



# Westinghouse

REMEDIAL INVESTIGATION  
FEASIBILITY STUDY  
WORK PLAN  
Revision 0

May 9, 2003

And Supporting Plans  
Quality Assurance Project Plan (QAPP)  
Site Safety and Health Plan (SSHP)  
Community Relations Plan (CRP)

Leggette, Brashears & Graham, Inc.  
4850 Lemay Ferry Road, Suite 205  
St. Louis, MO 63129  
Office (314) 845-0535  
Fax (314) 845-3573



**REMEDIAL INVESTIGATION  
FEASIBILITY STUDY  
WORK PLAN**

**Revision 0**

for the

Westinghouse Electric Company LLC  
Hematite Missouri Facility  
3300 State Road P  
Festus, MO 63028

Prepared by:

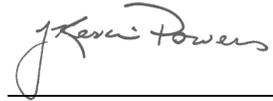
LEGGETTE, BRASHEARS AND GRAHAM, INC.  
Professional Ground-Water and Environmental Services  
4850 Lemay Ferry Road, Suite 205  
St. Louis, MO 63129  
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Approved by:  
J. Kevin Powers, CPG  
LBG, Vice President

Prepared by:

LEGGETTE, BRASHEARS AND GRAHAM, INC.  
Professional Ground-Water and Environmental Services  
4850 Lemay Ferry Road, Suite 205  
St. Louis, MO 63129  
(314) 845-0535



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John L. Bognar, RG  
LBG, Senior Associate

## **Executive Summary**

The nuclear fuel manufacturing facility at Hematite, Missouri recently ceased production after nearly 47 years of operations, under various owners and operators. Westinghouse Electric Company, LLC, the present owner, now seeks to decommission the plant and remediate the property. Two major regulatory bodies, the Nuclear Regulatory Commission (NRC) and the Missouri Department of Natural Resources (MDNR) Hazardous Waste Program, are expected to provide critical roles in defining the regulatory path to decommissioning the site license and remediating the plant property. Areas of Concern (AOCs) have been identified and are discussed throughout this RI/FS Work Plan.

This RI/FS Work Plan follows the standard format prescribed by EPA and thus considers the goals of the National Contingency Plan. A stand-alone set of plates accompanies this document to demonstrate the features of the Site, AOC's and proposed investigation locations. Appendices include the Quality Assurance Project Plan, the Site Health and Safety Plan, the Environmental Data Resources Report, and the Community Relations Plan.

The Field Sampling Plan (FSP) is designed to characterize specific AOCs, provide data for future potential remedy selection, understand risks, and fill data gaps from previous characterization efforts. This FSP is designed with the assumption that infrastructure of the Site will be removed as part of decommissioning the Hematite Plant. The FSP calls for borings to be advanced relative to the AOCs including an exploratory band of borings around the Plant. Media of concern include ground water, surface water, stream and pond sediments, and surface and subsurface soils. The FSP contains a field investigation strategy to characterize and evaluate interaction among the various aquifers and their hydrostratigraphic units. This information is needed to assess potential contaminant paths, assist in remedial alternative analysis and provide a defensible basis for a ground-water flow, fate and transport model to be conducted under the baseline risk assessment.

Two other important issues which may require more or less independent study (independent from the FSP) are addressed, because they could impact final remedial strategies and monetary cost to the project. Cultural Resources and COE jurisdictional

streams, surface waters and wetlands are protected by federal and state legislation and thus any activities that impact these resources will be conducted in compliance with the regulatory guidelines.

The Site Conceptual Model within shows the potential pathways of contaminant migration. According to the Site Conceptual Model contaminants may migrate from AOCs through surface water, sediment, soils, groundwater or air leaving a certain level of risk to human health and the environment.

This RI/FS Work Plan considers the regulatory approach by providing a preliminary and rough assessment of Applicable or Relevant and Appropriate Requirements (ARARs), including common federal ARARs, State of Missouri ARARS and ARAR Waivers. Perhaps of great importance to this Site is the potential for Mixed Waste. Depending on whether mixed waste is present and its character and quantity, the issue may have impact to the project's critical path decisions and schedules.

The RI/FS framework for this work plan includes 11 RI/FS tasks and one post RI/FS task as discussed in Section 4.5. Preliminary cost estimates and key assumptions are provided in Section 4.6, and Project Management is presented in Section 4.7. References are provided in Section 5.0 and Appendices are provided as an attachment at the end of this work plan.

## LIST OF ACRONYMS CITED

AA	atomic absorption
ABB	Asea Brown Boveri
ACM	asbestos-containing materials
ACOE	U.S. Army Corps of Engineers
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
AMSL	above mean sea level
AOCs	areas of concern
ARARs	applicable or relevant and appropriate
ASTM	American Society for Testing and Materials
BA	biological assessment
bgs	below ground surface
BMP	best management practices
BNAs	base/neutral/acid extractable compounds
BS	blank spike
bsbsp	blank spike and blank spike duplicate
CAA	Clean Air Act
CALM	cleanup levels for Missouri
CAOs	corrective action objectives
CAR	Corrective Action Report
CE	Combustion Engineering, Inc.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFCs	chlorofluorocarbons
CFR	code of federal regulations
cm	centimeters
cm/s	centimeters per second
cm <sup>2</sup>	centimeters squared
COCs	constituents of concern
cpm	counts per minute
CRM	Cultural Resource Management
CRP	Community Relations Plan
CSSG	clayey, silty, sandy-gravel
CWA	Clean Water Act
DA	disassociated ammonia
DCGL	derived concentration guideline level
DGLS	Division of Geology and Land Survey (MDNR)
DGPS	Differential Global Positioning System
DHSS	Department of Health and Senior Services
DNAPLs	dense nonaqueous phase liquids
DOE	U. S. Department of Energy
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
dpm/100 cm <sup>2</sup>	disintegrations per minute per 100 square centimeters
DQO	data quality objective
DSCC	deeper, silty clay/clay
EC	electrical conductivity
ECU	Envirocare of Utah
EDR	Environmental Data Resources, Inc.

EPA	U.S. Environmental Protection Agency
eV	electron voltage
FAA	Federal Aviation Administration
FHA	Federal Highway Administration
FID	flame ionization detector
FIDLER	field instrument for detecting low energy radiation
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FRA	Federal Railroad Administration
FSP	field sampling plan
ft	feet
ft/day	feet per day
GC	gas chromatograph
GM	Geiger-Mueller
gpm	gallon per minute
GPS	global positioning system
GSRAD	Geologic Survey Resource Assessment Division
Gulf	Gulf United Nuclear Fuels Corporation
GWS	Gamma Walkover Survey
HASP	Health and Safety Plan
HCl	hydrochloric acid
HEU	high-enriched uranium
HF	hydrogen fluoride
HLW	high-level radioactive waste
HMTA	Hazardous Materials Transportation Act
HPGe	high purity germanium
HPLC	high-performance liquid chromatography
HSA	hollow-stem augers
HWP	Hazardous Waste Program (MDNR)
IDW	investigative derived waste
kV	kilovolts
LCL	lower control limit
LDR	land disposal restrictions
LEL	lower explosive limit
LEU	low-enriched uranium
LIMS	laboratory information management system
LLW	low-level radioactive waste
LUST	leaking underground storage tanks
LWL	lower warning limit
MARSSIM	Multi Agency Radiation Survey and Site Assessment Manual
MCLGs	maximum contaminant level goals
MCLs	maximum contaminant levels
MDC	minimum detectable concentration
MDC	Missouri Department of Conservation
MDL	method detection limit
MDNR	Missouri Department of Natural Resources
mg/kg	milligrams per kilograms
mg/L	milligrams per liter
MHPO	Missouri Historic Preservation Office
MIP	membrane interface probe
mL	milliliter
MNA	monitored natural attenuation
MNG	Missouri Natural Gas

MPCs	Maximum Permission Concentration Limits
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate
MSDs	material safety data sheets
MTR	materials test reactors
NaI	sodium iodide
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute for Occupational Safety and Health
NORM	naturally-occurring radioactive materials
NPDES	Nation Pollution Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NSSSC	near Surface Silt, Silty-Clay
nT	nanoTeslas
O.D.	outside diameter
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAHs/PNAs	polycyclical aromatic hydrocarbons/polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	perchloroethylene
pCi	picoCurie
pCi/g	picoCurie per gram
pCi/l	picoCurie per liter
PID	photoionization detector
POC	point of contact
POTW	publicly-owned treatment works
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PRP	potential responsible party
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
QC	quality control
Ra-226	radium 226
RAGS	Risk Assessment Guidance for Superfund
RCOPS	radiological constituents of potential concern
RCRA	Resource Conservation and Recovery Act
RE	relative error
RESRAD	Residual Radioactivity Computer Code
RF	response factor
RI/FS	remedial investigation/feasibility study
RMC	Radiation Management Corporation
RME	reasonable maximum exposure
ROD	Record of Decision
RPD	relative percent difference
RQD	rock quality distribution
RSD	relative standard deviation
RSMO	Revised Statutes of Missouri
RSPA	Research and Special Programs Administration

SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCLs	secondary maximum contaminant levels
SNM	special nuclear material
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SRM	standard reference material
SSHP	site safety health plan
SVOCs	semivolatile organic compounds
T & E	threatened and endangered
Tc-99	Technicium 99
TCE	trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
Th-232	Thorium 232
TPH	total petroleum hydrocarbons
TRU	transuranic
TSCA	Toxic Substances Control Act
TWA	time-weighted average
U-234	uranium 234

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## **1.0 Introduction**

The Westinghouse Electric Co., LLC (“Westinghouse”) is the present owner of a nuclear fuel manufacturing facility in Hematite. Westinghouse has ceased manufacturing at the facility and plans to close the facility and decommission and remediate the site. The goals of the project are the termination of the Nuclear Regulatory Commission (NRC) license and remediation of the site in a manner consistent with applicable regulations.

Westinghouse has retained Leggette, Brashears & Graham, Inc. (“LBG”) to prepare this Remedial Investigation/Feasibility Study Work Plan (RI/FS Work Plan) consistent with the National Contingency Plan (NCP; 40 CFR Chapter 1 Part 300.430) Remedial Investigation/Feasibility Study and Selection of Remedy, using EPA’s “Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.301, October 1988,” (the “Guidance”).

The RI/FS Work Plan addresses applicable components of the “Multi-Agency Radiation Survey and Site Investigation Manual, August 2000,” (MARSSIM) to provide information on planning, conducting, evaluating and documenting surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards.

This RI/FS Work Plan is made up of the elements outlined in the Guidance and contains the elements listed below.

Section 1.0 introduces the RI/FS Work Plan; Section 2.0 provides information on the facility background; Section 3.0 details the initial evaluation of Site characteristics; Section 4.0 describes the RI/FS Work Plan rationale including the Field Sampling Plan, Cost and Schedule; Section 5.0 includes references and Appendices are listed in Section 6.0.

The Quality Assurance Project Plan (QAPP), the Site Safety Health Plan (SSHP) and the Community Relations Plan (CRP) are included as Appendices attached to this work plan. These appendices may act as stand alone documents with reference to the RI/FS Work Plan.

The MDNR and the NRC have provided comments regarding the facility (primarily the burial area) characterization activity conducted in 1998. The characterization activity proposed in Section 4.4, addresses the MDNR and NRC comments.

## **2.0 Site Background**

This section of the RI/FS Work Plan provides a description of the physical setting of the facility; historical operations; known geologic conditions and hydrogeology of the facility; and an overview of investigations that have taken place in order to characterize potential environmental impacts due to past operations.

### **2.1 Physical Setting**

The property consists of approximately 228 acres, of which eight have most recently been used for operations. It is located in the east portion of Missouri in Jefferson County near the town of Hematite. The facility is located on Missouri State Road P, between the hills to the northwest and a terrace/floodplain of Joachim Creek. The Pleistocene terrace deposit has a surface topography that slopes gently to the southeast eventually blending with the alluvial floodplain deposits of the Joachim Creek, a tributary of the Mississippi River.

The “Site” is defined as that portion of the property and facility that historically has been impacted by plant operations. A topographic map showing the general location of the Site is Figure 1. A Site map with property boundaries, building locations, and other infrastructure features is included as Plate 1.

### **2.2 Site Historical Operations**

In 1955 Mallinckrodt Chemical Works purchased the parcel of farmland on which the plant sits. The Plant became operational in July of 1956 producing uranium for use in the navy nuclear fuel program. Mallinckrodt Chemical Works operated the facility until approximately May of 1961 at which time ownership was transferred to the United Nuclear Corporation (UNC). UNC provided uranium products to the federal government.

In 1970, UNC and Gulf Nuclear Corporation entered into a joint venture forming, Gulf United Nuclear Fuels Corporation (Gulf) which owned and operated the facility until the spring of 1973 when UNC closed the plant and began decommissioning. Combustion Engineering Inc. (CE) purchased the Property in May of 1974. In 1989 Asea Brown Boveri (ABB) acquired the stock of CE and began operating the facility as ABB

Combustion Engineering. In April of 2000, Westinghouse purchased the nuclear operations of ABB which include the Hematite facility.

Primary functions at the facility throughout its history have included the manufacture of uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride (UF<sub>6</sub>) gas of various <sup>235</sup>U enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and development was also conducted at the Plant, as were uranium scrap recovery processes.

During the period prior to CE's purchase of the Facility in 1974, government projects dominated the operations on Site. Much of the work on behalf of the government at the Site was classified, and therefore specific details regarding the exact nature of the processes are not known. Examples of known projects during this time include:

- production of uranium metal for nuclear submarines and a D1G destroyer reactor;
- the supply of specialized uranium oxides for the Army Package Power Reactor;
- the supply of high enriched oxides for a General Atomics gas-cooled reactor;
- the production of highly enriched metal for materials test reactors (MTR) utilized by the Navy;
- the supply of uranium-beryllium pellets for use in the "SL-1" reactor;
- the production of high enrichment uranium zirconia pellets for a naval reactor;
- and the production of highly enriched oxides to General Atomics for use in nuclear rocket projects.

Although the physical design of the Plant has changed over the years, certain areas of the Plant were dedicated to particular production processes as well as certain types of work (*i.e.*, low enrichment processes versus high enrichment processes). For example, Building 240 was historically dedicated to the chemical conversion of uranium into compounds, solutions, and metal. Building 240 was further divided into areas for

High Enriched Uranium (HEU) and Low Enriched Uranium (LEU) processes: the “Red Room” (area 240-2) containing high enriched conversion processes and the “Green Room” (area 240-3) containing low enriched conversion processes and high enriched scrap processing. The Red Room was specifically used for the reduction of  $UF_6$  to  $UF_4$ , the conversion of  $UF_4$  to uranium metal, high enriched uranium scrap recovery, and other chemical conversion processes using high or fully enriched uranium. Building 255 of the Plant was used for the fabrication of uranium compounds into physical shapes. Other activities within the Plant included the blending of  $UO_2$  with other chemical compounds.

Other areas of the Plant were used for storage, and again were separated primarily by degree of enriched material or product stored. High enrichment storage areas included Buildings 235, 250, and 252. Also, high enriched scrap was held in an outdoor, fenced 75' x 120' area to the south of the Plant. Plate 2 shows the infrastructure of the plant and specifically identifies the various buildings.

### **2.3 Background Information Review**

Subsequent to the Westinghouse acquisition of the Hematite facility, numerous interviews have been conducted with former employees regarding the historical operations. Information gathered during these interviews coupled with on site document reviews of the Site conditions were used to identify the listed Areas of Concern (AOCs) and describe the Site's complete history from the start of activities to the present time. Specific actions regarding the historical review include: Review of the burial area records, review of plant survey data and environmental monitoring data, review of plant files regarding regulatory action and license history, review of plant files regarding spills and leaks, review of pre-construction survey records, and review of historical plant photos taken during construction activities.

In addition to this internal records review, fire insurance maps, environmental regulatory database and aerial photographs were reviewed. Below is a summary of the various sources of public record historical information reviewed in preparation for the current investigation, as well as pertinent information derived.

### **2.3.1 Sanborn Maps**

Sanborn Fire Insurance Maps are comprised of fire risk information for various years from the late 1880s to present. The maps when available illustrate historic Site features, usage, and potential hazards. An attempt was made to acquire the Sanborn Fire Insurance Maps for the facility however according to Environmental Data Resources, owner of the Sanborn Map Company, Sanborn Fire Insurance maps were not published for this area.

### **2.3.2 Regulatory Database Search**

Federal and State environmental history records relating to the Site and surrounding properties were reviewed. These records provide information on whether environmentally-regulated or hazardous materials may have been improperly handled, stored or disposed at or near the Site.

The Federal and State record review was accomplished through a computer database (EDR, Inc.) search of facilities that appear on lists generated by federal, state and local governments. The review also considered sites surrounding the Site to a distance specified in ASTM Standard E 1527-00. A copy of the environmental database is included in Appendix C. The database identified no facilities within the specified query area.

### **2.3.3 Aerial Photography Review**

Readily-obtainable, high to medium altitude, black and white aerial photographs provided by Westinghouse, the United States Geological Survey and obtained from private sources were reviewed. These include the following years: 1937, 1954, 1956, 1959, 1960, 1962, 1966, 1971, 1973, 1974, 1975, 1978, 1980, 1986, 1990, 1991, 1993 and 1996. The available photographs were for a specific day in each of the above-referenced years. The purpose of the review was to discern visible evidence of potential environmental conditions on the Site, or contiguous areas. Findings are shown on Plate 3 and explained below.

In 1937 the Site contained the two existing tile barns in the northwest portion of the site. At least one residence and related outbuildings were located immediately southwest of the Site Pond, fronting the east-bound lane of State Highway P. Areas north

and south of the railway easement, south of State Highway P, were cultivated. The Northeast Site Creek located immediately northeast from the current plant appears to have been straightened. Some trees lined the intermittent tributaries of Joachim Creek, and were dense along those tributaries south of the rail line. A fence line and unimproved road were noted trending south-southeast from the highway, immediately southeast of current East Lake and northeast of North Lake tributary.

In 1954 one or two small structures were observed immediately south of the north-most tile barn. A fence was apparent around the south portion of the north-most tile barn. A south-southeast trending unimproved road located immediately northeast from the existing plant, originating from State Highway P, crossed the rail line and terminated near Joachim Creek. Agricultural activities were noted in the vicinity of the current Plant and immediately south of the rail line. A potential fence line was observed south, and parallel to, the rail line. The southeast-trending unimproved road near the East Lake extended southeast of the rail line terminating near Joachim Creek.

In 1956, grading activities associated with construction of the plant facilities were observed. Disturbed or graded areas were observed northeast of the new plant structure, between the unimproved road and the Northeast Site Creek. Two plant structures were apparent in the 1959 photograph. The unimproved road located northeast from the Plant is no longer discernible in 1959, although a fence line may have been installed in its place. Scrub vegetation is noted northeast of the Northeast Site Creek. This portion of the Site between the Northeast Site Creek and the Residence (south of Highway P) did not exhibit row crops for the remaining photographs reviewed. A foot path or potential surface drainage channel was noted trending southwest from the plant, toward the Site Pond. Grading or disturbed areas were observed on both sides of the Site Pond. Construction of Lake Virginia was noted north from the Site.

In 1960, the parcel south of the rail line contained scrub vegetation and did not exhibit row crops for the remaining photographs reviewed. A darkened circular area, potentially a small body of standing water, is located east of the Site Pond, southwest of the Site structure. In 1962, three disturbed areas or areas of distressed vegetation were noted immediately northeast of the fence line (former unimproved road), southwest of the Northeast Site Creek.

In 1966, sedimentation or a disturbed area was observed in the north portion of the Site Pond. The Site Pond appeared dry. A disturbed area, larger than that identified in the 1962 photograph, was noted immediately northeast of the fence line located between the Site structure and the Northeast Site Creek. A structure or trailer was noted in the center of the disturbed area. Excavated or disturbed areas consistent with the current locations of the evaporation ponds were noted immediately south of the plant. The East Lake had been constructed and was apparent northeast. In 1971, the four or five structures noted southwest of the tile barns were no longer visible. An unimproved, northeast-trending path or trail was observed southeast of the rail line. Water was discernible within the evaporation ponds.

In 1973, a disturbed area was noted immediately southwest of the Site Creek, east of the Highway. Disturbed areas were also noted immediately south of the rail line, and near existing monitoring well WS-16. Circular tracks, indicative of cattle feed areas, were evident immediately east of the East Lake. No significant changes or features were observed in 1974. In 1975, distressed vegetation was noted immediately northeast from the plant, southwest of Northeast Site Creek. A small disturbed area was observed south of the Plant, immediately north of Joachim Creek. Construction of Missouri State Highway A was apparent east of the Site.

The 1978, 1980 and 1986 aerial photographs were taken from high altitudes limiting detailed assessment; however, changes or significant features were not observed. In 1990 and 1991, disturbed areas were noted northeast of the Site Plant, southwest of North Site Creek, and southwest of the tile barns. These areas may be associated with limestone gravel which was reportedly placed in similar locations. An unimproved access road from Highway P to the area northeast of the Plant was discernible. The 1991 photograph shows road and other construction associated with the water storage tank located in the north portion of the Site, north of Highway P. In 1993, the Site and immediate vicinity appear essentially as viewed today.

## **2.4 Geology**

In 1997 general and Site specific information was gathered to create an understanding of the geology and hydrogeology of the area. Major aquifers in the area as

well as their uses were identified. The bedrock structure and stratigraphic relations have been determined. The unconsolidated sediments, their depositional environment, lithology and stratigraphic relations have been determined. In 1998, LBG provided a more thorough understanding of the hydrogeology and geology at the Site as part of continuing investigations. Sections 2.4.1 through 2.5.3 provide an overview of the geology and hydrogeology of the Site. Comprehensive details regarding the Site geology and hydrogeology are described in various reports cited in Section 5.

#### **2.4.1 Regional Bedrock and Structures**

The Site is on the north, northeast flank of the Precambrian age St. Francis Mountains uplift, which created the Ozark Dome. Cambrian, Ordovician, Silurian, Devonian and Mississippian age sedimentary formations of various depositional environments are draped on the flanks of the Ozark Dome. The Site is situated over these sedimentary formations. Based upon the “Missouri Geologic Map, 1979” and the “Bedrock Geologic Map of the Festus 7.5 Minute Quadrangle, Jefferson County, Missouri, date unknown,” the uppermost bedrock beneath the Site is the lower Ordovician System, Canadian Series, Jefferson City-Cotter Dolomite.

The Jefferson City Formation and the Cotter Formation are described in Martin et. al. (1961) as mostly light-brown to medium-brown, medium to finely crystalline dolomite and argillaceous dolomite. Chert which is not abundant is typically oolitic, banded, mottled or sandy. Lithologic succession within the formation are complex and varies among locations. Because the two formations are difficult to differentiate without the aid of insoluble residue testing, they are often designated as a combined unit, the Jefferson City-Cotter Dolomite. The Jefferson City-Cotter Dolomite, averages statewide 400 feet thick, is bounded beneath by the Roubidoux Formation. The Roubidoux Formation is a sandy dolomite with lesser beds of dolomitic sandstone and dolomite.

The indurate sedimentary rocks in this area dip gently and uniformly to the northeast. There are no mapped or suspected faults within several miles of the Site.

##### **2.4.1.1 Site Specific Bedrock Stratigraphy**

In 1956, Mallinckrodt Chemical Company installed an industrial water supply well for the Plant, which was logged by a State of Missouri geologist. The “Missouri

Geological Survey and Water Resources Log No. 14993, 1956,” documents the bedrock stratigraphy encountered by the well. Unconsolidated sediments are present to 35 feet below ground surface (bgs). The Jefferson City-Cotter Dolomite extended from its upper erosional surface at 35 bgs to its bottom at 125 feet bgs, the Roubidoux Formation from 125 to 255 feet bgs, the Gasconade Formation from 255 to 470 feet bgs, the Gunter Sandstone Member of the Gasconade Formation from 455 to 470 feet bgs and the Eminence Dolomite, from 470 to the total depth of the well, which is 600 feet bgs.

Site specific unit thickness information gained from the interim hydrogeologic investigation matches data from that well.

#### **2.4.2 Unconsolidated Sediments (Pleistocene Series and Quaternary System)**

The Site is positioned in the valley of the Joachim Creek, which has incised into the surrounding Jefferson City-Cotter Dolomite. During late Pleistocene glacial regression, terrace units were deposited in the Joachim Creek valley. These units are chiefly derived from loess and colluvium. Later during the Holocene, alluvium was deposited in the Joachim Creek valley.

The “Bedrock Geologic Map of the Festus 7.5-Minute Quadrangle, Jefferson County, Missouri, date unknown,” describes the Holocene alluvium as clay, silt, sand and gravel chiefly derived from local loess and colluvium. Colluvium is described as a mixture of residuum, from fines to cobbles, and loess that is moving down slope as a result of slope wash and gravity. Colluvium accumulates at the base of valley slopes and in large valleys washes onto the floodplain, blending with the alluvium. Terraces typically contain lenticular beds of sand and gravel interbedded with silt and clay.

Several subsurface investigations within the terrace deposit at and near the Plant have produced geotechnical and geologic information, which allows a general stratigraphic interpretation to be made.

The more comprehensive geologic investigation performed by LBG in 1998 and 1999 greatly refined the knowledge of the unconsolidated subsurface. The study supported the concept of a sand/gravel unit typically present in the subsurface above the uppermost bedrock unit. Soil collected during the drilling process was analyzed for physical properties (i.e., permeability, coefficient distribution, etc.) and/or chemical

laboratory parameters. Generally, the geologic information collected during this investigation corroborated geologic data obtained during previous studies. Specifically, four unique stratigraphic units are located beneath the Plant portion of the Site:

- a near surface silt, silty-clay (NSSSC);
- a fat clay;
- a deeper, silty clay/clay (DSCC); and
- a clayey, silty, sandy-gravel (CSSG) sometimes later in this document is referred to as the sandy-gravel unit.

## **2.5 Hydrogeology, Hydrology, Water Supply**

This section provides a very brief summary of hydrogeology, hydrology and provides some information regarding public water supply. There is a basic understanding of the hydrogeology at the Site based on previous investigations: Leggette, Brashears & Graham, Inc., 1998, (LBG 1998), Gateway Environmental Associates, Inc., 1997, (Gateway 1997); a few points are presented below. In the hydrology sub-section, a gross summary of precipitation and stream characteristics is provided.

The Water Supply sub-section introduces the facts that nearby water users are supplied by ground-water sources (wells) and no nearby public drinking water sources are known to be from surface water sources. According to Westinghouse, Jefferson County Health officials during a community relations interview, indicated they believe that some shallow wells (10-20 feet) in Hematite may be producing from a sandy layer, which in their opinion may be influenced by surface water.

### **2.5.1 Hydrogeology**

LBG, 1998 characterized the near-surface hydrostratigraphic units at the Site. In that investigation, two ground-water monitoring wells were generally installed at each location to serve the purposes of discrete geologic unit mapping and sampling and to provide vertical hydraulic gradient information.

As part of LBG's hydrogeologic studies, single-well hydraulic conductivity tests were performed to characterize the horizontal hydraulic conductivity of distinct geologic horizons. From these tests, the mean average hydraulic conductivities of the

unconsolidated materials above bedrock were found to be  $3 \times 10^{-5}$  cm/sec and  $8 \times 10^{-4}$  cm/sec for the NSSSC and DSCC units, respectively. Single-well testing of the Jefferson City-Cotter Dolomite showed a mean average of hydraulic conductivity of  $6 \times 10^{-4}$  cm/sec. The hydraulic conductivity of the CSSG is  $3 \times 10^{-3}$  as determined in well WS-32. Variations in permeability exist and the values for permeability are dependent on the zones tested. The hydrogeologic characteristics of the Jefferson City-Cotter Dolomite and other bedrock formations are affected by fracturing and other features causing secondary porosity and permeability in the rock. The primary permeability of the bedrock (i.e., through the solid rock matrix) is measured to be low, thus, slow ground-water velocity would be predicted. However, ground water flowing discretely through fractures, partings, or other secondary permeability features may do so at a much higher velocity. The size, density, and orientation of these fractures and partings determine the effective hydraulic conductivity of the bedrock.

Potentiometric surface (ground-water elevation) maps were constructed for the NSSSC, DSCC, and Jefferson City-Cotter Dolomite units to determine ground-water flow direction and hydraulic gradient. In the NSSSC unit, ground water flows to the northeast and southeast. In the DSCC and Jefferson City-Cotter Dolomite units, ground water flows to the southeast. Recent work by LBG (in 2002 – discussed in Section 2.6.5 in more detail) shows the Roubidoux Formation piezometric surface as also indicating southeast flow direction. The orientation of the fractures and other secondary permeability features influence ground-water flow directions and gradients in the Jefferson City-Cotter Dolomite and other bedrock formations.

In 2002, responding to the need for more hydrogeologic data prompted by the discovery of contaminated private domestic wells, additional drilling and characterization was accomplished, adding to the hydrogeologic body of knowledge. That information is summarized in Section 2.6.5.

### **2.5.2 Hydrology, Precipitation and Stream Characteristics**

The “Missouri Water Atlas, 1986,” was referenced to determine local precipitation and stream characteristics. The area receives an average of 38 inches of precipitation per year, with 12 inches of average annual runoff. The maximum 10-day

event expected precipitation is 9 inches in a given 25-year event. The Atlas shows that Joachim Creek, located along the southeast Site boundary, is a permanent flowing stream. There are several other surface water features present on the Site, including a spring, intermittent perennial and ephemeral streams, a lake and ponds.

- The Site Spring flows an estimated 1 to 10 gallons per minute (gpm) most of the year. The spring is likely a result of fracture flow in the Jefferson City-Cotter Dolomite, which receives its source water in the hills northwest of the Site.
- The Site Pond is a small concrete dam impoundment southwest of the Plant. It receives flow from the Site Spring and storm water runoff from the Plant area.
- The Site Creek is the effluent from below the dam of the Site Pond which receives discharge from the sanitary and storm water system. It flows through a culvert beneath the railroad track and joins the effluent from the Lake Virginia drainage basin.
- Lake Virginia/Site Creek combined tributary flows east to the Joachim Creek.
- The Northeast Site Creek flows southeast to the east of the Burial Pits and then east to its confluence with the effluent of East Lake tributary, then to the Joachim Creek.
- East Lake east of the Site is an earth impoundment lake used as a water supply for cattle. It is reported to never have been used in conjunction with Plant operations.
- North Lake Tributary is the effluent drainage from North Lake and North Tributary. This tributary crosses the terrace, west of East Lake.
- North Tributary is an intermittent stream west of North Lake.

Quantitative data regarding flow quantity, duration, peak discharge, etc. is not available for all of these features. However some observations can be made.

- The Site Spring flows virtually continually.
- The ponds and lake on the Site hold water year round. (Flow is measured at the dam of Site Pond and reported quarterly to the MDNR Water Pollution Control Program.)

- The tributaries of the Joachim Creek flow intermittently.
- The Joachim Creek is perennial.

### **2.5.3 Water Supply**

Water for the Plant is supplied by a well located north of Building 253 within the fenced manufacturing area. Up to 36,000 gallons were withdrawn from this well daily. Well water is stored in an elevated 200,000 gallon tank and distributed as needed within the plant, primarily for process water.

According to “Water Resources Report 30, 1974,” domestic and industrial water wells in the vicinity produce water from the Powell - Gasconade Aquifer Group which includes the Jefferson City-Cotter Dolomite, the upper most bedrock unit at the Site. Wells in the area, may intersect the Jefferson City-Cotter Dolomite if it is present, but presumably do not derive significant quantities of water from it due to its poor storativity.

There are no public water supply intakes on Joachim Creek. According to an EPA field investigation report (1990) “Preliminary Assessment, Hematite Radioactive Site, Hematite, Jefferson County, Missouri, 1990,” most of the residents of Hematite receive their drinking water from Rural Water District #5. The report also states that surface water is not used for drinking within at least a four-mile radius of the Site.

## **2.6 Previous Environmental Investigations**

The previous environmental investigations detailed below have revealed the presence of contamination in various areas of the Site, including both radioactive contamination and volatile organic compounds (VOCs) related to various nuclear fuel processing operations. A brief description of previous investigations is provided in this subsection.

### **2.6.1 Radiological Survey of the Combustion Engineering Burial Site, July 1983**

Radiation Management Corporation (RMC), under contract to the Nuclear Regulatory Commission (NRC), conducted a radiological evaluation of the Burial Pits in the spring and summer of 1982 (RMC, 1983). Measurements were made to determine external radiation levels, surface and subsurface radionuclide concentrations and radioactivity in air and water. Results of the external radiation surveys revealed

detectable levels above background in the northwest corner of the burial site. RMC determined that these levels were due to sources on-site (most likely UF<sub>6</sub> storage area) at that time rather than buried material. RMC concluded that little or no thorium was present near the ground surface. Results of surface soil sampling revealed low level surface contamination. RMC concluded that the surface contamination may have resulted from burial activities or from past effluent (i.e., stack) releases. Results of subsurface soil sampling showed the highest U-234 activity in the Burial Pits to be approximately 400 pCi/g, and the highest U-234 level estimated for surface soil at approximately 47 pCi/g. These levels were based on an estimated U-234/U-238 activity ratio of about 10 to 1.

### **2.6.2 Investigation to Determine the Source of Technetium-99 in Groundwater Monitoring Wells WS-17 and WS-17B, September 1996**

Gateway Environmental Associates, Inc., conducted an investigation to determine the source of Technetium-99 (<sup>99</sup>Tc) in monitoring wells WS-17 and WS-17B. (Gateway, 1996a) The investigation was conducted to answer concerns expressed by the NRC regarding the source of <sup>99</sup>Tc. Gateway Environmental Associates concluded that the <sup>99</sup>Tc may have entered the ground-water system within the former ring storage area and traveled down gradient toward the monitoring wells in question. Historical <sup>99</sup>Tc and TCE waste disposal practices at the evaporation ponds, may have been a source for contamination in WS17/17B because a nearby gas pipeline may have created a connection between the evaporation ponds and WS17/17B.

<sup>99</sup>Tc is a low energy beta emitting byproduct of the nuclear fission of Uranium-235 and has a half-life of 213,000 years. <sup>99</sup>Tc has appeared as a contaminant in the fuel cycle from the United States Enrichment Company (USEC) facilities. The <sup>99</sup>Tc contaminant was present in commercial UF<sub>6</sub> as a result of US government recycling and re-enrichment activities at the gaseous diffusion plants.

One pathway to the evaporation ponds was through the cylinder wash operations. On site UF<sub>6</sub> cylinder washing was performed intermittently over the operating years of the facility. UF<sub>6</sub> cylinder heels preferentially contain the less volatile compounds including <sup>99</sup>Tc. The wash solution removed the technetium that was subsequently

released as an effluent according to the NRC's Maximum Permissible Concentration limits (MPCs). For  $^{99}\text{Tc}$  this limit was 600,000 pCi/l. The principle form of  $^{99}\text{Tc}$  found in the environment is the pertechnetate anion  $\text{TcO}_4$ . This form is highly water soluble, and mobile in soil and ground water.

### **2.6.3 Exploratory Probe-hole Investigation for the Evaporation Ponds at the ABB Combustion Engineering Hematite Facility, April 1997**

Gateway Environmental Associates, Inc. conducted an investigation of the evaporation ponds to evaluate the stratigraphy (Gateway, 1997). ABB retained samples to evaluate for gross radiation activity, however no formal data report other than stratigraphic observations was prepared. The stratigraphy includes silts and clays in a combination of grades above a sandy unit found approximately 25' below grade to 30' below grade, then limestone where drilling ceased.

### **2.6.4 Hydrogeologic Investigation and Groundwater, Soil and Stream Characterization**

LBG, under contract to ABB, conducted a hydrogeologic investigation in 1998 (LBG, 1998) to determine whether past operations and waste management practices at the Site have impacted groundwater and surface water quality around the Burial Pit area. Quarterly ground-water and surface water monitoring was conducted throughout 1999 in conjunction with the hydrogeologic investigation. Sampling activities included 14 monitoring wells and four surface water locations. Analyses included VOCs, polychlorinated biphenyls (PCB's), radionuclides, and metals. Results of these investigations reveal the presence of chlorinated solvents and radionuclides in ground water and surface water. Also included in this scope, a surface geophysical survey was conducted to delineate the burial area.

### **2.6.5 Interim Hydrogeologic Investigation to Address Impacted Private Wells**

In summer of 2002, Westinghouse retained LBG to perform an interim hydrogeologic investigation to address findings from the sampling of private water wells in the vicinity of the Plant. The purpose of the investigation was to evaluate which bedrock aquifers may have been impacted by VOCs and radiological parameters, the

geologic and hydrogeologic character of the bedrock aquifers, and the potential for contaminant migration based on these findings. The investigation also addressed monitoring for future off-site and vertical contaminant migration by installing sentry wells.

Bedrock coring of the Jefferson City-Cotter Dolomite, the Roubidoux Formation, and the top of the Gasconade Dolomite was performed at four locations. The geology and hydrogeologic properties of these formations was evaluated by various in-situ tests, and vertical profiling of ground water quality was accomplished by collecting continuous, discrete samples. Eight monitoring wells and two piezometers were installed in three hydrostratigraphic zones, specifically the overburden, the Jefferson City-Cotter Dolomite, and the Roubidoux Formation.

Data collected from the interim hydrogeologic investigation are being evaluated. Preliminary findings revealed that VOC contamination in the vicinity of Domestic Well #3 (east of the Plant) is limited to the Jefferson City-Cotter Dolomite. The data indicate that aquifers within the Roubidoux or Gasconade Formations may have not been directly impacted. Shallow ground water does not appear to be impacted along the high-pressure natural gas main at the east and west property boundaries.

Plate 4 shows the top of the bedrock for the Jefferson City-Cotter Dolomite. Plate 5 portrays a structural elevation map for the top of the Roubidoux Formation. Plates 6 and 7 show the ground-water potentiometric surface of the Jefferson City-Cotter Dolomite and Roubidoux Formation, the generalized extent of contaminant plumes, and the proposed boring locations for additional work (see Section 4.4.1.3.2). Plates 8 and 9 are schematic geologic cross sections through the Site and immediate vicinity.

## **2.6.6 Other Studies or Investigations**

The following subsections describe various assessments conducted on-site over the past.

### **2.6.6.1 Former Evaporation Ponds**

In 1992 Quadrex performed a characterization of the former Evaporation Ponds. Information gathered from this study was used to develop a source term for risk evaluation. Because of the residual contamination present in the Ponds, ABB decided to

remove soil from around the Evaporation Pond. The material from the retention ponds was disposed at a Low Level Waste Disposal facility. Although a large amount of contaminated soil was removed, the extent and nature of residual contamination is yet to be fully determined. Westinghouse does not have full knowledge of off-site facilities that were used for waste disposal by previous owners. Westinghouse has used Envirocare of Utah for disposal of wastes during its ownership of the facility.

#### **2.6.6.2 New Buildings**

Radiologic surveys were performed on soils prior to constructing new buildings in the late 1980's until the present time. The criterion used was based on an NRC approved release concentration of 30pCi/g of soil. Additional characterization beneath (so-called new buildings) is needed.

#### **2.6.6.3 Asbestos**

Global Environmental, Inc. conducted an asbestos survey in 1992 (Global, 1992). Asbestos was found to be present in limited areas on the interior of the older buildings. To date, all asbestos has been abated with the exception of a pipe bridge in Building 256-1 in the bulk drying room. The pipe bridge has been encapsulated with a metal liner.

#### **2.6.6.4 Lead Based Paint**

Lead based paint may have been used in some of the older buildings constructed prior to 1978.

### **3.0 Initial Evaluation**

A number of historical sources and potential sources of soil and ground-water contamination have been identified in the vicinity of the Plant. These sources and potential sources are referred to as “Areas of Concern” (AOCs). Section 3.1 identifies the potential migration pathways at the Site while Section 3.2 discusses the information available regarding the specific potential AOC.

#### **3.1 Site Conceptual Model - Potential Pathways of Contaminant Migration**

Information on contaminant sources, past operations and waste management practices, as well as geologic and hydrogeologic knowledge was used to develop a conceptual understanding of the potential risks to human health and environment. The Site Conceptual Model shown on Figure 2 diagrams current understanding of sources, pathways and potential receptors.

Previous investigations identified the following contaminant migration pathways as being of potential concern to public health and the environment.

- Ground-water migration of contaminants within the Site hydrostratigraphic units:
  - Unconsolidated Overburden Units
    - Near Surface Silt, Silty Clay (NSSC)
    - Deep Silty Clay/Clay (DSCC)
    - Clayey Silty Sandy Gravel (CSSG)
  - Jefferson City-Cotter Dolomite
  - Roubidoux Formation
- Surface water and sediment transport via the Site surface water drainage network.
- Surficial and subsurface soil and leaching of contaminants from contaminated soils. These soils typically represent sources rather than migration pathways except when evaluated with respect to erosion and transport, fugitive dust emissions, or direct dermal contact.
- Windborne particulates from plant operations.

## **3.2 Preliminary Identification of Areas of Concern**

This section lists and briefly describes the potential AOCs (Plate 10). Some are known to be a source of both radiological and chemical contamination, and, others require more specific examination to determine if contamination exists at these places. Table 1 lists radionuclides of potential concern by AOC, and Table 2 lists chemical constituents of potential concern by AOC.

### **3.2.1 Ground water**

Ground water is a confirmed AOC, because previous studies have identified areas impacted with radioactive and hazardous compounds. The sampling and analysis of ground water will focus on known sources, potential sources, and non-biased areas to explore the extent of contamination, and finally, aquifer characteristics to determine technical practicability of remedial alternatives as well as to provide data for numerical modeling of contaminant fate and transport.

### **3.2.2 Surface Water Features**

Three surface water features at the Site are considered AOCs. These three AOCs have been identified based upon patterns of groundwater, stormwater, and surface runoff that may influence the quality of these surface waters.

#### **3.2.2.1 Northeast Site Creek**

The Northeast Site Creek and intermittent stream is a potential AOC because it is adjacent to the Burial Pits. Storm water falling on the burial pits and shallow groundwater beneath the pits could have the potential to discharge to this creek.

#### **3.2.2.2 Site Pond and Effluent Stream**

The Site Pond and its effluent stream, Site Creek, receive storm water from the Site and effluent from the Plant water treatment plant. These may also receive effluent of unknown quality from off-site sanitary lagoons located in the Lake Virginia drainage.

### **3.2.2.3 Joachim Creek**

Joachim Creek is not known to have been impacted by plant operations, but because it is a perennial stream and a navigable water body possibly used for recreation, it should be characterized to understand whether it is an exposure point to potential receptors.

### **3.2.3 Burial Pits**

The Burial Pits are a confirmed AOC as a potential source of soil and ground-water contamination. The Burial Pits were actively used from the late 1950s to 1970, and they are located to the east of the Plant. Previous owners of the Site, discarded uranium-contaminated materials into the unlined burial pits in accordance with 10 CFR 20.304. There are 40 documented individual excavations making up the Burial Pits, each approximately 20 feet by 40 feet and 12 feet deep. There may also be some burial pits that are undocumented; Westinghouse is searching for more detailed information. Buried material includes combustibles, protective clothing and small pieces of equipment contaminated with uranium, which is expected primarily in the form of uranium oxide compounds.

### **3.2.4 Evaporation Ponds**

The Evaporation Ponds, located within the fenced perimeter of the Plant, historically were used to discard liquid wastes generated at the Site. Suspected waste includes but may not be limited to uranium compounds, chlorinated solvents and <sup>99</sup>Tc.

### **3.2.5 Former Leach Field**

The Former Leach Field and septic system were used until 1977 when a water treatment plant was built and placed into service. Located west of the water treatment plant and Evaporation Ponds, the leach field and septic system may have been used for sanitary waste and liquid waste from the operation and maintenance of the facility.

### **3.2.6 Buildings, Infrastructure and Radioactive Waste Management**

Buildings, Plant-related infrastructure and Radioactive Waste Management are grouped as a AOC. A general description of operations related to this AOC is below.

Included in this RI/FS Work Plan are plans to investigate soils beneath buildings however, to quantify the full nature and extent of building's impact, the buildings, floors, foundations and infrastructure must first be removed to allow access to soils and other media below.

### **3.2.6.1 Buildings**

Plate 2 shows the location of and identifies the buildings and facilities on the Site. Production and support activities involving Radiological Constituents of Potential Concern (RCOPCs) occurred within most of the current buildings on Site. A summary of the type of activity in each building follows. Locations of chemical and hazardous material storage areas are provided in Plate 11.

#### **Building 101 Tile Barn**

The Tile Barn functions as the emergency operations center. The building has been and is currently being used to store both clean and radiologically contaminated equipment. During the construction of the emergency operations center residual contamination was detected at low concentrations.

#### **Building 110 Office Building**

No work with radioactive or chemicals compounds was reportedly undertaken in this building.

#### **Building 115 Generator –Fire Pump building**

A diesel-powered emergency generator was located in this building and provides backup emergency power to maintain critical loads. Electrical power is provided by the Union Electric Company via a substation located approximately 100 yards northeast of Building 255. The substation steps down the voltage to 12.5 kV. Electrical power is distributed to several step-down transformers located on the Site. None of the transformers currently contain PCBs. No work with radioactive material was performed in this building. In addition to the diesel generator is a 600 gpm diesel powered fire water pump.

### **Building 120 Wood Barn**

The wood barn has been and is currently being used to store both clean and contaminated equipment. The floor is dirt and may have residual contamination in low concentrations.

### **Building 230 Rod Loading**

Finished pellets (standard, erbium and gadolinium) were loaded into fuel rods and assemblies for shipment offsite. This building was built circa 1992 and only had two small contact areas. No appreciable amounts of chemicals were used in this building.

### **Building 231 Warehouse**

The shipping container storage building, Building 231, is located south of Building 230. It measures approximately 60 feet x 100 feet and is 20 feet high. The building is metal siding on a metal frame. There is insulation on the ceiling only. Some shipping container refurbishment was performed in this area. A small potential for UO<sub>2</sub> contamination exists.

### **Building 235 West Vault**

The West Vault has been used to store depleted and natural uranium. The interior of the building was painted in 1994 and may have contamination under the paint.

### **Building 240 Recycle Recovery (Red Room, Green Room)**

This building contains laboratory and maintenance areas, a recycle recovery area, a waste incineration area and the Health Physics laboratory. Support-operations were conducted for conversion, pelletizing and fuel assembly including material recycle, scrap recovery, cylinder heel recovery, quality control and analytical laboratory, maintenance, waste consolidation and disposal preparation. This building was integral to the historic operations of the facility. Past operations included the conversion of HEU using a wet conversion process and wet recovery of scrap. The effluent streams were piped to the retention ponds for settling and evaporation. The pipe system is likely to remain and may contain HEU. Numerous spills and leaks have occurred in these areas and parts of the slab have been re-poured over the existing contaminated flooring. Additionally sub slab contamination was found during the 1989 construction of Building 253.

### **Building 252 South Vault**

The south vault is located within the contamination control area and has been used for the storage of source and special nuclear material of various enrichments up to 93%  $^{235}\text{U}$ , oil and chemicals. Because of the traffic in and out of the building it is likely that the floor is contaminated with special nuclear material (SNM).

### **Building 253 Office**

This building contains offices, various Site utilities, storage of uranium, processing areas and decontamination facilities. Within building 253 is an inner building 250 that was formerly a stand alone structure used for storage, and housed the boiler, cooling tower pumps, and recycle hopper.

### **Building 254 Pellet Plant**

In the pelletizing buildings granules of  $\text{UO}_2$  or  $\text{U}_3\text{O}_8$  were fed into a mill (micronizer) that produced fine powder for pressing. A Corn Starch and Die lubricant were added and blended into a batch and subsequently pressed into pellets. The "Green" fuel pellets were processed through a dewaxing furnace to remove the additives and then passed through a sintering furnace where they were made into a ceramic. These furnaces were electrically heated and used disassociated ammonia to provide a reducing atmosphere.

### **Building 255 Erbia Plant**

Building 255 contained one pelletizing line used for production of uranium-erbium pellets. Historically, this building was used as a pelletizing area until the 1989 construction of Building 254. In the pelletizing buildings, granules of  $\text{UO}_2$  or  $\text{U}_3\text{O}_8$  were fed into a mill (micronizer) that produced fine powder for pressing. A corn starch and die lubricant were added and blended into a batch and subsequently pressed into pellets. The "Green" fuel pellets were processed through a dewaxing furnace to remove the additives and then passed through a sintering furnace where they were made into a ceramic. These furnaces were electrically heated and used disassociated ammonia (DA) to provide a reducing atmosphere.

### **Building 256-1 Pellet Drying**

Pellet trays were loaded into pans, dried in an electric oven using disassociated ammonia (DA) as a cover gas and either stored or transferred to Building 230. This structure was originally used as warehouse space.

### **Building 256-2 Warehouse**

This building was the main site warehouse for shipping pellets and powder and for receiving site supplies.

### **Building 260 Oxide and Oxide Loading Dock**

The Oxide Building was built in approximately 1968 and is a four-story Butler type building. This building was used for the conversion of  $UF_6$  into  $UO_2$  granules. Chemicals used or generated in this area include:  $UF_6$ ,  $UO_2$ ,  $UO_2F_2$ ,  $U_3O_8$ , HF,  $NH_3$ ,  $N_2$ , DA, limestone and  $CaF_2$ .

## **3.2.6.2 Infrastructure**

### **Sanitary System**

Sanitary wastes flow to the sanitary system from sinks, toilets, showers and drinking fountains. This system also receives laundry water (after the water is filtered, neutralized and held for sampling) and wastewater from the process water demineralizer system and laboratory sinks. This package plant was a 1989 replacement for the septic tank originally installed in 1977.

The routing of the sanitary system drains is shown in Plate 12. The system includes an extended aeration sewage treatment plant in which sanitary sewer effluents are discharged to a chlorine contact tank where they are treated (only from April 1 to October 31) with dry chlorine tablets and finally treated with sodium sulfite for dechlorination before discharge into the Site Creek immediately below Site Pond. Design capacity of the treatment plant is 8,000 gallons per day. The effluent was sampled and analyzed weekly for gross alpha and beta activity. Discharge from the treatment plant is authorized under a National Pollutant Discharge Elimination System Permit To Discharge (NPDES) issued by the Missouri Department of Natural Resources (MDNR). Suspended solids noted at this outfall have accumulated in the creek. This

area has been remediated in the past and based on the current sludge visible it is likely that uranium contamination has re-accumulated.

Sanitary solids generated from the treatment plant are routinely dewatered and disposed of at the Envirocare of Utah (ECU) Low Level Waste (LLW) disposal facility. Characterization of the solids demonstrated that the waste was non hazardous and met the Waste Acceptance Criteria (WAC) for the disposal facility.

### **Storm Water System**

Water from roof and ground surface drains flows to the Site Pond above the dam via the storm water system. This system also received condensed steam from the UF<sub>6</sub> vaporizer steam jackets, non-contact cooling water from heat exchangers and boiler blow-down as well. The routing is shown in Plate 13. Discharges are authorized under a NPDES permit issued by the MDNR. The dam overflow is continuously proportionately sampled creating a sample which is then collected weekly to be analyzed for gross alpha and beta activity. Trace amounts of uranium have been detected in this outfall and likely settled in the Site Pond.

### **Chemical Storage**

Significant chemicals used or stored are listed here.

**Anhydrous Ammonia** – less than 750,000 pounds used per year as a reducing gas (cracked ammonia) in the production of UO<sub>2</sub> powder, pellets, and in preparation of material for recycle. Typically stored on site in 16,000 gallon tanks. Typical quantity stored on site was 47,000 lbs.

**Liquid Nitrogen** - approximately 10,000 liters per year are delivered by tanker or generated on site for use with ammonia to provide air vent cover gas in the conversion process and the pellet furnaces. Typical quantity stored on site: <8,000 gallons. 66,000 lbs typical storage.

**Potassium Hydroxide** - approximately 4,000 pounds used per year. Mixed with process water and used as wet scrubber liquor to remove hydrofluoric acid from the recycle pyrohydrolysis process effluent. Typical quantity stored on site: <4,000 pounds.

**Hydrochloric Acid** - approximately 900 pounds used per year in cleaning heat exchanger tubes in the steam boiler and demineralizer regeneration. Typical quantity stored on site: <1,000 pounds.

**Nitric Acid** - less than 15,000 pounds used per year to dissolve the  $U_3O_8$  wet recovery process feed material. Typical quantity stored on site: <5,000pounds.

**Hydrogen Peroxide** - approximately 20,000 pounds per year used to provide a source of oxygen in the wet recovery process. Typical quantity stored on site: <7,000 pounds.

**Isopropyl Alcohol** - approximately 5,000 pounds per year used in cleaning. Typical quantity stored on site: <3,000 pounds.

**Hydrogen Fluoride (HF)** - from 1998 until 2001 approximately 980,000 pounds of 35% hydrofluoric acid was generated as a byproduct of  $UF_6$  to  $UO_2$  conversion. Typical quantity stored on site: <60,000 pounds.

**Trichloroethylene (TCE)** – TCE was used as a manufacturing aid until the late 1980's, and as a degreaser until the early 1990's. Specific beginning and end dates for the use of this chemical is unknown. TCE was used at the facility as a thinner for a binding agent used in pellet manufacturing. Records indicate that one drum of TCE was buried in the burial pits.

**Perchloroethylene (PCE)** – PCE was used as a process catalyst until the early 1970's and was used at the facility in a historic uranium processing operation. Specific beginning and end dates for the use of this chemical is unknown.

### **3.2.6.3 Radioactive Waste Management**

#### **Liquid Wastes**

The only production process that routinely generated liquid waste with measurable radioactivity was the wet recovery process. The waste water filtrate from this process was collected in tanks and sampled to assure that the average concentration was less than the effluent release limits prior to transfer for off-site for disposal. Radioactive liquid wastes such as mop water, cleanup water and other liquids from the wet recovery process, were separated, evaporated and analyzed for uranium content and then either recovered or disposed at a licensed low level radioactive waste burial site. Liquid waste, as described in the work plan, were analyzed for uranium and shipped for deep well injection or disposal with sanitary sewage at a Publicly Owned Treatment Works (POTW) when the concentration was less than the 10 CFR 20 appendix B release limits

of  $3\text{E-}7$   $\mu\text{Ci/ml}$  uranium. This differs from low-level radioactive waste that was buried at a licensed low level waste disposal facility.

Trace amounts of radioactivity may be found in laundry, sink, shower water, and liquids from cleaning glassware in the laboratory. Laundry water was filtered and sampled prior to discharge to the sanitary waste system. Water from change room sinks and showers was also routed to the sanitary waste system. The sanitary waste effluent enters the Site Creek immediately below the Site Pond.

### **Solid Wastes**

Solid wastes that are potentially contaminated were generated throughout the restricted area of the Plant. These wastes consist primarily of rags, papers, packaging materials, worn-out shop clothing, equipment parts, and other miscellaneous materials that result from plant operations. Non-combustible radioactive wastes are shipped to a licensed low level radioactive waste burial site or decontamination facility. Combustible solid wastes are fed to a gas-fired incinerator to reduce volume. The ash is either processed to recover uranium or disposed of at a licensed low level radioactive waste burial facility. The Plant incinerator is equipped with a wet scrubber system to clean off gases prior to discharge.

### **3.2.7 Limestone Storage and Limestone Fill Areas**

Limestone (calcium carbonate) was used to capture hydrogen fluoride gas (HF) from the  $\text{UF}_6$  conversion facility. The HF was a byproduct of the conversion process and was captured in limestone scrubbers resulting in the production of  $\text{CaF}_2$  (spent limestone). Spent limestone was generated from 1968 to 1998. In 1998 a wet absorber system replaced the limestone scrubbers greatly improving the efficiency of HF collection. Currently the spent limestone is stored in one above surface pile within the fenced area of the Plant. At least two other areas, one near the Site Spring and the other in the northeast section of the Burial Pits, have been filled with the limestone. Additionally, spent limestone was used historically as fill for building and road foundations.

### **3.2.8 Outdoor and Shallow Surface Areas**

Several areas around the Site, (soils within the fence line and soil adjacent to the barns), are known to have surface and near surface uranium contamination.

Over the historic operations and to current times operations with uranium were conducted outside of the building and within the fence line. These areas are known to have surface contamination likely above cleanup levels. Adjacent to the Tile Barn is an area that was historically used to store excess contaminated equipment. Elevated levels of contamination have been noted in this area during the renovations to the Tile Barn. Additional characterization information is needed to understand the extent and nature of residual contamination in these areas.

### **3.2.9 Former Gas Station**

Formerly there was a gasoline retailing establishment on property now owned by Westinghouse. The location of the former gasoline vendor is approximately 1500 feet east from the Plant entrance on the westbound lane of State Road P. Potential contaminants of concern from the operation of a gasoline station include VOCs, SVOCs, TPH and metals. An underground storage tank (UST) is known to be present, although its status and potential impact to soil or ground water are not known.

### **3.2.10 Gas Pipeline**

Missouri Natural Gas (MNG), a subsidiary of Laclede Gas in St. Louis, Missouri owns and operates a high-pressure natural gas transmission line located on a right-of-way which parallels the railroad track. Because this line runs beneath or adjacent to the Evaporation Ponds, Burial Pits, and Former Leach Field it may be acting as a conduit for contaminant transport in the subsurface.

### **3.2.11 Railroad**

The railroad easement which cuts through the Site is not considered a potential AOC, however, the following should be noted. A portion of the ballast used to construct the railroad is rhyolite likely from a quarry in Southeast Missouri. The rhyolite deposit is known to have naturally occurring radioactivity. Leaching of radioactive elements from the rhyolite is not probable because the rock is virtually not dissolvable in normal climate

conditions. However future characterization teams should be aware of the rhyolite and not allow it to improperly influence characterization findings or remedial decisions.

### **3.3.12 Red Room Roof Burial Area (South of Tile Barn)**

Just south of the tile barn is an area where the roof of the red room (building 240) was buried. The red room was used for the handling of HEU in various chemical forms and the roof is likely to be radioactively-contaminated. The roof may have been constructed partially of asbestos containing material. In addition to the roof, small pieces of uranium-contaminated metals have surfaced in this area. Soil contamination has also been discovered in the area during 1993 renovations to the tile barn. This contamination is thought to be from a temporary scrap storage area. Limited information is available to understand the extent and nature of residual contamination in this area and additional characterization information is needed.

### **3.2.13 Domestic Well #3**

A domestic well (hereafter referred to as Domestic Well #3) located in the northeast portion of the property was sampled and analyzed by the Department of Health and Senior Services in December 2001 at the request of the MDNR. Domestic Well #3 is located approximately 1,000 feet northeast of the Northeast Site Creek, and serves a residence/farm complex currently leased to tenants. The analysis of ground-water samples identified volatile organic compounds, including perchloroethylene, trichloroethylene, and their degradation products (e.g., cis-1,2 dichloroethylene and vinyl chloride). Additional ground-water samples were collected from Domestic Well #3 by Westinghouse confirming the presence of multiple VOCs. No verified radiological contamination was found in this well.

### **3.2.14 Deul's Mountain**

During the construction of the Building 256 warehouse a large area of potentially-contaminated soil was removed and stored along the southeast corner of the fence-line. This pile has become known as "Deul's Mountain". Limited information is available to understand the extent and nature of residual contamination in Deul's Mountain and additional characterization information is needed.

### **3.2.15 Cistern Burn Pit Area**

The cistern near the Tile Barn was used historically to burn contaminated wood and pallets. In early 1993 the cistern was cleaned to less than 30 pCi/g uranium. Additional characterization will be needed to assess the effectiveness of the prior remediation efforts.

### **3.2.16 Joachim Creek Bridge**

Concerned citizens have verbally reported that material may have been buried on or near the southwest portion of the property, in the vicinity of the Joachim Creek bridge. Documentation to establish the validity of these claims has not been found. Additional characterization information is needed.

## **3.3 Preliminary Identification of Response Objectives and Remedial Action Alternatives**

Based upon the conceptual understanding of the Site and existing information, potential remedial action objectives and a preliminary range of remedial actions are presented below.

### **3.3.1 Preliminary Response Objectives and Technologies**

The overall objectives of the final response actions for the Site are:

- protect human health and the environment in both the short and long term by developing a permanent solution that addresses the radioactive and chemical contaminants of concern in the affected media while limiting related exposures;
- implement the actions in a manner that will minimize contaminant transport to unaffected areas and attain compliance with applicable or relevant and appropriate environmental requirements, including the National Contingency Plan; and
- release the property for reuse to the extent practicable.

The affected environmental media include groundwater, contaminated sediment and bedrock, in the saturated and unsaturated zones, surface water and potentially sediment in streams and ponds. Response objectives are based upon (1) complying with

regulatory standards and guidelines and (2) limiting potential exposures and risks. Environmental regulations that will be considered relative to compliance are identified in Section 4.1.

General risk-based objectives that encompass each of these media are as follows:

- exposures to radionuclides should be reduced to levels as low as reasonably achievable (ALARA), as far below health-based criteria as limited by the natural presence of radionuclides in the given media;
- exposures to carcinogenic chemicals should not result in a total increment lifetime risk to an individual of more than  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ , as limited by the natural presence of chemicals in the given media;
- exposures to noncarcinogenic chemicals should not result in significant adverse health effects to an individual; and
- exposures of biota should be limited to levels that are not associated with significant adverse ecological effects.

In developing response objectives for the Site, these broad actions could be applied to each affected media:

- institutional controls;
- in-situ containment;
- removal;
- treatment;
- short-term storage; and
- disposal.

### **3.3.2 Preliminary and Conceptual Remedial Action Alternatives**

The nature and complexity of this Site were considered when creating the preliminary list of alternatives that are protective of human health, the environment and designed to meet preliminary response section objectives. Decommissioning the Site and

eliminating, reducing, or controlling the risks posed by remaining potential exposure pathways would achieve protection of human health and environment.

Two major categories of response are considered:

- Containment – involving little or no treatment but protective of human health and the environment by preventing and controlling exposures to contaminants through decommissioning and removal to off-site containment, or by other engineering measures and by using institutional controls as necessary to ensure the continued effectiveness; and
- Treatment – ranging from alternatives that use treatment as the primary element to alternatives to reduce the toxicity, mobility, or volume of contaminated material to the maximum extent feasible, minimizing the need for long-term management.

As noted previously nuclear and or chemical impacts may be present in soils and or ground water beneath Plant buildings and infrastructure. For purposes of this RI/FS Work Plan six conceptual remedial alternatives have been identified to represent a general classification of possible activities for the Site after decommissioning and infrastructure removal is achieved. These alternatives are based on the current understanding of the potential remaining exposure routes and receptors. The alternatives will be refined and possibly combined as the RI/FS process proceeds, however the purpose of identifying potential alternatives now is to see that appropriate data are collected to support the analyses of possible technologies and potentially preferred alternatives. The potential alternatives are as follows:

- Alternative 1 – No action.
- Alternative 2 – Institutional controls and monitoring would be implemented for soils/sediments and ground water associated with the Site.
- Alternative 3 – Monitored natural attenuation would be implemented for ground water associated with the Site.
- Alternative 4 – Identified sources of soils/sediments contamination would be remediated to the extent possible, and ground water would be remediated to the

extent possible by using a pump-and-treat technology, or soil vapor extraction technology;

- Alternative 5 – Identified sources of soils/sediments contamination would be remediated to the extent possible, as for alternative 4; and ground water would be remediated to the extent possible by using other available technologies.
- Alternative 6 – Identified sources of sediment and soil contamination would be remediated to the extent possible.

