinate pits area were conducted to determine whether overcrowding, habitat loss, or contaminated resources are affecting deer populations on site. Quarterly deer spot-light surveys were conducted to document deer locations, activities, and numbers.

Fish samples have been routinely collected to determine uranium concentrations. Since 1993, only edible portions have been collected, such as fillets and fishcakes.

Agricultural products, such as corn, soybeans, and milo, have been collected to characterize radiological concentrations and to determine background levels.

3.4.2 Monitoring Rationale

A biological monitoring program comprising various aquatic and terrestrial studies will be conducted in 1995 to meet monitoring requirements. The studies will focus primarily on vicinity properties that receive effluent from the site.

Radiological parameters analyzed will include total uranium in fish, invertebrates, agricultural products, soils, and surface waters. Ra-226, Ra-228, and isotopic thorium will also be analyzed in agricultural products collected from the St. Charles County well field. When collecting surface water samples, physical parameters that describe ecological conditions will be collected such as pH, alkalinity, and dissolved oxygen in sediments as a part of the zooplankton and benthic invertebrate study. Uranium, lead, and mercury will be analyzed in fish.

3.4.3 Aquatic Habitats

Aquatic habitats monitored include a number of lakes and streams that are impacted or potentially impacted by the Weldon Spring site. These locations are described in this section and can be found on Figure 3-11. To the north, chemical plant drainage impacts Busch Lakes 35 and 36, and contaminated groundwater that surfaces at Burgermeister Spring impacts Busch Lake 34. Waters from these lakes flow to Dardenne Creek and eventually to the Mississippi River. To the south, runoff flows from the chemical plant down the Southeast Drainage to the Missouri River.

In the vicinity of the Weldon Spring Quarry two bodies of are water monitored; the Femme Osage Slough and the Little Femme Osage Creek. Femme Osage Slough is south of the quarry and receives contaminated groundwater migrating from the quarry. Little Femme Osage Creek is west of the quarry and does not receive runoff from the quarry.

Other lakes, creeks, and springs will be monitored as background locations. Background locations include such areas as Busch Lake 33.

3.4.3.1 Fish Sampling. Fish are routinely monitored at off-site locations primarily to ensure public health and safety. Review of fish data indicates that sunfish samples from Busch Lakes 35 and 36 are accumulating uranium at levels significantly above background (Ref. 28). Therefore, routine monitoring will be conducted every other year. In addition, samples will be collected if average uranium concentrations in water are found to be statistically higher than found in the lakes from previous years. The concentrations are extremely low and the calculated total estimated dose is less than 1.0 mrem/year. No significant difference was found between species of fish, although the current data set is small. Hence, fish monitoring will be limited to sampling the flesh of game species from Busch Lakes 34, 35, and 36 and the Femme Osage Slough. Busch Lake 33 will be used as a background location. In addition, only fish within 20% of the legal length will be sampled, or in the case of species with no designated limit, only individuals greater than 17.5 cm (7 in.) will be taken.

Fish will be sampled in conjunction with the Missouri Department of Conservation fisheries program. Adult fish will be collected using the electrofishing technique in which fish are stunned with a low electrical current, dip-netted from the water, and placed in holding tanks prior to data collection. All fish collected will be identified, measured (total length), and recorded for analysis of fish populations. In addition, a gross examination of each fish will be made to determine the incidence of external disease, parasites, or physical abnormalities.

Fillets and/or fish cakes from game species (specifically bass, sunfish, crappie, and catfish) will be prepared for uranium analysis. Results of this analysis will be used to calculate the effective dose equivalent to humans via consumption of fish.

3.4.3.2 Invertebrates and Zooplankton. Benthic invertebrates and zooplankton are routinely used as indicators of water and ecological quality in lakes and streams, and

Department of Energy Order 5400.1 specifies monitoring of benthics and organisms in the water column.

According to the regulatory guide and DOE Order 5400.5, the interim absorbed dose to protect native aquatic organisms, other than plants, is 1 rad/day. A three year site-specific aquatic assessment was conducted from 1991 to 1994, with the final phase being completed in December 1994. Once the final 1994 report is received from the subcontractor in 1995, the three reports and all the data will be compared and one comprehensive report will be written. This report will draw conclusions concerning impacts, if any, associated with the Weldon Spring site, document habitat quality as it stands now in case of an off-site release, and will be used to determine the criteria for initiating additional sampling.

Until the criteria is established, receiving bodies of water and those with the potential for becoming contaminated, will be monitored on a routine basis according to the surface water monitoring program described in Section 3.1. These water bodies include the Southeast Drainage, Frog Pond drainage, Ash Pond drainage, Busch Lakes 34, 35, and 36, Burgermeister Spring, Femme Osage Slough, and Little Femme Osage Creek.

Although the trigger levels to initiate increased sampling will not be established until the comprehensive report is issued, the surveillance program, if needed, will follow the 1994 protocol. This protocol is discussed below. Once the criteria is established, this section will be updated to include any program changes and to discuss the associated requirements.

If it is determined that sampling needs to be initiated, lakes, ponds, and sloughs will be sampled for benthic invertebrates and zooplankton. Benthic samples, when collected, will consist of a single composite sample collected from each lake using a dredge type sampler. Zooplankton will be sampled using a single composite of samples taken from each lake location using a vertical tow with a plankton net. Samples will be taken starting at the bottom of the lake and towing to the surface at a constant speed.

The rapid bioassessment technique (protocol IV) will be used at the creeks and drainages. This protocol conducts an assessment of the habitat and benthic invertebrates. Benthic invertebrate samples will also consist of a single composite sample collected from each creek or drainage using a dredge or surber.

A variety of hydrological data will be collected at each sample location to assist in the interpretation of the biological data. Physical parameters, such as temperature, dissolved oxygen, pH, and water clarity (secchi disc) will be measured. The radiological and chemical analyses that will be conducted on water and sediment samples will be determined in the final report.

3.4.4 Terrestrial Habitats

The terrestrial community in the area of the Weldon Spring site is diverse. Much of the land immediately surrounding the chemical plant is made up of state-owned conservation area (Ref. 11). Habitats include old field; cultivated farmlands; and upland, slope, and bottomland forests. The terrestrial community supports a wide variety of fauna including avian and mammal species. White-tailed deer, gray squirrels, and cottontail rabbits have been sighted within the chemical plant boundaries. Opossum, fox, and coyote roam the areas. Many birds are summer residents or spring/fall migratory species. Eastern screech and barred owls have been sighted in upland forests south of the chemical plant and great horned owls have been sighted at Ash Pond.

Monitoring during past years has included extensive efforts to characterize terrestrial fauna and habitats at the chemical plant as part of the requirement for assessing exposure and impact to biota.

3.4.4.1 Foodstuffs. Surveillance of foodstuffs within a 16 km (10 mi) radius of the site is required by the regulatory guide (Ref. 3). Foodstuffs include such items as meat, eggs, milk, and grains. To establish a representative foodstuff surveillance policy, the WSSRAP developed an agricultural monitoring program. This program was based upon a tiered approach, looking first at the most prominent agricultural activity in the Weldon Spring site area, which is crop production. Most of the crops grown in the area, and therefore sampled, included corn, soybeans, and milo.

Agricultural lands surrounding the site comprise approximately 20% of the terrestrial habitat. The August A. Busch Memorial Conservation Area and Weldon Spring Conservation Area cover approximately 890 ha (2,200 acres) of agricultural lands which are leased to sharecroppers. There are also private farms in the immediate area. Agricultural products grown

in the area include corn, soybeans, and milo, which are grown primarily as cattle feed and/or left as wildlife feed.

The extent of terrestrial foodstuff sampling under Department of Energy Order 5400.5 is based on the projected dose to off-site populations via an air-to-crop-to-human pathway. The Weldon Spring site has a projected dose of <0.1 mrem/year to members of the public from this pathway. Therefore, a surveillance level will be established for agricultural monitoring. These results will be published in subsequent site environmental reports until resampling is performed.

Data from 1991 and 1992 indicate low levels of radionuclides (>1.0 pCi/g) in agricultural products. Air monitoring results show no detectable particulate emissions. Contaminated surface waters in the surrounding areas are not used to irrigate the agricultural fields. During 1993, air monitoring results did not show above background concentrations at the chemical plant perimeter or critical receptor locations. As a result of these conditions, monitoring will basically be reduced to surveillance. Sampling will be conducted only if air monitoring results indicate above background concentrations of radionuclides.

If sampling is required because air radionuclide concentrations are above background, or the St. Charles County well field is flooded, then samples will be taken from within the 16 km (10 mi) radius area. Samples equal to 1% of the total number of acres planted within the study area will be selected based on the type of crops currently planted. A minimum of four samples from each field will be collected. Weather conditions at the time of the release and distance from the contamination source will be taken into account when samples are collected. Grain samples may include corn, milo, or soybeans. Samples will be analyzed for Ra-226, Ra-228, Th-228, Th-230, Th-232, and total uranium. Collection will take place in accordance with the *Agricultural Sampling Plan* (Ref. 29).

3.4.5 Data Reporting

All information gathered from ecological surveys and monitoring activities will be used to determine ecological conditions at the Weldon Spring site. Survey data will be summarized to indicate population densities, species presence, usage patterns, and species diversities.

Data collected for biouptake studies will be used to determine exposures to human and animal populations. Dose calculations for humans will be based on ingestion of contaminated biota and will be performed as discussed in Section 6.2. Contaminants found in detectable concentrations in fauna, water, or sediments will be compared to data gathered from designated background locations. Statistical tests will be used to determine whether biota utilizing contaminated resources have significantly higher levels of contaminant concentrations than background biota at a 90% confidence level. The student's T-test or the Mann-Whitney U-test will be used based upon whether the distribution of data populations can be assumed to be normal. Preliminary tests of variance and normality will be determined by using the W-test and the F-test. For the W-test, data reported as nondetects or less than the detection limit (DL) will be quantified as DL/2, according to Environmental Protection Agency guidance (Ref. 12).

3.4.6 Collection Permits

The taking of specific fauna for scientific study is authorized by permits from the Missouri Department of Conservation and the U.S. Fish and Wildlife Service. Applications for permits, as required by sampling plans and State and Federal regulations, will be submitted prior to sample collection. Applicable State and local laws will be complied with during sample collection.

3.4.7 Natural Resource Trusteeship

At the WSSRAP, the Department of Energy is the primary Federal Natural Resource Trustee for the response actions being carried out under CERCLA. Other agencies that may act as co-trustees are the U.S. Department of the Interior (U.S. Fish and Wildlife Service) and the State of Missouri. The Department of Energy has notified these agencies of their status as co-trustees and of releases of CERCLA hazardous substances. The Department of Energy will also coordinate with the co-trustees on requests for further information regarding the potential damage to natural resources.

4 EFFLUENT MONITORING

The Weldon Spring Site Remedial Action Project (WSSRAP) has established two distinct monitoring programs which it characterizes as "effluent monitoring." These include airborne and waterborne effluents that could migrate beyond the site perimeters. These programs are described in the following sections.

4.1 National Pollution Discharge Elimination System Program

As a Federal facility, the WSSRAP is subject to, and complies with, Executive Order 12088, which requires all Federal facilities to comply with applicable pollution control standards. Further, U.S. Department of Energy Order 5400.1 states that the Department of Energy is "to conduct the Department's operations in compliance with the letter and spirit of applicable environmental statutes, regulations and standards." In this light, and since the WSSRAP contains point sources for waterborne pollutants, the project operates under Federal *Clean Water Act* requirements and Missouri Clean Water Commission Laws and Regulations. The Missouri Department of Natural Resources has issued National Pollutant Discharge Elimination System (NPDES) permits to the Department of Energy for the discharge of storm and other waters.

4.1.1 Goal

In addition to verifying compliance with NPDES permitted effluent limitations, the goal of the NPDES effluent monitoring program is to characterize the water releases from the WSSRAP. The Project Management Contractor will use this information to develop ways to minimize the discharge of waterborne contaminants from the site in accordance with the WSSRAP policy that all surface water will be closely monitored and treated, as necessary, to meet Federal and State requirements. Known sources of water on the site are listed in Table 4-1.

The remedial action goal is to clean up the site with no increase in contaminant discharge or degradation of the off-site streams. Therefore, the remedial action program includes source identification and periodic sampling and analyses which enable the Project Management Contractor to identify treatment requirements. The program uses studies to identify, analyze,

TABLE 4-1 Existing or Potential Water Sources

Source	Category[a]	Quantity
SITE		
Reffinate Pits No. 1[b] 2[b] 3[b] 4[b]	RAD RAD RAD RAD	1.3×10^6 gal 1.3×10^6 gal 7.7×10^6 gal 32.9×10^5 gal
Frog Pond	STR	500,000 gal maximum[b]
Ash Pond	STR/RAD	1,800,000 gal maximum[b]
Decontamination Pad	RAD	8.3 gpm[c]
TSA (10 ac)	RAD	9,800,000 gpy[b][c]
MSA (9 ac)	STR/RAD	8,800,000 gpy[b][c]
Sanitary Sewage Treatment Plant	SAN	4,000 gpd
Laboratory	TBD[d]	<10gpd
Sumps and Tanks	TBD[d]	<10,000 gpy[b]
Storm Water Discharges (200 ac)	STR	185,000,000 gpy[c]
Worker Toilets	SAN	...[f]
Worker Showers	RAD	1.7 gpm[c]
Decontamination Facilities	RAD	<1,000 GPD[c]
Retention Basins	STR/RAD	TBD[b]
Dust Control Water	STR	Unknown
Mud Wash Water	STR	Unknown
QUARRY		
Quarry Sump	RAD	3,000,000 gal[b]
Quarry Storm Water (9 ac)	RAD	8,800,000 gpy[c]
Quarry Washdown[c]	RAD	2.5 gpm
Decontamination Pad[c]	RAD	2.0 gpm
Worker Toilets	SAN	...[f]
Worker Showers	TBD[d]	0.6 gpm[c]

TABLE 4-1 Existing or Potential Water Sources (Continued)

Source	Category[a]	Quantity
VICINITY PROPERTIES		
Femme Osage Slough	STR	Unknown
Busch Lake No. 34	STR	Unknown
Busch Lake No. 35	STR	Unknown
Busch Lake No. 36	STR	Unknown

(a) Category is based on the primary treatment method required and the existing natural uranium concentration.
(b) Part of storm water
(c) While operating
(d) Case-by-case basis
(e) Based on average annual precipitation
(f) Removed off site

MSA Material Storage Area
RAD Complex Treatment; Uranium - greater than 600 pCi/l
SAN Biological Treatment; Uranium - background to 30 pCi/l
STR Sediment Treatment; Uranium - less than 600 pCi/l
TBD To Be Determined
TSA Temporary Storage Area

and evaluate appropriate measures for control of runoff, erosion, sediment, and contamination sources. From these studies, procedures and plans are developed for appropriate control and maintenance measures. Control measures for storm water are used to minimize erosion and remove sediment to a level commensurate with the "best practical technology."

4.1.2 NPDES Effluent Evaluation

Required effluent monitoring at the Weldon Spring Chemical Plant includes effluent from four storm water outfalls; one treated sanitary sewer outfall from the administration building treatment plant, one hydrostatic test water outfall, and one site water treatment plant outfall. The site water treatment plant is designed to treat the various contaminated waters at the chemical plant. The hydrostatic test water permit is for use during construction of the site water treatment plant Train II. Effluent monitoring is also required at the borrow area and the borrow area haul road, although there are no specified outfalls or parameters to be monitored. Required effluent monitoring at the Weldon Spring Quarry consists of one quarry water treatment plant

effluent outfall. The quarry water treatment plant treats contaminated water from several sources: (1) quarry pond, (2) storm water, and (3) equipment decontamination operations. All of these discharges are monitored in accordance with NPDES permits issued for the Weldon Spring site by the Missouri Department of Natural Resources.

Existing or potential water sources for permitted outfalls at the chemical plant and raffinate pits are listed in Table 4-1. Estimates of the quantity of water from the sources are described in rates or total volume, depending on the source. The current treatment category is also provided for each source. Certain waters, however, are not clearly characterized and will require monitoring on a case-by-case basis to determine what treatment they will need.

4.1.2.1 NPDES Permits. The WSSRAP has four active NPDES permits issued by the Missouri Department of Natural Resources:

- Permit MO-0107701, for the chemical plant.
- Permit MO-0108987, for the quarry.
- Permit MO-G679035, for site water treatment plant Train II construction hydrostatic test water.
- Permit MO-R100869, for the borrow area and haul road.

Discharge monitoring reports are required as compliance deliverables for Permits MO-0107701, MO-0108987, and MO-G679035. Permit MO-R100869 requires only that monitoring be conducted and records be retained. Reporting is required only under certain circumstances. The annual site environmental report and quarterly environmental data summaries also summarize the data from the outfalls covered by these permits. Discharge data are also reported to EG&G at Idaho Nuclear Engineering Laboratories and to the Department of Energy Oak Ridge Environmental Protection Division, as detailed in the *Effluent Information System (EIS) and Onsite Discharge Information System (ODIS) Users Manual* (Ref. 13).

NPDES permit MO-0107701 was originally issued to the Department of Energy on July 29, 1988, for the discharge of surface water runoff through five outfalls (NP-0001 through

NP-0005) from the chemical plant. A sixth outfall (NP-0006) was added on November 4, 1988, for discharge from the sewage treatment plant at the administration building. A seventh outfall (NP-0007) was added on October 1, 1990, for the discharge of treated effluent from the site water treatment plant, which is used to treat contaminated water during remedial activities at the chemical plant. The permit was reissued on March 4, 1994, at which time storm water outfall NP-0010 was added to monitor the construction material storage area and outfall NP-0004 was deleted. Outfall NP-0001 has been effectively removed by removing the pipe leading to the outfall; however, approximately 80 ft of pipe remains. This pipe has been capped on both ends and backfilled. Until the remaining pipe is removed, and MDNR deletes outfall NP-0001 from the permit, "no discharge" will be reported for this outfall in monitoring reports. Figures 4-1 and 4-2 show the location of the permitted outfalls for the chemical plant.

NPDES permit MO-0108987 was originally issued to the Department of Energy on May 5, 1989, for the discharge of treated effluent from the quarry water treatment plant, which is used to treat contaminated water during remedial activities at the quarry. This permit expired on May 4, 1994, and was reissued on June 10, 1994. Figure 4-2 shows the location of the permitted outfall (NP-1001) for the quarry.

NPDES Permit MO-R100869 was issued to the Department of Energy on September 1, 1994, for discharge of storm water from the borrow area and the borrow area haul road. The permit does not specify outfalls.

NPDES Permit MO-G679035 was issued to the Department of Energy on August 31, 1994, for discharge of hydrostatic test water during the construction of the site water treatment plant Train II. The water will, in most cases, flow to outfall NP-0005.

4.1.2.2 NPDES Permitted Parameters. Monitoring parameters for the storm water outfalls (NP-0002, NP-0003, NP-0005, and NP-0010) and the administration building sanitary sewage treatment plant outfall (NP-0006) are listed in Table 4-2. Permitted parameters for outfall NP-0007 of the site water treatment plant and NP-1001 of the quarry water treatment plant are shown on Table 4-3. The treated water is to be analyzed for the specified parameters, and compliance demonstrated, before each batch of treated effluent is discharged to the Missouri

TABLE 4-2 NPDES Permit Monitoring Requirements - Sanitary and Storm Water Sources

Parameters	Units	Permitted Limit	Frequency
Site NP-0002, NP-0003, NP-0005 and NP-0010[d] (see Table 4-6 also)[e]			
Flow	gpd	Monitor	once/month
Settleable Solids	ml/l/hr	1.0	once/month
Total Suspended Solids	mg/l	Monitor[c]	once/month
Nitrate + Nitrite as N	mg/l	Monitor	once/month
Uranium, total	mg/l	Monitor	once/month
Gross Alpha	pCi/l	Monitor	once/month
pH	SU	6-9	once/month
Site NP-0006			
Flow	gpd	Monitor	once/month
Biochemical Oxygen Demand	mg/l	10/15[a]	once/quarter
Total Suspended Solids	mg/l	15/20[a]	once/quarter
pH	SU	6-9	once/quarter
Fecal Coliform	Colonies/100 ml	400/1,000[b]	once/quarter

(a) Monthly average/weekly average
(b) Monthly average/daily maximum
(c) Limit is 50 mg/l if erosion control is not designed for 1 in 10 year, 24 hour storm.
(d) Described in permit as outfall 008
(e) Outfall NP-0001 remains on the permit, but discharge has been effectively eliminated; "no discharge" will be reported for this outfall in monitoring reports until the MDNR removes the outfall from the permit.

TABLE 4-3 NPDES Permit Monitoring Requirements - Quarry Water Treatment Plant and Site Water Treatment Plant

Parameter	Permit Limit	Frequency	Sample Type
Site NP-0007 and Quarry NP-1001			
Flow	Monitor, gpd	once/batch	24-hr total
Chemical Oxygen Demand	90/60 mg/l[a]	once/batch	grab
Total Suspended Solids	50/30 mg/l[a]	once/batch	grab
pH	6-9 standard units	once/batch	grab
Arsenic, Total	0.10 mg/l	once/batch	grab
Chromium, Total	0.10 mg/l	once/batch	grab
Copper, Total: Quarry	1.0 mg/l	once/month	grab
Lead, Total	0.1 mg/l	once/batch	grab
Manganese, Total	0.1 mg/l	once/batch	grab
Mercury, Total	0.004 mg/l	once/batch	grab
Selenium, Total	0.02 mg/l	once/batch	grab
Cyanide, Amenable	0.0075 mg/l	once/batch	grab
2,4-DNT	0.22 µg/l	once/batch	grab
Fluoride, Total	4.0 mg/l	once/batch	grab
Nitrate + Nitrite as N: Site	20 mg/l	once/batch	grab
Nitrate + Nitrite as N: Quarry	Monitor, mg/l	once/batch	grab
Sulfate as SO_4	500 mg/l	once/batch	grab
Chloride	Monitor, mg/l	once/batch	grab
Gross Alpha	Monitor, pCi/l	once/batch	grab
Gross Beta	Monitor, pCi/l	once/batch	grab
Uranium, Total	Monitor, pCi/l[b]	once/batch	grab
Ra-226	Monitor, pCi/l	once/month	grab
Ra-228	Monitor, pCi/l	once/month	grab
Th-230	Monitor, pCi/l	once/month	grab
Th-232	Monitor, pCi/l	once/month	grab
Priority Pollutants	Monitor, mg/l	once/year	grab

TABLE 4-3 NPDES Permit Monitoring Requirements - Quarry Water Treatment Plant and Site Water Treatment Plant (Continued)

Parameter	Permit Limit	Frequency	Sample Type
Whole Effluent Toxicity[d]	(c)	once/quarter	grab
Polonium 210: Quarry	Monitor, pCi/l	once/year	grab
Actinium 227: Quarry	Monitor, pCi/l	once/year	grab
Radon: Quarry	Monitor, pCi/l	once/year	grab
In-Stream River Sediment SD-4090 and SD-4091			
Uranium, Total	Monitor, pCi/g	once/year	grab

(a) Daily maximum/monthly average
(b) Water will not be discharged if greater than 100 pCi/l
(c) No statistical significance was observed between mortality observed in the effluent test concentration and the upstream receiving water control at a 95% confidence level
(d) Requires upstream receiving water control sample to be collected from Missouri River at location SW-1011

River. The treated water from the site and quarry water treatment plants will be monitored in the effluent basins prior to discharge.

In addition to the batch and monthly parameters for NP-0007 and NP-1001, other parameters are periodically monitored. Monitoring for priority pollutants (Table 4-4) is required for these discharges once per year. The priority pollutants are organic compounds that are included in the following major categories: volatile organic compounds, semi-volatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs), as well as certain metals, total cyanide, and total phenols. Additional periodic monitoring is required for other parameters such as whole effluent toxicity (WET) screens, supplemental monitoring of additional radionuclides, and analysis of river sediment for uranium.

To encourage good erosion control practices, the special condition sections of both NPDES permits place limitations on total suspended solids and pH for runoff from material storage or construction areas that do not have treatment designed for a one in 10 year, 24 hour storm. These parameters are monitored at the storm water outfalls.