Alternatives 3 through 6 may also require institutional controls, which would be evaluated in conjunction with the identified remedial efforts.

Industry experience has demonstrated that remedial alternatives that only treat the affected ground water are unlikely to be successful in certain geologic settings. VOC contamination in ground water at this Site may be widespread and may be in small pores and/or fractures and therefore not practically remediated. The aquifer characteristics of the hydrostratigraphic units with affected ground water are yet to be quantified, but likely include low conductivity and low sustained pumping yields. It may be possible however, to control the gradient and direction of ground-water flow in various hydrostratigraphic units to reduce risk to potential receptors, even though ground-water quality may not reasonably be improved to Safe Drinking Water Act Standards.

This preliminary list of alternatives will be refined as additional data are collected and as further analyses are performed to support the evaluation of a final response.

### **3.4 Cultural Resources Management**

The Antiquities Act of 1906 and Historic Sites Act of 1935 seek to preserve for public use, historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the United States.

#### **3.4.1 Investigative and Evaluative Procedures**

Cultural Resource Management (CRM) activities would be carried out in three phases. Phase I consists of a records and literature review along with a pedestrian survey. Phase II includes archaeological test excavations at selected sites that may be significant, and Phase III investigations are full scale data recovery efforts at identified significant

sites. A vast number of archaeological sites and historic resources which are initially located are deemed, non-significant, that is, further investigations of the site would not contribute new or significant information about the past. These would be recommended as requiring no further evaluation at the Phase I level. A few archaeological sites may require further evaluation through Phase II excavations to make a recommendation of significance or non-significance, and finally if a site is determined historically significant, Phase III data recovery would occur if the site cannot be avoided (i.e. adversely impacted by construction or remediation).

### **3.5 Jurisdictional Wetlands and Surface Water Issues**

Jurisdictional wetlands and surface water issues would be considered in operations and actions related to executing this RI/FS Work Plan and decommissioning the Westinghouse Facility. This section contains discussion relating to these issues and how they may be considered/incorporated into long term planning and management.

#### **3.5.1 Wetland Issues**

Wetlands are believed to be present on the Site and the surrounding properties. This natural resource is under the jurisdiction of the federal government, jointly administered by the United States (U.S.) Army Corps of Engineers (ACOE) and the U.S. Environmental Protection Agency (EPA). At the state level, jurisdiction is administered by participating state agencies including the MDNR and the Missouri Department of Conservation Wetlands Management Program. This section of the RI/FS Work Plan specifically outlines the tasks necessary to address the effects decommissioning may have on this natural resource.

#### **Investigate and Evaluation Procedures**

The scope of work under this section includes the following tasks:

- classify the wetlands on site according to the appropriate federal, state and, if applicable, local government's regulations/guidelines;
- delineate the wetlands on site, in accordance with ACOE 1987 Wetland Delineation Manual;
- survey the delineated wetlands to create a site plan wetland overlay map;

- determine the target areas and potential impacts, based on the above-referenced map, which may result during the decommissioning of the facility, including both:
  - Direct Impacts – impacts directly to wetlands, and
  - Indirect Impacts – impacts as result of runoff onto wetlands or activities in adjacent “buffer” areas;
- establish baseline environmental conditions of the wetlands and adjacent areas prior to commencing decommissioning activities, including, among other things, state and/or federal threatened and/or endangered species;
- identify and obtain appropriate local, state and/or federal permits for work that is determined to adversely impact wetlands;
- coordinate with appropriate local, state and/or federal agencies to identify issues and concerns associated with the decommissioning work relative to impacts on wetlands; and
- evaluate, design and implement best management practices (BMPs) to minimize, eliminate and/or mitigate any impacts to wetlands.

### **3.5.2 Surface Water Issues**

Five intermittent tributaries (North Lake Tributary, East Lake Tributary, Northeast Site Creek, Site Creek, and Lake Virginia/Site Creek Tributary) and one perennial stream (Joachim Creek) flow across or run adjacent to the Site. Two ponds/lakes, including East Lake, and Site Creek Pond are also on the property. These water resources, just as wetlands, are under the jurisdiction of the federal government and the State of Missouri. This section of the RI/FS Work Plan specifically outlines the tasks necessary to address the effects decommissioning the Westinghouse facility may have on these tributaries and ponds/lakes.

#### **3.5.2.1 Investigative and Evaluative Procedures**

The scope of work under this section of the work plan includes the following tasks:

- classify the surface waters on site according to MDNR Water Protection and Soil Conversation Division, Water Pollution Control Program;
- survey the surface water bodies to create a site plan surface water overlay map;
- determine the surface water areas that are subject to potential impacts, based on the above-referenced map, which may result during the decommissioning of the facility, including both:
  - Direct Impacts – impacts directly to on-site ponds, lakes, and creeks, and
  - Indirect Impacts – impacts on-site ponds, lakes and creeks as a result of runoff from, or activities on, adjacent land areas and/or discharge, or lake thereof, of ground-water to these surface water bodies;
- establish baseline environmental conditions of the one-site ponds, lakes and creeks prior to commencing decommissioning activities, among other things, state and/or federal threatened and/or endangered species;
- identify and obtain appropriate local, state and/or federal permits for work that is determined to adversely impact surface water bodies;
- coordinate with appropriate local, state and/or federal agencies to identify issues and concerns associated with the decommissioning work relative to impacts on surface water bodies; and
- evaluate, design and implement BMPs to minimize and/or eliminate any impacts to surface water bodies.

### **3.6 Threatened and Endangered Species**

An evaluation of the potential effects of the Plant’s decommissioning may have on threatened and endangered species is an important aspect of the RI/FS Work Plan because threatened and endangered species are protected under federal and state statute and because threatened and endangered species are often key indicators to the overall health of an ecosystem.

#### **3.6.1 Investigative and Evaluative Procedures**

An evaluation of the potential presence of threatened and endangered species within the project area and assessment of potential impacts to these species and/or their

habitats will utilize a multi-phased approach. First, listed species potentially occurring within the project area will be identified through consultation with the MDC and from the list of threatened, endangered, and proposed species provided by the USFWS. Second, existing site-specific and regional information will be collected and reviewed to assess the potential of the project area to provide the habitat requirements of threatened or endangered species. This information, in addition to existing data regarding the range and habitat preferences of potential T & E species, will be used to determine the potential for occurrence of these species in the project area and to determine the need and focus of field surveys. Once a review of existing information is completed, a field reconnaissance of the project area will be conducted to verify project area habitats, assess current habitat conditions, and identify any unique habitat features. The final step in the evaluation process will be a determination of effects for those species that may occur within the project area or be affected by offsite or indirect impacts such as changes in downstream water quality. If a potential listed species is not expected to be present or affected by the proposed project, evidence or rationale for supporting this conclusion will be presented. A final impact assessment report will be prepared addressing all state and federal listed threatened and endangered species potentially affected by proposed decommissioning activities.

#### **4.0 RI/FS Work Plan Rationale**

The final disposition of the Site is assumed to be, release for future use. Conceptual planned actions to achieve that status includes the removal of:

- buildings (except the main office structure) their foundations and slabs;
- infrastructure including above grade and subsurface utilities, roads and parking lots and walkways;
- unused bulk chemicals;
- residuals of raw materials used in manufacturing;
- materials in the burial pits;
- contaminated soils found at other Areas of Concern, dependent upon the type of contamination depth and health risk.

If removal of these items becomes the accepted preferred alternative and removal is accomplished, essentially all sources for ground-water contamination would be eliminated, thus creating a situation in which currently contaminated ground water would be the sole potential transport mechanism to potential receptors.

The intent of the Site characterization effort within the RI/FS Work Plan is to build upon known information of previous studies, to fill data gaps, and to determine the nature and extent of contamination for the Site in total, as well as the for specific Areas of Concern. The RI/FS Work Plan contains elements of non-source biased characterization to determine the nature and extent of contaminants within soils and ground-water outside of the immediate Plant area.

Data acquired from these characterization efforts will be used to:

- complete the Site characterization;
- model ground-water flow to determine potential receptors;
- model contaminant fate and transport to determine potential risk to potential receptors in the ground-water path;

- model potential dose equivalent of the residential farmer scenario using RESRAD;
- determine technical practicability of effective ground-water monitoring, remediation, and flow control.

#### **4.1 Applicable or Relevant and Appropriate Requirements (ARARS)**

This section introduces the concept of applicable or relevant and appropriate requirements (ARARs) and introduces those that may be initially applied or considered for the RI/FS process at the Site. During the RI/FS process, Westinghouse would conduct an ARAR analysis suitable to the scope of the project and nature of contamination.

The Superfund Amendments and Reauthorization Act (SARA) of 1986, added CERCLA Section 121(d), which stipulates that the remedial standard or level of control for each hazardous substance, pollutant, or contaminant meet any ARAR under federal or state environmental law. For example, Clean Water Act (CWA) restrictions can be applicable to hazardous substances discharged into surface water from a Superfund site. Regulations codified in the NCP govern the identification of ARARs and require compliance with ARARs throughout the Superfund response process, including during certain removal actions to the extent practicable.

CERCLA Section 121(d) specifies that on-Site Superfund remedial actions must attain federal standards, requirements, criteria, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate to the circumstances at a given site. Such ARARs are identified in this RI/FS Work Plan and at other stages in the remedy selection process. For removal actions, ARARs are identified whenever practicable depending upon site circumstances. To be applicable, a state or federal requirement must directly and fully address the hazardous substance, the action being taken, or other circumstance at a Site. A requirement which is not applicable may be relevant and appropriate if it addresses problems or pertains to circumstances similar to those encountered at a Site.

#### **4.1.1 Applicable Requirements**

Applicable requirements are those cleanup standards, controls, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a site. To be applicable, a requirement must directly and fully address an activity.

#### **4.1.2 Relevant and Appropriate Requirements**

Relevant requirements are those cleanup standards, standards of control, or other substantive environmental provisions that do not directly and fully address site conditions, but address similar situations or problems to those encountered at a site. Resource Conservation and Recovery Act (RCRA) landfill design standards could, for example, be relevant to a landfill used at a site, if the wastes being disposed of were similar to RCRA hazardous wastes. Whether or not a requirement is appropriate (in addition to being relevant) will vary depending on factors such as the duration of the response action, the form or concentration of the chemicals present, the nature of the release and the availability of other standards that more directly match the circumstances at the site. In some cases only a portion of the requirement may be relevant and appropriate.

#### **4.1.3 Types of ARARS**

Environmental laws and regulations fit more or less into three categories: 1) those that pertain to the management of certain chemicals; 2) those that restrict activities at a given location; and 3) those that control specific actions. There are therefore three primary types of ARARs.

Chemical-specific ARARs are usually health or risk-based restrictions on the amount or concentration of a chemical that may be found in or discharged to the environment. Examples include RCRA land disposal restrictions (LDR) treatment standards and Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs).

Location-specific ARARs prevent damage to unique or sensitive areas, such as floodplains, historic places, wetlands, and fragile ecosystems, and restrict other activities

that are potentially harmful because of where they take place. RCRA, for example, prohibits the placement of hazardous waste in geologically unstable areas.

Action-specific ARARs are activity or technology based. These ARARs control remedial activities involving the design or use of certain equipment, or regulate discrete actions. The decision to dispose of a waste contaminated with PCBs could, for example, trigger requirements under the Toxic Substances Control Act (TSCA) to burn the waste in an incinerator that meets TSCA design and operating standards.

#### **4.1.3.1 Federal ARARs: RCRA, CAA, CWA, SDWA, TSCA, AEA, HMTA, OSHA**

Federal statutes and regulations contain requirements that may function as ARARs. Since no two sites are alike, universal applicability statements are not possible. Certain federal laws and the accompanying regulations do, however, address circumstances often encountered at CERCLA sites. Among the federal laws with requirements that may be applicable or relevant and appropriate to this project are RCRA, CAA, CWA, SDWA, TSCA, AEA, HMTA and OSHA.

##### **4.1.3.1.1 Resource Conservation and Recovery Act**

RCRA regulates various waste management activities in order to encourage resource conservation and protect human health and the environment. RCRA Subtitle C and the Subtitle C regulations (appearing in 40 CFR Parts 260-299), which govern hazardous wastes from the point of generation through the point of disposal, have the greatest likelihood of being applicable or relevant and appropriate to CERCLA response actions.

##### **4.1.3.1.2 Clean Air Act (CAA)**

The Clean Air Act is designed to protect and enhance the quality of air resources so as to promote the public health and welfare and the productive capacity of its population. The Act is divided into seven different titles, or sections, which regulate various types of air emissions, including obvious air emission sources, such as incinerators, as well as less obvious sources, such as air stripping, solidification/stabilization, and other waste treatment technologies.

Only Titles I and III of CAA are likely to directly affect a Superfund remedial action.

#### **4.1.3.1.3 Clean Water Act**

The primary purpose of the Clean Water Act, also known as the Federal Water Pollution Control Act, is to restore and maintain the quality of surface waters by restricting discharges of all designated pollutants, which include 126 “priority toxic pollutants,” various “conventional pollutants,” and certain “non conventional pollutants.” CWA, like RCRA and CAA, is intimately connected to CERCLA; all 126 CWA priority toxic pollutants are CERCLA hazardous substances (CERCLA Section 101(14)). CWA regulations that are most likely to be ARARs at Superfund sites are standards governing direct discharges to surface waters, indirect discharges to publicly owned treatment works (POTWs), and discharges of dredge-and-fill materials into U.S. waters.

#### **4.1.3.1.4 Safe Drinking Water Act**

The Safe Drinking Water Act and the SDWA regulations (40 CFR Parts 141-149) are designed to protect human health from contaminants in drinking water. To achieve these ends, EPA has developed concentration-based limits for certain contaminants and management techniques that ensure the quality of public drinking water supplies. Substantive SDWA requirements that may be applicable or relevant and appropriate at CERCLA sites include: drinking water standards, restrictions on the underground injection of wastes, and groundwater protection programs.

##### **Drinking Water Standards**

There are two types of SDWA drinking water standards that serve to protect public water systems: primary and secondary drinking water standards. Primary drinking water standards consist of federally enforceable maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs). For CERCLA actions, MCLGs or MCLs are applicable when response actions impact public water systems that have at least 15 service connections or serve at least 25 year-round residents. The MCLG for a particular contaminant will be the applicable level to meet unless it is zero, in which case the MCL for the contaminant becomes the applicable level to attain. MCLs or MCLGs

may also be relevant and appropriate as cleanup standards for on-site ground or surface waters that are current or potential sources of drinking water.

Secondary drinking water standards consisting of secondary maximum contaminant levels (SMCLs) pertain to the aesthetic qualities of drinking water (i.e., color, odor, and taste). In states that have adopted secondary drinking water standards, SMCLs are potential ARARs.

### **Sole Source Aquifer and Wellhead Protection Programs**

SDWA prevents federal funding from being committed to any project that may contaminate a "sole source aquifer," meaning any EPA- designated aquifer that is the only principal drinking water supply for a given area which, if contaminated, would present a significant human health hazard. Generally, CERCLA activities do not in and of themselves increase pre-existing contamination of sole source aquifers. Although it is unlikely that CERCLA activities would be subject to funding restrictions, a review of potential problems associated with sole source aquifers should be part of the RI/FS process.

The SDWA wellhead protection program is a state-implemented initiative intended to protect wells and groundwater recharge areas that supply public drinking water systems. Elements of Missouri's Wellhead Protection Program may be ARARs at this Site.

#### **4.1.3.1.5 Toxic Substances Control Act**

TSCA creates a broad range of chemical control measures including information gathering, chemical testing, labeling, inspection, storage, and disposal requirements. For example, under TSCA authority, EPA requires chemical manufacturers to notify the Agency prior to producing a new chemical (known as premanufacture notification), and can require manufacturers to test selected chemicals for toxic effects. TSCA Section 6 allows EPA to strictly regulate any chemical that poses an "unreasonable risk," based on its likelihood to cause adverse effects to human health or the environment.

Chemicals regulated under TSCA include asbestos, chlorofluorocarbons (CFCs) used as aerosol propellants, hexavalent chromium, and PCBs.

#### **4.1.3.1.6 Atomic Energy Act**

Radionuclides are regulated under the authority of the Atomic Energy Act (AEA) as amended, including the Energy Research and Development Act and the Energy Reorganization Act. These acts collectively authorize NRC (and DOE) to regulate radioactive materials, including wastes, and the facilities that generate or manage these materials. The AEA also authorizes the EPA to provide radiological standards for radioactive material and waste management. In general, the AEA and its amendments and the Nuclear Waste Policy Act authorize what is now the NRC to regulate, among other things, commercial generation and handling of radioactive materials and wastes, and all high-level radioactive waste (HLW) disposal. The NRC (and DOE) must also implement the EPA's 40 CFR Part 191.

#### **4.1.3.1.7 Hazardous Materials Transportation Act**

The Hazardous Materials Transportation Act of 1975 (HMTA) as amended, is the major transportation-related statute relating to shipment of hazardous materials. HMTA is designed to provide regulatory and enforcement authority through the Department of Transportation to protect against risks to life and property which are inherent in the transportation of hazardous materials in commerce. The HMTA may designate as hazardous material, any particular quantity or form of a material that may pose an unreasonable risk to health and safety or property.

The HMTA applies to any person who transports, or causes to be transported or shipped, a hazardous material; or who manufactures, fabricates, marks, maintains, reconditions, repairs, or tests a package or container which is represented, marked, certified, or sold by such person for use in the transportation in commerce of certain hazardous materials.

Enforcement of the HMTA is shared by each of the following administrations under delegations from the Secretary of the Department of Transportation (DOT).

- Research and Special Programs Administration (RSPA) - Responsible for container manufacturers, reconditioners, and retesters and shares authority over shippers of hazardous materials.

- Federal Highway Administration (FHA) - Enforces all regulations pertaining to motor carriers.
- Federal Railroad Administration (FRA) - Enforces all regulations pertaining to rail carriers.
- Federal Aviation Administration (FAA) - Enforces all regulations pertaining to air carriers.
- Coast Guard - Enforces all regulations pertaining to shipments by water.

#### **4.1.3.1.8 Occupational Safety and Health Act**

The Occupational and Safety Health Act (OSHA) is designed to ensure worker and workplace safety. Under OSHA employers shall provide their workers a place of employment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress, or unsanitary conditions.

OSHA also created the National Institute for Occupational Safety and Health (NIOSH) as the research institution for the OSHA. OSHA is a division of the U.S. Department of Labor that oversees the administration of the Act and enforces standards in all 50 states.

OSHA Subparts H, I, and J relating to Hazardous Materials, Personal Protective Equipment and General Environmental Controls respectively, may be applicable.

#### **4.1.3.1.9 Radioactive Materials ARARs**

- 10 CFR19 - “Notices, Instructions and Reports to Workers: Inspection and Investigations”
- 10 CFR Part 20 – “Standards for Protection Against Radiation”
- 10 CFR 40 - “Domestic Licensing of Source Material”
- 10 CFR 61 “Licensing Requirements of Land Disposal of Radioactive Waste”
- 10 CFR Part 70 – Domestic Licensing of Source and Special Nuclear Material
- 10 CFR 71 - “Transportation of Radioactive Material”

- 10 CFR 75 - “Safeguards on Nuclear Material – Implementation of US/IAEA agreement”

#### **4.1.3.1.10 Other Federal ARARs**

ARARs may stem from various other federal laws and regulations. Among the federal laws which may come into play are the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Endangered Species Act, Rivers and Harbors Act and the National Historic Preservation Act. Certain primarily administrative federal laws, such as the National Environmental Policy Act (NEPA), do not, however, normally serve as ARARs.

#### **4.1.3.2 State and Local ARARs**

Many states implement environmental regulations that differ from federal standards. CERCLA Section 121(d)(2) requires compliance with applicable or relevant and appropriate state requirements when they are more stringent than federal rules and have been "promulgated" at the state level.

Missouri has a voluntary regulatory program, the Cleanup Levels for Missouri (CALM) guidance document outlines a process for determining cleanup goals at site with known or suspected hazardous substance contamination. The CALM process was developed for hazardous substance contamination which is remediated under Missouri's Voluntary Cleanup Program (VCP) laws and regulations administered by the Missouri Department of Natural Resources' Hazardous Waste Program. The cleanup goals for soil and ground water are intended to protect human health and the environment.

MDNR recognizes that sites vary greatly in terms of complexity, physical and contaminant characteristics, exposure factors, and in the risk that they may pose to human health and the environment. The CALM process recognizes this diversity by developing cleanup levels based on actual or potential risk considering various site land and use scenarios and by using a tiered approach that integrates sites assessment and response actions with human health and ecological risk assessment.

Other State of Missouri ARARs potentially include:

- Missouri Clean Water Law;

- Missouri Drinking Water Act;
- Missouri Water Pollution Control Program Regulations;
- Missouri Water Quality Standards;
- Missouri Well Construction Code;
- Missouri Solid and Hazardous Waste Regulations; and
- Cave Resources Act.

#### **4.1.4 ARAR Waivers**

Certain circumstances under which a law or regulation that would normally be an ARAR may be waived. The following types of “ARAR waivers” and others may be applied during a remedial action. It should be noted that ARARs can not normally be waived without formal regulatory approval.

- **Interim Measurers**

An ARAR may be temporarily waived to implement a short-term alternative, or interim measure, provided that the final remedy will, within a reasonable time, attain all ARARs without causing additional releases, complicating the response process, presenting an immediate threat to public health or the environment, or interfering with the final remedy.

- **Greater Risk to Human Health and the Environment**

An ARAR may be waived if compliance with the requirement will result in greater risk to human health and the environment than non-compliance.

- **Technical Impracticability**

An ARAR may be waived if it is technically impracticable from an engineering standpoint, based on the feasibility, reliability, and cost of the engineering methods required. It is, for example, often technically impracticable to remove from an aquifer, dense nonaqueous phase liquids (DNAPLs) to a level compliant with MCLs.

- **Equivalent Standard of Performance**

An ARAR may be waived if an alternative design or method of operation can produce equivalent or superior results, in terms of the degree of protection

afforded, the level of performance achieved, long-term protectiveness, and the time required to achieve beneficial results.

- **Inconsistence Application of State Standard**

A State ARAR may be waived if evidence exists that the requirement has not been applied to other sites or has been applied variably or inconsistently.

#### **4.1.5 Mixed Waste**

Radioactive wastes that are also designated as hazardous wastes under RCRA are termed “mixed waste.” Radioactive wastes contaminated with PCBs are regulated under TSCA, while radioactive and hazardous or toxic remediation-derived waste and environmental media are subject to treatment/clean-up requirements under CERCLA.

Radiological waste, hazardous waste, and perhaps mixed wastes are expected to be present at the Site. Some identification and segregation of waste types will be easily accomplished. For example, most building demolition debris if contaminated, likely will have a radiological component only. Conversely, AOCs such as the Evaporation Pond and Burial Pits may have media such as soil and ground water contaminated with both a radiological and hazardous component.

Mixed waste treatment, the technical specification that the treated waste must meet, and the process operation, effluent, and emission controls required at treatment facilities are driven by regulatory requirements to protect public health and the environment and to provide aspects of workers safety. In deciding remedial strategies, Westinghouse will consider both sets of requirements to treat mixed wastes before land disposal and the specification that the treated waste must meet for the waste itself and for the treatment facilities.

#### **4.2 Community Relations Plan**

The Community Relations Plan (CRP) is provided as a stand-alone document in Appendix D. The CRP will be implemented in accordance with the schedule outlined therein.

### **4.3 Data Quality Objectives**

Data Quality Objectives (DQO) are addressed in Section 4.0 of the Quality Assurance Project Plan (QAPP) (Appendix A). The QAPP has been prepared as a stand-alone document and is included as Appendix A.

### **4.4 Sampling and Analysis Plan**

The Sampling and Analysis Plan contains two parts; the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP). Although it is part of the SAP, the QAPP has been prepared as a stand-alone document. Generally the QAPP describes the organization, function activities and quality assurance and quality control needed to achieve sufficient and valid data. The FSP presented within the text of this document is essentially instruction for field data acquisition and sampling protocol.

#### **4.4.1 Field Sampling Plan**

The FSP is intended to provide instruction for fieldwork by defining the sampling and data-gathering methods to be used in this investigation. The purpose of the FSP is to serve as a reference document such that field sampling personnel unfamiliar with the Site would be able to gather field data and perform sampling as required.

The FSP is composed of the following six elements:

- Site background;
- sampling objectives;
- sampling location and frequency;
- sample designation;
- sampling equipment and procedures; and
- sample handling and analysis.

Field investigation activities will be conducted using standard quality assurance and quality control measures, including sampling and analysis of appropriate QC samples as outlined in the QAPP. In addition, activities will be conducted in accordance with

health and safety procedures outlined in the Site Safety and Health Plan, included as Appendix B of this Work Plan.

#### **4.4.1.1 Site Background**

The purpose of this section is to summarize existing data, provide a description of the Site and surrounding areas, and present a discussion of known and suspected contaminant sources, probable transport pathways and other information about the Site. Site background and previous investigations are presented in this RI/FS Work Plan in Section 2.0 and its subsections.

#### **4.4.1.2 Sampling Objectives**

The primary objective of the RI is to determine the horizontal and vertical extent of contamination in environmental media at the Site. The FSP addresses areas that may have been impacted by historic Site operations and specific AOCs. The FSP also provides a process to determine background concentration of radiological and certain metals in soils and ground water.

Another important component of the FSP relates to determining the aquifer characteristics of various hydrostratigraphic units for future application relating to remedial alternative analysis.

Characterization efforts planned in the FSP relating to geology and interpretation of geologic data will be conducted under the responsible charge of a Missouri Registered Geologist.

#### **4.4.1.3 Sample Locations and Frequency**

The following sub-sections describe how specific AOCs and aquifer properties will be investigated. Table 3 and Plates 14 through 24 have been prepared to summarize the scope of investigation and show sampling areas and locations. The vertical and horizontal sampling locations shall be established by appropriate survey method. The survey data will be in state planar coordinates or convertible to state planar coordinates. Wells and borings will be installed according to Missouri Code and comply with accuracy requirement of the code. The location of other samples will be identified by

typical methods including field measurement, handheld GPS, or survey where appropriate. Table 4 provides an overview of the sample media by AOC.

#### **4.4.1.3.1 Preliminary Areas of Concern**

The following preliminary AOCs will be the subject of the characterization effort:

- AOC #1 Groundwater;
- AOC #2 Surface Water Features;
- AOC #3 Burial Pits;
- AOC #4 Evaporation Ponds;
- AOC #5 Former Leach Field/Sanitary Sewer System;
- AOC #6 Soil Beneath Buildings;
- AOC #7 Limestone Storage and Limestone Fill Areas;
- AOC #8 Outdoor and Shallow Surface Area;
- AOC #9 Former Gas Station;
- AOC #10 Gas Pipeline;
- AOC #11 Red Room Roof Burial Area;
- AOC #12 Domestic Well #3;
- AOC #13 Deul's Mountain; and
- AOC #14 Cistern Burn Pit Area.
- AOC #15 Joachim Creek Bridge

##### **4.4.1.3.1.1 Ground water (AOC #1)**

Ground water sampling has previously been conducted at the Site and revealed the presence radiological contaminants, and VOCs, specifically 1,1-DCE, 1,1-DCA, cis-1,2-DCE, total 1,2-DCE, TCE, PCE, vinyl chloride, and carbon disulfide. The last round of groundwater sampling took place approximately 13 months ago and not all existing monitoring wells were sampled. Analyses have included VOCs, RCRA metals, PCBs, and radiological constituents. Full characterization of the Site groundwater has not been completed, therefore, this scope of analyses proposed includes the full suite of Target

Compound and Target Analyte Lists, fluoride, nitrate/nitrite, sulfates and radiological parameters.

### **Baseline Ground-Water Analysis**

There are thirty-six existing monitoring wells and piezometers installed to monitor the unconsolidated and bedrock aquifers at the Site. Thirty-four of the thirty-six will be sampled as the first step in the characterization process to develop a baseline of chemical and radiological ground-water quality data. Prior to sampling, each well/piezometer will be inspected for compliance with Missouri Well Construction rules to determine whether rehabilitation or maintenance may be required. Some wells/piezometers have not been developed/sampled in several years, and may require development (i.e., may have excessive silt/sand accumulation). Table 5 summarizes existing monitoring well/piezometer construction. Plates 14 and 17 show the location of the existing monitoring well/piezometer network. Piezometers BR1-JC and BR2-JC do not require sampling.

### **Private Water Supply Well Water Quality Analysis**

In December 2001, the Department of Health and Senior Services (DHSS) conducted annual radiological monitoring of four private wells near the site. DHSS elected to include VOC monitoring during this event. Results of that sampling revealed one private drinking water well (Domestic Well #3) had VOCs, including perchloroethylene (PCE), and trichloroethylene (TCE) significantly above drinking water standards. This well had been last sampled in 1996 and found to be clean at that time. The MDNR informed Westinghouse of the results and directed Westinghouse to conduct follow-up testing. Westinghouse reports in March 2002, 20 additional wells were tested and analysis identified five more private wells had been impacted with VOC contamination. The location of the impacted wells are shown on Plate 15. In April 2002, the MDNR and DHSS sampled a total of 51 additional private wells; while Westinghouse conducted repeat sampling of those previously sampled. Analytical results of this event showed no additional private well contamination, however two more wells in addition to these six were found to have concentrations of VOC's during a subsequent sampling event conducted in August 2002.

An inventory of private water wells within a 2-mile radius of the site was completed in May 2002. The survey was completed using three sources; (1) MDNR well log library, (2) MDNR Well-head Protection Division Water Well certification and Pump records, and (3) information obtained from private well owners.

Westinghouse supplied drinking water to those residences most likely to be affected by contaminated drinking water. In addition, for those homes that demonstrated detectable levels of VOCs potentially related to site operations, Westinghouse arranged for the installation of activated carbon filter canisters. Westinghouse reports a total of eight private wells to date, have been affected and have filtration systems installed. The canister filtration systems are being monitored monthly to check for breakthrough of contaminants. In addition, Westinghouse conducts quarterly monitoring for a network of residences in the area to assist in monitoring potential movement of the VOC plume in the off-site groundwater.

### **Sequence of Ground-water Characterization/Monitoring**

Ground-water quality will be evaluated at several Areas of Concern by installing temporary monitoring wells. In the plant area, temporary monitoring wells are planned specifically not to disturb the upper-most bedrock aquifer; the Jefferson City-Cotter Dolomite. When an area of contamination is encountered in the shallower unconsolidated unit, contamination (especially DNAPLS) could be spread to the Jefferson City-Cotter Dolomite if the shallow section is not cased and precautionary well installation methods are not employed. Therefore, at the Areas of Concern where new ground-water quality assessment is planned, a second phase of investigation may be required to determine ground-water quality of the Jefferson City-Cotter Dolomite or deeper bedrock units, depending on what is found in the unconsolidated units.

Because the potential for contaminants in the shallow aquifer is diminished with distance from the plant, some temporary wells completed in bedrock are planned alongside proposed unconsolidated unit temporary wells. Analytes of concern are summarized in Table 3.

Once ground-water quality data are available (from the network of existing and new temporary wells) and have been evaluated, the nature and extent of groundwater contamination will be understood to a greater degree, and a ground-water monitoring

system of permanent wells will be proposed, planned and installed. Some of the temporary wells may be converted to permanent status.

### **In-door Air Sampling**

A single event is planned to sample the air in the basement of houses with wells impacted by VOC contamination. The sampling will be conducted in accordance with USEPA Compendium Method TO-15, which determines the concentration of VOCs in air collected in specially prepared canisters as analyzed by gas chromatography/mass spectrometry. Analytical results will be used to determine the need for future air monitoring in these residences. The USEPA compendium method TO-15 is provided as an attachment to the QAPP addendum.

#### **4.4.1.3.1.2 Surface Water-Features (AOC #2)**

Of the several surface water bodies, three make-up this AOC because past practices may have impacted these features. The Site Pond receives stormwater discharge runoff, sanitary sewer discharge, former septic tank/leachfield discharge, and is also fed by a natural spring. The Site Pond discharges into the Site Creek that eventually discharges to Joachim Creek. The Northeast Site Creek also discharges to the Joachim Creek. Sediment depositional features will be considered when selecting exact sampling locations.

Staff gauges will be installed (and surveyed) in important surface water bodies (e.g., Site pond, East Lake, Site Creek, Northeast Site Creek, Joachim Creek, Evaporation Ponds). Surface water levels shall be measured to coincide with groundwater monitoring events to confirm the hydraulic relationship between these surface waters and local groundwater.

#### **Northeast Site Creek**

The media of concern for the Northeast Site Creek are surface water and stream sediment. Three surface water samples will be collected including one located north of State Highway P. Six sediment samples will be collected along the length of the creek. The analytes of concern are provided in Table 3. Sample locations are noted in Plate 17.

### **Site Pond/Site Creek**

The media of concern for the Site Pond and Site Creek are surface water, stream sediment, soil and ground water. A total of four surface water samples will be collected: one from the Lake Virginia tributary west of State Highway P; one from the Site Spring; one from the Site Pond, and one at the confluence of the combined Lake Virginia/Site Creek Tributary and the Joachim Creek. Seven stream sediment samples will be collected: three from the Site Pond; and four from the Site Creek and combined Lake Virginia/Site Creek combined tributary.

A direct push rig will advance a total of eight borings in the vicinity of the Site Pond. Four borings will be located on each side of the Pond (east and west). Soil samples will be collected from the surface and at depth from the eight borings, and all eight will be completed as temporary, one-inch O.D. PVC monitoring wells. The stratigraphic zones of interest include NSSSC, DSCC and the CSSG. Temporary monitoring wells will be screened across zones as planned by best professional judgment, as determined by data acquired in the field. Ground-water samples would be collected from each well and analyzed. The analytes of concern are provided in Table 3. Sample locations are noted on Plate 18.

### **Joachim Creek**

The media of concern for Joachim Creek are surface water and stream sediment. Four surface water and three stream sediment samples will be collected along Joachim Creek. The surface water and stream sediment samples will be collected in close proximity to one another at each location (if co-located). The sampling locations are as follows: mid-point between the confluences of the Lake Virginia/Site Creek and Northeast Site Creek with the Joachim Creek; immediately north of the bridge over the Joachim Creek, near the south Site boundary; and along the northeast property boundary.

The analytes of concern are provided in Table 3. Sample locations are noted on Plate 17.

#### **4.4.1.3.1.3 Burial Pits (AOC #3)**

Ground-water monitoring results show that materials placed in the pits have impacted ground-water quality. Monitoring wells around the Burial Pits including two

screened in the Jefferson City-Cotter Dolomite, have been very recently sampled showing VOC contamination in the bedrock. These will provide an indication as to potential impact to ground water from the burial pits. To further characterize the Burial Pits, Westinghouse will perform a detailed review of corporate historical information including a rigorous review of the written records. The media of concern for the Burial Pits is soil. Surface soil samples will be collected from 20 locations throughout the burial area. Four trenches will also be excavated in areas suspected of containing buried material. The purpose of the trenches is to determine the depth and nature of the fill. No sampling of the trenches will be performed. The ground-water monitoring wells surrounding this area will be sampled as described in AOC #1 to determine impact to the ground-water quality the burial pits may have had. The analytes of concern are provided in Table 3. Boring/sampling and trench locations are noted on Plate 19.

In previous investigations, geophysical methods defined the horizontal extent of the documented Burial Pits. Additional geophysical characterization is planned (once cultural interference's are removed) to augment the previous geophysical survey.

#### **4.4.1.3.1.4 Evaporation Ponds (AOC #4)**

Past waste management practices have included the disposal of TCE and <sup>99</sup>Tc containing water from cylinder washing. Based on the aerial photography review, the evaporation ponds were constructed sometime after 1966 and before 1971.

The media of concern for the Evaporation Ponds are soil and ground water. Surface soil samples will be collected from 20 locations. At nine of these locations, a direct-push drilling rig will be used to advance into the deeper unconsolidated units. The nine borings will be completed as temporary monitoring wells. Some boring locations may coincide with those in AOC #10.

The stratigraphic zones of interest include NSSSC, DSCC and the CSSG. Monitoring wells will be screened across these zones as determined by data acquired in the field and according to best professional judgment. Ground-water samples will be collected and analyzed from all nine wells. The analytes of concern for soil and groundwater are provided in Table 3. Boring locations are noted on Plate 20.

#### **4.4.1.3.1.5 Former Leach Field (AOC #5)**

Waste management practices are not known from the time that the leachfield was in use. It is assumed that the leachfield received sanitary discharge from the septic tank, however, potential exists that other wastes could have been placed into sanitary drains. The media of concern that may have been impacted by the Former Leach Field are soil and ground water.

A direct push drilling rig will be used to advance five borings in the vicinity of the Former Leach Field. Soil samples will be collected from the surface and at depth from the five borings, and all five will be completed as temporary, one-inch O.D. monitoring wells. The stratigraphic zones of interest include NSSSC, DSCC and the CSSG. Monitoring wells will be screened across these zones as determined by data acquired in the field and according to best professional judgment. Ground-water samples will be collected and analyzed from all wells. The analytes of concern for soil and groundwater are provided in Table 3. Boring locations are noted on Plate 20.

#### **4.4.1.3.1.6 Soils Beneath Building(s) (AOC #6)**

The media of concern for the areas beneath the buildings are limestone fill, soil, and ground water. The buildings and adjacent exterior areas that will be addressed are based on past operational activities, and their potential for environmental impact.

A direct push rig will advance 15 borings, and soil samples will be collected from the fill beneath the impervious surface cover, from the surface soil immediately beneath the fill, and from soil at depth at each boring. Some boring locations may coincide with those in AOC #8. All 15 borings will be completed as temporary one-inch O.D. monitoring wells. The stratigraphic zones of interest include NSSSC, DSCC and CSSG. Monitoring wells will be screened across these zones as determined in the field by best professional judgment. Ground-water samples will be collected and analyzed from all newly installed wells. The analytes of concern for fill, soil and groundwater are provided in Table 3. Boring locations are noted on Plate 21.

#### **4.4.1.3.1.7 Limestone Storage and Limestone Fill Areas (AOC #7)**

Spent limestone has been stored on-site and has not been fully characterized. As discussed previously, additional information is required to assess the environmental characteristics of the limestone, and whether it has impacted the surrounding area.

Samples of the spent limestone will be collected from 20 locations within each of the three limestone piles at various depths, somewhat evenly spaced and randomly selected (see Plate 22). Each of these 60 total samples will be analyzed by gamma spectroscopy. From each of the 20 locations, one composite sample will also be prepared. These three composite samples will be analyzed for fluoride and TAL metals.

Shovels or hand augers will be used to collect the random samples. If analytical data suggest limestone has significant potential to impact the environment from a hazardous or radiological perspective additional characterization in the areas of limestone storage and fill would be warranted. The analytes of concern for limestone material are provided in Table 3. Locations of limestone storage and fill areas are noted on Plate 22.

#### **4.4.1.3.1.8 Outdoor and Shallow Surface Areas (AOC #8)**

The medium of concern for the Outdoor and Shallow Surface Areas is soil. Surface soil samples shall be collected at 64 locations throughout the area of concern as denoted in Plate 23. The analytes of concern for soil are provided in Table 3.

#### **4.4.1.3.1.9 Former Gasoline Station (AOC #9)**

During the past, previous owners/operators of the Site made an ongoing effort to expand the property boundaries through real estate acquisitions. One parcel currently located within the property boundary, north of Missouri State Route P (See Plate 20), may have operated as a gasoline service station. The dates of operation of the service station, and the status of the UST (s), is not known. There are no known radiological issues associated with this AOC. The media of concern are soil and ground water. The analytes of concern and the number of borings are shown on Table 3.

Once the status of the former service station site is determined, it should be closed according to MDNR UST guidelines. In addition to sampling required for UST closure one boring will be advanced and a soil and ground-water sample collected and analyzed.

Characterization efforts will include areas where waste oil and degreasing solvents may have been disposed, including potential sanitary waste systems.

#### **4.4.1.3.1.10 Gas Pipeline (AOC #10)**

A subgrade, high-pressure natural gas pipeline runs along the north side of the railroad easement. The pipeline, ranging in depth 3 to 5 feet bgs, is operated and maintained by Missouri Natural Gas Company (MNG). Due to the proximity of the pipeline to potential source areas such as the Evaporation Ponds and Burial Pits, it may be acting as a pathway for contamination migration.

Consultation with MNG and results of the summer 2002 drilling program has confirmed the construction details of the pipeline trench. The pipeline was backfilled with the native material. Sample results from two locations along the pipeline at the property boundaries did not identify any levels of contamination. Given the grain size of the backfill material it has likely compacted to the original condition. With this new information the likelihood of contaminate migration along the pipeline is reduced from originally thought.

The media of concern for the gas pipeline is soil. A direct push drilling rig will advance as many as 9 borings within the natural gas pipeline trench, to a depth of approximately 15 feet bgs. Soil samples will be collected from the surface and at depth from the 9 borings. The analytes of concern are provided in Table 3. Proposed boring locations are noted on Plate 18.

#### **4.4.1.3.1.11 Red Room Roof Burial (AOC #11)**

The exact location of the Red Room Roof Burial area is not known. Additional information regarding the aerial extent may be provided by the gamma walkover survey. Two borings will be installed to a maximum depth of ten feet each, five surface soil samples will be collected throughout this area. The media of concern is soil. The analytes of concern are provided on Table3. The approximate suspected location of the Red Room Roof Burial Area is noted on Plate 23.

#### **4.4.1.3.1.12 Domestic Well #3 (AOC #12)**

Domestic Well #3 was found to contain VOCs in December 2001. Ground-water monitor wells were installed in discrete hydrostratigraphic zones between the Plant and Domestic Well #3 and the direction of ground-water flow was determined. Upgradient nested wells were installed to include a deep Jefferson City-Cotter Dolomite well and a Roubidoux Formation well. Sampling and analysis of ground water from these wells show the Jefferson City-Cotter Dolomite well to be contaminated but the deeper horizons are clean. Downgradient wells in the Jefferson City-Cotter Dolomite and the Roubidoux Formation are planned, in order to determine the path of migrating VOCs. Locations of Domestic Well #3, the new upgradient wells and the planned exploratory wells are shown on Plate 24.

#### **4.4.1.3.1.13 Deul's Mountain (AOC #13)**

Deul's Mountain may be addressed as an early action response. Two surface soil samples at the former location will be collected and analyzed. The analytes of concern are provided in Table 3. The location of Deul's Mountain is noted on Plate 23.

#### **4.4.1.3.1.14 Cistern Burn Pit Area (AOC #14)**

A direct push drilling rig will advance one boring in the vicinity of the former cistern/burn pit. One soil sample will be collected from the surface and at depth from the boring, which will be completed as a temporary, one-inch O.D. monitoring well. The stratigraphic zones of interest include NSSSC, DSCC and the CSSG. The temporary monitoring well will be screened across these zones, and ground-water samples collected and analyzed. The analytes of concern are provided in Table 3. The boring location is noted on Plate 23.

#### **4.4.1.3.1.15 Joachim Creek Bridge (AOC #15)**

Concerned citizens have verbally reported that material may have been buried on or near the southwest portion of the property, in the vicinity of Joachim Creek bridge. During the geophysical survey (see Section 4.4.1.3.4), a magnetometer survey will be conducted to locate potential ferrous materials. The survey may determine where potential subsurface metal debris exists. Areas showing geophysical anomalies would be

further investigated with invasive techniques. The location of the AOC is noted on Plate 10.

#### **4.4.1.3.2 Exploration for Nature and Extent of Contamination.**

Information gathered from the testing of nearby private water wells and the related interim hydrogeologic investigation defined general horizontal and vertical limits of soil and ground-water contamination outside the Plant area. Plates 6 and 7 shows an interpretation of the extent of the contaminant plumes based on the preliminary information collected during the interim hydrogeologic investigation and the private well sampling. The proposed exploration plan includes advancing 37 borings at 19 locations in areas downgradient from the Plant. These locations were selected to better understand plume locations and hydrogeology.

The media of concern for the exploratory borings are soil (including surface soil) and ground water. Three geologic zones of interest will be targeted for soil and ground-water quality characterization: the unconsolidated unit, the Jefferson City-Cotter Dolomite, and the Roubidoux Formation. Direct-push drilling will be used in areas where only the unconsolidated unit will be addressed. The individual zones in the unconsolidated units, if identified, may be evaluated separately or may be considered a homogenous material. In areas where bedrock will also be explored, an auger drilling rig will be utilized to characterize the unconsolidated unit and a wet rotary diamond coring rig will be utilized to characterize the bedrock. An air rotary rig will follow the coring rig to accommodate installation of bedrock monitoring wells. The unconsolidated unit will receive 14 borings/monitoring wells, the Jefferson City-Cotter Dolomite will receive 12 borings/monitoring wells, and the Roubidoux Formation will receive 11 borings/monitoring wells. Proposed boring locations are noted on Plates 6, 7 and 16.

The media of concern for the Jefferson City-Cotter Dolomite and Roubidoux Formation is ground water. After initial characterization of the bedrock aquifer by wet rotary diamond coring methods, an air rotary drilling rig will advance the borings into competent rock. After the unconsolidated stratigraphic zone has been cased off, a two-inch O.D. PVC monitoring well will be installed to the desired depth and ground-water samples collected.

Field screening and analytical laboratory results of soil and ground-water samples from these exploratory borings and wells will dictate the need for additional drilling, if any. The need for additional downgradient or upgradient borings and or wells, would be based on the newly defined limit of impacted soil and/or ground water. The analytes of concern are provided in Table 3.

#### **4.4.1.3.3 Gross Gamma Walk-over Survey**

Gross gamma walk-over surveys will be performed over approximately 100% of the area immediately surrounding the buildings and creek banks as noted in Plate 25. Trees, brush, fences, equipment, and other obstructions will have to be worked around during the survey as practical. Approximately ten percent of the remainder of the Site will be surveyed. These surveys will provide position-correlated gross gamma count rate data, in units of counts per minute, that is proportional to gross gamma fluence rate at the ground surface. Results of these measurements will provide semi-quantitative data regarding the potential for elevated surface uranium and thorium. Although these measurements are quantitative in nature, detector readings are influenced by any gamma emitting radionuclides and are not specific to uranium, hence their use as semi-quantitative measurements.

#### **4.4.1.3.4 Geophysical Survey**

To screen for ferrous materials which may have been placed in the subsurface a reconnaissance magnetometer survey shall be conducted. This survey will be conducted using a cesium magnetometer (or equivalent), which will record the natural magnetic field of the earth as measured in nanoTeslas (nT). Data will be collected continuously along parallel profile lines. These profile lines shall be spaced approximately 5 feet apart (although the wooded nature of the some survey areas may cause some variation in profile line locations). Variations of profile line locations will be noted on a Site map and in the field. Profile lines will be staked and labeled in the field. At the end of each day in the field, the data will be initially reduced and plotted. This allows for real time data review and any adjustments to the survey based on the data can be made. Data points in the vicinity of magnetic anomalies will subsequently be located utilizing a GPS device.

The results of the magnetometer survey should allow the determination of anomalous areas where subsurface metal debris exists. These areas can then be further investigated if necessary. Based on the previous geophysical investigation at the subject Site, it is recommended that frequency-domain electromagnetic induction data collection be conducted in the anomalous areas established by the magnetometer survey. Frequency-domain electromagnetic induction is used to detect and map electrical conductivity variations and is sensitive to surficial and buried metal and changes in subsurface saturation, soil thickness, and dissolved ion concentrations. Consequently, this method would most likely aid in predicting the size and depths of the previously detected magnetic anomalies. This method requires concentrated data collection grids with straight profile lines, and therefore clearing and grubbing of the immediate area of the magnetic anomalies will be necessary. It should be noted that the final decision on the specific geophysical technique(s) and instruments to utilize for additional investigation of the magnetic anomalies should be made after the magnetic data is collected and analyzed, to allow for unanticipated field conditions.

These areas are the targets of this investigation:

- Suspected Red Room Roof Burial Area
- Joachim Creek Bridge
- Augmented Burial Pits Area
- Air Photo Areas of Interest.

Locations of magnetic survey are shown on Plate 25.

#### **4.4.1.3.5 Determination of Background Concentrations**

The media of concern for establishing radiological parameters and selected metals background are soil, ground water and surface water. Background characterization for radiological and metals parameters will be conducted outside of the presumed influence of Site operations. Background values for all parameters will be used to compare analytical results from samples collected at the Site.

## **Soil**

For the terrace and alluvial soil strata about 15 samples will be collected from each unit and analyzed for radiological parameters and metals. Three soil samples each will be collected from ten borings (5 borings in alluvium, 5 in terrace) located at least one-mile southwest of the Site, along the Joachim Creek Valley. The soil samples will be collected from 1 to 3 feet below ground surface (bgs), 3 to 5 feet bgs, and 5 to 7 feet bgs.

## **Ground water**

It is essential to understand background concentrations relative to the interpretation of site conditions and assessment of remedial options, from both a radiologic and conventional contaminant standpoint. However, prior to reviewing specific baseline data from the site, a full assessment of the potential background data is needed for the various media. Initial samples will be collected in accordance with the work plan and then Westinghouse will evaluate and propose additional data needs to determine background at the site. The subsequent data needs may include additional monitoring points or additional samples from the existing monitoring points.

Unconsolidated – (Terrace/Alluvial) - For background in ground water in the unconsolidated stratigraphic units, which is the alluvial, and terrace units, a single monitoring well per unit will be installed. One ground-water sample from each well will be collected to serve as an indication of background. The sample will be analyzed for radiological parameters and metals. The plan does not make a distinction of any identifiable stratigraphic members (i.e., NSSSC, DSCC) of the unconsolidated material since we do not know what exists at those locations. The individual zones in the unconsolidated units, if identified, may be evaluated separately or may be considered a homogenous material. This section indicates two units that contain various lithologic units. Since we do not know what those units are at those locations, we plan to investigate two distinct geomorphic features, the terrace and the alluvium. Depending on what is discovered those units may be sub-divided and treated in more detail.

Bedrock - To determine background of water quality from the upper bedrock aquifer, an air rotary drilling rig will advance a boring to a depth equal to the bottom of the Jefferson City-Cotter Dolomite (approximately 325' above mean sea level). The boring will be located in the north portion of the Site, north of State Highway P. The

unconsolidated portion of the boring will be cased off, and an open rock monitoring well installed in the Jefferson City-Cotter Dolomite. An open rock completion is planned to account for the various permeable zones identified in previous borings (BR1 through BR4). A ground-water sample will be collected once and analyzed to serve as an indication of background for radiological parameters and metals.

### **Surface Water**

Background surface water samples will be collected at four locations: Northeast Creek Tributary, Lake Virginia Tributary, Site Spring and Joachim Creek. The Northeast Creek and Lake Virginia tributaries samples will be collected immediately north and west of State Highway P, north of the Plant. The Site Spring sample will be collected prior to discharge to the Site Pond. The Joachim Creek background sample will be collected at least one-mile upstream from the Site. Each location will be sampled once and analyzed for radiological parameters and metals.

The analytes of concern are provided in Table 3. Sample locations are noted on Plate 17 (upstream soil, ground water and surface water locations are not shown on the map).

#### **4.4.1.4 Sample Designation**

Each sample will be given a unique designation indicating Area of Concern, location number, sampled media.

#### **4.4.1.5 Sampling Equipment and Procedures**

Sections below outline the processes used in collecting samples at the Site. This includes drilling methods, field screening of soils for VOCs and radionuclides, geologic logging, monitoring well installation and soil, ground-water, surface-water and stream sediment sampling.

##### **4.4.1.5.1 Drilling and Sampling Methods**

Borings conducted as part of the FSP will be performed by five drilling methods:

- hand auger/spade;
- direct push;

- hollow-stem auger;
- wet rotary (rotary diamond); or
- direct air rotary.

Regulated borings shall be constructed and if abandoned, will be done in accordance with Missouri Well Construction Code. Near surface soil and stream sediment samples will be collected with a stainless steel hand auger and/or spade. Direct push drilling procedures will be utilized for the majority of borings advanced on the Site. It enables rapid vertical and horizontal delineation of contaminants in the unconsolidated zone (soils and ground water) with a substantial reduction in investigative derived wastes (IDW).

Hollow-stem auger drilling will be used in areas where wet-rotary drilling (coring) is required in the bedrock, or where installation of standard ( $\geq 2$ " O.D.) monitoring wells in the unconsolidated zone is required. Air rotary drilling will be performed in areas that require bedrock drilling.

A decontamination pad will be established at the Site. The specific location has not been determined but will likely be near the tile barn. The construction will be temporary in nature and likely consist of straw bale dikes and an impermeable membrane. Drilling equipment, including rods, augers, probes, tools, etc will be steam-cleaned at the onset of the investigation. The exterior of drilling rigs will also be steam-cleaned. Once drilling activities are initiated, decontamination activities will be limited to down-hole drilling equipment only which will be decontaminated between each boring.

Decontamination water would be collected and containerized with investigative derived wastes of similar type.

#### **4.4.1.5.2 Soil and Rock Logging**

Drilling operations will be conducted under the direct responsible charge of a Missouri Registered Geologist. Logging of soils in the unconsolidated zone will be done by electrical conductivity (EC) logging, and by visual, physical soil classification. As part of the field screening (see Section 4.4.2.5.3), a direct push drilling rig will advance a probe into the subsurface to collect in-situ VOC concentration data, probing speed and

soil EC data. Data from the EC probe will reveal variances in soil conductivity relative to grain size allowing the geologist to rapidly log the soil stratigraphy. Due to radiological field screening requirements, a continuous core will be collected and logged immediately adjacent to the EC probehole. This will also allow continuous correlation of the EC data to stratigraphy.

Where continuous soil sampling is performed, two or five foot soil cores will be collected to target depth. Samples will be logged by a field geologist according to the Unified Soil Classification System (USCS). Rock coring will provide continuous 10-foot core samples commonly retrieved with a wireline. Rock core will be logged and data recorded such as fracture frequency, rock quality designation (RQD), recovery, etc will be noted on the field logs.

In some drilling operations only cuttings will be produced. The field geologist will collect, bag, date and log cuttings generated during these drilling operations.

#### **4.4.1.5.3 Field Screening**

Field screening will be performed in conjunction with boring advancement and/or soil sampling procedures. Soils will be field screened for VOCs and radiological parameters.

#### **VOCs**

Soil from the unconsolidated zone will be screened by two methods:

- In-situ screening utilizing a Membrane Interface Probe (MIP); and
- Photoionization detector (PID) headspace analysis of continuous soil cores.

The MIP is a direct-reading probe, advanced through the subsurface by hydraulic-push drilling. It is capable of logging both chlorinated and non-chlorinated volatile contaminants in soil and ground water. The MIP has the capability to detect VOCs in soil to 100 µg/kg, but the instrument can be affected by soil conditions or interferences which could raise the sensitivity by several orders of magnitude. The MIP is used qualitatively to correlate field conditions to laboratory conditions. As the probe is pushed into the soil, VOCs in the subsurface come into contact with the heated surface of the

MIP polymer membrane. Upon contact, a certain quantity of the VOCs will partition into the polymer membrane. Once absorbed into the membrane, VOC molecules will move by diffusion across the membrane to regions where their concentration is lowest. Because the membrane is heated and its profile thin, this movement across the membrane is very rapid, taking place in less than a second for light hydrocarbons.

A clean carrier gas is circulated across the internal surface of the membrane. VOCs in the subsurface diffuse across the membrane and partition into the carrier gas where they can be swept to the detector at the surface. The mobile lab at the surface can be configured with different detectors (e.g., PID, FID) for contaminant response. A real-time log is displayed as the probe is advanced showing contaminant data. This real-time log also displays a depth/speed graph and an electrical log of the formation.

The MIP log provides semi-quantitative/qualitative information on contaminant levels and allows for the collection of targeted samples from contaminated zones to define specific analyte and precise concentrations, information on contaminant distribution and migration pathways. A continuous soil core collected adjacent to the MIP location for the purpose of radiological screening will also be screened with a PID. This will allow for the calibration of MIP data to conventional PID headspace analysis (see below) and calibration of subsurface soil stratigraphy gathered from electrical conductivity logging to visual, physical logging of continuous soil core.

Conventional soil screening will be performed on those borings where soil cores are collected continuously to depth. Soil samples collected in this manner will be screened for VOCs with a photoionization detector using headspace analysis. This is accomplished by filling a glass soil jar approximately half full, placing an aluminum foil cap over the mouth of the jar, then carefully threading the screw cap on the jar. Samples are left at ambient temperature (and may be placed inside a heated area if ambient temperatures are low) for at least ten minutes. The container is then shaken vigorously for perhaps ten seconds, the solid cap is unscrewed, and the tip of the PID probe is inserted through the foil liner into the jar headspace. The highest sustained PID response is then recorded.

## **Radionuclides**

GM detector scans will be performed to screen soil core samples at the time of collection. Using a beta/gamma sensitive GM, soil cores will be scanned and the area of highest response selected for sampling. Following the scan of the sample, the area of highest response should be counted for one minute and the results recorded.

### **4.4.1.5.4 Monitoring Well Installation, Surveying and Development**

Temporary monitoring wells will be installed in borings advanced with the MIP, or the adjacent boring utilized to extract the continuous core. Three and one-quarter inch O.D. probe rods are advanced through the open borehole to just above bedrock. A two and one half-inch O.D. pre-packed well screen assembly will then be lowered into the probe rod string. The riser material consists of one-inch O.D. Schedule 40 PVC. The length of pre-packed screen is dependent on the thickness of the unconsolidated aquifer, which is estimated to be an average of 25 feet. The screen will be installed to intercept the entire saturated thickness of the unconsolidated aquifer.

Once the well assembly is lowered to the bottom of the probe rod string, the probe rods are retracted to a point above the screen. A sand barrier, installed directly above the well screen, prevents grout from entering the screens. This barrier will be created by natural formation collapse (occurring during the initial probe rod retraction) or by gravity installation of fine-grade sand through the rod annulus. With the barrier in place to a minimum of two feet above the top of the screen a bentonite slurry would be installed in the annulus to form a well seal, up to the ground surface.

Temporary monitoring wells must be abandoned no later than 30 days after installation. A variance can be requested through MDNR-GSRAD for conversion of the temporary wells to permanent wells, assuming they are completed to code (i.e., surface casing or flush mount completions).

Conventional monitoring wells in the unconsolidated zone, such as those for determination of background concentrations and for aquifer testing, will be installed through four and one quarter-inch O.D. hollow-stem augers (HSA). These wells will be constructed of two-inch O.D. Schedule 40 PVC, with 0.010-inch slotted screen and blank riser. Silica sand will be emplaced around the well screen material to extend two-foot

above the top of the screen. A two-foot thick layer of fine sand will overlay the primary filter pack to act as a buffer to restrict bentonite slurry from penetrating the primary filter pack. A three-foot thick layer of concrete will overlay the bentonite annular seal, and then a flush grade or above grade protective casing would be installed. A typical monitoring well construction diagram is show in Figure 3.

For bedrock monitoring wells, an air rotary drilling rig will advance an eight-inch boring five-feet into competent rock. Six-inch nominal PVC surface casing will be grouted in place and allowed to cure. After curing, an air rotary drilling rig will advance a six-inch boring to the desired depth. Monitoring well installation will proceed according to the procedures outlined above. Depending on depth of the well, Schedule 80 PVC may be required, as well as installation of a centralizer.

After installation activities are completed, the conventional unconsolidated and bedrock monitoring wells will be developed. The method chosen to develop the wells will surge the water to remove fine sand, silt and clay from the area surrounding the well screen and sand pack. The procedure will remove any geologic materials that may have entered the saturated strata during installation and restore the screened strata to its natural hydraulic conductivity. Development will continue until pH, temperature, and conductivity stabilizes on three consecutive readings taken each time a single well volume is removed. Pre-packed temporary monitoring wells will not need to be developed after installation, due to the nature of the pre-pack construction. Those wells will be purged of three volumes however, prior to sampling. All of the wells will be installed, constructed and developed according to Missouri Well Construction Code. All development water will be containerized and stored at the Site pending analytical results for final disposition.

Each ground-water monitoring well will be located by physical survey by a Missouri licensed land surveyor. The horizontal coordinates, the top of casing elevation (within 0.01-foot) and the ground surface elevation will be established by the surveyor and incorporated into the base map. Horizontal coordinates will be referenced to Missouri State Plane Coordinates and vertical measurements will be referenced to NGVD 1983. The point at which the top of casing elevation is measured will be marked so that readings may be made consistently at that mark.

#### **4.4.1.5.5 Sampling**

Samples will be collected from the following media:

- soil;
- surface water;
- stream sediment;
- ground water; and
- Limestone fill material.

##### **4.4.1.5.5.1 Soil/Fill Material Sampling**

Surface soil samples (zero to 12 inches) will be collected by utilizing a direct push, hand auger, or hand trowel. In AOC's where VOC samples are to be collected at depth, the direct push drilling rig will advance a boring adjacent to the MIP location, and a soil sample will be collected from the depth which registered the highest VOC reading during MIP advancement. If no appreciable MIP or PID readings are observed, the sample will be collected from the zone designated by the field geologist (typically the capillary fringe zone or bedrock/overburden interface). Samples collected at depth for radiological analysis will be chosen dependent on gamma screening of soil cores. Soil from the highest screening value will be selected.

Samples will be placed into clean laboratory approved containers and delivered to the analytical laboratory using chain-of-custody and sample handling and preservation methods outlined in SOPS provided in the QAPP.

##### **4.4.1.5.5.2 Ground-water Elevation Gauging and Sampling**

After the wells have been installed and developed, prior to purging for sampling, static ground-water elevations will be gauged using an electronic water level meter. Results will be recorded to the nearest 0.01 ft. Once the gauging event is complete, sampling will be conducted. The samples will be placed into clean laboratory approved containers and delivered to the analytical laboratory using chain-of-custody and sample handling and preservation methods outlined in SOPS provided in the QAPP. Ground-

water samples will be collected in accordance with procedure 3-2 provided in the QAPP. It is likely that initial ground-water samples will be collected by bailers.

#### **4.4.1.5.5.3 Surface Water Sampling**

Prior to sampling, field parameters such as pH, temperature and conductivity will be collected at each surface water sampling location. Samples will be collected with a pond dipper from intermittent tributaries and from Joachim Creek. Care should be exercised while collecting the surface water samples to reduce or eliminate entrainment of sediment. Downstream samples shall be taken first and the sampler shall work in an upstream direction. At locations where water and sediment samples are co-located, ensure that the water sample is collected before the sediment sample, and upstream from any imprint the sampler may make in the streambed. Samples will be placed into clean laboratory approved containers and delivered to the analytical laboratory using chain-of-custody and sample handling and preservation methods outlined in SOPS provided in the QAPP.

#### **4.4.1.5.5.4 Stream and Pond Sediment Sampling**

Stream and pond sediment samples will be collected from the top one-foot of the sediment profile using a stainless steel hand auger or hand trowel. The core or sample is extracted from the sampling device and placed in appropriate laboratory containers. To avoid possible volatilization, the sample should not be homogenized prior to filling the laboratory containers. Samples should have at least 30 percent solids content, and excess water should be decanted. Samples should be delivered to the analytical laboratory using chain-of-custody and sample handling and preservation methods outlined in SOPS provided in the QAPP.

#### **4.4.1.5.6 Investigative Derived Wastes**

Westinghouse will manage investigation derived waste (IDW) according to the IDW management plan provided as an attachment to the QAPP.

#### **4.4.1.5.7 Aquifer Testing**

An aquifer testing location is proposed in the northeast section of the Site, which is away from the Plant and probably not contaminated (see Plate 26). A ground-water sample will be collected from each hydrostratigraphic unit and analyzed for water quality prior to aquifer testing, to understand if ground water is contaminated. If ground water is not contaminated, the discharge of pumped water to the surface would be allowed. If ground water is contaminated at this location or if the hydrostratigraphy is not representative of that found at the Plant, an alternate location would be identified and investigated for appropriateness as a test site. It is extremely important that the unconsolidated hydrostratigraphic units at the aquifer testing area are similar in thickness and lithology to those properties known at the Plant. If the data acquired is not representative of conditions at the plant, modeling efforts or remedial efforts may not be applicable.

The purpose of aquifer testing is to establish essential hydrodynamic properties of the various hydrostratigraphic units for later use; to model ground-water flow, model fate and transport of contaminants, and determine technical practicability of ground-water remediation methods. The aquifer tests will require installation of pumping and observation wells in a pattern shown on Plate 26. Pumping tests will be performed to measure hydrodynamic properties such as hydraulic conductivity, transmissivity, specific capacity and yield.

#### **Step Draw Down Test**

Once each pumping well is installed and developed, an eight-hour step test will be performed on each pumping well. Drawdown in the well is directly proportional to the pumping rate if flow to the well is laminar, however turbulent flow occurs in most wells when pumped at a sufficiently high rate. Under turbulent conditions the linear relationship between pumping and drawdown is no longer valid and the specific capacity of the well declines dramatically. To understand the effects of turbulent flow on drawdown, this task will be conducted. The step test consists of four, 120-minute “steps”, where the well is pumped at approximately 60, 75, 90 and 100% of its capacity, and the water-level drawdown is recorded. This test is necessary to determine the degree of development of the well, the hydraulic efficiency of the well, the optimum pumping

rate and the pump placement within the well. This information will be used to select the optimum pumping rate for the constant-rate aquifer test.

### **Constant Rate Aquifer Test**

The constant-rate pumping test offers the most powerful method to analyze the hydrologic characteristics of an aquifer. In performing the constant rate pumping test these tasks will be conducted:

#### Pretest Measurements of Surface Water Features, Observation Wells, Pumping Well

Pressure transducers will be installed to measure water levels in the nearby surface water features, observation wells and pumping wells. These transducers will be connected to computerized data recorders that will monitor the elevation of ground water and surface water for a period of two weeks prior to the start of the constant-rate test. These data allow the analytical hydrogeologist to understand natural fluctuation in surface water and ground-water elevations, an important variable to understand during test data analysis.

#### Temperature Monitoring - Pretest, Test, Recovery Periods

Temperature monitoring of relevant ground water and surface water points will be conducted throughout the two-week pretest, the pumping test and recovery periods. Changes in ground water temperature can be indicative of surface water influence. Temperature measurements recorded during the pretest period will provide a baseline indicator of the average temperature range for the surface and ground water. Any subsequent changes in ground water temperature observed during the pumping and recovery portions of the test may then be combined with the water level data during the analysis to indicate the rate of response, rate and amount of infiltration, and amount of control the surface water bodies impose on the aquifer. A thorough understanding of the natural and induced temperature fluctuations in the surface water and ground water will provide a better understanding of aquifer characteristics and aquifer performance under pumping conditions.

### Constant Rate Pumping Test [72 Hours (minimum)]

A constant rate pumping test will be conducted on each aquifer. Duration of the test will be at least 72 hours of continuous pumping, but may be longer depending upon the judgment of the hydrogeologist on Site during the test. A test of this duration is required to accurately show the effects of the pumping and the influence of the recharge and no-flow boundaries if any surrounding the aquifer. Water level data will be collected from the pumping wells, observation wells, and surface water bodies to permit calculation of the aquifer characteristics. Calculation of aquifer characteristics from pumping test data is far more accurate than other methods.

A constant-rate pumping test demonstrates the performance of the aquifer and allows the aquifer characteristics to be calculated and understood. Analysis of test data can be used to determine potential radii of influence of wells pumping at varying rates, interference between multiple wells, spacing between wells to minimize interference, maximize utilization of land area, and appropriate pumping rates. These calculations will allow the prediction of aquifer drawdown resulting from long-term pumping at various discharge rates and may show otherwise undetected impermeable boundaries that may limit the extent of the aquifer.

### Recovery Period Monitoring

Water level measurements shall be obtained using pressure transducers and data loggers from the points monitored during the pretest and constant rate test periods for a minimum of 24 hours and/or until the pumping well is 95% recovered. Data shall be recorded for later analysis.

## Data Analysis

These analytical exercises will be conducted using data derived from the pretest, test, and recovery events.

Time versus distance and time versus drawdown analysis of drawdown and recovery data;

- Temperature Data Analysis; and
- Aquifer Effect on pumping.

## Establish Horizontal on Vertical Control

The horizontal and vertical coordinates of the observation wells, surface water monitoring points, and pumping wells installed for this test as well as any other pertinent features will be established by land survey. Vertical accuracy shall be to the nearest 0.01 foot.

## **Sand/Gravel Unit**

A drilling contractor will advance 8.75-inch I.D. hollow-stem augers to the top of the competent rock. A field geologist will continuously sample and log soils in order to get an accurate portrayal of the soil stratigraphy. A 6-inch nominal PVC well will be installed through the augers, and will serve as the pumping test well. The screened zone will be only within the sand and gravel layer located at the base of the DSCC unit. The sand/gravel layer is expected to be approximately 5-feet thick. Observation wells will be located in a “Y” pattern, along trend lines situated on 120° angles from the pumping well. Two observation wells each will be installed along the northwest and northeast trend lines, at distances of 30’ and 100’, respectively, from the pumping well. The two observation wells south of the pumping well will be located at distances of 30’ and 75’ from the pumping well, respectively. The six observation wells will be screened only within the sand/gravel layer of the DSCC. Two additional observation wells will be installed at distances of 15’ and 65’, respectively, along the northeast arm of the “Y”, and

screened above the sand/gravel layers of the DSCC. These observation wells will gauge the interaction between the sand/gravel layer, and the upper DSCC/NSSSC units during pumping state. A map showing the location of the proposed pumping test area, pumping and observation wells and detailed cross sections are provided as Plate 26.

Pumping well (6-inch nominal) and observation wells (2-inch nominal) will be constructed of Schedule 40 PVC screen and blank riser, and will be installed according to the Missouri Well Construction rules. Wells will be developed prior to initiation of pumping tests. Since the pumping test area is located outside of the impacted area, well development water and pumping water will not be contained.

### **Jefferson City-Cotter Dolomite**

Pumping test wells and observation wells will be installed in the Jefferson City-Cotter Dolomite to assess the hydrodynamic properties of the upper-most bedrock aquifer. The pumping and observation wells will be located in close proximity to those installed for the sand/gravel pumping test (see 26).

The pumping test well will be located approximately 10-feet east of the sand/gravel pumping test well. Observation wells will also be placed in a “Y” pattern, similar to the sand/gravel observation wells. Two observation wells each, per trend line, will be located 25’ and 50’ respectively, from the pumping test well.

The test and observation wells will be drilled using a conventional auger rig and by air rotary drilling. Twelve-inch outside diameter hollow stem augers will advance five-feet into competent bedrock. Surface casing will be grouted in place, and once cured, air rotary drilling will advance the boring to the desired depth (approximately 25’ below top of bedrock). A field geologist will continuously collect and log soil core and rock cuttings. Six-inch outside diameter Schedule 40 PVC screen and blank riser will be installed in the pumping test borehole. The screened interval will be 10-feet in length for the pumping testing well. The placement of the screen for the observation wells will be such that the centerline of the 5-foot screened section of each observation well intersects the centerline of the 10-foot section of the pumping test well.

### **Roubidoux Formation**

A well will be installed in the Roubidoux Formation to serve as both as a pumping well and an observation well when other hydrostratigraphic units are being

pumped, to observe the vertical interaction between the Jefferson City-Cotter Dolomite aquifer and the underlying Roubidoux Formation aquifer. Prior to installation of this well, and after surface casing has been set, core drilling will be performed using wet rotary methods. A diamond core drill bit will advance the borehole in 10-foot sections (run) to approximately 15-feet below the top of the Roubidoux Formation. The top of the Roubidoux is expected to be approximately 195-feet below ground surface. The core barrel will be a standard 3-inch (NX) sampler, retrieved via wireline method. The core will be logged by the field geologist noting features such as but not limited to lithology, porosity fracture frequency and rock quality designation (RQD).

After completion of coring activities, the corehole will be reamed using air rotary methods. Schedule 80 PVC screen (5 foot length) and blank riser will be installed in the borehole. A detail map and schematic cross-section showing the location of the proposed bedrock pumping/observation wells are provided as Plate 26.

### **Video Logging**

A downhole video camera will be used to view boreholes advanced in the Jefferson City-Cotter Formation, and the deep corehole penetrating the Roubidoux Formation. The identification of potential secondary porosity features is important to understand some flow characteristics in the bedrock aquifers. Video logging of the borehole/corehole can substantiate information gathered during the drilling phase; information such as fractured zones or areas where water loss occurred.

### **In-Situ Hydraulic Conductivity Test**

In-situ hydraulic conductivity aquifer tests (slug test) will be performed on all pumping test wells and observation wells. The tests will be conducted by displacing a known volume of water within the well and measuring the subsequent rise or fall in water level over time. A 1.25-inch diameter, 5-feet long, or other appropriate size PVC slug will be introduced into, and extracted from, the well to provide both falling and rising head measurements. A pressure transducer and a chronological instrument will be used to record the changes in water level through time.

The slug test data will be analyzed by importing it into a ground-water modeling software program to compute an analytical solution for hydraulic conductivity. The results of the analysis, including averages calculated for the falling head test, the rising

head test as well as the average of the well's combination of tests will be presented in the report and used for several applications.

#### **4.5 Remedial Investigation/Feasibility Study Tasks**

The EPA provides a framework consisting of 11 tasks to be performed during the RI/FS process and one post RI/FS task, for a total of 12 tasks. This framework will be used in carrying out a comprehensive program that addresses Site investigation, risk assessment, and evaluation of technologies and alternatives for the RI/FS process being undertaken.

The RI/FS tasks and the phase approach suggested by the EPA are presented in Figure 4. Site-specific activities carried out to fulfill each of the 12 tasks are discussed in Section 4.5.1 through 4.5.12. These twelve tasks may be phased, as deemed appropriate and/or necessary, to implement the RI/FS Work Plan in several operational units.

##### **4.5.1 Task 1: Project Planning**

The contents of this RI/FS Work Plan and the associated supported documents (i.e., Field Sampling Plan, Health and Safety Plan, Quality Assurance Project Plan, and Community Relations Plan) describe planning activities for the project. Activities under this task include the following:

- collecting and evaluating available historical and characterization data or information;
- developing a Site conceptual exposure model on the basis of available information;
- identifying data needs and developing DQOs;
- identifying preliminary remedial action objectives and potential remedial alternatives;
- identifying potential treatability studies, as appropriate; and
- identifying preliminary ARARs.

#### **4.5.2 Task 2: Community Relations**

The CRP shall include a description of the Plant area, community relation strategies, community profile, and community environmental concerns. Information related to Site remedial activities will be provided to the public through news releases, fact sheets, public meetings, and briefings. Westinghouse will continue to use these mechanisms to inform the public regarding RI/FS activities. In addition, the public shall have access to documentation related to the RI/FS process at repository location in the community. The CRP is provided as Appendix D.

#### **4.5.3 Task 3: Field Investigation**

Task 3 involves activities to be under taken during the RI phase. Upon required concurrence of the sampling and analysis plan by appropriate regulatory agencies, subcontractors will be procured. This task is complete when the subcontractors are demobilized from the field. The following activities will be conducted as part of this task:

- mobilization of field activities,
- gamma site walkover
- media or contaminant sampling,
- hydrogeological investigations,
- wetlands investigation,
- threatened and endangered species,
- cultural features, and
- other field measurements.

Field investigation methods are documented in the field sampling plan (Section 4.4.2) and are undertaken in accordance with the established DQOs. To the extent practicable, data needs for RI/FS have been categorized into those that will provide contaminant profile of the various environmental AOCs and provide further characterization of the hydrogeological features, and Wetlands, Threatened and Endangered Species, and Cultural Features, if applicable.

#### **4.5.4 Task 4: Sample Analysis and Verification**

For Task 4, samples collected during the field investigation will be analyzed in accordance with the DQOs primarily to ensure that documentation and data reported are technically correct. The sample verification process includes a review of sample identification and preservation, chain-of-custody documentation, analytical holding times, and completeness of data reported.

Validation of the data collected is also performed to ensure that the quality of data is adequate for its intended use.

#### **4.5.5 Task 5: Data Evaluation**

Task 5 involves analysis of the data after verification activities have been performed. The task begins when the first set of validated data is received and ends during preparation of the RI reports or any supplemental investigations when the determination is made that no additional data are required. The following activities are typically performed under Task 5:

- comparing potential site-related contaminant concentrations with values representatives of background levels, and
- developing a data set for use in the baseline risk assessments.

#### **4.5.6 Task 6: Risk Assessment**

The objective of the Baseline Risk Assessment is to examine the extent of risk to human health and the environment by the presence of the constituents detected in various media at the Facility during the RI. To complete the assessment, “Missouri Department of Natural Resources Cleanup Levels for Missouri (CALM), September 2001”, guidance document will be utilized with “Risk Assessment Guidance for Superfund (RAGS) Human Health Evaluation, December 1989 with updates”. These two documents will be utilized as the benchmark in the decision-making process for assessing constituents of concern (COCs) identified in soil and groundwater and how they may impact human health based on various fate and transport mechanisms, current and future land use

management strategies, and conservative yet reasonable maximum exposure (RME) scenarios. In addition, various EPA guidance related to risk assessment will be instrumental in completing the Facility-specific evaluation, including but not limited to: “Exposure Factor Handbook, 1997a”, “Integrated Risk Information System, <http://www.epa.gov/iris/>”, and “RAGS Part E-Supplemental Guidance for Dermal Risk Assessment, 2001”.

The activities that will be performed and presented in the baseline risk assessment reports include those related to (1) identification of the contaminants of concern from the standpoint of both human health and ecological concerns; (2) exposure assessment, including ground water fate and transport and RESRAD modeling; (3) toxicity assessment, including non-carcinogenic and carcinogenic components; and (4) risk characterization.

The CALM guidance document was developed for assessing COCs in soil, considering standard EPA exposure scenarios including ingestion, inhalation of particulates and volatiles, dermal contact, and leaching to groundwater. All exposure pathways will be considered with respect to current and future land-use scenarios, and independent of engineering or institutional controls. CALM guidance will facilitate the development of corrective action objectives (CAOs) related to soil and assist with the feasibility of implementation of potentially identified remedial strategies. It should be noted that CALM does not provide guidance on the evaluation of radiological COCs. Radiological risks will be assessed based on EPA RAGS guidance. The EPA has developed cancer factors per unit of intake for radioactive contaminants that are analogous to factors for chemical carcinogens. These factors will be used to estimate risks from exposure to radioactive contaminants. Chemical and radiological risks will be analyzed separately to provide an understanding of the source of risk (i.e., radiological or chemical).

At present, CALM guidance does not support a risk-based process or mechanism for evaluating impacted groundwater. In order to evaluate risk, and ultimately establish CAOs, EPA RAGS will be utilized to develop a Facility-specific evaluation. Similar to soils, all potential exposure pathways will be evaluated, including ingestion, inhalation (indoor/ambient), and dermal contact (swim/wade/bathe/shower). In addition,

groundwater fate and transport mechanisms will be thoroughly assessed to determine potential risk to surface water bodies, including the risk to aquatic and wildlife receptors. To assist in the evaluation of risk to aquatic wildlife receptors, the “Missouri Water Quality Standards, August 2000,” will be used to assess specific surface water bodies and identification of their respective beneficial use designation as classified waters of the state. The MDNR’s newly proposed “Comprehensive Risk Based Groundwater Remediation Rule, February 2002,” provides a process by which risk-based corrective action could be applied toward groundwater remediation sites to protect groundwater resources, while providing flexibility with restoring groundwater to risk-based levels, rather than automatically applying potable drinking water standards. The goal of this process is to recognize that while groundwater resources are an important asset and should be preserved and restored, a balance should be ascertained with respect to exposure practicability and actual resource use. The principles and theories driving this proposed rule shall be applied toward the Facility, during the EPA RAGS evaluation.

A qualitative evaluation of potentially complete exposure pathways for the Facility on site and off site, considering data gathered from examination of historical information sources and from invasive on-site preliminary investigations is included as Table 6. The information presented in this table is subject to change as the RI progresses, and will eventually include all exposure pathways deemed complete for quantitative evaluation.

The overall goal of the Facility-specific evaluation is to improve selection and design of appropriate corrective actions, if deemed necessary. The use of CALM and EPA RAGS promotes high quality, efficient remedial approaches, and insures that the corrective actions are protective of human health, safety and the environment by achieving acceptable levels of exposure and risk reduction. Any identified risk to receptor populations will be addressed through some manner of corrective action measures, including, but not limited to: remedial action, compliance monitoring, field-testing and evaluation, or engineering/institutional controls that will either reduce toxicity, mobility, or volume of the contaminant, and/or prevent media exposure.

#### **4.5.6.1 Ground-water Flow and Transport Model**

A ground-water flow and transport model for the Site will be developed that would create a quantitative understanding of the flow of ground water and the transport of radioactive elements and organic constituents at the Site. Ground-water models are valuable tools in developing an appropriate conceptual understanding of subsurface fluid dynamics, ground water-surface water interaction, and contaminant fate and transport. Models also offer a quantitative means of validating conceptual hydrogeologic models and testing hypotheses concerning remedial alternatives and associated risks.

The process below will be followed to construct and calibrate a steady-state ground-water model to address current and future issues at the Site. Specific objectives of the modeling effort include:

- 1) Provide a quantitative framework to evaluate radionuclide transport that will be incorporated into the RESRAD exposure model using the resident farmer scenario to demonstrate NRC regulatory compliance,
- 2) Guide future Site monitoring requirements and help develop "lines of evidence" to support monitored natural attenuation (MNA) and/or gradient control as a viable component of an overall remedial program,
- 3) Guide future hydrogeologic and contaminant characterization efforts that the NRC and MDNR may request, and
- 4) Serve as a flexible and expandable tool to satisfy investigative and regulatory objectives pertaining to remedial alternatives and risk assessment.

Developing an appropriate Site conceptual hydrogeologic model as well as a quantitative flow and transport model will aid in meeting each of these objectives. These seven tasks are necessary to meet the objectives described above.

#### **Task A – Develop a Site Conceptual Hydrogeologic Model and Perform Pre-Modeling Calculations**

Prior to developing a quantitative numerical model to assess the ground-water flow system, a conceptual hydrogeologic model will be developed. A conceptual model is a concise description of the components of the ground-water flow system, and is developed from regional, local, and Site-specific data. A conceptual model is a precursor

to the development of a mathematical model, and identifies ground-water sources and sinks, geologic configuration of the aquifers, aquifer properties, and general flow system behavior. The conceptual model guides the construction and calibration of the numerical model, and aids in interpretation of model results by presenting a general understanding of the ground-water flow system. The conceptual model for the Site will be based on the previous and results of proposed hydrogeologic characterization work at the Site, regional geologic setting, and the pertinent boundaries of the flow system.

Several calculations would be made prior to implementation of the solute fate and transport model. These calculations include sorption and retardation, NAPL/water partitioning, simple ground-water flow velocity, biodegradation rate-constant, analysis of contaminant, daughter products, electron acceptors, metabolic by-product, and total alkalinity data.

#### **Task B –Construct a Ground-water Flow Model**

Previous hydrogeologic investigations and new information gained will be used as a basis for developing a simple numerical model for the Site. Soil collected during other previous work was sampled for physical (i.e., permeability, coefficient distribution, etc.) and/or chemical laboratory measurements. Generally, the geologic information collected to date shows six unique stratigraphic units are located beneath the Plant:

- a near surface silt, silty-clay (NSSSC);
- a fat clay;
- a deeper, silty clay/clay (DSCC);
- a clayey, silty, sandy-gravel;
- Jefferson City-Cotter Dolomite; and
- Roubidoux Formation.

The Jefferson City-Cotter Dolomite is part of the Powell-Gasconade Aquifer Group, which is a major stratigraphic unit and ground-water resource that extends throughout much of the state of Missouri.

The model developed in this phase of the evaluation will be steady-state and will not take into account slight changes in water level over time. Boundary conditions for

the model will be based on the measured water levels and flow directions at the Site. The model will incorporate previous estimates of permeability developed during the Site characterization work. Every effort will be made to ensure that the model hydrostratigraphy corresponds well with the regional setting. To do this, available published work will be used to link data from other sources into the conceptual model and the numerical model when appropriate.

The model is to be developed using the United States Geological Survey (USGS) MODFLOW code. The MODFLOW code is a standard quantitative flow model tool for this type of evaluation and has become a well-accepted tool in the regulatory community.

### **Task C – Calibrate the Ground-water Flow Model**

Calibration of a ground-water flow model is the process of adjusting model parameters until the model reproduces field-measured values of head, discharge, and/or contaminant concentration. Calibration will entail using historical information to set parameters in the model, so the model appropriately simulates present conditions in the groundwater system to the degree possible. Successful calibration of a flow model to observed conditions increases confidence that the model may be used appropriately for prediction of future aquifer conditions.

Model calibration is judged by quantitatively analyzing the difference (called a residual) between observed and model-computed values. Several statistical and graphical methods are used to assess the model calibration. The flow model statistics will be calibrated according to methods described in ASTM (American Society for Testing Materials) “D5490-93A, Standard Guide for Comparing Ground-Water Flow Model Simulations to Site-Specific Information, 2002.” The historical data from the year of quarterly monitoring obtained during 1998 and 1999 as appropriate, and future data will be used to calibrate the flow model.

### **Task D – Particle Tracking Simulations to Evaluate Pathways from Potential Sources**

After the model is appropriately calibrated, ground-water particle tracking will be performed to assess advective ground-water movement in the system. These simulations will help determine where potential source of contamination may be located based on current flow conditions at the Site. In addition, the particle tracking scenarios will aid in

the conceptual model auditing process. Each step in the modeling process gives insight into the appropriateness of the conceptual model and whether that conceptual model has been correctly incorporated into the numerical model.

#### **Task E – Simulate Uranium Fate and Transport to Support RESRAD Dose Calculations**

The conceptual model and flow model will be used to develop insights into the processes affecting fate and transport of uranium in the ground-water system. Particular attention will be given to the development of scenarios of exposure for the resident farmer. These scenarios may range from the worst case (drinking water well located in a Burial Pit) to more plausible scenarios such as downgradient well placement. For selected scenarios, radionuclide concentrations in groundwater will be provided for input in RESRAD for final dose calculations.

#### **Task F – Develop a Contaminant Transport Model to Evaluate Organic Solvent Fate and Transport**

The EPA guidance manual, “Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, September 1998,” addresses fate and transport modeling as follows:

“Simulating natural attenuation allows prediction of the migration and attenuation of the contaminant plume through time. Natural attenuation modeling is a tool that allows Site-specific data to be used to predict the fate and transport of solutes under governing physical, chemical, and biological processes. Hence, the results of the modeling effort are not in themselves sufficient proof that natural attenuation is occurring at a given Site. The results of the modeling effort are only as good as the original data input into the model; therefore, an investment in thorough Site characterization will improve the validity of the modeling results. In some cases, straightforward analytical models of solute transport are adequate to simulate natural attenuation. Several well-documented and widely accepted solute fate and transport models are available for simulating the fate and transport of contaminants under the influence of advection, dispersion, sorption, and biodegradation.”

As stated clearly above, the ground-water fate and transport model does not replace Site characterization but rather, compliments and streamlines the characterization

process. The modeling process and the resulting flow and transport model will be used as a tool to better understand the flow system and better refine the conceptual model for the Site.

Ground-water velocities estimated with MODFLOW will be used in conjunction with the RT3D code to assess the fate and transport of the chlorinated solvents. RT3D is a modular computer code developed at Pacific Northwest National Laboratory for simulating reactive multi-species transport in 3-Dimensional ground-water aquifers. The model has a reaction module specifically designed to evaluate aerobic and anaerobic degradation pathways of PCE and TCE. Assuming first-order biodegradation kinetics, transport and transformation of PCE, TCE, DCE, VC, ETH, and CI can be simulated.

The RT3D model will be developed to run with the MODFLOW model developed and calibrated in Tasks 3 and 4. Because very little is known about potential source areas of organic solvents, the model will be helpful in testing and evaluating potential source zones locations and configuration. For example, the model will be helpful in discerning the potential source configurations necessary to result in the observed concentrations in the monitoring wells. In addition, the fate and transport model will be valuable for performing scoping level evaluations of downgradient transport.

#### **Task G – Document the Model Development and Modeling Results**

A summary report will be prepared that documents the conceptual model, pre-modeling calculations, as well as the modeling assumptions, development, steady-state calibration, and simulation results. The summary report will provide observations and recommendations pertaining to Site characterization objectives and methods, methods to establish “lines of evidence” for demonstration of natural attenuation, and any insights gleaned concerning remedial alternatives at the facility.

#### **4.5.7 Task 7: Treatability Studies**

Task 7 is performed to provide information needed for alternatives to be fully developed and evaluated during the RI/FS Work Plan process. Treatability studies shall provide data important to an adequate evaluation of certain technologies. Such data include information on performance, operating parameters, and cost in sufficient detail to

support the process of remedy selection and the related design. This task may involve efforts for bench-scale or pilot-scale testing. For ground water, a literature search will be performed prior to making decisions regarding potential treatability studies. The purpose of the literature search is to identify potential methods for extraction and treatment; however, because of the properties of the shallow ground water system (i.e., low transmissivity, low specific yield, and imprecisely known fracture/conduit geometry), finding a comprehensive effective remediation strategy is improbable.

#### **4.5.8 Task 8: Remedial Investigation Report (RI)**

Task 8 is to prepare the RI report. The activities conducted and the conclusions drawn during the remedial investigation (Tasks 3 through 7) will be documented in an RI report (supporting data and information shall be included in the appendixes of the report). Westinghouse will prepare and submit a draft RI report to MDNR/NRC for review. Once comments on the draft RI report are received, Westinghouse will prepare a final RI report incorporating comments.

The RI report will include:

- brief summaries of data relevant to the RI/FS but collected prior to the RI efforts of this RI/FS Work Plan;
- summaries of data generated to fulfill data requirements;
- brief summary discussing validation and verification of data;
- data interpretation (contaminant distribution and comparison of background concentrations to potential Site contaminant concentrations) will be presented and illustrated by using text, tables, figures, and maps; and
- summaries of the baseline risk assessment.

#### **4.5.9 Task 9: Remedial Alternatives Development and Screening**

Task 9 involves screening the initial development and evaluation of remedial action alternatives that will be fully evaluated under Task 10. The objective of the screening process undertaken within Task 9 is to narrow the number of alternatives that will undergo detailed evaluation. This process begins with identification of the remedial

action objectives, then proceeds through narrowing of the list of potential technologies on the basis of applicability and effectiveness, and ends with identification of a set of remedial action alternatives. Each remedial action alternative may involve application of a single technology or a combination of two or more technologies. Task 9 consists of the following activities:

- identifying response objectives and response actions;
- listing potential remedial technologies;
- screening remedial technologies and process options on the basis of Site-specific criteria;
- assembling potential remedial action alternatives from the screened technologies and process options;
- evaluating potential remedial action alternatives on the basis of screening criteria (i.e., effectiveness, implementability, and cost); and
- identifying candidate alternatives for remedial action to undergo detailed evaluation in Task 10.

#### **4.5.10 Task 10: Detailed Analysis of Alternatives**

The remedial alternatives that pass the screening process during Task 9 will be evaluated in detail with Task 10. The nine criteria for evaluating these alternatives are as follows:

1. overall protection of human health and the environment;
2. compliance with ARARs;
3. long-term effectiveness and permanence;
4. reduction of toxicity, mobility, and volume;
5. short-term effectiveness;
6. implementability;
7. cost;
8. acceptance by the MDNR and NRC; and
9. acceptance by the community.

A summary of each alternative, including the no-action alternative, is prepared on the basis of these criteria. The use of these nine criteria is consistent with the NCP.

#### **4.5.11 Task 11: Feasibility Study Report**

Task 11 involves the coordination and preparation of the FS reports. The task is complete when the FS report is released. The following are activities under this task:

- formatting data for report purposes;
- preparing graphics;
- writing the report;
- printing and distributing the report;
- responding to review comments; and
- or the report on the basis of agency and public comments.

#### **4.5.12 Task 12: Post-Remedial Investigation/Feasibility Study Support**

Task 12 includes efforts to prepare the proposed plans and responsiveness summaries, support development of the RODs, and conduct predesign activities. Task 12 activities include the following:

- preparing the proposed plans;
- attending public meetings;
- preparing the responsiveness summaries and draft RODs;
- finalizing documents in response to agency and public comments;
- preparing the predesign reports; and
- completing the conceptual designs.

The proposed plans would be summary documents that identify the preferred alternative for remedial action and the rationale for selection, describe the alternatives evaluated in the RI/FS Work Plan process, and solicit public review and comment on the screened alternatives presented in the FS. Preparation of the responsiveness summaries

and the RODs will be initiated following public review of the RI/FS documents and comment upon the proposed plan.

#### **4.6 Costs and Key Assumption**

Cost estimates are not required for State or potentially responsible parties (PRP) lead RI/FSs, however federal-lead RI/FSs, require a detailed summary of projected labor and expense cost broken down by various RI/FS tasks. Initial gross budgetary cost ranges are provided in Table 7. The budget estimate provided is a preliminary non-detailed, rough range of values, as determined by past similar project experience. It is not possible to estimate costs, even in a rough sense for some tasks at this stage.

#### **4.7 Schedule**

Figure 5 provides a draft schedule. The Schedule is driven by an a milestone for the submission of a decommissioning plan by April 2004. The proposed schedule has been prepared assuming there are no local, state or federal permit requirements for completion of the RI/FS tasks.

#### **4.8 Project Management**

There are two lead agencies expected to have significant oversight and decision roles: the Nuclear Regulatory Commission and the Missouri Department of Natural Resources. The NRC is concerned with the facility's NRC licensed material and those issues required to terminate the license and release the Site. MDNR is charged with environmental protection of human health and the environment. Westinghouse intends to work closely with both agencies as well as other interested persons such as PRPs if any, concerned citizens groups, and community leaders. Figure 6 diagrams the planned relationship among Westinghouse and the aforementioned entities, as well as the hierarchy of contractors whom would provide services and report to Westinghouse.

##### **4.8.1 Staffing**

Agency specific staff members and their role in this project have not yet been identified. Agencies and others should conduct correspondence directly with or through

Mr. Thomas Dent, who is the Project Director for Westinghouse. Mr. Dent's contact information is:

Westinghouse Electric Company  
3300 State Road P  
Festus, MO 63028, USA  
Phone: +1 (636) 937-4691, Ext. 368  
Fax: +1 (636) 937-7955

#### **4.8.2 Coordination**

Westinghouse will coordinate required efforts relating to the RI/FS Work Plan with the consulting firm of Leggette, Brashears & Graham, Inc. LBG's role in creating this RI/FS Work Plan relates to soil, ground-water and non-radiological environmental engineering issues while others subcontracted to LBG, provided the required support relating to NRC decommissioning and radiological concerns.

The QAPP, SSHP and the CRP are documents initially drafted by subcontractors to Westinghouse all of which have been edited, produced internally and controlled by Westinghouse.

## **5.0 References Cited**

- American Society of Testing Materials, 2002, D5490-93 (2002), Standard Guide for Comparing Ground-Water Flow Model Simulations to Site Specific Information.
- Gateway Environmental Associates, Inc., April 1997, Exploratory Probe-Hole Investigation for the Evaporation Ponds at the ABB Combustion Engineering Hematite Facility.
- Gateway Environmental Associates, Inc., September 1996, Investigation to Determine the Source of Technetium-ii in Groundwater Monitoring Wells 17 and 17B, Combustion Engineering, Hematite, Missouri.
- Global Environmental, Inc., December 1992, Building Inspection Summary:
- Leggette, Brashears & Graham, Inc., 1998, Hydrogeologic Investigation and Ground-Water, Soil and Stream Characterization.
- Martin, J.A., Knight, R.D., and Hayes, W.C., 1961 (Martin et al., 1961a), Ordovician System, in Howe, W.B., coordinator, and Koenig, J.W., editor, The Stratigraphic Succession in Missouri: Missouri Geological Survey and Water Resources, 2<sup>nd</sup> Series, V. 40, P. 20-32.
- Mearns, S.L., Ph. D., April 1990, Preliminary Assessment, Hematite Radioactive Site, Hematite, Jefferson County, Missouri: Ecology and Environment, Inc., Field Investigation Team Zone II, Contract No. 68-01-7347, EPA Hazardous Site Evaluation Division, E & E/Fit for Region VIII EPA.
- Miller, D.E., et al., 1974, Water Resources of the St. Louis Area: Missouri Geological Survey and Water Resources, WR30.
- Missouri Department of Natural Resources, Division of Environmental Quality, updated September 2001, Missouri Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM).
- Missouri Department of Natural Resources, Division of Geology and Land Survey, 1986, Missouri Water Atlas.
- Missouri Geological Survey, 1979, Geologic Map of Missouri.
- Missouri Geological Survey and Water Resources, September 28, 1956, Log No. 14993.
- Radiation Management Corporation, July 1983, Radiological Survey of the Combustion Engineering Burial Site, Hematite, Missouri: NUREG/CR3387.

- State of Missouri, August 2000, Code of State Regulations: Rules of Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 7 – Water Quality.
- State of Missouri, February 2002, Missouri Register: Title 10 – Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 7 – Water Quality, Proposed Rule, Comprehensive Risk-Based Groundwater Remediation Rule.
- United States Environmental Protection Agency, 1997a, Exposure Factor Handbook.
- United States Environmental Protection Agency, 1998, Technical Protocol for Evaluation, Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128.
- United States Environmental Protection Agency, 2001, RAGS Part E – Supplemental Guidance for Dermal Risk Assessment.
- United States Environmental Protection Agency, date unknown, Integrated Risk Information System: <http://www.epa.gov/iris/>.
- United States Environmental Protection Agency, December 1989 with updates, Risk Assessment Guidance for superfund (RAGS) Human Health Evaluation.
- United States Environmental Protection Agency, October 1988, Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.301.
- United States Nuclear Regulatory Commission, NMSS Decommissioning Standard Review Plan, NUREG-1727.
- United States Nuclear Regulatory Commission, August 2000, Multi-Agency Radiation Survey and Site Investigation Manual (MARRSIM).
- Whitfield, J.W., and Middendorf, M.A., Data Unknown, Bedrock Geologic Map of the Festus 7.5-Minute Quadrangle: Missouri Department of Natural Resources, Division of Geology and Land Survey.

## **TABLES**

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 1 – RADIONUCLIDES OF POTENTIAL CONCERN BY AREA OF CONCERN**

<b>AOC</b>	<b>Radionuclides</b>	<b>Enrichment</b>	<b>Chemical Speciation</b>
1. Ground Water	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc	LEU, HEU	Unknown
2. Surface Water	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc, <sup>232</sup> Th	LEU	Unknown
3. Burial Pits	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>232</sup> Th, <sup>99</sup> Tc	HEU, LEU, DU, N	ThO <sub>2</sub> , UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub> , UF <sub>4</sub> , U <sub>metal</sub> , UC <sub>4</sub> ,
4. Former Evaporation Ponds	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc, <sup>232</sup> Th	HEU, LEU, NAT, DU	Uranyl nitrate, UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>
5. Former Leach Field	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>232</sup> Th, <sup>99</sup> Tc	HEU, LEU, DU	Unknown
6. Soil Beneath Buildings	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc, <sup>232</sup> Th	HEU, LEU, DU	Uranyl nitrate, UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>
7. Limestone Storage Areas	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc, <sup>232</sup> Th	LEU, DU, NAT	UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub> , fluorinated compounds of uranium
8. Outdoor Areas	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>99</sup> Tc, <sup>232</sup> Th	HEU, LEU, DU, NAT	UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>
9. Former Gas Station	None	NA	NA
10. Gas Pipeline	<sup>99</sup> Tc, <sup>232</sup> Th	NA	Unknown
11. Red Room Roof Burial Area	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>232</sup> Th	HEU, LEU, DU, NAT	UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub> ,
12. Domestic Well #3	None	NA	NA
13. Deul's Mountain	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>232</sup> Th	HEU, LEU, DU, NAT	UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>
14. Cistern Burn Pit Area	<sup>238</sup> U, <sup>235</sup> U, <sup>234</sup> U, <sup>232</sup> Th	HEU, LEU, DU, NAT	UO <sub>2</sub> , U <sub>3</sub> O <sub>8</sub>
15. Joachim Creek Bridge	None	NA	NA

HEU – High enriched uranium (20 to 93 percent <sup>235</sup>U)  
 LEU – Low enriched uranium (0.71 to 20 percent <sup>235</sup>U, typically ~4% <sup>235</sup>U)  
 DU - Depleted uranium (<0.2 % <sup>235</sup>U)  
 NAT – Natural uranium (0.71 % <sup>235</sup>U)  
<sup>232</sup>Th is understood to be in secular equilibrium with its daughters.

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 2 – CHEMICAL CONSTITUENTS OF POTENTIAL CONCERN BY AREA OF CONCERN**

AOC	Chemical Constituents of Potential Concern
1. Ground Water	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
2. Surface Water	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
3. Burial Pits	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
4. Former Evaporation Ponds	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
5. Former Leach Field	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
6. Soil Beneath Buildings	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
7. Limestone Storage Areas	Fluoride
8. Outdoor Areas	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
9. Former Gas Station	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), SVOCs, TPH, Metals
10. Gas Pipeline	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
11. Red Room Roof Burial Area	Fluoride
12. Domestic Well #3	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products)
13. Deul's Mountain	Fluoride
14. Cistern Burn Pit Area	VOCs, (Perchloroethylene, Trichloroethylene and associated degradation products), SVOCs, Metals, Dioxin, Fluoride
15. Joachim Creek Bridge	None

**Note:** Chemical constituents of potential concern identified above are those which are thought to have potentially impacted a particular AOC. The minimum analytical requirements listed by AOC on Table 3 may include additional chemicals not listed in Table 2, but will be performed for negative documentation purposes. Therefore, chemical constituents of potential concern and minimum analytical requirements in Tables 2 and 3, respectively, will not always correlate.

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 3 - PROPOSED DRILLING, SAMPLING AND ANALYTICAL REQUIREMENTS**

Proposed Sampling Area	Area of Concern No. (if applicable)	Number of Proposed Borings	Media of Concern	Number of Proposed Samples	Shown on Plate No.	Proposed Drilling Strategy	Sampler Type	VOC Screen Y/N	Rad Screen Y/N	Completed as Monitoring Well	General Stratigraphic Zone Monitored	Minimum Analytical Requirements	
Ground Water (Existing Monitoring Wells/Piezometers)	1	NA	Ground water	34	14, 17	NA	NA	NA	NA	NA	See Table 5	2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 10, 11, 13	
Surface Water Features	Northeast Site Creek	NA	Stream sediment	6	17	HA	NA	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Surface water	3								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11	
	Site Pond/Creek	2	8	Surface soil	8	17, 18	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Soil	8								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Stream sediment	7								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Surface water	4								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
				Ground water	8								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
				Ground water	8								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
	Joachim Creek	NA	Stream sediment	3	17	HA	NA	NA	NA	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Surface water	3								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11	
Burial Pit Area	3	20	Surface soil	20	19	HA	SC	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9	
Evaporation Ponds	4	20 <sup>1</sup>	Surface soil	20	20	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>8</sup> , 7 <sup>9</sup> , 9	
			Soil	9								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Ground water	9								2, 3, 5 <sup>3</sup> , 6 <sup>8</sup> , 9, 11	
Former Leach Field	5	5	Surface soil	5	20	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9	
			Soil	5								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Ground water	5								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11	
Soils Beneath Buildings	6	15	Fill	15	21	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9	
			Surface soil	15								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Soil	15								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Ground water	15								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11	

**Drilling Strategy Key**

HA - Hand Auger  
HSA - Hollow Stem Auger  
AR - Air Rotary  
DP - Direct-Push  
DC - Diamond Coring

**Sampler Type Key**

SS - Split-spoon  
CT - Cuttings  
SC - Soil Core  
RC - Rock Core  
TR - Trowel/Spade

**Monitoring Well/Zone Monitoring Key**

P - Permanent  
T - Temporary  
U - Unconsolidated  
JC - Jefferson City-Cotter Dolomite  
RB - Roubidoux Formation

**Analytical Parameters/Methods**

1 - Volatile Organic Compounds (VOCs) - EPA 8260  
2 - Gross Alpha - EPA 900  
3 - Gross Beta - EPA 900  
4 - Gamma Spectroscopy - EPA 901.1M  
5 - Isotopic Uranium by Alpha Spectroscopy - EPA/ASTM 3972-90M  
6 - <sup>99</sup>Tc Liquid Scintillation - 906.0M  
7 - Plutonium - EPA/ASTM 3972-90M  
8 - Total Petroleum Hydrocarbons (TPH) - EPA 8015 OA1/OA2  
9 - Fluoride - EPA 9214  
10 - Sulfate - EPA 300  
11 - Target Compound List/Target Analyte List  
Volatile Organic Compounds (8260)  
Sem-volatile Organic Compounds (8270)  
Organochlorine pesticides and PCBs (8081/8082)  
23 metals plus Cyanide (6010/7471/9010)  
12 - Dioxin - EPA 3290  
13 - Nitrate/Nitrite by EPA 300

**Notes:**

- <sup>1</sup> Includes surface soil sample locations  
<sup>2</sup> Includes ground-water samples from completed wells. Ground-water samples may be collected from the bedrock in discrete intervals.  
<sup>3</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for isotopic uranium by alpha spectroscopy.  
<sup>4</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.  
<sup>5</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for isotopic uranium by alpha spectroscopy.  
<sup>6</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.  
<sup>7</sup> Soil and/or sediment samples which exhibit <sup>241</sup>Am, or greater than 14 pCi/g <sup>238</sup>U, will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.  
<sup>8</sup> 50% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.  
<sup>9</sup> 50% of soil will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.  
<sup>10</sup> 100% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.  
<sup>11</sup> Target Analyte List Metals Only  
<sup>12</sup> Domestic Well #3 area was addressed during Interim Hydrogeologic Investigation. Additional wells in the vicinity are proposed under AOC #1.  
<sup>13</sup> A geophysical survey will be performed to locate potential ferrous material and debris. Geophysical anomalies, if found, will be further investigated.  
NA - Not applicable.

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 3 - PROPOSED DRILLING, SAMPLING AND ANALYTICAL REQUIREMENTS**

Proposed Sampling Area	Area of Concern No. (if applicable)	Number of Proposed Borings	Media of Concern	Number of Proposed Samples	Shown on Plate No.	Proposed Drilling Strategy	Sampler Type	VOC Screen Y/N	Rad Screen Y/N	Completed as Monitoring Well	General Stratigraphic Zone Monitored	Minimum Analytical Requirements
Limestone Storage	7	NA	Limestone Fill	60 (3 composite)	22	NA	TR	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9 (3 comp.), 11 (3 comp.)
Outdoor and Shallow Surface Areas	8	64	Surface soil	64	23	HA, DP	SC	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9
Former Gas Station	9	1	Soil	1	20	DP	SC	Y	N	T	U	8, 9, 11
			Ground water	1								8, 9, 11
Gas Pipeline	10	9	Surface soil	9	18	HA, DP	SC	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	9								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Red Room Roof Burial Area	11	5 <sup>1</sup>	Surface soil	5	23	HA, DP	SC	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	2								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Domestic Well #3 <sup>12</sup>	12	NA	Surface soil	NA	24	HSA, AR, DC	SC, RC, CT	Y	Y	P	JC, RB	NA
			Soil									
			Ground water									
Deul's Mountain	13	2	Surface soil	2	23	HA, DP	SC, TR	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Cistern Burn Pit	14	1	Surface soil	1	23	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11, 12
			Soil	1								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11, 12
			Ground water	1								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11, 12
Joachim Creek Bridge <sup>13</sup>	15	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA
Exploration for Nature and Extent of Contamination	NA	37	Surface soil	14	6, 7, 16	DP, HSA, AR, DC	SC, SS, RC, CT	Y	Y	T	U (14), RB (11), JC (12)	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	14								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Ground water <sup>2</sup>	37								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
Background	NA	11	Soil	30	16	HA, HSA, AR	SS, CT	N	N	P	U (2), JC(1)	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11 <sup>11</sup>
			Ground water	3								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11 <sup>11</sup>
			Surface water	4								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11 <sup>11</sup>
Aquifer Testing Area	NA	18	Ground water	3	26	HSA, DC, AR	SS, RC, CT	N	N	T	U (1), JC (1), RB(1)	6 <sup>10</sup> , 9, 11

**Drilling Strategy Key**

HA - Hand Auger  
HSA - Hollow Stem Auger  
AR - Air Rotary  
DP - Direct-Push  
DC - Diamond Coring

**Sampler Type Key**

SS - Split-spoon  
CT - Cuttings  
SC - Soil Core  
RC - Rock Core  
TR - Trowel/Spade

**Monitoring Well/Zone Monitoring Key**

P - Permanent  
T - Temporary  
U - Unconsolidated  
JC - Jefferson City-Cotter Dolomite  
RB - Roubidoux Formation

**Analytical Parameters/Methods**

- 1 - Volatile Organic Compounds (VOCs) - EPA 8260
- 2 - Gross Alpha - EPA 900
- 3 - Gross Beta - EPA 900
- 4 - Gamma Spectroscopy - EPA 901.1M
- 5 - Isotopic Uranium by Alpha Spectroscopy - EPA/ASTM 3972-90M
- 6 - <sup>99</sup>Tc Liquid Scintillation - 906.0M
- 7 - Plutonium - EPA/ASTM 3972-90M
- 8 - Total Petroleum Hydrocarbons (TPH) - EPA 8015 OA1/OA2
- 9 - Fluoride - EPA 9214
- 10 - Sulfate - EPA 300
- 11 - Target Compound List/Target Analyte List
  - Volatile Organic Compounds (8260)
  - Sem-volatile Organic Compounds (8270)
  - Organochlorine pesticides and PCBs (8081/8082)
  - 23 metals plus Cyanide (6010/7471/9010)
- 12 - Dioxin - EPA 3290
- 13 - Nitrate/Nitrite by EPA 300

**Notes:**

- <sup>1</sup> Includes surface soil sample locations
  - <sup>2</sup> Includes ground-water samples from completed wells. Ground-water samples may be collected from the bedrock in discrete intervals.
  - <sup>3</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>4</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>5</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>6</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>7</sup> Soil and/or sediment samples which exhibit <sup>241</sup>Am, or greater than 14 pCi/g <sup>238</sup>U, will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>8</sup> 50% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>9</sup> 50% of soil will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>10</sup> 100% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>11</sup> Target Analyte List Metals Only
  - <sup>12</sup> Domestic Well #3 area was addressed during Interim Hydrogeologic Investigation. Additional wells in the vicinity are proposed under AOC #1.
  - <sup>13</sup> A geophysical survey will be performed to locate potential ferrous material and debris. Geophysical anomalies, if found, will be further investigated.
- NA - Not applicable.

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 4 - SAMPLE MEDIA BY AREA OF CONCERN**

<b>AOC</b>	<b>Description</b>	<b>GW</b>	<b>SW</b>	<b>SD</b>	<b>SS</b>	<b>Soil</b>	<b>Other</b>
#1	Ground Water	X					
#2	Surface Water Features	X	X	X	X	X	
#3	Burial Pit Area				X		Trenching and Additional Record Search
#4	Evaporation Ponds	X			X	X	
#5	Former Leach Field	X			X	X	
#6	Soils Beneath Buildings	X			X	X	Fill
#7	Limestone Storage						Limestone
#8	Outdoor & Shallow Surface Area				X		
#9	Former Gas Station	X				X	Record Search; Interviews
#10	Gas Pipeline				X	X	
#11	Red Room Roof Burial Area				X	X	
#12	Domestic Well #3						Addressed During Interim Hydrogeologic Investigation
#13	Deul's Mountain				X		
#14	Cistern Burn Pit	X			X	X	
#15	Joachim Creek Bridge						Magnetometer survey

Notes:

- GW – groundwater
- SW – surface water
- SD – sediment
- SS – surface soil
- Soil – subsurface soil

WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 5 - MONITORING WELL/PIEZOMETER CONSTRUCTION DATA

WELL DESIGNATION	DATE INSTALLED	SCREEN/CASING MATERIAL	WELL CASING DIAMETER (INCHES O.D.)	GRADE ELEVATION (FEET AMSL)	TOP OF CASING ELEVATION (FEET AMSL)	WELL BOTTOM ELEVATION (FEET AMSL)	DEPTH OF WELL (FEET BGS)	DEPTH OF WELL (FEET BTOC)	SCREEN LENGTH (FEET)	SCREENED INTERVAL (FEET BGS)	HYDROSTRATIGRAPHIC ZONE MONITORED
WS-7	Unknown	PVC/Unknown	4	432.25	432.28	409.77	22.48	22.51	Unknown	Unknown	Unconsolidated
WS-8	Unknown	PVC/Unknown	4	431.71	433.70	414.04	17.67	19.66	Unknown	Unknown	Unconsolidated
WS-9	Unknown	PVC/Unknown	4	431.77	432.84	406.47	25.30	26.37	Unknown	Unknown	Unconsolidated
RMC-9	Unknown	PVC/Unknown	2	433.51	436.07	Unknown	Unknown	Unknown	Unknown	Unknown	Unconsolidated
WS-13	Unknown	PVC/PVC	2	434.02	435.80	Unknown	Unknown	20.70	Unknown	Unknown	Unconsolidated
WS-14	Unknown	PVC/PVC	2	433.56	435.65	Unknown	Unknown	25.58	Unknown	Unknown	Unconsolidated
WS-15	Unknown	PVC/PVC	2	430.58	432.76	406.79	23.79	25.97	Unknown	Unknown	Unconsolidated
WS-16	Unknown	PVC/PVC	2	430.19	432.25	410.55	19.64	21.70	Unknown	Unknown	Unconsolidated
WS-17B	26-Jun-96	PVC/PVC	2	433.39	435.36	412.85	20.54	22.51	13.00	7.0-20.0	Unconsolidated
WS-22	24-Sep-98	PVC/PVC	2	438.22	441.12	421.96	16.26	19.16	5.00	10.5-15.5	NSSSC/Unconsolidated
WS-23	24-Sep-98	PVC/PVC	2	438.15	441.16	399.63	38.52	41.53	10.00	28.52-38.52	DSCC/Unconsolidated
WS-24	23-Sep-98	PVC/PVC	2	436.76	439.64	420.00	16.76	19.64	10.00	5.5-15.5	NSSSC/Unconsolidated
WS-25	23-Sep-98	PVC/PVC	2	436.55	439.09	398.34	38.21	40.75	10.00	28.4-38.4	DSCC/Unconsolidated
WS-26	28-Sep-98	PVC/PVC	2	430.48	433.53	415.32	15.16	18.21	10.00	5.0-15.0	NSSSC/Unconsolidated
WS-27	28-Sep-98	PVC/PVC	2	430.69	433.56	398.23	32.46	35.33	10.00	21.8-31.8	DSCC/Unconsolidated
WS-28	25-Sep-98	PVC/PVC	2	425.71	428.61	409.87	15.84	18.74	10.00	6.5-16.5	NSSSC/Unconsolidated
WS-29	25-Sep-98	PVC/PVC	2	425.32	428.20	397.53	27.79	30.67	7.00	20.4-27.4	DSCC/Unconsolidated
WS-30	15-Oct-98	PVC/PVC	2	425.41	428.27	376.20	49.21	52.07	10.00	38.9-48.9	Jefferson City-Cotter Dolomite
WS-31	13-Oct-98	PVC/PVC	2	424.95	427.63	343.54	81.41	84.09	10.00	71.3-81.3	Jefferson City-Cotter Dolomite
WS-32	30-Sep-98	PVC/PVC	2	433.20	436.11	397.98	35.22	38.13	5.00	30.8-35.8	DSCC/Unconsolidated
WS-33	22-Sep-98	PVC/PVC	2	434.23	437.12	416.32	17.91	20.80	10.00	7.6-17.6	NSSSC/Unconsolidated
WS-34	21-Sep-98	PVC/PVC	2	434.21	436.96	398.76	35.45	38.20	10.00	25.6-35.6	DSCC/Unconsolidated
PZ-1	28-Sep-98	PVC/PVC	2	431.75	434.74	407.85	23.90	26.89	10.00	13.5-23.5	NSSSC/Unconsolidated
PZ-2	28-Sep-98	PVC/PVC	2	431.63	434.81	398.14	33.49	36.67	10.00	23.5-33.5	DSCC/Unconsolidated
PZ-3	13-Oct-98	PVC/PVC	2	433.23	435.85	372.28	60.95	63.57	10.00	50.3-60.3	Jefferson City-Cotter Dolomite
PZ-4	13-Oct-98	PVC/PVC	2	438.17	440.71	378.86	59.31	61.85	10.00	49.3-59.3	Jefferson City-Cotter Dolomite
OB-1	15-May-02	PVC/PVC	2	426.67	429.64	400.47	26.20	29.17	16.20	10.0-26.2	Unconsolidated
OB-2	28-May-02	PVC/PVC	2	427.71	430.52	390.71	37.00	39.81	27.00	10.0-37.0	Unconsolidated

**Note**

- O.D. = Outside Diameter
- AMSL = Above Mean Sea Level
- BGS = Below Ground Surface
- BTOC = Below Top of Casing
- NSSSC = Near-Surface, Silt; Silty-Clay
- DSCC = Deep, Silty-Clay; Clay

WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY

REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 5 - MONITORING WELL/PIEZOMETER CONSTRUCTION DATA

WELL DESIGNATION	DATE INSTALLED	SCREEN/CASING MATERIAL	WELL CASING DIAMETER (INCHES O.D.)	GRADE ELEVATION (FEET AMSL)	TOP OF CASING ELEVATION (FEET AMSL)	WELL BOTTOM ELEVATION (FEET AMSL)	DEPTH OF WELL (FEET BGS)	DEPTH OF WELL (FEET BTOC)	SCREEN LENGTH (FEET)	SCREENED INTERVAL (FEET BGS)	HYDROSTRATIGRAPHIC ZONE MONITORED
BR1-JC	06-Jun-02	PVC/PVC	1	439.29	442.08	332.29	107.00	109.79	10.00	97.0-107.0	Jefferson City-Cotter Dolomite
BR1-RB	24-Jul-02	PVC/PVC	2	440.03	442.63	275.03	165.00	167.60	40.00	125-165	Roubidoux Formation
BR2-JC	23-Jul-02	PVC/PVC	1	428.64	431.33	313.64	115.00	117.69	5.00	105-115	Jefferson City-Cotter Dolomite
BR2-RB	24-Jul-02	PVC/PVC	2	428.23	431.50	93.23	335.00	338.27	40.00	295-335	Roubidoux Formation
BR3-OB	23-Jul-02	PVC/PVC	2	418.65	421.72	394.35	24.30	27.37	11.10	13.2-24.3	DSCC/Unconsolidated
BR3-RB	24-Jul-02	PVC/PVC	2	418.12	420.73	228.12	190.00	192.61	40.00	150-190	Roubidoux Formation
BR4-JC	24-Jul-02	PVC/PVC	2	432.11	434.51	327.11	105.00	107.40	10.00	95-105	Jefferson City-Cotter Dolomite
BR4-RB	24-Jul-02	PVC/PVC	2	431.95	434.93	191.95	240.00	242.98	40.00	200-240	Roubidoux Formation

**Note**

O.D. = Outside Diameter  
 AMSL = Above Mean Sea Level  
 BGS = Below Ground Surface  
 BTOC = Below Top of Casing  
 NSSSC = Near-Surface, Silt; Silty-Clay  
 DSCC = Deep, Silty-Clay; Clay

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 6 - PRELIMINARY SCREENING OF CURRENT AND FUTURE EXPOSURE SCENARIOS  
ON-SITE AND OFF-SITE**

Medium	Exposure Medium	Receptor Population	Receptor Age	Exposure Route	Rationale for Selection or Exclusion of Exposure Pathway
Groundwater	Groundwater	Resident	Adult	Dermal	This is a complete pathway for current and potential future use scenarios on-site and off-site of the Facility. As an interim response and remedy, complete home carbon filter units have been supplied to residents with known or suspected impacts to private well supply. This procedure will continue as a corrective action measure, which would eliminate dermal contact (shower/bath), ingestion, and indoor inhalation of vapors (showering/cooking/laundry) from household activities from a quantitative evaluation.
				Ingestion	
			Child	Dermal	
				Ingestion	
	Shower Air		Adult	Inhalation	
	Building Air		Adult	Inhalation	
		Child	Inhalation		
	Groundwater	Construction Worker	Adult	Dermal	This is a complete pathway for on-site current and future exposure potential. Groundwater is shallow and could affect construction workers in utility corridors at some locations on the Facility. The pathway is not complete for off-site. Groundwater is too deep to be encountered during routine excavation/utility scenarios.
				Ingestion	This is not a complete pathway for quantitative evaluation for both on-site and off-site. Ingestion of impacted groundwater by construction worker scenarios is incidental, and risk to construction workers will be driven by dermal contact and inhalation pathways.
		Air		Inhalation	This is a complete pathway for on-site current and future exposure potential. Since groundwater is shallow at the Facility, and could exist at normal excavation/utility depths, workers could be exposed to volatiles from open trenches/excavations. Typically, quantitative risk calculations will indicate that these exposures are not risk drivers, because volatilization to ambient air has a large dilution effect prior to exposure contact.
Groundwater	Commercial/ Industrial	Adult	Dermal	This pathway is not a concern for current or future on-site exposure, but may be a complete pathway for current or future off-site exposure. Similar to the residential scenario above, any on-site impacted industrial water supply well will be fitted with treatment units for drinking water supply. There is no process use of groundwater (contact water) as the Facility is shutdown. Current and future potential use of groundwater in an industrial scenario off-site will need to be investigated once the plume has been defined.	
			Ingestion		
Building Air			Inhalation		This is a complete pathway for current and future on-site exposure. There are areas at the facility where shallow groundwater exists just below grade, and although this pathway typically is reserved for indoor air exposures related to accumulation in basements, the assessment will attempt to quantify current industrial exposure. It should be noted that due to OSHA regulations, the on-site buildings are already equipped with air exchange units, etc., therefore this pathway is probably not of concern.
Surface Water	Surface Water	Recreational/ Trespasser	Adult	Dermal	This is a complete pathway for current and future on-site and off-site quantitative evaluation. There are streams and tributaries that could potentially be affected by migration of impacted groundwater. Although access to these streams and tributaries are private property, trespassing seems obvious by evidence of trails. In addition, these areas are aesthetically pleasing, therefore wading, swimming, and fishing scenarios will be evaluated. Incidental ingestion of surface water is negligible for swimming scenarios.
				Ingestion	
			Child	Dermal	
	Ingestion				
Aquatic Organisms	Aquatic Organisms	Adult	Ingestion	This pathway will be considered for current/future on-site and off-site exposure. Actual identified receptor streams/tributaries will be investigated to determine their "status" with respect to sustenance fishing versus recreational fishing exposure potential.	
		Child	Ingestion		

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 6 - PRELIMINARY SCREENING OF CURRENT AND FUTURE EXPOSURE SCENARIOS  
ON-SITE AND OFF-SITE**

Medium	Exposure Medium	Receptor Population	Receptor Age	Exposure Route	Rationale for Selection or Exclusion of Exposure Pathway				
Soil	Soil	Resident	Adult	Dermal	This will not be a pathway considered for quantitative evaluation for on-site or off-site exposure scenarios. Current on-site residential use of the property is not within an AOC, and there is no potential for exposure to impacted site soils. Expanded future residential use of the property is highly unlikely (floodplain). There are no known past disposal practices or impacts to off-site soils.				
				Ingestion					
			Child	Dermal					
				Ingestion					
	Air			Adult		Inhalation			
						Child	Inhalation		
				Soil			Trespasser/ Visitor	Adult	Dermal
						Ingestion			
Child	Dermal								
	Ingestion								
Air			Adult	Inhalation					
				Child	Inhalation				
			Soil		Construction Worker	Adult	Dermal	These pathways will be considered complete for current and future on-site, but will not be considered for off-site due to lack of impacted soil in off-site locations. Impacted soil lies within typical excavation/utility corridor limits. Construction workers, although exposure frequency would be minimal, would be exposed by limited dermal contact (hands, head, forearms), incidental ingestion of particulates from soils, and ambient air inhalation from volatilization. In addition, any corrective action would require handling of soils by remedial workers, although this type of work would require OSHA-certified contractors to complete the job.	
				Ingestion					
Inhalation									
Air			Adult	Dermal					
				Ingestion					
				Inhalation					
Soil	Commercial/ Industrial	Adult	Dermal	These pathways will be considered complete for current and future on-site, but will not be considered for off-site due to lack of impacted soil in off-site locations. Although the Facility is shutdown, there are still industrial workers on-site that could be exposed to impacted soils. Typical work activities would not expose the general industrial worker to impacted soils, because they would be indoors, but occasionally during favorable weather and seasonal conditions, there would be occasion for exposure. Industrial workers would have limited, minimal exposure by dermal contact with soils (especially because most areas are covered by vegetation, concrete or asphalt), incidental ingestion/inhalation of particulates, and ambient air inhalation from subsurface volatilization.					
			Ingestion						
			Inhalation						
Air			Adult		Dermal				
					Ingestion				
					Inhalation				
Sediment	Sediment	Recreational/ Trespasser	Adult	Dermal	This is a complete pathway for current and future on-site and off-site quantitative evaluation. The Facility operated under a NPDES discharge permit for many years. There are streams and tributary sediments that could potentially be affected by migration of impacted groundwater or due to past common historical disposal practices. Although access to these streams and tributaries are private property, trespassing seems obvious by evidence of trails. In addition, these areas are aesthetically pleasing, therefore wading, swimming, and fishing scenarios will be evaluated. Incidental ingestion of sediments during recreational swimming/wading scenarios is unlikely and insignificant.				
				Ingestion					
				Child		Dermal			
			Ingestion						
			Aquatic Organisms					Adult	Ingestion
				Child					Ingestion
Ingestion									

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 7 - BUDGET ESTIMATE**

RI/FS Task	Task Components	Budget Low Range	Budget High Range	Cost Assumptions
Task 1 - Project Planning	<ul style="list-style-type: none"> <li>-Collecting and evaluating available historical and characterization data</li> <li>-Developing a Site conceptual exposure model</li> <li>-Identifying preliminary remedial action objectives and potential remedial alternatives</li> <li>-Identifying potential treatability studies</li> <li>-Identifying preliminary ARARs</li> </ul>	\$150,000.00	\$175,000.00	Cost shown is budget to prepare RI/FS workplan prior to Regulatory and Public Comments, if any.
Task 2 - Community Relations	-Community Relations Plan	\$8,000.00	\$20,000.00	Cost quoted by subcontractor selected by Westinghouse
Task 3 - Field Investigation	<ul style="list-style-type: none"> <li>-Mobilization of field activities</li> <li>- media or contaminant sampling</li> <li>- aquifer testing and analysis</li> <li>- Wetlands, Threatened and Endangered Species and Cultural Features</li> <li>- Gamma Walkover Survey - Electromagnetic Survey</li> </ul>	<ul style="list-style-type: none"> <li>\$20,000.00</li> <li>\$400,000.00</li> <li>\$125,000.00</li> <li>\$50,000.00</li> <li>\$70,000.00</li> </ul>	<ul style="list-style-type: none"> <li>\$30,000.00</li> <li>\$500,000.00</li> <li>\$200,000.00</li> <li>\$100,000.00</li> <li>\$90,000.00</li> </ul>	Based on acceptance of FSP by DNR/NRC and little to no additional characterization, and previous similar project experience
Task 4 - Sample Analysis and Verification	- Sample analysis (Analytical Lab Cost) and verification	\$350,000.00	\$500,000.00	Based on acceptance of FSP by DNR/NRC and little to no additional characterization, and previous similar project experience

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 7 - BUDGET ESTIMATE**

RI/FS Task	Task Components	Budget Low Range	Budget High Range	Cost Assumptions
Task 5 - Data Evaluation	- Comparing potential site-related contaminant concentrations with values representative of background levels  -Developing a data set for use in the baseline risk assessments	\$50,000.00	\$75,000.00	Based on acceptance of FSP by DNR/NRC and little to no additional characterization, and previous similar project experience
Task 6 - Risk Assessment	A) Construct a ground-water flow model	\$50,000.00	\$100,000.00	Based on acceptance of FSP by DNR/NRC and little to no additional characterization, and previous similar project experience
	B) Dose assessment using RESRAD	\$40,000.00	\$75,000.00	
	C) Create Baseline Risk Assessment	\$50,000.00	\$100,000.00	
Task 7 - Treatability Studies	- Evaluation of technologies  - Literature search  - Bench/pilot-scale testing	?		Not possible to estimate now
Task 8 - Remedial Investigation Report	- Remedial Investigation Report	\$150,000.00	\$250,000.00	Based on proposed RI/FS Work Plan

**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 7 - BUDGET ESTIMATE**

RI/FS Task	Task Components	Budget Low Range	Budget High Range	Cost Assumptions
Task 9 - Remedial Alternatives Development and Screening	- Identifying response objectives and response actions	?	?	Not possible to estimate now
	- List potential remedial technologies		?	
	- Screen remedial technologies and process options on the basis of Site specific criteria		?	
	- Assemble potential remedial action alternatives from the screened technologies and process options		?	
	- Evaluate potential remedial action alternatives on the basis of screening criteria		?	
Task 10 - Detailed Analysis of Alternatives	- Identify candidate alternatives for remedial action	?	?	Not possible to estimate now
	- Overall protection of human health and the environment		?	
	- Compliance w/ARARs		?	
	- Long-term effectiveness and performance		?	
	- Reduction of toxicity, mobility and volume		?	
	- Short-term effectiveness		?	
	- Ability to Implement		?	
	- Acceptance by MDNR/NRC		?	
- Acceptance by community	?			