TABLE 4-4 NPDES Permit Monitoring Requirements - Priority Pollutant List Quarry (NP-1001) and (Site NP-0007)

Acenaphthylene	1,3-dichloropropylene
Acenaphthene	4-chlorophenyl phenyl ether
Acrolein	4-bromophenyl phenyl ether
Acrylonitrile	Bis (2-chloroisopropyl) ether
Benzene	Bis (2-chloroethoxy) methane
Benzidine	Methylene chloride (dichloromethane)
Carbon Tetrachloride (tetrachloromethane)	Methyl chloride (chloromethane)
Chlorobenzene	Methyl bromide (bromomethane)
1,2,4-trichlorobenzene	Bromoform (tribromomethane)
Hexachlorobenzene	Dichlorobromomethane
1,2-dichloroethane	Chlorodibromomethane
1,1,1-trichloroethane	Hexachlorobutadiene
Hexachloroethane	Hexachlorocyclopentadiene
1,1-dichloroethene	Isophorone
1,1,2-trichloroethane	Naphthalene
1,1,2,2-tetrachloroethane	Nitrobenzene
Chloroethane	2-nitrophenol
Bis (2-chloroethyl) ether	4-nitrophenol
2-chloroethylvinyl ether	2,4-dinitrophenol
N-nitrosodi-n-propylamine	4,6-dinitro-o-cresol
Pentachlorophenol	N-nitrosodimethylamine
Phenol	N-nitrosodiphenylamine
Bis (2-ethylhexyl) phthalate	Phenanthrene
Butyl benzyl phthalate	dibenzo(a,h)anthracene
Di-n-butyl phthalate	Indeno (1,2,3-cd) pyrene
Di-n-octyl phthalate	Pyrene
Diethyl phthalate	Tetrachloroethylene
Dimethyl phthalate	Toluene
benzo(a)anthracene	Trichloroethylene

TABLE 4-4 NPDES Permit Monitoring Requirements Priority Pollutant List Quarry NP-1001 and Site NP-0007 (Continued)

Benzo(a)pyrene	Vinyl chloride (chloroethylene)
3,4-benzofluoranthene (benzo(b)fluoranthene)	Aldrin
benzo(k)fluoranthene	Dieldrin
Chrysene	Chlordane
Anthracene	4,4'-DDT
benzo(ghi)perylene	4,4'-DDE
Fluorene	4,4'-DDD
2-chloronaphthalene	Alpha-endosulfan
2,4,6-trichlorophenol	Beta-endosulfan
p-chloro-m-cresol	Endosulfan sulfate
Chloroform (trichloromethane)	Endrin
2-chlorophenol	Endrin aldehyde
1,2-dichlorobenzene	Heptachlor
1,3-dichlorobenzene	Heptachlor epoxide
1,4-dichlorobenzene	Alpha-BHC
3,3'-dichlorobenzidine	Beta-BHC
1,1-dichloroethylene	Gamma-BHC
1,2-trans-dichloroethylene	Delta-BHC
2,4-dichlorophenol	PCB-1242 (Arochlor 1242)
1,2-dichloropropane (1,3-dichloropropene)	PCB-1254 (Arochlor 1254)
2,4-dimethylphenol	PCB-1221 (Arochlor 1221)
2,4-dinitrotoluene	PCB 1232 (Arochlor 1232)
2,6-dinitrotoluene	PCB-1248 (Arochlor 1248)
1,2-diphenylhydrazine	PCB-1260 (Arochlor 1260)
Ethylbenzene	PCB-1016 (Arochlor 1016)
Fluoranthene	Toxaphene
Antimony	Arsenic
Beryllium	Cadmium
Chromium	Copper
Lead	Mercury

TABLE 4-4 NPDES Permit Monitoring Requirements Priority Pollutant List Quarry NP-1001 and Site NP-0007 (Continued)

Nickle	Selenium
Silver	Thallium
Zinc	Cyanide, Total
Phenols, Total	

NPDES Permit MO-R100869, for the borrow area and haul road, does not specify outfalls, parameters, or frequency of monitoring; however, the ES&H staff will sample parameters as specified in Table 4-5. Reporting limits will be self imposed as footnoted in the table. Outfalls will be chosen to monitor disturbed areas until they are stabilized.

NPDES Permit MO-G679035, for hydrostatic test water from site water treatment plant Train II construction, requires that oil and grease and total suspended solids be monitored. The parameters, limits, frequency, and sampling type for these discharges are listed in Table 4-6. A discharge monitoring report must be submitted to MDNR within 30 days of each discharge event.

TABLE 4-5 NPDES Permit MO-R100869, Monitoring Requirement - Borrow Area and Haul Road Storm Water

Parameter	Reporting Level	Frequency	Sample Type
Settleable Solids	2.5 ml/l/hr[a]	once/quarter	grab
Oil and grease[b]	10 mg/l [a]	once/quarter	grab

(a) This is not an effluent limitation but a self imposed reporting level. If settleable solids exceed 2.5 ml/l/hr or oil and grease exceeds 10 mg/l, the Missouri Department of Natural Resources must be informed in writing within five days of receipt of results.

(b) At selected locations

TABLE 4-6 NPDES Permit MO-G679035, Monitoring Requirements - SWTP Train II Construction Hydrostatic Test Water

Parameter	Permit Limit	Frequency	Sample Type
Flow	*	**	Total
TSS	*	**	Grab
Oil and Grease	*	**	Grab

* Monitoring requirements only
** One sample per discharge event taken during the first 60 minutes of event.

4.1.3 Description of Effluent Monitoring Program

The monitoring program is best presented in tabular form. Tables 4-2 through 4-6 summarize the permit requirements for the four permits. The land disturbance NPDES permit, MO-R100869, will have a varying number of outfalls. The other outfalls are the quarry and site water treatment plant outfalls, the sanitary sewage treatment plant outfall, four storm water outfalls, and a hydrostatic test water outfall.

4.1.3.1 Routine Monitoring Requirements. As the tables indicate, the outfalls are sampled at various frequencies. The storm water outfalls are sampled once per month as they discharge. Each batch of treated water in the effluent ponds at the water treatment plants is sampled, and the water is held until compliance with the permit standards is demonstrated. Sewage treatment plant effluent is sampled once per quarter. Hydrostatic test water is sampled once per discharge and borrow area and haul road storm water will be sampled at least once every three months. Several parameters in the tables show "monitoring only", where no effluent standard is applied.

The administration building sewage treatment plant outfall, NP-0006, involves treatment of sanitary waste with no radioactive contamination. The permitted limits are typical of a domestic treatment facility, which discharges to a losing stream. The requirements are considered a high level of treatment, i.e., monthly averages of 10 mg/l for biochemical oxygen demand and 15 mg/l for total suspended solids. The storm water outfall permit requirements have been established to monitor storm water discharges and confirm that site activities are not adversely affecting water quality. Storm water also includes water pumped from the material

storage area pond, excavation trenches and pits, and potable water used for dust control and mud removal. The uranium contamination levels in storm water are highly variable, but are considered to be below the correction level because the concentration is historically less than the Department of Energy derived concentration guideline of an annual average of 600 pCi/l for natural uranium. A primary contaminant encountered in the surface water is sediment derived from erosion occurring during overland or channel flow. This process has been occurring for years, but has been minimized by natural vegetation that established itself after the facility ceased operation and the effective use of erosion control practices. The only imposed effluent limits dealing with controlling erosion and sediment during remedial activities are: settleable solids levels must be 1 ml/l/hr or less and total suspended solids (if no erosion control) must be 50 mg/l or less. Storm water discharge levels for uranium have been monitored over a significant time and vary considerably. The established goal for uranium concentration in rain-induced discharges is to not exceed historic levels, and to remain below the derived concentration guideline. New or additional contaminant controls must be designed to preclude discharges that would exceed the derived concentration guideline of an annual average of 600 pCi/l natural uranium established by Department of Energy Order 5400.5.

The contaminated water in the quarry sump, raffinate pits, and potentially in other miscellaneous waters, requires treatment to the high levels shown in Table 4-3. The high levels of treatment imposed by the permit are due to the desire of the State to meet standards associated with drinking water supplies. Although the Department of Energy goal for uranium concentration in water is to discharge less than an annual average of 600 pCi/l, the treatment required to remove nonradioactive contamination also removes uranium and allows for a significantly lower uranium level for these discharges. The lower level is based on the as-low-as-reasonably-achievable (ALARA) concept, which in this case means treatment to a level of an average of 30 pCi/l, not to exceed a maximum of 100 pCi/l, which is cost effective and technically achievable.

Flow is measured continuously at Outfalls NP-0002, NP-0003, NP-0005, NP-0007, and NP-1001. The outfall flows are measured by flow recorders with an accuracy of at least ±10%. The meters will be calibrated before use and recalibrated annually and after actions that could affect calibration in accordance with WSSRAP standard operation procedure.

4.1.3.2 Intermittent Monitoring Requirements. In response to regulatory and public concerns, the Department of Energy has agreed to additional monitoring associated with discharges from the water treatment plant. River sediment will be collected annually from the two locations shown on Figure 4-2 and analyzed for total uranium. The quarry water treatment plant effluent will be monitored annually for Po-210, Ac-227, and radon. Preoperational monitoring for these parameters has been performed on the quarry pond water (see Table 4-3). When required for operational purposes, additional parameters may be monitored in the quarry and site water treatment plant effluent.

4.1.3.3 Emergency Monitoring Requirements. In the event that contaminated water is accidentally released, or in the event of spills, effluent monitoring will be conducted. Parameters will be determined on a case-by-case basis.

4.1.3.4 Upstream Source Identification Needs. Sources of contamination are present upstream of the three main storm water discharges. These main discharges are located at the weir downstream of Frog Pond (NP-0002), the weir downstream of Ash Pond (NP-0003), and the Southeast Drainage weir (NP-0005). Remediation activities above these outfalls have an influence on the character of the discharges that is not fully understood. The variability of these discharges can best be assessed by a concerted effort to monitor the upstream ditches, storm sewers, etc. Monitoring of these upstream facilities is not required by the permit, but since they are also sources for contamination of the outfalls, they will be monitored. Monitoring can be used to fully understand the effects of remediation efforts on waste characteristics at the permitted outfalls. The results of upstream sampling can then be used to determine ways to reduce contaminant levels at the outfalls to acceptable levels. Also, explanations of violations of permit limits are required by the Missouri Department of Natural Resources when the sampling results vary significantly from the norm, and upstream water analysis data are often needed for these explanations. Three upstream locations have been identified for monthly water monitoring. This monitoring will take place at the same time the monthly ongoing NPDES sample is collected so that a direct comparison can be made. The discharge from Frog Pond will be sampled in conjunction with NP-0002; the discharge from Ash Pond will be sampled in conjunction with NP-0003; and the discharge from NP-0107 will be sampled in conjunction with NP-0005 (Table 4-7). These locations are shown in Figure 4-1. Sample parameters will be total uranium and gross alpha. If there is no flow through the discharge pipes from Frog Pond, Ash Pond, or NP-0107 during NPDES sampling, no sample will be collected for that month. As site

conditions change, additional parameters may be monitored at these locations on a case-by-case basis. Other sample locations will be selected on a case-by-case basis and the water will be analyzed for uranium on the site KPA.

TABLE 4-7 Upstream Monitoring in Conjunction with NPDES Monitoring at NP-0002, NP-0003, and NP-0005

Parameters	Units	Frequency
Upstream Sampling Locations: Frog Pond, (SW-2011), Ash Pond, (SW-2010), and NP-0107		
Flow	gpd	Once per month during collection of NPDES samples
Uranium, total	pCi/l	Once per month during collection of NPDES samples
Gross Alpha	pCi/l	Once per month during collection of NPDES samples

4.1.4 Storm Water Requirements and Needs

4.1.4.1 Current Erosion and Sediment Control Requirements. Permits for both the site and quarry place limitations on total suspended solids and pH levels for runoff from material storage and construction areas if this runoff is not treated in a facility that is designed, constructed, and operated to treat the volume of water associated with a 10-yr, 24-hr rainfall event. The total suspended solids must not exceed 50 mg/l, and the pH must remain in the range of 6.0 to 9.0 standard units at the outfalls. Additionally, limits for settleable solids are 1.0 ml/l/hr and for pH are 6.0 to 9.0 for the storm water outfalls. The *WSSRAP Chemical Plant Surface Water and Erosion Control Report* (Ref. 30) and ES&H Procedure 4.2.1, *Erosion Control Survey*, ensure that erosion control measures are designed and maintained to control erosion for 1 in 10 year 24-hour storms.

To evaluate the effectiveness of erosion control measures during precipitation events, the Department of Energy and Project Management Contractor will periodically collect surface water samples downstream of construction or material storage areas for analysis of settleable solids and uranium. The samples will have the prefix of SR. Sample locations will be selected on a case-by-case basis. Total suspended solids, settleable solids, and pH measurements from the

permitted outfalls are reported to the Missouri Department of Natural Resources in the regular *Discharge Monitoring Report*.

4.1.4.2 Material Staging Area Pond and Ash Pond Monitoring. Surface water location SW-2015, the material staging area basin, has been added to the environmental monitoring schedule in order to determine the contaminant levels in runoff produced from precipitation falling on materials at the staging area and collected in a holding basin. This impoundment is pumped periodically into the Ash Pond diversion channel, which ultimately discharges into Busch Lake 35. This location will be monitored for total uranium, Ra-226, Ra-228, Th-228, Th-230, Th-232, PAHs, As, Cr, Tl, Pb, PCBs, and 2,4,6-TNT on a quarterly basis. Monitoring may be reduced or eliminated as storage activity decreases and/or previous monitoring shows no contaminant levels of concern.

Surface water location SW-2010, Ash Pond, has been added to the environmental monitoring schedule to determine the contaminants in the pond water produced from storm water runoff from the pond watershed. Ash Pond discharges to Outfall NP-0003 and ultimately to Busch Lake 35. This location will be monitored for total uranium, Ra-226, Ra-228, Th-228, Th-230, Th-232, 2,4,6-TNT, PCBs, PAHs, and metals: As, Cr, Pb, and Tl on a quarterly basis. Monitoring may be reduced or eliminated based on site activity and/or previous sampling results.

4.1.4.3. Site Storm Water Outfall Baseline Monitoring. In order to evaluate proposed release criteria for ponded storm water during foundation removal, an expanded list of parameter analyses will be conducted for water from storm water outfalls NP-0002, NP-0003, and NP-0005, starting with the monthly sample collected during September 1994. The expanded list of analyses will be conducted monthly for six consecutive months. The parameters will include the permitted parameters and nitroaromatics, HSL metals, lithium, molybdenum, Ra-226, Ra-228, Th-228, Th-230, Th-232, PCBs, and polynuclear aromatic hydrocarbons. This baseline data will also be used to determine if pollutant levels are increasing during foundation removals.

4.1.4.4 Retained Storm Water Monitoring. Storm water that is retained in excavations, trenches, tanks, barrels, secondary containment, retention basins, etc. is managed in accordance with the *Surface Water Management Plan* (Ref. 31) and the surface water management procedure. These documents require that PMC personnel determine, using site

characterization data and process knowledge, whether or not the retained storm water is to be sampled, and if sampled, for which parameters. The procedure specifies criteria to be used to determine if the retained storm water may be released to the surface or must be treated before release.

4.2 Airborne Effluent and Environmental Surveillance Program

This section documents the rationale and requirements of the programs that will be implemented to monitor airborne emissions from the WSSRAP and to evaluate the impacts of those emissions on the public and the environment. The WSSRAP has two diffuse sources of airborne radiological emissions: the chemical plant and the quarry. In 1995, the WSSRAP will have the following point sources: site water treatment plants, quarry water treatment plant, and chemical stabilization/solidification pilot facility. Emissions from these sources and the estimated exposures are predicted to be low. The emissions monitoring program is tailored to be commensurate with the low potential for exposure and to meet the requirements of Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide* (Ref. 3).

4.2.1 Source Assessment

As required by Department of Energy guidance, an assessment of the sources was conducted. The assessment included documenting the different radionuclides that could be released from the sources and their concentrations. The Department of Energy guidance also requires that these sources be assessed under normal operating conditions with loss of emissions controls. In addition, the assessment addressed the factors that could contribute to the resuspension of contaminants. The assessment provided a basis for the airborne emissions monitoring program and enabled the design to provide timely, representative, and adequately sensitive monitoring results. The loss of emissions controls for the diffuse sources at the WSSRAP would require the affected remediation activities to halt. Loss of emission controls used at the WSSRAP, such as water spray, cleaning of surfaces, high efficiency particulate air (HEPA) filtration, could not go unnoticed, and as a result, the loss of emission controls would result in no emissions.

4.2.1.1 Point Source Assessment. The point sources at the WSSRAP include the site Train 1 and quarry water treatment plant filter press ventilation system exhaust vents, the

site Train 2 water treatment plant distillate tank vent, and the chemical stabilization/solidification pilot facility.

The site water treatment plant will treat contaminated water from the raffinate pits, and the quarry water treatment plant will treat quarry sump waters. Filter press operation at each of the plants is a source of potential emissions. The filter presses are isolated in rooms that are ventilated through HEPA filters. Engineering calculations and CAP-88 PC model results show that the exhaust vents from either of the treatment plant filter press room ventilation systems will not produce an annual dose greater than 0.1 mrem to any member of the public. The engineering calculations are contained in the 1993 National Emission Standards for Hazardous Air Pollutants plan.

The site water treatment plant Train 2 will treat water in Raffinate Pits 1 and 3 which contain nitrates. The plant will use a vapor compression distillation system. Because the vapor compression distillation system is closed to the atmosphere the potential for air particulate emissions are insignificant. The distillate tank is vented through a carbon radon adsorber system which has the capability of in place regeneration. Engineering calculations and ISCST2 model results show that uncontrolled radon emissions would not produce an annual dose greater than 0.1 mrem to any member of the public.

The chemical stabilization/solidification pilot facility will treat Raffinate Pit 3 sludges. The facility utilizes an off-gas collection system that collects all air and gas emitted by the process vessels, thus closing the process to the atmosphere. The off-gases containing radon are stored in a decay vessel prior to venting through HEPA filter system. Engineering calculations and ISCST2 model results show that the venting of the decay vessel will not produce an annual dose greater than 0.1 mrem to any member of the public. Modeling was also performed for loss of emission controls of the decay vessel. For modeling purposes the loss of emission controls assumed the evacuation of a full decay vessel in a short time period. Engineering calculations and ARCHIE model results show that the maximum dose received by a member of the public would be less than 0.1 mrem based on this catastrophic event.

4.2.1.2 Weldon Spring Quarry Diffuse Source Assessment. The quarry diffuse source is a 3.6 ha (9-acre) limestone quarry located approximately 6.4 km (4 mi) south-southwest of the chemical plant area. The quarry is essentially in a closed basin; surface water

within the rim flows to the quarry floor and into a pond which covers approximately 0.2 ha (0.5 acre). The quarry was used as a disposal area for dinitrotoluene (DNT) and trinitrotoluene (TNT) process wastes, uranium, radium, and thorium residues and the associated daughter products from on-site and off-site processing of uranium and thorium, and building rubble and soils from the demolition of a uranium processing facility in St. Louis, Missouri. Airborne emissions from the quarry result from the wind-blown resuspension of radioactive particulates from quarry soils and resuspension of radioactive particulates due to remediation activities at the quarry, such as the operation of heavy equipment and the excavation of soils. In addition, there are also airborne releases of Rn-220 (thoron gas) and Rn-222 (radon gas) from the quarry due to the decay of Ra-224 and Ra-226 (daughters of Th-232 and U-238) decay chain, respectively.

Characterization of the quarry soils has been completed in support of the *Feasibility Study for Management of the Bulk Wastes at the Weldon Spring Quarry* (Ref. 4). The radiological contaminants in the quarry are uranium and thorium and their respective daughters. Concentrations range from 3.0 pCi/g to 1600 pCi/g U-238, < 1.0 pCi/g to 2780 pCi/g Ra-226, 0.7 pCi/g to 36 pCi/g Th-232, < 1.0 pCi/g to 2200 pCi/g Ra-228, and < 1.0 pCi/g to 6800 pCi/g Th-230. A study was conducted to determine the lung solubility class of quarry bulk wastes. This data will allow a more accurate assessment of dose equivalents resulting from an inhalation uptake.

Statistical evaluation of the results of effluent monitoring at the quarry during 1993 indicated no evidence that levels at any of the perimeter air particulate samplers were greater than background. Statistical analysis also indicated that levels at five of the eight radon track etch detectors were greater than background. The calculated effective dose equivalent to a hypothetical maximally exposed individual from the airborne emissions from the quarry was 1.9 mrem (Ref. 14). The 1.9 mrem dose calculated for the hypothetical individual from the airborne inhalation pathway was exclusively due to radon emissions. Conservative assumptions were used to calculate the hypothetical effective dose equivalent. It was assumed that the radon daughter equilibrium ratio at Highway 94, where the individual walked twice daily, was 50% and that the concentration of radon at Highway 94 was the same as the concentration measured within the quarry controlled area. A DOE functional appraisal was conducted at the WSSRAP in 1994. The appraisal found that the scenario described above used in estimating the dose to the hypothetical maximally exposed individual (MEI) at the quarry was unrealistically conservative. Therefore, the exposure scenario for the hypothetical MEI at the quarry will be

changed to involve hiking near the northeast perimeter of the quarry. From published information (Ref. 7) hiking is the predominant activity among Weldon Spring Wildlife Area visitors, with an average of 2.5 hours spent per year. If this average is increased by a factor of two, an exposure scenario can be based on the hypothetical MEI who hikes around the northeast quarry perimeter 5 hours per year.

In August 1993, a major remediation project involving the removal and controlled temporary storage of approximately 180,000 m^3 (140,000 cu yd) of contaminated bulk wastes began. The bulk wastes to be excavated from the quarry will have significantly higher concentrations of radiological contaminants. Engineering controls will be used during removal to restrict the release of airborne particulates from the quarry. The *Feasibility Study for Management of the Bulk Waste at the Weldon Spring Quarry* (Ref. 4) provides estimates of public dose resulting from quarry bulk waste removal. The dose estimate from airborne radioactive particulates for a hypothetical individual who walks along Missouri State Route 94 twice a day, during the 1.25 years that will be required to remove the bulk waste, was 1.3 mrem. The dose estimate calculated for a nearby resident with an assumed 100% occupancy time during the 1.25 years was 0.18 mrem.

Radon concentrations measured at the quarry have historically been above background because the radium concentrations in bulk wastes are greater than background concentrations and because the quarry is a large depression in the terrain with side walls ranging from 3 m to 15 m (10 ft to 50 ft) high which allows radon concentrations to build up within the quarry. Above background radium concentrations, in conjunction with stable meteorological conditions, which tend to trap emanating radon within the quarry, result in the measured above background concentrations at the perimeter. The *Feasibility Study for Management of the Bulk Wastes at the Weldon Spring Quarry* (Ref. 4) evaluates the potential emissions of radon during the excavation of the bulk waste. The results of the study indicate that a dose of 1.0 mrem would be received by the hypothetical individual who walked along Highway 94 twice a day for 1.25 years. Although the dose estimate in the feasibility study is lower than the calculated dose to the hypothetical maximally exposed individual from airborne emissions during 1990, it is based on more realistic assumptions. A daughter equilibrium ratio of 10% was assumed based on measured radon and radon daughter concentrations taken during 1989 (Ref. 9), and the concentration at Highway 94 was calculated using the computer model MILDOSE (Ref. 15) which was modified to more accurately assess airborne concentrations resulting from releases

from large areas (Ref. 16). The radon dose calculated for a nearby resident in the feasibility study was 2.3 mrem.

4.2.1.3 Weldon Spring Chemical Plant and Raffinate Pits Diffuse Source Assessment. The Weldon Spring Chemical Plant and raffinate pits diffuse source encompasses 87 ha (217 acres) on which approximately 45 building foundations, four raffinate pits, the temporary storage area (TSA), and the material staging area (MSA) are located. Airborne emissions from the chemical plant result from windblown resuspension of radioactive particulates from site soils and chemical plant building material/debris, and resuspension of radioactive particulates from site operations such as bulk waste placement and soil excavation. In addition, there are airborne emissions from the chemical plant due to the transformation of Ra-224 and Ra-226 (daughters of Th-232 and U-238), into Rn-220 (thoron gas) and Rn-222 (radon gas).

Characterization of the buildings and soils has been completed in support of the site remedial investigation and feasibility study. Radiological contaminants in the buildings are uranium, thorium, and their daughters. Concentrations in bulk samples collected from the buildings range from background levels to 20,000 pCi/g U-238, 190 pCi/g Ra-226, 5,400 pCi/g Ra-228, and 540 pCi/g Th-230. Particle analysis and a lung solubility study was conducted using materials from the chemical plant. Bulk samples from process buildings and the raffinate pits were collected for the study.

The site soils characterization indicates that the contaminants in the soils are uranium and thorium and their associated daughters. Most of the 87 ha (217 acres) of the chemical plant site have above background concentrations of uranium (>1 pCi/g). Concentrations range from 0.3 pCi/g to 2,259 pCi/g U-238, 0.6 pCi/g to 452 pCi/g Ra-228, and 0.3 pCi/g to 123 pCi/g Th-230.

The buildings demolition was completed in 1994 and the foundations removal work is scheduled for 1996. Therefore, the potential release of airborne contaminants from these mechanisms will not be present in 1995.

The building materials placed on the MSA have been washed, wet wiped, and/or HEPA vacuumed to minimize removable contamination. This was done to minimize migration of contaminants via air and water.