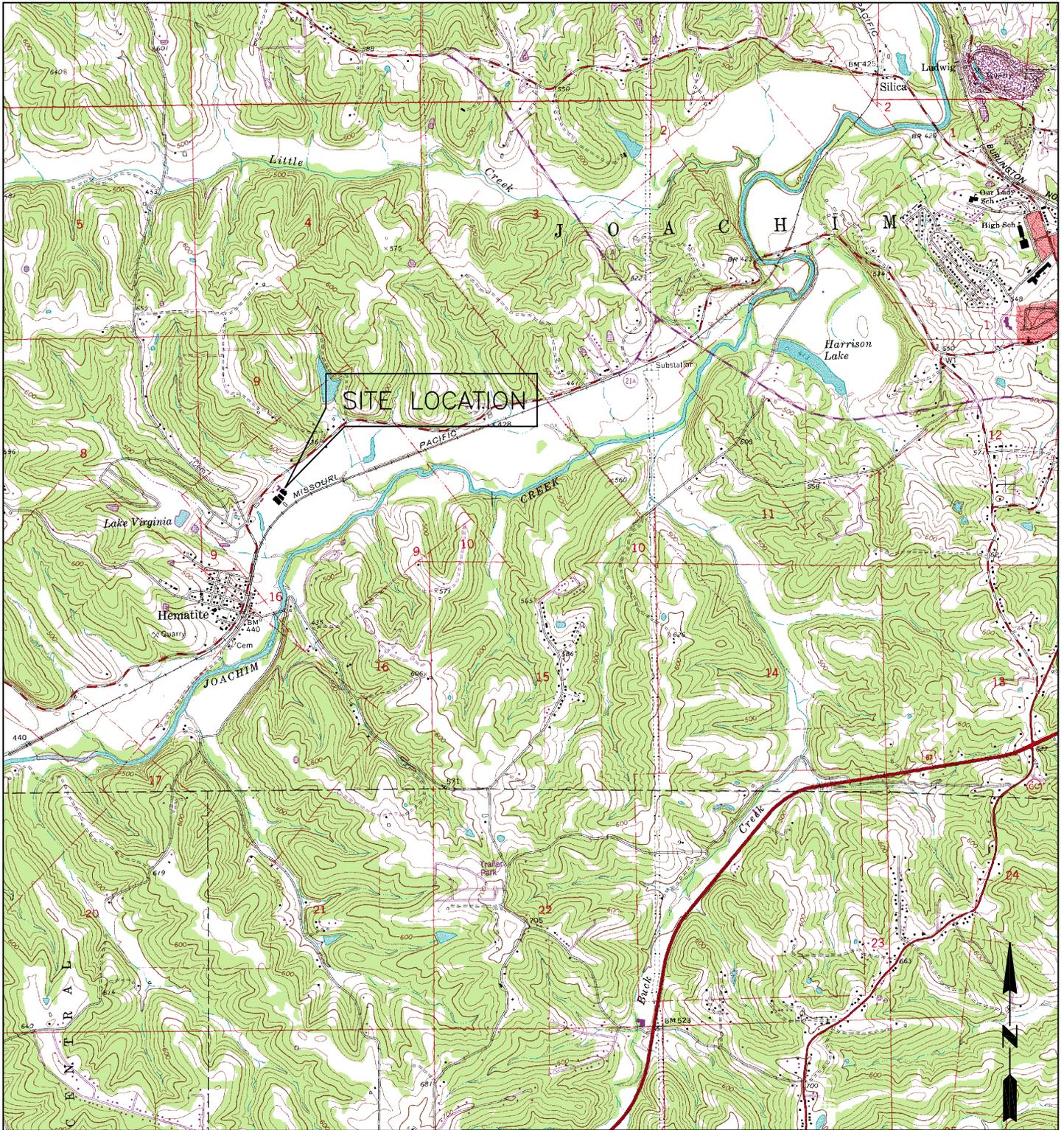
**WESTINGHOUSE ELECTRIC CO. LLC  
HEMATITE, MISSOURI FACILITY**

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN  
TABLE 7 - BUDGET ESTIMATE**

RI/FS Task	Task Components	Budget Low Range	Budget High Range	Cost Assumptions
Task 11 - Feasibility Study Report	- Formatting data		?	Gross estimate
	- Preparing graphics		?	
	- Writing report	?	?	
	- Printing and distributing report		?	
	- Respond to review comments		?	
	- Revise report		?	
Task 12 - Post-Remedial Investigation/Feasibility Study Support	- Prepare proposed plans		?	Not possible to estimate now
	- Attend public meetings		?	
	- Prepare responsiveness summaries and draft RODs	?	?	
	- Finalize documents in response to agency and public comments		?	
	- Prepare pre-design reports		?	
	- Complete conceptual design		?	
<b>Total Budgetary Gross Estimate Range*</b>		\$2,178,000.00	\$2,215,000.00	

Costs for Some Tasks Not Estimated

## **FIGURES**



WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE, MISSOURI FACILITY  
HEMATITE, MISSOURI

AREA LOCATION MAP

SOURCE:  
U.S.G.S. TOPOGRAPHIC MAP  
FESTUS, MISSOURI  
7.5 MINUTE QUADRANGLE

DATE	REVISED	Prepared By:	
		LEGGETTE, BRASHEARS & GRAHAM, INC.	
		Professional Ground-Water and Environmental Engineering Services	
		4850 Lemay Ferry, Suite 205	
		St. Louis, MO 63129	
		(314) 845-0535	
FILE:	12WWP01D.dwg	DATE:	MAY 2003
		FIGURE:	1

# Conceptual Site Model

Primary Potential Sources  
(Areas of Concern)

Primary Release Mechanism

Secondary Sources

Secondary Release Mechanism

Pathway

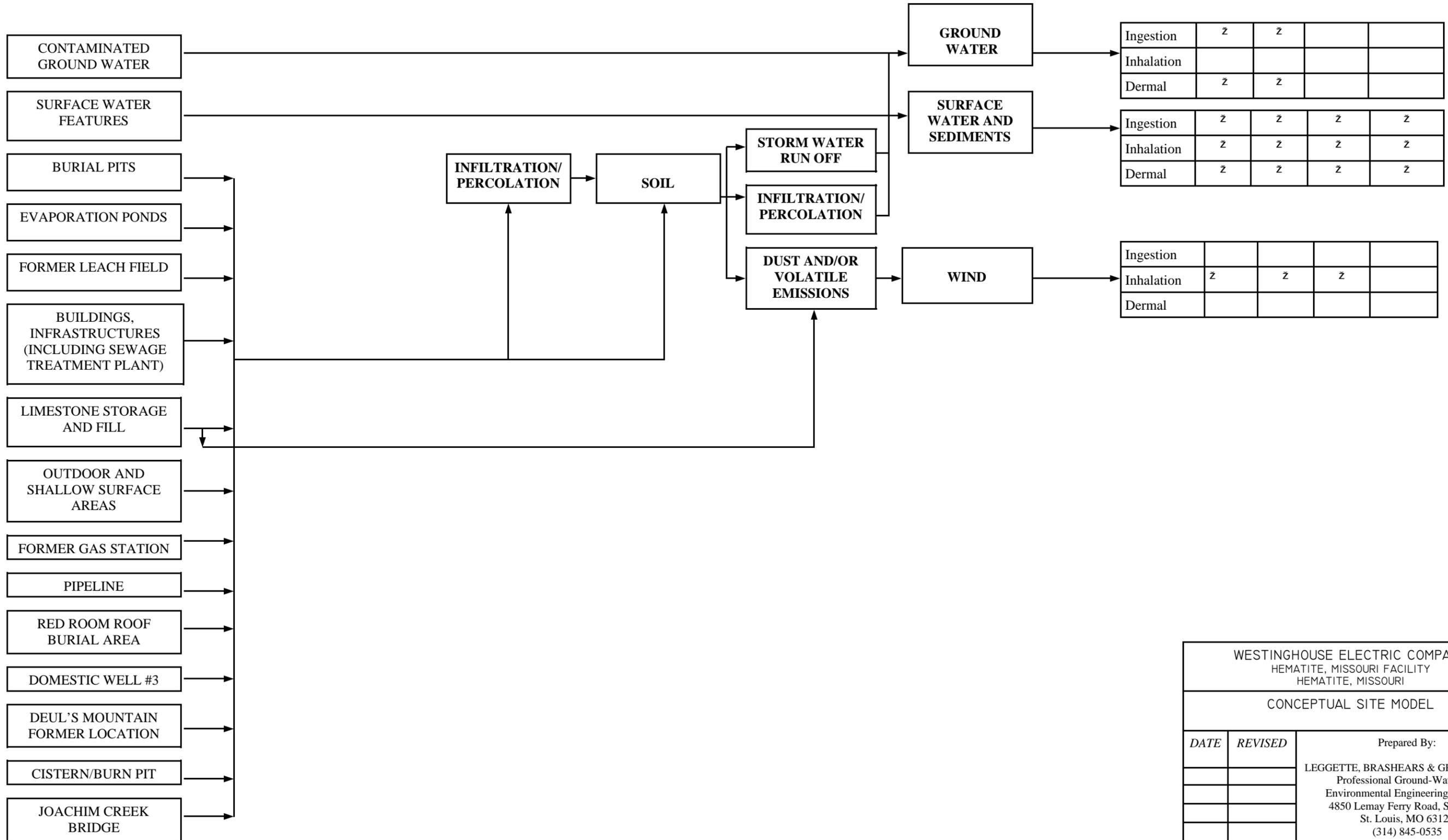
Exposure Route

Human Residents

Visitors

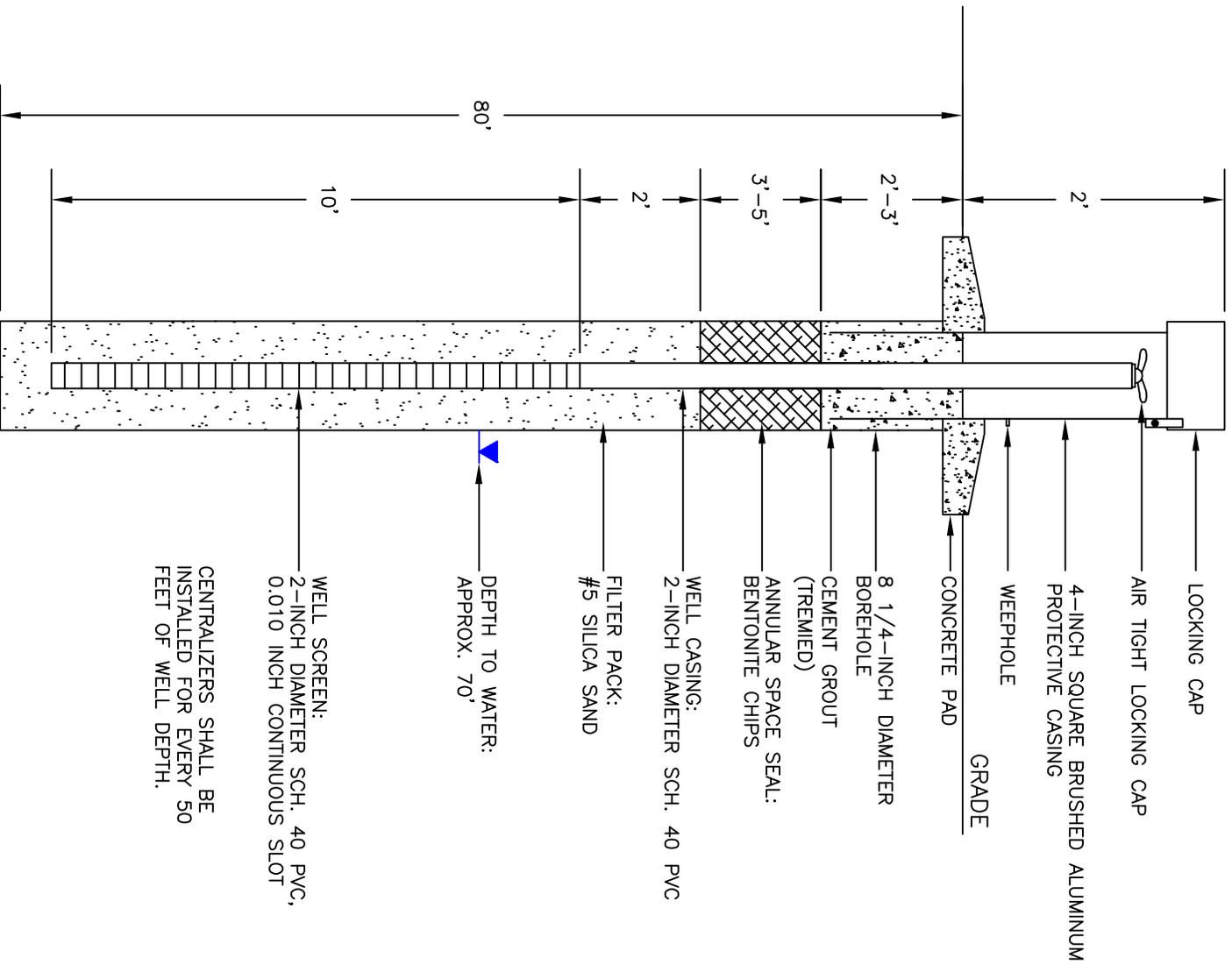
BIOTA Terrestrial

Aquatic



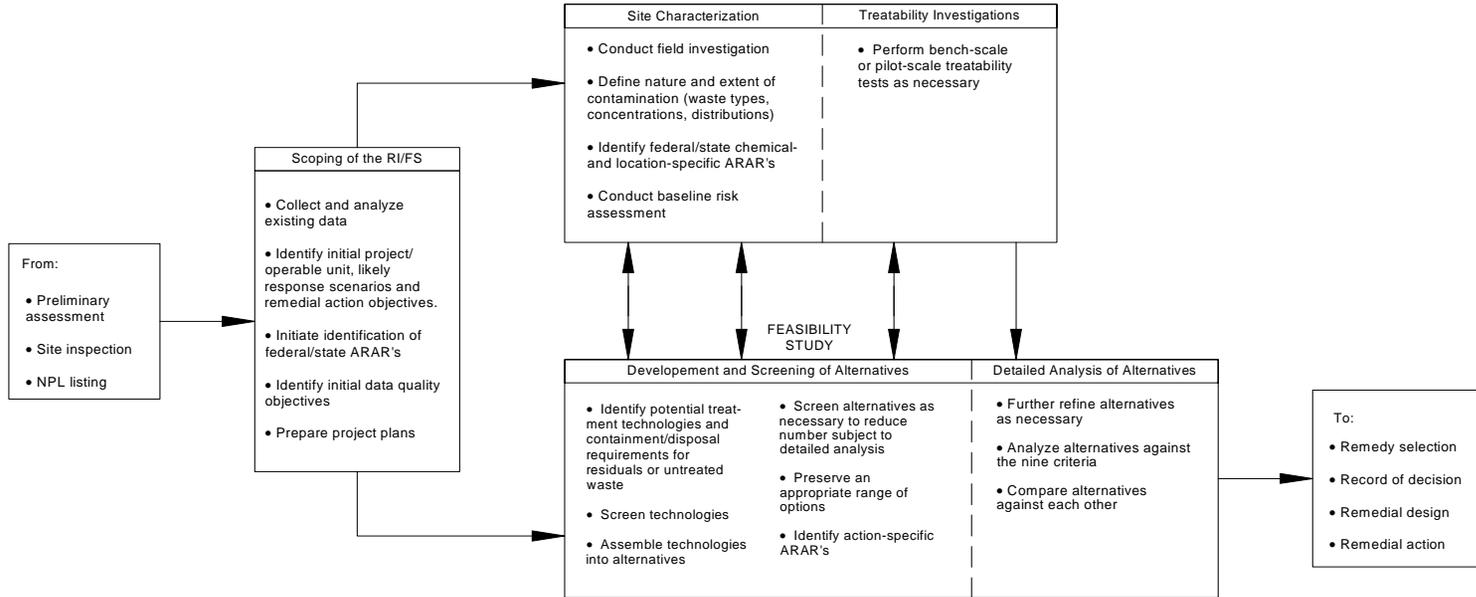
Note: Areas of Concern are the known and suspected source of contamination.

WESTINGHOUSE ELECTRIC COMPANY HEMATITE, MISSOURI FACILITY HEMATITE, MISSOURI			
CONCEPTUAL SITE MODEL			
DATE	REVISED	Prepared By: LEGGETTE, BRASHEARS & GRAHAM, INC. Professional Ground-Water and Environmental Engineering Services 4850 Lemay Ferry Road, Suite 205 St. Louis, MO 63129 (314) 845-0535	
FILE:		DATE: MAY 2003	FIGURE: 2



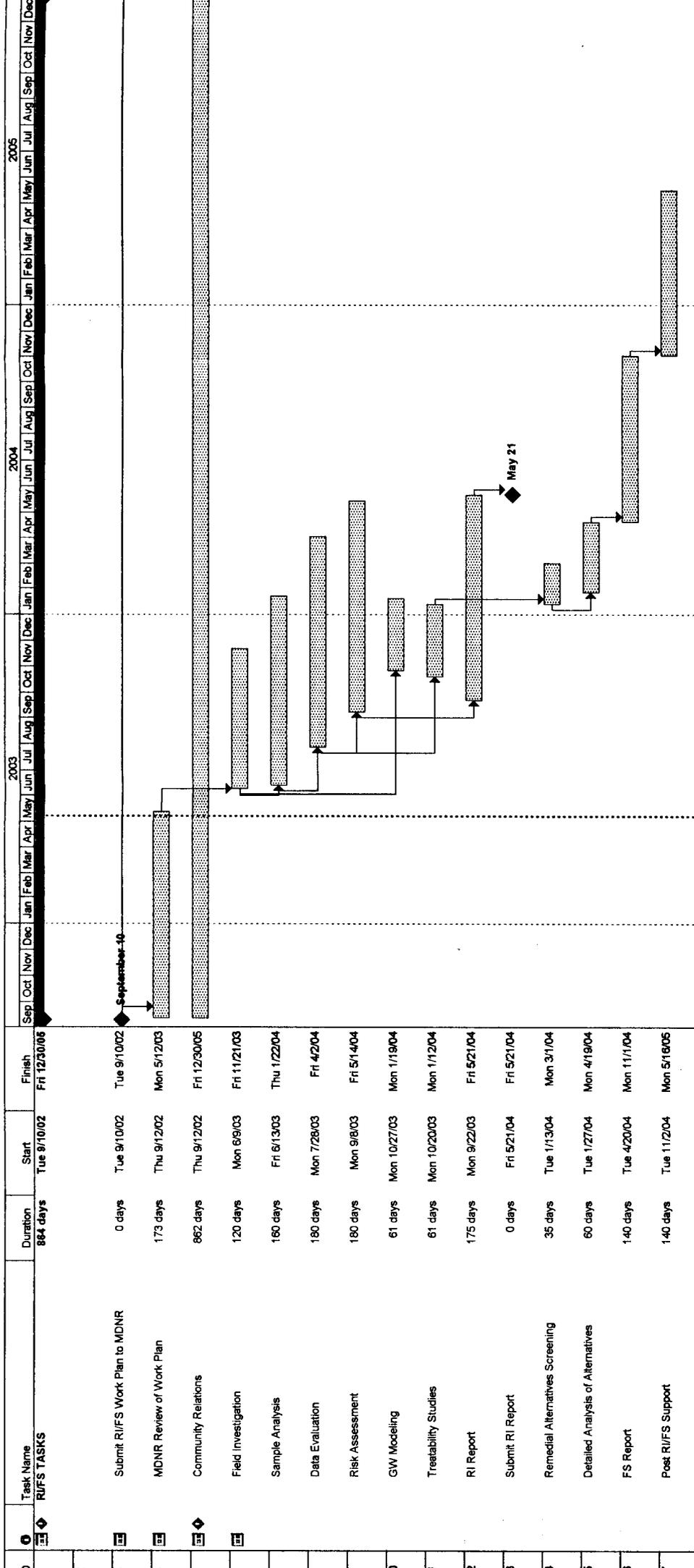
DATE	REVISED	Prepared By:	WESTINGHOUSE ELECTRIC COMPANY
		<b>IRCGETTE, BRASHBARS &amp; GRAHAM, INC.</b> Professional Ground-Water and Environmental Engineering Services 4860 Lemay Ferry, Suite 205 St. Louis, MO 63129 (314) 845-0535	HEMATITE, MISSOURI FACILITY
			HEMATITE, MISSOURI
			TYPICAL WELL CONSTRUCTION DIAGRAM
			FILE: 12WWP01R.dwg DATE: MAY 2003 FIGURE: 3

# REMEDIAL INVESTIGATION



WESTINGHOUSE ELECTRIC COMPANY HEMATITE, MISSOURI FACILITY HEMATITE, MISSOURI			
SUMMARY DIAGRAM OF THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS			
<i>DATE</i>	<i>REVISED</i>	Prepared By:	
		LEGGETTE, BRASHEARS & GRAHAM, INC. Professional Ground-Water and Environmental Engineering Services 4850 Lemay Ferry Road, Suite 205 St. Louis, MO 63129 (314) 845-0535	
FILE:		DATE: MAY 2003	FIGURE: 4

**FIGURE 5  
PROPOSED CONCEPTUAL SCHEDULE FOR RI/FS TASKS  
WESTINGHOUSE, HEMATITE MISSOURI SITE**



Project: RI-FS Schedule  
Date: Wed 5/7/03

Task: [Task Icon] Milestone: [Milestone Icon] Summary: [Summary Icon]

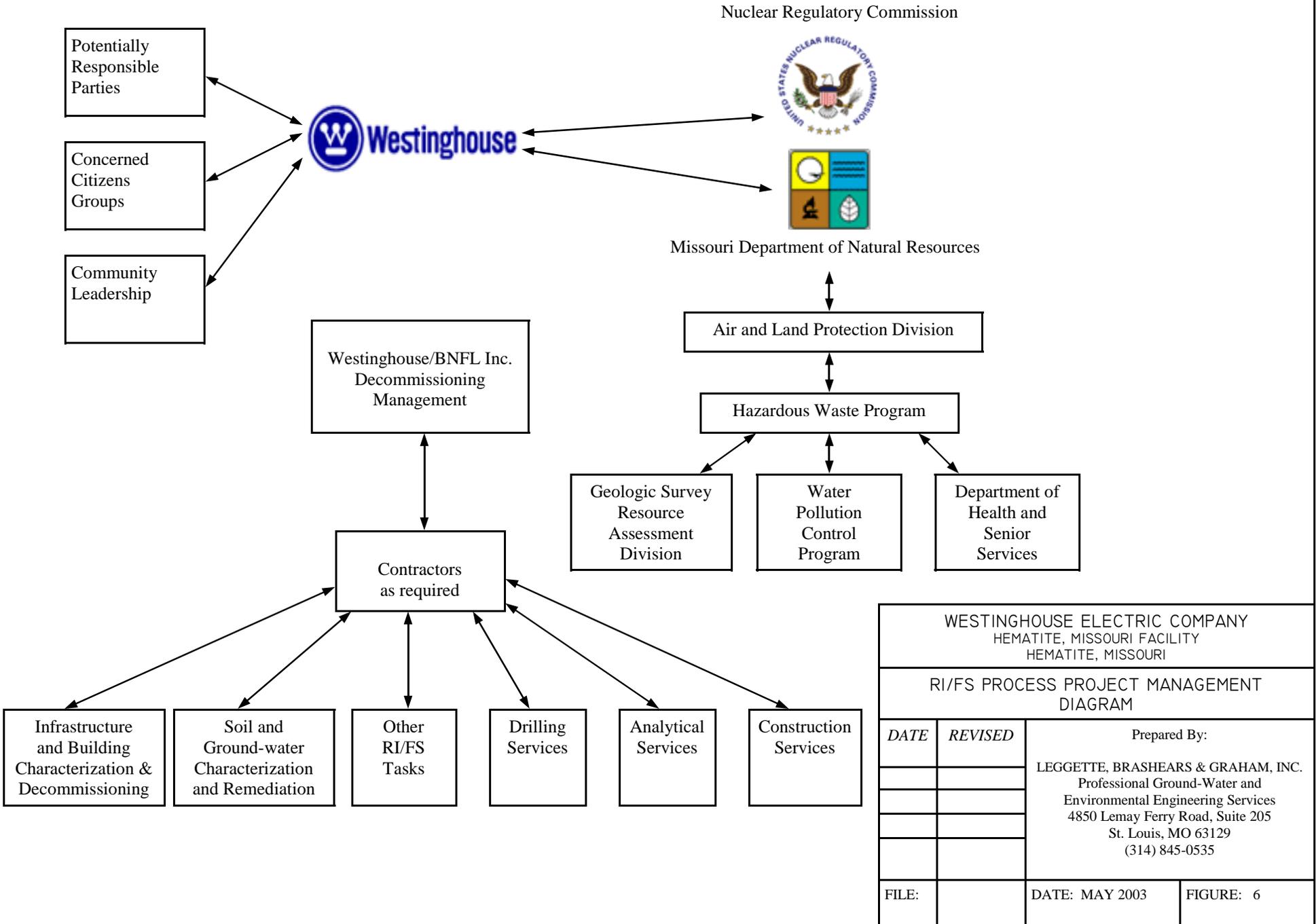
Progress: [Progress Icon] Rolled Up Task: [Rolled Up Task Icon] Rolled Up Milestone: [Rolled Up Milestone Icon]

External Tasks: [External Tasks Icon] Project Summary: [Project Summary Icon]

Group By Summary: [Group By Summary Icon]

[LEGGETTE, BRASHEARS & GRAHAM, INC.]

# Westinghouse—Hematite Facility RI/FS Process Project Management Diagram



## **APPENDICES**

## **APPENDIX A**

### **Draft Quality Assurance Project Plan**

*Final Draft*

**QUALITY ASSURANCE PROJECT PLAN**  
**Hematite Remedial Investigation/Feasibility**  
**Study**

**Hematite, Missouri**

Westinghouse Electric Company, LLC  
Hematite Missouri Facility  
3300 State Road P  
Hematite, MO 63047

**Revision 1.1**

May 2003

*Final Draft*

# QAPP APPROVAL

Revision 1.1

**Approvals (EPA OA/R-5 Element A1)**

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**Thomas Dent – Westinghouse Program Director**

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**Mike Prattke – Westinghouse Program Manager**

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**– FFCF Project Manager**

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**Julieann Warren – MDNR Project Manager**

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Figure F-7: Document Distribution Record

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### **ATTACHMENTS**

Attachment A FIDLER MDC TECHNICAL MEMORANDUM

Attachment B ESTIMATION OF LUDLUM 44-9 INSTRUMENT SCAN SENSITIVITY

Attachment C INVESTIGATIVE DERIVED WASTE (IDW) MANAGEMENT PLAN

Attachment D COMPENDIUM METHOD TO-15

Attachment E STANDARD OPERATING PROCEDURES FOR  
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Attachment F RESPONSE TO MDNR COMMENTS (JULIEANN WARREN, E-MAIL –  
11/22/2002)

Attachment G INTERNAL CLARIFICATIONS AND REVISIONS

**Distribution List** (*EPA QA/R-5 Element A3*)

<b>Name</b>	<b>Organization</b>
Mark Mertens	Jefferson County Presiding Commissioner
Ben Moore	MDNR
Julieann Warren	MDNR
Gale Carlson	Missouri Department of Health and Senior Services
Rose Basko	Missouri Department of Health and Senior Services
Joe Hainline	Jefferson County Health Department
Mike McCann	Nuclear Regulatory Commission
Thomas Dent	Westinghouse Electric Company
Kevin Hayes	Westinghouse Electric Company
Mike Prattke	Civil & Environmental Consultants, Inc.
John Bognar	Leggette, Brashears & Graham, Inc.
Administrative Record	Festus, Missouri Library

## 1.0 PROJECT MANAGEMENT

### 1.1 Background/Introduction

This Quality Assurance Project Plan (QAPP) was prepared to support Remedial Investigations/Feasibility Studies as well as all other applicable activities including but not limited to Removal Actions (time and non-time critical) and Interim Investigations.

The Hematite Site is approximately 228 acres, of which eight acres have most recently been used for operations, and is located in the eastern portion of Missouri in Jefferson County near the town of Hematite. It fronts the eastbound lane of Missouri State Road P, between the hills to the northwest and a terrace/floodplain of Joachim Creek to the southeast. The topography slopes gently to the southeast eventually blending with the alluvial floodplain deposits of the Joachim Creek, which flows into the Mississippi River.

The Site became operational as a uranium product facility in July of 1956 serving both the federal government's nuclear fuel research and production needs and commercial customers.

Primary functions at the Site have been to manufacture uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride ( $\text{UF}_6$ ) gas of various  $^{235}\text{U}$  enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and development was also conducted at the Plant, as were uranium scrap recovery processes.

The use of reprocessed uranium recycled from spent fuel is postulated to raise the potential for transuranics to be present in trace quantities with the feed uranium stock. In addition, quantities of Technetium-99 ( $^{99}\text{Tc}$ ), as a contaminant in the uranium received from the US enrichment facilities, have been detected in some of the environmental monitoring wells at the Hematite Facility. Also, a limited amount of work was performed with thorium compounds as part of early research into the use of thorium in the fuel cycle. Any thorium present at the Site is assumed to be derived from naturally occurring  $^{232}\text{Th}$  in secular equilibrium with its progeny.

A review of the characteristics of recycled uranium was examined in the Department of Energy (DOE) Project Overview and Field Site Reports entitled "A Preliminary Review of the Flow and Characteristics of Recycled Uranium Throughout the DOE Complex 1951-1999". This publication notes that most of the fission products and transuranic isotopes were disposed of as high level waste during reprocessing. It further notes that trace concentrations of plutonium (Pu), neptunium ( $^{237}\text{Np}$ ), and  $^{99}\text{Tc}$  remained with the recovered uranium. The activation product,  $^{236}\text{U}$ , may also be observed as a contaminant. Natural uranium does not contain  $^{236}\text{U}$  in detectable quantities. The gaseous diffusion plants then blended the recycled

uranium with natural uranium, the predominant feed to the enrichment process, further diluting any contaminants. For a subset of samples an isotopic plutonium analysis will be performed. The purpose of the analysis is primarily to confirm the assumption that Pu, if present, is found at trivial concentrations relative to the uranium isotopes.

Since the  $^{99}\text{Tc}$  forms volatile and semi-volatile chemical compounds that tend to migrate toward the top of the enrichment cascade, it is reasonable to assume that technetium would tend to end up in the enriched product. On the basis of activity fraction, it was found that the most significant isotope observed in representative sampling of contaminants in depleted uranium is  $^{99}\text{Tc}$ , followed by Americium ( $^{241}\text{Am}$ ), and then by  $^{237}\text{Np}$ . Enriched product, such as 3.5 wt %  $^{235}\text{U}$  likely to be encountered at the Hematite Site would tend to favor the lower mass isotopes ( $^{99}\text{Tc}$  versus higher mass number isotopes).

The DOE report noted transuranic concentrations in very high enriched, as well as low enriched uranium product, were less than detectable limits (e.g., <5dpm/g of U equivalent to 2.3 pCi per gram of total uranium). On the basis of this information,  $^{99}\text{Tc}$  is expected to be the predominant recycled uranium contaminant observed at the Site followed by  $^{241}\text{Am}$  and  $^{237}\text{Np}$  at significantly lower concentrations. For purposes of this Remedial Investigation/Feasibility Study (RI/FS),  $^{237}\text{Np}$  will not be analyzed unless detectable quantities of  $^{241}\text{Am}$  are measured since the  $^{241}\text{Am}$  source term is expected to be larger than  $^{237}\text{Np}$ .

Details describing the physical design of the Plant and descriptions of historical production operations are included in Section 2.2 of the RI/FS Work Plan.

## 1.2 Project/Task Organization (*EPA QA/R-5 Element A4*)

Figure F-1 presents the organizational structure for the Former Fuel Cycle Facility (FFCF) project. This project will be performed within the management and organizational structure described below. Responsibilities of key individuals are shown in the following subsections. Additional staff, along with applicable subcontractors may be utilized as appropriate.

### Westinghouse Program Manager (WPM)

The WPM will be the project contact within the Westinghouse organization. The WPM will provide direction to the contractor project team and will have routine contact with the contractor Project Manager.

### Project Manager (PM):

The PM is responsible for overall project planning and execution, including, but not limited to, the following:

- Review project work, safety, and Quality Assurance (QA) plans to ensure they contain appropriate provisions and are adequate to control work planned for this project.

- Ensure project personnel properly execute the requirements of the plans.
- Maintain overall responsibility for the health and safety of all project personnel.
- Manage assigned project tasks within their scope, schedules and budget.
- Ensure project deliverables meet or exceed Westinghouse requirements.
- Collaborate with the field supervisor in selecting appropriate field staff and technical resources in support of project tasks.
- Serve as the project interface between Westinghouse, subcontractors, and regulatory agencies involved with the work effort.
- Communicate project requirements to team members.
- Authorize the assignment of project staff.
- Manage assigned resources to complete this project.

In addition, the PM is responsible for ensuring that survey activities are conducted in accordance with the QAPP and associated guidance documents. At a minimum, these additional responsibilities include:

- Advising the Program Manager and team members on QA matters.
- Conducting or arranging surveillance of activities.
- Conducting or arranging QA training.
- Tracking the implementation of QA requirements and consulting periodically with the Program Manager.

Finally, the PM is responsible for maintaining the Quality Assurance Project Plan (QAPP) and distribution of QAPP revisions to project team members.

**Field Supervisor (FS):**

The FS reports to the PM and is responsible for:

- Preparing and reviewing project documents.
- Assigning duties to project staff and orienting the staff to the needs and requirements of this scope of work.
- Supervising project team performance and day-to-day field operations.
- Ensuring major project deliverables are reviewed for technical accuracy and completeness prior to their release.
- Ensuring field personnel receive necessary training on the requirements of the RI/FS Work Plan, QAPP, Health & Safety Plan, and other project documents, as well as applicable regulatory issues.
- Ensuring the requirements of the RI/FS Work Plan are implemented.
- Routinely communicating project status, progress, and/or problems to the PM.
- Proactively identifying and responding to Quality Assurance/Quality Control (QA/QC) needs.

### **Environmental Health and Safety Manager (EHS Manager)**

The EHS Manager reports directly to the Program Manager and may be the Health Physicist (HP). He is responsible for ensuring that the environmental health and safety plan is followed and for ensuring Site personnel are appropriately trained in its provisions. The EHS Manager has authority to issue stop work orders on Site tasks he believes may be unsafe. When so stopped, work shall not recommence until the EHS Manager approves the restart. The EHS Manager is responsible for ensuring project operations are conducted using appropriate levels of radiation safety, the radiological safety of project personnel and the environment is maintained, and all work is performed consistent with the Westinghouse Special Nuclear Material License SNM-33 or contractor license, if applicable. The EHS Manager is also responsible for ensuring compliance with applicable Occupational Safety and Health Association (OSHA), Environmental Protection Agency (EPA) or Department of Natural Resources (DNR), and Department of Transportation (DOT) regulations and permits. The EHS Manager is available as a resource to answer project personnel questions/concerns regarding any potential safety issues. In addition, the EHS Manager is responsible for:

- Ensuring that workers have the necessary experience, training and qualifications.
- Observing and evaluating employee safety performance.
- Conducting periodic safety inspections, and conducting accident investigations and preparing accident reports as necessary.

- Reviewing project tasks and work plans to ensure no undue hazards are posed.
- Monitoring project operations to assess safety implications arising out of potentially changing conditions.
- Advising the PM and FS regarding potential safety issues.

### **Quality Assurance Manager (QA Manager)**

The QA Manager is responsible for programmatic oversight for both the nuclear and environmental programs. The QA Manager is responsible for ensuring that project objectives and activities are conducted in accordance with the Nuclear Regulatory Commission (NRC) license. The QA Manager is also responsible for vendor surveillance.

### **Technical Staff**

Technical staff will be assigned to perform project tasks as necessary. Technical staff will be experienced professionals possessing the expertise and technical competence required to effectively and efficiently perform project tasks. The PM is responsible for ensuring that technical staff members meet the minimum requirements of the job tasks prior to implementation of the RI/FS Work Plan.

Qualifications for technical staff members will be determined on a case-by-case basis, depending on the type of work for which the individuals are selected.

A list of the individuals selected to fill the positions listed in this section will be provided to Westinghouse for review and approval prior to mobilization.

### **Field Labor**

Field labor may include geologists, scientists, drillers, health physicals and engineers. Contractor field labor will be familiar with the RI/FS Work Plan and will follow procedures as specified in the plan.

### 1.3 Problem Definition/Background (EPA QA/R-5 Element A5)

Results of previous investigations and routine monitoring at the Site have identified uranium and technetium concentrations in surface and subsurface soil that exceed natural background concentrations. Interviews with past employees indicate that natural thorium was handled in small quantities as well. This material is believed to exist in, on and under the Site buildings to various degrees. Previous investigations have also revealed the presence of volatile organic compounds (VOCs) on-site, currently the extent of the VOC contamination in groundwater and surface water has not been defined.

The issue of concern here is the presence of residual radioactive material and VOCs associated with past Site operations in and around the facility. The Site is being closed and will be prepared for unrestricted release. When operating, the Site possessed and used High Enriched Uranium (HEU) up to 93%  $^{235}\text{U}$ , Low Enriched Uranium (LEU) typically less than 5%  $^{235}\text{U}$ , Depleted Uranium (DU), natural uranium and natural thorium. Additionally,  $^{99}\text{Tc}$  is present as a past contaminant of recycled uranium processing operations performed at the Paducah, KY, and Portsmouth, OH, gaseous diffusion plants.

These radiological constituents were used within buildings, structures and work processes associated with the preparation, storage, and shipping of fuel elements utilized in commercial and federal nuclear power and propulsion systems. Contamination of buildings and adjacent land areas has occurred during the operations phase of the Hematite facility. The surrounding soil, shallow subsurface soil, surface water and groundwater on the Site are also suspected of having low levels of contamination associated with plant operations.

The radioisotopes of concern are related to the radioactive materials described above and occur as three distinct decay series: (1) the uranium series, (2) the thorium series and (3) the actinium series (Figures F-1, F-2, and F-3). The decay products shown do not exist in full equilibrium due to disruption of the decay series progeny during metal processing and enrichment processes elsewhere. The uranium series, Figure F-2, is in approximate equilibrium with the  $^{238}\text{U}$  through the daughter progeny  $^{234\text{m}}\text{Pa}$ . The thorium series, Figure F-3, is in approximate equilibrium with all daughter progeny. The actinium series, Figure F-3, is in approximate equilibrium with the  $^{235}\text{U}$  through its daughter  $^{231}\text{Th}$ .

Solvents have historically been used and disposed of on-site, which has caused VOC contamination of Site groundwater and surface water. In January 2002, results from the Missouri Department of Health and Senior Services (DHSS) sampling of private wells revealed the presence of VOCs in private drinking water wells downgradient from the site.

#### 1.3.1 Summary of Existing Site Data

Site radiological constituents of potential concern (RCOPCs) are expected to be primarily components of uranium (i.e.,  $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ), and limited amount of thorium, with additional occurrences of  $^{99}\text{Tc}$ . With the exception of  $^{99}\text{Tc}$ , the preceding nuclides are present

naturally in the environment. A thorough background characterization will be performed as part of this work scope.

The Hematite Site does not have Derived Concentration Guideline Levels (DCGLs) associated with the RCOPCs that are expected to be present on the Site. Therefore the NRC “Interim Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels” as described by table C2.3 in NUREG 1727 NMSS Decommissioning SRP, may be utilized as a screening level.

Based on previous investigations, the main chemical constituents of potential concern (CCOPCs) are volatile organic compounds in groundwater, surface water and soils. Previous investigations have been conducted with the objective of responding to NRC inquiries and were limited in scope relative to the chemical characterization of the Site. Although data exist for the various media, the data is limited to a subset of monitoring wells, soil borings, surface water and sediment sample locations. In addition, although the various media have been investigated with respect to VOC analyses, other CCOPCs may not have been analyzed for (i.e., total analyte list [TAL] metals, target compound list semi-volatile organic compounds [TCL SVOCs], fluoride, and pesticides/PCBs). Therefore, rationale for the CCOPCs will include a full suite analyses to include; VOCs (USEPA Method 8260), SVOCs (USEPA Method 8270), Organochlorine pesticides and PCBs (Method 8081/8082), fluoride (Method 9214), and TAL metals (Method 6010/7471). Table Q-1 presents the overall proposed drilling, sampling and analytical requirements.

### **1.3.2 Project/Task Description (*EPA QA/R-5 Element A6*)**

The purpose of the characterization effort is to build upon known information of previous studies and historical reviews, and to fill data gaps and further define the nature and extent of contamination for the Site in total, as well as for specific Areas of Concern.

Data acquired from this characterization will be used to:

- Determine the nature and extent of contamination;
- Support evaluation of remedial alternatives and design;
- Provide inputs useable for final status survey design;
- Model ground-water flow to determine potential receptors;
- Model contaminant fate and transport to determine potential risk to potential receptors in the ground-water path;
- Model potential dose equivalent using isotopic concentrations determined during the characterization survey; and

- Provide information to develop a decommissioning plan for submission to the Nuclear Regulatory Commission.

The project is organized in discrete field sampling tasks, which are described in detail in the RI/FS Work Plan, Section 4.4. In general, a baseline ground-water sampling event will be conducted first. The purpose of this sampling event is to obtain a baseline of the current levels of contamination that exist in the ground-water. Surface water and sediment samples will be collected from water bodies at the Site to evaluate potential impacts from contaminated ground water. Field screening of soils for VOCs and radionuclides will be completed across the Site. Temporary monitoring wells will be installed to assist in determining the extent of ground-water contamination on-site. A pumping test will be conducted in support of ground-water modeling. Specific field programs for each area of concern are detailed in the RI/FS Work Plan Section 4.4.

Gamma walkover surveys will provide a measure of position-correlated gross gamma count rate data proportional to the gross gamma fluence rate at the ground surface. The results of these measurements will provide semi-quantitative data regarding the potential for elevated surface uranium and thorium concentrations.

Quantitative surface soil measurements will be provided by gamma spectroscopy performed on all samples. This will provide a measure of the uranium, thorium, and other gamma emitters present at the sample location in the region of the surface and immediately below the surface. Alpha spectroscopy will be performed on a selected number of surface soil samples based upon results of the soil gamma spectroscopy and gamma walkover surveys.

Quantitative waterway sediment measurements will be provided by gamma spectroscopy performed on all samples. This will provide a measure of the uranium, thorium, and other gamma emitters present at the sample location in the region of the surface and 12 inches below the sediment surface. Alpha spectroscopy will be performed on a selected number of sediment samples based upon results of the sediment gamma spectroscopy and gamma walkover surveys.

Down hole core samples, existing wells, and surface water bodies will provide groundwater and surface water samples for gross alpha/beta sample analysis. Isotopic uranium analysis and technetium analysis will be performed on a selected number of the water samples based upon the gross alpha/beta results.

Westinghouse approved laboratories will conduct analytical testing. Equipment blanks and matrix spike/matrix spike duplicate (MS/MSD), duplicates, and standard reference material (SRM) samples will be analyzed with the samples. Analytical methods, target analyses, holding times, reporting limits, and laboratory QA/QC protocols are detailed and addressed in this project QAPP.

#### 1.4 Data Quality Objectives (*epa qa/r-5 ELEMENT A7*)

Data Quality Objectives (DQOs) are qualitative and quantitative statements that are developed to define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs are used to develop a data collection design that meets all performance criteria. The EPA has developed a seven-step process to develop DQOs, which serves as the basis for the DQOs herein.

##### **Step 1: – State the Problem**

The purpose of this step is to identify the planning team members, provide a brief description of the contamination problem at the Site, and to identify resources available to address the problem.

##### *Planning Team Members*

Westinghouse Electric Company is performing the Remedial Investigation (RI) for the Hematite facility and has subcontracted Leggette, Brashears & Graham, Inc. (LBG) to provide support developing the RI/FS Work Plan. A contractor for the field effort has not been selected at this time. Other significant stakeholders include the local community, the Missouri Department of Natural Resources (DNR) and the NRC.

##### *Statement of Problem*

The problem is the presence of residual radioactive material and VOCs associated with past Site operations in and around the facility.

##### *Available Resources*

Sufficient resources are available through the combined staff of Westinghouse and sub-contractors to perform and complete work required to achieve the objectives of this RI/FS Work Plan. The estimated budget required for the field sampling plan described herein is discussed in Section 4.6 of the RI/FS Work Plan. Westinghouse is scheduled to complete a decommissioning Plan for submittal to the NRC in the future.

##### **Step 2: – Identify the Decision**

The purpose of this step is to identify the decision that requires new environmental data to address the contamination problem at the Site. Essentially, key decisions are addressed as described below.

*Principal Study Questions*

- 1.) What is the nature and extent of residual radioactive material ( $^{238}\text{U}$ ,  $^{235}\text{U}$ ,  $^{234}\text{U}$ ,  $^{232}\text{Th}$ ,  $^{228}\text{Th}$ , and  $^{241}\text{Am}$ ) in surface and shallow sub-surface soil due to historical Site operations and does this material pose an unacceptable risk to human health or the environment?
- 2.) What is the nature and extent of  $^{99}\text{Tc}$ ,  $^{238}\text{U}$ ,  $^{235}\text{U}$ , and  $^{234}\text{U}$  contamination present in the groundwater and surface water bodies due to historical Site operations and does this material pose an unacceptable risk to human health or the environment?
- 3.) What is the nature and extent of VOC contamination in groundwater and surface water due to historical operations and does this material pose an unacceptable risk to human health or the environment?
- 4.) What is the nature and extent of VOC contamination in soil due to historical operations and does this pose an unacceptable risk to human health or the environment?

*Alternative Actions*

The following alternative actions could result from resolution of principal study question 1 and 4 for this investigation:

- Recommend that additional investigations of surface and near-surface soil are not necessary;
- Recommend that additional investigations of surface and near-surface soil are necessary; and/or,
- Recommend that a possible response action be considered.

The following alternative actions could result from resolution of principal study question 2 and 3 for this investigation:

- Designate a source area/volume requiring remediation;
- Do not designate a source area;
- Recommend treatment alternatives for groundwater and surface water; and/or,
- Recommend a groundwater/surface water monitoring program.

### *Decision Statement*

Based on the alternative actions listed above, the decision statement for this investigation is:

- (1) Determine the lateral and vertical extent of soil contamination and whether surface and near-surface uranium, thorium and technetium concentrations in soil associated with Site operations exceed background concentrations and require further investigation or a response action, or recommend that no further investigation of these media is necessary.
- (2) Determine the lateral and vertical extent of groundwater contamination, the extent of surface water contamination and whether groundwater and surface water uranium, and technetium concentrations associated with Site operations exceed background concentrations and require further investigation or a response action, or recommend that no further investigation of these media is necessary.
- (3) Determine the lateral and vertical extent of groundwater contamination above cleanup objectives, and whether an ongoing source exists at the Site and recommend further investigation or response actions.
- (4) Determine the extent of contamination within the subsurface soils above cleanup objectives and recommend further investigation or response objectives.

### **Step 3: – Identify Inputs to the Decision**

Inputs to the decision statements are discussed in two parts. The first discussion focuses on the RCOPCs and the second discussion focuses on the CCOPCs.

#### *RCOPCs*

Radioactivity concentrations, in excess of background, in surface and near-surface soil, sediments, and waste piles are the necessary inputs to the decision. Thus, uranium, thorium and technetium concentrations in impacted areas and non-impacted areas need to be measured. The following field activities will be performed to gather data.

#### **Gross Gamma Walk-Over Survey**

Gross gamma walkover surveys will be performed over 100% of reasonably accessible Site areas. These surveys will provide position-correlated gross gamma count rate data

proportional to gross gamma fluence rate at the ground surface. The results of these measurements will provide semi-quantitative data regarding the potential for elevated surface uranium and thorium. Gross gamma measurements provide readings, in units of counts per minute, which are proportional to the gamma fluence rate at the measurement locations. Although these measurements are quantitative in nature, detector readings are influenced by gamma-emitting radionuclides and are not specific to uranium or thorium.

Gross gamma walkover surveys will be performed using a Field Instrument for the Detection of Low Energy Radiation (FIDLER) detectors, coupled to appropriate ratemeter/scalers, and data linked with differential global positioning system (DGPS) receiver/data loggers or equivalent. DGPS may be impacted for areas within 20 to 30 feet of the larger structures or where significant tree and foliage cover result in loss of signal. For these cases reliance on the DGPS time stamp and surveyor's travel path will be used to fully develop the survey data. This system will log the gross gamma reading and position, in State Plan Coordinates, every second. The survey will be performed following Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocol by walking straight parallel lines over an area while moving the detector in a serpentine motion, 2 inches to 4 inches above the ground surface. Survey passes will be approximately 1 meter apart and the scan rate will be approximately 1.5 feet per second.

Gross gamma data will be evaluated separately for each AOC. The average and standard deviation of measurements in each of these areas of concern will be calculated. The "Z" score for each data point (i.e., number of standard deviations from the average) will be calculated, contoured using a geospatial interpolation program, and graphically plotted. Z-score plots for each of the AOCs will provide visual representations of gross gamma fluence changes to aid in the identification and selection of biased sample locations.

Gross gamma walkover surveys will be performed over 100% of the area immediately surrounding the following buildings.

- Building 101, Tile Barn
- Building 120, Wood Barn
- Building 230, Finished Pellets
- Building 231, Shipping Container Storage
- Building 235, West Vault
- Building 240, Recycle Recovery and support services
- Building 252, South Vault
- Building 253, Utilities, Storage, & Office
- Building 260, Oxide and Oxide Loading Dock

- Building 254, Pellet Building
- Building 255, Erbia Plant
- Building 256-1, Pellet Drying.
- Building 256-2 Warehouse
- Surrounding Sanitary System Extended Aeration Sewage Treatment Plant, Chlorine Contact Tank, & Associated Piping
- Surrounding Storm Water System Piping and Site Pond Discharge
- Limestone Storage and Limestone Fill Areas
- Cistern/Burn Pit
- Deul's Mountain
- Natural Gas Pipeline (MNG) right-of-way

Approximately ten percent of the remainder of the Site will be surveyed for gross gamma activity. These surveys will provide position-correlated gross gamma count rate data, in units of counts per minute that is proportional to gross gamma fluence rate at the ground surface. Results of these measurements will provide semi-quantitative data regarding the potential for elevated surface uranium and/or thorium

For the 100% survey, the survey passes will be approximately one meter apart and the scan rate will be approximately 1.5 feet per second. For the 10% coverage areas, the passes will be approximately ten meters apart and the scan rate will be approximately 1.5 feet per second. These specifications conform with guidance contained in the MARSSIM.

Table Q-2 summarizes the FIDLER estimated gross gamma scan minimum detectable concentration (MDC) as a function of contamination layer thickness and isotope. Attachment A provides the basis for the FIDLER MDCs.

### **Surface Soil Samples**

Surface soil samples will be taken at systematic and biased locations and analyzed for the RCOPC,  $^{99}\text{Tc}$ , a beta emitter not detectable by gross gamma walkover scans. This isotope is detected at low concentrations through the use of liquid scintillation. Surface soil samples are collected and sent to an approved lab for analysis.

$^{99}\text{Tc}$  is a highly mobile element in the environment and may not necessarily be found in close proximity to the uranium with which it was initially associated. Samples are collected at systematic locations and at locations exhibiting gamma scan walkover Z-score plots in excess

of 3.0. Ten percent of the soil samples will be analyzed for <sup>99</sup>Tc. The samples will be biased to assure adequate sampling coverage of the Site.

Gamma spectroscopy will be performed on 100 percent of the soil samples to provide an estimate of the uranium, and thorium levels as well as other gamma emitting species. Uranium-238, uranium-235, and thorium-232 levels may be directly estimated from the gamma spectroscopy. These surface soils samples will be used select the soil samples to be selected for laboratory alpha spectroscopy.

Ten percent of the soil and sediment samples from each AOC will be analyzed for isotopic uranium using alpha spectroscopy. Plutonium is a potential contaminant associated with recycled uranium. One plutonium isotopic sample will be chosen per AOC. The plutonium samples will be chosen based upon presence of the gamma spectroscopy results indicating the plutonium daughter <sup>241</sup>Am. In the absence of detection of <sup>241</sup>Am, soil sample levels of <sup>238</sup>U exceeding the NRC interim screening value for soil surface contamination of 14 pCi/g will be used to determine which sample is chosen for plutonium alpha spectroscopy analysis.

The following table summarizes the fraction of soil samples analyzed and the minimum detectable concentration (MDC) by sample analysis type.

SAMPLE ANALYSIS	SOIL / SEDIMENT	
	Fraction of Samples Taken	MDC (pCi/g)
Gamma Spectroscopy	1.0	0.5 (Cs-137)
Alpha Spectroscopy (uranium)	0.1 / AOC	0.1
Alpha Spectroscopy (plutonium)	1 Sample/ AOC	0.1
Technetium-99	0.1 / AOC	10

### **Collection of Soil Cores/Discrete Samples**

A direct push drilling rig will be utilized during the advancement of soil borings. Soil vapor samples will be collected and screened with an on-site gas chromatograph (GC) to detect zones of contamination and to assist in the collection of soil samples as well as to assist in the placement of monitoring wells.

Continuous soil cores inserted by means of direct push technology direct push will be collected at each boring location. Soil cores will vary in length depending on location and may be withdrawn in acrylic sleeves or split spoon type cores. Soil cores will be approximately 4 ft in length and will be withdrawn in acrylic sleeves where practical. The continuous soil cores will be collected to depths of up to 25 ft below ground surface (bgs) or refusal. The core length will be scanned by a GM detector as described in the next section, GM Scans of Soil Cores, identifying the area of highest counts. Following this step, the core soil volume at the area of highest counts and soil 6-8 inches on either side of the chosen area

are removed to provide a sample volume of approximately 1 liter. A second sample comprised of the soil surface and 6-12 inches bgs of soil will be collected to provide a sample volume of approximately 1 liter. The collected samples will be analyzed by gamma spectroscopy and liquid scintillation to provide a measure of the surface and vertical distribution of RCOPCs. The remaining portion of the core will be available for additional analysis should additional vertical analysis information be requested.

### **GM Scans of Soil Cores**

Soil cores will be scanned with a Geiger-Mueller (GM) detector to identify sub-surface soil with elevated radioactivity concentrations. The results of these scans will provide semi-quantitative data regarding the potential for elevated uranium, thorium, and technetium in soil cores. The potential for the detection of highly mobile and soluble technetium contamination in soil is low, but may be observed.

GM measurements provide readings, in units of counts per minute, which are proportional to the soil surface beta/gamma emission rate at the measurement locations. Although these measurements are quantitative in nature, detector readings are influenced by any beta or gamma emitting radionuclides and are not specific to uranium, thorium or technetium contamination and therefore are used in a semi-quantitative manner. Significant count rates (estimated exceeding background by a factor of 3) may indicate the presence of a RCOPC.

These GM scans will be performed using a 15 cm diameter pancake GM detector coupled to a rate meter. Following soil core withdrawal, a core-cutting device will be used to open a portion of the acrylic sleeve along the entire length of the sleeve. The GM detector will be held as close as practical to the exposed soil and slowly moved along the entire length of the core. The audible output of the detector and deflection of the count rate needle will be monitored during the scan. The detector count rate will be recorded at the two locations of concern. These locations are the core surface elevation to 6-12 inches bgs and a second core area with the highest count rate. One minute static GM count rates will be provided for these 2 core scans. During the scan, any areas clearly in excess of the ambient background level will be noted and recorded along with the vertical depth bgs.

The GM estimated gross gamma scan minimum detectable concentration (MDC) is estimated to be 72 pCi/g for a background of 100 cpm when measuring natural uranium. The scan value will decrease to approximately 23 pCi/g for a 1-minute static count for a 100 cpm background. These values will increase or decrease as a function of <sup>235</sup>U enrichments and presence of <sup>99</sup>Tc. Attachment B provides the basis for the GM MDCs for soil cores.

### **Groundwater and Surface Water Samples**

Groundwater and surface water samples will be collected from existing wells, at down-hole direct push locations, and from onsite surface water bodies. The water will be analyzed for

gross alpha/beta. Ten percent of the samples will be further analyzed for isotopic uranium ( $^{238}\text{U}$ ,  $^{235}\text{U}$ ,  $^{234}\text{U}$ ) and  $^{99}\text{Tc}$  analysis.

The following table summarizes the fraction of water samples analyzed and the minimum detectable concentration (MDC) by sample analysis type.

SAMPLE ANALYSIS	WATER	
	Percentage of Samples Collected	MDC (pCi/l)
Gross Alpha/Beta	100%	3.0/4.0
Alpha Spectroscopy (uranium)	10%	0.1
Technetium-99	10%	1

### Contract Laboratory Sample Analyses

Based on previous investigations and Site knowledge, RCOPCs are limited to isotopes of uranium and thorium and their progeny, and  $^{99}\text{Tc}$ . Figures F-1, F-2, and F-3 show the decay scheme for the RCOPC's uranium and thorium. Technetium is not depicted since it does not exhibit a decay chain and decays to a stable isotope. The radiological samples proposed for each Area of Concern are shown on Table Q-3, along with the number of each type, the media in which the samples will be obtained, and the analyte for which each sample will be analyzed. Samples collected on Site will identify and quantify the nature and extent of contaminants, while, if collected, samples in the Reference Areas will provide estimates of background radionuclide concentrations. The following radiological analyses will be performed on volumetric samples submitted to the laboratory:

Soil samples will be analyzed by gamma spectroscopy using EPA method 901.1M to identify/quantify  $^{235}\text{U}$  and  $^{238}\text{U}$ , along with other gamma emitting radionuclides, if any.

Soil samples collected for  $^{99}\text{Tc}$  analysis will be analyzed by liquid scintillation to identify/quantify  $^{99}\text{Tc}$  using a modified version of EPA 906.0. Soil samples will be screened on Site by gamma spectroscopy to semi quantitatively identify/quantify  $^{235}\text{U}$  and  $^{238}\text{U}$ , along with other gamma emitting radionuclides, if any. Results of these analyses can be used to direct additional samples if necessary while in the field.

A select subset (5% to 10% of soil and sediment samples will be analyzed for isotopic uranium and plutonium by alpha spectroscopy ( $^{234}\text{U}$ ,  $^{235}\text{U}$ ,  $^{238}\text{U}$ ,  $^{238}\text{Pu}$ , and  $^{239/240}\text{Pu}$ ) using EPA ASTM 3972-90M.

Groundwater samples will be analyzed for gross alpha and beta radiation using EPA method 900.0 and for  $^{99}\text{Tc}$  using liquid scintillation with EPA 906.0 modified. A select subset will be analyzed for isotopic uranium by alpha spectroscopy ( $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ).

### *CCOPCs*

Determination of the vertical and horizontal extent of groundwater contamination and verifying whether VOCs have reached the surface water bodies are necessary inputs to the decision. VOCs that have been detected in groundwater are various chlorinated compounds (1,1-DCE, 1,1-DCA, cis 1,2-DCE, total 1,2-DCE, TCE, PCE and vinyl chloride) and carbon disulfide. The following field activities will take place in order to gather the necessary data. The chemical samples proposed for each AOC are shown on Table Q-4.

### **Baseline Groundwater Sampling and Analysis**

Groundwater samples from existing monitoring wells will be sampled and analyzed for the full suite analyses to include; VOCs (USEPA Method 8260), SVOCs (USEPA Method 8270), Organochlorine pesticides and PCBs (Method 8081/8082), TAL metals (Methods 6010/7471), fluoride (Method 9214), sulfate (Method 300), nitrate/nitrite (Method 300). The purpose of the baseline groundwater sampling is to establish a baseline of current contaminant levels present in the groundwater at the Site.

### **Groundwater Quality Assessment**

Groundwater quality will be evaluated at AOCs by installing temporary monitoring wells as described in Section 4.4.2.3 of the RI/FS Work Plan. Groundwater samples will be obtained and submitted to a Westinghouse-approved analytical laboratory for analyses. Temporary monitoring wells will be installed in both the shallow unconsolidated unit as well as into the bedrock as described in the Field Sampling Plan, Section 4.4 of the RI/FS Work Plan.

### **Surface Water and Sediment Sample Analyses**

Surface water and sediment samples will be obtained from the Northeast Site Creek, the Site Pond, and from Joachim Creek to ascertain whether or not these surface water bodies have been impacted by the CCOPCs. CCOPCs detected in surface waters include PCE, and carbon disulfide. Due to the limited number of surface water and sediment samples and the limited analyses previously conducted, a full suite of analyses is proposed for the surface water and sediment samples. Samples will be submitted to a Westinghouse-approved analytical laboratory and analyzed for; VOCs (USEPA Method 8260), SVOCs (USEPA Method 8270), Organochlorine pesticides and PCBs (Method 8081/8082), fluoride (Method 9214) and TAL metals (Method 6010/7471).

### **Soil Sample Analyses**

Previous soil samples were analyzed for VOCs only (with respect to CCOPCs). All soil samples collected for this RI/FS program will be analyzed for the full suite to include: VOCs (USEPA Method 8260), SVOCs (USEPA Method 8270), Organochlorine pesticides and PCBs (Method 8081/8082), fluoride (Method 9214) and TAL metals (Method 6010/7471).

Exceptions will include the addition of total petroleum hydrocarbons (TPH, Method 8015) to the former gas station AOC and dioxin (Method 3290) to the Cistern/burn Pit AOC.

#### **Step 4: – Define the Study Boundaries**

The population of interest is surface and shallow sub-surface soil that may have been contaminated with RCOPCs during historical Site operations. Section 4.4.2.3 of the RI/FS Work Plan provides a basis for RCOPCs by AOC. The population of interest for the CCOPCs is primarily groundwater and surface water, however, soils will be field screened and discrete soil samples may be selected for analysis.

#### **Spatial Boundaries of the Decision Statement**

The population of interest for this RI is horizontally limited to the 228-acre facility property. Boundaries may be expanded if the results of survey activities indicate that expansion of these areas is appropriate. The population of interest has not been vertically limited at this time.

#### **Constraints on Data Collection**

Data collection activities can be constrained due to excessive soil moisture, rain, or snow, which can impact the ability of equipment to traverse the study area, can result in unsafe conditions, and can reduce gross gamma detection sensitivity due to increased gamma attenuation from water. Gross gamma walkover surveys will not be performed in any areas with standing water or saturated soil in the first six inches below ground surface.

#### **Step 5: – Develop a Decision Rule**

The intent of this effort is to identify surface soil, sediments, below grade soils and water samples where radionuclide concentrations exceed background and where VOC concentrations in groundwater and surface water exceed applicable standards. Data collected will be evaluated to determine the need for additional actions. Radiological data from the gamma walkover survey will be transformed into “z-scores”, which are values describing the number of standard deviations given data points are from the arithmetic mean of the sample set. Data from locations exhibiting z-scores greater than three will be evaluated to determine the need for further investigation. Results from radiological laboratory analyses will be compared to radionuclide concentration values from background locations for the same purpose. NRC interim soil surface screening values for  $^{238}\text{U}$  (14 pCi/g) may be used to determine the need for further analysis. Results of samples taken for evaluation of VOCs will be compared to the applicable Missouri Water Quality Standards to determine the need for additional investigation.

### **Step 6: – Specify Limits on Decision Errors**

The quality applicable to off-site laboratory data generated during this effort is categorized as definitive data. Definitive data are generated using rigorous analytical methods such as approved USEPA reference methods. Data are analyte-specific and both identification and quantification are confirmed. These methods have standardized quality control and documentation requirements. Definitive data are not restricted in their use unless quality problems require data qualification. Specific quality control procedures to define the acceptable range of precision, accuracy, and representativeness are presented in Tables Q-5 and Q-6. Data will be validated and will be flagged or rejected if the requirements are not adequately fulfilled. Field gamma spectroscopy sample screening data will undergo similar levels of quality control.

Gross gamma data is not radionuclide-specific and is generally recorded in units of counts (or interactions) per unit time (e.g., counts per minute). Changing the instrument's upper or lower level pulse discriminator and/or operating voltage can significantly affect the response of a gross gamma detector to a given source. Such settings are typically established during instrument calibration. Thus, if more than one gross gamma instrument is used during this effort, it is important that the detectors' response is matched during calibration, to the extent practical. Response differences greater than 10% at the time of calibration will not be accepted.

### **Step 7: – Optimize the Design for Obtaining Data**

To the extent practical, the design for collecting data presented in the RI/FS Work Plan and summarized in this appendix has been optimized to achieve the stated DQOs. The scope of work and data collection process has been designed to provide near real-time data during implementation of field activities. This data will be used to modify and expand the scope of field activities, as needed, to ensure the DQOs are met.

### **Data Quality Assessment**

The DQOs discussed in this QAPP will be met by ensuring that the following analytical objectives are met. These analytical objectives are:

- To collect and analyze samples under controlled situations using standard methods.
- To obtain usable and defensible analytical results.

The following sections discuss the steps that will be taken to ensure the validity of the data acquired during the Hematite Site work. The representativeness of the measurement data is a function of the sampling strategy and will be achieved by following the procedures discussed in the Section 4.4. The quality of the analytical results is a function of the analytical system

and will be achieved by using standard methods and the quality control system discussed in this section. The basis for assessing precision, accuracy, completeness, representativeness, and comparability is discussed in the following subsections.

### **Definition of Criteria**

This section defines how project analytical measurement data objectives will be assessed during the Hematite Site work.

The intent of this effort is to identify where the RCOPC concentrations exceed background. Data is being collected on Site and in a background Reference Area. The Reference Area has been selected at a non-impacted area of similar topography and geologic composition.

In order to resolve the decision statement, estimates of RCOPC concentrations in soil and water, in excess of background, across the Site are necessary. These data will be used to support development of baseline human health risk assessment.

The RI field program has been developed to provide real and near real-time feedback through the implementation of on-site radiological screening measurements. The following decision rules pertaining to these measurements will be used during implementation of the field effort to ensure proper and sufficient data is collected to meet projects objectives.

#### *Gross Gamma Walk-over*

As stated previously, position-correlated gross gamma walkover will be translated into Z-scores, contoured, and graphically plotted. Gross gamma data will be evaluated separately for each AOC. The investigation level for these plots will be locations where Z-score contours exceed 3 (i.e., locations where gamma count rates are 3 standard deviations greater than the average count rate). Locations exceeding this investigation level will be considered for biased sampling. In addition, if areas exceeding the investigation level are identified on or near the perimeter of an AOC, the boundaries of the area may be expanded as appropriate.

It should be noted that Site surface features might prove the gross gamma walkover investigation levels to be impractical due to the gravel that covers Site surface soils to varying thicknesses. The presence of gravel that varies in thickness would provide varying degrees of attenuation to gammas emitted from the soil and can result in significantly different surface gross gamma fluence rates and associated instrument response. Such variations could frequently trigger investigation levels in areas that are not impacted by Site radiological operations and result in the needless collection of biased samples or expansion of boundaries. If the results of on-site gamma spectroscopy laboratory screening indicate that investigation levels are inappropriate, with the approval of the WPM, qualitative review of gross gamma walk-over measurements may be used to select biased sample locations. Aberrant data will be identified, resolved, and removed during analysis.

### *Surface Soil Samples*

The surface soil samples will be taken at systematic and biased locations and analyzed by gamma spectroscopy and liquid scintillation for  $^{99}\text{Tc}$ , a beta emitter not detectable by gross gamma walkover scans or gamma spectroscopy. One hundred percent of the surface soil samples (including soil core surface volumes) will be analyzed by gamma spectroscopy. Based on the gamma spectroscopy results, the highest 10% concentrations of  $^{235}\text{U}$  samples in each AOC will be analyzed by alpha spectroscopy for uranium isotopes and  $^{99}\text{Tc}$ . One sample per AOC will be analyzed by plutonium spectroscopy for plutonium isotopes. Soil samples chosen for plutonium alpha spectroscopy will be based upon the presence of  $^{241}\text{Am}$ . In the absence of  $^{241}\text{Am}$ , levels of  $^{238}\text{U}$  exceeding the NRC interim screening value for soil surface contamination of 14 pCi/g will be used to determine which sample is chosen for plutonium alpha spectroscopy analysis. Aberrant data will be identified, resolved, and removed during analysis.

### *GM Scans of Soil Cores*

The results of GM measurements will be evaluated based on comparison to reference measurements and the results of other measurements in the same borehole. GM measurements on the reference soil cores will be used to establish the average background GM response. The investigation of core readings in potentially impacted Site areas will include the analysis by gamma spectroscopy and liquid scintillation of the surface level to 6-12 inches bgs and the highest core count rate at a second location on the core sample. One minute static GM count rates will be provided for these 2 core scans. Core GM scan count rates a levels seceding 3 times the average background response will be recorded by depth bgs and GM count rate. Aberrant data will be identified, resolved, and removed during analysis.

### *Groundwater and Surface Water Samples*

Groundwater and surface water samples will be collected from existing wells, at down-hole direct push locations, and from surface bodies of water. The water will be analyzed for gross alpha/beta. A selected 10-20 percent of the samples will be further analyzed for isotopic uranium ( $^{238}\text{U}$ ,  $^{235}\text{U}$ ,  $^{234}\text{U}$ ) and  $^{99}\text{Tc}$  analysis. Aberrant data will be identified, resolved, and removed during analysis.

### *Precision*

Precision measures the reproducibility of repetitive measurements. Precision is strictly defined as the degree of mutual agreement among independent measurements as the result of the repeated application of the same process under similar conditions. Analytical precision is a measurement of the variability associated with duplicate (2) or replicate (more than 2) analyses of the same sample in the laboratory and is determined by analysis of matrix spike duplicates or laboratory control sample duplicates. Total precision is a measurement of the

variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and includes all possible sources of variability. Precision will be estimated for this work using the relative percent difference (RPD) between duplicate measurements of laboratory control samples. In cases in which one of more of the reported values is less than the MDC no RPD value can be reported. This condition will be noted on the appropriate report.

RPDs for laboratory control samples outside specified criteria indicate the analytical system is out of control and require batch-related samples to be reanalyzed. Precision of the analytical measurement system will not be assessed by matrix spike duplicates nor field duplicates, both of which contain matrix effects, which cannot be controlled. Results of these duplicate determinations will be used to evaluate the total precision possible in natural-matrix sample results.

#### *Accuracy*

Accuracy is a statistical measurement of correctness, and includes components of random error (variability due to imprecision) and systematic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value. Analytical method accuracy is typically measured by determining the percent recovery of known target analytes that are spiked into a field sample (a matrix spike) or reagent water or soil (laboratory control sample) before extraction, at known concentrations. Bias in terms of “percent of recovery” is evaluated to determine the accuracy. Surrogate compound recovery is another spiking technique used to assess method accuracy for each sample analyzed for organic compounds. The stated accuracy objectives apply to spiking levels at five times the method detection limits or higher. The individual methods provide equations for acceptance criteria at lower spiking levels.

Both accuracy and precision are calculated for specific sampling or analytical batches, and the associated sample results must be interpreted considering these specific measures. An additional consideration in applying accuracy and precision is the concentration level of the samples; a procedure capable of producing the same value within 50% would be considered precise for low-level (near the detection limit) analyses of minor constituents, but would be unacceptable, and possibly useless, for major constituents at high concentrations.

Accuracy goals will be met if individual laboratory control sample recoveries are within approved criteria. Laboratory control sample recoveries outside criteria indicate the analytical system is out of control and require samples to be reanalyzed.

#### *Completeness*

Completeness is calculated from the aggregation of data for each method for any particular sampling event. For each method and each Site, the number of valid results, divided by the

number of individual analyte results initially planned for, expressed as a percentage, determines the completeness for the data set. The objective for completeness is 90%.

Valid results used to meet completeness objectives are those results that provide defensible estimates of the true concentration of an analyte in a sample. These valid results include data that is not qualified and data for which QC results indicate qualification is necessary but which may still be used to meet project objectives. Invalid results are those data for which there is an indication that the prescribed sampling or analytical protocol was not followed.

#### *Representativeness*

Objectives for representativeness will be defined for each sampling and analysis task and will be a function of the investigative objectives. Representativeness will be achieved in part through use of the standard sampling and analytical procedures described in the RI/FS Work Plan and this QAPP. Representativeness is also determined or influenced by appropriate program design, considering elements such as proper well locations, drilling and installation procedures, or sampling locations. The Site-specific program design that includes sampling locations and procedures is described in the RI/FS Work Plan.

#### *Comparability*

Comparability is the confidence with which one data set can be compared to other data sets. The objectives for this QA/QC program are to produce data with the greatest degree of comparability possible. The number of matrices that will be sampled and the range of field conditions encountered must be considered in ultimately determining comparability. Comparability will be achieved by using standard methods for sampling and analysis, reporting data in standard units, and using standard and comprehensive reporting formats. Analysis of reference samples may also be used to provide additional information that can be used to assess comparability of analytical data produced within the laboratory and among laboratories, if more than one laboratory is used on the project. However, for this project, all reasonable attempts will be made to attain 85% completeness or better (field and laboratory). The completeness goal for laboratory measurements is 90%.

### **1.5 Special Training/Certification (QA/R-5 Element A8)**

Where relevant and appropriate as required by OSHA 1910.120 all personnel for the FFCF project will have completed the 40-hour basic hazardous waste (HAZWOPER) training program and the annual 8-hour HAZWOPER refresher. For relevant and applicable work situations supervisory personnel will have completed the 8-hour supervisory training program as required by 29 CFR 1910.120. Documentation of current OSHA training will be kept on-site.

The roles of each team member are described in Sections 1.2. These key project personnel should be familiar with the content of this QAPP, thus obtaining a project overview, including

information on all functions of the measurement systems, from sampling to data validation and reporting. The PM is responsible for ensuring that project participants are properly trained to perform individual tasks. Additional guidance about actual site operations for this project is provided to the site operators in the form of checklists, field forms, SOPs, and other material forming part of this QAPP. In addition, all project personnel must review and understand the SOPs applicable to their respective area of responsibility.

The indoctrination of new personnel will be accomplished through their reading of the appropriate SOPs, coupled with on-the-job training by experienced personnel. If major revisions or enhancements are made to this QAPP or SOPs, all affected individuals must review those revisions at that time.

Site specific training required in order to work within the radiologically restricted area (fenced area of Site) includes:

- Criticality safety
- Radiological safety
- Contamination control
- Security control
- Emergency response

#### **1.6 Documentation and Records (*QA/R-5 Element A9*)**

This QAPP summarizes FFCF project measurements, defines data quality indicators, and specifies data quality objectives. Field and laboratory SOPs developed for the FFCF project are followed and revised as needed. Revisions made to SOPs during the study period are noted and archived for traceability.

##### **Definitions:**

Forms – Prepared documentation provided to ensure compliance against requirements. Forms have predefined fields for recording data.

Logs – Logs provide day-to-day documentation in a chronological fashion to identify what transpired during the execution of a project.

Reports – Reports provide a compilation of project data, the analysis of that data and the conclusions derived from the data analysis

Quality Records – Quality Records (Records) shall be recognized as any compilation of logs, forms or reports which pertain to a project or to regulatory compliance.

Receipts – Documentation of transfer of records from one individual or organization to another.

Records will be prepared in dark ink and shall be clear, neat, accurate and concise. Pre-prepared forms shall be used whenever available to collect information such as survey data or instrument analysis results. When a procedure has defined a form for a specific purpose, the PM may authorize generation of the proper method of documentation

Controlled records shall be transferred using the EDMS 2000 Documentum Workspace owned by Westinghouse Electric Corporation. EDMS 2000 meets NRC and ISO requirements for the long-term storage of records and is the Westinghouse standard application for document workflow, delivery and storage processes. Controlled records produced by subcontractors and suppliers will be provided electronically for input into the EDMS system. EDMS also has the capacity to scan documents for input into the system. Westinghouse has prepared a Hematite Quality Assurance Program Plan (HQAPP) referencing document control procedures in Section 7.4.

Record corrections will be completed by drawing a single line through the error and making the correction adjacent to the error. The line out shall be initialed and dated by the corrector.

Relevant and appropriate project information will be retained in project files. The information contained in these files may include, but is not necessarily limited to, the following items:

- Chain-of-custody records
- Field notes and information
- Correspondence and telephone memoranda
- Meeting notes
- Laboratory information; sample receipt forms
- Data evaluation information
- Reference information
- Audit information
- Copies of reports

These files will be retained for a minimum of five years in Westinghouse project files.

## 2.0 MEASUREMENT/DATA ACQUISITION (*EPA QA/R-5 ELEMENT B*)

### 2.1 Sampling Design

The types and numbers of samples required are presented in Table Q-1.

### 2.2 Sampling Procedures (*EPA QA/R-5 Element B2*)

The accuracy of data is dependent upon well conceived and carefully implemented sampling and analysis procedures. The details of the required sampling procedures are provided in the RI/FS Work Plan. In the text and in attachments to this plan, procedures are provided with which samples will be collected or measurements made during the execution of the project. Specifically, compendium Method TO-15 is provided for in-door air sampling. Also, Westinghouse provides an Investigative Derived Waste (IDW) Management Plan as an attachment.

#### Changes in Procedures

Field conditions may require minor and/or major changes to the RI/FS Work Plan and/or QAPP. Any major changes to the procedures detailed in the RI/FS Work Plan and QAPP will be documented and transmitted to the WPM. Approval from the WPM is required prior to actual implementation of any major changes. Minor procedural changes, as determined by the PM, will be documented in the field notebook and laboratory case narrative, as applicable.

#### Acquisition of Samples

Sampling will be performed in accordance with approved project procedures. The procedures discussed in the RI/FS Work Plan will address the following items as applicable:

- A description of the planned sampling locations
- A description of containers, procedures, etc., used for sample collection, preservation, transport and storage
- A discussion of special conditions for the preparation of sampling equipment and containers to avoid sample contamination
- A description of sample preservation methods
- A discussion of the time considerations for shipping samples promptly to the laboratory
- Examples of the custody or chain-of-custody procedures and forms

- A description of the forms, notebooks, and procedures to be used to record sample history, sampling conditions, and analyses to be performed
- A discussion of field QC checks such as rinsate blanks, etc.

Samples shall be adequately marked for identification from the time of collection and packaging through shipping and storage. Marking shall be on a sample label attached to the sample container. Sample identification shall be in accordance with the naming convention specified in Section 4.4.2.4 of the RI/FS Work Plan.

### **2.3 Sample Handling and Custody (*EPA QA/R-5 Element B3*)**

Sample handling and custody procedures ensure sample integrity from the time of sampling through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in the field and laboratory. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession, (2) it is in their view, after being in their possession, (3) it was in their possession and they locked it up or, (4) it is in a designated secure area.

Sample custody will be documented by means of a chain of custody (COC) form (Figure F-5):

- Unique sample identification for each location (Table Q-7)
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples shall be uniquely identified, labeled, and documented in the field at the time of collection in accordance with the RI/FS Work Plan.

Samples for chemical analysis will be packaged, labeled, and placed in coolers with ice or equivalent coolant packs as soon as possible after collection. Radiological sample containers will be packed in coolers as required to preclude any breakage. Coolers containing radiological samples may be shipped at ambient temperature, therefore, the use of ice or coolant packs is not necessary.

Sample containers provided, with the exception of those for radiological analyses will be new, pre-cleaned ICHM Series 200 Eagle Picher, or equivalent, that are provided with certificates of analysis. Sample containers will arrive from the contract laboratory complete with any required preservatives. There are no preservation requirements for radiological samples.

The methods and references for collecting samples are provided in the RI/FS Work Plan. Appropriately prepared (and preserved) sample containers are supplied by the laboratory. Reagents, preservation procedures and analytical holding times will be in accordance with the published analytical methods and USEPA guidelines. Tables Q-8 and Q-9 present analytical methods, sample containers, preservation and analytical hold times for aqueous and for soil and sediment samples. Sample containers will be kept closed until the time each set of sample containers are to be filled. After filling, the containers will be securely closed, residue wiped from the sides of the containers, and immediately placed in a cooler. The sample designation scheme is presented in Table Q-7.

Samples collected in the field shall be transported to the laboratory as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples shall be packed in ice to keep them cool during collection and transportation. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a glass sampling vial or other small container filled with tap water) shall be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory. If the temperature of the samples upon receipt exceeds the temperature requirement (generally plus or minus 2 degrees C), the exceedance shall be documented in laboratory records and discussed with the PM. The decision regarding the potentially affected samples shall also be documented.

Once the samples reach the laboratory, they shall be checked against information on the COC form for anomalies. The condition, temperature, and appropriate preservation of samples shall be checked and documented on the COC form. The occurrence of any anomalies in the received samples and their resolution shall be documented in laboratory records. All sample information shall then be entered into a tracking system, and unique analytical sample identifiers shall be assigned. A copy of this information shall be reviewed by the laboratory for accuracy. Sample holding time tracking begins with the collection of samples and

continues until the analysis is complete. Holding times for methods proposed for this effort are specified in Tables Q-8 and Q-9.

Internal laboratory COC procedures shall also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch. Standard operating procedures (SOPs) describing sample control and custody shall be maintained by the laboratory.

Samples are physical representations collected from a structure or the environment. Chain-of-custody procedures have been established to ensure sample traceability from the time of collection through completion of analysis.

The National Enforcement Investigations Center (NEIC) of USEPA considers a sample to be in custody under the following conditions:

1. It is in your possession; or
2. It is in your view after being in your possession; or
3. It was in your possession and you locked it up; or
4. It is in a designated secure area.

Environmental samples will be handled under strict chain-of-custody procedures beginning in the field. The Field Supervisor will be the field sample custodian and will be responsible for ensuring that the procedures outlined in the RI/FS Work Plan and QAPP are followed. Sample custody for field activities will include the use of chain-of-custody forms, sample labels, custody seals, and field logbooks. Dedicated field logbooks will be used throughout the project to document field activities. Supplies and reagents (source and lot numbers, if appropriate) used for field measurements will be recorded in the field logbooks. The chain-of-custody document is presented as Figure F-5.

Once samples are transported to the laboratory, custodial responsibility is transferred to the Laboratory Sample Manager to assure that the appropriate procedures and methods are followed. The selected laboratory's Quality Assurance Plan (QAP) will detail the laboratory Chain-of-Custody and sample storage procedures. The laboratory will keep final evidence files containing all relevant and appropriate project sample information. This sample information includes, but is not limited to the following items:

- Chain-of-custody records
- Sample log-in receipt forms

- Copies of laboratory sheets
- Copies of bench sheets
- Instrument raw data printouts
- Chromatograms
- Pertinent correspondence memoranda

## **2.4 Chemical Analytical Methods (QA/R-5 Element B4)**

Chemical analyses for this project include methods to detect volatile organic compounds (VOCs) semi-volatile organic compounds (SVOCs), pesticides/PCBs, and metals. Analytical methods to be used at the contract laboratory are EPA Methods 8260, 8270, 8081/8082 and 6010 respectively. In addition nitrate/nitrite and sulfate analytical parameters will be evaluated.

The analytical method to be used for drinking water analysis is EPA Method 524.2.

Laboratory method detection limits and routine reporting limits are provided in Tables Q-10 through Q-15.

## **2.5 Quality Control Samples (QA/R-5 Element B5)**

Field duplicates, matrix spikes (MS), matrix spike duplicates (MSD), and rinsate blanks will be collected and submitted to the analytical laboratory to provide a means to assess the quality of the data resulting from the field sampling program. Field duplicate samples will be analyzed to check for sampling and laboratory reproducibility. Rinsate blanks will be used as a measure of contamination of samples from the sampling equipment. Matrix spike and laboratory control samples will be analyzed to assess if recoveries falling outside acceptance windows are attributable to sample matrix interferences and not to laboratory analytical errors, as well as to measure the accuracy of the analysis. Matrix spike duplicates for organic analytes will be analyzed to evaluate laboratory reproducibility or precision.

Definitive data documentation will be obtained from the laboratories and will be retained within the project files for a minimum of 2 years from the time of receipt from the laboratory.

### **Field Duplicate Procedures**

A field duplicate is an environmental sample, which is divided into two separate aliquots. The aliquots are processed separately and the results compared to evaluate the effects of the matrix on the precision of the analysis. Results are expressed as relative percent difference (RPD) between the duplicate aliquot analyzed. The RPD should be in the (25-35%) range for water samples. Duplicate field samples will be obtained at a rate of 1 per 10 environmental

samples or one per batch of samples (which ever is greater) and submitted to the contract lab as blind samples.

### **Matrix Spike (MS)**

A matrix spike (MS) is an environmental sample to which known concentrations of analytes have been added. The matrix spike is taken through the entire analytical procedure and the recovery of the analytes calculated. Results are expressed as percent recovery of the known amount spiked. The matrix spike is used to evaluate the effect of the sample matrix on the accuracy of the analysis. In addition, matrix spike duplicates (MSD) will be obtained. In order to verify that poor recoveries (recoveries out of control limits) are due to matrix effect and not lab error for either the matrix spike or the matrix spike duplicate, the laboratory will run a blank (deionized water) spiked at the same level as the MS (LCS). The lab must be able to prove that poor spike recoveries are not a result of lab error. Matrix spike analysis will be conducted at a rate of one per matrix per batch of 20 samples, and will be designated as an MS/MSD on the chain-of-custody by field sampling personnel. Extra sample volume will be collected for matrix spike samples. A determination will be made in the field concerning representative matrices.

### **Matrix Spike Duplicate (MSD)**

A matrix spike duplicate (MSD) is the same environmental sample as the MS, which is spiked with known concentrations of analytes. The two spiked aliquots are processed separately and the results compared to evaluate the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as relative percent differences (RPD) between the duplicate samples analyzed and percent recovery. Matrix spike duplicates will be analyzed at a rate of one per batch of 20 samples, and will be designated on the chain-of-custody by field sampling personnel. Extra sample volume will be collected for matrix spike duplicate samples.

### **Rinsate Blanks**

A rinsate blank is prepared in the field by pouring "clean" deionized, distilled (i.e., laboratory provided analyte free) or High Performance Liquid Chromatograph (HPLC) grade water over or through a sample collection device or equipment after it has been decontaminated. A rinsate blank is sometimes referred to as an equipment blank or wash blank. A rinsate blank is prepared at a frequency of one per day of sampling and is analyzed for the analytes being sampled by the sampling equipment.

## Trip Blanks

Each shipment of VOC samples must contain a trip blank for VOC analysis. Trip blanks are identified by date and sequentially numbered when multiple trip blanks are required on any day. Trip blanks will be provided by the analytical laboratory and will travel with VOC samples as they are collected in the field.

### **2.6 Instrument Equipment Testing, Inspection, and Maintenance (QA/R-5 Element B6)**

Prior to deployment in the field, each instrument is tested and inspected. Maintenance frequency varies depending on the instrument. Instrument and equipment testing, inspection, and maintenance requirements are discussed in detail in the SOPs.

### **2.7 Calibration Procedures (QA/R-5 Element B7)**

Instrumentation used on this project will be maintained and calibrated to manufacturer's specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments are maintained. A project file will be kept on equipment used in field screening analysis. Current instrument calibration/maintenance records kept on site for review and inspection will include, at a minimum, the following:

- Name of the equipment
- Equipment identification (model and serial number)
- Manufacturer
- Date of Calibration
- Calibration Due Date

Radiological instruments will be calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for its calibration sources, which shall be NIST traceable. Field instruments will be source-checked periodically throughout the workday relative to the latest calibration record, in accordance with applicable procedures. In addition, the instruments will be checked daily in order to ensure that the calibration is current (i.e., not expired). Written records of daily checks will be maintained and filed in the project file.

#### *Gross Gamma Detector Quality Control and Trending*

Prior to and after daily use, instruments will be QC-checked by comparing the instrument's response to ambient background and to a designated gamma radiation source. More frequent

checks may be required at the discretion of the Site HP. The results of the ambient background and source checks will be recorded in a field logbook or equivalent.

Instrument response to ambient background will be used to establish a mean background response for each instrument, following the system source check but prior to the commencement of gross gamma survey at the study areas. Gamma measurements will be collected in a selected reference location. Reference readings shall be conducted at the beginning of each day prior to collecting data in the field. Results from these surveys will be used to monitor gross fluctuations in gamma fluence in the reference area (e.g., from changes due to barometric pressure and other, non-contaminant related causes), and to check detector response. Please note that the reference measurements are made solely for the purpose of normalizing each day's survey results, as appropriate, and eliminating bias introduced by natural fluctuations in Site radiological conditions. Given the qualitative nature of the scanning portion of this study, no attempt will be made to remove naturally occurring radioactivity from survey data to derive net activity.

Source checks will consist of one to five minute integrated counts with the designated source positioned in a reproducible geometry, performed at the designated location. Instrument response to the designated check source will be plotted on control charts and evaluated against the average established at the start of the field activities. A performance criterion of  $\pm 20\%$  of this average will be used as an investigation action level. The Site HP will investigate results exceeding this criterion and will make appropriate corrections to instrument readings if response is deviated by factors beyond personnel control, such as large humidity or temperature changes. The Site HP has authority to decide whether or not the instrument is acceptable to use or must be removed from service.

During QC checks, instruments used to obtain radiological data should be inspected for physical damage, current calibration and erroneous readings in accordance with applicable protocols. The individual performing these tasks shall document the results in accordance with the associated instrument protocol. Instrumentation that does not meet the specified requirements of calibration, inspection, or response check will be removed from operation. If the instrument fails the QC response check, any data obtained to that point, but after the last successful QC check will be considered invalid due to faulty instrumentation.

### **GPS Quality Control**

A reference location will be established for precision checks of the GPS system(s). At the start of the field effort, when average NaI source and ambient background response is established, the average GPS position will also be established. During subsequent routine checks, GPS position data will be plotted on control charts, compared to the established averages, and recorded in the field logbook. Measurements differing by more than one meter from this average will be investigated and corrective actions may be implemented.

Additional quality control checks/measures will be implemented including mapping control points, viewing plotted survey data, and keeping detailed field notes. Mapping control points

(a discrete point at a known location such as in the corner of a base map) will ensure that the area surveyed will overlay with existing maps. Gamma surveys, when plotted, should exhibit the same configuration as shown in annotated field sketches and field notes. Any anomalies observed by the data processing specialist and/or technicians performing field surveys will be brought to the attention of the PM.

GPS positioning may be affected by overhead obstructions during the course of survey. A loss of satellite signal due to these obstructions will prevent location data collection. The collection of data will not resume until satellite lock is regained (usually by moving past the obstruction). If the signal is lost during a survey, the operator shall continue to walk/drive at constant velocity in a straight line on the same heading until satellite lock has been reestablished or until a boundary is reached. Post-processing may enable interpolation or extrapolation of gamma data between pairs of GPS positional data. Erroneous results will be obtained if the survey team varies its velocity and/or direction. In cases where data interpolation is not possible or practical (e.g., extensive distance between satellite lock positions, etc.) data gaps may be filled by manually surveying areas containing the gaps.

Extrapolation and/or interpolation of gamma data positions beyond good GPS locations require additional post-processing programs or hand editing of data. It is desirable, therefore, to begin and end a survey path with good GPS positions. The survey crew shall extend the beginning or end of a survey path (in a straight line) beyond a designated boundary in order to obtain satellite lock, if necessary.

#### *HPGe Calibration and QC*

The HPGe gamma spectroscopy system will be efficiency calibrated by the manufacturer. Detector energy calibrations (i.e., channel number as a function of gamma energy) will be performed during the survey as necessary, with a radiation source traceable to NIST. The mathematical efficiency modeling algorithms used for *in situ* HPGe (if used) will be evaluated daily using the NIST traceable source.

System quality assurance will be ensured by tracking peak energy, peak resolution, and net peak area for a high and low energy peak, based on daily counts of a NIST traceable source. These quality assurance checks will be performed in accordance with the instrument's standard operating procedure. Instrument control charts will be generated and evaluated in accordance with this procedure and will be included as appendices to the final project report. Additionally, each spectral data report will be reviewed by a qualified radiological engineer, signed by the engineer when approved, and included in appendices to the final project report, along with nuclide identification/quantification libraries.

In ten percent of samples for which HPGe measurements are performed, duplicate measurements will be performed. Duplicate measurements will be compared to the measurements they duplicate by determining a Z-score value for each data set by the following equation:

$$Z = \frac{|S - D|}{\sqrt{\sigma_S^2 + \sigma_D^2}}$$

Where: S, D,  $\equiv$  value of (S)ample and (D)uplicate measurements; and,  
 $\sigma$   $\equiv$  one sigma error associated with (S)ample and (D)uplicate measurements.

The calculated Z-Score results will be compared to a performance criteria of less than or equal to 2.57. The value of 2.57 corresponds to a 99% confidence level, or, 99% of the Z-Score values will be below 2.57, and only 1% of the values will be above this acceptance criteria, if the sample and the duplicate are truly of the same distribution. Calculated Z-values less than 2.57 will be considered acceptable and values greater than 2.57 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- The sample measurement and duplicate or replicate measurement are of the same normally distributed population
- The standard deviations,  $\sigma_S$  and  $\sigma_D$ , represent the true standard deviation of the measured population

#### *PID Calibration and QC*

Prior to daily field operations, the instrument will be checked for electronic calibration and adjusted as necessary. Appropriate standards will be used for establishing instrument settings. If non-compliant instrument performance is noted, the instrument will be checked following the manufacturer's trouble-shooting procedures. Instrument specific calibration and maintenance and records will be placed into bound notebooks and stored by the field operations manager. Details of calibration operations will be described in the contractor procedures.

For a positive response check, use the cap of an indelible pen or other similar source. Calibration gas will be provided per the manufacturer. Typically for chlorinated compounds calibration gases consist of isobutylene and a zero gas. The field operator must be certain not to draw water or other foreign matter into the instrument as that can cause internal drainage. Daily tasks for care and maintenance include the following:

- Calibrate the PID with the proper calibration gas every day before use.
- Document calibration in the project field logbook and the projects calibration log book.

- Perform a positive response check a minimum of twice per day to ensure that the PID is functioning properly.
- Establish ambient air (background) VOC reading and record in field logbook.
- Place the intake port of the PID/FID near the source from which you want to take a reading (e.g., wellhead, open split spoon, etc...).
- A VOC value will appear as a number in parts per million (ppm) on display of the meter.
- Record PID/FID reading in the field logbook and on other appropriate field forms (e.g., boring logs).

## **2.8 Inspection/Acceptance Requirements for Supplies and Consumables (*EPA QA/R-5 Element B8*)**

Field/laboratory supplies, consumables, quantities, cost, frequency of replacement, catalog number. And vendor information are listed in detail in each SOP. Field supervisors are responsible for checking/replenishing supplies.

## **2.9 Non-Direct Measurements (*EPA QA/R-5 ELEMENT B9*)**

Data from file reviews, interviews, and historical assessments will be filed in site files for the FFCF project. This data will be used in support of scoping the RI/FS, and design of field sampling programs. Results from field sampling programs will be utilized to verify non-direct measurements (e.g., interviews and historical assessments).

## **2.10 Data Management (*EPA QA/R-5 Element B10*)**

Analytical data generated by the laboratory will be submitted to the PM in hard-copy and electronic deliverable. The electronic deliverable will be submitted in MS Excel format either on a floppy diskette or email. The excel spreadsheet will then be manipulated by the PM and imported into a database system. The database system will be designed to allow for various queries of the data for reporting requirements. Hard copy deliverables will be kept on file in the FFCF files at the Site.

### **3.0 ASSESSMENT AND OVERSIGHT (*EPA QA/R-5 ELEMENT C*)**

#### **3.1 Assessments and Response Actions (*EPA QA/R-5 Element C1*)**

Success of the project will be evaluated in terms of: 1) accuracy, precision, validity, and completeness of acquired data; 2) extent to which data can be used to develop conclusions; and 3) relevance of project conclusions to overall project objectives. Assessment tools include performance evaluations, data quality assessments, field audits, and project reviews. Project team meetings will be held every other week and verbal reports to the WPM will be provided at these meetings.

#### 4.0 DATA VALIDATION AND USABILITY (*QA/R-5 Element D*)

Data evaluation serves 3 main purposes:

- It qualifies data for further use to ensure data are not inappropriately used;
- It serves as a check on a laboratory to ensure they are meeting contractual deliverables and regulatory requirements;
- It establishes due diligence and allows errors to be addressed sooner in a program, so that the impact will be less than if the errors were detected later.

The contract laboratory will present all the data in the data quality package, along with QC supporting data. The contract laboratory will send a copy of this data quality package to the PM. The details of this package are provided in the following sections.

##### 4.1 Data Review (*EPA QA/R-5 Element D1*)

During the project, the data deliverables to be submitted are listed in this section. All data shall be submitted to the project manager.

###### *Analytical Results*

One data deliverable for chemical analysis results will be formatted in MS Excel spreadsheets and e-mailed to the PM within one month of sample receipt. The laboratory shall provide analytical data in electronic format as described in Appendix A. The hard copy of the analytical results with laboratory quality control/internal check data will be delivered as soon after the electronic package as practically achievable.

- Reported analytes should be bracketed by an established calibration curve.
- The lab should analyze an additional low standard at or near the project Practical Quantitation Limit (PQL).
- Batches of samples analyzed shall be bracketed by appropriate calibration verification standard.
- Corrective action procedures implemented are to be documented, summarize within the case narrative.

Non detects (NDs) is not an acceptable form of data reporting. Results that are below the laboratory's quantitation limit shall be reported as less than their PQLs.

*Laboratory Analytical Data Report Package*

A complete data set shall be submitted to the PM for review for completeness and verification that the DQOs were met.

This deliverable shall contain at a minimum all of the items listed below to allow the PM to perform an adequate data evaluation (Data shall be presented in tabular format whenever possible):

- Sample Identification - Prepare a tabular presentation that matches the contract laboratory sample identifications to the field identification numbers assigned to each sample.
- Cooler Receipt Forms - Provide copies from all sample shipments received at the contract laboratory.
- Chain of Custody Record Forms - Provide copies from all sample shipments received by the contract laboratory.
- General Inorganic Reports - For each analytical method run, report results of all analytes for each sample (concentration detected or less than the specific quantitation limit). On the sample's data sheets, clearly identify the specific analytical batch the sample belongs to and the corresponding QC data reported. Report any dilution factors, as well as date of extraction (if applicable) and date of analysis for each sample.
- Internal Quality Control (QC) Reports - For each analytical batch, report a complete set of QC results. At a minimum, Internal QC samples shall be analyzed at rates specified in the methods.
- At a minimum, the following Internal QC results shall be submitted:
  - (1) Laboratory Blanks (Method and Instrument Blanks) - Report all analytes for each laboratory blank analyzed per sample batch.
  - (2) Surrogate Spike Samples - Report recoveries with all organic method reports, where applicable (i.e. when the method requires surrogate spikes). Also specify the control limits for surrogate spike results, and the concentration used for the spike.
  - (3) Matrix Spike Samples - Report recoveries for all organic and inorganic analyses. Also, specify the control limits for matrix spike results, each method, and matrix.

General sample results shall be designated as corresponding to a particular matrix spike sample.

- (4) Laboratory Duplicates and/or Matrix Spike Duplicate Pairs - Report the Relative Percent Difference (RPD) for each duplicate pair and the analyte/matrix-specific control limits.
- (5) Laboratory Control Samples - When run for a method's internal QC, report the results of the laboratory control sample (LCS) with the corresponding project sample data. Also, specify the control limits for the LCSs.
- (6) Field Duplicates and Field Blanks - Field duplicates shall be identified by the PM, after analysis but just before completion of the Data Report Package. Report the Relative Percent Difference for all field duplicate pairs.

#### **4.2 Data Validation (EPA QA/R-5 Element D2)**

Third party data validation is not anticipated at this time. QA review of non-CLP analyses will be based upon method-specific QC criteria, hold times, blanks, and completeness as specified by the individual analytical methods. Raw data (i.e., bench sheets) and batch QC data will also be reviewed. The overall responsibility for reporting laboratory data lies with the laboratory director. Professional judgment will be used to determine data usability with respect to DQOs and project goals.

Method and rinsate blanks are expected not to contain any target analytes with concentrations greater than the reported detection limit with the possible exception of common laboratory contaminants.

Field and laboratory duplicate results will be assessed based upon the relative percent difference (RPD) between values, using the following equation:

$$RPD = \frac{(D1 - D2)}{(D1 + D2)/2} \times 100\%$$

where, D1 = Primary sample result; and,  
D2 = Duplicate sample result.

Laboratory control spiked samples will be assessed based upon the percent recovery (%R) of spiked analytes. The percent recovery will be calculated using the following equation:

$$\%R = \frac{X}{TV} \times 100\%$$

where, X = observed value of measurement; and,  
TV = "true" value of spiked analyte.

Matrix spike/matrix spike duplicate (MS/MSD) data will be assessed based upon the percent recovery of spiked analytes using the following equation:

$$\% R = \frac{(SSR - SR)}{SA} \times 100\%$$

where, SSR = Spiked sample result for analyte x;  
SR = Sample result for analyte x; and,  
SA = Spike added of analyte x.

The relative percent difference between the MS/MSD results will be calculated using the RPD equation presented above.

Data completeness will be assessed based upon the amount of valid data obtained from a particular measurement system (sampling and analysis). It may be quantitatively expressed using the following equation:

$$\text{Completeness} = \frac{N1}{N2} \times 100\%$$

where, N1 = number of valid measurements obtained; and,  
N2 = number of valid measurements expected.

The laboratory will assess all QC data with regard to precision and accuracy. Corrective actions will be initiated as necessary (see Section 0).

Individuals making field measurements will determine whether field QC criteria and corrective actions will be initiated as necessary.

Laboratory analytical data and field data will be assessed by the PM to determine usability with regard to the DQOs specified in Section 0.

### **4.3 Corrective Action (EPA QA/R-5 Element D3)**

The need for corrective action, if any, will be based upon predetermined limits for acceptability for all aspects of sample collection and analysis. Predetermined limits for acceptability may include, but are not limited to, historical data, laboratory control spike sample results, and experience using the analytical procedures for measurement in relation to the specific methodologies. By following standard QA/QC procedures, problems which could result in erroneous data should be detected. The need for corrective action may be determined by the samplers, analysts, supervisors, quality assurance personnel, laboratory managers and/or PMs.

The selected laboratory's QAP will describe the corrective action procedures used by the laboratory to eliminate problems in the analytical systems. Problems that cannot be resolved by the analysts, laboratory managers or QA officers will be brought to the attention of the PM. The PM will determine the corrective action to be taken, if any.

The laboratory personnel will assess laboratory QC samples, if applicable, and re-analyze samples which do not meet QC criteria prior to expiration of hold times, when possible. Corrective actions for samples not meeting QC criteria may include re-analysis, or re-sampling and analysis. Laboratory personnel use Corrective Action Report forms to document identification and resolution of defects. These report forms are kept on file in the laboratory QA files.

The detection of system and performance problems and the corrective actions procedures to be used in the field during sample collection and data measurement will be documented in the field logbooks and placed in the project files. Any problems that cannot be resolved by the sampler or field manager will be brought to the attention of the WPM. The WPM will determine the corrective action to be taken, if any.

If a system or performance audit uncovers problems requiring corrective action, the corrective action will be initiated upon approval of the responsible supervisor(s). Documentation of corrective actions will be made in a letter report to the WPM.

## **REFERENCES**

- |          |  |
|----------|--|
| EPA 1998 | EPA Guidance for Quality Assurance Project Plans EPA QA/G-5, EPA/600/R-98/018, February 1998 |
| EPA 2000 | EPA Guidance for the Data quality Objectives Process, EPA QA/G-4                             |
| EPA 2000 | Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW        |
| EPA 2001 | EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5                             |

## **TABLES**

TABLE Q-1

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Proposed Drilling, Sampling and Analysis Requirements

Proposed Sampling Area	Area of Concern No. (if applicable)	Number of Proposed Borings	Media of Concern	Number of Proposed Samples	Shown on Plate No.	Proposed Drilling Strategy	Sampler Type	VOC Screen Y/N	Rad Screen Y/N	Completed as Monitoring Well	General Stratigraphic Zone Monitored	Minimum Analytical Requirements	
Ground Water (Existing Monitoring Wells/Piezometers)	1	NA	Ground water	34	14, 17	NA	NA	NA	NA	NA	See Table 5	2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 10, 11, 13	
Surface Water Features	Northeast Site Creek	NA	Stream sediment	6	17	HA	NA	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11	
			Surface water	3								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11	
	Site Pond/Creek	2	8	Surface soil	8	17, 18	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Soil	8								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Stream sediment	7								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
				Surface water	4								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
				Ground water	8								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
	Joachim Creek	NA	Stream sediment	3	17	HA	NA	NA	NA	NA	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Surface water			3	2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11									
Burial Pit Area	3	20	Surface soil	20	19	HA	SC	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9	
Evaporation Ponds	4	20 <sup>1</sup>	Surface soil	20	20	HA, DP	SC	Y	Y	T	U	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9
			Soil	9									4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Ground water	9									2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
Former Leach Field	5	5	Surface soil	5	20	HA, DP	SC	Y	Y	T	U	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9
			Soil	5									4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Ground water	5									2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
Soils Beneath Buildings	6	15	Fill	15	21	HA, DP	SC	Y	Y	T	U	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9
			Surface soil	15									4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	15									4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Ground water	15									2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11

**Drilling Strategy Key**

HA - Hand Auger  
HSA - Hollow Stem Auger  
AR - Air Rotary  
DP - Direct-Push  
DC - Diamond Coring

**Sampler Type Key**

SS - Split-spoon  
CT - Cuttings  
SC - Soil Core  
RC - Rock Core  
TR - Trowel/Spade

**Monitoring Well/Zone Monitoring Key**

P - Permanent  
T - Temporary  
U - Unconsolidated  
JC - Jefferson City-Cotter Dolomite  
RB - Roubidoux Formation

**Analytical Parameters/Methods**

- 1 - Volatile Organic Compounds (VOCs) - EPA 8260
- 2 - Gross Alpha - EPA 900
- 3 - Gross Beta - EPA 900
- 4 - Gamma Spectroscopy - EPA 901.1M
- 5 - Isotopic Uranium by Alpha Spectroscopy - EPA/ASTM 3972-90M
- 6 - <sup>99</sup>Tc Liquid Scintillation - 906.0M
- 7 - Plutonium - EPA/ASTM 3972-90M
- 8 - Total Petroleum Hydrocarbons (TPH) - EPA 8015 OA1/OA2
- 9 - Fluoride - EPA 9214
- 10 - Sulfate - EPA 300
- 11 - Target Compound List/Target Analyte List
  - Volatile Organic Compounds (8260)
  - Sem-volatile Organic Compounds (8270)
  - Organochlorine pesticides and PCBs (8081/8082)
  - 23 metals plus Cyanide (6010/7471/9010)
- 12 - Dioxin - EPA 3290
- 13 - Nitrate/Nitrite by EPA 300

**Notes:**

- <sup>1</sup> Includes surface soil sample locations
  - <sup>2</sup> Includes ground-water samples from completed wells. Ground-water samples may be collected from the bedrock in discrete intervals.
  - <sup>3</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>4</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>5</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>6</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>7</sup> Soil and/or sediment samples which exhibit <sup>241</sup>Am, or greater than 14 pCi/g <sup>238</sup>U, will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>8</sup> 50% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>9</sup> 50% of soil will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>10</sup> 100% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>11</sup> Target Analyte List Metals Only
  - <sup>12</sup> Domestic Well #3 area was addressed during Interim Hydrogeologic Investigation. Additional wells in the vicinity are proposed under AOC #1.
  - <sup>13</sup> A geophysical survey will be performed to locate potential ferrous material and debris. Geophysical anomalies, if found, will be further investigated.
- NA - Not applicable.

TABLE Q-1

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Proposed Drilling, Sampling and Analysis Requirements

Proposed Sampling Area	Area of Concern No. (if applicable)	Number of Proposed Borings	Media of Concern	Number of Proposed Samples	Shown on Plate No.	Proposed Drilling Strategy	Sampler Type	VOC Screen Y/N	Rad Screen Y/N	Completed as Monitoring Well	General Stratigraphic Zone Monitored	Minimum Analytical Requirements
Limestone Storage	7	NA	Limestone Fill	60 (3 composite)	22	NA	TR	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9 (3 comp.), 11 (3 comp.)
Outdoor and Shallow Surface Areas	8	64	Surface soil	64	23	HA, DP	SC	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9
Former Gas Station	9	1	Soil	1	20	DP	SC	Y	N	T	U	8, 9, 11
			Ground water	1								8, 9, 11
Gas Pipeline	10	9	Surface soil	9	18	HA, DP	SC	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	9								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Red Room Roof Burial Area	11	5 <sup>1</sup>	Surface soil	5	23	HA, DP	SC	Y	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	2								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Domestic Well #3 <sup>12</sup>	12	NA	Surface soil	NA	24	HSA, AR, DC	SC, RC, CT	Y	Y	P	JC, RB	NA
			Soil									
			Ground water									
Deul's Mountain	13	2	Surface soil	2	23	HA, DP	SC, TR	N	Y	NA	NA	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
Cistern Burn Pit	14	1	Surface soil	1	23	HA, DP	SC	Y	Y	T	U	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11, 12
			Soil	1								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11, 12
			Ground water	1								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11, 12
Joachim Creek Bridge <sup>13</sup>	15	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA
Exploration for Nature and Extent of Contamination	NA	37	Surface soil	14	6, 7, 16	DP, HSA, AR, DC	SC, SS, RC, CT	Y	Y	T	U (14), RB (11), JC (12)	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Soil	14								4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11
			Ground water <sup>2</sup>	37								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11
Background	NA	11	Soil	30	16	HA, HSA, AR	SS, CT	N	N	P	U (2), JC(1)	4, 5 <sup>5</sup> , 6 <sup>6</sup> , 7 <sup>7</sup> , 9, 11 <sup>11</sup>
			Ground water	3								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11 <sup>11</sup>
			Surface water	4								2, 3, 5 <sup>3</sup> , 6 <sup>4</sup> , 9, 11 <sup>11</sup>
Aquifer Testing Area	NA	18	Ground water	3	26	HSA, DC, AR	SS, RC, CT	N	N	T	U (1), JC (1), RB(1)	6 <sup>10</sup> , 9, 11

**Drilling Strategy Key**

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**Sampler Type Key**

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- 5 - Isotopic Uranium by Alpha Spectroscopy - EPA/ASTM 3972-90M
- 6 - <sup>99</sup>Tc Liquid Scintillation - 906.0M
- 7 - Plutonium - EPA/ASTM 3972-90M
- 8 - Total Petroleum Hydrocarbons (TPH) - EPA 8015 OA1/OA2
- 9 - Fluoride - EPA 9214
- 10 - Sulfate - EPA 300
- 11 - Target Compound List/Target Analyte List
  - Volatile Organic Compounds (8260)
  - Sem-volatile Organic Compounds (8270)
  - Organochlorine pesticides and PCBs (8081/8082)
  - 23 metals plus Cyanide (6010/7471/9010)
- 12 - Dioxin - EPA 3290
- 13 - Nitrate/Nitrite by EPA 300

**Notes:**

- <sup>1</sup> Includes surface soil sample locations
  - <sup>2</sup> Includes ground-water samples from completed wells. Ground-water samples may be collected from the bedrock in discrete intervals.
  - <sup>3</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>4</sup> 10% to 20% of ground-water and surface water samples (or a minimum of one per area of concern), which exhibit elevated alpha and/or beta concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>5</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for isotopic uranium by alpha spectroscopy.
  - <sup>6</sup> 10% of soil and/or sediment samples (or a minimum of one per area of concern), which exhibit elevated gamma concentrations will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>7</sup> Soil and/or sediment samples which exhibit <sup>241</sup>Am, or greater than 14 pCi/g <sup>238</sup>U, will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>8</sup> 50% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>9</sup> 50% of soil will be analyzed for Plutonium. At least one soil/sediment sample per area of concern will be analyzed for Plutonium.
  - <sup>10</sup> 100% of soil samples will be analyzed for <sup>99</sup>Tc by liquid scintillation.
  - <sup>11</sup> Target Analyte List Metals Only
  - <sup>12</sup> Domestic Well #3 area was addressed during Interim Hydrogeologic Investigation. Additional wells in the vicinity are proposed under AOC #1.
  - <sup>13</sup> A geophysical survey will be performed to locate potential ferrous material and debris. Geophysical anomalies, if found, will be further investigated.
- NA - Not applicable.

TABLE Q-2

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Estimated FIDLER Gross Gamma Scan MDCs

<i>Geometry</i> <sup>(1, 2)</sup>	<i>Estimated Scan MDC (pCi/g)</i> <sup>(3)</sup>									
	<i>Thorium (15 cm thick layer) Series</i> <sup>(4)</sup>	<i>Thorium (1 inch thick layer) Series</i> <sup>(4)</sup>	<i>DU (15 cm thick layer)</i>	<i>DU (1 inch thick layer)</i>	<i>Natural Uranium (15 cm thick layer)</i> <sup>(5)</sup>	<i>Natural Uranium (1 inch thick layer)</i> <sup>(5)</sup>	<i>LEU (15 cm thick layer)</i> <sup>(6)</sup>	<i>LEU (1 inch thick layer)</i> <sup>(6)</sup>	<i>HEU (15 cm thick layer)</i> <sup>(7)</sup>	<i>HEU (1 inch thick layer)</i> <sup>(7)</sup>
Detector centered over material	0.46	1.0	4.9	9.4	7.2	14.1	12.6	26.4	24.2	54.4

- Notes:**
- <sup>(1)</sup> All geometries based on assumed cylindrical volume of radioactive material with 56 cm diameter, 15 cm thickness or 1 inch thickness, and soil density of 1.6 grams per cm<sup>3</sup>.
  - <sup>(2)</sup> Geometry based on detector passing directly over radioactive volume.
  - <sup>(3)</sup> MDCs based on project-specific maximum scan speed of 1.5 feet per second.
  - <sup>(4)</sup> <sup>232</sup>Thorium series is assumed to be in 50-year secular equilibrium with progeny.
  - <sup>(5)</sup> Natural uranium represents uranium series in 50-year secular equilibrium with progeny (activity percents: 48.9% <sup>238</sup>U, 2.2% <sup>235</sup>U, 48.9% <sup>234</sup>U).
  - <sup>(6)</sup> LEU represents low enriched uranium in 50-year equilibrium with progeny (activity percents: 14.7% <sup>238</sup>U, 3.4% <sup>235</sup>U, 81.8% <sup>234</sup>U).
  - <sup>(7)</sup> HEU represents high enriched uranium in 50-year equilibrium with progeny (activity percents: 0.03% <sup>238</sup>U, 2.97% <sup>235</sup>U, 97% <sup>234</sup>U).

TABLE Q-3

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Radionuclides Constituents of Potential Concern by Area of Concern

AOC	Radionuclides	Enrichment	Chemical Speciation
1. Ground Water	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$	LEU, HEU	Unknown
2. Surface Water	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$ , $^{232}\text{Th}$	LEU	Unknown
3. Burial Pits	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{232}\text{Th}$ , $^{99}\text{Tc}$	HEU, LEU, DU, N	$\text{ThO}_2$ , $\text{UO}_2$ , $\text{U}_3\text{O}_8$ , $\text{UF}_4$ , $\text{U}_{\text{metal}}$ , $\text{UC}_4$ ,
4. Former Evaporation Ponds	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$ , $^{232}\text{Th}$	HEU, LEU, NAT, DU	Uranyl nitrate, $\text{UO}_2$ , $\text{U}_3\text{O}_8$
5. Former Leach Field	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{232}\text{Th}$ , $^{99}\text{Tc}$	HEU, LEU, DU	Unknown
6. Soil Beneath Buildings	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$ , $^{232}\text{Th}$	HEU, LEU, DU	Uranyl nitrate, $\text{UO}_2$ , $\text{U}_3\text{O}_8$
7. Limestone Storage Areas	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$ , $^{232}\text{Th}$	LEU, DU, NAT	$\text{UO}_2$ , $\text{U}_3\text{O}_8$ , fluorinated compounds of uranium
8. Outdoor Areas	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{99}\text{Tc}$ , $^{232}\text{Th}$	HEU, LEU, DU, NAT	$\text{UO}_2$ , $\text{U}_3\text{O}_8$
9. Former Gas Station	None	NA	NA
10. Gas Pipeline	$^{99}\text{Tc}$ , $^{232}\text{Th}$	NA	Unknown
11. Red Room Roof Burial Area	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{232}\text{Th}$	HEU, LEU, DU, NAT	$\text{UO}_2$ , $\text{U}_3\text{O}_8$ ,
12. Domestic Well #3	None	NA	NA
13. Deul's Mountain	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{232}\text{Th}$	HEU, LEU, DU, NAT	$\text{UO}_2$ , $\text{U}_3\text{O}_8$
14. Cistern Burn Pit Area	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , $^{232}\text{Th}$	HEU, LEU, DU, NAT	$\text{UO}_2$ , $\text{U}_3\text{O}_8$
15. Joachim Creek Bridge	None	NA	NA

HEU – High enriched uranium (20 to 93 percent  $^{235}\text{U}$ )  
 LEU – Low enriched uranium (0.71 to 20 percent  $^{235}\text{U}$ , typically ~4%  $^{235}\text{U}$ )  
 DU - Depleted uranium (<0.2 %  $^{235}\text{U}$ )  
 NAT – Natural uranium (0.71 %  $^{235}\text{U}$ )  
 $^{232}\text{Th}$  is understood to be in secular equilibrium with its daughters.

**TABLE Q-4**

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Chemical Constituents of Potential Concern by Area of Concern**

<b>AOC</b>	<b>Chemical Constituents of Potential Concern</b>
1. Ground Water	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
2. Surface Water	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
3. Burial Pits	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
4. Former Evaporation Ponds	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
5. Former Leach Field	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
6. Soil Beneath Buildings	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
7. Limestone Storage Areas	Fluoride
8. Outdoor Areas	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
9. Former Gas Station	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), SVOCs, TPH, Metals
10. Gas Pipeline	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products), Fluoride
11. Red Room Roof Burial Area	Fluoride
12. Domestic Well #3	VOCs (Perchloroethylene, Trichloroethylene and associated degradation products)
13. Deul's Mountain	Fluoride
14. Cistern Burn Pit Area	VOCs, (Perchloroethylene, Trichloroethylene and associated degradation products), SVOCs, Metals, Dioxin, Fluoride
15. Joachim Creek Bridge	None

**Note:** Chemical constituents of potential concern identified above are those which are thought to have potentially impacted a particular AOC. The minimum analytical requirements listed by AOC on Table 3 may include additional chemicals not listed in Table 2, but will be performed for negative documentation purposes. Therefore, chemical constituents of potential concern and minimum analytical requirements in Tables 2 and 3, respectively, will not always correlate.

**TABLE Q-5**

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Quality Control Acceptance Criteria for Alpha Spectroscopy**

<b>Parameter</b>	<b>Aqueous Matrix Spike</b>		<b>Solid Matrix Spike</b>		<b>LCS Spike</b>	
	<b>Accuracy (% Recovery)</b>	<b>Precision (RPD)</b>	<b>Accuracy (% Recovery)</b>	<b>Precision (RPD)</b>	<b>Accuracy (% Recovery)</b>	<b>Precision (RPD)</b>
Isotopic Uranium	80-120	20	70-130	20	70-130	20
Isotopic Thorium	80-120	20	70-130	20	70-130	20

RPD = Relative percent difference.

LCS = Laboratory control sample.

NA = Not applicable.

**TABLE Q-6**

**WESTINGHOUSE ELECTRIC FACILITY  
HEMATITE MISSOURI FACILITY**

**Quality Control Measures and Criteria for Radiological Analyses**

<b>Analytical Method</b>	<b>Applicable Parameter</b>	<b>Quality Control Check</b>	<b>Minimum Frequency</b>	<b>Acceptance Criteria</b>	<b>Corrective Action<sup>a</sup></b>
HASL-300	Isotopic Thorium	Efficiency/ Background Check	Daily	Investigation Level: average response $\pm$ 2 sigma.  Action Level: average response $\pm$ 3 sigma.	1. Repeat check if failure is greater than investigation level but less than action level. If second check exceeds investigation level, remove from service and contact CSC. 2. If check exceeds action level, remove from service and contact CSC.
		LCS/LCS Duplicate	One LCS/LCSD pair per analytical batch	Recovery within QC Acceptance Criteria in Table Q3	1. Accuracy: a. If recoveries are out in both the LCS and LCSD, stop and correct problem. Contact the CSC for instructions on re-analysis or re-preparation. b. If the result is out in either the LCS or LCSD, check the calibration. If the recoveries for the calibration are acceptable, proceed with analyses. If results are still out, stop and correct instrument problem. Contact the CSC for instructions on reanalysis or re-preparation. 2. Precision: Demonstrate acceptable RPDs for analyses that failed by analyzing a 3rd LCS. If RPDs between the 3rd and either LCS or LCSD are acceptable, proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem. Contact the CSC for approval to proceed, write QCER.

TABLE Q-6 (continued)

WESTINGHOUSE ELECTRIC FACILITY

HEMATITE MISSOURI FACILITY

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action <sup>a</sup>
		MS/MS Duplicate	1 MS/MSD per extraction batch	QC Acceptance Criteria in Table Q3	1. If either MS or MSD is outside of either accuracy or precision tolerances and LCS/LCSD results are acceptable, then flag MS/MSD results and write QCER 2. Contact CSC to determine if special measures should be performed in an attempt to resolve matrix interferences.
		Method Blanks	1 per extraction batch and analytical batch	1. <MDC 2. Must meet surrogate criteria	1. If sample concentration is <MDC or if sample concentration is >10 times the concentration in the method blank, then report results and write QCER; 2. Otherwise, re-extract/reanalyze if still within HT and enough sample volume; if not within HT or enough sample, contact CSC for decision.
		Laboratory Duplicate	One per batch of $\leq 20$ samples, per day, not to exceed 20 samples.	NAD $\leq 1.96$	Flag data. Discuss in Case Narrative.
		Sample Duplicate	One per batch of $\leq 20$ samples, per day, not to exceed 20 samples.	NAD $\leq 1.96$	Flag data. Discuss in Case Narrative.
EPA 901.1	Gamma Spectroscopy	Efficiency/Resolution Check	Daily	Investigation Level: average $\pm 2$ sigma.  Action Level: average $\pm 3$ sigma.	1. Repeat check if failure is greater than investigation level but less than action level. If second check exceeds investigation level, remove from service and contact CSC. 2. If check exceeds action level, remove from service and contact CSC.
		Energy Calibration Check	Daily	Peak centroid $\leq 1$ keV from actual energy	Remove from service and contact CSC.