As mentioned in Subsection 4.2.1.2, placement of the quarry bulk waste at the temporary storage area was initiated during August of 1993. Engineering controls such as the use of water to control airborne particulate emissions will also be used. Radon gas emissions at the temporary storage area due to the higher radium concentrations in the bulk waste will be minimized through the use of an attenuating cover material. In the *Feasibility Study for Management of the Bulk Waste at the Weldon Spring Quarry* (Ref. 4), a dose estimate for airborne emissions from the bulk waste at the temporary storage area was calculated. In the study, a dose estimate was calculated for a worker in an on-site office building and a student at Francis Howell High School. The calculated dose to the office worker was 0.08 mrem from radon, and 0.84 mrem from radioactive particulates for a total of 0.92 mrem. The calculated dose for the student was 0.05 mrem from radon, and 0.05 mrem from radioactive airborne particulates for a total of 0.1 mrem.

Action levels have been established for airborne radioactive particulate concentration levels, radon concentrations, and total dust concentrations. These action levels have been established to control emissions to levels that are as low as reasonably achievable (ALARA), and are discussed in detail in Section 4.2.2.

4.2.2 Airborne Monitoring Programs

To effectively monitor the two WSSRAP diffuse sources that have been described, three air monitoring programs will be utilized: site specific monitoring, perimeter monitoring, and critical receptor monitoring. These three programs are designed to meet the requirements for airborne effluent monitoring and environmental surveillance as specified in the *Regulatory Guide* (Ref. 3) and Department of Energy Orders 5400.1 and 5400.5.

Changes in the airborne monitoring program include the addition of 22 electret radon monitoring locations and the deletion of five alpha track radon monitoring locations. Also, the two continuous radon gas monitors have been replaced with continuous radon progeny monitors.

Locations, equipment, sampling time, minimum detection levels, accuracy, and investigation levels are discussed in the site specific, site perimeter, and critical receptor monitoring program sections of this plan. In addition, sample heights, proximity to obstructions, and linear flow rates are discussed in the individual monitoring program sections.

4.2.2.1 Site Specific Monitoring Program. As mentioned in the chemical plant site source assessment, the large diffuse source is made up of a number of smaller diffuse sources that include wind blown resuspension of radioactive particulates from contaminated soils; and resuspension of radioactive particulates due to site remediation activities such as bulk waste placement and excavation of soils and radon emissions from SSE pilot facility activities and raffinate pits. Although there is some potential for resuspension of radioactive particulates due to natural meteorological occurrences, it is small compared to the potential for site remediation activities to resuspend radioactive air particulates. In order to assess the contribution of site remediation activities to the total airborne emissions from the chemical plant, site specific monitoring will be utilized. Site specific monitoring will also be used at the quarry to supplement data from the perimeter monitors. Site specific monitoring will use mobile air particulate samplers and total dust monitors to measure the airborne radioactive particulate and dust concentrations and radon gas and radon progeny monitors to measure radon gas and progeny concentrations.

Site specific monitoring, in addition to providing data concerning the contribution of specific activities to the total airborne inventory, will provide faster feed back concerning the effectiveness of engineering controls and data concerning dispersion patterns. Filters from site-specific air particulate monitors will be collected on a daily basis as compared to weekly for the perimeter samplers. The total dust monitors will provide instantaneous airborne dust concentrations. The continuous radon gas and progeny monitors are capable of hourly measurements. Also electret radon monitors may be used for short term measurements of 2 days to 14 days depending on the radon concentration.

Air particulate samplers will be placed at the work zone perimeters. The number of samplers used will be commensurate with the potential for above background emissions. In addition, a group of site specific samplers may be used to monitor separate work activities that are in relatively close proximity to one another. This will facilitate more efficient use of site-specific samplers and maintain air monitoring coverage for all the activities. Total dust measurements will be taken within the work zones as needed to measure total dust concentrations. Radon gas and radon progeny measurements will also be collected within the work zones when there is a significant potential for elevated concentrations.

When possible, the air particulate samplers will be placed in areas that are free from obstructions or conditions that could effect the air sampling results. The air particulate samplers are usually placed twice the distance from an obstruction or structure as the obstruction or structure is high (i.e., an air sampler would be placed 3 m [10 ft] from a 1.5 m [5 ft] tall tree). In addition, the samplers will be placed, if possible, in areas that do not have turbulent air conditions, such as nearby busy roads or active equipment. Total dust monitors will be used as needed to make instantaneous checks of total airborne dust concentrations during work activities to confirm that engineering controls and good work practices are effective.

Equipment that will be used for site specific air particulate sampling includes a portable air particulate sampler with a filter holder and a vacuum pump, a rotameter, a filter, a portable power supply, and an air sampler stand. Equipment used for site specific total dust measurements includes a total dust monitor and data logger. Equipment used for the radon gas and radon progeny measurements includes continuous radon gas and progeny monitors, electret chambers, alpha track monitors, associated wheater housings, and an electret voltage meter.

The portable air samplers that will be used for site specific air particulate sampling are low volume carbon vane oilless vacuum pumps. The low volume pumps generally operate at approximately 40 l/min (1.4 cu ft). The linear flow rate for the low volume air samplers, volume sampled per unit time, divided by the filter area, is approximately 23 m/min (7 ft/min). The total dust monitors that will be used are self-contained aerosol monitors whose sensing principle is based on the detection of scattered electromagnetic radiation in the near infrared range. The radon monitoring equipment is discussed in Section 4.2.2.2.

A rotometer, calibrated to National Institute of Standards and Testing (NIST) specifications, is used to set portable monitor beginning flow rates and measure ending flow rates for each sampling period. Monitor flow rates can change due to filter dust loading or ambient temperature changes. If the ending flow rate change is greater than +/-20% of the ending flow rate, the flow meter will be evaluated to determine if service is required. The data will be flagged and flow rate change noted when the data is reported.

The portable sampler pumps will not be leak tested because the flow rate is determined by placing a rotameter in the line between the filter assembly and the pump. Pump leakage will not affect the flow reading, which is made on the air passing through the filter to the pump. In

addition, the *Regulatory Guide* (Ref. 3) and Environmental Protection Agency Methods 5 and 17, for measurement of airborne particulates, specify that the filter head assemblies need only to be designed and inspected to minimize leakage around the filter.

The filters that will be used for low-volume samplers are a mixed cellulose esters membrane. These filters have a pore size of 0.8 μm and are 47 mm (1.85 in.) in diameter and the filter media retains 99.98% of dioctylphalate particles with an aerodynamic mean diameter of 0.3 μm at 32 l/min (1.1 cu ft/min) across a surface area of 100 cm^2 (15.2 $in.^2$). The samplers will be placed on portable stands at a height of approximately 0.8 m (2.5 ft) off the ground. The air samplers will be placed at 0.8 m (2.5 ft) rather than 1.5 m (5 ft), as specified by the Environmental Protection Agency, due to the weight of the pumps and the safety problems that would be brought about by placing the pumps 1.5 m (5 ft) off the ground. The 1.5 m (5 ft) height would require personnel to lift the pumps, which are relatively heavy and will be moved frequently, above their heads. In addition, the stands would have a high center of gravity, making them susceptible to tipping in strong winds. Due to the proximity of the portable monitors to the work area, placement of the monitors at a lower height would provide conservative measurement of fugitive dust and any subsequent dose assessments.

Because at present there is no electrical service in the controlled area of the chemical plant where the portable air samplers will generally be used, portable generators will power the air samplers.

The minimum detectable concentration that will typically be achieved during site-specific monitoring is approximately 5.0E-14 μCi/ml. Because work activities may not always have a duration long enough to collect a large sample volume, a sample minimum detectable concentration may be higher than the typical minimum detectable concentration of 5.0E-14 μCi/ml. Whenever possible, a large sample volume will be collected in order to reduce the minimum detectable concentration.

At one sigma, the total typical uncertainty associated with a site specific air particulate sample at a concentration of 2.4E-14 μCi/ml is 8.3E-15 μCi/ml. The total sample uncertainty is dependent on the uncertainty associated with a number of sources, which include the volume sampled, detector calibration, uncertainties with efficiency and background count rate, and sample count rate.

After samples are collected, the filters will be stored for a minimum of five working days before they are counted to allow for decay of the short-lived radon and thoron decay products. The activity of the samples will then be counted on an alpha-scintillation detector or a gas-flow proportional counter. The counting times will generally be 60 minutes. Since detection sensitivity increases as counting times increase, counting times may be longer to achieve a lower minimum detectable concentration.

Quality control procedures that will be implemented as part of the site-specific monitoring program include the calibration of instruments, source and background counts, recounts of samples, review of documentation, and use of standard operating procedures (SOPs). The quality control procedures are intended to check the accuracy and validity of the data.

Calibration will be required for the alpha-scintillation and gas-flow proportional detectors and the rotameters. The alpha-scintillation detector will be calibrated a minimum of every 6 months using NIST traceable radioactive sources in accordance with the applicable SOPs. The gas-flow proportional counter will be calibrated when repairs are made to the detector or if daily checking of the detector indicates that the instrument requires recalibration. Calibration will be in accordance with applicable SOPs. The rotameter will be calibrated on an annual basis to NIST specifications using a standard soap bubble meter. The portable airborne particulate samplers will be leak tested on an annual basis to ensure that the measured volume of air is passing through the sample collection filter. The total dust monitors will be calibrated with a NIST traceable reference scatter prior to each use.

Daily source and background counts will be made on the alpha-scintillation and gas-flow proportional detectors in accordance with the applicable SOPs, and these count results will be compared to the calibration results. If daily checks are within three standard deviations when compared to results obtained during calibration, or within control limits as generated by the gas flow proportional software package, the instruments will be put into service. Instruments failing the daily background and/or source check will be taken out of service as described in the applicable WSSRAP standard operating procedure.

At least one in 20 air particulate samples will be recounted and the results compared to the initial count results. The precision between the two sample counts will be calculated and the results kept on file.

A review by an individual other than the sampler of the sample documentation and calculations will be required as part of the quality control procedure. The reviewer will be responsible for ensuring that the documentation is complete and the calculations correct.

4.2.2.2 Site Perimeter Monitoring. A perimeter monitoring program will be used to monitor airborne emissions from the chemical plant area and the quarry, which encompass soils with above background radionuclide concentrations. The program will require the use of 17 air particulate sampler, 15 radon alpha track detector, five electret radon monitoring, and two continuous radon/thoron progeny monitor locations. These locations are summarized in Tables 4-7, 4-8, and 4-9 and shown on Figures 4-3 through 4-7. In addition, three portable air particulate samplers may be deployed depending on the current work activity at six possible monitoring locations.

The monitors will be used in conjunction with site specific monitoring to estimate the total airborne emissions. The use of air monitors at the chemical plant and quarry perimeter, in conjunction with site specific monitoring, is the most effective way to monitor airborne emissions from the project.

The sources described in the source assessment are primarily ground sources. Sources such as stacks or vents that release radioactive material at a significant distance from the ground have the highest measured concentrations at ground level some distance from the source. This occurs because it takes time for the material to reach the ground, and as the material falls, it is driven from the source by the wind. Ground sources, however, have the highest concentration measured at the ground level at points closest to the source. As a result, the highest concentrations that leave the chemical plant and quarry are at ground level.

There will be seven permanent and six temporary perimeter radioactive air particulate monitoring stations at the chemical plant site (Figure 4-3). These monitors will generally be equally spaced along the perimeter fence with distances ranging from approximately 76 meters 610 m (250 ft to 2,000 ft). Because the potential for airborne emissions is low, any airborne emissions that do occur will be intermittent and have low concentrations. Hence, the use of 13 perimeter monitor location is consistent with the potential for exposure to the general public.

TABLE 4-8 Air Particulate Monitoring Locations

Station	Location	Air Volume	
		Low	High
Chemical Plant Area			
AP-2001	Northeast corner of site	Yes	Yes
AP-2002	North perimeter of site	Yes	No
AP-2005	Southeast of Administration Building	Yes	Yes
AP-2013	Southwest of Frog Pond	Yes	No
AP-2019*	Northeast of Site Water Treatment Plant	Yes	No
AP-2020*	Southeast of Site Water Treatment Plant	Yes	No
AP-2022*	Northwest corner of site	Yes	No
AP-2023*	North perimeter of site	Yes	No
AP-2024*	East perimeter of site at main entrance	Yes	No
AP-3003	Northwest of Raffinate Pit #4	Yes	No
AP-3004	South of Raffinate Pit #3 and west of TSA	Yes	No
AP-3014	West of Raffinate Pit #3	Yes	No
AP-3021*	Southwest of Raffinate Pit #4	Yes	No
Quarry Area			
AP-1009	Northeast corner of quarry	Yes	Yes
AP-1010	South perimeter of quarry	Yes	No
AP-1015	North perimeter of quarry	Yes	No
AP-1016	North perimeter of quarry	Yes	No
AP-1017	South of Quarry Water Treatment Plant	Yes	No
Off-Site Critical Receptors			
AP-4006	Francis Howell High School	Yes	Yes
AP-4007	Busch Conservation Area	Yes	No
AP-4008	Army Site Guard House	Yes	Yes
AP-4011	Residence West of Quarry	Yes	Yes
Background			
AP-4012	Daniel Boone Elementary School, New Melle	Yes	Yes

* Portable monitoring equipment

TABLE 4-9 Radon Monitoring Locations

Station	Location	Station	Location
Chemical Plant Area			
RD-2002	North perimeter of site	RD-3006	Southeast of TSA
RD-2003	North perimeter of site	RD-3007	South side of Raffinate Pit #4
RD-2004	Northeast corner of site, adjacent to Highway Department facility	RD-3008	East side of Raffinate Pit #3
RD-2006	Southeast of Administration Building	RD-3009	North side of Raffinate Pit #1
RD-2007	East of Site Water Treatment Plant	RD-3010	West side of Raffinate Pits #1/#2
RD-3001	Northwest of Raffinate Pit #4	RD-3011	East side of Raffinate Pits #1/#2
RD-3002	West of Raffinate Pit #4	RD-3012	South side of Raffinate Pit #2
RD-3003	South of Raffinate Pit #4 and west of TSA	RD-3013	Southeast side of Raffinate Pit #4
RD-3004	South of TSA	RD-3014	North side of Raffinate Pit #3
		RD-3015	North side of Raffinate Pit #4
Quarry Area			
RD-1002	Northeast corner of quarry	RD-1006	West perimeter of quarry
RD-1003	South perimeter of quarry	RD-1008	North of Quarry Water Treatment Plant
RD-1004	South perimeter of quarry	RD-1009	North perimeter of quarry
RD-1005	South of Quarry Water Treatment Plant		
Off-Site and Background			
RD-4001	Busch Conservation Area	RD-4007	Residence west of quarry
RD-4002	Army Site Guard House	RD-4008	Katy Trail south of quarry
RD-4003	Francis Howell High School	RD-4009	Daniel Boone Elementary School, New Melle
RD-4005	West of Army Site		

There will be five permanent perimeter radioactive particulate monitoring stations at the quarry (Figure 4-4). These monitors will also be evenly spaced around the perimeter of the area with distances ranging from approximately 137 m to 305 m (450 ft to 1,000 ft).

There will be 10 alpha track and five electret radon monitoring stations at the chemical plant site perimeter (Figure 4-3) placed approximately 122 m to 610 m (400 ft to 2000 ft) apart. Due to the characteristics of the chemical plant diffuse radon source, the density of radon monitoring stations around the perimeter will be commensurate with the potential for causing an exposure from radon to the general public. Remediation of the chemical plant is not expected to increase radon emissions at the site perimeter, but some increase may occur due to the transfer of bulk waste from the quarry to the temporary storage area and CSS pilot facility operations. Because the transferred waste will have higher concentrations of radon bearing waste than the chemical plant soils, there is a higher potential for radon emissions from the temporary storage area than from the chemical plant. Also, working with the raffinate sludges increases the potential for releases of radon. As a result, the perimeter monitoring stations near the temporary storage area and CSS pilot facility will be closer together.

Nine alpha track and 13 electret radon monitoring stations will be placed around the perimeters of the raffinate pits to measure radon levels that can be expected during future remediation activities and dredging activities for the chemical stabilization/solidification pilot facility. Four alpha track and four electret monitors will be placed around Raffinate Pits 1 and 2, and five alpha track and nine electret monitors will be placed around Raffinate Pits 3 and 4 (Figure 4-3 and 4-7). These monitors will be placed approximately 60 m to 367 m (200 ft to 1200 ft) apart.

There will be seven alpha track and four electret radon monitoring stations on the quarry perimeter (Figure 4-8). These stations will be approximately 76 m to 198 m (250 ft to 650 ft) apart. The distance between these stations is less than at the chemical plant because of the higher radium concentration at the quarry, and because the quarry is a large depression in the terrain with sidewalls ranging from 3 m to 15 m (10 ft to 50 ft) high. When meteorological conditions are stable, this configuration tends to trap emanating radon within the quarry and raises the concentrations along the perimeter. As a result there is higher potential for radon emissions from the quarry than from the chemical plant area, and thus the distance between perimeter stations is smaller.

sensitivities of the continuous radon progeny monitors are 1.0 mWL. The accuracy for the continuous radon progeny monitors is within ±10% of the measured concentration.

The alpha track monitors are made of a plastic material and monitor both radon and thoron gas. The principle of radon/thoron detection is based on the production of damage tracks in the plastic from passage of alpha particles from radon/thoron decays. The track density is determined by manual or automated scanning and is proportional to the integrated exposure. Processing and exposure determination are provided by the vendor. The radon alpha track detectors have a minimum sensitivity of 0.2 pCi/l. The uncertainty of one sigma for the radon alpha track detectors is ±25% of the measured concentration. The detectors will be placed in pairs at each of the locations, and will be exchanged on a quarterly basis.

The electret operates by filtered diffusion of ambient air into an electrically conducting plastic chamber where decay generates ions that are collected by the charged electret. The change in electret charge is measured after the monitoring period with a voltage reader. The surface charge of the electret is reduced proportionately during the monitoring period with the integrated radon/thoron concentration. Typically the electrets are deployed for a minimum of 14 days at an uncertainty of +/-25%. The minimum sensitivity for a 14 day exposure is approximately 0.4 pCi/l.

A rotometer is used to set and measure low volume air particulate samples. The low volume air particulate samplers will be run continuously at a flow rate of approximately 40 l/min (1.4 cu ft/min) with weekly filter replacement. Prior to changing the filter each week, the flow rate will be measured. After the filter is changed, the flow rate will be adjusted as needed to 40 l/min (1.4 cu ft/min). The starting flow rate of 40 l/min (1.4 cu ft/min) will then be averaged with the ending flow rate, and the average flow rate used to calculate the total volume of air sampled. If the flow rate changes by ±20% during the sampling period, the monitor will be evaluated to determine if service is required. The data will be flagged and the change in flow rate noted when the data is reported. The linear flow rate for the perimeter low volume air particulate samplers will be approximately 23 m/min (75.4 ft/min) at 40 l/min (1.4 cu ft/min). The site perimeter airborne particulate samplers will not be leak tested. Leak testing will not be necessary because the flow rate will be determined by placing a mass flow meter in line between the filter assembly and the pump. Pump leakage will not affect the flow reading, which will be made only on the air passing through the filter to the pump.

An effective dose equivalent of 0.08 mrem was calculated at the nearest chemical plant critical receptor with the highest potential for an exposure to the general public as a result of radon emission from temporary storage area operation (Ref. 4). Therefore, the 10 alpha track and five electret radon monitoring stations at the chemical plant perimeter will be sufficient to monitor potential radon emissions.

An effective dose equivalent of 1.0 mrem was calculated at the nearest quarry critical receptor with the highest potential for exposure of the general public as a result of radon emissions from bulk waste removal (Ref. 4). Therefore, seven alpha track and four electret radon monitoring stations at the quarry perimeter will be sufficient to monitor radon emissions.

The number of radioactive air particulate and radon monitoring stations at the chemical plant and quarry is in proportion to the potential for emissions from the sources. In addition, the use of site specific monitoring will allow monitors to be placed such that the density of monitors will be increased during activities with higher potential for airborne emissions.

Equipment for the site and quarry perimeter monitoring program includes low volume air particulate samplers, continuous radon progeny monitors, rotometer, scintillation detectors, a gas-flow proportional detector, filters, and alpha track and electret radon detectors.

The low volume permanent and temporary air particulate samplers at the chemical plant and quarry site perimeter locations are self-adjusting carbon-vane oilless air pumps. Each permanent sampler will be mounted in a weather-protective housing with a 110 volt outlet and a thermostat-controlled cooling fan. Each temporary sampler will be mounted on a wheeled platform inside a protective housing. The permanent and temporary samplers will have hour meters to document the operational period, and regulators to maintain a constant flow.

The continuous radon progeny monitors (Figures 4-3 and 4-4) will be portable, fully automated instruments capable of continuously monitoring for radon and thoron daughters. The radon progeny monitors use a silicon barrier diode detector to detect radon and thoron daughters that are deposited on a membrane filter with a 0.45 μm pore size. The continuous radon progeny monitors will have internal data storage capabilities. The data will be retrieved at least once every two weeks by downloading the data from the samplers to a portable computer. The

The filters used to monitor the site perimeter will be the same mixed cellulose ester filters used for site-specific monitoring. These filters are 47 mm (1.85 in.) in diameter, have a pore size of 0.8 μm and retain 99.98% of dioclylphalate particles with an aerodynamic mean diameter of 0.3 μm.

The perimeter air particulate samplers and the electret radon detectors will be placed at approximately 1.5 m (5 ft) above the ground. The alpha track radon detectors and the continuous radon progeny monitors will be placed above the ground approximately 2 m (6.25 ft) and 1 m (3.2 ft), respectively. With the exception of the monitors at the quarry perimeter, samplers, detectors, and monitors will be placed away from unusual localized effects or other conditions (e.g., large buildings, vehicular traffic, and trees) that could result in artificially high or low concentrations. Several of the quarry perimeter monitoring stations are near trees. Because the trees serve as a natural barrier to airborne emissions, the trees will not be removed from the areas near the monitoring locations. In addition, due to the limited space available along the ridge at the southeastern perimeter of the quarry, the stations cannot be moved away from the trees.

The air particulate filters will be counted to determine the gross alpha concentrations using an alpha scintillation detector or a gas flow proportional detector. The counting times for samples will in general be 60 min.

Each sample will be collected for a period long enough to ensure that a gross alpha minimum detectable concentration of 1E-15 μCi/ml can be obtained. Because naturally occurring Po-210 and Pb-210 exist in the atmosphere at concentrations on the order of 2.5E-15 μCi/ml, obtaining a minimum detectable concentration less than 1E-15 μCi/ml is of little value due to the interference from Po-210 and Pb-210. In addition, the Derived Concentration Guideline of Th-232, Class W (most restrictive derived concentration guideline for contaminants at the Weldon Spring site) is 7.0E-15 μCi/ml. With a background of 2.0E-15 μCi/ml and a gross alpha activity of 1.0E-15 μCi/ml, the composite activity of 3.0E-15 μCi/ml is still less than the Th-232 derived concentration guideline. The minimum detectable concentration is dependent on sample volume (sample time multiplied by the flow rate), the efficiency and background count rate of the instrument used to measure the activity on the filter, and the sample and background count times.

At one sigma, the total typical uncertainty associated with a site perimeter air particulate sample at a gross alpha concentration of 8.7E-16 μCi/ml is 3.0E-16 μCi/ml. The total sample uncertainty is dependent on the uncertainty associated with the volume sampled, detector calibration uncertainties with the determination of detector efficiency, and detector background count rate, as well as the uncertainty associated with the sample count rate. Uncertainty may vary because different detectors are used, and because of variations in the other sources of uncertainty; however, 1E-16 μCi/ml represents a typical uncertainty achieved with a sample having a gross alpha concentration of 1E-15 μCi/ml.

The investigation level that will be established for the perimeter air monitoring program is based on a one tail hypothesis test which compares the data collected at the background station with the data from a particular monitoring station. The test uses data collected from the previous 52 weeks to determine if a particular monitoring station's data is different than background at the 95% confidence level.

Because the alpha track radon detectors will be collected on a quarterly basis, there will be only four data points per year per location, therefore, the alpha track radon detectors will be compared to the background stations results only on an annual basis. Each monitoring period the electret radon detector will be compared to the background station results. If the results from a monitoring location are found to be statistically greater than the results from the background stations, an investigation will be conducted to determine the source of the above background concentrations, with the exception of the quarry TSA and raffinate pit monitoring stations, which are historically greater than background because of the radiologically contaminated material in these locations.

The quality assurance/quality control procedures for the low volume air particulate samplers will be the same as those described for site specific monitoring. The quality assurance/ quality control procedures that will be implemented for the continuous radon progeny monitors include calibration standard operating procedures. The continuous radon progeny monitors will be calibrated annually at the Technical Measurement Center at Grand Junction, Colorado. The continuous radon progeny monitors will be operated in accordance with the applicable standard operating procedures.