TABLE Q-6 (continued)

WESTINGHOUSE ELECTRIC FACILITY

HEMATITE MISSOURI FACILITY

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action <sup>a</sup>
		Background Assessment	Weekly	Bounds test established internally at laboratory	1. Perform decontamination on detector, shielding, and associated equipment. 2. R-perform check. If check exceeds action level, remove from service and contact CSC
		Laboratory Duplicate	One per batch of ≤ 20 samples, per day, not to exceed 20 samples.	NAD ≤ 1.96	Flag data. Discuss in Case Narrative.
		Sample Duplicate	One per batch of ≤ 20 samples, per day, not to exceed 20 samples.	NAD ≤ 1.96	Flag data. Discuss in Case Narrative.

<sup>a</sup> All corrective actions associated with project work shall be documented and the records maintained by the laboratory.

CSC = Client Services Coordinator

HT = Hold Time

LCS = Laboratory Control Sample

LCSD = Laboratory Control Sample Duplicate

MSD = Matrix Spike Duplicate

NAD = Normalized Absolute Difference

QL = Quantitation Limit

QC = Quality Control

RF = Response Factor

RPD = Relative Percent Difference

RT = Retention Time

Analyses of field and laboratory duplicates will be compared to the initial analytical results by determining a Normalized Absolute Difference (NAD) value for each data set by the following equation:

$$\text{Normalized Absolute Difference}_{\text{Duplicate}} = \frac{|\text{Sample} - \text{Duplicate}|}{\sqrt{\sigma_{\text{Sample}}^2 + \sigma_{\text{Duplicate}}^2}}$$

Where: Sample = first sample value (original),  
Duplicate = second sample value (duplicate),  
 $\sigma_{\text{Sample}} = 2 \times$  counting uncertainty of the sample, and,

**TABLE Q-6 (continued)**

**WESTINGHOUSE ELECTRIC FACILITY**

**HEMATITE MISSOURI FACILITY**

Duplicate = 2 counting uncertainty of the duplicate

The calculated NAD results will be compared to a performance criteria of less than or equal to 1.96. Calculated NAD values less than 1.96 will be considered acceptable and values greater than 1.96 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- the sample measurement and duplicate or replicate measurement are of the same normally distributed population
- the standard deviations,  $\sigma_{\text{Sample}}$  and  $\sigma_{\text{Duplicate}}$ , represent the true standard deviation of the measured population.

**TABLE Q-7**

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Sample Designation Scheme**

Proposed Sampling Area	Abbreviation	Medium of Concern	Sample Label Designation	Suffix <sup>2</sup>
Ground Water (Existing Monitoring Wells or Piezometers)	NA	Ground Water	WS-# (existing well number)	NA
			RMC-# (existing well number)	NA
			PZ-# (existing piezometer number)	A,B,C
Public/Private Water Wells	WW	Ground Water	WW-# <sup>1</sup> -GW	NA
Surface Water Features	SW	Soil	SW-#-SL	A,B,C
		Ground Water	SW-#-GW	NA
		Stream Sediment	SW-#-SS	A,B,C
		Surface Water	SW-#-SW	NA
Burial Pit Area	BP	Soil	BP-#-SL	A,B,C
Evaporation Ponds	EP	Soil	EP-#-SL	A,B,C
		Ground Water	EP-#-GW	NA
Former Leach Field	LF	Soil	LF-#-SL	A,B,C
		Ground Water	LF-#-GW	NA
Soil Beneath Building	BD	Soil	BD-#-SL	A,B,C
		Ground Water	BD-#-GW	NA
Limestone Storage	LS	Limestone	LS-#-LS	A,B,C
Outdoor and Shallow Surface Areas	OA	Soil	OA-#-SL	A,B,C
		Ground Water	OA-#-GW	NA
Former Gas Station	GS	Soil	GS-#-SL	A,B,C
		Ground Water	GS-#-GW	NA
Natural Gas Pipeline	PL	Soil	PL-#-SL	A,B,C
Deul's Mountain	DM	Soil	DM-#-SL	A,B,C
Cistern/Burn Pit Area	CB	Soil	CB-#-SL	A,B,C
		Ground Water	CB-#-GW	NA
Exploration for Nature and Extent of Contamination	NB	Soil	NB-#-SL	A,B,C
		Ground Water	NB-#-GW	NA
Background	BG	Soil	BG-#-SL	A,B,C
		Ground Water	BG-#-GW	NA
Aquifer Testing Area	AQ	Surface Water	BG-#-SW	NA
		Ground Water	AQ-#-GW	NA

<sup>1</sup> Indicates location number within Area of Concern.

<sup>2</sup> Suffix assigned for soil or sediment samples where multiple samples per media are collected per location (e.i., surface and subsurface). It is anticipated that only one ground-water sample will be collected per location. If vertical profiling of ground water necessitates multiple samples per location, an alphanumeric suffix will be assigned.

TABLE Q-8

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Analytical Methods, Sample Containers, Preservation and  
Analytical Hold Times for Aqueous Samples

PARAMETER	METHODOLOGY <sup>(d)</sup>	CONTAINER	MINIMUM SAMPLE	PRESERVATION <sup>(b)</sup>	FIELD FILTERED	HO
Organochlorine Pesticides and PCBs	EPA 8081/8082	2-1000 ml	G	Cool 4 deg C	No	
Volatile Organic Compounds (VOCs)	EPA 8260	2-40 ml	G	Cool 4 deg C; HCl	No	
Semi-Volatile Organic Compounds (SVOCs)	EPA 8270	1-1000 ml	G	Cool 4 deg C	No	
Nitrate/Nitrite	EPA 300	1-250 ml	P	Cool 4 deg C	No	
Sulfate	EPA 300	1-250 ml	P	Cool 4 deg C	No	
Target Analyte List Metals (Diss)	SW846 6010B/7000	1-1000 ml	P	250 ml Cool 4 deg C;HNO3,pH<2	Yes	1
Isotopic Plutonium	EPA/ASTM 3972-90M	2-1000 ml	P	1000 ml None	No	
Isotopic Uranium	EPA/ASTM 3972-90M	2-1000 ml	P	1000 ml None	No	
Liquid Scintillation ( <sup>99</sup> Tc)	EPA 906.0 Modified	2-1000 ml	P	2000 ml None	No	
Gross Alpha and Beta	EPA 900 Modified	2-1000 ml	P	1000 ml None	No	
Temperature	Thermometer	NA	NA	NA None	No	Field
pH	Electrode	NA	NA	NA None	No	Field
Dissolved Oxygen	Electrode	NA	NA	NA None	No	Field
Conductivity	Electrode	NA	NA	NA None	No	Field
Redox Potential (ORP)	Electrode	NA	NA	NA None	No	Field
Turbidity	Electrode	NA	NA	NA None	No	Field
Salinity	Electrode	NA	NA	NA None	No	Field

NOTES:

- (a) Hold time for Mercury is 28 days.
- (b) Sample Preservation is performed by sampler immediately upon sample collection.
- (c) Hold time based upon day of sample collection not verified time of sample receipt.
- (d) Analytical methods must be capable of meeting Missouri Water Quality Standards and Federal MCLs.  
Alternate analytical methods can be utilized but must first be approved by Westinghouse and MDNR.

NA = Not applicable

TAL = Target Analyte List.

EPA = Chemical Methods for the Analysis of Water and Waste, 1979, Revised March 1983.

SW846 = Test Methods for Evaluating Solid Wastes, Update III, January 1997.

EPA 1993 = Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100.

TBD = To be determined.

P = Polyethylene

G = Glass

\* - Standard Methods for the Examination of Waste and Wastewater, 20th edition, 1998.

TABLE Q-9

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Analytical Methods, Sample Containers, Preservation and  
Analytical Hold Times for Soil/Sediment Samples

PARAMETER	METHODOLOGY <sup>(d)</sup>	CONTAINER	MINIMUM SAMPLE	PRESERVATION <sup>(b)</sup>	HOLD TIME <sup>(c)</sup>	
Organochlorine Pesticides and PCBs	EPA 8081/8082	1-8 oz.	G	Cool 4 deg C	7 days	
Volatile Organic Compounds (VOCs)	EPA 8260	1-4 oz.	G	Cool 4 deg C	14 days	
Semi-Volatile Organic Compounds (SVOCs)	EPA 8270	1-8 oz.	G	Cool 4 deg C	7 days	
Nitrate/Nitrite	EPA 300	1-4 oz.	P	Cool 4 deg C	48 hrs	
Sulfate	EPA 300	1-4 oz.	P	Cool 4 deg C	48 hrs	
Target Analyte List Metals	SW846 6010B/7000	1-4 oz.	P	Cool 4 deg C	180 days <sup>(a)</sup>	
Gamma Spectroscopy	EPA 901.1M	1-8 oz.	P	300 g	None	6 months
Isotopic Plutonium	EPA/ASTM 3972-90M	1-8 oz.	P	5 g	None	6 months
Isotopic Uranium	EPA/ASTM 3972-90M	1-8 oz.	P	5 g	None	6 months
Liquid Scintillation ( <sup>99</sup> Tc)	EPA 906.0 Modified	1-8 oz.	P	50 g	None	6 months

NOTES:

- (a) Hold time for Mercury is 28 days.
- (b) Sample Preservation is performed by sampler immediately upon sample collection.
- (c) Hold time based upon day of sample collection not verified time of sample receipt.
- (d) Analytical methods must be capable of meeting Missouri Soil Cleanup Levels.  
Alternate analytical methods can be utilized but **must** first be approved by Westinghouse and MDNR.

EPA = Chemical Methods for the Analysis of Water and Waste, 1979, Revised March 1983.

SW846 = Test Methods for Evaluating Solid Wastes, Update III, January 1997.

EPA 1993 = Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100.

P = Polyethylene

G = Glass

\* - Standard Methods for the Examination of Waste and Wastewater, 20th edition, 1998.

TABLE Q-10

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Laboratory Method Detection Limits and Routine Reporting Limits  
for**

**VOLATILE ORGANIC COMPOUNDS BY SW 8260B**

## SOIL

Chemical Name	MDL mg/kg	Routine RL mg/kg
1,1,1-Trichloroethane	0.00047	0.005
1,1,2-Trichloroethane	0.0003	0.005
1,1-Dichloroethylene	0.00053	0.005
1,1-Dichloroethane	0.0003	0.005
1,2,4-Trichlorobenzene	0.00042	0.005
1,2-Dibromo-3-Chloropropane	0.00022	0.005
1,2-Dibromoethane	0.00017	0.005
1,2-Dichloroethane	0.00023	0.005
1,2-Dichloropropane	0.00046	0.005
1,3-Dichloropropene (total)	0.0004	0.010
Acetone	0.0003	0.010
Benzene	0.00038	0.005
Bromodichloromethane	0.00029	0.005
Bromoform	0.00023	0.005
Butanol	0.013	1.00
Carbon disulfide	0.00035	0.005
Carbon tetrachloride	0.00043	0.005
Chlorobenzene	0.00027	0.005
Chlorodibromomethane	0.00022	0.005
Chloroform	0.00032	0.005
cis-1,2-Dichloroethylene	0.00037	0.005
Ethylbenzene	0.00029	0.005
m/p-Xylene	0.00061	0.005
Methyl bromide	0.00097	0.010
Methylene chloride	0.00093	0.005
o-Xylene	0.00024	0.005
Styrene	0.00032	0.005
Tetrachloroethylene	0.00031	0.005
Toluene	0.00042	0.005
trans-1,2-Dichloroethylene	0.00032	0.005
Trichloroethylene	0.00050	0.005
Vinyl acetate	0.00027	0.010
Vinyl Chloride	0.00029	0.010
Xylenes (total)	0.00061	0.005
<b>Additional TAL Compounds</b>	<b>ug/kg</b>	<b>ug/kg</b>
Chloromethane	.25	10
1,2-Dichloroethene (total)	.33	5
2-Butanone	.15	10
cis-1,3-Dichloropropene	.28	5
trans-1,3-Dichloropropene	.19	5
4-Methyl-2-Pentanone	.25	10
2-Hexanone	.21	10
1,1,2,2,-Tetrachloroethane	.16	5
Chloroethane	.63	10

## WATER

Chemical Name	MDL mg/l	Routine RL mg/l
1,1,1-Trichloroethane	0.00010	0.005
1,1,2-Trichloroethane	0.00028	0.005
1,1-Dichloroethylene	0.00043	0.005
1,1-Dichloroethane	0.00015	0.005
1,2,4-Trichlorobenzene	0.00031	0.005
1,2-Dibromo-3-Chloropropane	0.00088	0.005
1,2-Dibromoethane	0.00017	0.005
1,2-Dichloroethane	0.00034	0.005
1,2-Dichloropropane	0.00018	0.005
1,3-Dichloropropene	0.00021	0.010
Acetone	0.0048	0.010
Benzene	0.00020	0.005
Bromodichloromethane	0.00017	0.005
Bromoform	0.00030	0.005
Butanol	0.016	1.00
Carbon disulfide	0.0057	0.005
Carbon tetrachloride	0.00016	0.005
Chlorobenzene	0.00014	0.005
Chlorodibromomethane	0.00020	0.005
Chloroform	0.00033	0.005
cis-1,2-Dichloroethylene	0.00023	0.005
Ethylbenzene	0.00013	0.005
Methyl bromide	0.00014	0.010
Methylene chloride	0.00028	0.005
Styrene	0.00013	0.005
Tetrachloroethylene	0.00024	0.005
Toluene	0.00018	0.005
trans-1,2-Dichloroethylene	0.00041	0.005
Trichloroethylene	0.00053	0.005
Vinyl acetate	0.00020	0.010
Vinyl Chloride	0.00027	0.010
Xylenes (total)	0.00024	0.005
<b>Additional TAL Compounds</b>	<b>mg/l</b>	<b>ug/l</b>
Chloromethane	.36	10
1,2-Dichloroethene (total)	.41	5
2-Butanone	.69	10
cis-1,3-Dichloropropene	.16	5
trans-1,3-Dichloropropene	.22	5
4-Methyl-2-Pentanone	1.73	10
2-Hexanone	.39	10
1,1,2,2,-Tetrachloroethane	.43	5
Chloroethane	.42	10

MDL - Method Detection Limits

RL - Reporting Limits

TABLE Q-11

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Laboratory Method Detection Limits and Routine Reporting Limits  
for

SEMI-VOLATILE ORGANIC COMPOUNDS BY SW 8270C

SOIL

Chemical Name	MDL mg/kg	Routine RL mg/kg
1,2-Dichlorobenzene	0.021	0.33
1,4-Dichlorobenzene	0.023	0.33
2,4,5-Trichlorophenol	0.045	1.65
2,4,6-Trichlorophenol	0.030	0.33
2,4-Dichlorophenol	0.026	0.33
2,4-Dimethylphenol	0.039	0.33
2,4-Dinitrophenol	0.047	1.65
2,4-Dinitrotoluene	0.039	0.33
2,6-Dinitrotoluene	0.026	0.33
2-Chlorophenol	0.038	0.33
2-Methylphenol	0.026	0.33
3,3'-Dichlorobenzidine	0.30	0.66
4-Chloroaniline	0.034	0.33
Acenaphthene	0.030	0.33
Anthracene	0.023	0.33
Benzo(a)anthracene	0.040	0.33
Benzo(a)pyrene	0.026	0.33
Benzo(b)fluoranthene	0.025	0.33
Benzo(k)Fluroanthene	0.032	0.33
Benzoic Acid	0.38	1.65
Bis(2-chloroethyl)ether	0.028	0.33
Bis(2-ethylhexyl)phthalate	0.14	0.33
Butyl benzyl phtalate	0.031	0.33
Carbazole	0.10	0.33
Chrysene	0.033	0.33
Dibenzo(a,h)anthracene	0.031	0.33
Diethyl phthalate	0.036	0.33
Di-n-butyl phthalate	0.042	0.33
Di-n-octyl phthalate	0.073	0.33
Fluoranthene	0.021	0.33
Fluorene	0.033	0.33
Hexachlorocyclopentadiene	0.044	0.33
Hexachloroethane	0.033	0.33
Hexachorobenzene	0.039	0.33
Indeno(1,2,3-c,d)pyrene	0.048	0.33
Isophorone	0.024	0.33
Naphthalene	0.048	0.33
Nitrobenzene	0.030	0.03
N-Nitrosodi n-propylamine	0.051	0.33
N-Nitrosodiphenylamine	0.17	0.33
Pentachlorophenol	0.079	1.65
Phenol	0.048	0.33
Pyrene	0.024	0.33

WATER

Chemical Name	MDL mg/l	Routine RL mg/l
1,2-Dichlorobenzene	0.0014	0.010
1,4-Dichlorobenzene	0.00074	0.010
2,4,5-Trichlorophenol	0.0011	0.050
2,4,6-Trichlorophenol	0.0014	0.010
2,4-Dichlorophenol	0.0016	0.010
2,4-Dimethylphenol	0.00084	0.010
2,4-Dinitrophenol	0.0013	0.050
2,4-Dinitrotoluene	0.00056	0.010
2,6-Dinitrotoluene	0.00066	0.010
2-Chlorophenol	0.0013	0.010
2-Methylphenol	0.00064	0.010
3,3'-Dichlorobenzidine	0.0094	0.020
4-Chloroaniline	0.00078	0.010
Acenaphthene	0.0014	0.010
Anthracene	0.0012	0.010
Benzo(a)anthracene	0.0011	0.010
Benzo(a)pyrene	0.0010	0.010
Benzo(b)fluoranthene	0.00096	0.010
Benzo(k)Fluroanthene	0.0014	0.010
Benzoic Acid	0.016	0.050
Bis(2-chloroethyl)ether	0.00063	0.010
Bis(2-ethylhexyl)phthalate	0.0015	0.010
Butyl benzyl phtalate	0.00076	0.010
Carbazole	0.0018	0.010
Chrysene	0.00079	0.010
Dibenzo(a,h)anthracene	0.0014	0.010
Diethyl phthalate	0.00091	0.010
Di-n-butyl phthalate	0.0012	0.010
Di-n-octyl phthalate	0.00097	0.010
Fluoranthene	0.00087	0.010
Fluorene	0.0015	0.010
Hexachlorocyclopentadiene	0.0023	0.010
Hexachloroethane	0.0010	0.010
Hexachorobenzene	0.00073	0.01
Indeno(1,2,3-c,d)pyrene	0.00084	0.010
Isophorone	0.00069	0.010
Naphthalene	0.0015	0.010
Nitrobenzene	0.0014	0.010
N-Nitrosodi n-propylamine	0.0010	0.010
N-Nitrosodiphenylamine	0.0014	0.010
Pentachlorophenol	0.0010	0.050
Phenol	0.00059	0.010
Pyrene	0.00092	0.010

MDL - Method Detection Limits  
RL - Reporting Limits

TABLE Q-12

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Laboratory Method Detection Limits and Routine Reporting Limits  
for  
METALS CN 6010/7000/9014

SOIL

Chemical Name	MDL mg/kg	Routine RL mg/kg
Antimony	0.33	0.8
Arsenic	0.29	0.7
Barium	0.035	0.5
Beryllium	0.021	0.3
Cadmium	0.032	0.2
Chromium	0.1	0.4
Cobalt	0.08	0.2
Copper	0.12	0.8
Lead	0.11	0.6
Manganese	0.052	0.2
Mercury	0.00005	0.02
Nickel	0.24	0.5
Selenium	0.17	0.8
Silver	0.15	0.5
Thallium	0.32	0.8
Vanadium	0.072	0.5
Zinc	0.19	0.6
CN, amen (9014)		0.125

WATER

Chemical Name	MDL mg/l	Routine RL mg/l
Antimony	0.0043	0.02
Arsenic	0.0048	0.02
Barium	0.0054	0.012
Beryllium	0.0012	0.0026
Cadmium	0.00061	0.002
Chromium	0.00099	0.004
Cobalt	0.0014	0.002
Copper	0.0056	0.012
Lead	0.0044	0.01
Manganese	0.00064	0.001
Mercury	0.000045	0.0002
Nickel	0.0024	0.005
Selenium	0.0063	0.05
Silver	0.0032	0.01
Thallium	0.0063	0.014
Vanadium	0.0049	0.011
Zinc	0.0018	0.006
CN, amen (9014)	0.0041	0.005

Additional TAL Metals

Chemical Name	Soil MDL	mg/kg RL
Aluminium	.21	1.0
Calcium	1.9	5.0
Iron	.16	1.0
Magnesium	2.4	5.0
Potassium	.24	5.0
Sodium	.305	5.0

Chemical Name	Water MDL	mg/L RL
Aluminium	0.0021	.01
Calcium	.019	.05
Iron	.0016	.01
Magnesium	.024	.05
Potassium	.0024	.05
Sodium	.0031	.05

**TABLE Q-13**

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Laboratory Method Detection Limits and Routine Reporting Limits  
for  
Polychlorinated Biphenyls-8082**

**SOIL**

<b>Analyte Name</b>	<b>MDL (ug/kg)</b>	<b>Routine RL (ug/kg)</b>
Aroclor 1016	22.71	80
Aroclor 1221	23.10	160
Aroclor 1232	11.19	80
Aroclor 1242	5.60	80
Aroclor 1248	7.66	80
Aroclor 1254	7.27	160
Aroclor 1260	15.06	160

**WATER**

<b>Analyte Name</b>	<b>MDL (ug/L)</b>	<b>Routine RL (ug/L)</b>
Aroclor 1016	0.16	0.50
Aroclor 1221	0.17	1.00
Aroclor 1232	0.13	0.50
Aroclor 1242	0.20	0.50
Aroclor 1248	0.10	0.50
Aroclor 1254	0.12	1.00
Aroclor 1260	0.0097	1.00

TABLE Q-14

WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY

Laboratory Method Detection Limits and Routine Reporting Limits  
for  
Organochlorine Pesticides 8081A

SOIL

Chemical Name	RL mg/kg	MDL mg/kg	Routine RL mg/kg
Aldrin	0.5	0.00022	0.008
alpha-BHC	0.0005	0.00026	0.008
Chlordane	0.5	0.017	0.16
DDD	3	0.00032	0.016
DDE	2	0.00024	0.016
DDT	2	0.00066	0.016
Dieldrin	0.004	0.00028	0.016
Endosulfan	18	0.0012	0.008
Endrin	1	0.00028	0.016
gamma-BHC	0.009	0.00037	0.008
Heptachlor	0.1	0.00025	0.008
Heptachlor epoxide	0.07	0.00026	0.008
Methoxychlor	160	0.005	0.08
Toxaphene	0.6	0.023	0.08

WATER

Chemical Name	RL mg/l	MDL mg/l	Routine RL mg/l
Aldrin	0.00004	0.0000058	0.00005
alpha-BHC	0.00003	0.0000023	0.00005
Chlordane	0.002	0.000052	0.0005
DDD	0.00011	0.0000051	0.00010
DDE	0.00004	0.0000035	0.00010
DDT	0.00012	0.0000089	0.00010
Dieldrin	0.00002	0.0000041	0.00010
Endosulfan	0.042	0.0000051	0.00005
Endrin	0.002	0.0000019	0.00010
gamma-BHC	0.0002	0.0000028	0.00005
Heptachlor	0.0004	0.0000031	0.00005
Heptachlor epoxide	0.0002	0.0000027	0.00005
Methoxychlor	0.04	0.000012	0.00050
Toxaphene	0	0.00023	0.00050

**TABLE Q-15**

**WESTINGHOUSE ELECTRIC COMPANY  
HEMATITE MISSOURI FACILITY**

**Laboratory Method Detection Limits and Routine Reporting Limits  
for  
Nitrate, Nitrite and Sulfate - Method 300**

**WATER**

<b>Chemical Name</b>	<b>MDL (mg/L)</b>	<b>Routine RL (mg/L)</b>
Nitrate	0.012	0.02
Nitrite	0.017	0.15
Sulfate	0.369	1.00

## **FIGURES**

FIGURE F-1  
FORMER FUEL CYCLING FACILITY

Project Organization

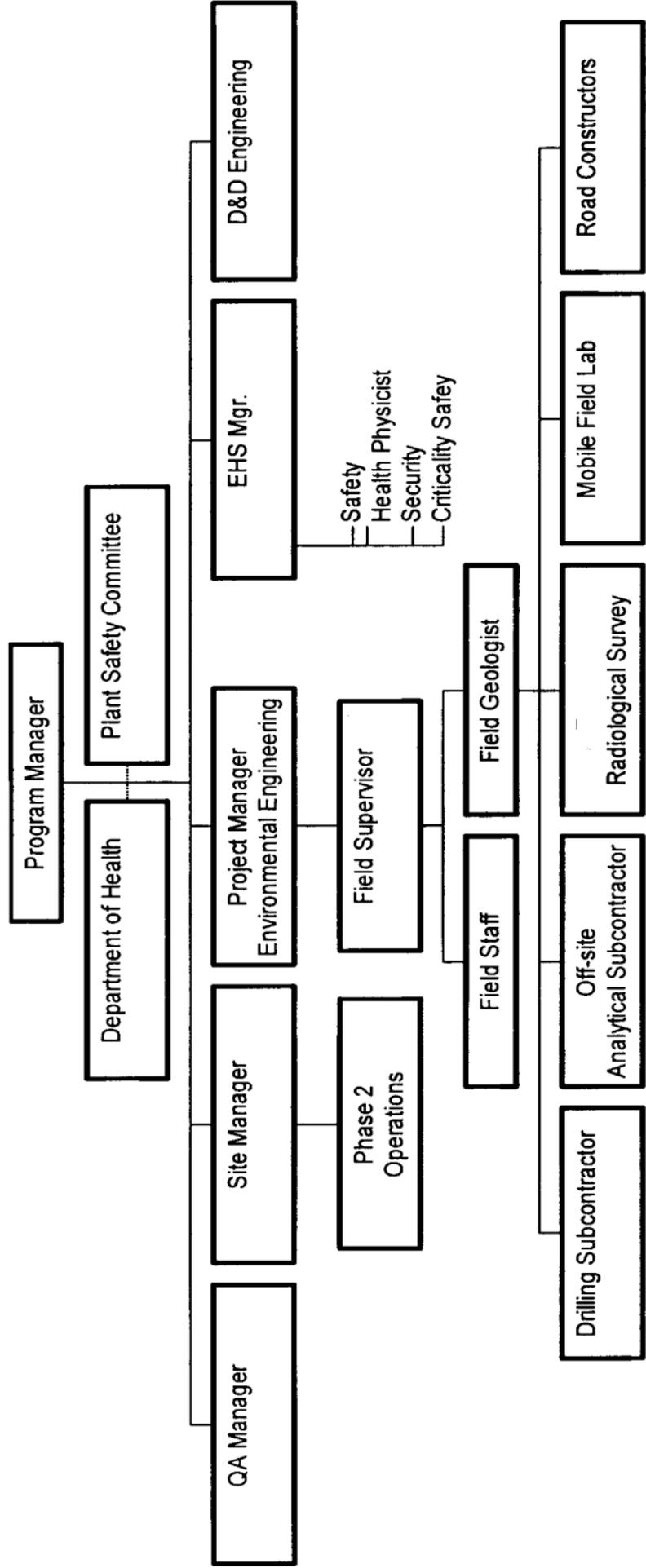


Figure F-2: Uranium Decay Series

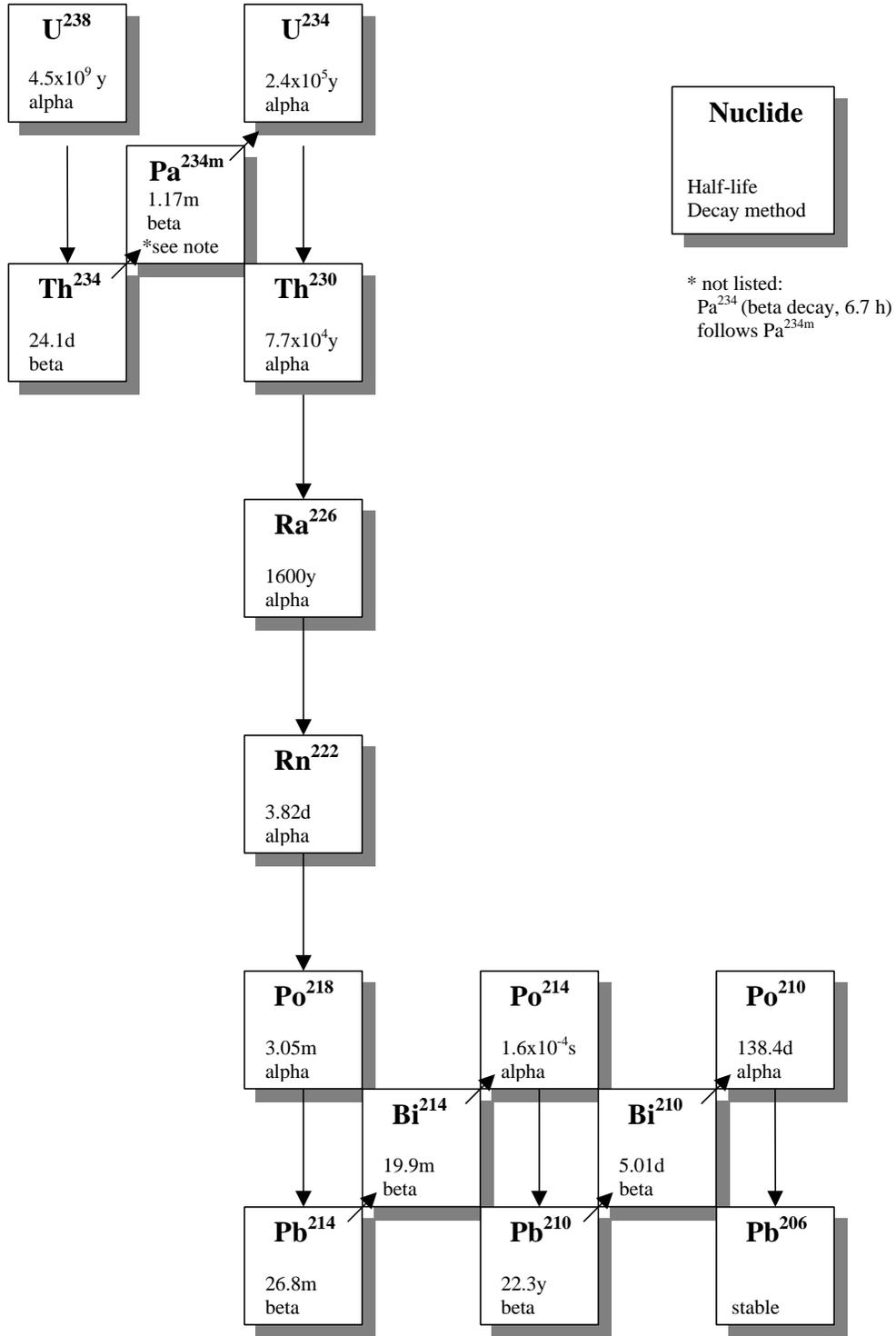


Figure F-3: Thorium Decay Series

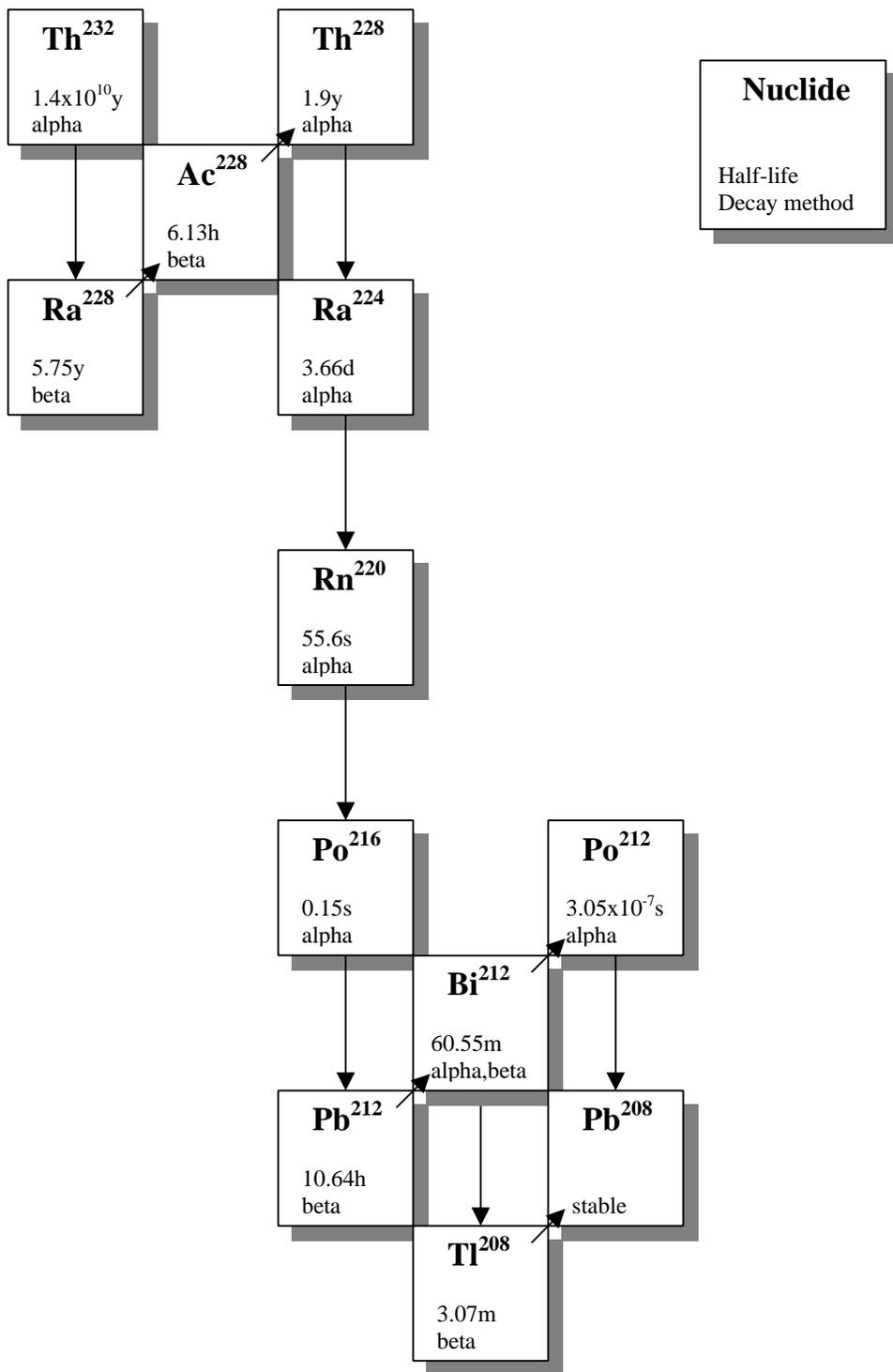
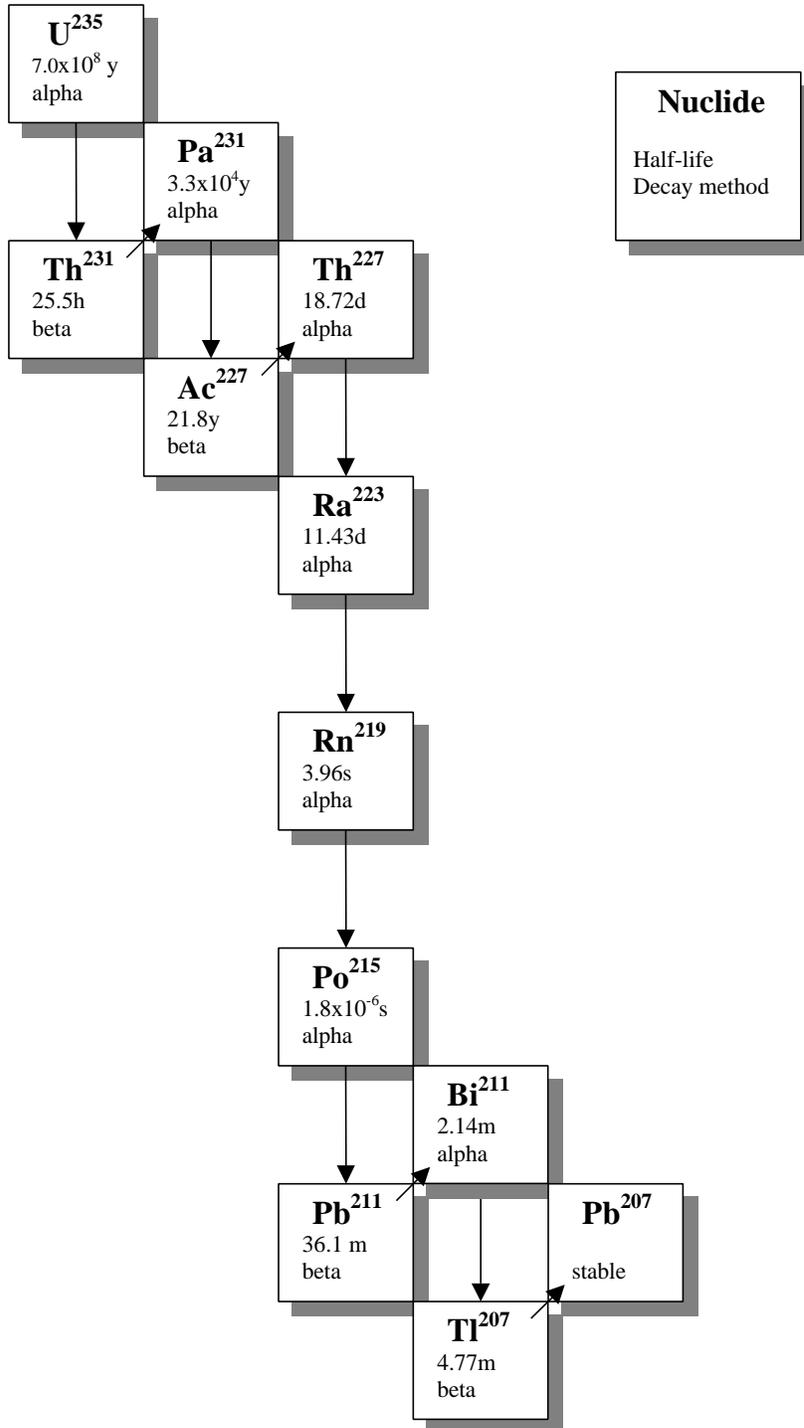


Figure F-4: Actinium Decay Series



**Figure F-5: Chain of Custody Form**

Project Manager or Contact:		Parameters/Method Numbers for Analysis												Chain of Custody Record Company			
Project No.		Phone:		Project Name:		No. of Containers		LPM:									
Dept.:            Task:		ATO Number:															
Sample Storage Location:		Report #:															
Date	Time	Water	Soil	Sample Identification 15 Characters													
Samples by: (Signature)				Date/Time		Relinquished by: (Signature)				Date/Time		Received by: (Signature)				Date/Time	
Relinquished by: (Signature)				Date/Time		Received by Laboratory: (Signature)				Date/Time		Airbill Number:		Sample Shipped by: (Circle) Fed Ex.    Puro.    UPS			
Cooler Temp. ____ C    pH: ____ Yes ____ No				Comments:				Custody Seals Intact ____ Yes ____ No				Hand Carried					
NOTE: Please indicate method number for analyses requested. This will help clarify any questions with laboratory techniques.												Other:					





**Figure F-8: Document Transmittal Record**

NAME AND TITLE OF RECIPIENT:					
QTY.	DOCUMENT TITLE	DOCUMENT NUMBER	REV. NO	DESCRIPTION	CONTROL NUMBER
DOCUMENT(S) SENT BY:					
DOCUMENT(S) SENT TO:					
NAME:					
ADDRESS:					
CITY/STATE/ZIP:					
TELEPHONE:					
<b>PLEASE CHECK ONE OF THE FOLLOWING SIGN AND RETURN TO SENDER</b>					
I acknowledge that I received the document(s) or document(s) revision(s) and that I have updated my records.					
I am returning the document(s) with this transmittal record.					
I have destroyed the old document and I am returning only the transmittal record.					
Signature			Date:		
Document Transmittal Record Complete and Approved					
Signature:			Date:		

## **ATTACHMENTS**

**ATTACHMENT A**

**FIDLER MDC TECHNICAL MEMORANDUM**

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**ATTACHMENT A  
FIDLER MDC TECHNICAL MEMORANDUM**

**Introduction**

The Hematite uranium product facility used uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride (UF<sub>6</sub>) gas of various <sup>235</sup>U enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and development was also conducted at the Plant, as were uranium scrap recovery processes. In addition to uranium, work was performed with thorium compounds as part of early research into the use of thorium in the fuel cycle.

Work has been ongoing at the Site commencing since 1956. Uranium used at the facility was previously separated and enriched at other facilities. This time period allowed uranium isotopes and certain daughter progeny to come into an equilibrium state. Any thorium present at the site is assumed to be derived from naturally occurring <sup>232</sup>Th in secular equilibrium with its progeny.

The Hematite Site will be monitored for potential uranium and thorium contamination utilizing a Bicon G-5 Fidler NaI scintillation detector. Scans of the subject area will be accomplished by a walking speed (1.5 ft/sec) walkover by the surveyor at a detector height of approximately 2-4 inches above the ground surfaces. Results will be tallied by counts per minute (CPM).

**Objectives**

The objective of this technical memorandum is to determine the scan sensitivity of the G-5 Fidler NaI scintillation detector utilized for the planned gamma walkover survey for thorium, depleted uranium, natural uranium, low enriched uranium and high enriched uranium. Two cases were examined for each isotope – a 15 cm-thick layer and a 1 inch-thick layer of contaminated soil. The scan sensitivity is important for use in interpretation of potential volumetric concentrations of uranium and thorium in the soil.

**SITE RADIOLOGICAL CONDITIONS**

The Site area to be surveyed consists of surface soils potentially contaminated with uranium metal at various <sup>235</sup>U concentrations with the potential for presence of thorium metal. The uranium present in the ore is in equilibrium with its progeny. During the refining process, the uranium metal that is removed from the ore resulting in a disruption and removal of the uranium from its progeny. This will result in the permanent removal of the longer lived non-uranium progeny from the refined uranium metal. Short-lived isotopes such as thorium-234, thorium-231, and protactinium-234m will rapidly “grow” back into the uranium metal and become contributors to overall activity. Small, trivial amounts of long-lived progeny such as

radium-226 and thorium-230 will also be present in trace quantities. The  $^{235}\text{U}$  enrichment processes carried on off-site will further alter the mix of uranium and progeny isotopes. Any thorium present will be in equilibrium with its progeny. All thorium is initially comprised of  $^{232}\text{Th}$ .

Uranium or thorium contamination may be present in soils and areas surrounding buildings and structures processing, handling, and storing the finished product. In addition, process systems and piping such as the sanitary system and leach field may contain uranium and thorium contamination in the sub-surface soils. It has been assumed for detection calculations that the contamination is present in a layer on the surface with no cover and that the uranium or thorium contaminants are uniformly mixed with the soil in a volume of soil 56 cm in diameter with a 15 cm or 1 inch thickness.

### **Scan Minimum Detectable Concentration (MDC) Calculation and Methodology**

The methodology used to determine the NaI scintillation detector scan MDC is based on NRC NUREG –1507, titled “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions” December 1997. Factors included in this analysis are the surveyor scan efficiency, index of sensitivity, the natural background of the surveyed area, scan rate, detector to source geometry, areal extent of the hot spot, and energy and yield of gamma emissions.

The computer code Microshield was used to model the presence of a normalized 1 pCi/g total uranium with a low enrichment of 3.4%  $^{235}\text{U}$  isotopic concentration and its 50-year decay progeny in soil with the assumption that the activity was uniformly distributed to a depth of 1 inch and spread over a disk shaped area with a diameter of 56 cm. The uncontaminated soil cover thickness has zero thickness (contamination on the surface) and there is a 0.051 cm aluminum shield simulating the cover of the NaI detector to complete the model source term. This model is consistent with the NUREG-1507 methodology and provides for a count rate to exposure rate ratio (CPM/ $\mu\text{R/hr}$ ) to be calculated. A separate calculation is required for each  $^{235}\text{U}$  concentration and thorium case examined.

The following sections provide tabulated data based upon the NUREG-1507 methodology as applied toward the Bicron G-5 Fidler NaI scintillation detector used in this survey, a  $^{235}\text{U}$  enrichment of 3.4%, zero thickness soil cover, and a 56 cm diameter soil uniformly contaminated to a 1 inch thickness. The dose point is centered over the contaminated disk of soil. Additional details and discussion describing the NUREG analysis methodology are described in that publication.

### **Fluence Rate to Exposure Rate (FRER, no units)**

The fluence rate to exposure rate (FRER) may be approximated by:

$$\text{FRER} \sim (1 \mu\text{R/hr}) / (E_{\gamma})(\mu_{\text{en}}/\rho)_{\text{air}}$$

Where,

$E_{\gamma}$  = energy of the gamma photon of concern, keV

$(\mu_{\text{en}}/\rho)_{\text{air}}$  = the mass energy absorption coefficient for air,  $\text{cm}^2/\text{g}$

And in tabular form:

<b>Energy<sub>g</sub>, keV</b>	<b>(u<sub>en</sub>/r)<sub>air</sub>, cm<sup>2</sup>/g</b>	<b>FRER</b>
15	1.29	0.0517
20	0.516	0.0969
30	0.147	0.2268
40	0.064	0.3906
50	0.0384	0.5208
60	0.0292	0.5708
80	0.0236	0.5297
100	0.0231	0.4329
150	0.0251	0.2656
200	0.0268	0.1866
300	0.0288	0.1157
400	0.0296	0.0845
500	0.0297	0.0673
600	0.0296	0.0563
800	0.0289	0.0433
1,000	0.0280	0.0357
1,500	0.0255	0.0261
2,000	0.0234	0.0214

**TABLE 1**

### **Probability of Interaction (P) Through Detector End for a Given Energy**

The probability, P, of a gamma ray interaction in the NaI scintillation crystal entering through the end of the crystal is given by:

$$\text{Probability (P)} = 1 - e^{-(\mu/\rho)_{\text{NaI}}(X)(\rho_{\text{NaI}})}$$

Where

$(\mu/\rho)_{\text{NaI}}$  = the mass attenuation coefficient for NaI

X = the thickness through the thin edge (end facing the soil) of the G-5 Fidler NaI crystal, 0.16 cm

$\rho$  = the density of the NaI crystal, 3.67 g/cm<sup>3</sup>

And in tabular form:

<u>Energy<sub>γ</sub>, keV</u>	<u>(μ/ρ)<sub>NaI</sub>, cm<sup>2</sup>/g</u>	<u>P</u>
15	47.4	1.00
20	22.3	1.00
30	7.45	0.99
40	19.3	1.00
50	10.7	1.00
60	6.62	0.98
80	3.12	0.84
100	1.72	0.64
150	0.625	0.31
200	0.334	0.18
300	0.167	0.09
400	0.117	0.07
500	0.0955	0.05
600	0.0826	0.05
800	0.0676	0.04
1,000	0.0586	0.03
1,500	0.0469	0.03
2,000	0.0413	0.02

TABLE 2

**Relative Detector Response (RDR)**

The Relative Detector Response (RDR) by energy is determined by multiplying the relative fluence rate to exposure rate (FRER) by the probability (P) of an interaction and is given by:

$$\text{RDR} = \text{FRER (table 1)} \times \text{P (table 2)}$$

And in tabular form:

<u>Energy<sub>γ</sub>, keV</u>	<u>FRER</u>	<u>P</u>	<u>RDR</u>
15	0.0517	1.00	0.0517
20	0.0969	1.00	0.0969
30	0.2268	0.99	0.2239
40	0.3906	1.00	0.3906
50	0.5208	1.00	0.5199
60	0.5708	0.98	0.5591
80	0.5297	0.84	0.4449
100	0.4329	0.64	0.2752
150	0.2656	0.31	0.0816
200	0.1866	0.18	0.0332
300	0.1157	0.09	0.0108
400	0.0845	0.07	0.0056
500	0.0673	0.05	0.0037
600	0.0563	0.05	0.0027
800	0.0433	0.04	0.0017
1,000	0.0357	0.03	0.0012
1,500	0.0261	0.03	0.0007
2,000	0.0214	0.02	0.0005

TABLE 3

**Determination of CPM per mR/hr as a Function of Energy**

The equivalent FRER, P, and finally RDR may be calculated for a NaI Scintillation detector at the cesium-137 energy of 662 keV. Manufacturers of this equipment typically provide an instrument response in terms of CPM and  $\mu\text{R/hr}$  at the cesium-137 energy. This point allows one to determine the CPM per  $\mu\text{R/hr}$  and ultimately activity concentration and minimum detection sensitivity level in terms of pCi/g.

Based on measured counts in a known field it is estimated that a typical G-5 Fidler NaI response is 1,287 CPM/ $\mu\text{R/hr}$  and using the same methodology as shown in the tables above, the FRER, P and RDR are calculated. The mass energy absorption coefficient for air and the mass attenuation coefficient for NaI are interpolated from tables in the Radiological Health Handbook, Revised Edition January 1970, pages 139, and 140.

	<u>FRER</u>	<u>Energy<sub>i</sub>, keV</u>	<u>(<math>\mu_{en}/\rho</math>)<sub>air</sub>, cm<sup>2</sup>/g</u>
	0.0514	662	0.0294
And			
	<u>Energy<sub>i</sub>, keV</u>	<u>(<math>\mu/\rho</math>)<sub>NaI</sub>, cm<sup>2</sup>/g</u>	<u>P</u>
	662	0.0780	0.04

And Cesium-137 RDR (662 keV) = 0.0023

The detector response (CPM) to another energy is based upon the ratio of the RDR at an energy to the known Cs-137 energy RDR

$$\begin{aligned} \text{CPM}/\mu\text{R/hr, } E_i &= (\text{CPM}_{\text{Cs-137}}) \times (\text{RDR}_{E_i}) / (\text{RDR}_{\text{Cs-137}}) \\ &= (1287) \times (\text{RDR}_{E_i}) / (\text{RDR}_{\text{Cs-137}}) \end{aligned}$$

and in tabular form:

Energy <sub>y</sub> , keV	RDR <sub>E<sub>i</sub></sub>	Fidler NaI Detector, E <sub>i</sub> , cpm per μR/hr
15	0.0517	28934
20	0.0969	54250
30	0.2239	125355
40	0.3906	218695
50	0.5199	291052
60	0.5591	313006
80	0.4449	249068
100	0.2752	154090
150	0.0816	45680
200	0.0332	18602
300	0.0108	6053
400	0.0056	3140
500	0.0037	2056
600	0.0027	1493
662	0.0023	1287
800	0.0017	942
1,000	0.0012	676
1,500	0.0007	398
2,000	0.0005	287

TABLE 4

A “typical” measured background is 10 μR/hr in an uncontaminated area in the eastern U.S. when not near granite outcroppings. Based on the measured background the count rate to exposure rate ratio of 1,287 CPM/μR/hr, a background value of 12,870 CPM is computed.

Finally, the count rate to exposure rate ratio for each of the uranium isotopes and progeny gamma emissions and their contribution to the total exposure rate may be computed using the output of the Microshield runs and the count rate to exposure rate ratios from table 4.

keV	MicroShield Exposure Rate, μR/hr (with buildup, 1 pCi/g total U)	cpm/μR/hr	cpm/μR/hr (weighted)	Percent of NaI detector response
15	2.557E-08	28934	1	0.0%
20	2.058E-10	54250	0	0.0%
30	1.495E-05	125355	1574	2.9%
40	1.703E-09	218695	0	0.0%
50	5.360E-06	291052	1310	2.4%
60	4.068E-05	313006	10693	19.6%
80	3.871E-05	249068	8097	14.9%
100	1.534E-04	154090	19851	36.4%

150	1.034E-04	45680	3967	7.3%
200	5.659E-04	18602	8841	16.2%
300	1.255E-06	6053	6	0.0%
400	1.150E-06	3140	3	0.0%
500	1.499E-06	2056	3	0.0%
600	7.332E-06	1493	9	0.0%
800	5.151E-05	942	41	0.1%
1000	1.986E-04	676	113	0.2%
1500	5.835E-06	398	2	0.0%
2000	1.131E-06	287	0	0.0%
Total	1.191E-03		54511	100%

TABLE 5

### Scan MDC Value

The scan MDC is calculated using the NUREG-1507 methodology where:

The average number of background counts in an interval  $b_i = \text{CPM}/60$

And for the Ludlum generic count rate to exposure rate ratio value of 1287 CPM/ $\mu\text{R}/\text{hr}$  and 10  $\mu\text{R}/\text{hr}$  assumed background gives

$$b_i = (10 \mu\text{R}/\text{hr}) \times (1287 \text{ CPM}/\mu\text{R}/\text{hr}) / 60 = 214.5 \text{ counts}$$

The minimum detectable count rate, MDCR is

$$\text{MDCR} = (d') \times (b_i)^{0.5} \times (60 \text{ sec}/1 \text{ min})$$

Where  $d'$  is from table 6.1 of NUREG-1507 and represents rate of detections at 95% and a false positive rate of 60%,  $b_i$  is the background counts, 60 seconds/1 minute is a conversion factor and

$$\text{MDCR} = (1.38) \times (214.5)^{0.5} \times (60 \text{ sec}/1 \text{ min}) = 1212.6 \text{ CPM}$$

The Minimum Detectable Count Rate for the surveyor is given as

$$\text{MDCR}_{\text{surveyor}} = \text{MDCR}/(p)^{0.5}$$

Where

$p$  = Surveyor Efficiency, equal to 0.75 to 0.5 as given by NUREG-1507 (0.5 is chosen as a conservative choice) and

$$\text{MDCR}_{\text{surveyor}} = 1212.6/0.707 = 1715 \text{ CPM}$$

The Minimum Detectable Exposure Rate for the surveyor is obtained from the  $\text{MDCR}_{\text{surveyor}}$  divided by the Table 5 weighted count rate to exposure rate value of 54511 CPM/ $\mu\text{R}/\text{hr}$  for total uranium and its progeny is

$$(1715 \text{ CPM}) / (54511 \text{ CPM } / \mu\text{R/hr}) = 0.0314 \mu\text{R/hr}$$

The scan MDC is then equal to the ratio of the Minimum Detectable Exposure Rate in the field to the exposure rate determined for the normalized 1 pCi/g concentration of total uranium and

$$\text{Scan MDC} = (\text{Normalized } U_{\text{Total Conc}}) \times (\text{Exposure Rate}_{\text{Surveyor}}) / (\text{Exposure Rate}_{\text{normalized U conc}})$$

$$\text{Scan MDC} = (1 \text{ pCi/g}) \times (0.0314 \mu\text{R/hr}) / (1.191\text{E-}3 \mu\text{R/hr}) = 26.4 \text{ pCi/g}$$

The process described above is repeated to provide MicroShield inputs for the depleted uranium, natural uranium, high enriched uranium, and thorium cases with soil thicknesses of 15 cm and 1 inch. The summarized results for these cases are:

Depleted Uranium 15 cm thick soil layer

Minimum Detectable Exposure Rate = 0.0364  $\mu\text{R/hr}$  and

Scan MDC = 4.9 pCi/g

Depleted Uranium 1 inch thick soil layer

Minimum Detectable Exposure Rate = 0.025  $\mu\text{R/hr}$  and

Scan MDC = 9.4 pCi/g

Natural Uranium 15 cm thick soil layer

Minimum Detectable Exposure Rate = 0.0378  $\mu\text{R/hr}$  and

Scan MDC = 7.2 pCi/g

Natural Uranium 1 inch thick soil layer

Minimum Detectable Exposure Rate = 0.0267  $\mu\text{R/hr}$  and

Scan MDC = 14.1 pCi/g

Low Enriched Uranium (3.5 wt%) 15 cm thick soil layer

Minimum Detectable Exposure Rate = 0.041  $\mu\text{R/hr}$  and

Scan MDC = 12.6 pCi/g

Low Enriched Uranium (3.5 wt%) 1 inch thick soil layer (CASE SHOWN IN TEXT)

Minimum Detectable Exposure Rate = 0.0314  $\mu\text{R/hr}$  and

Scan MDC = 26.4 pCi/g

High Enriched Uranium (93.4 wt%) 15 cm thick soil layer

Minimum Detectable Exposure Rate = 0.045  $\mu$ R/hr and

Scan MDC = 24.2 pCi/g

High Enriched Uranium (93.4 wt%) 1 inch thick soil layer

Minimum Detectable Exposure Rate = 0.037  $\mu$ R/hr and

Scan MDC = 54.4 pCi/g

Natural Thorium 15 cm thick soil layer

Minimum Detectable Exposure Rate = 0.443  $\mu$ R/hr and

Scan MDC = 0.46 pCi/g

Natural Thorium 1 inch thick soil layer

Minimum Detectable Exposure Rate = 0.307  $\mu$ R/hr and

Scan MDC = 1.0 pCi/g

## **CONCLUSION**

The Bicon G-5 Fidler NaI Scintillation scan MDC, for total low enriched uranium ( $^{235}\text{U}$  3.5 wt%), in 50-year equilibrium with progeny, being uniformly distributed in surface soil with dimensions of 56 cm diameter and 1 inch thick, is estimated to be 26.4 pCi/g. The minimum detection exposure rate for total uranium and progeny is approximately 0.0314  $\mu$ R/hr, equivalent to 1715 CPM.

The use of low enriched uranium at 3.5 wt%  $^{235}\text{U}$  closely matches the most common uranium enrichment material used on the Hematite Site. A 1 inch soil thickness for uniform distribution of the contaminants is considered conservative. Other scan MDCs and geometries are provided for comparison and completeness.

The values computed are indicative of an instrument more sensitive than a 3"x 3" NaI scintillation detector and agree well with other data presented in NUREG-1507.

**ATTACHMENT B**

**ESTIMATION OF LUDLUM 44-9 INSTRUMENT SCAN  
SENSITIVITY**

**ATTACHMENT B****ESTIMATION OF LUDLUM 44-9 INSTRUMENT SCAN SENSITIVITY****INTRODUCTION**

The Hematite uranium product facility used uranium metal and uranium compounds from natural and enriched uranium for use as nuclear fuel. Specifically, operations included the conversion of uranium hexafluoride (UF<sub>6</sub>) gas of various <sup>235</sup>U enrichments to uranium oxide, uranium carbide, uranium dioxide pellets, and uranium metal. These products were manufactured for use by the federal government and government contractors and by commercial and research reactors approved by the Atomic Energy Commission (AEC). Research and development was also conducted at the Plant, as were uranium scrap recovery processes. In addition to uranium, work was performed with thorium compounds as part of early research into the use of thorium in the fuel cycle.

Work has been ongoing at the Site commencing since 1956. Uranium used at the facility was previously separated and enriched at other facilities. This time period allowed uranium isotopes and certain daughter progeny to come into an equilibrium state. A limited amount of thorium was introduced to the Hematite Site and is not considered to be present in sufficient quantities to significantly change the uranium analysis shown in this memorandum. Likewise, <sup>99</sup>Tc contamination, possibly present due to recycled uranium, may be detected in the soil cores. However, to date, <sup>99</sup>Tc has been shown to be present in groundwater at the Site. This is considered the primary location on site for this radiological contaminant of potential concern. Consequently, only uranium isotopes and progeny are considered in the memorandum.

The Hematite soil cores will be monitored for potential total uranium (and progeny) contamination utilizing a Ludlum 44-9 pancake G-M detector, or equivalent. Scan measurements of soil cores will be accomplished with a 44-9 probe scanning the soil core at a speed of 1.5 in/sec. Direct scan measurements will be performed over the length of the soil core with a 44-9 and ratemeter and observing the average count rate over a time of several seconds. All results will be recorded in counts per minute.

**Objective**

The specific objective of this technical memorandum is to estimate the scan and static minimum detectable concentration (MDC) for a 44-9 pancake G-M detector with ratemeter. The detection equipment will be used to scan soil cores along the length of the core to provide 1-minute static measurements at top of the core (0-12 inches bgs) and at another location along the core with the highest scan count rate. It is important to note that this document is solely to be used to estimate scan and static MDCs prior to conducting core surveys on the Hematite property. Actual field conditions and background rates will affect these estimates.

**SOURCE TERM ABSTRACTION**

Based upon knowledge from previous characterization surveys, sampling, and historical information the radiological constituent of concern has been determined to be uranium metal

present in the soil at various enrichment concentrations. Natural uranium concentrations were chosen since most work onsite involved natural and low enriched uranium. The radionuclides of concern associated with the uranium are uranium-238, uranium-235, uranium-234, thorium-234, thorium-231, and protactinium-234m. Protactinium-234 is also present but in very small quantities and is ignored for purposes of this calculation. The two thorium isotopes and the protactinium isotope are short-lived daughter products from the decay of uranium 238 and uranium-235. Uranium-238, uranium-235, and uranium-234 isotopes are present in naturally occurring uranium with activity percentages compared to total uranium activity of 48.9 %, 2.2%, and 48.9% respectively. Thorium 234 and protactinium-234m are in secular equilibrium with parent uranium-238. Thorium-231 is in secular equilibrium with parent uranium-235.

For natural uranium at this facility, the isotope U-238 comprises 48.9% of the total uranium activity. The remaining activity consists of approximately 48.9% U-234 and 2.2% U-235. Each U-238 decay contributes 1 beta particle from Th-234 and 0.98 particles from Pa-234m. The U-234 has no beta particles associated with it and because it is an alpha emitter and its daughters have not grown in to any appreciable extent due to the half-life of daughter Th-230. Each U-235 decay provides 1 beta particle from the Th-231 daughter. No other isotopes beyond Th-231 have grown in because of the long half-life (3.2E4 yr) of its daughter, Pa-231, which has not grown in appreciably.

Accounting for the activity percentage of each isotope in the total uranium and the relative number of beta particles associated with each isotope the number of beta particles emitted per total uranium decay is:

$$\text{Number beta particles per total uranium decay} = [(1+0.98) \times 0.489] + (1 \times 0.022) = 0.99$$

Rounding yields a summed total of 1.0 beta particles per total natural unenriched uranium decay.

## **DETECTABILITY OF BETA PARTICLES IN SOIL CORES**

### **Range of Detectable Beta Particles in Soil Cores**

A G-M frisker consisting of a Ludlum Model 3 and 44-9 probe or equivalent will be used to make the desired measurements on the soil cores. The total active area of a 44-9 probe is 15 cm<sup>2</sup>. This is equivalent to a disk diameter of approximately 1.7 inches. The soil core diameter is 2 inches resulting in the full coverage of the probe active area by the soil core containing potential radioactive contamination.

The response of the frisker to uranium and progeny in the soil is due primarily to the beta particles. The small gamma and bremsstrahlung component contributions to instrument response are ignored and the alpha particles have too small a range in soil to result in significant response. The average energy and range (density thickness) of the beta particles from the energetic Pa-234m is 0.825 MeV and 320 mg/cm<sup>2</sup>. The average energy and the resultant range within the soil cores of the Th-234 and Th-231 beta particles are small (0.050

MeV and 0.085 MeV respectively) and may be conservatively ignored for purposes of this calculation.

Assuming a density of the soil as  $1.6 \text{ g/cm}^3$ , the average range of a Pa-234m beta in soil is:

$$\text{Linear Range} = \frac{\text{density thickness}}{\text{soil density}} = \frac{320 \text{ mg/cm}^2}{(1.6 \text{ g/cm}^3)(1000 \text{ mg/g})} = 0.2 \text{ cm}$$

### **Scan Volume of Soil Core Beta Particles Detected by 44-9 GM Probe**

The average thickness of the soil core that has uranium beta particles capable of being detected by the 44-9 GM probe is 0.2 cm. It is assumed that beta particles more energetic than this average energy will be detected while those with lesser energy will have insufficient range to be detected.

This average range of the beta particles in the soil core results in the probe being able to detect uranium in a volume of soil equal to approximately the size of the probe active area times a thickness equal to the linear range of the average beta particle or:

$$\begin{aligned} \text{Volume of soil} &= (\text{probe active area}) \times (\text{linear range of beta}) = (15 \text{ cm}^2) \times (0.2 \text{ cm}) \\ &= 3 \text{ cm}^3 \text{ soil} \end{aligned}$$

### **ESTIMATION OF MINIMUM DETECTABLE CONCENTRATION**

#### **MDCR Ludlum Model 44-9 or Equivalent**

The scan minimum detectable count rate (MDCR) is dependent upon several factors including surveyor performance, instrument sensitivity, distribution of contamination, etc.

#### *Determination of Number of Source Counts*

The MDCR is calculated by obtaining the minimum detectable number of source counts ( $S_i$ ) in a given time interval,  $i$ .  $S_i$  is calculated by using equation 6-8 in MARSSIM as:

$$S_i = d' \sqrt{b_i}$$

Where:  $d'$  = is the detectability value associated with the desired performance selected from Table 6-5 in MARSSIM

$b_i$  = background counts during interval,  $i$

The background counts will fluctuate with the background materials present at the Site and in the soil core. Varying concentrations of naturally occurring radioactive materials are present in the soil. Based upon manufacturer specifications, it is also assumed that the response of the Ludlum Model 44-9 to ambient background radiation is 3300 cpm/mR/hr. Based on various background rates, the following 44-9 count rates may be expected.

Table 1 Count Rates based on ambient gamma background

	Ambient Gamma Background Rate		
	5 uR/hr	10 uR/hr	15 uR/hr
<b>Average 44-9 Count Rate (cpm)</b>	17	33	50

It is assumed that during a typical scanning survey an elevated source of radioactivity will remain under the probe for one second. The diameter of the detector is 4.4 cm. Assume a scan speed of 1 cm per second. At this scan rate the majority of the activity in the soil viewed by the probe active area will be present for at least 1 second. This assumes that any elevated radioactivity is a point source. Further it is conservatively assumed that the higher background rate of 15 uR/hr exists and this is doubled to 100 cpm to account for low levels of potassium-40 and other naturally occurring beta emitters in the soil. This results in background counts in the observation interval of one second when scanning the soil core as:

$$b_i = (100 \text{ cpm})(1 \text{ second}) \left( \frac{\text{minute}}{60 \text{ seconds}} \right) = 1.67 \text{ counts}$$

The value of  $d'$  is selected from Table 6.5 in MARSSIM and is based upon the acceptable true and corresponding false positive proportions or rates during scanning. For example, if a 95% confidence level is placed on the ability to correctly detect the presence of radioactivity above background, then there is only a 5% chance that radioactivity above background will be missed. Further, if a 25% confidence level is placed on falsely identifying areas as containing radioactivity above background, 75% of the time areas not containing radioactivity above background will be correctly determined as background. For the purposes of the work plan, a 95% confidence level will be used for correctly detecting the presence of radioactivity, with an allowance for 60% false positive detection. Having a higher percentage of false positives does not require increased sampling, but rather further investigation by either slowing the scan speed in the location of interest or performing an integrated count. A higher false positive value is actually conservative because background locations are investigated as though they contained residual radioactivity. The ramification of increasing the false positive proportion is that survey scanning time is increased. The value for  $d'$  in Table 6-5 of MARSSIM for the confidence levels specified above is 1.38. Therefore, the minimum number of source counts, when scanning soil cores, is calculated as:

$$S_i = 1.38 \sqrt{1.67} = 1.8 \text{ counts}$$

#### Calculation of MDCR

The MDCR is calculated by using equation 6-9 in MARSSIM.

$$\text{MDCR} = S_i \frac{60}{i}$$

As stated in Section 0, it is assumed that during a typical scanning survey an elevated source of radioactivity will remain under the probe for one second. Therefore, when scanning the soil core, the MDCR is calculated as:

$$\text{MDCR} = (1.8 \text{ counts}) \left( \frac{60 \text{ sec.}}{1 \text{ sec. min.}} \right) = 108 \text{ cpm}$$

#### *Estimation of Scan MDC*

The scan MDC is determined from the Minimum Detectable Count Rate (MDCR) by applying necessary conversion factors that account for surveyor performance, detector efficiency, probe area, etc. The scan MDC is calculated by using equation 6-10 in MARSSIM as:

$$\text{Scan MDC}(\text{dpm}/100\text{cm}^2) = \frac{\text{MDCR}}{\sqrt{p} \epsilon_i \epsilon_s \frac{\text{probe area}}{100 \text{ cm}^2}}$$

Where: MDCR = minimum detectable count rate

$\epsilon_i$  = instrument efficiency

$\epsilon_s$  = surface efficiency

$p$  = surveyor efficiency

The Nuclear Regulatory Commission publication NUREG-1507 recommends surveyor efficiency values between 0.75 and 0.5. To be conservative, 0.5 is chosen. Based upon manufacturer specifications, the anticipated efficiency for the Model 44-9 probe for high energy betas such as protactinium 234m is 20%. This efficiency is assumed as the combined surface and instrument efficiency listed above. The probe area of the Model 44-9 is 15 square centimeters. The scan MDC for a soil core is calculated as:

$$\text{Scan MDC} = \frac{108 \text{ cpm}}{\sqrt{0.5} \left( 0.2 \frac{\text{c}}{\text{d}} \right) \left( \frac{15 \text{ cm}^2}{100 \text{ cm}^2} \right)} = 5,090 \text{ dpm}/100\text{cm}^2$$

Applying the volume of soil calculated in Section 3.2, and adjusting for the active area of the probe and soil density, the scan MDC may be expressed in terms of activity concentration:

$$\text{ActivityScan MDC} = \frac{\left(\frac{5,090 \text{ dpm}}{100 \text{ cm}^2}\right) \times \left(\frac{15 \text{ cm}^2}{\text{frisk}}\right)}{\left(\frac{2.22 \text{ dpm}}{\text{pCi}}\right) \times \left(\frac{1.6 \text{ g}}{\text{cm}^3}\right) \times (3 \text{ cm}^3)} = 72 \text{ pCi/g}$$

## ESTIMATION OF STATIC DIRECT MEASUREMENT SENSITIVITY

The static MDC or direct measurement sensitivity is dependent only upon the background rate.

### Minimum Detectable Concentration Expression

The critical level ( $L_C$ ) and the detection limit ( $L_D$ ) for direct measurement sensitivity is given by MARSSIM equation 6-6. Based upon Type I and Type II errors set at 0.05 these expressions are:

$$L_C = 2.33\sqrt{B} \quad \text{and}$$

$$L_D = 3 + 4.65\sqrt{B}$$

Where,

$L_C$  = critical level (counts)

$L_D$  = detection limit (counts)

$B$  = background counts that are expected while performing the actual measurement

### Detection Equipment and direct measurement sensitivity

A G-M pancake probe such as the Ludlum 44-9 or equivalent provides a highly sensitive detector for detecting beta emissions. It is also sensitive to gamma radiation but at a lower rate. Utilizing the same assumptions as in section 2.1.1 with respect to ambient background gamma and naturally occurring beta radiations from the soil the following  $L_C$  and  $L_D$  values are calculated:

$$L_C = 2.33\sqrt{B} = 2.33\sqrt{100} = 23 \text{ counts}$$

$$L_D = 3 + 4.65\sqrt{B} = 3 + 4.65\sqrt{100} = 50 \text{ counts}$$

These values are somewhat higher than MARSSIM Table 6.4 estimates of beta survey instrumentation sensitivity due to conservative background estimates.

The MDC is calculated from equation 6-7 of MARSSIM:

$$\text{MDC} = C \times (3 + 4.65\sqrt{B})$$

Where, for a one minute count basis

C = total detection efficiency over the volume of soil core with detectable 44-9 probe counts, and

$$\text{Activity MDC} = \frac{\left(\frac{5 \text{ dpm}}{\text{cpm}}\right)}{\left(\frac{2.22 \text{ dpm}}{\text{pCi}}\right)} \times \frac{(3 + 4.65\sqrt{100})}{(4.8 \text{ g})} = 23 \text{ pCi/g}$$

## SUMMARY

Using MARSSIM methodology, the calculated scan MDC sensitivities for a Ludlum 44-9 pancake G-M probe or equivalent for this radiological survey when using a 60% false positive and a 95% true positive proportion is:

- Ludlum 44-9 probe scan MDC for total uranium:
  - For a 100 cpm background and contribution from naturally occurring beta emitters in the soil the MDC is 5,090 dpm/100 cm<sup>2</sup>.
  - For a 100 cpm background and contribution from naturally occurring beta emitters in the soil the MDC is 72 pCi/g.

Using MARSSIM methodology, the calculated scan direct measurement sensitivities for a Ludlum 44-9 pancake G-M probe or equivalent for this radiological survey when using Type I and Type II errors set at 0.05 is:

- Ludlum 44-9 probe direct measurement sensitivity for total uranium:
  - For a 100 cpm background and contribution from naturally occurring beta emitters in the soil the L<sub>C</sub> = 23 counts.
  - For a 100 cpm background and contribution from naturally occurring beta emitters in the soil the L<sub>D</sub> = 50 counts.
  - For a 100 cpm background the static MDC is 23 pCi/g.

**ATTACHMENT C**

**INVESTIGATIVE DERIVED WASTE (IDW) MANAGEMENT PLAN**



## Hematite Former Fuel Cycle Facility Decommissioning

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### Investigative Derived Waste (IDW) Management Plan

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#### 1.0 PURPOSE

This plan identifies the requirements to ensure the proper management of investigative derived waste (IDW) generated during the field investigation activities performed as part of the remedial investigation (RI) at the former Hematite Former Fuel Cycle Facility (FFCF). The anticipated activities will generate solid and/or liquid IDW from within the approximate 228 acres of property (Property) currently owned by Westinghouse Electric Company, LLC (Westinghouse), including the former 8-acre plant site, and on property owned by others. IDW will be characterized and managed according to the procedures described in this plan.

IDW solids include:

- Decontamination solids
- Drilling solids
- Personal Protective Equipment (PPE) and/or associated general trash.

IDW liquids include:

- Decontamination liquids
- Development water
- Drilling liquids

These terms are defined in Section 3.

## 2.0 APPLICABILITY

This plan applies to management of IDW during the RI at the former FFCF site (Site).

## 3.0 DEFINITIONS/ACRONYMS

**Decontamination Liquids** – Liquids generated during the decontamination of drilling and sampling equipment.

**Decontamination Solids** - Solids generated during the decontamination of drilling and sampling equipment.

**Development Water** – Groundwater generated from the task of developing the monitoring well prior to sampling.

**Drilling Liquids** – Fluids generated from a borehole during drilling activities in order to remove cuttings, clean and cool the drill bit, and/or to reduce friction between the bit and the sides of the hole.

**Drilling Solids** – Solid materials brought to the surface during drilling activities including soil and/or rock cuttings.

**Investigative Derived Wastes** – Material and/or waste that is generated during an environmental investigation.

**Personal Protective Equipment** – Equipment and clothing used for protection from safety and health-related concerns on or within the site under investigation.

<b>AOC</b>	Area of Concern
<b>ASTM</b>	American Society for Testing and Materials
<b>CALM</b>	Cleanup Action Levels for Missouri
<b>EPA</b>	Environmental Protection Agency
<b>FFCF</b>	Former Fuel Cycle Facility
<b>FG</b>	Field Geologist
<b>FOL</b>	Field Operations Leader
<b>HPT</b>	Health Physics Technician
<b>IDW</b>	Investigative Derived Waste
<b>MDNR</b>	Missouri Department of Natural Resources
<b>NRC</b>	Nuclear Regulatory Commission
<b>pCi/l</b>	Picocuries per liter
<b>PM</b>	Project Manager
<b>PPE</b>	Personal Protective Equipment
<b>RCRA</b>	Resource Conservation and Recovery Act

<b>RPP</b>	Radiation Protection Plan
<b>RSO</b>	Radiation Safety Officer
<b>RWP</b>	Radiation Work Permit
<b>SNM</b>	Special Nuclear Material
<b>Tc-99</b>	Technetium 99
<b>USEPA</b>	United States Environmental Protection Agency
<b>VOCs</b>	Volatile Organic Compounds

#### 4.0 REFERENCES

ASTM D 5092-90; *Standard Practice For Design and Installation of Groundwater Monitoring Wells in Aquifers*

USEPA, 1992, *Guide to Management of Investigation-Derived Wastes*, EPA 9345.3-03FS

USEPA, 1991. *Management of Investigation-Derived Wastes during Site Inspections*. EPA/540/G-91/009.

Leggette, Brashears & Graham, 2002. *Remedial Investigation Feasibility Study Work Plan for the Westinghouse Electric Company, Hematite Missouri Facility*.

MDNR, Division of Environmental Quality, updated September 2001, Missouri *Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM)*.

#### 5.0 RESPONSIBILITIES

Project Manager (PM) – the PM is responsible for ensuring that personnel are familiar with this plan/procedure and have access to a copy of this procedure. Procedures will be provided to field personnel at a kick-off meeting at the onset of fieldwork.

Field Operations Leader (FOL) – The FOL is responsible for monitoring compliance with this procedure and training personnel in the proper management of IDW. The FOL reviews this procedure with field personnel and documents personnel that have been through the training via an attendance sheet.

Field Geologist (FG) – During field assignments, the FG is responsible for ensuring that this procedure is implemented.

Radiation Safety Officer (RSO) – The RSO directs and manages radiation protection personnel and resources in the accomplishment of job responsibilities. The RSO is responsible for health physics, radiation protection, nuclear criticality safety, supporting

environmental monitoring, and radiological and hazardous material waste management operations.

Health Physics Technician - Health Physics Technicians (HPT) provide day-to-day support of the field operations. They perform routine environmental monitoring and collect representative samples where directed by the RSO or EH&S Manager.

Environmental Health and Safety (EH&S) Manager – The EH&S Manager directs and manages the Health Physics Technician(s) in the accomplishment of job responsibilities. The EH&S Manager is responsible for non-radiological environmental protection and monitoring, occupational health and safety, and hazardous waste management operations.

## **6.0 GENERAL**

The procedure for IDW management at the Site will depend on the state (solid or liquid) of the IDW and where it is generated.

IDW liquids will be collected at the various points of generation and transported to a drop off tank located as shown in Figure 1. The liquid will be pumped through a bag filter to an equalization or holding tank(s). When there is a sufficient quantity in the tank(s), the liquid will be discharged through a carbon filtration system to the on-site wastewater treatment plant. The flow discharged to the wastewater treatment plant will be recorded daily. The discharge from the wastewater treatment plant will meet the criteria in the existing discharge (NPDES) permit (MO-0000761).

Sampling taps will be installed prior to the carbon filtration units and before the last carbon unit. Samples of the IDW liquid will be taken from these two points during the first day when discharge occurs and weekly thereafter. The samples will be analyzed for radiologic parameters and volatile organic compounds (VOCs).

IDW solid management practices are described below and will vary depending on where the solid is generated. IDW, which is comprised of trash and/or PPE, will be collected and containerized at the plant site, and managed in accordance with the RPP.

### **6.1 IDW Management**

The following sections describe the procedures for management of solid (non-trash/PPE) IDW generated from:

1. Within the Property, inside the controlled (fenced) area (Figure 1).
2. Within the Property, outside of the controlled (fenced) area.
3. Outside (off) of the Property.

#### 6.1.1 IDW solids generated within the Property, inside the controlled area

Screen the drill solids for contaminants (auger cuttings or soil from drive and wash or mud tub) with field instrumentation (i.e. PID or radiation survey meter) as stated in the project work plan.

Collect and containerize cuttings (auger cuttings or soil from a drive and wash or mud tub) in appropriate storage container. Depending on the amount of cuttings appropriate storage can range from a 55-gallon drum to a roll-off container.

Label individual containers with the site name, location identification, description of contents (i.e. soil, decontamination solids, drilling solids), and date collected.

At the end of each work day, containers shall be covered (drum lids, plastic sheeting or roll-off tarpaulin) to restrict the entry of rainwater.

Transport waste storage containers to a temporary storage area on-site, which is located inside of the secured fenced area (Figure 1).

Document the collection and handling of IDW solids in a field logbook, including the number and types of waste storage containers and/or estimated volume of IDW.

#### 6.1.2 IDW solids generated on the Property, outside the controlled area

Screen the drill solids (auger cuttings or soil from drive and wash or mud tub) with field instrumentation (i.e. PID or radiation survey meter) as stated in the project work plan.

Collect cuttings (auger cuttings or soil from a drive and wash or mud tub) in appropriate size container(s) or place atop and cover with polyethylene sheeting at the drill site.

At the end of each work day, containers shall be covered (drum lids, plastic sheeting or roll-off tarpaulin) to restrict the entry of rainwater.

Note the selected management method and site name, location identification, description of contents, and any appropriate comments in field notes. Record pertinent data including location and physical characteristics of material (e.g., texture, water content, odor, and field instrumentation readings associated with material) and the number and types of storage containers and/or estimated volume of IDW in field logbook.

### 6.1.3 IDW solids generated outside (off) of the Property

Screen the drill solids (auger cuttings or soil from drive and wash or mud tub) with field instrumentation (i.e. PID or radiation meter) as stated in the project work plan.

Collect cuttings (auger cuttings or soil from a drive and wash or mud tub) in appropriate size container(s) for transport. IDW solids from off the Property will be transported to an existing drilling site on the Property for maintenance and evaluation as described herein.

At the end of each work day, containers shall be covered (drum lids, plastic sheeting or roll-off tarpaulin) to restrict the entry of rainwater, and secured. Security shall be accomplished by installing barrier tape or plastic fencing with appropriate warning placards.

Note the selected management method and site name, location identification, description of contents, and any appropriate comments in field notes. Record pertinent data including location and physical characteristics of material (e.g., texture, water content, odor, and field instrumentation readings associated with material) and/or estimated volume of IDW in field logbook.

## 6.2 Characterization of IDW

Representative samples will be obtained where indicated below from a waste container, storage tank or pile and submitted for analysis to characterize the IDW. Analyses will include volatile organic analyses (EPA Method 8260), gross alpha and gross beta (EPA 900), total uranium (ASTM-D 5174 (1991)) and Tc99 (906.0M).

### 6.2.1 IDW Liquids

#### Radiological Evaluation Criteria

Liquid IDW will be considered contaminated with radiological constituents if analytical results reveal levels of Uranium or Tc-99 above the effluent concentration limits as defined in 10 CFR 20 Appendix B, Table 2, or the effluent release criteria (for gross alpha and gross beta) in the site license (SNM-33). These limits are 300 pCi/L for Uranium, 60,000 pCi/L for Tc-99, 300pCi/L for gross alpha, and 5,000 pCi/L for gross beta.

## Volatile Organic Compound (VOC) Evaluation Criteria

Liquid IDW will be considered contaminated with VOCs if analytical results reveal levels of VOCs above the concentrations identified in 40 CFR 261.24 Toxicity Characteristics – Table 1.

### 6.2.1.1 Disposition of Liquid IDW

IDW liquids that meet the evaluation criteria for both VOCs and radiological parameters will be discharged to the Sewage Treatment Facility in accordance with effluent release criteria stated in Chapter 5 of SNM-33. Average alpha and beta releases from the sewage treatment plant will not exceed 300 pCi/L and 5,000 pCi/L respectively, and the volume will not exceed the actual flow identified in the current NPDES permit (8,000 gallons/day). In this manner, the total flow from the outfall will remain below the design flow (9,000 gallons/day) identified in the NPDES permit.

If radiological parameters or VOC's are identified in the liquid IDW above the evaluation criteria, and confirmed by follow-up sampling, other management methods or off-site disposal options will be considered.

### 6.2.2 IDW Solids

Drilling and decontamination solids will be stored in containers, or stockpiled and isolated by use of polyethylene sheeting as described above. A representative sample will be collected from the pile or container(s) and analyzed for VOCs (method 8260) and radiological parameters as described below. Where IDW solids are generated from outside the controlled area, the following criteria will be assessed. IDW solids from within the controlled area will be containerized and managed consistent with the overall remedy for the site.

#### Radiological Evaluation Criteria

After collection of IDW solids is complete, they shall be evaluated by field measurements for the presence of unacceptable levels of radiological contaminants. IDW solids will be directly scanned with calibrated field instruments for radiological contamination. The field instrument will also be used to assess the local undisturbed soil conditions for radiological levels. The field measurements will be recorded in a field logbook.

If the field measurements from the IDW are less than or equal to 2 times the local soil measurements, then the IDW will be considered not contaminated. If the field measurements of the IDW are greater than twice that of the local soils, then samples will be collected from the local undisturbed soil and the IDW solid. The

IDW sample will be collected where the field scanning indicates the highest readings. The samples will be analyzed for gross alpha and gross beta radioactivity.

The results of the IDW sample will be compared to those from the local surface soil sample. If the IDW sample results (for both gross alpha and gross beta) are less than or equal to 2 times the undisturbed sample results, the IDW will be considered not contaminated.

#### Volatile Organic Compound Evaluation Criteria

If the IDW solid has concentrations of VOC's at or below those target concentrations listed in Table B1 - Scenario A (residential) in CALM; it will be considered not contaminated. If the IDW solid media has concentrations of VOC's above the Scenario A target concentrations, alternate disposal options will be evaluated. Additional sampling or re-sampling may be performed to more accurately characterize the solids.

##### 6.2.2.1 Disposition of IDW Solids

IDW solids where concentrations of VOCs are below the Scenario A target levels (Table B1 – CALM) and the radiological parameters are less than or equal to 2 times the nearby soil conditions, the IDW will be spread in the vicinity where they were generated. In the case where IDW was relocated from off the Property, the IDW will be evaluated according to the same criteria. Soils that do not meet these criteria will be containerized and evaluated for other disposal or management options including off-site disposal.

##### 6.2.3 Personal Protective Equipment/Trash

Personal protective equipment (PPE) will be separated and containerized according to where it was utilized (i.e. inside or outside the controlled area). The PPE and trash generated within the controlled area will be managed in accordance with the RPP. PPE and trash from outside the controlled area will be screened for radiological parameters (as required by the RSO) and VOCs and managed appropriately.

## 7.0 FORMS

No specific forms are required under this procedure. IDW types and quantities will be documented in the field logbook as described in Section 6.0 above.

## **8.0 APPENDICES**

Appendix A - Cleanup Levels for Missouri (CALM) - Table B1 – Soil and Groundwater Target Concentrations (STARC and GTARC)

Appendix B - 40 CFR 261.24, Table 1 – Maximum Concentration of Contaminants for the Toxicity Characteristic.

## **9.0 FIGURES**

Figure 1 - Drawing B-5020-2076 – Plant Layout – Revised Fencing

## APPENDICES

APPENDIX A

Cleanup Levels for Missouri Table B1

Table B1. Soil and Groundwater Target Concentrations (STARC and GTARC)

Chemical	CAS #	Soil Target Concentrations (STARC) (see Appx. B, Sec. 2 & Fig. B2 for guidance in selecting cleanup levels)				Groundwater Target Concns (GTARC) mg/l
		Direct Exposure (Ingestion/Dermal/Inhalation) $C_{IDI}$			Leaching to Groundwater	
		Scenario A $C_{IDI}$ mg/kg	Scenario B $C_{IDI}$ mg/kg	Scenario C $C_{IDI}$ mg/kg	$C_{LEACH}$ mg/kg	
Acenaphthene	83-32-9	1700	2400	5400	1,000	1.2
Acetone	67-64-1	2,700	3,700	8,700	No GTARC	No GTARC
Acetonitrile	75-05-8	150	200	420	No GTARC	No GTARC
Acifluorfen	62476-59-9	51	71	200	No Kd	0.001
Acrylamide	79-06-1	0.4	0.5	1.0	7.8E-05	1.0E-05
Acrylic Acid	79-10-7	34,000	48,000	110,000	No GTARC	No GTARC
Acrylonitrile	107-13-1	0.8	1.0	2	1.2E-04	6.0E-05
Alachlor	15972-60-8	20	29	81	0.05	0.002
Aldicarb	116-06-3	70	98	230	0.03	0.007
Aldicarb sulfone	1646-88-4	70	98	230	0.02	0.007
Aldrin	309-00-2	0.1	0.1	0.4	0.6	2.0E-06
Allyl alcohol	107-18-6	350	490	1,200	No GTARC	No GTARC
Allyl chloride	107-05-1	3,500	4,900	11,000	No GTARC	No GTARC
Ametryn	834-12-8	630	880	2,100	2.9	0.06
Ammonium sulfamate	7773-06-0	5,600	7,900	18,000	No Kd	2
Anthracene (PAH)	120-12-7	8,500	12,000	27,000	33,000	9.6
Antimony	7440-36-0	85	120	300	No Kd	0.006
Arsenic	7440-38-2	11	11	14	No Kd	0.05
Atrazine	1912-24-9	7	10	29	0.18	0.003
Barium	7440-39-3	14,000	20,000	51,000	1,700	2
Baygon	114-26-1	280	390	920	0.06	0.003
Bentazon	25057-89-0	180	250	580	No Kd	0.2
Benzene	71-43-2	6	8	13	0.05	0.005
Benzdine	92-87-5	0.01	0.01	0.03	0.002	1.2E-07
Benzo(a)anthracene (PAH)	56-55-3	1	2	4	0.2	4.4E-6
Benzo(a)pyrene (PAH)	50-32-8	0.2	0.2	0.6	24	2.0E-04
Benzo(b)fluoranthene (PAH)	205-99-2	0.9	1	4	0.6	4.4E-6
Benzo(k)fluoranthene (PAH)	207-08-9	8	12	32	0.6	4.4E-6
Benzoic Acid	65-85-0	280,000	390,000	920,000	No GTARC	No GTARC
Beryllium	7440-41-7	0.05	0.07	0.2	130	0.004
1,1-Biphenyl	92-52-4	1,400	2,000	4,500	No GTARC	No GTARC
Bis(2-ethylhexyl)phthalate	117-81-7	410	570	1,800	11,000	0.006
Bis(2-chloroethyl) ether	111-44-4	0.5	0.7	2	1.0E-04	3.0E-05
Bis(2-chloroisopropyl) ether	39638-32-9	8	11	27	2.6	0.3
Bis(chloromethyl) ether	542-88-1	0.001	0.002	0.004	3.4E-07	1.6E-07
Boron	7440-42-8	19,000	27,000	68,000	No Kd	0.6
Bromodichloromethane	75-27-4	11	15	41	0.7	0.08
Bromoform	75-25-2	140	200	450	1.0	0.08
4-Bromophenyl phenyl ether	101-55-3	150	150	150	No GTARC	No GTARC
Butyl benzyl phthalate	85-68-7	930	930	930	20,000	3
Cadmium	7440-43-9	110	150	380	11	0.005
Captan	133-06-2	470	660	1,800	No GTARC	No GTARC
Carbaryl	63-25-2	7,000	9,800	23,000	10	0.7
Carbazole	86-74-8	82	110	320	No GTARC	No GTARC
Carbofuran	1563-66-2	350	490	1,200	0.30	0.04
Carbon disulfide	75-15-0	630	721	721	No GTARC	No GTARC
Carbon tetrachloride	56-23-5	2	3	5	0.13	0.005
Carboxin	5234-68-4	7,000	9,800	23,000	No Kd	0.7

Table B1. Soil and Groundwater Target Concentrations (STARC and GTARC)

Chemical	CAS #	Soil Target Concentrations (STARC) (see Appx. B, Sec. 2 & Fig. B2 for guidance in selecting cleanup levels)				Groundwater Target Concns (GTARC) mg/l
		Direct Exposure (Ingestion/Dermal/Inhalation) $C_{DI}$			Leaching to Groundwater $C_{LEACH}$ mg/kg	
		Scenario A	Scenario B	Scenario C		
		$C_{DI}$ mg/kg	$C_{DI}$ mg/kg	$C_{DI}$ mg/kg		
Chloramben	133-90-4	1,100	1,500	3,500	2.4	0.1
Chlordane	12789-03-6	7	10	30	28	0.002
p-Chloroaniline	106-47-8	280	390	920	No GTARC	No GTARC
Chlorobenzene	108-90-7	66	92	180	2.8	0.1
Chloroform	67-66-3	0.8	1.0	1.0	0.6	0.08
2-Chlorophenol	95-57-8	140	200	450	1.9	0.04
Chlorothalonil	1897-45-6	150	210	590	100	0.15
Chlorpyrifos	2921-88-2	210	290	690	4.4	0.02
Chromium, total	7440-47-3	2,100	3,000	4,500	38	0.1
Chrysene (PAH)	218-01-9	36	52	140	0.2	4.4E-6
Copper	7440-50-8	1,100	3,100	4,700	No Kd	1.3
Cyanazine	21725-46-2	2	3	8	0.06	0.001
Cyanide	57-12-5	5480	7670	20400	39	0.2
Cyanogen bromide	506-68-3	2,500	2,500	2,500	No GTARC	No GTARC
Dalapon, sodium salt	75-99-0	850	850	850	0.4	0.2
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	1,000	1,500	3,500	No Kd	0.07
DDD	72-54-8	12	17	48	240	0.002
DDE	72-55-9	8	12	34	1,100	0.002
DDT	50-29-3	8	12	34	620	0.002
Demeton	8065-48-3	1	2	4	No GTARC	No GTARC
Diazinon	333-41-5	59	59	59	0.02	6.0E-04
Dibenzo(a,h)anthracene (PAH)	53-70-3	0.2	0.2	0.6	2	4.4E-6
Dibenzofuran	132-64-9	110	160	360	No GTARC	No GTARC
1,4-Dibromobenzene	106-37-6	700	980	2,300	No GTARC	No GTARC
Dibromochloromethane	124-48-1	20	27	77	0.8	0.08
1,2-Dibromo-3-chloropropane	96-12-8	1	2	5	0.001	2.0E-04
Dibutyl phthalate	84-74-2	2,300	2,300	2,300	11,000	2.7
Dicamba	1918-00-9	2,100	2,900	6,900	3.1	0.2
1,2-Dichlorobenzene	95-50-1	600	600	600	45	0.6
1,4-Dichlorobenzene	106-46-7	17	24	51	5.6	0.075
3,3-Dichlorobenzidine	91-94-1	4	5	14	0.003	4.0E-05
1,2-Dichloroethane	107-06-2	2	3	6	0.02	0.005
1,1-Dichloroethylene	75-35-4	0.4	0.6	1	0.09	0.007
cis-1,2-Dichloroethylene	156-59-2	1,200	1,200	1,200	0.5	0.07
trans-1,2-Dichloroethylene	156-60-5	2,900	3,100	3,100	1.0	0.1
2,4-Dichlorophenol	120-83-2	210	290	690	0.4	0.02
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6	560	790	1,800	No GTARC	No GTARC
1,2-Dichloropropane	78-87-5	10	14	25	0.04	0.005
1,3-Dichloropropene	542-75-6	0.9	1	2	0.004	0.0004
Dieldrin	60-57-1	0.1	0.1	0.4	0.005	2.0E-06
Diethyl phthalate	84-66-2	2,000	2,000	2,000	830	23
Dimethoate	60-51-5	14	20	46	No GTARC	No GTARC
Dimethyl phthalate	131-11-3	1,360	1,360	1,360	2,100	313
2,4-Dimethylphenol	105-67-9	1,400	2,000	4,600	14	0.54
2,6-Dimethylphenol	576-26-1	42	59	140	No GTARC	No GTARC
3,4-Dimethylphenol	95-65-8	70	98	230	No GTARC	No GTARC
1,3-Dinitrobenzene	99-65-0	7	10	23	0.01	0.001
2,4-Dinitrophenol	51-28-5	140	200	460	0.14	0.07

Table B1. Soil and Groundwater Target Concentrations (STARC and GTARC)

Chemical	CAS #	Soil Target Concentrations (STARC) (see Appx. B, Sec. 2 & Fig. B2 for guidance in selecting cleanup levels)				Groundwater Target Concns (GTARC) mg/l
		Direct Exposure (Ingestion/Dermal/Inhalation) $C_{IDI}$			Leaching to Groundwater	
		Scenario A $C_{IDI}$ mg/kg	Scenario B $C_{IDI}$ mg/kg	Scenario C $C_{IDI}$ mg/kg	$C_{LEACH}$ mg/kg	
2,4-Dinitrotoluene	121-14-2	2	3	10	0.0007	5.0E-05
2,6-Dinitrotoluene	606-20-2	2	3	10	5.0E-04	5.0E-05
Di-n-octylphthalate	117-84-0	0.3	0.3	0.3	No GTARC	No GTARC
Dinoseb	88-85-7	70	98	230	0.10	0.007
1,4-Dioxane	123-91-1	150	210	590	0.01	0.003
Diphenamid	957-51-7	2,100	2,900	6,900	No Kd	0.2
Diphenylamine	122-39-4	1,800	2,500	5,800	15	0.2
Diquat	85-00-7	150	220	510	No Kd	0.02
Disulfoton	298-04-4	2	2	2	6.0E-04	3.0E-04
Diuron	330-54-1	140	200	460	0.5	0.01
Endosulfan	115-29-7	420	590	1,400	No GTARC	No GTARC
Endothall	145-73-3	1,400	2,000	4,600	1.6	0.1
Endrin	72-20-8	21	29	69	3.0	0.002
Ethylbenzene	100-41-4	400	400	400	32	0.7
Ethylene glycol	107-21-1	124,000	124,000	124,000	34	14
Ethylene thiourea	96-45-7	6	8	18	6.0E-04	2.0E-04
Fenamiphos	22224-92-6	18	25	57	0.08	0.002
Fluometuron	2164-17-2	910	1,300	3,000	2.0	0.09
Fluoranthene (PAH)	206-44-0	1,600	2,300	5,200	3,800	0.3
Fluorene (PAH)	86-73-7	1,100	1,600	3,600	2,100	1.3
Fonofos	944-22-9	1,400	2,000	4,600	No Kd	0.01
Formaldehyde	50-00-0	14,000	20,000	46,000	No Kd	1
Glyphosate	1071-83-6	7,000	9,800	23,000	300	0.7
Heptachlor	76-44-8	0.3	0.4	0.9	67	4.0E-04
Heptachlor epoxide	1024-57-3	0.2	0.3	0.7	2.0	2.0E-04
Hexachlorobenzene	118-74-1	0.9	1	3	6.5	0.001
Hexachlorobutadiene	87-68-3	14	20	46	6.3	0.001
a-Hexachlorocyclohexane	319-84-6	0.3	0.4	1	3.2E-04	2.2E-06
b-Hexachlorocyclohexane	319-85-7	0.9	1	3	3.3E-04	2.2E-06
g-Hexachlorocyclohexane	58-89-9	1	2	5	0.03	2.0E-04
d-Hexachlorocyclohexane	319-86-8	No tox data	No tox data	No tox data	0.001	2.2E-06
Hexachlorocyclopentadiene	77-47-4	9	13	17	1,200	0.05
Hexachloroethane	67-72-1	70	98	230	0.2	0.001
Hexachlorophene	70-30-4	21	29	70	No GTARC	No GTARC
n-Hexane	110-54-3	110	160	183	No GTARC	No GTARC
Hexazinone	51235-04-2	2,300	3,200	7,600	No Kd	0.4
HMX	2691-41-0	3,500	4,900	12,000	2.5	0.4
Indeno(1,2,3-cd)pyrene (PAH)	193-39-5	3	4	11	1.8	4.4E-6
Isophorone	78-59-1	1,700	2,400	4,570	0.7	0.1
Isopropylbenzene	98-82-8	210	210	210	No GTARC	No GTARC
Lead	7439-92-1	260	660	660	No Kd	0.015
Malathion	121-75-5	1,400	1,600	1,600	21	0.1
Maleic anhydride	108-31-6	7,000	9,800	23,000	No GTARC	No GTARC
Maleic hydrazide	123-33-1	35,000	49,000	120,000	27	4
Maneb	12427-38-2	27	38	110	No GTARC	No GTARC
Manganese	7439-96-5	3,700	5,200	11,000	No Kd	0.05
Mercury	7439-97-6	0.6	0.8	1	3.2	0.002
Methamidophos	10265-92-6	4	5	12	No GTARC	No GTARC

Table B1. Soil and Groundwater Target Concentrations (STARC and GTARC)

Chemical	CAS #	Soil Target Concentrations (STARC) (see Appx. B, Sec. 2 & Fig. B2 for guidance in selecting cleanup levels)				Groundwater Target Concns (GTARC) mg/l
		Direct Exposure (Ingestion/Dermal/Inhalation) $C_{DI}$			Leaching to Groundwater	
		Scenario A $C_{DI}$ mg/kg	Scenario B $C_{DI}$ mg/kg	Scenario C $C_{DI}$ mg/kg	$C_{LEACH}$ mg/kg	
Methanol	67-56-1	35,000	49,000	120,000	No GTARC	No GTARC
Methomyl	16752-77-5	1,800	2,500	5,800	0.7	0.2
Methoxychlor	72-43-5	350	490	1,200	460	0.04
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6	35	49	120	0.05	0.004
Methyl ethyl ketone	78-93-3	7,400	10,000	16,000	No GTARC	No GTARC
Methyl iodide	74-88-4	15,000	15,000	15,000	No GTARC	No GTARC
Methyl isobutyl ketone	108-10-1	1,000	1,500	2,300	No GTARC	No GTARC
Methyl parathion	298-00-0	18	25	58	1.2	0.002
2-Methylphenol	95-48-7	3,500	4,900	12,000	No GTARC	No GTARC
3-Methylphenol	108-39-4	3,500	4,900	7,000	No GTARC	No GTARC
4-Methylphenol	106-44-5	250	350	820	No GTARC	No GTARC
Methylene chloride	75-09-2	51	71	150	0.02	0.005
Methyl tertiary butyl ether (MTBE)	1634-04-4	8760	8760	8760	0.067	0.02
Metolachlor	51218-45-2	11,000	15,000	35,000	No Kd	0.1
Metribuzin	21087-64-9	1,800	2,500	5,800	2.6	0.2
Mirex	2385-85-5	0.9	1	4	No GTARC	No GTARC
Molybdenum	7439-98-7	1,300	1,900	4,900	No Kd	0.04
Naled	300-76-5	140	200	460	No GTARC	No GTARC
Naphthalene (PAH)	91-20-3	120	170	240	24	0.1
Nickel	7440-02-0	4,800	6,700	17,000	170	0.1
Nitrobenzene	98-95-3	12	17	35	0.2	0.017
n-Nitrosodimethylamine	62-75-9	0.03	0.05	0.1	2.4E-06	7.0E-07
n-Nitrosodiphenylamine	86-30-6	330	470	1,300	0.8	0.005
Oxamyl	23135-22-0	1,800	2,500	5,800	0.6	0.2
Paraquat	4685-14-7	320	440	1,000	55	0.03
Pendimethalin	40487-42-1	2,800	3,900	9,300	No GTARC	No GTARC
Pentachlorobenzene	608-93-5	56	79	180	350	0.074
Pentachloronitrobenzene	82-68-8	6	9	25	No GTARC	No GTARC
Pentachlorophenol	87-86-5	6	9	25	0.07	0.001
Phenol	108-95-2	5,200	7,300	17,000	21	4
m-Phenylenediamine	108-45-2	420	590	1,400	No GTARC	No GTARC
Phenylmercuric acetate	62-38-4	6	8	18	No GTARC	No GTARC
Phorate	298-02-2	14	20	46	No GTARC	No GTARC
Picloram	1918-02-1	4,900	6,900	16,000	310	0.5
Polychlorinated biphenyls (PCBs)	1336-36-3	0.6	0.9	2.5	18	5.0E-04
Prometon	1610-18-0	1,100	1,500	3,500	6.4	0.1
Pronamide	23950-58-5	5,300	7,400	17,000	1.3	0.05
Propachlor	1918-16-7	910	1,300	3,000	3.0	0.09
Propanil	709-98-8	350	490	1,200	No GTARC	No GTARC
Propazine	139-40-2	1,400	2,000	4,600	0.2	0.01
Propham	122-42-9	1,400	2,000	4,600	1.2	0.1
n-Propylbenzene	103-65-1	28	40	91	No GTARC	No GTARC
Pyrene (PAH)	129-00-0	2,100	2,900	6,900	12,000	0.96
RDX	121-82-4	15	21	59	No Kd	0.002
Rotenone	83-79-4	280	390	920	No GTARC	No GTARC
Selenium	7782-49-2	300	410	970	4.3	0.05
Silver	7440-22-4	140	200	450	26	0.1
Silvex	93-72-1	560	790	1,800	0.4	0.05

Table B1. Soil and Groundwater Target Concentrations (STARC and GTARC)

Chemical	CAS #	Soil Target Concentrations (STARC) (see Appx. B, Sec. 2 & Fig. B2 for guidance in selecting cleanup levels)				Groundwater Target Concns (GTARC) mg/l
		Direct Exposure (Ingestion/Dermal/Inhalation) $C_{IDI}$			Leaching to Groundwater	
		Scenario A $C_{IDI}$ mg/kg	Scenario B $C_{IDI}$ mg/kg	Scenario C $C_{IDI}$ mg/kg	$C_{LEACH}$ mg/kg	
Simazine	122-34-9	14	19	54	0.07	0.004
Strontium	7440-24-6	130,000	180,000	460,000	No Kd	4
Strychnine	57-24-9	21	29	69	No GTARC	No GTARC
Styrene	100-42-5	1,500	1,500	1,500	9.4	0.1
Terbacil	5902-51-2	910	1,300	3,000	0.6	0.09
Terbufos	13071-79-9	2	2	6	0.07	9.0E-04
1,1,1,2-Tetrachloroethane	630-20-6	10	13	24	0.8	0.07
1,1,2,2-Tetrachloroethane	79-34-5	2	2	5	0.004	3.0E-04
Tetrachloroethylene	127-18-4	40	55	120	0.1	0.005
Tetrahydrofuran	109-99-9	87	120	330	No GTARC	No GTARC
Thallium Compounds	10031-59-1	17	24	61	2.8	0.002
Toluene	108-88-3	650	650	650	3.7	0.15
Total petroleum hydrocarbons (TPH)	NA	200	500	1,000	No Kd	10
Toxaphene	8001-35-2	1	2	6	91	0.003
Triallate	2303-17-5	54	54	54	No GTARC	No GTARC
1,2,4-Trichlorobenzene	120-82-1	270	380	860	15	0.07
1,3,5-Trichlorobenzene	108-70-3	No tox data	No tox data	No tox data	3.4	0.04
1,1,1-Trichloroethane	71-55-6	1,200	1,200	1,200	3.5	0.2
1,1,2-Trichloroethane	79-00-5	5	7	14	0.04	0.005
Trichloroethylene	79-01-6	40	56	89	0.1	0.005
Trichlorofluoromethane	75-69-4	770	1,100	1,400	No GTARC	No GTARC
2,4,5-Trichlorophenol	95-95-4	7,000	9,800	23,000	500	2.6
2,4,6-Trichlorophenol	88-06-2	140	190	510	0.1	0.003
1,2,3-Trichloropropane	96-18-4	0.09	0.1	0.4	0.3	0.04
1,1,2-Trichlorotrifluoroethane	76-13-1	1,100	1,100	1,100	No GTARC	No GTARC
Trifluralin	1582-09-8	210	300	840	8.1	0.005
1,2,4-Trimethylbenzene	95-63-6	100	140	180	No GTARC	No GTARC
1,3,5-Trimethylbenzene	108-67-8	42	59	76	No GTARC	No GTARC
1,3,5-Trinitrobenzene	99-35-4	2,100	2,900	6,900	No GTARC	No GTARC
2,4,6-Trinitrotoluene	118-96-7	35	49	120	0.08	0.002
Vanadium	7440-62-2	1,500	2,100	5,300	No GTARC	No GTARC
Vinyl chloride	75-01-4	0.3	0.4	0.6	0.02	0.002
Warfarin	81-81-2	21	29	69	No GTARC	No GTARC
White phosphorus	7723-14-0	4	6	15	No Kd	1.0E-04
Xylenes	1330-20-7	418	418	418	16	0.32
Zinc	7440-66-6	38,000	53,000	130,000	3,000	2

NOTES

Scenario A – “Unrestricted” land use including residential

Scenario B – “Commercial” land use; requires institutional controls

Scenario C – “Industrial” land use; requires institutional controls

No tox data – Reliable toxicological data necessary to calculate cleanup levels were not identified for this contaminant.

No GTARC – Groundwater target concentration not available for this contaminant.

No Kd – Reliable partitioning coefficient data necessary for calculating  $C_{LEACH}$  was not identified for this contaminant.

## APPENDIX B

Table 1 – Maximum Concentration of Contaminants for the Toxicity Characteristic

## § 261.24 Toxicity characteristic.

(a) A solid waste (except manufactured gas plant waste) exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure, test Method 1311 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter, the extract from a representative sample of the waste contains any of the contaminants listed in table 1 at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself; after filtering using the methodology outlined in Method 1311, is considered to be the extract for the purpose of this section.

(b) A solid waste that exhibits the characteristic of toxicity has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Table 1--Maximum Concentration of Contaminants for the Toxicity Characteristic

EPA HW No.\1\	Contaminant	CAS No.\2\	Regulatory Level (mg/L)
D004	Arsenic.....	7440-38-2	5.0
D005	Barium.....	7440-39-3	100.0
D018	Benzene.....	71-43-2	0.5
D006	Cadmium.....	7440-43-9	1.0
D019	Carbon tetrachloride.....	56-23-5	0.5
D020	Chlordane.....	57-74-9	0.03
D021	Chlorobenzene.....	108-90-7	100.0
D022	Chloroform.....	67-66-3	6.0
D007	Chromium.....	7440-47-3	5.0
D023	o-Cresol.....	95-48-7	\4\200.0
D024	m-Cresol.....	108-39-4	\4\200.0
D025	p-Cresol.....	106-44-5	\4\200.0
D026	Cresol.....	.....	\4\200.0
D016	2,4-D.....	94-75-7	10.0
D027	1,4-Dichlorobenzene.....	106-46-7	7.5
D028	1,2-Dichloroethane.....	107-06-2	0.5
D029	1,1-Dichloroethylene.....	75-35-4	0.7
D030	2,4-Dinitrotoluene.....	121-14-2	\3\0.13
D012	Endrin.....	72-20-8	0.02
D031	Heptachlor (and its epoxide).	76-44-8	0.008
D032	Hexachlorobenzene.....	118-74-1	\3\0.13
D033	Hexachlorobutadiene.....	87-68-3	0.5
D034	Hexachloroethane.....	67-72-1	3.0
D008	Lead.....	7439-92-1	5.0
D013	Lindane.....	58-89-9	0.4
D009	Mercury.....	7439-97-6	0.2
D014	Methoxychlor.....	72-43-5	10.0
D035	Methyl ethyl ketone.....	78-93-3	200.0
D036	Nitrobenzene.....	98-95-3	2.0
D037	Pentachlorophenol.....	87-86-5	100.0
D038	Pyridine.....	110-86-1	\3\5.0

D010	Selenium.....	1182-49-2	1.0
D011	Silver.....	7440-22-4	5.0
D039	Tetrachloroethylene.....	127-18-4	0.7
D015	Toxaphene.....	8001-35-2	0.5
D040	Trichloroethylene.....	79-01-6	0.5
D041	2,4,5-Trichlorophenol.....	95-95-4	400.0
D042	2,4,6-Trichlorophenol.....	88-06-2	2.0
D017	2,4,5-TP (Silvex).....	93-72-1	1.0
D043	Vinyl chloride.....	75-01-4	0.2

---

\1\Hazardous waste number.

\2\Chemical abstracts service number.

\3\Quantitation limit is greater than the calculated regulatory level.

The quantitation limit therefore becomes the regulatory level.

\4\If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/l.

[55 FR 11862, Mar. 29, 1990, as amended at 55 FR 22684, June 1, 1990; 55 FR 26987, June 29, 1990; 58 FR 46049, Aug. 31, 1993; 67 FR 11254, Mar. 13, 2002]

FIGURE 1

Drawing B-5020-2076 – Plant Layout – Revised Fencing



**ATTACHMENT D**  
**COMPENDIUM METHOD TO-15**

**Compendium of Methods  
for the Determination of  
Toxic Organic Compounds  
in Ambient Air**

**Second Edition**

**Compendium Method TO-15**

**Determination Of Volatile Organic  
Compounds (VOCs) In Air Collected In  
Specially-Prepared Canisters And  
Analyzed By Gas Chromatography/  
Mass Spectrometry (GC/MS)**

**Center for Environmental Research Information  
Office of Research and Development  
U.S. Environmental Protection Agency  
Cincinnati, OH 45268**

**January 1999**

## Method TO-15 Acknowledgements

This Method was prepared for publication in the *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b)*, which was prepared under Contract No. 68-C3-0315, WA No. 3-10, by Midwest Research Institute (MRI), as a subcontractor to Eastern Research Group, Inc. (ERG), and under the sponsorship of the U.S. Environmental Protection Agency (EPA). Justice A. Manning, John O. Burckle, and Scott Hedges, Center for Environmental Research Information (CERI), and Frank F. McElroy, National Exposure Research Laboratory (NERL), all in the EPA Office of Research and Development, were responsible for overseeing the preparation of this method. Additional support was provided by other members of the Compendia Workgroup, which include:

- John O. Burckle, EPA, ORD, Cincinnati, OH
- James L. Cheney, Corps of Engineers, Omaha, NB
- Michael Davis, U.S. EPA, Region 7, KC, KS
- Joseph B. Elkins Jr., U.S. EPA, OAQPS, RTP, NC
- Robert G. Lewis, U.S. EPA, NERL, RTP, NC
- Justice A. Manning, U.S. EPA, ORD, Cincinnati, OH
- William A. McClenny, U.S. EPA, NERL, RTP, NC
- Frank F. McElroy, U.S. EPA, NERL, RTP, NC
- Heidi Schultz, ERG, Lexington, MA
- William T. "Jerry" Winberry, Jr., EnviroTech Solutions, Cary, NC

This Method is the result of the efforts of many individuals. Gratitude goes to each person involved in the preparation and review of this methodology.

### Author(s)

- William A. McClenny, U.S. EPA, NERL, RTP, NC
- Michael W. Holdren, Battelle, Columbus, OH

### Peer Reviewers

- Karen Oliver, ManTech, RTP, NC
- Jim Cheney, Corps of Engineers, Omaha, NB
- Elizabeth Almasi, Varian Chromatography Systems, Walnut Creek, CA
- Norm Kirshen, Varian Chromatography Systems, Walnut Creek, CA
- Richard Jesser, Graseby, Smyrna, GA
- Bill Taylor, Graseby, Smyrna, GA
- Lauren Drees, U.S. EPA, NRMRL, Cincinnati, OH

Finally, recognition is given to Frances Beyer, Lynn Kaufman, Debbie Bond, Cathy Whitaker, and Kathy Johnson of Midwest Research Institute's Administrative Services staff whose dedication and persistence during the development of this manuscript has enabled its production.

### DISCLAIMER

***This Compendium has been subjected to the Agency's peer and administrative review, and it has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.***

## METHOD TO-15

### Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/ Mass Spectrometry (GC/MS)

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## METHOD TO-15

### Determination of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/ Mass Spectrometry (GC/MS)

#### 1. Scope

**1.1** This method documents sampling and analytical procedures for the measurement of subsets of the 97 volatile organic compounds (VOCs) that are included in the 189 hazardous air pollutants (HAPs) listed in Title III of the Clean Air Act Amendments of 1990. VOCs are defined here as organic compounds having a vapor pressure greater than  $10^{-1}$  Torr at 25°C and 760 mm Hg. Table 1 is the list of the target VOCs along with their CAS number, boiling point, vapor pressure and an indication of their membership in both the list of VOCs covered by Compendium Method TO-14A (1) and the list of VOCs in EPA's Contract Laboratory Program (CLP) document entitled: *Statement-of-Work (SOW) for the Analysis of Air Toxics from Superfund Sites (2)*.

Many of these compounds have been tested for stability in concentration when stored in specially-prepared canisters (see Section 8) under conditions typical of those encountered in routine ambient air analysis. The stability of these compounds under all possible conditions is not known. However, a model to predict compound losses due to physical adsorption of VOCs on canister walls and to dissolution of VOCs in water condensed in the canisters has been developed (3). Losses due to physical adsorption require only the establishment of equilibrium between the condensed and gas phases and are generally considered short term losses, (i.e., losses occurring over minutes to hours). Losses due to chemical reactions of the VOCs with cocollected ozone or other gas phase species also account for some short term losses. Chemical reactions between VOCs and substances inside the canister are generally assumed to cause the gradual decrease of concentration over time (i.e., long term losses over days to weeks). Loss mechanisms such as aqueous hydrolysis and biological degradation (4) also exist. No models are currently known to be available to estimate and characterize all these potential losses, although a number of experimental observations are referenced in Section 8. Some of the VOCs listed in Title III have short atmospheric lifetimes and may not be present except near sources.

**1.2** This method applies to ambient concentrations of VOCs above 0.5 ppbv and typically requires VOC enrichment by concentrating up to one liter of a sample volume. The VOC concentration range for ambient air in many cases includes the concentration at which continuous exposure over a lifetime is estimated to constitute a  $10^{-6}$  or higher lifetime risk of developing cancer in humans. Under circumstances in which many hazardous VOCs are present at  $10^{-6}$  risk concentrations, the total risk may be significantly greater.

**1.3** This method applies under most conditions encountered in sampling of ambient air into canisters. However, the composition of a gas mixture in a canister, under unique or unusual conditions, will change so that the sample is known not to be a true representation of the ambient air from which it was taken. For example, low humidity conditions in the sample may lead to losses of certain VOCs on the canister walls, losses that would not happen if the humidity were higher. If the canister is pressurized, then condensation of water from high humidity samples may cause fractional losses of water-soluble compounds. Since the canister surface area is limited, all gases are in competition for the available active sites. Hence an absolute storage stability cannot be assigned to a specific gas. Fortunately, under conditions of normal usage for sampling ambient air, most VOCs can be recovered from canisters near their original concentrations after storage times of up to thirty days (see Section 8).

**1.4** Use of the Compendium Method TO-15 for many of the VOCs listed in Table 1 is likely to present two difficulties: (1) what calibration standard to use for establishing a basis for testing and quantitation, and (2) how

to obtain an audit standard. In certain cases a chemical similarity exists between a thoroughly tested compound and others on the Title III list. In this case, what works for one is likely to work for the other in terms of making standards. However, this is not always the case and some compound standards will be troublesome. The reader is referred to the Section 9.2 on standards for guidance. Calibration of compounds such as formaldehyde, diazomethane, and many of the others represents a challenge.

**1.5** Compendium Method TO-15 should be considered for use when a subset of the 97 Title III VOCs constitute the target list. Typical situations involve ambient air testing associated with the permitting procedures for emission sources. In this case sampling and analysis of VOCs is performed to determine the impact of dispersing source emissions in the surrounding areas. Other important applications are prevalence and trend monitoring for hazardous VOCs in urban areas and risk assessments downwind of industrialized or source-impacted areas.

**1.6** Solid adsorbents can be used in lieu of canisters for sampling of VOCs, provided the solid adsorbent packings, usually multisorbent packings in metal or glass tubes, can meet the performance criteria specified in Compendium Method TO-17 which specifically addresses the use of multisorbent packings. The two sample collection techniques are different but become the same upon movement of the sample from the collection medium (canister or multisorbent tubes) onto the sample concentrator. Sample collection directly from the atmosphere by automated gas chromatographs can be used in lieu of collection in canisters or on solid adsorbents.

## **2. Summary of Method**

**2.1** The atmosphere is sampled by introduction of air into a specially-prepared stainless steel canister. Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister. A pump ventilated sampling line is used during sample collection with most commercially available samplers. Pressurized sampling requires an additional pump to provide positive pressure to the sample canister. A sample of air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into the pre-evacuated and passivated canister.

**2.2** After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to the laboratory for analysis.

**2.3** Upon receipt at the laboratory, the canister tag data is recorded and the canister is stored until analysis. Storage times of up to thirty days have been demonstrated for many of the VOCs (5).

**2.4** To analyze the sample, a known volume of sample is directed from the canister through a solid multisorbent concentrator. A portion of the water vapor in the sample breaks through the concentrator during sampling, to a degree depending on the multisorbent composition, duration of sampling, and other factors. Water content of the sample can be further reduced by dry purging the concentrator with helium while retaining target compounds. After the concentration and drying steps are completed, the VOCs are thermally desorbed, entrained in a carrier gas stream, and then focused in a small volume by trapping on a reduced temperature trap or small volume multisorbent trap. The sample is then released by thermal desorption and carried onto a gas chromatographic column for separation.

As a simple alternative to the multisorbent/dry purge water management technique, the amount of water vapor in the sample can be reduced below any threshold for affecting the proper operation of the analytical system by

reducing the sample size. For example, a small sample can be concentrated on a cold trap and released directly to the gas chromatographic column. The reduction in sample volume may require an enhancement of detector sensitivity.

Other water management approaches are also acceptable as long as their use does not compromise the attainment of the performance criteria listed in Section 11. A listing of some commercial water management systems is provided in Appendix A. One of the alternative ways to dry the sample is to separate VOCs from condensate on a low temperature trap by heating and purging the trap.

**2.5** The analytical strategy for Compendium Method TO-15 involves using a high resolution gas chromatograph (GC) coupled to a mass spectrometer. If the mass spectrometer is a linear quadrupole system, it is operated either by continuously scanning a wide range of mass to charge ratios (SCAN mode) or by monitoring select ion monitoring mode (SIM) of compounds on the target list. If the mass spectrometer is based on a standard ion trap design, only a scanning mode is used (note however, that the Selected Ion Storage (SIS) mode for the ion trap has features of the SIM mode). Mass spectra for individual peaks in the total ion chromatogram are examined with respect to the fragmentation pattern of ions corresponding to various VOCs including the intensity of primary and secondary ions. The fragmentation pattern is compared with stored spectra taken under similar conditions, in order to identify the compound. For any given compound, the intensity of the primary fragment is compared with the system response to the primary fragment for known amounts of the compound. This establishes the compound concentration that exists in the sample.

Mass spectrometry is considered a more definitive identification technique than single specific detectors such as flame ionization detector (FID), electron capture detector (ECD), photoionization detector (PID), or a multidetector arrangement of these (see discussion in Compendium Method TO-14A). The use of both gas chromatographic retention time and the generally unique mass fragmentation patterns reduce the chances for misidentification. If the technique is supported by a comprehensive mass spectral database and a knowledgeable operator, then the correct identification and quantification of VOCs is further enhanced.

### 3. Significance

**3.1** Compendium Method TO-15 is significant in that it extends the Compendium Method TO-14A description for using canister-based sampling and gas chromatographic analysis in the following ways:

- Compendium Method TO-15 incorporates a multisorbent/dry purge technique or equivalent (see Appendix A) for water management thereby addressing a more extensive set of compounds (the VOCs mentioned in Title III of the CAAA of 1990) than addressed by Compendium Method TO-14A. Compendium Method TO-14A approach to water management alters the structure or reduces the sample stream concentration of some VOCs, especially water-soluble VOCs.
- Compendium Method TO-15 uses the GC/MS technique as the only means to identify and quantitate target compounds. The GC/MS approach provides a more scientifically-defensible detection scheme which is generally more desirable than the use of single or even multiple specific detectors.
- In addition, Compendium Method TO-15 establishes method performance criteria for acceptance of data, allowing the use of alternate but equivalent sampling and analytical equipment. There are several new and viable commercial approaches for water management as noted in Appendix A of this method on which to base a VOC monitoring technique as well as other approaches to sampling (i.e., autoGCs and solid

adsorbents) that are often used. This method lists performance criteria that these alternatives must meet to be acceptable alternatives for monitoring ambient VOCs.

- Finally, Compendium Method TO-15 includes enhanced provisions for inherent quality control. The method uses internal analytical standards and frequent verification of analytical system performance to assure control of the analytical system. This more formal and better documented approach to quality control guarantees a higher percentage of good data.

**3.2** With these features, Compendium Method TO-15 is a more general yet better defined method for VOCs than Compendium Method TO-14A. As such, the method can be applied with a higher confidence to reduce the uncertainty in risk assessments in environments where the hazardous volatile gases listed in the Title III of the Clean Air Act Amendments of 1990 are being monitored. An emphasis on risk assessments for human health and effects on the ecology is a current goal for the U.S. EPA.

## 4. Applicable Documents

### 4.1 ASTM Standards

- **Method D1356** *Definitions of Terms Relating to Atmospheric Sampling and Analysis.*
- **Method E260** *Recommended Practice for General Gas Chromatography Procedures.*
- **Method E355** *Practice for Gas Chromatography Terms and Relationships.*
- **Method D5466** *Standard Test Method of Determination of Volatile Organic Compounds in Atmospheres (Canister Sampling Methodology).*

### 4.2 EPA Documents

- *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II*, U. S. Environmental Protection Agency, EPA-600/R-94-038b, May 1994.
- *Technical Assistance Document for Sampling and Analysis of Toxic Organic Compounds in Ambient Air*, U. S. Environmental Protection Agency, EPA-600/4-83-027, June 1983.
- *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-14, Second Supplement*, U. S. Environmental Protection Agency, EPA-600/4-89-018, March 1989.
- *Statement-of-Work (SOW) for the Analysis of Air Toxics from Superfund Sites*, U. S. Environmental Protection Agency, Office of Solid Waste, Washington, D.C., Draft Report, June 1990.
- *Clean Air Act Amendments of 1990*, U. S. Congress, Washington, D.C., November 1990.

## 5. Definitions

*[Note: Definitions used in this document and any user-prepared standard operating procedures (SOPs) should be consistent with ASTM Methods D1356, E260, and E355. Aside from the definitions given below, all pertinent abbreviations and symbols are defined within this document at point of use.]*

**5.1 Gauge** Pressure—pressure measured with reference to the surrounding atmospheric pressure, usually expressed in units of kPa or psi. Zero gauge pressure is equal to atmospheric (barometric) pressure.