The quality assurance/quality control procedures that will be employed for the perimeter alpha track radon detectors include duplicates, spikes, chain-of-custody and laboratory authorization forms, field sheets, and review of vendor data. The pair of alpha track radon detectors placed at each location will serve as duplicates. Three spikes, alpha track detectors exposed to a known source, will be returned to the vendor for analysis on a quarterly basis. In addition, field sheets will be used during deployment and recovery of the radon track etch detectors to document detector locations and any unusual occurrences. Chain-of-custody and laboratory authorization forms will be filled out in accordance with the applicable standard operating procedure in order to track the radon alpha track detectors. Finally, the data received from the vendor will be reviewed for anomalies.

The quality assurance/quality control procedures used for the electret radon detectors include duplicates, reference electrets, gamma exposure rate measurements, field sheets, and review of vendor data. A pair of electrets are used at each monitoring location will serve as duplicates. Field sheets are used during deployment and recovery of the electrets to document detector locations and any unusual occurrences. High accuracy reference electrets are used to check the accuracy of the voltage reader. Gamma exposure rate are measured with a pressurized ion chamber in locations with expected elevated gamma radiation. Finally, the data is reviewed, by a second party, for anomalies.

4.2.2.3 Critical Receptor Monitoring. The most accurate method of dose calculation at nearby receptor points is through the use of actual concentration measurements at these locations. Measurements from nearby receptor points or critical receptors will be an important element in determining the emissions from the chemical plant and the quarry when used in connection with site-specific monitoring data and the perimeter air monitoring data. Critical receptors are defined as those locations at which individuals abide or reside where the highest potential off-site concentrations of radionuclides other than radon are likely to occur during remediation of the site. The sites that were selected as critical receptors are located within 1 km (0.6 mi) of the site where members of the public may spend at least 8 hours per day for a significant fraction of the year. The critical receptors will be monitored in accordance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) plan which has been approved by the U.S. Environmental Protection Agency, Region VII.

Critical receptor locations AP-2001, AP-4006, AP-4007, AP-4008, and AP-2005 (Figures 4-3 and 4-5) are strategically located to measure radioactive airborne emissions from the chemical plant at points where maximally exposed individuals reside or abide. Station AP-2001 is at the common boundary of the chemical plant and Missouri Highway Department Maintenance Facility. Station AP-4006 is located at the Francis Howell High School. Station AP-4007 is located at the August A. Busch Memorial Conservation Area. Station AP-4008 is located at the U.S. Army Reserve and National Guard Training Area. Station AP-2005 is located between the chemical plant and the WSSRAP administration building. Station AP-4011 (Figure 4-5) is located 50 m (165 ft) from the nearest residence 0.2 km (0.12 mi) west of the quarry. Station AP-4012 (Figure 4-6) is located approximately 12.9 km (8 mi) from the chemical plant and 11.3 km (7 mi) from the Weldon Spring Quarry to monitor the Daniel Boone Elementary School and establish background.

Other facilities (i.e., the St. Charles County water treatment plant and the Weldon Spring Heights subdivision) are located near the site; however, because of the greater distance, and because previous monitoring data from closer critical receptor locations indicate with 95% confidence that there has been no above-background radioactive airborne concentrations, these facilities are not considered critical receptors.

The critical receptor monitoring program will utilize high volume air samplers, low volume air samplers, and alpha track radon detectors at all locations. A electret radon monitor will also be used at critical receptor location AP-4006 (Francis Howell High School) and at background station AP-4012 (Daniel Boone Elementary School). The high volume samplers have heavy duty, turbine-type blowers and feature an electronic controller that automatically adjusts the speed of the sampler to correct for variations in line voltage, temperature, pressure, and filter loading. The low volume air samplers will be just as those used for site perimeter monitoring. All locations will use carbon vane air pumps. The radon monitors will be the alpha track and electret radon detectors described in the site perimeter monitoring program.

The rotometer used to set and measure low volume air particulate samples was replaced by a rotameter in March 1994. A mass flow meter will also be used to measure and set the flow rates of the high volume air samplers. The low volume and high volume air particulate samplers will be run continuously at 40 l/min (1.4 cu ft/min) and 940 l/min (33.2 cu ft/min) respectively. The linear flow rates for the low volume and high volume air particulate samplers are 23 m/min

(75.4 ft/min) and 48 m/min (157.4 ft/min), respectively. Flow rates for both low volume and high volume air samplers will be checked at the end of each week and then readjusted to the desired flow rate after the new filter is installed. The start and finish flow rates will be averaged, and the average will be used to calculate the total volume sampled. If the flow rate changes by ±20% during the sampling period, the monitor will be evaluated to determine if service is required. The data will be flagged and used for qualitative purposes only.

The filters used for the low volume air samplers will be the same as the filters used for site perimeter monitoring, and are 99.98% efficient in retaining 0.3 μm dioctyl phthalate particulates at a flow rate of 32 l/min (1.1 cu ft/min) across 100 cm^2 (15.5 in^2). The high volume air samplers use 203 mm by 254 mm (8 in by 10 in) glass fiber filters that have a mean dioctyl phthalate efficiency of 99.99% for particulate diameters of 0.3 μm to 0.4 μm.

The low volume air particulate samplers and continuous radon monitors will be placed at the same height specified in the site perimeter monitoring section. The high volume air particulate samplers have a sample height of approximately 1.2 m (4 ft). In addition, the monitoring receptor stations will not be located in proximity to unusual localized effects or other conditions (e.g., large buildings, vehicular traffic, or trees) that could result in artificially high or low concentrations.

On a quarterly basis, each of the 13 weekly filters from the high volume air particulate samplers at critical receptors and at the background station will be composited by location. The composite sample will then be dissolved and divided into three aliquots. The 18 composite samples (three aliquots from six sampler locations) will be analyzed for isotopic thorium, Ra-228, Ra-226, and total uranium.

The filters from the low-volume air samplers will be collected weekly and analyzed for gross alpha concentrations using the procedure described in the perimeter air monitoring program. The data stored in the continuous radon progeny monitors will be collected weekly as in the site perimeter monitoring program.

The investigation level for the critical receptor monitoring locations will be concentrations greater than background concentrations. The monitoring results from each location will be compared to the background station results using a statistical test. If a station is found to be

statistically different than background, an investigation will be conducted to determine the validity and/or source of this difference.

The quality control procedures for the low-volume air samplers and the continuous radon-progeny monitors will be the same as those in the site perimeter air monitoring program. The quality control program for the high volume air samplers will include spikes, duplicates, and blanks.

The high volume air particulate samplers will be operated in accordance with the applicable standard operating procedure. The standard operating procedure also specifies how filters are to be handled before, during, and after collection.

With each group of high volume sampler filters sent for radiochemical analysis, two filters will be spiked with known activities of Th-230, and two filters will be spiked with known activities of natural uranium (U-238, U-235 and U-234 in natural activity ratios). Since each filter composite collected at critical receptor locations is split into thirds, these thirds will serve as duplicates.

Field blanks will be collected each week when filters are exchanged. A field blank is an unused filter which the technician takes to the field. In addition, an unused filter will be collected directly from the filter package. The two sets of blanks will also be composited and analyzed radiochemically. Results from the blank composite will be used to identify field or laboratory contamination of filters.

In addition to the system of spikes, duplicates, and blanks, the radioanalytical analyses will be evaluated for internal consistency. At the site, U-238 and U-234 are in secular equilibrium. Uranium concentrations on air filters should also be in equilibrium. When radioanalytical results are provided, the degree of equilibrium will be evaluated. In most cases, Th-228 and Ra-228 are also in equilibrium. Equality between these radionuclides will also be evaluated.

4.3 Asbestos Monitoring

Site perimeter air monitoring for asbestos will be routinely performed only when activities involving disturbance of asbestos are taking place. Perimeter asbestos monitoring locations at the chemical plant and at the quarry are the same as those used for radioactive air particulate monitoring (Figures 4-3 and 4-4). At least two perimeter asbestos monitoring stations at both areas will be used, one upwind and the other downwind from activities involving handling of asbestos. A determination of which monitoring stations to use will be based on current meteorological conditions during activities involving asbestos. During activities involving handling of asbestos at the chemical plant, an asbestos monitor will be placed at the Francis Howell High School in the same location as the radioactive air particulate monitoring station.

When activities involving handling of asbestos are being performed at the site, daily asbestos monitoring will be performed in the immediate work area. Samples from the perimeter asbestos monitoring stations and from the Francis Howell High School monitoring station will be collected on a weekly basis. Samples from monitoring stations inside and adjacent to asbestos work areas will be collected on a daily basis. Sample results from the Francis Howell High School monitoring station and the perimeter monitoring stations will be reported in the annual site environmental report. If elevated levels are detected at any of these monitoring locations, the results from the adjacent and immediate work areas will be reviewed in relation to the elevated levels and pertinent data will be included in the annual site environmental report.

5 METEOROLOGICAL MONITORING PROGRAM

This section describes the meteorological parameters measured, meteorological instrumentation, and computer programs and models that support the environmental surveillance and emergency response activities at the Weldon Spring Site Remedial Action Project (WSSRAP). Radiological dose calculation to the general public is based on measurements from critical receptor locations (Section 4). The use of actual concentration measurements at these locations yields more accurate dose calculations than those based on modeling of downwind dispersion. The sources for off-site airborne releases at the site are primarily diffuse sources from waste areas and site remedial activities. No stack-type point sources operate at the site.

The WSSRAP has two sources of potential airborne radiological emissions: the Weldon Spring Chemical Plant and raffinate pits, and the Weldon Spring Quarry. The location of the meteorological station is on the eastern edge of the chemical plant area and is more than 122 m (400 ft) from the nearest building (Figure 5-1). An assessment of the sources was conducted as required by the *Regulatory Guide* (Ref. 3) and is summarized in Section 4.2.1. The assessment included documentation of concentrations of radionuclides that could be released from the sources.

The WSSRAP meteorological station records wind speed and direction, horizontal wind fluctuation, ambient air temperature, barometric pressure, and precipitation intensity and accumulation. The station microprocessor performs signal computations and stores data electronically. Provisions also exist to record data on a backup chart recorder which is located near the base of the station tower.

The meteorological station consists of a tower, an instrumentation enclosure, and a precipitation gauge. The wind speed and direction sensors are mounted 10 m (33 ft) above ground level on a retractable, tilt down tower. Sensors at greater heights are unnecessary since potential sources of airborne emissions are at or near ground level. The wind aspirated temperature sensor and barometric pressure transducer are mounted 2 m (6.6 ft) above ground level at the enclosure. Horizontal wind fluctuation is computed by the station microprocessor.

These parameters are collected and stored every 60 seconds. The one minute recordings are averaged once per hour and the hourly data are downloaded daily to a remote computer. These data are reviewed daily and archived digitally.

The meteorology information is used to support many WSSRAP environmental monitoring program functions such as:

- Station data enable dispersion and diffusion modeling to supplement critical receptor monitoring in the event of an airborne release.

- Ecological studies require rainfall, temperature, and wind speed data to determine water level fluctuation in lakes and wetland areas, foliar vegetation absorption analysis, and in agricultural data reviews.

- The Environmental Protection Group utilizes precipitation data to correlate aquifer level fluctuations in the Femme Osage Slough and the quarry. This aids in identifying the cause of fluctuating uranium concentrations in the area.

- Hydrological analyses utilize precipitation measurements to correlate surface and groundwater level fluctuations and to assess seasonal influences on contaminant concentration trends.

- Meteorological data are used to help prepare the annual site environmental report, study off-site effluent discharges, and to determine site watershed runoff coefficients for the Environmental Impact Statement/On-Site Discharge Information System report.

- Station data were also used in the application for the National Pollutant Discharge Elimination System (NPDES) storm water permit.

- The Construction Management and Operations Group utilizes wind speed data to comply with Occupational Safety and Health Administration requirements (e.g., crane operation).

Furthermore, the real-time data readout of meteorological variables aid site personnel in observing and analyzing the dispersion of potentially released airborne materials during and after potentially reportable incidents.

If it is determined that air pathway modeling is necessary, the WSSRAP will use either the computer program CAP-88 (a modified version of AIRDOS-EPA) or ISCST2 (Industrial Source Complex Short Term Dispersion Model, Version 2). Both models employ steady-state Gaussian equations to model the dispersion plume generated from an emission into the air.

A meteorological station upgrade was completed in August 1994. The upgrade included the following: (1) replacement of the damaged datalogger; (2) replacement of the meteorological tower and wind instrumentation with heavy duty units; and (3) enhancements to the computerized data retrieval and archival system. Also, an off-site contractor was selected to conduct semi-annual maintenance and performance checks, as well as perform monthly data comparisons with data obtained from other local sources, using data editing criteria developed by the Nuclear Regulatory Commission, National Climatic Data Center, and the Tennessee Valley Authority.

On-site inspection and maintenance of the meteorological station, data collection and archival, off-site monthly data reviews, semi-annual maintenance and performance checks are documented in accordance with procedure ES&H 4.8.3.

6 ENVIRONMENTAL MONITORING PROGRAM ADMINISTRATION

This section describes the activities that will constitute the environmental monitoring program at the Weldon Spring Site Remedial Action Project (WSSRAP). Data management and presentation are discussed along with regulatory compliance and dose assessments. In addition, special studies that are outside the scope of this document, emergency preparedness, and changes in the scopes of investigations are addressed.

6.1 Data Analysis and Statistical Treatment

Proper data analysis and statistical treatment practices are essential to quality results from the effluent monitoring and environmental surveillance programs required by U.S. Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide* (Ref. 3). Therefore, it is necessary to develop a plan for implementing the following action items:

- Determining contaminant concentrations at each sampling location for each sampling period, and evaluating the accuracy and precision of those concentrations.

- Comparison of the contaminant concentrations at each sampling location to previous concentration estimates at that point and identification of changes or inconsistencies in contaminant levels.

- Comparison of contaminant concentrations at sampling locations to the established limits for those contaminants and/or background concentrations.

The WSSRAP has taken steps to establish appropriate investigation levels for groundwater, surface water, and site effluents to achieve consistent review of environmental data and initiation of appropriate and timely action when necessary. The criteria applied by the WSSRAP to define the investigation levels for all environmental monitoring data are described in several Environmental Safety and Health Department procedures. The procedures listed below direct the WSSRAP staff in the evaluation of environmental monitoring data. These evaluations include assessing data quality and determining whether a given datum exceeds specific action levels. Administrative procedures that must be followed when action levels are exceeded are also defined. The procedures governing data review are:

ES&H 1.1.7 - *Reporting Above Normal Values from Environmental Monitoring Networks*

ES&H 4.6.4 - *Constant Flow Low Volume Air Sampler Operation and Air Sample Filter Handling*

ES&H 4.6.6 - *Constant Flow High Volume Air Sampler Operation and Air Sample Filter Handling*

ES&H 4.6.8 - *WLM-30 Radon Daughter Monitor: Operation and Data Handling*

ES&H 4.9.1 - *Environmental Monitoring Data Verification*

ES&H 4.9.3 - *Surface Water and Groundwater Data Review Procedure*

These procedures are intended to effectively address the Department of Energy guidance criteria for determining investigation levels for environmental monitoring programs.

The statistical techniques used to evaluate and analyze the data are designed to accommodate the environmental data sets. Such data sets typically include skewed distributions of time series data, variable analytical results, missing data, and data that are below analytical detection limits.

6.1.1 Summary of Data Analysis and Statistical Treatment Requirements

The following subsections summarize the procedures for data analysis and statistical treatment of the effluent and environmental data. Immediately upon receipt from the verification/validation group all new groundwater, surface water, and National Pollutant Discharge Elimination System (NPDES) data are evaluated against the corresponding historical data according to standard operating procedure ES&H 4.9.3. When they have been reviewed and verified in accordance with standard operating procedure ES&H 4.9.1, they are entered into the WSSRAP environmental database. Apparent outliers are qualified. These may be excluded from use only after investigation confirms that an error has been made in the sample collection, preparation, measurement, or data analysis process. Air monitoring data obtained from off-site laboratories, as required by the NESHAP, will be verified in accordance with procedure

ES&H 4.9.1. Air monitoring data obtained from the WSSRAP on-site laboratory will be handled in accordance with procedure ES&H 2.6.7.

The confidence level of the data will be estimated by using blank and spike samples and comparing the results of these analyses to the known concentrations. The precision of the data will be determined by comparing parent samples with replicate samples.

6.1.2 Variability of Effluent and Environmental Data

The variability of effluent and environmental data will determine the degree of precision and accuracy that can be expected. Careful design and execution of the monitoring and laboratory programs can substantially improve the quality of effluent and environmental monitoring data.

6.1.2.1 Sources of Variability. Variability of data may arise from six sources: sampling errors, analytical errors, statistical counting variations, data recording errors, and temporal and spatial variability between environmental samples. Efforts will be taken to minimize variability due to sampling, analytical, and recording errors. However, variability due to environmental factors (temporal and spatial) cannot be controlled and will be evaluated with statistical summaries.

6.1.2.2 Estimating Accuracy and Precision. The validation process will assess the accuracy and precision of groundwater, surface water, and NPDES data sets according to the WSSRAP data validation procedure (ES&H 4.9.2). National Emission Standards for Hazardous Air Pollutants (NESHAPs) air monitoring will be performed in accordance with 40 CFR 61, which outlines specific parameters for the accuracy and precision of each data set. Data will also be validated in accordance with procedure ES&H 4.9.2, if required. The accuracy and precision of data obtained from the WSSRAP on-site laboratory will be determined in accordance with procedure ES&H 2.6.7. The annual site environmental report will summarize the completeness, accuracy, and precision of the data.

6.1.3 Review of New Environmental Data and Testing for Outliers

Review of new environmental data encompasses comparison with historical trends and/or with action-level criteria. Data review is accomplished using a set of elementary statistical parameters that are easy for the reviewer to calculate and are included in the data management system software. The statistical procedures, which are described in ES&H 4.9.3, are intended to provide a consistent, simple method to screen analytical data for outliers that require further investigation and/or qualification and to detect data that exceed the action-level criteria (as defined in Procedures ES&H 4.9.3 and 1.1.7). These procedures are not recommended for other applications, such as evaluating a datum for compliance with a regulatory level or setting a confidence level about the mean. For these needs, data users are referred to the Environmental Protection Agency Guidance (Ref. 17).

The statistical algorithm for data review is based on the minimum, maximum, arithmetic mean, geometric mean, standard deviation, and a sliding window for historic data. The "expected range" for each parameter at each location is calculated from the arithmetic mean and the standard deviation. Technically, a Gaussian (normal) distribution is assumed when the mean and standard deviation are calculated; however, environmental data rarely fit such a distribution. To moderate the effects of expected deviations from Gaussian distributions, data sets may be trimmed of extreme values that strongly impact calculation of the mean and standard deviation. The trimming procedure, as described in ES&H 4.9.3, is based on the number of samples and comparison of the arithmetic mean with geometric mean, which is less sensitive to outliers.

Although trimming removes outliers and thus improves the estimate of the mean and standard deviation, it does not compensate for trends, bimodal populations, or strongly skewed distributions. These cases are best identified graphically and may require special handling. A sliding window will be used to accommodate the effects of gradual, monotonic trends in historic data; however, steep trends may require smaller sliding windows than the default, which is three years.

6.1.3.1 Data Below the Limit of Detection. Data below the limit of detection are included in all statistical calculations conducted for the purposes of data review except in special cases of high detection limits. A high detection limit is a limit that exceeds the mean of the detected values or exceeds two times the mean of previous detection limits for data sets that only

include nondetects. One half the detection limit (DL/2) is substituted for nondetects in statistical calculations supporting data review.

Uncensored data, when available, may substitute for DL/2 in these statistical calculations provided the uncensored value is greater than or equal to zero. Because negative concentrations are not possible in nature, all negative values will be rounded to zero and may be included in the statistical calculation after this conversion.

6.1.3.2 Elements of Good Practice. The review of data is documented in accordance with Procedure ES&H 4.9.1, which constitutes a formal record that becomes part of the data verification package.

The new electronic data management system will facilitate tracking and documenting data quality. Outliers that have been identified during the data review will be identified and tracked in the Data Reviewer Qualifier field. Verification and validation qualifiers will be displayed in their own field as will rankings for quality control samples. An extended comments field will be available to add additional comments on the quality of a datum. Field sheets, field data, and shipping information will also be stored in the system and may be retrieved by the reviewer to assist in evaluating data.

6.1.3.3 Testing for Outliers. When testing for outliers, data sets will be screened in accordance with the guidance set forth in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (Ref. 18) and American Standard for Testing and Materials (ASTM) Volume 14.02. Outlier analysis will not be performed on data sets of less than four points. For data sets with large time gaps, outlier analysis will not be performed until no fewer than three new data points are available. For the purposes of data review, outliers will be ranked relative to the trimmed mean at the 95% and 99% confidence intervals. All outliers exceeding the 99% confidence interval will require investigation; investigation of those within the 95% and 99% interval will be at the reviewer's discretion.

6.1.4 Treatment of Significant Figures

Calculations performed using the analytical data received from the laboratory will follow the accepted rules for significant figures. Results of calculations will not contain more significant figures than the least precise value used in the calculation.

6.1.5 Parent-Decay Product Relationships

The delays associated with sample collection to sample analysis are insignificant compared to the half-lives of the radionuclides routinely monitored at the Weldon Spring site. Therefore, it is not necessary to take into account decay times when calculating parent-decay product relationships.

6.1.6 Comparisons with Regulatory or Administrative Control Standards and Control Data

One reason for obtaining reliable estimates of contaminant concentrations at the monitoring stations is to compare the values with regulatory or administrative control standards or values at control stations to determine whether action must be taken to reduce the contaminant levels in the effluents.

6.1.6.1 Single Concentration Measurements. Statistical tests are not appropriate for comparisons of single values, such as when a single radionuclide concentration measurement is compared to its regulatory limit. Single values can have a large associated uncertainty, and they are not necessarily an accurate representation of how well the facility is complying with the limit. Therefore, statistical summaries of groups of related samples will be used when possible. If single concentration measurements cannot be grouped, statistical tolerance limits will be used.

6.1.6.2 Groups of Measurements. Concentration estimates from groups of sampling locations will be compared using standard analysis of variance techniques when the data meet the underlying assumptions of those tests. Standard nonparametric statistical comparison techniques will be used when the assumptions of the parametric tests are not met by the data. Caution will be used when comparing groups of readings from single points over time, because of the likely strong autocorrelation in the time series of data.

6.2 Dose Calculations

This section describes models, computer programs, input data, and data sources that will be used to assess accurate and realistic radiation doses to the population and to a hypothetical maximally exposed individual that could result from remediation activities at the Weldon Spring site. Environmental monitoring data will be used either as direct input data in dose calculations or, where appropriate, will serve as data input in exposure and dose models.

The results of the dose calculations will be reported in the annual site environmental report. The methodology used to calculate the exposure point concentration and estimate dose will also be documented in that report.

6.2.1 Surface Water and Groundwater Dose Calculations

Radiological dose from groundwater and surface water will be assessed by using data gathered from groundwater and surface water effluent monitoring and environmental surveillance monitoring programs. Site-specific monitoring data representing surface water and groundwater radionuclide concentrations will be used as input in the dose assessment calculations. These data will allow a more accurate assessment of doses to a maximally exposed individual and the population surrounding the site.

Exposure and dose will be estimated for both the general off-site population and a maximally exposed receptor. Intake variables for a given pathway will be selected to reflect a reasonable, realistic exposure mode.

The results from the surface water and groundwater effluent monitoring and environmental surveillance programs will be evaluated in the site environmental report for its potential to contribute a radiological dose to a member of the general public. If measured concentrations in surface water and groundwater effluent from the site exceed natural background concentrations with 95% confidence, an exposure scenario will be developed to assess the dose. Realistic ingestion rates and times will be assigned for a maximally exposed individual. A standard dose conversion factor will be assumed and referenced for the calculations.

6.2.2 Airborne Radiological Dose Calculations

Radiological dose from airborne emissions will be assessed using environmental data as well as computer models. Exposures for critical receptors and hypothetical maximally exposed individuals will be calculated from monitoring data. For sources where perimeter monitors indicate with 95% confidence that background levels have been exceeded, population dose estimates will be made by computer modeling. This would constitute a change over previous monitoring years when computer modeling was not utilized. The new site specific monitoring program, in conjunction with existing perimeter monitoring data, will be used to obtain a more reliable source term. This will allow computer modeling to be used if necessary.

The computer models that will be considered for use in this dose assessment include AIRDOS PC and ISCST2. ISCST2 is an Environmental Protection Agency approved computer model that can assess radiological dose from airborne emissions at distances less than 300 m (990 ft). ISCST2 can be used to model emissions from either stacks or vents and diffuse sources.

Those pathways that are complete and could realistically contribute to a dose to a member of the general public will be assessed and documented in the annual site environmental report. Justification for elimination of any pathways will also be provided in the annual site environmental report. Scenarios that reflect realistic but conservative assumptions will be developed for those pathways that could contribute to a dose to a member of the general public. Realistic occupancy times will be assumed for potentially exposed individuals. Standard breathing rates and dose conversion factors from the *Federal Guidance Report No. 11* (Ref. 19) will be used in the calculations.

6.3 Records and Reports

The WSSRAP recognizes numerous Department of Energy orders, notices, and directives in addition to Federal, State, and local regulations. Since the Weldon Spring site is a remedial action project, rather than an operating facility, the distinction between applicable and nonapplicable guidelines must be determined when interpreting these regulations. The project must comply with appropriate regulations, write and distribute reports in a timely manner, and maintain records properly.

6.3.1 Subject Orders

The following Department of Energy Orders govern activities at the site: 5000.3B, 5400.1, 5400.5, 5284.1B, and 5484.1. These orders are discussed in the following paragraphs.

Department of Energy Order 5000.3B, *Occurrence Reporting and Processing of Operations Information*, defines a system of reporting occurrences listed in Orders 5400.1, 5400.5, and 5484.1. Occurrences are categorized into nine groups: facility condition, environmental, personnel safety, personnel radiation protection, safeguards and security, transportation, value basis reporting, facility status, and cross category items and are divided into three categories in order of decreasing severity: emergencies, unusual occurrences, and off-normal occurrences.

Department of Energy Order 5400.1, *General Environmental Protection Program*, requires that all Department of Energy facilities comply with all applicable Federal, State, and local environmental protection laws and regulations. Both environmental occurrences and routine monitoring reporting are covered. The WSSRAP has prepared an *Environmental Protection Program Implementation Plan* (EPPIP) (Ref. 2) to meet the specific requirements of Department of Energy Order 5400.1. Environmental occurrences will be reported as stated in DOE 5484.1 and DOE 5000.3B in accordance with WSSRAP procedures.

Department of Energy Order 5400.5, *Radiation Protection of the Public and the Environment*, states that Department of Energy facilities will adopt specific standards and requirements that will not allow undue risk from radiation to effect the public or the environment. The WSSRAP has formulated its environmental protection program to meet the requirements of this order and the *Regulatory Guide* (Ref. 3).

Department of Energy Order 5482.1B, *Environment, Safety, and Health Appraisal Program*, establishes a review and appraisal program for the environmental safety and health programs at the WSSRAP. There are six levels of appraisals and audits: management appraisals, technical safety appraisals, functional appraisals, internal appraisals, environmental surveys, and environmental audits. Each appraisal and audit requires a quarterly status report, or a report as otherwise directed on corrective actions.

Department of Energy Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, outlines requirements and procedures for investigating occurrences which may impact environmental protection, safety, and health. Occurrences are categorized into three levels. In addition, the Annual Radiation Exposure Information Reporting System (REIRS) requires an annual report of any exposures of Department of Energy or Project Management Contractor employees, nonemployee radiation workers, and visitors.

6.3.2 Reports

The following are summaries of WSSRAP reports generated in accordance with Federal, State, and/or local environmental protection laws and regulations, Executive Orders, internal Department of Energy policies, or agreements with other agencies.

6.3.2.1 Environmental Monitoring Plan. The *Environmental Monitoring Plan* (this document) is produced in accordance with Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide* (Ref. 9) and details environmental and effluent monitoring, sampling, and analysis. This plan is required to be reviewed annually and reissued at least every three years.

6.3.2.2 Groundwater Protection Program Management Plan. The *Groundwater Protection Program Management Plan* (Ref. 10) structures the groundwater program into a consistent program which facilitates periodic review. This plan is reviewed and updated annually. The *Groundwater Protection Program Management Plan* (Ref. 10) is taken directly from the environmental monitoring plan (this document), with the focus on the groundwater monitoring program.

6.3.2.3 On-Site Discharge Data Report. The *Radioactive Effluent Information System and Onsite Discharge Data Report* is an annual report which documents any discharges or releases from the WSSRAP. This report is accompanied by Department of Energy Form F 5821.1.

6.3.2.4 Environmental Protection Program Implementation Plan. The *Environmental Protection Program Implementation Plan* (Ref. 2) outlines Department of Energy

Order 5400.1 as it applies to the WSSRAP. This plan is updated annually to outline how environmental occurrences and routine monitoring are administered at the WSSRAP.

6.3.2.5 Annual Site Environmental Report. The annual site environmental report presents the findings of the environmental monitoring program conducted at the site for each monitoring year. The report presents summaries of environmental data both routine and nonroutine, discusses compliance with environmental standards, and highlights significant programs and studies undertaken to better understand the impacts of the project on the environment and public. Annual environmental monitoring reports have been prepared for the Weldon Spring site (or portions thereof) since 1981. The results of special studies and nonannual sampling are summarized if the information is of public or environmental concern and reference is made to the next sampling event if applicable. These include Oak Ridge National Laboratories research on site, Federal Facility Agreement driven activities, and activities not scoped in this environmental monitoring plan.

An annual site environmental report is the vehicle for documenting the results of the extensive monitoring program at the WSSRAP. The report provides the public and concerned regulatory agencies with summary level discussions regarding the routine environmental monitoring program. It explains how the WSSRAP effluent monitoring program meets the requirements of the NPDES program and radionuclide NESHAPs regulations, and compares the measured contaminant levels in several environmental media to applicable Federal and State standards and Department of Energy requirements. Doses due to site activities are calculated on the basis of annual data and several scenarios. The report indicates whether changes that might equate to variations in potential exposure scenarios to the public or environmental receptors are occurring in contaminant distribution or contaminant source conditions on and around the site.

6.3.2.6 Quarterly Environmental Data Summary. Though not required by a Department of Energy Order, the *Quarterly Environmental Data Summaries* are produced to aid in communicating site environmental data to the public and participating regulatory agencies. The *Quarterly Environmental Data Summaries* summarize environmental data and highlight significant findings. This allows preliminary data to be reviewed by interested individuals and organizations on a more frequent basis.

6.3.2.7 Discharge Monitoring Reports. Permits issued under the NPDES and provisions of the *Clean Water Act* also require record keeping and reporting. Record keeping requirements are stated in the NPDES permits issued by Missouri Department of Natural Resources (MDNR). Discharge monitoring reports are submitted on a quarterly basis to the department and include information on sample collection, flow, and laboratory results. Also included in the reports are noncompliance events. If there is a noncompliance with a daily maximum limitation, the Department of Natural Resources must receive a written report within 5 days. Any noncompliance that may endanger health or the environment requires that oral notification be made to the MDNR within 24 hours followed by a written report within 5 days.

6.3.2.8 Performance Indicator Quarterly Reports. The Department of Energy Performance Indicator Program is a requirement of SEN-29-91 that calls for the production of a quarterly report. This program allows trending and analyzing operational data designed to improve Department of Energy and contractor line management control of operations. The report includes a management summary, and Indicator Program summary, trends and analysis, and quantitative data.

6.3.2.9 Compliance Reports. Under the *Federal Facility Agreement*, the Department of Energy must submit status reports on activities and technical documents to the Environmental Protection Agency for their review and approval. These include, but are not limited to, the *Quarterly Environmental Data Summary*, sampling plans, and unplanned sampling activity notifications. Each of these reports has its own reporting requirements and time constraints and will be detailed in the Federal Facility Agreement Implementation Plan.

Other reports covering environmental issues are produced by the Compliance Department. The *Quarterly Compliance Report* is required by the Department of Energy. This report covers issues of noncompliance for the quarter along with corrective actions. Also, the *Annual Report on Environmental Permits* is issued annually to the Department of Energy. This report is required by Department of Energy Order 5400.1 and covers all environmental permits issued to the site.

6.3.3 Records

Department of Energy Order 5400.1 requires that all environmental surveillance and effluent monitoring records, computer programs, raw data, and procedures be retained. These records must be protected against damage or loss. The WSSRAP maintains an *Environmental Data Administration Plan* (Ref. 20) which governs sampling plan preparation, data verification and validation, database administration, and data archiving.

The environmental data administration plan provides a tracking system for sampling activities. Field log books and field data forms are filled out at sample collection. A Chain-of-Custody Form is completed and accompanies the sample until it is properly disposed of or returned to the WSSRAP. The Chain-of-Custody Form and the shipping order form are sent along with the sample to authorize testing by an off-site laboratory. The sample information, such as identification number, date, and parameters are then entered into the Environmental Sample Tracking System. This system tracks the samples and calculates costs, invoice payments, and budget reports. Upon receipt of data from a laboratory, the data are reviewed through a verification process. The verification process reviews data delivery, sample preservation and identification, chain-of-custody, holding times, and data review to confirm compliance with the laboratory's quality assurance project plan and standard operating procedures.

Several databases are used to track samples and data at the WSSRAP. Sample information is entered into the Field Sample Tracking (FST) system before sampling occurs. Sample shipping and accounting are processed through the Environmental Sample Tracking (EST) system. Data are accessed by the Department of Energy and the Project Management Contractor using a computerized data management program developed on site, called the WSSRAP Information System for Archiving and Retrieving Data (WIZARD). The database allows data to be selected and sorted by identification number and parameter. Records are protected from alteration by the user.

Other computer programs used are the Training Matrix (TMAX) program, the Site Wide Audit Tracking System (SWATS), and the Waste Inventory Tracking System (WITS).

All environmental data and documentation from sampling, analysis, and quality review programs are maintained in hard copy records; i.e., documents and data in written, typed, or printed forms; and electronic records, i.e., computerized records of environmental data. Original documents are transferred to the Project Quality Department and stored as quality assurance records in a fireproof vault. Copies are kept in the Environmental Safety and Health Department files. Work data files and electronic data records are archived annually.

6.4 Environmental Activities Varying from Environmental Monitoring Plan Scope

When additional characterization and monitoring activities are conducted that are not defined within the scope of the environmental monitoring plan, a judgement will be made by the Environmental Protection Group Manager as to the relevance of each of those activities to the overall environmental reporting requirements. An example of an activity which might be reported in the annual site environmental report is a soil or water characterization effort that exceeds the scope of those previously performed in the area. Conversely, an example of activities that may not warrant reporting is "engineering characterization" efforts performed in support of various construction activities at the site. An exception to this is the ecological characterization required by the National Environmental Policy Act (NEPA) that would provide information to assess impact to the ecosystem.

During the monitoring year, it may be necessary to alter the scope of the monitoring program. In such a case, the changes in monitoring parameters, schedule, frequency, and/or locations will be authorized by the Environmental Protection Group Manager with notification given to the Environmental Safety and Health Department Manager. All variances from the program scope will be documented with a memorandum to project management and will be reported in the annual site environmental report.

6.5 Emergency Preparedness

The WSSRAP maintains on site the management and staffing structure necessary to respond to environmental and medical emergencies. Plans and procedures are in place that detail the response and reporting program, implementation criteria, and routine environmental response and safety drills. The specific plans which address these measures include the

Emergency Response Manual (Ref. 21) and the *Emergency Preparedness Plan* (Ref. 22). These plans encompass environmental emergencies, spills, fire, and medical and natural disasters.

6.6 Laboratory Programs

Laboratories performing analysis for the environmental monitoring plan mainly use Environmental Protection Agency Contract Laboratory Program (CLP) methodologies. For certain analyses (such as radiochemical and wet chemistry) the laboratories use EPA 600 (drinking water), EPA 900 (radiochemical analysis of drinking water), or a method that is reviewed and approved by the Project Management Contractor prior to analysis of a sample. Contracted laboratories have each submitted a site-specific quality assurance project plan to the WSSRAP and have submitted controlled copies of their standard operating procedures. The quality assurance project plan and standard operating procedures are reviewed and approved by the contractor prior to sample shipment to a laboratory. Any changes to the standard analytical protocols or methodology are documented in their controlled standard operating procedures. All laboratories currently being used by the WSSRAP have had preliminary assessments of their facilities to make sure they have the capability and facilities to perform work according to the specifications in their contracts. Quality assurance audits are performed to inspect the laboratory facilities and operations, to verify that the laboratories are performing analyses as specified in their contracts, and to check that WSSRAP data documentation and records are being properly maintained.

Site-specific quality assurance project plans from laboratories define standard practices aimed at ensuring that the laboratories are performing high quality work. Each plan is in accordance with the current *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (Ref. 23). The laboratories demonstrate compliance with additional quality assurance/quality control requirements as specified in their contracts which include sample preparation and analytical methods; calibration of instrumentation; periodic inspections, maintenance, and servicing; statistical procedures to control precision and accuracy; corrective action programs; participation in the external Environmental Protection Agency Performance Audit Program; maintenance and storage of WSSRAP records, hardcopy and electronic formatting; and notification of nonconforming issues.

The laboratories' standard operating procedures provide detailed information about internal policy on standard analytical protocol on methods. These standard operating procedures provide step by step instructions for performing analytical work and for calculating, reducing, and recording pertinent information about analyses.

The accuracy of chemical and radiological analyses of water media samples are monitored by the routine use of control samples. This is a requirement of many published protocols (i.e., those of the Environmental Protection Agency) and is good laboratory practice. A quarterly quality assurance summary report is prepared on the accuracy and precision of water media samples and the frequency of collection of quality control samples. This information is summarized in the annual site environmental report.

Detailed information on the Project Management Contractor laboratory evaluations program can be found in Section 10.2, Environmental Monitoring Program Quality Assurance, the WSSRAP *Environmental Data Administration Plan* (Ref. 20), and various ES&H Department procedures. These programs give information about sample collection, data administration, and management programs necessary to make the overall WSSRAP laboratory program accurate and reliable to the data users.

7 QUALITY ASSURANCE

Quality assurance for environmental monitoring activities at the Weldon Spring site is divided into two separate categories. The first, programmatic or overall project quality assurance, relates to the incorporation and documentation of the quality of all site activities. This approach is discussed in Section 7.1. The second category is specific to the environmental monitoring activities presented in this plan and is discussed in Section 7.2.

7.1 Programmatic Quality Assurance

The Weldon Spring Site Remedial Action Project (WSSRAP) is obligated to comply with Department of Energy Order 5700.6C. This requirement was developed to ensure that work performed at facilities handling, processing, or utilizing radioactive materials is of documented quality. To satisfy this obligation, the Project Management Contractor has prepared a project specific *Project Management Contractor Quality Assurance Program* (Ref. 25) which details the various aspects of DOE Order 5700.6C.

The WSSRAP *Project Management Contractor Quality Assurance Plan* (Ref. 25) details DOE Order 5700.6C requirements which support, control, or guide the environmental monitoring program. This plan has been reviewed and approved by project management, the Project Quality Manager, and the U.S. Department of Energy Project Manager. These requirements include: project organization, a quality assurance program, a document control system, the identification and control of items, inspections, the control of measuring and test equipment, handling, storage, and shipping of quality-affecting items, a program for implementing and verifying corrective action, a program for maintaining quality assurance records, and a routine audit program.

The WSSRAP also has prepared an *Environmental Quality Assurance Project Plan* (Ref. 26) to meet the intent of EPA QAMS-005/80 (Ref. 23). This document supports the project *Project Management Contractor Quality Assurance Plan* (Ref. 25) and is specific to environmental monitoring and characterization. The *Environmental Quality Assurance Project Plan* (Ref. 26) is being revised to meet the requirements of Department of Energy Order 5700.6C.

7.2 Environmental Monitoring Program Quality Assurance

The quality of the environmental monitoring program is maintained and documented through a number of measures described in the following subsections. The measures include: the use of standard operating procedures; the collection, analysis, and evaluation of quality control samples and performance evaluation samples; the use of standardized analytical methods; data management activities (data verification) and data quality evaluations (data validation); maintaining quality assurance records; performing self assessments; and auditing and evaluating analytical laboratories, sample collection activities, and programmatic procedures. Each of these items will be discussed in the following subsections.

7.2.1 Standard Operating Procedures

Standard operating procedures have been developed for routine activities associated with environmental monitoring at the Weldon Spring site. These procedures have been developed from U.S. Environmental Protection Agency and Department of Energy guidance and from standard industry practices and are specific to the site. Procedures at the site are prepared, reviewed, and approved by cognizant department managers, the Project Quality Manager, and project management. Controlled copies of procedures are maintained in accordance with the document control requirements of Department of Energy Order 5700.6C. Procedures are reviewed at least annually and revised as appropriate.

Personnel undergo training specific to their responsibilities, varying from procedure review, through classroom training, and "hands on" training under the supervision of a qualified individual. This training is tracked through the use of a training matrix. Each manager prepares a unique subset of procedures for each individual from a list of all site procedures. Training records are maintained by the Productivity Improvement Coordinator. As procedures are revised, the matrices are updated and personnel are retrained.

Standard operating procedures applicable to environmental monitoring activities at the WSSRAP are listed in Table 7-1. These procedures cover all activities from groundwater sampling through chain-of-custody samples and provide detailed instructions to monitoring personnel.

TABLE 7-1 Procedures Applicable to Environmental Monitoring Activities

Procedure Number	Procedure Title
ES&H 1.1.7	Reporting Above Normal Values from Environmental Monitoring Networks
ES&H 4.1.1	Environmental Numbering System
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
ES&H 4.3.1	Surface Water Sampling
ES&H 4.4.1	Groundwater Sampling
ES&H 4.4.2	Groundwater Level Monitoring and Well Integrity Inspections
ES&H 4.4.6	Soil/Sediment Sampling
ES&H 4.5.1	pH and Temperature Measurements in Water
ES&H 4.5.2	Specific Conductance Measurement in Water
ES&H 4.5.7	Measurement of Settleable Solids
ES&H 4.5.8	Water Sampling Filtering
ES&H 4.6.1	Area TLD Deployment for Environmental Sampling
ES&H 4.6.2	Radon Concentrations Measurement in Ambient Air
ES&H 4.6.4	Constant Flow Air Sampler Operation and Sample Filter Handling
ES&H 4.6.6	Constant Flow High Volume Air Sampler Operation and Sample Filter Handling
ES&H 4.9.1	Environmental Monitoring Data Verification
ES&H 4.9.2	Environmental Monitoring Data Validation
CM&O-15	Task-specific Safety Assessments
RC-30	Monitoring Well Waste Management

7.2.2 Quality Control Samples

Numerous quality control samples are collected in support of environmental monitoring activities. Quality control samples are collected in accordance with procedure ES&H 4.1.4. These include: duplicate samples, replicate samples, blank samples, and rinsate samples. Samples are also provided to the laboratory for internal laboratory quality control evaluations specific to sample media (matrix spikes and matrix spike duplicate/matrix duplicate samples).

Table 7-2 presents a summary of the various quality control samples that will be collected to support environmental monitoring activities.

Quality control samples will be collected for each defined matrix. The matrices associated with the environmental monitoring samples are the Weldon Spring quarry groundwater, the St. Charles well field groundwater, the quarry surface water, the Weldon Spring Chemical Plant groundwater, and the chemical plant surface water. Quality control samples are also collected for National Pollutant Discharge Elimination System (NPDES) samples and airborne radiological monitoring programs.

Quarterly quality assurance summary reports will be prepared to summarize quality control data and evaluate the performance of the WSSRAP data collection and analysis program. This report will also specify the precision and accuracy by matrix to determine the variability of the analyses.

TABLE 7-2 Field Quality Control Sample Summary

QC Sample Type	Frequency	Purpose
Matrix Spike/Matrix Spike Duplicate or Matrix Duplicate	*1 per 20	Assess matrix and possible intralaboratory variability
Blind Duplicate/Secondary Duplicate	1 per 20	Assess matrix intralaboratory and interlaboratory variability.
Replicate	*1 per 20	Assess matrix and intralaboratory variability
Equipment Blank (non-dedicated equipment only)	1 per 20	Assess effectiveness of decontamination
Distilled Water Blank**	1 per month	Assess quality of distilled water
Trip Blank	1 per day when analyzing for VOAs	Assess potential cross-contamination during shipping
Field Blank**	1 per month	Assess impact of ambient conditions on samples

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

Contracted laboratories will be required to submit for review all applicable performance evaluation samples from external programs, such as the Environmental Protection Agency environmental monitoring systems laboratory and Department of Energy environmental measurements laboratory programs. Evaluation of performance evaluation samples will be made by the Project Management Contractor during laboratory audits to determine if quality control is being met by the contracted laboratories.

7.2.3 Analytical Methods

Standardized analytical methods, procedures, and protocols that are used to analyze samples collected for the environmental monitoring plan are contained in Appendix B. These standardized analytical methods, procedures, and protocols will be used, whenever possible, or variations will be approved prior to analysis. Variations to methods, procedures, or protocols are documented in the controlled standard operating procedures received from contracted laboratories or by revisions to the WSSRAP standard operating procedures. Variations of contracted laboratories' standard operating procedures are approved and controlled by the Data Validation group and Project Quality Department. Appendix B also has a summary of the required detection limits, as well as accuracy and precision requirements and is taken from the *Environmental Data Administration Plan* (Ref. 20).

7.2.4 Data Management Activities and Data Quality Evaluations

Overall environmental data management activities for the Weldon Spring site are detailed in the *Environmental Data Administration Plan* (Ref. 20). The environmental data administration plan provides guidance for the development of sampling plans, describes data management activities, and details general data quality requirements. These general data quality goals have been adopted for this monitoring program. The primary activities associated with this environmental monitoring program include data verification, database management, and data validation. These programs document the quality of data generated by on-site and off-site analyses of samples.

Data verification is the WSSRAP's process of reviewing the sampling documentation and analytical data to ensure that adequate documentation is maintained and that all results are reported in compliance with established reporting requirements. All data generated by analytical

laboratories for the *Environmental Monitoring Plan* are verified. The verification process consists of reviewing accounting aspects, reviewing sampling documentation and chain-of-custody documentation, comparing actual holding times to method specified holding times, and a review of the data for comparability with historical results. All of these activities are documented according to procedure ES&H 4.9.1.

Following completion of data verification, data are merged into the site database and are available for general use. All databases are backed up regularly. To maintain the integrity of the computer files, access to edit the data base is restricted.

Data validation is an independent formal review of laboratory records performed by WSSRAP personnel to assess the quality of the reported data. Actual laboratory records are reviewed by data validation personnel to determine whether the analytical instruments were within calibration and to ensure that adequate documentation is available to support the validity of the data. Data validation is performed on approximately 10% of all the data generated which are randomly selected by the validation group. Validation activities provide the WSSRAP with qualified data and evaluate completeness of analytical data from the individual laboratories. All validated data receive a database qualifier that provides information for data users to evaluate the useability of the data. These activities are performed and documented in accordance with procedure ES&H 4.9.2.

7.2.5 Quality Assurance Records

Records generated as a result of environmental monitoring are maintained as quality assurance records. Field Sampling Forms, analytical data, equipment calibration records, and verification and validation documentation records are all considered quality assurance records and are maintained by the Project Quality Department in accordance with the requirements of SQP-7a. This provides both security and protection for these records.

7.2.6 Self Assessments

Consistent with Department of Energy Order 5482.1B, the WSSRAP has developed a formal self- assessment program. This program is detailed in WSSRAP procedure SQP-24a, *Administration and Conduct of Self-Assessment*. Implementation of this procedure requires that

all departments perform a self assessment at least annually. Self assessments are scheduled and tracked by the Project Quality Department and are performed by a team led by the manager of the department being assessed. A report that summarizes the areas evaluated and the assessment results is prepared following each self assessment. Findings and proposed corrective actions are tracked according to the Site Wide Audit Tracking System (SWATS) (SQP-26).

7.2.7 Audits

Three aspects of the WSSRAP are audited to evaluate the quality-related activities of the environmental monitoring program. These include analytical laboratories, sample collection activities, and programmatic procedures.

Analytical laboratories performing analyses for the site are audited annually. These audits are directed by a lead auditor from the Project Quality Department, with support provided by a team of site personnel who have knowledge of analytical methods and procedures. These audits focus on compliance with the specifications of the contract, the project-specific *Quality Assurance Project Plan* prepared by the laboratories prior to performing sample analysis, and with laboratory-specific procedures and policies. An audit report is generated and corrective actions tracked by the Project Quality Department.

The Project Quality Department routinely audits site operations, including environmental monitoring activities. These audits evaluate compliance with project-specific procedures. As with all other audits, an audit report is generated and corrective actions are tracked by the Project Quality Department. The department also reviews and approves all new and revised standard operating procedures to verify that they comply with quality related activities.

The Weldon Spring site is also routinely audited by numerous external entities including Department of Energy - Headquarters and Department of Energy - Oak Ridge. These audits assess compliance with applicable regulations, Department of Energy orders guidance, site plans, and procedures. Formal reports and corrective actions are tracked using the Site Wide Audit Tracking System (SWATS).

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5400.1 *General Environmental Protection Program*
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5482.1B *Environment, Safety, and Health Appraisal Program*
5484.1 *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*
5700.6C *Quality Assurance*

STATE REGULATIONS

10 CSR 20-6.010(10)E, *NPDES Construction and Operating Permits*

PROCEDURES

ES&H 1.1.7a *Reporting Above Normal Values from Environmental Monitoring Networks*
ES&H 2.6.4 *Ludlum Model 2000 Scaler and Model 43-10 Detector: Gross Alpha Measurement Operation and Calibration*
ES&H 2.6.5s *Calibration and Operation of the KPA-11 Kinetic Phosphorescence Analyzer*
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ES&H 4.1.1a *Environmental Numbering System*
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ES&H 4.1.4s *Packaging and Shipping Requirements for Non-regulated Samples*

ES&H 4.3.1s *Surface Water Sampling*
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ES&H 4.6.8s *WLM-30 Radon Daughter Monitor: Operation and Data Handling*
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SQP 24a *Administration and Conduct of Self-Assessment*
SQP 26 *Site Wide Audit Tracking*

APPENDIX A
Environmental Monitoring Plan Guidance Requirements

1.0 INTRODUCTION

1.1 As required in the Environmental Monitoring Requirements section of DOE 5400.1, all DOE sites should* develop and maintain documentation concerning their environmental protection programs in the form of environmental monitoring plans.

The WSSRAP has prepared this environmental monitoring plan to meet the requirements for U.S. Department of Energy environmental monitoring programs as specified in Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*.

1.2 These required plans should* clearly describe how the minimum requirements in this document are to be met and how compliance will be ensured.

This *Environmental Monitoring Plan* defines the effluent monitoring and environmental surveillance required to comply with applicable Federal, State, and local environmental protection laws and regulations, Executive Orders, and internal Department of Energy policies. The environmental monitoring plan is made available to the State and Federal regulatory agencies.

1.3 In meeting the minimum requirements, each site should* also consider the guidance provided in this document as "should" statements and document the specific procedural criteria that are adopted.

An evaluation of the applicability or nonapplicability of should* guidance provided in the *Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* has been included in the *Environmental Monitoring Plan* in accordance with the above-referenced guide. Other recommendations have been evaluated and included in this document where applicable.

2.0 LIQUID EFFLUENT MONITORING

2.1 All liquid effluent streams from DOE facilities should* be evaluated and their potential for release of radionuclides assessed.

Sections 2.2 and 2.2.1. All liquid effluent streams have been and/or will be assessed. The effluent streams are monitored under the provisions of the Weldon Spring Site Remedial Action Project (WSSRAP) National Pollutant Discharge Elimination System (NPDES) permits. The effluent streams include four storm water outfalls, two water treatment plant discharges, one hydrostatic test water discharge point, and one sanitary wastewater treatment plant discharge and an undetermined number of storm water outfalls from the borrow area and borrow area haul road.

2.2 The results of this assessment provide the basis for the facility's Effluent Monitoring Program (DOE 5400.5), which should* be documented in the site Environmental Monitoring Plan (as described in DOE 5400.1)

Section 4. The results of the assessments provide the basis for the environmental monitoring plan as noted in Section 4 of the environmental monitoring plan. The NPDES permits provide the basic monitoring program which has been expanded to form the complete effluent monitoring program.

2.3 Liquid effluents from DOE-controlled facilities that have the potential for radioactive contamination should* be monitored in accordance with the requirements of DOE 5400.1 and DOE 5400.5.

Section 4.1. The WSSRAP is not an operating facility. Storm water discharges are monitored and average below the derived concentration guideline (DCG) for uranium. Discharges that have a potential for radioactive contamination (site and quarry water treatment plants) will be sampled, analyzed and shown in compliance before discharge is allowed.

2.4 Facility operators should* provide monitoring of liquid waste streams adequate to 1) demonstrate compliance with the applicable requirements of DOE 5400.5, Chapter II, paragraphs 1a, 1d, 2a, and 3, 2) quantify radionuclides released from each discharge point, and 3) alert affected process supervisors of upsets in processes and emission controls.

Section 4.1. No process water is discharged from the WSSRAP; however, storm water, construction water, treated water, etc., is monitored to satisfactorily demonstrate compliance with Department of Energy Order 5400.5 Chapter II, paragraphs 1a, 1d, 2a, and 3, and quantify radionuclides. The water treatment plants discharge to holding ponds will be batch tested and released only if compliance is met.

2.5 When continuous monitoring or continuous sampling is provided, the overall accuracy of the results should* be determined (± % accuracy and the % confidence level) and documented in the Environmental Monitoring Plan.

Section 4.1.3.1. The only continuous monitoring that occurs is for flow monitoring at NPDES outfalls NP-0002, NP-0003, NP-0005, NP-0007, and NP-1001.

2.6 In addition, provisions for monitoring of liquid effluents during an emergency should* be considered when determining routine liquid effluent monitoring program needs.

Section 4.1.3.2. Emergency monitoring of liquid effluents is performed in the event that contaminated water is accidentally released before treatment or in the event of spills.

2.7 In addition, the selection or modification of a liquid effluent monitoring system should* be based on a careful characterization of the source(s), pollutant(s) (characteristics and quantities), sample-collection system(s), treatment system(s), and final release point(s) of the effluents.

Section 2.2. The rationale for the liquid effluent monitoring program includes a characterization of the sources, pollutants, sample collection systems, treatment systems;

and final release points. The NPDES permits also partially prescribe the parameters to be monitored.

2.8 **For all new facilities or facilities that have been modified in a manner that could affect effluent release quantity or quality or that could affect the sensitivity of monitoring or surveillance systems, a pre-operational assessment should* be made and documented in the Environmental Monitoring Plan to determine the types and quantities of liquid effluents to be expected from the facility and to establish the associated effluent monitoring needs of the facility.**

Section 4.1. The WSSRAP is not an operating facility; therefore, there are no process effluents. However, there have been assessments made to determine storm water and treated water flows and characteristics.

2.9 **The performance of the effluent monitoring systems should* be sufficient for determining whether effluent releases of radioactive material are within the Derived Concentration Guides (DCGs) specified in DOE 5400.5 and to comply with the reporting requirements of Chapter II, paragraph 7, of that Order.**

Section 4.1 and 7. The effluent monitoring systems are sufficient to determine if the effluent releases are within the DCGs described in Department of Energy Order 5400.5.

2.10 **The required detection levels of the analysis and monitoring systems should* be sufficient to demonstrate compliance with all regulatory requirements consistent with the characteristics of the radionuclides that are present or expected to be present in the effluent.**

Section 7.2.3 and Appendix B. Required detection levels are adequate for NPDES monitoring and to demonstrate compliance with all regulatory requirements.

2.11 Sampling systems should* be sufficient to collect representative samples that provide for an adequate record of releases from a facility, to predict trends, and to satisfy needs to quantify releases.

Section 4.1. Sampling of liquid effluents are performed in accordance with WSSRAP standard operating procedures in order to provide representative samples, to predict trends, record releases, and to quantify releases.

2.12 Continuous monitoring and sampling systems should* be calibrated before use and recalibrated any time they are subject to maintenance, modification or system changes that may affect equipment calibration.

Section 4.1.3.1. The only continuous monitoring systems for effluents are the flow meters at NP-0002, NP-0003, and NP-0005 and the flow meters at the site and quarry water treatment plants.

2.13 In addition, they should* be recalibrated at least annually and routinely checked with known sources to determine that they are consistently functioning properly.

Section 4.1.3.1. The flow meters will be recalibrated at least annually and will be routinely checked in accordance with WSSRAP standard operating procedures.

2.14 Environmental conditions (e.g., temperature, humidity, radiation level, dusts, and vapors) should* be considered when locating sampling and monitoring systems to avoid conditions that will influence the operation of the system.

Flow meters and automatic water samplers are the only sampling and monitoring systems and are designed for use under the existing conditions at the WSSRAP.

2.15 Off-line liquid transporting lines should* be replaced if they become contaminated (to the point where the sensitivity of the system is affected) with radioactive materials or if they become ineffective in meeting the design basis within the established accuracy/confidence levels.

This statement does not apply. The only off-site liquid transporting lines will be from the site and quarry water treatment plants. These lines will transport treated water that is sampled before entering the lines to ensure its composition.

2.16 If continuous monitoring/sampling and recording of the effluent quantity (stream flow) is not feasible for a specific effluent stream, the extenuating circumstances should* be documented in the Environmental Monitoring Plan.

This statement does not apply. One storm water outfall does not have continuous flow monitoring. Outfall NP-0010 is normally dry and is a very shallow swale. The flows are very low and normally non-existent making it impractical to use continuous monitoring.

2.17 Sampling/monitoring lines and components should* be designed to be compatible with the chemical and biological nature of the liquid effluent.

Section 4. The liquid effluent is water, which is compatible with sampling/monitoring lines and components.

2.18 The output signal instrumentation, monitoring system recorders, and alarms should* be in a location that is continuously occupied by operations or security personnel.

This statement does not apply. There are no industrial processes. When the site and quarry water treatment plants begin operation, they will be manned 24 hours a day; however, there will not be a continuous release of treated water. Water will only be released in batches after it is tested and found to be under permitted limits.

2.19 To signal the need for corrective actions that may be necessary to prevent public or environmental exposures from exceeding the limits or recommendations given in DOE 5400.5, when continuous monitoring systems are required, they should* have alarms set to provide timely warnings.

This statement does not apply. There is no continuous monitoring of effluent related to public exposure since the WSSRAP is not an operating facility.

2.20 As they apply to the monitoring/sampling of liquid effluents, the general quality assurance program provisions of Chapter 10 should* be followed.

Section 7. All sampling and monitoring activities are performed in accordance with the general quality assurance program provisions.

3.0 AIRBORNE EFFLUENT MONITORING

3.1 All airborne emissions from DOE-controlled facilities [a] should* be evaluated and their potential for release of radionuclides assessed.

Section 4.2.1. The WSSRAP has two diffused sources of airborne radiological emissions: the Weldon Spring Chemical Plant and raffinate pits and the Weldon Spring quarry. An assessment of the two diffused sources was conducted and included documenting the different radionuclides that could potentially be released and their concentrations. The assessment also addressed the factors that could potentially contribute to the suspension of contaminants.

3.2 The potential for emissions should* include consideration of the loss of emission controls while otherwise operating normally.

Section 4.2.1. Normal operations, consisting of remediation activities, will result in limited emissions due to the disturbance of soils and materials. Engineering controls including water spraying, cleaning of surfaces prior to movement radon capturing systems, and high efficiency particulate air (HEPA) filtration, have been incorporated into the remediation activities in order to prevent uncontrolled emissions. An assessment

of airborne emissions which included loss of emissions controls, was performed for the chemical stabilization/solidification pilot plant.

3.3 **The results of this evaluation also provide the basis for the site's effluent monitoring program (as discussed in DOE 5400.5), which should* be documented in the site Environmental Monitoring Plan (as discussed in DOE 5400.1).**

Section 4.2.1. The airborne emissions assessment provides a basis for the airborne emissions monitoring program and ensures that the design of the plan would provide timely, representative, and adequately sensitive monitoring results in accordance with Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide*.

3.4 **Airborne emissions from DOE-controlled facilities that have the potential for causing doses exceeding 0.1 mrem (effective dose equivalent) to a member of the public under realistic exposure conditions from emissions in a year should* be monitored in accordance with the requirements of DOE 5400.1 and DOE 5400.5.**

Section 4.2. Although the estimated exposures from the chemical plant and raffinate pits and the quarry, including both water treatment plants and the chemical stabilization/solidification pilot plant, are predicted to be low, the emissions monitoring program is tailored for the low potential for exposure and in accordance with Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide*.

3.5 **The criteria listed in 3-1 should* be used to establish the airborne emission monitoring program for DOE-controlled sites.**

Section 4.2. The WSSRAP airborne emissions monitoring plan has taken into account the criteria for monitoring the emissions with respect to the calculated maximum dose from emissions in a year to members of the public.

3.6 For all new facilities or facilities that have been modified in a manner that could affect effluent release quantity or quality or that could affect the sensitivity of monitoring or surveillance systems, a pre-operational assessment should* be made and documented in the site Environmental Monitoring Plan to determine the types and quantities of airborne emissions to be expected from the facility, and to establish the associated airborne emission monitoring needs of the facility.

Section 4.2.1. Engineering controls will be employed to minimize levels to those which are as low as reasonably achievable (ALARA). Engineering process documentation is used to determine the types and quantities of expected emission and associated airborne monitoring requirements.

3.7 The performance of the airborne emissions monitoring system should* be sufficient for determining whether the releases of radioactive materials are within the limits or requirements specified in DOE 5400.5.

Section 4.2.2. The airborne emissions monitoring system is divided into three sections: site specific monitoring, site perimeter monitoring, and critical receptor monitoring at both the chemical plant and the quarry. This three staged approach is designed to monitor the smaller sources in order to discern each sources contribution to the total amount of airborne emissions from either the chemical plant or the quarry. This approach will allow for quicker remedial action in the event elevated emissions are indicated at a specific work area, and in order to remain in compliance with the limits or requirements specified in Department of Energy Order 5400.5.

3.8 Sampling and monitoring systems should* be calibrated before use and recalibrated any time they are subject to maintenance or modification that may affect equipment calibration.

Section 4.2.2.1, 4.2.2.2, and 4.2.2.3. Sampling systems are calibrated in accordance with WSSRAP standard operating procedures and manufacturers' specifications.

3.9 Sampling and monitoring systems should* be recalibrated at least annually and routinely checked with known sources to determine that they are consistently functioning properly.

Section 4.2.2.1, 4.2.2.2, and 4.2.2.3. Monitoring systems are calibrated as stated in item 3.8, above.

3.10 Provisions for monitoring of airborne emissions during accident situations should* be considered when determining routine airborne emission monitoring program needs.

Section 4.2.2.1. Three air monitoring programs are utilized at the WSSRAP to monitor site specific areas, perimeter areas, and critical receptors. Site specific monitoring, in addition to providing data concerning the contributions of specific activities to the total airborne inventory, will provide faster feed back concerning the effectiveness of engineering controls and data concerning dispersion patterns. Filters from site-specific monitors will be collected on a daily basis as compared to weekly for the perimeter samplers in order to assess the possibility of accidental release of airborne contaminants. Site-specific monitoring will be utilized during remediation activities at the quarry. Monitors will be placed immediately outside the work areas based on current meteorological conditions to assess airborne emissions from specific activities and areas within the quarry.

3.11 Diffuse sources should* be identified and assessed for their potential to contribute to public dose and should* be considered in designing the site effluent monitoring and environmental surveillance program.

Section 4.2.1. Two diffuse sources have been identified at the WSSRAP: the chemical plant and the quarry. To effectively monitor these sources, three air monitoring programs will be utilized to monitor the site specific areas, the perimeter areas, and the critical receptors. The characteristics of these areas were used to determine the locations, equipment, sampling time, minimum detection levels, accuracy, and investigation levels for each program. These programs are designed to meet the

requirements of Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide*.

3.12 Diffuse sources that may contribute a significant fraction (e.g., 10%) of the dose to members of the public resulting from site operations should* be identified, assessed, documented, and verified annually.

Section 4.2.1. Two diffuse sources, the chemical plant and the quarry, are monitored under the airborne effluent and environmental surveillance program due to their potential to contribute a significant fraction of the dose to members of the public. These sources are evaluated annually in the *Environmental Monitoring Plan* which is revised annually for the WSSRAP.

3.13 Airborne emission sampling and monitoring systems should* demonstrate that quantification of airborne emissions is timely, representative, and adequately sensitive.

Section 4.2.2. The employment of site specific monitoring will ensure that response to elevated airborne emission will be timely, representative, and adequately sensitive.

3.14 However, where a significant potential (greater than once per year) exists for approaching or exceeding a large fraction of the emission standard (e.g., 20%), continuous monitoring should* be required.

Section 4.2.2. Although it is not expected that airborne emissions will exceed the emission standard, continuous monitoring is performed at the site perimeter and at the critical receptor locations. Continuous monitoring is performed during work hours at site specific locations.

3.15 Design of systems such that replacement of sorbent and filter should* not disturb the geometry between the collector and detectors.

Radioiodine monitors which require the replacement of sorbent and filter are not employed at the WSSRAP. The WSSRAP utilizes portable air samplers, mass flow meters, gas-flow proportional detectors, and alpha-scintillation detectors.

3.16 To signal the need for corrective actions that may be necessary to prevent public or environmental exposures from exceeding the limits or recommendations given in DOE 5400.5, when continuous monitoring systems (as required by the criteria in 3.1) are required, they should* have alarms set to provide timely warnings.

Continuous monitors at critical receptor locations are used to assess the airborne effluents at these locations.

3.17 As they apply to the monitoring of airborne emissions, the general quality assurance program provisions discussed in Chapter 10 should* be followed.

Quality control procedures which are implemented as part of the airborne effluent and environmental monitoring program include calibration of instruments, source and background counts, recounts of samples, review of documentation, and use of documented standard operating procedures. Additional quality assurance/quality control procedures which are employed in this program include duplicated, spikes, chain-of-custody and laboratory authorization forms, field sheets, and review of vendor data all in accordance with WSSRAP standard operating procedure.

4.0 METEOROLOGICAL MONITORING

4.1 Each DOE site (facility)[a] should* establish a meteorological monitoring program that is appropriate to the activities at the site, the topographical characteristics of the site, and the distance to critical receptors.

Section 5. The Weldon Spring Quarry is located approximately 4 km (2.4 mi) south-southwest of the Weldon Spring Chemical Plant and raffinate pits area. The quarry is located 200 m (650 ft) above Mean Sea Level (MSL) and the chemical plant and raffinate pits are located 153 m (500 ft) above MSL. It has been determined that the quarry and the chemical plant meteorological conditions do not differ significantly and do not require

separate meteorological monitoring stations. The meteorological monitoring station is located at eastern edge of the chemical plant and is more than 122 m (400 ft) from the nearest building.

4.2 The scope of the program should* beabased on an evaluation of the regulatory requirements, meteorological data needed for impact assessments, environmental surveillance activities, and emergency response.

Section 5. The meteorological information is used to support many WSSRAP environmental surveillance programs functions such as dispersion and diffusion modeling, ecological studies, hydrological analyses, and emergency response actions.

4.3 The site's meteorological program should* be documented in a meteorological monitoring section of the Environmental Monitoring Plan (DOE 5400.1).

Section 5. The meteorological program, consisting of parameters measured, instrumentation, and computer programs and models, is reviewed annually and documented in the environmental monitoring plan.

4.4 For data from an off-site source to be acceptable, the data should* be representative of conditions at the DOE facility and provide statistically valid data consistent with on site monitoring requirements.

The meteorological data utilized at the WSSRAP is obtained from an on-site meteorological monitoring station. During down time data from Lambert International Airport will be utilized.

4.5 Specific meteorological information requirements for each facility should* be based on the magnitude of potential source terms, the nature of potential releases from the facility, possible pathways to the atmosphere, distances from release points to critical receptors, and the proximity of other DOE facilities.

Section 2. The exposure pathway analysis was performed by initially determining the potential exposure routes and the factors to be considered and then using site specific

factors, determining those routes which will be evaluated in the environmental surveillance program. The meteorological measurements and frequencies were determined based on these criteria.

4.6 Meteorological information requirements for facilities should* be sufficient to support environmental monitoring and surveillance programs.

Section 5. Meteorological information requirements take into account the information required to support the environmental monitoring and surveillance programs as outlined in Item 4.3.

4.7 The meteorological monitoring program for each DOE site should* provide the data for use in atmospheric transport and diffusion computations that are appropriate for the site and application.

Section 5. Meteorological monitoring station data provides information pertinent to dispersion and diffusion modeling to supplement critical receptor monitoring in the event of an airborne release. The computer programs CAP-88 and ISCST2, employed with information from the monitoring station, are plume dispersion models designed to provide a schematic view of dispersion at the WSSRAP.

4.8 Before any model is deemed appropriate for a specific application, the assumptions* upon which the model is based should* be evaluated and the evaluation results documented.

Section 5. The WSSRAP will use the programs CAP-88 or ISCST2 if necessary. These models are based on the assumptions of steady-state Gaussian principles.

4.9 Meteorological programs for sites where on-site meteorological measurements are not required should* include a description of climatology in the vicinity of the site and should* provide ready access to representative meteorological data.

Meteorological measurements are required for activities performed at the WSSRAP.

4.10 Potential release modes, distances from release points to receptors, and meteorological conditions should* be considered in assessments for DOE facilities required to take on-site measurements.

Section 2 and 5. An exposure pathway analysis was performed by initially determining the potential exposure routes and the factors to be considered and then using site-specific factors to determine those routes which will be evaluated in the environmental surveillance program. Meteorological conditions, such as prevailing wind direction and speed, are taken into account in the determination of on-site measurements required.

4.11 Meteorological measurements should* be made in locations that, to the extent practicable, provide data representative of the atmospheric conditions into which material will be released and transported.

Section 5. The meteorological monitoring station is located at the Weldon Spring site and, therefore, provides adequate information regarding the media into which material may be released and transported at both the chemical plant and the quarry.

4.12 The instruments used in the monitoring program should* be capable of continuous operation in the expected range of atmospheric conditions at the facility.

Section 5. Measurements for wind speed and direction, horizontal wind fluctuation, ambient air temperature, barometric pressure, and precipitation intensity and accumulation are collected and stored every 60 sec. The 1-min recordings are averaged once per hour and the data downloaded daily to a remote computer. Real-time data can also be obtained to aid site personnel observing and analyzing the dispersion of potentially released airborne material during and after an incident.

4.13 Wind measurements should* be made at a sufficient number of heights to adequately characterize the wind at potential release heights.

The wind speed and direction sensors are mounted 10 m (33 ft) above ground level. Sensors at greater heights are unnecessary since potential releases of airborne emissions are at, or near, ground level.

4.14 The meteorological monitoring program should* provide for routine inspection of the data and scheduled maintenance and calibration of the meteorological instrumentation and data-acquisition system at a minimum, based on the calibration frequency recommendations of the manufacturers.

Section 5. Inspection and maintenance of the meteorological monitoring station, daily review of meteorological data, and semi-annual calibration of the instrumentation are documented and performed in accordance with ES&H Procedure 4.8.3.

4.15 Inspections, maintenance, and calibrations should* be conducted in accordance with written procedures, and logs of the inspections, maintenance, and calibrations should* be kept and maintained as permanent records.

Section 5. Inspection and maintenance of the meteorological monitoring station, daily review of meteorological data, and semi-annual calibration of the instrumentation are documented and performed in accordance with Procedure ES&H 4.8.3.

4.16 The instrument system should* provide data recovery of at least 90% on an annual basis for wind direction, wind speed, those parameters necessary to classify atmospheric stability, and other meteorological elements required for dose assessment.

Section 5. The instrument system is expected to provide 90% data recovery on an annual basis based on inspection and maintenance of equipment in accordance with Procedure ES&H 4.8.3.

4.17 The topographic setting of a facility and the distances from the facility to points of public access should* be considered when evaluating the need for supplementary instrumentation.

Supplementary instrumentation is not necessary due to the determination by a certified meteorologist that the chemical plant and the quarry do not have differing meteorological conditions.

4.18 If meteorological measurements at a single location cannot adequately represent atmospheric conditions for transport and diffusion computations, supplementary measurements should* be made.

Supplementary instrumentation is not necessary due to the determination by a certified meteorologist that the chemical plant and the quarry do not have differing meteorological conditions.

4.19 A site-wide meteorological monitoring program should* be established at each multifacility site to provide a comprehensive database that can be used for all facilities located within the site.

The WSSRAP is not a multifacility site and the meteorological condition for the chemical plant and the quarry have been determined to be similar.

4.20 As they apply to meteorological monitoring, the general quality assurance program provisions described in Chapter 10 should* be followed.

Section 5. Inspection and maintenance of the meteorological monitoring station, daily review of meteorological data, and semi-annual calibration of the instrumentation are documented and performed in accordance with ES&H Procedure 4.8.3.

5.0 ENVIRONMENTAL SURVEILLANCE

5.1 An evaluation should* be conducted and used as the basis for establishing an environmental surveillance program for all DOE-controlled sites.

Section 2. The WSSRAP Environmental Monitoring Program has been established and modified yearly as a result of the evaluation of environmental conditions, pathway analyses, and Federal, State, and local laws and environmental protection regulations, Executive Orders, and internal Department of Energy policies.

5.2 The results of this evaluation should* be documented in the site Environmental Monitoring Plan (as required by DOE 5400.1).

Sections 3 and 7. This *Environmental Monitoring Plan* summarizes the environmental surveillance sampling or measurement locations for both the Weldon Spring Chemical Plant and raffinate pits area and the Weldon Spring Quarry sites and the minimum required analyses or measurement frequencies for these locations in order to adequately ensure the protection of the public and the environment. These locations are sampled or measured in accordance with documented standard operating procedures which incorporate U.S. Environmental Protection Agency and Department of Energy guidance and standard industry practices. The minimum detection level and accuracy of the analyses or measurements are in accordance with Federal, State, and local laws and environmental protection regulations, Executive Orders, and internal Department of Energy policies. The quality of the Environmental Monitoring Program is maintained and documented by standard operating procedures, quality control samples, performance audit samples, standardized analytical methods, data management, data quality evaluations, quality assurance records, self assessments, laboratory audits, and quality audits. If above normal or anomalous data values are suspected after review of data, written standard operating procedures regarding actions and reporting are employed.

5.3 The environmental surveillance program for DOE-controlled sites should* be conducted in accordance with the requirements of DOE 5400.1 and DOE 5400.5.

Section 3. The environmental surveillance program has been prepared to meet the requirements for Department of Energy environment monitoring programs as specified in Department of Energy Orders 5400.1 and 5400.5 and the *Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, as well as applicable Federal, State, and local laws and environmental protection regulations.

5.4 The criteria for environmental surveillance programs (listed in 5-1) should* be used for establishing the environmental surveillance program for DOE-controlled sites.

Section 3. Criteria listed in 5-1 of the *Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* were used in the establishment of the environmental surveillance program and are further discussed in items 5.6 through 5.10.

5.5 Any additional site-specific criteria should* be documented in the site Environmental Monitoring Plan.

Additional site specific criteria which effect or alter the criteria listed in 5-1 are documented in the *Environmental Monitoring Plan* and discussed in items 5.6 through 5.10.

5.6 When feasible, all environmental media that, as determined by site-specific radiation exposure pathway analysis, might lead to a measurable annual dose of site origin at the site boundary should* be routinely sampled and analyzed (for the critical radionuclides to dose) and routine measurements of penetrating radiation should* be performed at those sites that, as determined by site-specific exposure pathway analysis, might result in an annual dose of site origin at the site boundary, if the total exceeds a) 5 mrem effective dose equivalent; or b) 100 person-rem collective effective dose equivalent within a radius of 80 km of a central point in the site.

Sections 3 and 4.2. Measurements are made as determined by the site specific pathway analysis within the site boundaries, at the site boundaries, and at points outside the site boundaries as outlined in the previously mentioned Sections.

5.7 Environmental surveillance measurements may be performed periodically, but should* be performed at least every five years, to confirm the low dose levels, if the projected annual effective dose equivalent of site origin is ≤ 0.1 mrem.

Sections 3 and 4.2. Environmental surveillance is performed on a regular basis as specified in the previously mentioned sections.

5.8 Actual measurements on two media for each critical radionuclide/pathway combination, one of which might be the effluent stream, should be performed as part of the site routine effluent monitoring and environmental surveillance program.

Measurements on two media for each critical radionuclide/pathway combination are not necessary due to extensive characterization of the media and historic monitoring. The *Environmental Monitoring Plan* has been designed to take into account the radionuclide/pathway combinations requiring environmental surveillance.

5.9 Use of data should be based on statistically significant differences between the point of measurement and background (or control) data.

Background sampling or measurement locations have been established for all pathway media at both the chemical plant and the quarry. In an agreement with the U.S. Geological Survey, the Department of Energy has established background for the Missouri River Alluvium by the sampling of seven temporary wells installed by the U.S. Geological Survey. Background locations for both the Little Femme Osage Creek and the Missouri River are monitored routinely. Background for groundwater at the Weldon Spring Chemical Plant and raffinate pits area is based on the results of an ongoing sampling program by the Missouri Department of Health. Private drinking water wells in the vicinity of the chemical plant are routinely monitored by that department and the results provided to the WSSRAP, therefore, these locations are not routinely monitored as background locations. Several lakes in the Busch Wildlife Area and Dardenne Creek are sampled routinely as background locations for surface waters near the chemical plant. The Remedial Investigation for the Weldon Spring site has established statistical background levels for chemical constituents at the Weldon Spring site. A background air monitoring station is monitored routinely to establish background levels for the chemical plant and the quarry. The background monitoring station is located approximately 12.9 km (8 mi) from the chemical plant and 11.3 km (7 mi) from the quarry.

5.10 Provisions should* be made, as appropriate, for the detection and quantification of unplanned releases of radionuclides to the environment.

Source measurement and control of all contained surface water is performed at the Weldon Spring site to prevent the release of radionuclide to the groundwater and surface waters. Monthly storm water sampling is performed to monitor the transport and release of radionuclides at the Weldon Spring site. Perimeter air monitoring is performed routinely, as well as work place monitoring, to determine releases of radionuclides at the Weldon Spring site.

Section 4.2.2.1. Three air monitoring programs are utilized at the WSSRAP to monitor site specific areas, perimeter areas, and critical receptors. Site specific monitoring, in addition to providing data concerning the contributions of specific activities to the total airborne inventory, will provide faster feedback concerning the effectiveness of engineering controls and data concerning dispersion patterns. Filters from site-specific monitors will be collected on a daily basis as compared to weekly for the perimeter samplers, in order to assess the possibility of accidental release of airborne contaminants. Site-specific monitoring will be utilized during remediation activities at the Weldon Spring Quarry. Monitors will be placed immediately outside the work areas based on current meteorological conditions to assess airborne emissions from specific activities and areas within the quarry.

5.11 The need for environmental sampling and analysis should* be evaluated, by exposure pathway analysis, for each site radionuclide effluent or emission (liquid or airborne).

Section 2. The exposure pathway analysis for the WSSRAP was performed to evaluate the impact on human or ecological receptors due to radiological effluent or emissions from the WSSRAP. Sampling or measurement locations were determined based on this exposure pathway analysis in order to ensure the protection of the public and the environment.

5.12 This analysis with appropriate data, references, and site-specific assumptions, along with site-specific criteria for selection of samples, measurements, instrumentation, equipment, and sampling or measurement locations should* be documented in the site Environmental Monitoring Plan.

Section 2. The exposure pathway analysis was performed by initially determining the potential exposure routes and the factors to be considered, and then using site specific factors, determining those routes which should be evaluated in the environmental surveillance program. The selection samples, measurements, and locations were determined based on the selected exposure routes.

5.13 A critical pathway analysis (radionuclide/ media) should* be performed, documented, and referenced in the annual Site Environmental Report.

The critical pathway analysis is revised annually for inclusion in both the environmental monitoring plan and the annual site environmental report.

5.14 If the projected dose equivalent from inhalation of particulates exceeds the criteria of 5-1, particle-size analysis of the emission should* be conducted at least annually.

Sections 4.2.1.1 and 4.1.1.2. Particle size analysis will be performed on an annual basis on specific sources which have higher potential for airborne emissions.

5.15 For all new or modified facilities coming on-line, a pre-operational assessment should* be made and documented in the site Environmental Monitoring plan to determine the types and quantities of effluents to be expected from the facility and to establish the associated environmental surveillance program.

Section 3. Two water treatment plants were operational in 1993 and the chemical stabilization/solidification pilot facility is expected to be operational in 1995. Additional monitoring of these facilities prior to operation was performed based on a pre-operational assessment as to the types and quantities of effluents from the facility and establish pre-

operational characteristics of the groundwater, surface water, and ambient air at the Weldon Spring site.

Preoperational monitoring is also being performed prior to the construction of the disposal cell and supporting facilities, which will disrupt large areas of the chemical plant area.

Section 4.2.1. Engineering controls will be employed to minimize levels to those which are ALARA. Engineering process documentation is used to determine the types and quantities of expected emission and associated airborne monitoring requirements.

5.16 Calibration of dosimeters and exposure-rate instruments should* be based on traceability to National Institute for Standards and Testing (NIST) standards.

Sections 4.2 and 3.3.4. Calibration of monitoring systems requiring known value sources is performed using NIST traceable radioactive sources.

5.17 Gross radioactivity analyses should* be used only as trend indicators, unless documented supporting analyses provide a reliable relationship to specific radionuclide concentrations or doses.

Section 4.2.3.3. The WSSRAP has done extensive characterization of the Weldon Spring Chemical Plant and raffinate pits area and the Weldon Spring Quarry to provide reliable relationships between radionuclides. In addition, the WSSRAP continues to perform radionuclide specific analysis such as the critical receptor monitoring program.

5.18 The overall accuracy (± % accuracy) should* be estimated, and the approximate Environmental Detection Limit at a specified % confidence level for environmental measurements for beta-gammas, alphas, and neutrons should* be determined and the two levels documented in the site Environmental Monitoring Plan.

Sections 4.2.2.1 and 4.2.2.2. The overall accuracy and the approximate Environmental Detection Limit for the environmental measurements are documented in the previously mentioned Sections.

5.19 Sample preservation methods should* be consistent with the analytical procedures used.

Section 6. Preservation of environmental samples is performed in accordance with Environmental Protection Agency methodology for the analyses of specific parameters.

5.20 All environmental surveillance techniques should* be designed to take a representative sample or measurement of the important radiation exposure pathway media.

Sections 3, 4, and 7. The environmental sampling techniques employed at the Weldon Spring site are performed in accordance with documented standard operating procedures in order to obtain representative samples of the media.

5.21 Sampling or measurement frequencies for each significant radionuclide or environmental medium combination (e.g., those that contribute 10% or more to off-site dose greater than 0.1 mrem EDE from emissions in a year) should* take into account the half-life of the radionuclides to be measured and should* be documented in the site Environmental Monitoring Plan.

The radionuclides that exist at the WSSRAP which contribute 10% or more to off-site dose all have lengthy half-lives and would have no significance on the sampling frequency.

5.22 "Background" or "control" location measurements should* be made for every significant radionuclide and pathway combination (e.g., those that contribute 10% or more to off site dose greater than 0.1 mrem EDE from emissions in a year) for which environmental measurements are used in the dose calculations.

Section 3. Background sampling and measurement locations have been designated for both the Weldon Spring Chemical Plant and raffinate pits area and the Weldon Spring Quarry sites for all exposure media routes.

5.23 An annual review of the radionuclide composition of effluents or emissions should* be made and compared with those used to establish the site Environmental Monitoring Plan.

Section 3 and 4. The radionuclide composition of exposure media at the chemical plant and the quarry sites are determined annually for evaluation of additional environmental surveillance.

5.24 Any deviations from routine environmental surveillance requirements, including sampling or measurement station placement, should* be documented in an approved revised site Environmental Monitoring Plan.

Sections 1 and 6.4. The WSSRAP *Environmental Monitoring Plan* is reviewed annually due to the complexity and evolution of the remedial work being performed. A revised *Environmental Monitoring Plan* will be issued if it is determined that the monitoring program does not satisfy the requirements of the Department of Energy orders and applicable requirements or if there is a significant change in requirements. All variances from the program scope are documented in a memorandum to project management and reported in the annual Site Environmental Report.

5.25 The air sampling rate should* not vary by more than ±20% and total air flow or total running time should* be indicated; air sampling systems should* be leak-tested, flow-calibrated, and tested and inspected on a routine basis at a minimum, using the calibration frequency recommendations of the equipment manufacturers.

Section 4.2.2.1, 4.2.2.2, and 4.2.2.3. Sampling systems are calibrated in accordance with WSSRAP standard operating procedures and manufacturers' specifications. Alpha-scintillation detectors are calibrated a minimum of every six months using NIST traceable radioactive sources. The gas-flow proportional counter is calibrated when repairs are made to the detector or there has been a potential for drift in the readings in the equipment. The rotometer is calibrated to NIST specifications on an annual basis. If the flow rate in the field changes more than 20% during the sampling period, the monitor will be evaluated to determine if service is required.

5.26 State and local game officials should* be consulted when selecting appropriate protected species to sample.

The ecological monitoring program is designed in close consultation with local conservation and protection agencies. Preliminary activities for annual monitoring relate to sampling of game species within the surrounding wildlife areas. State and Federal collection permits are obtained as necessary for sampling and all sampling programs are reviewed with appropriate agencies prior to work. No sampling of protected species; i.e. Federally or State listed endangered or threatened species is planned. Monitoring activities for protected species are limited to visual observations and identification for purposes of documenting occurrence of species within the Weldon Spring site area.

5.27 DOE Operations Offices and contractor staff should* ensure that groundwater monitoring plans are consistent with State and regional EPA groundwater monitoring requirements under RCRA and CERCLA, to avoid unnecessary duplication.

Section 1. The WSSRAP has prepared the *Environmental Monitoring Plan* to meet the requirements for Department of Energy environmental monitoring programs as specified in Department of Energy Orders 5400.1 and 5400.5, the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, and applicable Federal, State, and local laws and environmental protection regulations. Copies of the environmental monitoring plan are made available to the State and Federal regulatory agencies.

5.28 DOE Operations Offices and contractor staff should* consult with State and regional EPA personnel as needed to ensure that the requirements are incorporated into the Radiological Monitoring Plan.

Section 1. All applicable Federal, State, and local laws and environmental protection regulations regarding radiological parameters are incorporated into the environmental surveillance programs for the Weldon Spring sites. Copies of the environmental monitoring plan are provided to the State and Federal regulatory agencies.

5.29 Any changes in the site-specific or generic factors should* be noted in the plan and the retired or replaced values preserved for historical purposes.

Section 2. The site-specific factors effecting the environmental surveillance program are evaluated, revised, and documented annually in the *Environmental Monitoring Plan*.

5.30 When neutron monitoring is required, the method of measurement should* be based on the anticipated flux and energy spectrum.

No significant neutron sources are present at the WSSRAP.

5.31 The sample exchange frequency for non-particulate sampling should be determined on a site-specific basis and should* be documented in the environmental surveillance files.

Sections 4.2.2.1, 4.2.2.2, and 4.2.2.3. The sampling frequency for non particulate sampling is documented in the applicable standard operating procedures and in the previously mentioned Sections.

5.32 Liquid milk samples should be refrigerated or otherwise preserved prior to analysis; however, the analytical procedure to be used should* be considered when choosing a sample preservation method.

The 1994 environmental program does not include sampling of milk products; therefore, no sample preservation methods have been selected. Agricultural products such as corn and milo are primary foodstuffs grains within the 16 km (10 mi) monitoring area and are sampled. The foodstuffs monitoring program is designed as a tiered sampling program.

Dairy farms are few in the area and currently three have been identified in the 16 km (10 mi) border. Air monitoring data indicate no particulate emissions that would require dairy product monitoring.

5.33 As they apply to environmental surveillance activities, the general quality assurance program provisions of Chapter 10 should* be followed.

Section 7. All environmental surveillance activities are performed in accordance with the Department of Energy and site quality assurance program provisions.

6.0 LABORATORY PROCEDURES

6.1 Laboratory procedures and practices should* be documented in the site Environmental Monitoring Plan (in compliance with DOE 5400.1.

Section 6. All laboratories performing analysis for the environmental monitoring program have procedures and practices documented in their specific quality assurance project plans. At this time, the WSSRAP has several laboratories analyzing samples collected as part of the environmental monitoring program. In addition, the WSSRAP proposed a new laboratory specification that will replace currently used laboratories and add new ones. Due to the large amount of information required from these laboratories, it would be impractical to document all of the procedures and practices in the *Environmental Monitoring Plan.*

6.2 Each monitoring and surveillance organization should* have a sample identification system that provides positive identification of samples and aliquots of samples throughout the analytical process.

Sections 3.0, 6.3, and 7.2. The WSSRAP has a sample identification system that uniquely identifies samples for collection to data submittal to database usage (procedure ES&H 4.1.1). Laboratories under contract to the WSSRAP generally have internal sample tracking and identification systems, but sample identification is reported back to the WSSRAP using WSSRAP identification numbers.

6.3 The system should* incorporate a method for tracking all pertinent information obtained in the sampling process.

Sections 6.3 and 7.2. The WSSRAP has the Environmental Sample Tracking (EST) system that is used to track environmental samples from collection to receipt to invoice approval for each laboratory under contract. The WSSRAP also has the WSSRAP Information System for Achiving and Retrieving Data (WIZARD) system that is used to maintain the environmental data received from the laboratories. WIZARD is utilized to comply Department of Energy requirements, compare data, and perform statistical analyses on routine samples that are part of the environmental monitoring program.

6.4 To prevent incorrect analysis results caused by the spread of contamination among samples, each laboratory should* establish and adhere to written procedures to minimize the possibility of cross-contamination between samples.

This requirement is not summarized in this plan. However, laboratories under contract to WSSRAP have standard operating procedures that specify identification and prevention of cross-contamination among samples. In addition, the WSSRAP Verification Group and the data reviewers request validation for data that is suspected to be in error or cross-contaminated.

6.5 High-activity samples should* be kept separate from low-activity samples.

This requirement is not summarized in this plan. However, laboratories under contract to the WSSRAP have Nuclear Regulatory Commission licenses or similar State licenses. These laboratories screen samples received from the WSSRAP to determine if they can accept the samples. According to requirements in their licenses, they can only accept samples whose activities are below specific levels. Most laboratories have controlled areas that process samples with activities above a certain level. Generally, environmental samples collected from the WSSRAP have low activity.

6.6 In addition, the integrity of samples should* be maintained; that is, the degradation of samples should* be minimized by using proper preservation and handling practices that are compatible with the analytical methods used.

Section 7. WSSRAP standard operating procedures (ES&H 4.3.1 and 4.4.1) outline the proper preservation and sample handling practices. These procedures explain what parameters are compatible with similar parameters.

6.7 **To provide that the analyses performed are consistent and of the highest quality, specific analytical methods should* be identified, documented, and used to identify and quantify all radionuclides in the facility inventory or effluent that contribute 10% or more to the public dose or environmental contamination associated with the site.**

Section 7.2 and Appendix B. A variety of WSSRAP and subcontractor procedures, plans, and programs are utilized to ensure that analytical methods are of the highest quality. The analytical methods are identified and documented in Sections 6.1 through 6.6 of this appendix.

6.8 **Standard analytical methods should* be used for radionuclide analyses (when available), and any modification of a standard method(s) should* be documented.**

Sections 6.3 and 7.2. Some radionuclide analyses have modifications to the standard method. All changes to standard methods are reviewed and approved by the Project Management Contractor prior to analyses.

6.9 **In addition, methods, requirements, and necessary documentation should* be specified in any analytical contracts established with outside laboratories.**

Sections 6.3 and 7.2. The specifications of the contracts with the laboratories include the requirements for documentation, methods, and other requirements regarding quality assurance. Laboratories are audited annually to confirm their compliance with these issues.

6.10 **All sites that release or could release gamma-emitting radionuclides should* have the capability (either in-house or outside) of having samples analyzed by gamma-ray spectroscopy systems.**

This requirement is not summarized in this plan. However, the WSSRAP has the capability of analyzing gamma emitting radionuclides using gamma ray spectroscopy and also has the capability of analyzing for alpha/beta emitting radionuclides using a gas-flow proportional counter and an alpha spectroscopy system.

6.11 Counting equipment should* be calibrated using, at a minimum, the calibration frequency recommendations of the manufacturers so that accurate results are obtained.

Section 4.2. All counting equipment is calibrated using the calibration frequency recommended by the manufacturer and in accordance with Procedure ES&H 2.6.4, *Ludlum Model Scaler and Model 43-10 Detector: Gross Alpha Measurement Operation and Calibration.*

6.12 In addition, check sources should* be counted periodically on all counters to verify that the counters are giving correct results.

This requirement is not summarized in this plan. However, check sources are periodically counted to verify that the counters are giving correct results in accordance with Procedure ES&H 2.6.7, *Calibration and Operation of the WT-1000 Low Background Gas Flow Proportional Counter.*

6.13 Samples that are sent off site for analysis or for laboratory intercomparison should* be monitored for contamination and radiation levels and packaged in a manner that meets applicable transportation regulations and requirements.

This requirement is not summarized in this plan. However, samples that are sent off site for analysis are monitored for contamination and radiation levels in a manner that meets applicable transportation regulations and requirements. This is accomplished by the Site Shipping Officer, who is also responsible for properly packaging the shipments in accordance with Procedure RC-17s, *Off-site Transportation of Hazardous Materials.*

7.0 DATA ANALYSIS AND STATISTICAL TREATMENT

7.1 The statistical techniques used to support the concentration estimates, to determine their corresponding measures of reliability, and to compare radionuclide data between stations and times should* be designed with consideration of the characteristics of effluent and environmental data.

Section 6.1. Environmental data are statistically summarized using known and proven methods to determine the distribution, central tendency, dispersion, and outliers of the data. The statistical techniques take into account the characteristics of skewed distribution of time series data, high variability analytical results, missing data, and results below the analytical detection limits. All new data are evaluated against the corresponding historical statistics. Apparent outliers are only excluded from use after investigation confirms that an error has been made during sample collection, preparation, measurement, or analysis process.

7.2 Documented and approved sampling, sample-handling, analysis, and data management techniques should* be used to reduce variability of the results as much as possible.

Section 6.1. Standard operating procedures have been developed for environmental monitoring activities specific to the Weldon Spring site. These procedures have been developed from Environmental Protection Agency and Department of Energy guidance and standard industry practices. Personnel undergo training specific to their responsibilities varying from procedure review through classroom training and "hands on" training under the supervision of a qualified individual.

7.3 The level of confidence in the data due to the radiological analyses should* be estimated by analyzing blanks and spiked pseudosamples and by comparing the resulting concentration estimates to the known concentrations in these samples.

Section 6.1. Numerous quality control samples are collected in support of environmental monitoring activities including blank samples, matrix spikes, and matrix duplicates. The

confidence level of the data is estimated by comparing the results of the quality control samples with known concentrations.

7.4 The precision of radionuclide analytical results should* be reported as a range, a variance, a standard deviation, a standard error, and/or a confidence interval.

Section 6.1. The environmental monitoring data is statistically summarized by the determination of the range, variance, and standard deviation of the data values at each sampling location.

7.5 Data should* be examined and entered into the appropriate databases promptly after analysis.

Section 6.1. Immediately upon receipt from the laboratory, all new data are verified and entered into the WSSRAP database (Section 7.2).

7.6 When selecting the data to be considered, outliers should* be excluded from the data only after investigation confirms that an error has been made in the sample collection, preparation, measurement, or data analysis process.

Section 6.1. Apparent outliers are qualified and excluded from use only after investigation confirms that an error has been made in the sample collection, preparation, measurement, or data analysis process. Procedures are employed to aid in the interpretation of the data and to improve the quality of the results from the program by helping to detect erroneous measurements.

7.7 As each data point is collected, it should* be compared to previous data, because such comparison can help identify unusual measurements that require investigation or further statistical evaluation.

Section 6.1. All new data are evaluated against corresponding historical statistics to aid in the identification of unusual data values which may require further investigation or evaluation in accordance with WSSRAP standard operating procedures.

7.8 As they apply to data analysis and statistical treatment activities, the general quality assurance program provisions of Chapter 10 should* be followed.

Section 7. Overall data management activities for the WSSRAP are detailed in the *Environmental Data Administration Plan*. This plan provides guidance for the development of sampling plans, describes data management activities, and details general data quality requirements. These general data quality goals have been adopted for this environmental monitoring plan. The primary activities associated with this environmental monitoring plan include data verification, database management, and data validation. These programs document the quality of data generated by on-site and off-site analyses of samples.

8.0 DOSE CALCULATIONS

8.1 Except where mandated otherwise (e.g., compliance with 40 CFR Part 61), the assessment models selected for all environmental dose assessments should* appropriate characterize the physical and environmental situation encountered.

Section 6.2. Assessment models selected for environmental dose estimates at the WSSRAP are intended to assess accurate and realistic radiation doses to the population and to a hypothetical maximally exposed individual that could result from remediation activities. Environmental monitoring data are used either as direct input data in dose calculations or where appropriate, serves as data input in exposure and dose models.

8.2 The information used in dose assessments should* be as accurate and realistic as possible.

Section 6.2. Radiological dose assessments for selected environmental media employ data from the effluent monitoring and environmental surveillance programs in order to ensure that the data are accurate and realistic.

8.3 Complete documentation of assessments of the radiation dose resulting from the operation of DOE-controlled facilities should* be provided in a manner that supports the annual site Environmental Monitoring Report, Environmental Monitoring Plan, or other application, and show the 1) models used, 2) computer programs used, and 3) input data and data source assumptions made.

Section 6.2. The annual site environmental report includes documentation of the models, computer programs, input data, and data sources used in the assessment of radiation doses.

8.4 Default values used in model applications should* be documented and evaluated to determine appropriateness to the specific modeling situation.

Section 6.2. Model default values are evaluated to determine the appropriateness of the values as they apply to the modelling situation. The use of default values is documented with the results of dose modeling.

8.5 When performing human food chain assessments, a complete set of human exposure pathways should* be considered, consistent with current methods (IAEA 1982; Moore et.al. 1979; NCRP Report No. 76; NUREG/CR-3332).

Section 3.4.4.2 and 6.2. The foodstuffs sampling program provides data to determine the projected dose to off-site persons from an air to crop to human exposure route. A projected dose of <0.1 mrem/yr dose to a member of the public has been estimated.

8.6 Surface water and groundwater modeling should* be conducted as necessary to conform with the applicable requirements of the state government and the regional office of the EPA.

Section 3. The WSSRAP has received no specific requirements to perform groundwater or surface water modeling from the State or regional regulators. Pursuant to CERCLA and RCRA guidance, the WSSRAP has and continues to conduct a variety of groundwater contaminant transport modeling efforts.

8.7 The general quality assurance program provisions of Chapter 10 should* be followed as they apply to performing calculations that assess dose impacts.

Section 6.2. All general quality assurance program provisions are followed as they apply to performing calculations that assess dose impacts.

9.0 RECORDS AND REPORTS

9.1 Accordingly, DOE officials and DOE management and operating contractors should* identify and comply with the relevant requirements.

Section 6. Activities at the Weldon Spring site are performed in accordance with Department of Energy Orders 5000.3A, 5400.1, 5400.5, 5284.1b. and 5484.1; National Pollution Discharge Elimination System permits issued by the Missouri Department of Natural Resources; and the *Federal Facilities Agreement*, as well as other applicable Federal, State, and local laws and environmental protection regulations.

9.2 Timely notification of occurrences and information involving DOE and its contractors should* be made to the appropriate DOE officials and to other responsible authorities.

Section 6. Reporting of all occurrences listed in Department of Energy Orders 5400.1, 5400.5, and 5484.1 is performed in accordance with Department of Energy Order 5000.3B.

9.3 Auditable records relating to environmental surveillance and effluent monitoring should* be maintained.

Section 6. The WSSRAP maintains an *Environmental Data Administration Plan* (MKF and JEG 1992d) which governs sampling plan preparation, data verification and validation, database administration, and data archiving. All environmental data from sampling, analysis, and quality review programs are maintained in hard copy and electronic copy. All original documentation is transferred to the Project Quality Department and stored in a controlled area in a fireproof safe.

9.4 Calculations, computer programs, or other data handling should* be recorded or referenced.

Section 6. Computer programs and data management systems utilized at the Weldon Spring site are the Environmental Sample Tracking (EST) system, the Field Sample Tracking (FST) System, the Generic Universal Report Utility (GURU) program, the Safety, Health, and Radiation Protection (SHARP) program, the Site Wide Audit Tracking System (SWATS), and the Waste Inventory Tracking System (WITS).

9.5 As they apply to reporting and record keeping activities, the general quality assurance program provisions of Chapter 10 should* be followed.

Section 7. Standard operating procedures are maintained and documented to ensure the quality of the environmental monitoring program and those activities which influence the program.

10.0 QUALITY ASSURANCE

10.1 In addition to these plans, the Environmental Monitoring Plan should* contain a section on quality assurance and should* cover the monitoring activities at each site, consistent with applicable elements of the 18-element format in ANSI/ASME NQA-1.

Section 7. The quality assurance section of the environmental monitoring plan outlines the requirements for the activities at the WSSRAP, which is obligated to comply with the requirements of ANSI/ASME NQA-1 as outlined in Department of Energy Order 5700.6C. A Quality Assurance Program is maintained for the Weldon Spring site, which addresses the requirements of Department of Energy Order 5700.6C. Also, a project specific Quality Assurance Project Plan describing how various aspects of Department of Energy Order 5700.6C and the Quality Assurance Program will be implemented at the Weldon Spring site.

10.2 Periodic audits should* be performed to verify compliance with operational and quality control procedures.

Section 7. Audits are performed periodically to evaluate quality related activities in the environmental monitoring program. Analytical laboratories performing analyses for the Weldon Spring site are audited annually by Weldon Spring site personnel from the Project Quality Department and other related departments. The Project Quality Department routinely audits site operations associated with environmental monitoring activities. The Weldon Spring site is also routinely audited by external entities, including Department of Energy-Headquarters and Department of Energy-Oak Ridge.

10.3 **The following requirements from ANSI/ASME NQA-1 should* be followed: Planned and scheduled audits should* be performed to verify compliance with all aspects of the quality assurance program and to determine its effectiveness. These audits should* be performed independently in accordance with written procedures or checklists by personnel who do not have direct responsibility for performing the activities being audited (i.e., supervisors cannot audit their own facilities). Audit results should* be documented and reported to and reviewed by responsible management. Follow-up action should* be taken where indicated.**

Section 7. The Project Quality Department routinely audits environmental monitoring activities to evaluate compliance with project-specific procedure. Audit reports are generated and corrective actions are monitored by the Project Quality Department.

10.4 **The elements of a quality assurance program plan should* be derived from the 18 criteria in ANSI/ASME NQA-1 and those stipulated in 10 CFR Part 50.**

The WSSRAP complies with the requirements of ANSI/ASME NQA-1 in accordance with Department of Energy Order 5700.6c. The WSSRAP is not a nuclear production or utilization facility and, therefore, the Quality Assurance program is not derived from the criteria stipulated in 10 CFR Part 50 which pertains to these types of facilities.

10.5 **Radiation measurement, including portable instruments, environmental dosimetry, in situ monitoring equipment, and laboratory instruments, should* be calibrated with standards traceable to NIST calibration standards (NCRP 1978; National Bureau of Standards Special Publication 609).**

Section 7. Calibration of all radiation measurements is performed in accordance with documented procedures, industrial practices, and Department of Energy Orders which have standards traceable to NIST calibration standards.

APPENDIX B
Data Quality Requirements

B-1 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Routine Water and Soil Monitoring and Characterization

Category	Analytical Parameter	Analytical Method (b)	MDL soil µg/g (b)	Precision (a) (soil)	Accuracy (a) (soil)	MDL (b) µg/l	Precision (a) (water)	Accuracy (a) (water)	Comments
Radiation Screening	Gross Alpha	2.6.4 *	NA	NA	NA	NA	NA	NA	ES&H SOP
	Gross Beta/Gamma	2.6.3 *	NA	NA	NA	NA	NA	NA	ES&H SOP
Field Measurements	pH	4.5.1 *	NA	NA	NA	NA	20	NA	ES&H SOP
	Temperature	4.5.1 *	NA	NA	NA	NA	20	NA	ES&H SOP
	Conductivity	4.5.2 *	NA	NA	NA	NA	20	NA	ES&H SOP
	Specific Ions	4.5.5 *	NA	NA	NA	NA	20	NA	ES&H SOP
	Organic Vapors	3.1.1 *	NA	NA	NA	NA	20	NA	ES&H SOP
	Settleable Solids	4.5.7 *	NA	NA	NA	0.1 ml/l	20	NA	ES&H SOP
On-site Radiological Measurements	U-238, U-235,	901.1	1 pCi/g	50	30	NA	NA	NA	
	Ra-226, Ra-228	901.1	1 pCi/g	50	20	NA	NA	NA	
	Th-230, Th-232	UNC	2 pCi/g	50	20	NA	NA	NA	
Off-site Radiological Measurements	Natural Uranium	EPA 908.0	1 pCi/g	50	30	1 pCi/l	20	20	
	Ra-226, -228	EPA 903.1	1 pCi/g	50	30	1 pCi/l	20	20	
	Th-230, -232	EERF 00/07	1 pCi/g	50	30	1 pCi/l	20	20	

TABLE B-1 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Routine Water and Soil Monitoring and Characterization (Continued)

Category	Analytical Parameter	Analytical Method (b)	MDL soil µg/g (b)	Precision (a) (soil)	Accuracy (a) (soil)	MDL (b) µg/l	Precision (a) (water)	Accuracy (a) (water)	Comments
Off-site Radiological Measurements (Continued)	Gross Alpha	EPA 900.0	3 pCi/g	50	30	3 pCi/l	40	40	
	Gross Beta	EPA 900.0	3 pCi/g	50	30	8 pCi/l	40	40	
Nitroaromatic Compounds	TNT	USATHAMA	e	e	e	0.03 d	f	f	
	2,4-DNT	USATHAMA	e	e	e	0.03 d	f	f	
	2,6-DNT	USATHAMA	e	e	e	0.01 d	f	f	
	1,3,5-TNB	USATHAMA	e	e	e	0.03 d	f	f	
	1,3-DNB	USATHAMA	e	e	e	0.08 d	f	f	
	Nitrobenzene	USATHAMA	e	e	e	0.03 d	f	f	
Miscellaneous	TSS	EPA 160.2	NA	NA	NA	2 mg/l	20	20	
	TDS	EPA 160.2	NA	NA	NA		20	20	
	TOC	EPA 415.1				0.1	20	20	
	Li	EPA 200.7	5	50	50	50	20	20	
	Mo	EPA 200.7	4	50	50	4	20	20	
	Zr	EPA 200.7	20	50	50	20	20	20	
	Cr^{+3}	EPA 200.7		50	50	10	20	20	

TABLE B-1 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Routine Water and Soil Monitoring and Characterization (Continued)

Category	Analytical Parameter	Analytical Method (b)	MDL soil µg/g (b)	Precision (a) (soil)	Accuracy (a) (soil)	MDL (b) µg/l	Precision (a) (water)	Accuracy (a) (water)	Comments
Miscellaneous (Continued)	Cr^{+6}	Colorimetric		50	50	5	20	20	
	TOX	EPA 450.0	5	50	50		20	20	
	NO_3	300.0/353.1	0.5	50	50	0.25/0.1c*	20	20	mg/l
	SO_4	300.0/375.1,.2	5	50	50	1.0/1.0c*	20	20	mg/l
	Cl	300.0/325.1,.3	1.5	50	50	0.25/0.2c*	20	20	mg/l
	F	300.0/340.1,.2,.3	1.25	50	50	0.25/0.8c*	20	20	mg/l
	NO_2	354.1,.2	0.5	50	50		20	20	mg/l
	% Moisture	ASTM	NA	50	NA	NA	NA	NA	
	pH (soil)	EPA 150.2	NA	50	NA	NA	NA	NA	
	Asbestos-PCM/TEM	3.1.4	NA	NA	NA	NA	NA	NA	ES&H SOP
CLP	VOA	CLP	CRDL	As required by CLP		CRDL	As required by CLP		
	BNA	CLP	CRDL	As required by CLP		CRDL	As required by CLP		
	Pest/PCB	CLP	CRDL	As required by CLP		CRDL	As required by CLP		

TABLE B-1 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Routine Water and Soil Monitoring and Characterization (Continued)

Category	Analytical Parameter	Analytical Method (b)	MDL soil µg/g (b)	Precision (a) (soil)	Accuracy (a) (soil)	MDL (b) µg/l	Precision (a) (water)	Accuracy (a) (water)	Comments
CLP-Metals	Al	CLP-ICP	20	As required by CLP		200	As required by CLP		
	As	CLP-ICP	1	As required by CLP		10	As required by CLP		
	Be	CLP-ICP	0.5	As required by CLP		5	As required by CLP		
	Cd	CLP-ICP	0.5	As required by CLP		5	As required by CLP		
	Cr	CLP-ICP	1	As required by CLP		10	As required by CLP		
	Cu	CLP-ICP	2.5	As required by CLP		25	As required by CLP		
	Pb	CLP-AA	0.5	As required by CLP		5	As required by CLP		
	Hg	CLP-CV	0.1	As required by CLP		0.2	As required by CLP		
	Ni	CLP-ICP	4	As required by CLP		40	As required by CLP		
	Na	CLP-ICP	500	As required by CLP		5000	As required by CLP		
	Zn	CLP-ICP	2	As required by CLP		20	As required by CLP		
	Ba	CLP-ICP	20	As required by CLP		200	As required by CLP		
	Ag	CLP-ICP	1	As required by CLP		10	As required by CLP		
	Fe	CLP-ICP	10	As required by CLP		10	As required by CLP		
	K	CLP-ICP	500	As required by CLP		5000	As required by CLP		
	Mn	CLP-ICP	1.5	As required by CLP		15	As required by CLP		

TABLE B-1 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Routine Water and Soil Monitoring and Characterization (Continued)

Category	Analytical Parameter	Analytical Method (b)	MDL soil µg/g (b)	Precision (a) (soil)	Accuracy (a) (soil)	MDL (b) µg/l	Precision (a) (water)	Accuracy (a) (water)	Comments
CLP-Metals (Continued)	Mg	CLP-ICP	500	As required by CLP		5000	As required by CLP		
	Se	CLP-AA	0.5	As required by CLP		5	As required by CLP		
	Va	CLP-ICP	5	As required by CLP		50	As required by CLP		
	Tl	CLP-AA	1	As required by CLP		10	As required by CLP		
	Sb	CLP-ICP	6	As required by CLP		60	As required by CLP		
	Ca	CLP-ICP	500	As required by CLP		5000	As required by CLP		
	Co	CLP-ICP	5	As required by CLP		50	As required by CLP		
Other parameters not listed		TBD	TBD	50	50	TBD	20	20	See Note

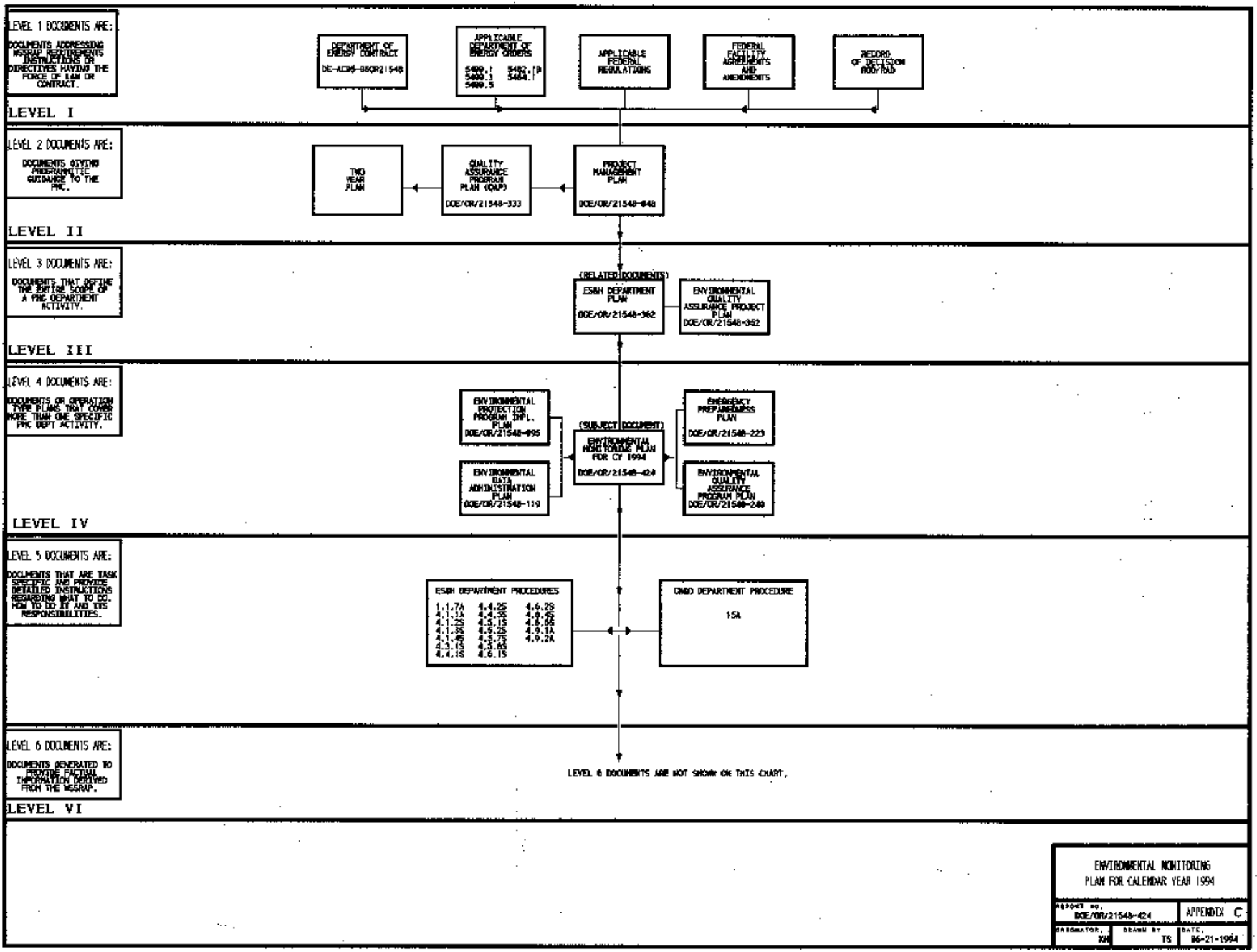
* See comment section
TBD To Be Determined
NA Not Applicable
Accuracy = Percent Bias = Percent Recovery - 100
(a) Accuracy and precision data are listed as percent and presented from EPA DQR guidance document - specific precision and accuracy to be negotiated with the laboratory
(b) Detection limits and methods from existing contract - new detection limits and/or methods to be established with new laboratory
(c) JTC methods and detection limits
(d) Army Environmental Hygiene Agency (AEHA) detection limits
(e) To be negotiated with the laboratory
(f) To be provided by AEHA
NOTE: Generic DQRs apply to media and/or analytical methods not listed in this table. Specific DQRs may be developed as a part of future sampling and analysis plans

B-2 Data Quality Requirements for the WSSRAP Precision and Accuracy Guidelines for Airborne Monitoring

Category	Analytical Parameter	Analytical Method	MDL	Precision	Accuracy	Comments
Radon Track Etch	Radon	N/A	0.1 pCi/l	N/A	N/A	---
Continuous Radon	Radon	4.6.7	0.1 pCi/l	N/A	N/A	ES&H SOP
Continuous Radon Daughter	Radon Daughter	4.6.8	1.0 mWL	N/A	N/A	ES&H SOP
Low Volume Airborne Particulate	Airborne Particulate (Gross Alpha)	2.4.3*	2.5E-15	N/A	N/A	ES&H SOP
TLD	External Gamma	N/A	1 μrem/hr	N/A	N/A	ANSI N 545 1976

N/A Not Applicable
* See Comments Section
mWL milli Working Levels

APPENDIX C
Document Hierarchy for the Environmental Monitoring Plan


LEVEL 1 DOCUMENTS ARE:
DOCUMENTS ADDRESSING MISSION REQUIREMENTS INSTRUCTIONS OR DIRECTIVES HAVING THE FORCE OF LAW OR CONTRACT.
DEPARTMENT OF ENERGY CONTRACT
DE-AC05-86OR21548
APPLICABLE DEPARTMENT OF ENERGY ORDERS
5400.1 5482.1B
5400.3 5484.1
5400.5
APPLICABLE FEDERAL REGULATIONS
FEDERAL FACILITY AGREEMENTS AND AMENDMENTS
RECORD OF DECISION (ROD/RAD
LEVEL I
LEVEL 2 DOCUMENTS ARE:
DOCUMENTS GIVING PROGRAMMATIC GUIDANCE TO THE PMC.
TWO YEAR PLAN
QUALITY ASSURANCE PROGRAM PLAN (QAP)
DOE/OR/21548-333
PROJECT MANAGEMENT PLAN
DOE/OR/21548-848
LEVEL II
LEVEL 3 DOCUMENTS ARE:
DOCUMENTS THAT DEFINE THE ENTIRE SCOPE OF A PMC DEPARTMENT ACTIVITY.
(RELATED DOCUMENTS)
ES&H DEPARTMENT PLAN
DOE/OR/21548-362
ENVIRONMENTAL QUALITY ASSURANCE PROJECT PLAN
DOE/OR/21548-352
LEVEL III
LEVEL 4 DOCUMENTS ARE:
DOCUMENTS OR OPERATION TYPE PLANS THAT COVER MORE THAN ONE SPECIFIC PMC DEPT ACTIVITY.
ENVIRONMENTAL PROTECTION PROGRAM IMPL. PLAN
DOE/OR/21548-895
ENVIRONMENTAL DATA ADMINISTRATION PLAN
DOE/OR/21548-119
(SUBJECT DOCUMENT)
ENVIRONMENTAL MONITORING PLAN FOR CY 1994
DOE/OR/21548-424
EMERGENCY PREPAREDNESS PLAN
DOE/OR/21548-229
ENVIRONMENTAL QUALITY ASSURANCE PROGRAM PLAN
DOE/OR/21548-240
LEVEL IV
LEVEL 5 DOCUMENTS ARE:
DOCUMENTS THAT ARE TASK SPECIFIC AND PROVIDE DETAILED INSTRUCTIONS REGARDING WHAT TO DO, HOW TO DO IT AND ITS RESPONSIBILITIES.
ES&H DEPARTMENT PROCEDURES
1.1.7A 4.4.2S 4.6.2S
4.1.1A 4.4.3S 4.6.4S
4.1.2S 4.5.1S 4.8.6S
4.1.3S 4.5.2S 4.9.1A
4.1.4S 4.5.7S 4.9.2A
4.3.1S 4.5.8S
4.4.1S 4.6.1S
ONSD DEPARTMENT PROCEDURE
15A
LEVEL 6 DOCUMENTS ARE:
DOCUMENTS GENERATED TO PROVIDE FACTUAL RESULTS OR INFORMATION DERIVED FROM THE MSSRAP.
LEVEL VI
LEVEL 6 DOCUMENTS ARE NOT SHOWN ON THIS CHART.
ENVIRONMENTAL MONITORING PLAN FOR CALENDAR YEAR 1994
REPORT NO. DOE/OR/21548-424
APPENDIX C
DESIGNATOR, XM
DRAWN BY TS
DATE, 06-21-1994

APPENDIX D

Telecon From L. Hopkins to File Regarding the Use of Uncensored Data Sets, Dated June 1, 1992

MK-FERGUSON
A DIVISION OF
MORRISON KNUDSEN CORPORATION

INTER-OFFICE CORRESPONDENCE

DATE: June 1, 1992

TO: File

FROM: Loren Hopkins.

SUBJECT: TELECON ON UNCENSORED DATA

Date of Telecon: May 27, 1992

Caller: Loren Hopkins

Call to: Bob O'Brien, Statistical Policy Branch of US EPA, Washington, DC

Telephone: (202) 260-2683

SUBJECT: UTILIZING UNCENSORED DATA IN STATISTICAL CALCULATIONS

Mr. O'Brien returned my call regarding this subject. I explained to Mr. O'Brien that the 1991 DOE Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance specified the following:

7.3.4 Less-Than-Detectable Values

Monitoring programs often include measurement of extremely low concentrations of radionuclides, below the detection limit of the counting instruments. Data sets with large numbers of less-than-detectable values need special consideration in the statistical analyses (Gilbert 1987).

Less-than-detectable data will produce numerical measurements with values below the detection limit and sometimes negative values. All of the actual values, including those that are negative, should be included in the statistical analyses. Practices such as assigning a zero, the detection limit value, or some in-between value to the below detectable data point, or discarding those data points can severely bias the resulting parameter estimates and should be avoided.

When analytical instruments or laboratories do not supply the actual values for readings less than the detection limit, but make some designation such as "ND", the actual values for those data points should be obtained. When obtaining these data points is not possible, at least the number of less-than-detectable values should be obtained.

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Form 232-A 30M 8-87

Data from censored distributions (for which the number of less-than-detectable values is known) are more amenable to standard statistical analyses than are those from truncated distributions (for which the number of values below the detection limit are not known), which require special statistical techniques (Gilbert and Kinnison, 1981).

I explained that in incorporating uncensored data (including negative numbers) in our statistical calculations, in one case we obtained a negative dose. We question the use of applying the policy of incorporating uncensored data across the board because the results of using means derived from uncensored data may lead to physically impossible results. In addition, we were wondering if some sort of weighting epproach should be applied to data below the detection limit because there is less confidence associated with these values. I asked if he had any feel for when the use of uncensored data should or should not be applied and if there was a study that validated this request for incorporation of uncensored data. Mr. O'Brien did not have an answer for me and referred me to Richard Gilbert at Batelle (509) 375-2979).

I called Richard Gilbert and explained the situation and concerns I had explained to Mr. O'Brien. He was not aware of the DOE guidance and was not aware that he was referenced in the guidance. He felt that any across-the-board application of his recommendations of the use of uncensored data was ill-founded. He recommended that we use scientific, professional judgement in including uncensored data. In general, he felt we should obtain and use uncensored data since he felt it still contained some meaning. However, if the results were not possible, we should include a caveat and explain our reasoning.

Mr. Gilbert suggested I look up a paper by Diane Lambert entitled Non-detects, Detection Limits and the Limit of Probability", from the Journal of the American Statistical Association regarding my question with weighting data below the detection limit with less confidence.

LK/ccb

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MK-Ferguson Company
Weldon Spring Site Remedial Action Project

TRANSMITTAL OF CONTRACT DELIVERABLE

Date: 3-28-95 Transmittal No.: CD-0027-02

Title of Document: Environmental Monitoring Plan

Doc. Num.: 424 Rev. No.: 2 Date of Document: March 1995

Purpose of Transmittal: Request for Department of Energy acceptance of contract deliverable.

The Project Management Contractor has reviewed and approved the attached document and hereby delivers it to the U.S. Department of Energy, Weldon Spring Site Office.

The document will be considered accepted unless we receive written notification to the contrary within 30 days of the date of this transmittal.

James R. Powers
Project Director