**5.2 Absolute Pressure**—pressure measured with reference to absolute zero pressure, usually expressed in units of kPa, or psi.

**5.3 Cryogen**—a refrigerant used to obtain sub-ambient temperatures in the VOC concentrator and/or on front of the analytical column. Typical cryogenes are liquid nitrogen (bp  $-195.8^{\circ}\text{C}$ ), liquid argon (bp  $-185.7^{\circ}\text{C}$ ), and liquid  $\text{CO}_2$  (bp  $-79.5^{\circ}\text{C}$ ).

**5.4 Dynamic Calibration**—calibration of an analytical system using calibration gas standard concentrations in a form identical or very similar to the samples to be analyzed and by introducing such standards into the inlet of the sampling or analytical system from a manifold through which the gas standards are flowing.

**5.5 Dynamic Dilution**—means of preparing calibration mixtures in which standard gas(es) from pressurized cylinders are continuously blended with humidified zero air in a manifold so that a flowing stream of calibration mixture is available at the inlet of the analytical system.

**5.6 MS-SCAN**—mass spectrometric mode of operation in which the gas chromatograph (GC) is coupled to a mass spectrometer (MS) programmed to SCAN all ions repeatedly over a specified mass range.

**5.7 MS-SIM**—mass spectrometric mode of operation in which the GC is coupled to a MS that is programmed to scan a selected number of ions repeatedly [i.e., selected ion monitoring (SIM) mode].

**5.8 Qualitative Accuracy**—the degree of measurement accuracy required to correctly identify compounds with an analytical system.

**5.9 Quantitative Accuracy**—the degree of measurement accuracy required to correctly measure the concentration of an identified compound with an analytical system with known uncertainty.

**5.10 Replicate Precision**—precision determined from two canisters filled from the same air mass over the same time period and determined as the absolute value of the difference between the analyses of canisters divided by their average value and expressed as a percentage (see Section 11 for performance criteria for replicate precision).

**5.11 Duplicate Precision**—precision determined from the analysis of two samples taken from the same canister. The duplicate precision is determined as the absolute value of the difference between the canister analyses divided by their average value and expressed as a percentage.

**5.12 Audit Accuracy**—the difference between the analysis of a sample provided in an audit canister and the nominal value as determined by the audit authority, divided by the audit value and expressed as a percentage (see Section 11 for performance criteria for audit accuracy).

## 6. Interferences and Contamination

**6.1** Very volatile compounds, such as chloromethane and vinyl chloride can display peak broadening and co-elution with other species if the compounds are not delivered to the GC column in a small volume of carrier gas. Refocusing of the sample after collection on the primary trap, either on a separate focusing trap or at the head of the gas chromatographic column, mitigates this problem.

**6.2** Interferences in canister samples may result from improper use or from contamination of: (1) the canisters due to poor manufacturing practices, (2) the canister cleaning apparatus, and (3) the sampling or analytical system. Attention to the following details will help to minimize the possibility of contamination of canisters.

**6.2.1** Canisters should be manufactured using high quality welding and cleaning techniques, and new canisters should be filled with humidified zero air and then analyzed, after “aging” for 24 hours, to determine cleanliness. The cleaning apparatus, sampling system, and analytical system should be assembled of clean, high quality components and each system should be shown to be free of contamination.

**6.2.2** Canisters should be stored in a contaminant-free location and should be capped tightly during shipment to prevent leakage and minimize any compromise of the sample.

**6.2.3** Impurities in the calibration dilution gas (if applicable) and carrier gas, organic compounds out-gassing from the system components ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running humidified zero air blanks. The use of non-chromatographic grade stainless steel tubing, non-PTFE thread sealants, or flow controllers with Buna-N rubber components must be avoided.

**6.2.4** Significant contamination of the analytical equipment can occur whenever samples containing high VOC concentrations are analyzed. This in turn can result in carryover contamination in subsequent analyses. Whenever a high concentration (>25 ppbv of a trace species) sample is encountered, it should be followed by an analysis of humid zero air to check for carry-over contamination.

**6.2.5** In cases when solid sorbents are used to concentrate the sample prior to analysis, the sorbents should be tested to identify artifact formation (see Compendium Method TO-17 for more information on artifacts).

## 7. Apparatus and Reagents

*[Note: Compendium Method To-14A list more specific requirements for sampling and analysis apparatus which may be of help in identifying options. The listings below are generic.]*

### 7.1 Sampling Apparatus

*[Note: Subatmospheric pressure and pressurized canister sampling systems are commercially available and have been used as part of U.S. Environmental Protection Agency's Toxic Air Monitoring Stations (TAMS), Urban Air Toxic Monitoring Program (UATMP), the non-methane organic compound (NMOC) sampling and analysis program, and the Photochemical Assessment Monitoring Stations (PAMS).]*

#### **7.1.1 Subatmospheric Pressure (see Figure 1, without metal bellows type pump).**

**7.1.1.1 Sampling Inlet Line.** Stainless steel tubing to connect the sampler to the sample inlet.

**7.1.1.2 Sample Canister.** Leak-free stainless steel pressure vessels of desired volume (e.g., 6 L), with valve and specially prepared interior surfaces (see Appendix B for a listing of known manufacturers/resellers of canisters).

**7.1.1.3 Stainless Steel Vacuum/Pressure Gauges.** Two types are required, one capable of measuring vacuum (–100 to 0 kPa or 0 to - 30 in Hg) and pressure (0–206 kPa or 0–30 psig) in the sampling system and a second type (for checking the vacuum of canisters during cleaning) capable of measuring at 0.05 mm Hg (see Appendix B) within 20%. Gauges should be tested clean and leak tight.

**7.1.1.4 Electronic Mass Flow Controller.** Capable of maintaining a constant flow rate ( $\pm 10\%$ ) over a sampling period of up to 24 hours and under conditions of changing temperature (20–40°C) and humidity.

**7.1.1.5 Particulate Matter Filter.** 2- $\mu\text{m}$  sintered stainless steel in-line filter.

**7.1.1.6 Electronic Timer.** For unattended sample collection.

**7.1.1.7 Solenoid Valve.** Electrically-operated, bi-stable solenoid valve with Viton® seat and O-rings. A Skinner Magnelatch valve is used for purposes of illustration in the text (see Figure 2).

**7.1.1.8 Chromatographic Grade Stainless Steel Tubing and Fittings.** For interconnections. All such materials in contact with sample, analyte, and support gases prior to analysis should be chromatographic grade stainless steel or equivalent.

**7.1.1.9 Thermostatically Controlled Heater.** To maintain above ambient temperature inside insulated sampler enclosure.

**7.1.1.10 Heater Thermostat.** Automatically regulates heater temperature.

**7.1.1.11 Fan.** For cooling sampling system.

**7.1.1.12 Fan Thermostat.** Automatically regulates fan operation.

**7.1.1.13 Maximum-Minimum Thermometer.** Records highest and lowest temperatures during sampling period.

**7.1.1.14 Stainless Steel Shut-off Valve.** Leak free, for vacuum/pressure gauge.

**7.1.1.15 Auxiliary Vacuum Pump.** Continuously draws air through the inlet manifold at 10 L/min. or higher flow rate. Sample is extracted from the manifold at a lower rate, and excess air is exhausted.

*[Note: The use of higher inlet flow rates dilutes any contamination present in the inlet and reduces the possibility of sample contamination as a result of contact with active adsorption sites on inlet walls.]*

**7.1.1.16 Elapsed Time Meter.** Measures duration of sampling.

**7.1.1.17 Optional Fixed Orifice, Capillary, or Adjustable Micrometering Valve.** May be used in lieu of the electronic flow controller for grab samples or short duration time-integrated samples. Usually appropriate only in situations where screening samples are taken to assess future sampling activity.

**7.1.2 Pressurized (see Figure 1 with metal bellows type pump and Figure 3).**

**7.1.2.1 Sample Pump.** Stainless steel, metal bellows type, capable of 2 atmospheres output pressure. Pump must be free of leaks, clean, and uncontaminated by oil or organic compounds.

*[Note: An alternative sampling system has been developed by Dr. R. Rasmussen, The Oregon Graduate Institute of Science and Technology, 20000 N.W. Walker Rd., Beaverton, Oregon 97006, 503-690-1077, and is illustrated in Figure 3. This flow system uses, in order, a pump, a mechanical flow regulator, and a mechanical compensation flow restrictive device. In this configuration the pump is purged with a large sample flow, thereby eliminating the need for an auxiliary vacuum pump to flush the sample inlet.]*

**7.1.2.2 Other Supporting Materials.** All other components of the pressurized sampling system are similar to components discussed in Sections 7.1.1.1 through 7.1.1.17.

## 7.2 Analytical Apparatus

**7.2.1 Sampling/Concentrator System (many commercial alternatives are available).**

**7.2.1.1 Electronic Mass Flow Controllers.** Used to maintain constant flow (for purge gas, carrier gas and sample gas) and to provide an analog output to monitor flow anomalies.

**7.2.1.2 Vacuum Pump.** General purpose laboratory pump, capable of reducing the downstream pressure of the flow controller to provide the pressure differential necessary to maintain controlled flow rates of sample air.

**7.2.1.3 Stainless Steel Tubing and Stainless Steel Fittings.** Coated with fused silica to minimize active adsorption sites.

**7.2.1.4 Stainless Steel Cylinder Pressure Regulators.** Standard, two-stage cylinder regulators with pressure gauges.

**7.2.1.5 Gas Purifiers.** Used to remove organic impurities and moisture from gas streams.

**7.2.1.6 Six-port Gas Chromatographic Valve.** For routing sample and carrier gas flows.

**7.2.1.7 Multisorbent Concentrator.** Solid adsorbent packing with various retentive properties for adsorbing trace gases are commercially available from several sources. The packing contains more than one type of adsorbent packed in series.

**7.2.1.7.1A** pre-packed adsorbent trap (Supelco 2-0321) containing 200 mg Carboxpack B (60/80 mesh) and 50 mg Carboxieve S-III (60/80 mesh) has been found to retain VOCs and allow some water vapor to pass through (6). The addition of a dry purging step allows for further water removal from the adsorbent trap. The steps constituting the dry purge technique that are normally used with multisorbent traps are illustrated in Figure 4. The optimum trapping and dry purging procedure for the Supelco trap consists of a sample volume of 320 mL and a dry nitrogen purge of 1300 mL. Sample trapping and drying is carried out at 25°C. The trap is back-flushed with helium and heated to 220°C to transfer material onto the GC column. A trap bake-out at 260°C for 5 minutes is conducted after each run.

**7.2.1.7.2** An example of the effectiveness of dry purging is shown in Figure 5. The multisorbent used in this case is Tenax/Ambersorb 340/Charcoal (7). Approximately 20% of the initial water content in the sample remains after sampling 500 mL of air. The detector response to water vapor (hydrogen atoms detected by atomic emission detection) is plotted versus purge gas volume. Additional water reduction by a factor of 8 is indicated at temperatures of 45°C or higher. Still further water reduction is possible using a two-stage concentration/dryer system.

**7.2.1.8 Cryogenic Concentrator.** Complete units are commercially available from several vendor sources. The characteristics of the latest concentrators include a rapid, "ballistic" heating of the concentrator to release any trapped VOCs into a small carrier gas volume. This facilitates the separation of compounds on the gas chromatographic column.

## **7.2.2 Gas Chromatographic/Mass Spectrometric (GC/MS) System.**

**7.2.2.1 Gas Chromatograph.** The gas chromatographic (GC) system must be capable of temperature programming. The column oven can be cooled to subambient temperature (e.g., -50°C) at the start of the gas chromatographic run to effect a resolution of the very volatile organic compounds. In other designs, the rate of release of compounds from the focusing trap in a two stage system obviates the need for retrapping of compounds on the column. The system must include or be interfaced to a concentrator and have all required accessories including analytical columns and gases. All GC carrier gas lines must be constructed from stainless steel or copper tubing. Non-polytetrafluoroethylene (PTFE) thread sealants or flow controllers with Buna-N rubber components must not be used.

**7.2.2.2 Chromatographic Columns.** 100% methyl silicone or 5% phenyl, 95% methyl silicone fused silica capillary columns of 0.25- to 0.53-mm I.D. of varying lengths are recommended for separation of many of the possible subsets of target compounds involving nonpolar compounds. However, considering the diversity of the target list, the choice is left to the operator subject to the performance standards given in Section 11.

**7.2.2.3 Mass Spectrometer.** Either a linear quadrupole or ion trap mass spectrometer can be used as long as it is capable of scanning from 35 to 300 amu every 1 second or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode, and producing a mass spectrum which meets all the instrument performance acceptance criteria when 50 ng or less of p-bromofluorobenzene (BFB) is analyzed.

**7.2.2.3.1 Linear Quadrupole Technology.** A simplified diagram of the heart of the quadrupole mass spectrometer is shown in Figure 6. The quadrupole consists of a parallel set of four rod electrodes mounted in a square configuration. The field within the analyzer is created by coupling opposite pairs of rods together and applying radiofrequency (RF) and direct current (DC) potentials between the pairs of rods. Ions created in the ion source from the reaction of column eluates with electrons from the electron source are moved through the

parallel array of rods under the influence of the generated field. Ions which are successfully transmitted through the quadrupole are said to possess stable trajectories and are subsequently recorded with the detection system. When the DC potential is zero, a wide band of  $m/z$  values is transmitted through the quadrupole. This "RF only" mode is referred to as the "total-ion" mode. In this mode, the quadrupole acts as a strong focusing lens analogous to a high pass filter. The amplitude of the RF determines the low mass cutoff. A mass spectrum is generated by scanning the DC and RF voltages using a fixed DC/RF ratio and a constant drive frequency or by scanning the frequency and holding the DC and RF constant. With the quadrupole system only 0.1 to 0.2 percent of the ions formed in the ion source actually reach the detector.

**7.2.2.3.2 Ion Trap Technology.** An ion-trap mass spectrometer consists of a chamber formed between two metal surfaces in the shape of a hyperboloid of one sheet (ring electrode) and a hyperboloid of two sheets (the two end-cap electrodes). Ions are created within the chamber by electron impact from an electron beam admitted through a small aperture in one of the end caps. Radio frequency (RF) (and sometimes direct current voltage offsets) are applied between the ring electrode and the two end-cap electrodes establishing a quadrupole electric field. This field is uncoupled in three directions so that ion motion can be considered independently in each direction; the force acting upon an ion increases with the displacement of the ion from the center of the field but the direction of the force depends on the instantaneous voltage applied to the ring electrode. A restoring force along one coordinate (such as the distance,  $r$ , from the ion-trap's axis of radial symmetry) will exist concurrently with a repelling force along another coordinate (such as the distance,  $z$ , along the ion traps axis), and if the field were static the ions would eventually strike an electrode. However, in an RF field the force along each coordinate alternates direction so that a stable trajectory may be possible in which the ions do not strike a surface. In practice, ions of appropriate mass-to-charge ratios may be trapped within the device for periods of milliseconds to hours. A diagram of a typical ion trap is illustrated in Figure 7. Analysis of stored ions is performed by increasing the RF voltage, which makes the ions successively unstable. The effect of the RF voltage on the ring electrode is to "squeeze" the ions in the  $xy$  plane so that they move along the  $z$  axis. Half the ions are lost to the top cap (held at ground potential); the remaining ions exit the lower end cap to be detected by the electron multiplier. As the energy applied to the ring electrode is increased, the ions are collected in order of increasing mass to produce a conventional mass spectrum. With the ion trap, approximately 50 percent of the generated ions are detected. As a result, a significant increase in sensitivity can be achieved when compared to a full scan linear quadrupole system.

**7.2.2.4 GC/MS Interface.** Any gas chromatograph to mass spectrometer interface that gives acceptable calibration points for each of the analytes of interest and can be used to achieve all acceptable performance criteria may be used. Gas chromatograph to mass spectrometer interfaces constructed of all-glass, glass-lined, or fused silica-lined materials are recommended. Glass and fused silica should be deactivated.

**7.2.2.5 Data System.** The computer system that is interfaced to the mass spectrometer must allow the continuous acquisition and storage, on machine readable media, of all mass spectra obtained throughout the duration of the chromatographic program. The computer must have software that allows searching any GC/MS data file for ions of a specified mass and plotting such ion abundances versus time or scan number. This type of plot is defined as a Selected Ion Current Profile (SICP). Software must also be available that allows integrating the abundance in any SICP between specified time or scan number limits. Also, software must be available that allows for the comparison of sample spectra with reference library spectra. The National Institute of Standards and Technology (NIST) or Wiley Libraries or equivalent are recommended as reference libraries.

**7.2.2.6 Off-line Data Storage Device.** Device must be capable of rapid recording and retrieval of data and must be suitable for long-term, off-line data storage.

### 7.3 Calibration System and Manifold Apparatus (see Figure 8)

**7.3.1 Calibration Manifold.** Stainless steel, glass, or high purity quartz manifold, (e.g., 1.25-cm I.D. x 66-cm) with sampling ports and internal baffles for flow disturbance to ensure proper mixing. The manifold should be heated to ~50°C.

**7.3.2 Humidifier.** 500-mL impinger flask containing HPLC grade deionized water.

**7.3.3 Electronic Mass Flow Controllers.** One 0 to 5 L/min unit and one or more 0 to 100 mL/min units for air, depending on number of cylinders in use for calibration.

**7.3.4 Teflon Filter(s).** 47-mm Teflon® filter for particulate collection.

### 7.4 Reagents

**7.4.1 Neat Materials or Manufacturer-Certified Solutions/Mixtures.** Best source (see Section 9).

**7.4.2 Helium and Air.** Ultra-high purity grade in gas cylinders. He is used as carrier gas in the GC.

**7.4.3 Liquid Nitrogen or Liquid Carbon Dioxide.** Used to cool secondary trap.

**7.4.4 Deionized Water.** High performance liquid chromatography (HPLC) grade, ultra-high purity (for humidifier).

## 8. Collection of Samples in Canisters

### 8.1 Introduction

**8.1.1** Canister samplers, sampling procedures, and canister cleaning procedures have not changed very much from the description given in the original Compendium Method TO-14. Much of the material in this section is therefore simply a restatement of the material given in Compendium Method TO-14, repeated here in order to have all the relevant information in one place.

**8.1.2** Recent notable additions to the canister technology has been in the application of canister-based systems for example, to microenvironmental monitoring (8), the capture of breath samples (9), and sector sampling to identify emission sources of VOCs (10).

**8.1.3** EPA has also sponsored the development of a mathematical model to predict the storage stability of arbitrary mixtures of trace gases in humidified air (3), and the investigation of the SilcoSteel™ process of coating the canister interior with a film of fused silica to reduce surface activity (11). A recent summary of storage stability data for VOCs in canisters is given in the open literature (5).

### 8.2 Sampling System Description

#### 8.2.1 Subatmospheric Pressure Sampling [see Figure 1 (without metal bellows type pump)].

**8.2.1.1** In preparation for subatmospheric sample collection in a canister, the canister is evacuated to 0.05 mm Hg (see Appendix C for discussion of evacuation pressure). When the canister is opened to the atmosphere containing the VOCs to be sampled, the differential pressure causes the sample to flow into the canister. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-weighted-average (TWA) samples (duration of 1-24 hours) taken through a flow-restrictive inlet (e.g., mass flow controller, critical orifice).

**8.2.1.2** With a critical orifice flow restrictor, there will be a decrease in the flow rate as the pressure approaches atmospheric. However, with a mass flow controller, the subatmospheric sampling system can maintain a constant flow rate from full vacuum to within about 7 kPa (1.0 psi) or less below ambient pressure.

### 8.2.2 Pressurized Sampling [see Figure 1 (with metal bellows type pump)].

**8.2.2.1** Pressurized sampling is used when longer-term integrated samples or higher volume samples are required. The sample is collected in a canister using a pump and flow control arrangement to achieve a typical 101-202 kPa (15-30 psig) final canister pressure. For example, a 6-liter evacuated canister can be filled at 10 mL/min for 24 hours to achieve a final pressure of 144 kPa (21 psig).

**8.2.2.2** In pressurized canister sampling, a metal bellows type pump draws in air from the sampling manifold to fill and pressurize the sample canister.

### 8.2.3 All Samplers.

**8.2.3.1** A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled (to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling) over the desired sample period. The flow rate can be calculated by:

$$F = \frac{P \times V}{T \times 60}$$

where:

F = flow rate, mL/min.

P = final canister pressure, atmospheres absolute. P is approximately equal to

$$\frac{\text{kPa gauge}}{101.2} + 1$$

V = volume of the canister, mL.

T = sample period, hours.

For example, if a 6-L canister is to be filled to 202 kPa (2 atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by:

$$F = \frac{2 \times 6000}{24 \times 60} = 8.3 \text{ mL/min}$$

**8.2.3.2** For automatic operation, the timer is designed to start and stop the pump at appropriate times for the desired sample period. The timer must also control the solenoid valve, to open the valve when starting the pump and to close the valve when stopping the pump.

**8.2.3.3** The use of the Skinner Magnelatch valve (see Figure 2) avoids any substantial temperature rise that would occur with a conventional, normally closed solenoid valve that would have to be energized during the entire sample period. The temperature rise in the valve could cause outgassing of organic compounds from the Viton® valve seat material. The Skinner Magnelatch valve requires only a brief electrical pulse to open or close at the appropriate start and stop times and therefore experiences no temperature increase. The pulses may be obtained either with an electronic timer that can be programmed for short (5 to 60 seconds) ON periods, or with a conventional mechanical timer and a special pulse circuit. A simple electrical pulse circuit for operating the Skinner Magnelatch solenoid valve with a conventional mechanical timer is illustrated in Figure 2(a). However, with this simple circuit, the valve may operate unreliably during brief power interruptions or if the timer is manually switched on and off too fast. A better circuit incorporating a time-delay relay to provide more reliable valve operation is shown in Figure 2(b).

**8.2.3.4** The connecting lines between the sample inlet and the canister should be as short as possible to minimize their volume. The flow rate into the canister should remain relatively constant over the entire sampling period.

**8.2.3.5** As an option, a second electronic timer may be used to start the auxiliary pump several hours prior to the sampling period to flush and condition the inlet line.

**8.2.3.6** Prior to field use, each sampling system must pass a humid zero air certification (see Section 8.4.3). All plumbing should be checked carefully for leaks. The canisters must also pass a humid zero air certification before use (see Section 8.4.1).

### 8.3 Sampling Procedure

**8.3.1** The sample canister should be cleaned and tested according to the procedure in Section 8.4.1.

**8.3.2** A sample collection system is assembled as shown in Figures 1 and 3 and must be cleaned according to the procedure outlined in Sections 8.4.2 and 8.4.4.

*[Note: The sampling system should be contained in an appropriate enclosure.]*

**8.3.3** Prior to locating the sampling system, the user may want to perform "screening analyses" using a portable GC system, as outlined in Appendix B of Compendium Method TO-14A, to determine potential volatile organics present and potential "hot spots." The information gathered from the portable GC screening analysis would be used in developing a monitoring protocol, which includes the sampling system location, based upon the "screening analysis" results.

**8.3.4** After "screening analysis," the sampling system is located. Temperatures of ambient air and sampler box interior are recorded on the canister sampling field test data sheet (FTDS), as documented in Figure 9.

*[Note: The following discussion is related to Figure 1]*

**8.3.5** To verify correct sample flow, a "practice" (evacuated) canister is used in the sampling system.

*[Note: For a subatmospheric sampler, a flow meter and practice canister are needed. For the pump-driven system, the practice canister is not needed, as the flow can be measured at the outlet of the system.]*

A certified mass flow meter is attached to the inlet line of the manifold, just in front of the filter. The canister is opened. The sampler is turned on and the reading of the certified mass flow meter is compared to the sampler mass flow controller. The values should agree within  $\pm 10\%$ . If not, the sampler mass flow meter needs to be recalibrated or there is a leak in the system. This should be investigated and corrected.

*[Note: Mass flow meter readings may drift. Check the zero reading carefully and add or subtract the zero reading when reading or adjusting the sampler flow rate to compensate for any zero drift.]*

After 2 minutes, the desired canister flow rate is adjusted to the proper value (as indicated by the certified mass flow meter) by the sampler flow control unit controller (e.g., 3.5 mL/min for 24 hr, 7.0 mL/min for 12 hr). Record final flow under "CANISTER FLOW RATE" on the FTDS.

**8.3.6** The sampler is turned off and the elapsed time meter is reset to 000.0.

*[Note: Whenever the sampler is turned off, wait at least 30 seconds to turn the sampler back on.]*

**8.3.7** The "practice" canister and certified mass flow meter are disconnected and a clean certified (see Section 8.4.1) canister is attached to the system.

**8.3.8** The canister valve and vacuum/pressure gauge valve are opened.

**8.3.9** Pressure/vacuum in the canister is recorded on the canister FTDS (see Figure 9) as indicated by the sampler vacuum/pressure gauge.

**8.3.10** The vacuum/pressure gauge valve is closed and the maximum-minimum thermometer is reset to current temperature. Time of day and elapsed time meter readings are recorded on the canister FTDS.

**8.3.11** The electronic timer is set to start and stop the sampling period at the appropriate times. Sampling starts and stops by the programmed electronic timer.

**8.3.12** After the desired sampling period, the maximum, minimum, current interior temperature and current ambient temperature are recorded on the FTDS. The current reading from the flow controller is recorded.

**8.3.13** At the end of the sampling period, the vacuum/pressure gauge valve on the sampler is briefly opened and closed and the pressure/vacuum is recorded on the FTDS. Pressure should be close to desired pressure.

*[Note: For a subatmospheric sampling system, if the canister is at atmospheric pressure when the field final pressure check is performed, the sampling period may be suspect. This information should be noted on the sampling field data sheet.]*

Time of day and elapsed time meter readings are also recorded.

**8.3.14** The canister valve is closed. The sampling line is disconnected from the canister and the canister is removed from the system. For a subatmospheric system, a certified mass flow meter is once again connected to the inlet manifold in front of the in-line filter and a "practice" canister is attached to the Magelatch valve of the sampling system. The final flow rate is recorded on the canister FTDS (see Figure 9).

*[Note: For a pressurized system, the final flow may be measured directly.]*

The sampler is turned off.

**8.3.15** An identification tag is attached to the canister. Canister serial number, sample number, location, and date, as a minimum, are recorded on the tag. The canister is routinely transported back to the analytical laboratory with other canisters in a canister shipping case.

## **8.4 Cleaning and Certification Program**

### **8.4.1 Canister Cleaning and Certification.**

**8.4.1.1** All canisters must be clean and free of any contaminants before sample collection.

**8.4.1.2** All canisters are leak tested by pressurizing them to approximately 206 kPa (30 psig) with zero air.

*[Note: The canister cleaning system in Figure 10 can be used for this task.]*

The initial pressure is measured, the canister valve is closed, and the final pressure is checked after 24 hours. If acceptable, the pressure should not vary more than  $\pm 13.8$  kPa ( $\pm 2$  psig) over the 24 hour period.

**8.4.1.3** A canister cleaning system may be assembled as illustrated in Figure 10. Cryogen is added to both the vacuum pump and zero air supply traps. The canister(s) are connected to the manifold. The vent shut-off valve and the canister valve(s) are opened to release any remaining pressure in the canister(s). The vacuum pump is started and the vent shut-off valve is then closed and the vacuum shut-off valve is opened. The canister(s) are evacuated to  $<0.05$  mm Hg (see Appendix B) for at least 1 hour.

*[Note: On a daily basis or more often if necessary, the cryogenic traps should be purged with zero air to remove any trapped water from previous canister cleaning cycles.]*

Air released/evacuated from canisters should be diverted to a fume hood.

**8.4.1.4** The vacuum and vacuum/pressure gauge shut-off valves are closed and the zero air shut-off valve is opened to pressurize the canister(s) with humid zero air to approximately 206 kPa (30 psig). If a zero gas generator system is used, the flow rate may need to be limited to maintain the zero air quality.

**8.4.1.5** The zero air shut-off valve is closed and the canister(s) is allowed to vent down to atmospheric pressure through the vent shut-off valve. The vent shut-off valve is closed. Repeat Sections 8.4.1.3 through 8.4.1.5 two additional times for a total of three (3) evacuation/pressurization cycles for each set of canisters.

**8.4.1.6** At the end of the evacuation/pressurization cycle, the canister is pressurized to 206 kPa (30 psig) with humid zero air. The canister is then analyzed by a GC/MS analytical system. Any canister that has not tested clean (compared to direct analysis of humidified zero air of less than 0.2 ppbv of targeted VOCs) should not be used. As a "blank" check of the canister(s) and cleanup procedure, the final humid zero air fill of 100% of the canisters is analyzed until the cleanup system and canisters are proven reliable (less than 0.2 ppbv of any target VOCs). The check can then be reduced to a lower percentage of canisters.

**8.4.1.7** The canister is reattached to the cleaning manifold and is then reevacuated to <0.05 mm Hg (see Appendix B) and remains in this condition until used. The canister valve is closed. The canister is removed from the cleaning system and the canister connection is capped with a stainless steel fitting. The canister is now ready for collection of an air sample. An identification tag is attached to the inlet of each canister for field notes and chain-of-custody purposes. An alternative to evacuating the canister at this point is to store the canisters and reevacuate them just prior to the next use.

**8.4.1.8** As an option to the humid zero air cleaning procedures, the canisters are heated in an isothermal oven not to exceed 100°C during evacuation of the canister to ensure that higher molecular weight compounds are not retained on the walls of the canister.

*[Note: For sampling more complex VOC mixtures the canisters should be heated to higher temperatures during the cleaning procedure although a special high temperature valve would be needed].*

Once heated, the canisters are evacuated to <0.05 mm Hg (see Appendix B) and maintained there for 1 hour. At the end of the heated/evacuated cycle, the canisters are pressurized with humid zero air and analyzed by a GC/MS system after a minimum of 12 hrs of "aging." Any canister that has not tested clean (less than 0.2 ppbv each of targeted compounds) should not be used. Once tested clean, the canisters are reevacuated to <0.05 mm Hg (see Appendix B) and remain in the evacuated state until used. As noted in Section 8.4.1.7, reevacuation can occur just prior to the next use.

#### **8.4.2 Cleaning Sampling System Components.**

**8.4.2.1** Sample components are disassembled and cleaned before the sampler is assembled. Nonmetallic parts are rinsed with HPLC grade deionized water and dried in a vacuum oven at 50°C. Typically, stainless steel parts and fittings are cleaned by placing them in a beaker of methanol in an ultrasonic bath for 15 minutes. This procedure is repeated with hexane as the solvent.

**8.4.2.2** The parts are then rinsed with HPLC grade deionized water and dried in a vacuum oven at 100°C for 12 to 24 hours.

**8.4.2.3** Once the sampler is assembled, the entire system is purged with humid zero air for 24 hours.

#### **8.4.3 Zero Air Certification.**

*[Note: In the following sections, "certification" is defined as evaluating the sampling system with humid zero air and humid calibration gases that pass through all active components of the sampling system. The system is "certified" if no significant additions or deletions (less than 0.2 ppbv each of target compounds) have occurred when challenged with the test gas stream.]*

**8.4.3.1** The cleanliness of the sampling system is determined by testing the sampler with humid zero air without an evacuated gas sampling canister, as follows.

**8.4.3.2** The calibration system and manifold are assembled, as illustrated in Figure 8. The sampler (without an evacuated gas canister) is connected to the manifold and the zero air cylinder is activated to generate a humid gas stream (2 L/min) to the calibration manifold [see Figure 8(b)].

**8.4.3.3** The humid zero gas stream passes through the calibration manifold, through the sampling system (without an evacuated canister) to the water management system/VOC preconcentrator of an analytical system.

*[Note: The exit of the sampling system (without the canister) replaces the canister in Figure 11.]*

After the sample volume (e.g., 500 mL) is preconcentrated on the trap, the trap is heated and the VOCs are thermally desorbed and refocused on a cold trap. This trap is heated and the VOCs are thermally desorbed onto the head of the capillary column. The VOCs are refocused prior to gas chromatographic separation. Then, the oven temperature (programmed) increases and the VOCs begin to elute and are detected by a GC/MS (see Section 10) system. The analytical system should not detect greater than 0.2 ppbv of any targeted VOCs in order for the sampling system to pass the humid zero air certification test. Chromatograms (using an FID) of a certified sampler and contaminated sampler are illustrated in Figures 12(a) and 12(b), respectively. If the sampler passes the humid zero air test, it is then tested with humid calibration gas standards containing selected VOCs at concentration levels expected in field sampling (e.g., 0.5 to 2 ppbv) as outlined in Section 8.4.4.

#### **8.4.4 Sampler System Certification with Humid Calibration Gas Standards from a Dynamic Calibration System**

**8.4.4.1** Assemble the dynamic calibration system and manifold as illustrated in Figure 8.

**8.4.4.2** Verify that the calibration system is clean (less than 0.2 ppbv of any target compounds) by sampling a humidified gas stream, *without* gas calibration standards, with a previously certified clean canister (see Section 8.1).

**8.4.4.3** The assembled dynamic calibration system is certified clean if less than 0.2 ppbv of any targeted compounds is found.

**8.4.4.4** For generating the humidified calibration standards, the calibration gas cylinder(s) containing nominal concentrations of 10 ppmv in nitrogen of selected VOCs is attached to the calibration system as illustrated in Figure 8. The gas cylinders are opened and the gas mixtures are passed through 0 to 10 mL/min certified mass flow controllers to generate ppb levels of calibration standards.

**8.4.4.5** After the appropriate equilibrium period, attach the sampling system (containing a certified evacuated canister) to the manifold, as illustrated in Figure 8(b).

**8.4.4.6** Sample the dynamic calibration gas stream with the sampling system.

**8.4.4.7** Concurrent with the sampling system operation, realtime monitoring of the calibration gas stream is accomplished by the on-line GC/MS analytical system [Figure 8(a)] to provide reference concentrations of generated VOCs.

**8.4.4.8** At the end of the sampling period (normally the same time period used for experiments), the sampling system canister is analyzed and compared to the reference GC/MS analytical system to determine if the concentration of the targeted VOCs was increased or decreased by the sampling system.

**8.4.4.9** A recovery of between 90% and 110% is expected for all targeted VOCs.

#### **8.4.5 Sampler System Certification without Compressed Gas Cylinder Standards.**

**8.4.5.1** Not all the gases on the Title III list are available/compatible with compressed gas standards. In these cases sampler certification must be approached by different means.

**8.4.5.2** Definitive guidance is not currently available in these cases; however, Section 9.2 lists several ways to generate gas standards. In general, Compendium Method TO-14A compounds (see Table 1) are available commercially as compressed gas standards.

## 9. GC/MS Analysis of Volatiles from Canisters

### 9.1 Introduction

**9.1.1** The analysis of canister samples is accomplished with a GC/MS system. Fused silica capillary columns are used to achieve high temporal resolution of target compounds. Linear quadrupole or ion trap mass spectrometers are employed for compound detection. The heart of the system is composed of the sample inlet concentrating device that is needed to increase sample loading into a detectable range. Two examples of concentrating systems are discussed. Other approaches are acceptable as long as they are compatible with achieving the system performance criteria given in Section 11.

**9.1.2** With the first technique, a whole air sample from the canister is passed through a multisorbent packing (including single adsorbent packings) contained within a metal or glass tube maintained at or above the surrounding air temperature. Depending on the water retention properties of the packing, some or most of the water vapor passes completely through the trap during sampling. Additional drying of the sample is accomplished after the sample concentration is completed by forward purging the trap with clean, dry helium or another inert gas (air is not used). The sample is then thermally desorbed from the packing and backflushed from the trap onto a gas chromatographic column. In some systems a "refocusing" trap is placed between the primary trap and the gas chromatographic column. The specific system design downstream of the primary trap depends on technical factors such as the rate of thermal desorption and sampled volume, but the objective in most cases is to enhance chromatographic resolution of the individual sample components before detection on a mass spectrometer.

**9.1.3** Sample drying strategies depend on the target list of compounds. For some target compound lists, the multisorbent packing of the concentrator can be selected from hydrophobic adsorbents which allow a high percentage of water vapor in the sample to pass through the concentrator during sampling and without significant loss of the target compounds. However, if very volatile organic compounds are on the target list, the adsorbents required for their retention may also strongly retain water vapor and a more lengthy dry purge is necessary prior to analysis.

**9.1.4** With the second technique, a whole air sample is passed through a concentrator where the VOCs are condensed on a reduced temperature surface (cold trap). Subsequently, the condensed gases are thermally desorbed and backflushed from the trap with an inert gas onto a gas chromatographic column. This concentration technique is similar to that discussed in Compendium Method TO-14, although a membrane dryer is not used. The sample size is reduced in volume to limit the amount of water vapor that is also collected (100 mL or less may be necessary). The attendant reduction in sensitivity is offset by enhancing the sensitivity of detection, for example by using an ion trap detector.

## 9.2 Preparation of Standards

### 9.2.1 Introduction.

**9.2.1.1** When available, standard mixtures of target gases in high pressure cylinders must be certified traceable to a NIST Standard Reference Material (SRM) or to a NIST/EPA approved Certified Reference Material (CRM). Manufacturer's certificates of analysis must be retained to track the expiration date.

**9.2.1.2** The neat standards that are used for making trace gas standards must be of high purity; generally a purity of 98 percent or better is commercially available.

**9.2.1.3** Cylinder(s) containing approximately 10 ppmv of each of the target compounds are typically used as primary stock standards. The components may be purchased in one cylinder or in separate cylinders depending on compatibility of the compounds and the pressure of the mixture in the cylinder. Refer to manufacturer's specifications for guidance on purchasing and mixing VOCs in gas cylinders.

### 9.2.2 Preparing Working Standards.

**9.2.2.1 Instrument Performance Check Standard.** Prepare a standard solution of BFB in humidified zero air at a concentration which will allow collection of 50 ng of BFB or less under the optimized concentration parameters.

**9.2.2.2 Calibration Standards.** Prepare five working calibration standards in humidified zero air at a concentration which will allow collection at the 2, 5, 10, 20, and 50 ppbv level for each component under the optimized concentration parameters.

**9.2.2.3 Internal Standard Spiking Mixture.** Prepare an internal spiking mixture containing bromochloromethane, chlorobenzene-d<sub>5</sub>, and 1,4-difluorobenzene at 10 ppmv each in humidified zero air to be added to the sample or calibration standard. 500 µL of this mixture spiked into 500 mL of sample will result in a concentration of 10 ppbv. The internal standard is introduced into the trap during the collection time for all calibration, blank, and sample analyses using the apparatus shown in Figure 13 or by equivalent means. The volume of internal standard spiking mixture added for each analysis must be the same from run to run.

### 9.2.3 Standard Preparation by Dynamic Dilution Technique.

**9.2.3.1** Standards may be prepared by dynamic dilution of the gaseous contents of a cylinder(s) containing the gas calibration stock standards with humidified zero air using mass flow controllers and a calibration manifold. The working standard may be delivered from the manifold to a clean, evacuated canister using a pump and mass flow controller.

**9.2.3.2** Alternatively, the analytical system may be calibrated by sampling directly from the manifold if the flow rates are optimized to provide the desired amount of calibration standards. However, the use of the canister as a reservoir prior to introduction into the concentration system resembles the procedure normally used to collect samples and is preferred. Flow rates of the dilution air and cylinder standards (all expressed in the same units) are measured using a bubble meter or calibrated electronic flow measuring device, and the concentrations of target compounds in the manifold are then calculated using the dilution ratio and the original concentration of each compound.

$$\text{Manifold Conc.} = \frac{(\text{Original Conc.}) (\text{Std. Gas Flowrate})}{(\text{Air Flowrate}) + (\text{Std. Gas Flowrate})}$$

**9.2.3.3** Consider the example of 1 mL/min flow of 10 ppmv standard diluted with 1,000 mL/min of humid air provides a nominal 10 ppbv mixture, as calculated below:

$$\text{Manifold Conc.} = \frac{(10 \text{ ppm})(1 \text{ mL/min})(1000 \text{ ppb/1 ppm})}{(1000 \text{ mL/min}) + (1 \text{ mL/min})} = 10 \text{ ppb}$$

#### 9.2.4 Standard Preparation by Static Dilution Bottle Technique

*[Note: Standards may be prepared in canisters by spiking the canister with a mixture of components prepared in a static dilution bottle (12). This technique is used specifically for liquid standards.]*

**9.2.4.1** The volume of a clean 2-liter round-bottom flask, modified with a threaded glass neck to accept a Mininert septum cap, is determined by weighing the amount of water required to completely fill up the flask. Assuming a density for the water of 1 g/mL, the weight of the water in grams is taken as the volume of the flask in milliliters.

**9.2.4.2** The flask is flushed with helium by attaching a tubing into the glass neck to deliver the helium. After a few minutes, the tubing is removed and the glass neck is immediately closed with a Mininert septum cap.

**9.2.4.3** The flask is placed in a 60°C oven and allowed to equilibrate at that temperature for about 15 minutes. Predetermined aliquots of liquid standards are injected into the flask making sure to keep the flask temperature constant at 60°C.

**9.2.4.4** The contents are allowed to equilibrate in the oven for at least 30 minutes. To avoid condensation, syringes must be preheated in the oven at the same temperature prior to withdrawal of aliquots to avoid condensation.

**9.2.4.5** Sample aliquots may then be taken for introduction into the analytical system or for further dilution. An aliquot or aliquots totaling greater than 1 percent of the flask volume should be avoided.

**9.2.4.6** Standards prepared by this method are stable for one week. The septum must be replaced with each freshly prepared standard.

**9.2.4.7** The concentration of each component in the flask is calculated using the following equation:

$$\text{Concentration, mg/L} = \frac{(V_a)(d)}{V_f}$$

where:  $V_a$  = Volume of liquid neat standard injected into the flask,  $\mu\text{L}$ .

$d$  = Density of the liquid neat standard,  $\text{mg}/\mu\text{L}$ .

$V_f$  = Volume of the flask, L.

**9.2.4.8** To obtain concentrations in ppbv, the equation given in Section 9.2.5.7 can be used.

*[Note: In the preparation of standards by this technique, the analyst should make sure that the volume of neat standard injected into the flask does not result in an overpressure due to the higher partial pressure produced by the standard compared to the vapor pressure in the flask. Precautions should also be taken to avoid a significant decrease in pressure inside the flask after withdrawal of aliquot(s).]*

#### 9.2.5 Standard Preparation Procedure in High Pressure Cylinders

*[Note: Standards may be prepared in high pressure cylinders (13). A modified summary of the procedure is provided below.]*

**9.2.5.1** The standard compounds are obtained as gases or neat liquids (greater than 98 percent purity).

**9.2.5.2** An aluminum cylinder is flushed with high-purity nitrogen gas and then evacuated to better than 25 in. Hg.

**9.2.5.3** Predetermined amounts of each neat standard compound are measured using a microliter or gastight syringe and injected into the cylinder. The cylinder is equipped with a heated injection port and nitrogen flow to facilitate sample transfer.

**9.2.5.4** The cylinder is pressurized to 1000 psig with zero nitrogen.

*[Note: User should read all SOPs associated with generating standards in high pressure cylinders. Follow all safety requirements to minimize danger from high pressure cylinders.]*

**9.2.5.5** The contents of the cylinder are allowed to equilibrate (~24 hrs) prior to withdrawal of aliquots into the GC system.

**9.2.5.6** If the neat standard is a gas, the cylinder concentration is determined using the following equation:

$$\text{Concentration, ppbv} = \frac{\text{Volume}_{\text{standard}}}{\text{Volume}_{\text{dilution gas}}} \times 10^9$$

*[Note: Both values must be expressed in the same units.]*

**9.2.5.7** If the neat standard is a liquid, the gaseous concentration can be determined using the following equations:

$$V = \frac{nRT}{P}$$

and:

$$n = \frac{(\text{mL})(d)}{\text{MW}}$$

where:

- V = Gaseous volume of injected compound at EPA standard temperature (25°C) and pressure (760 mm Hg), L.
- n = Moles.
- R = Gas constant, 0.08206 L-atm/mole °K.
- T = 298°K (standard temperature).
- P = 1 standard pressure, 760 mm Hg (1 atm).
- mL = Volume of liquid injected, mL.
- d = Density of the neat standard, g/mL.
- MW = Molecular weight of the neat standard expressed, g/g-mole.

The gaseous volume of the injected compound is divided by the cylinder volume at STP and then multiplied by  $10^9$  to obtain the component concentration in ppb units.

### 9.2.6 Standard Preparation by Water Methods.

*[Note: Standards may be prepared by a water purge and trap method (14) and summarized as follows].*

**9.2.6.1** A previously cleaned and evacuated canister is pressurized to 760 mm Hg absolute (1 atm) with zero grade air.

**9.2.6.2** The air gauge is removed from the canister and the sparging vessel is connected to the canister with the short length of 1/16 in. stainless steel tubing.

*[Note: Extra effort should be made to minimize possible areas of dead volume to maximize transfer of analytes from the water to the canister.]*

**9.2.6.3** A measured amount of the stock standard solution and the internal standard solution is spiked into 5 mL of water.

**9.2.6.4** This water is transferred into the sparge vessel and purged with nitrogen for 10 mins at 100 mL/min. The sparging vessel is maintained at 40°C.

**9.2.6.5** At the end of 10 mins, the sparge vessel is removed and the air gauge is re-installed, to further pressurize the canister with pure nitrogen to 1500 mm Hg absolute pressure (approximately 29 psia).

**9.2.6.6** The canister is allowed to equilibrate overnight before use.

**9.2.6.7** A schematic of this approach is shown in Figure 14.

### 9.2.7 Preparation of Standards by Permeation Tubes.

**9.2.7.1** Permeation tubes can be used to provide standard concentration of a trace gas or gases. The permeation of the gas can occur from inside a permeation tube containing the trace species of interest to an air stream outside. Permeation can also occur from outside a permeable membrane tube to an air stream passing through the tube (e.g., a tube of permeable material immersed in a liquid).

**9.2.7.2** The permeation system is usually held at a constant temperature to generate a constant concentration of trace gas. Commercial suppliers provide systems for generation and dilution of over 250 compounds. Some commercial suppliers of permeation tube equipment are listed in Appendix D.

### 9.2.8 Storage of Standards.

**9.2.8.1** Working standards prepared in canisters may be stored for thirty days in an atmosphere free of potential contaminants.

**9.2.8.2** It is imperative that a storage logbook be kept to document storage time.

## 10. GC/MS Operating Conditions

### 10.1 Preconcentrator

The following are typical cryogenic and adsorbent preconcentrator analytical conditions which, however, depend on the specific combination of solid sorbent and must be selected carefully by the operator. The reader is referred to Tables 1 and 2 of Compendium Method TO-17 for guidance on selection of sorbents. An example of a system using a solid adsorbent preconcentrator with a cryofocusing trap is discussed in the literature (15). Oven temperature programming starts above ambient.

#### 10.1.1 Sample Collection Conditions

##### Cryogenic Trap

##### Adsorbent Trap

Set point	-150°C	Set point	27°C
Sample volume	- up to 100 mL	Sample volume	- up to 1,000 mL
Carrier gas purge flow	- none	Carrier gas purge flow	- selectable

[*Note: The analyst should optimize the flow rate, duration of sampling, and absolute sample volume to be used. Other preconcentration systems may be used provided performance standards (see Section 11) are realized.*]

### 10.1.2 Desorption Conditions

#### Cryogenic Trap

Desorb Temperature	120°C
Desorb Flow Rate	~ 3 mL/min He
Desorb Time	<60 sec

#### Adsorbent Trap

Desorb Temperature	Variable
Desorb Flow Rate	~3 mL/min He
Desorb Time	<60 sec

The adsorbent trap conditions depend on the specific solid adsorbents chosen (see manufacturers' specifications).

### 10.1.3 Trap Reconditioning Conditions.

#### Cryogenic Trap

Initial bakeout	120°C (24 hrs)
Variable (24 hrs)	
After each run	120°C (5 min)

#### Adsorbent Trap

Initial bakeout	
After each run	Variable (5 min)

## 10.2 GC/MS System

**10.2.1** Optimize GC conditions for compound separation and sensitivity. Baseline separation of benzene and carbon tetrachloride on a 100% methyl polysiloxane stationary phase is an indication of acceptable chromatographic performance.

**10.2.2** The following are the recommended gas chromatographic analytical conditions when using a 50-meter by 0.3-mm I.D., 1 µm film thickness fused silica column with refocusing on the column.

<u>Item</u>	<u>Condition</u>
Carrier Gas:	Helium
Flow Rate:	Generally 1-3 mL/min as recommended by manufacturer
Temperature Program:	Initial Temperature: -50°C
	Initial Hold Time: 2 min
	Ramp Rate: 8° C/min
	Final Temperature: 200°C
	Final Hold Time: Until all target compounds elute.

**10.2.3** The following are the recommended mass spectrometer conditions:

<u>Item</u>	<u>Condition</u>
-------------	------------------

Electron Energy:	70 Volts (nominal)
Mass Range:	35-300 amu [the choice of 35 amu excludes the detection of some target compounds such as methanol and formaldehyde, and the quantitation of others such as ethylene oxide, ethyl carbamate, etc. (see Table 2). Lowering the mass range and using special programming features available on modern gas chromatographs will be necessary in these cases, but are not considered here.
Scan Time:	To give at least 10 scans per peak, not to exceed 1 second per scan].

A schematic for a typical GC/MS analytical system is illustrated in Figure 15.

### 10.3 Analytical Sequence

**10.3.1 Introduction.** The recommended GC/MS analytical sequence for samples during each 24-hour time period is as follows:

- Perform instrument performance check using bromofluorobenzene (BFB).
- Initiate multi-point calibration or daily calibration checks.
- Perform a laboratory method blank.
- Complete this sequence for analysis of  $\leq 20$  field samples.

### 10.4 Instrument Performance Check

**10.4.1 Summary.** It is necessary to establish that a given GC/MS meets tuning and standard mass spectral abundance criteria prior to initiating any data collection. The GC/MS system is set up according to the manufacturer's specifications, and the mass calibration and resolution of the GC/MS system are then verified by the analysis of the instrument performance check standard, bromofluorobenzene (BFB).

**10.4.2 Frequency.** Prior to the analyses of any samples, blanks, or calibration standards, the Laboratory must establish that the GC/MS system meets the mass spectral ion abundance criteria for the instrument performance check standard containing BFB. The instrument performance check solution must be analyzed initially and once per 24-hour time period of operation.

The 24-hour time period for GC/MS instrument performance check and standards calibration (initial calibration or daily calibration check criteria) begins at the injection of the BFB which the laboratory records as documentation of a compliance tune.

**10.4.3 Procedure.** The analysis of the instrument performance check standard is performed by trapping 50 ng of BFB under the optimized preconcentration parameters. The BFB is introduced from a cylinder into the GC/MS via a sample loop valve injection system similar to that shown in Figure 13.

The mass spectrum of BFB must be acquired in the following manner. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is conducted using a single scan prior to the elution of BFB.

**10.4.4 Technical Acceptance Criteria.** Prior to the analysis of any samples, blanks, or calibration standards, the analyst must establish that the GC/MS system meets the mass spectral ion abundance criteria for the instrument performance check standard as specified in Table 3.

**10.4.5 Corrective Action.** If the BFB acceptance criteria are not met, the MS must be retuned. It may be necessary to clean the ion source, or quadrupoles, or take other necessary actions to achieve the acceptance criteria.

**10.4.6 Documentation.** Results of the BFB tuning are to be recorded and maintained as part of the instrumentation log.

## 10.5 Initial Calibration

**10.5.1 Summary.** Prior to the analysis of samples and blanks but after the instrument performance check standard criteria have been met, each GC/MS system must be calibrated at five concentrations that span the monitoring range of interest in an initial calibration sequence to determine instrument sensitivity and the linearity of GC/MS response for the target compounds. For example, the range of interest may be 2 to 20 ppbv, in which case the five concentrations would be 1, 2, 5, 10 and 25 ppbv.

One of the calibration points from the initial calibration curve must be at the same concentration as the daily calibration standard (e.g., 10 ppbv).

**10.5.2 Frequency.** Each GC/MS system must be recalibrated following corrective action (e.g., ion source cleaning or repair, column replacement, etc.) which may change or affect the initial calibration criteria or if the daily calibration acceptance criteria have not been met.

If time remains in the 24-hour time period after meeting the acceptance criteria for the initial calibration, samples may be analyzed.

If time does not remain in the 24-hour period after meeting the acceptance criteria for the initial calibration, a new analytical sequence shall commence with the analysis of the instrument performance check standard followed by analysis of a daily calibration standard.

**10.5.3 Procedure.** Verify that the GC/MS system meets the instrument performance criteria in Section 10.4.

The GC must be operated using temperature and flow rate parameters equivalent to those in Section 10.2.2. Calibrate the preconcentration-GC/MS system by drawing the standard into the system. Use one of the standards preparation techniques described under Section 9.2 or equivalent.

A minimum of five concentration levels are needed to determine the instrument sensitivity and linearity. One of the calibration levels should be near the detection level for the compounds of interest. The calibration range should be chosen so that linear results are obtained as defined in Sections 10.5.1 and 10.5.5.

Quantitation ions for the target compounds are shown in Table 2. The primary ion should be used unless interferences are present, in which case a secondary ion is used.

### 10.5.4 Calculations.

*[Note: In the following calculations, an internal standard approach is used to calculate response factors. The area response used is that of the primary quantitation ion unless otherwise stated.]*

**10.5.4.1 Relative Response Factor (RRF).** Calculate the relative response factors for each target compound relative to the appropriate internal standard (i.e., standard with the nearest retention time) using the following equation:

$$\text{RRF} = \frac{A_x C_{is}}{A_{is} C_x}$$

where: RRF = Relative response factor.  
 $A_x$  = Area of the primary ion for the compound to be measured, counts.  
 $A_{is}$  = Area of the primary ion for the internal standard, counts.  
 $C_{is}$  = Concentration of internal standard spiking mixture, ppbv.  
 $C_x$  = Concentration of the compound in the calibration standard, ppbv.

[*Note: The equation above is valid under the condition that the volume of internal standard spiking mixture added in all field and QC analyses is the same from run to run, and that the volume of field and QC sample introduced into the trap is the same for each analysis.  $C_{is}$  and  $C_x$  must be in the same units.*]

**10.5.4.2 Mean Relative Response Factor.** Calculate the mean RRF for each compound by averaging the values obtained at the five concentrations using the following equation:

$$\overline{RRF} = \sum_{i=1}^n \frac{x_i}{n}$$

where:  $\overline{RRF}$  = Mean relative response factor.  
 $x_i$  = RRF of the compound at concentration i.  
 n = Number of concentration values, in this case 5.

**10.5.4.3 Percent Relative Standard Deviation (%RSD).** Using the RRFs from the initial calibration, calculate the %RSD for all target compounds using the following equations:

$$\%RSD = \frac{SD_{RRF}}{\overline{RRF}} \times 100$$

and

$$SD_{RRF} = \sqrt{\sum_{i=1}^N \frac{(RRF_i - \overline{RRF})^2}{N - 1}}$$

where:  $SD_{RRF}$  = Standard deviation of initial response factors (per compound).  
 $RRF_i$  = Relative response factor at a concentration level i.  
 $\overline{RRF}$  = Mean of initial relative response factors (per compound).

**10.5.4.4 Relative Retention Times (RRT).** Calculate the RRTs for each target compound over the initial calibration range using the following equation:

$$RRT = \frac{RT_c}{RT_{is}}$$

where:  $RT_c$  = Retention time of the target compound, seconds  
 $RT_{is}$  = Retention time of the internal standard, seconds.

**10.5.4.5 Mean of the Relative Retention Times ( $\overline{RRT}$ ).** Calculate the mean of the relative retention times ( $\overline{RRT}$ ) for each analyte target compound over the initial calibration range using the following equation:

$$\overline{\text{RRT}} = \sum_{i=1}^n \frac{\text{RRT}}{n}$$

where:  $\overline{\text{RRT}}$  = Mean relative retention time for the target compound for each initial calibration standard.

RRT = Relative retention time for the target compound at each calibration level.

**10.5.4.6 Tabulate Primary Ion Area Response (Y) for Internal Standard.** Tabulate the area response (Y) of the primary ions (see Table 2) and the corresponding concentration for each compound and internal standard.

**10.5.4.7 Mean Area Response ( $\overline{Y}$ ) for Internal Standard.** Calculate the mean area response ( $\overline{Y}$ ) for each internal standard compound over the initial calibration range using the following equation:

$$\overline{Y} = \sum_{i=1}^n \frac{Y_i}{n}$$

where:  $\overline{Y}$  = Mean area response.

Y = Area response for the primary quantitation ion for the internal standard for each initial calibration standard.

**10.5.4.8 Mean Retention Times ( $\overline{\text{RT}}$ ).** Calculate the mean of the retention times ( $\overline{\text{RT}}$ ) for each internal standard over the initial calibration range using the following equation:

$$\overline{\text{RT}} = \sum_{i=1}^n \frac{\text{RT}_i}{n}$$

where:  $\overline{\text{RT}}$  = Mean retention time, seconds

RT = Retention time for the internal standard for each initial calibration standard, seconds.

### 10.5.5 Technical Acceptance Criteria for the Initial Calibration.

**10.5.5.1** The calculated %RSD for the RRF for each compound in the calibration table must be less than 30% with at most two exceptions up to a limit of 40%.

*[Note: This exception may not be acceptable for all projects. Many projects may have a specific target list of compounds which would require the lower limit for all compounds.]*

**10.5.5.2** The RRT for each target compound at each calibration level must be within 0.06 RRT units of the mean RRT for the compound.

**10.5.5.3** The area response Y of at each calibration level must be within 40% of the mean area response  $\overline{Y}$  over the initial calibration range for each internal standard.

**10.5.5.4** The retention time shift for each of the internal standards at each calibration level must be within 20 s of the mean retention time over the initial calibration range for each internal standard.

### 10.5.6 Corrective Action.

**10.5.6.1 Criteria.** If the initial calibration technical acceptance criteria are not met, inspect the system for problems. It may be necessary to clean the ion source, change the column, or take other corrective actions to meet the initial calibration technical acceptance criteria.

**10.5.6.2 Schedule.** Initial calibration acceptance criteria *must* be met before any field samples, performance evaluation (PE) samples, or blanks are analyzed.

## 10.6 Daily Calibration

**10.6.1 Summary.** Prior to the analysis of samples and blanks but after tuning criteria have been met, the initial calibration of each GC/MS system must be routinely checked by analyzing a daily calibration standard to ensure that the instrument continues to remain under control. The daily calibration standard, which is the nominal 10 ppbv level calibration standard, should contain all the target compounds.

**10.6.2 Frequency.** A check of the calibration curve must be performed once every 24 hours on a GC/MS system that has met the tuning criteria. The daily calibration sequence starts with the injection of the BFB. If the BFB analysis meets the ion abundance criteria for BFB, then a daily calibration standard may be analyzed.

**10.6.3 Procedure.** The mid-level calibration standard (10 ppbv) is analyzed in a GC/MS system that has met the tuning and mass calibration criteria following the same procedure in Section 10.5.

**10.6.4 Calculations.** Perform the following calculations.

*[Note: As indicated earlier, the area response of the primary quantitation ion is used unless otherwise stated.]*

**10.6.4.1 Relative Response Factor (RRF).** Calculate a relative response factor (RRF) for each target compound using the equation in Section 10.5.4.1.

**10.6.4.2 Percent Difference (%D).** Calculate the percent difference in the RRF of the daily RRF (24-hour) compared to the mean RRF in the most recent initial calibration. Calculate the %D for each target compound using the following equation:

$$\%D = \frac{RRF_c - \overline{RRF}_i}{\overline{RRF}_i} \times 100$$

where:  $RRF_c$  = RRF of the compound in the continuing calibration standard.

$\overline{RRF}_i$  = Mean RRF of the compound in the most recent initial calibration.

**10.6.5 Technical Acceptance Criteria.** The daily calibration standard must be analyzed at the concentration level and frequency described in this Section 10.6 and on a GC/MS system meeting the BFB instrument performance check criteria (see Section 10.4).

The %D for each target compound in a daily calibration sequence must be within  $\pm 30$  percent in order to proceed with the analysis of samples and blanks. A control chart showing %D values should be maintained.

**10.6.6 Corrective Action.** If the daily calibration technical acceptance criteria are not met, inspect the system for problems. It may be necessary to clean the ion source, change the column, or take other corrective actions to meet the daily calibration technical acceptance criteria.

Daily calibration acceptance criteria must be met before any field samples, performance evaluation (PE) samples, or blanks are analyzed. If the % D criteria are not met, it will be necessary to rerun the daily calibration sample.

## 10.7 Blank Analyses

**10.7.1 Summary.** To monitor for possible laboratory contamination, laboratory method blanks are analyzed at least once in a 24-hour analytical sequence. All steps in the analytical procedure are performed on the blank

using all reagents, standards, equipment, apparatus, glassware, and solvents that would be used for a sample analysis.

A laboratory method blank (LMB) is an unused, certified canister that has not left the laboratory. The blank canister is pressurized with humidified, ultra-pure zero air and carried through the same analytical procedure as a field sample. The injected aliquot of the blank must contain the same amount of internal standards that are added to each sample.

**10.7.2 Frequency.** The laboratory method blank must be analyzed after the calibration standard(s) and before any samples are analyzed.

Whenever a high concentration sample is encountered (i.e., outside the calibration range), a blank analysis should be performed immediately after the sample is completed to check for carryover effects.

**10.7.3 Procedure.** Fill a cleaned and evacuated canister with humidified zero air (RH >20 percent, at 25°C). Pressurize the contents to 2 atm.

The blank sample should be analyzed using the same procedure outlined under Section 10.8.

**10.7.4 Calculations.** The blanks are analyzed similar to a field sample and the equations in Section 10.5.4 apply.

**10.7.5 Technical Acceptance Criteria.** A blank canister should be analyzed daily.

The area response for each internal standard (IS) in the blank must be within  $\pm 40$  percent of the mean area response of the IS in the most recent valid calibration.

The retention time for each of the internal standards must be within  $\pm 0.33$  minutes between the blank and the most recent valid calibration.

The blank should not contain any target analyte at a concentration greater than its quantitation level (three times the MDL as defined in Section 11.2) and should not contain additional compounds with elution characteristics and mass spectral features that would interfere with identification and measurement of a method analyte.

**10.7.6 Corrective Action.** If the blanks do not meet the technical acceptance criteria, the analyst should consider the analytical system to be out of control. It is the responsibility of the analyst to ensure that contaminants in solvents, reagents, glassware, and other sample storage and processing hardware that lead to discrete artifacts and/or elevated baselines in gas chromatograms be eliminated. If contamination is a problem, the source of the contamination must be investigated and appropriate corrective measures need to be taken and documented before further sample analysis proceeds.

If an analyte in the blank is found to be out of control (i.e., contaminated) and the analyte is also found in associated samples, those sample results should be "flagged" as possibly contaminated.

## 10.8 Sample Analysis

**10.8.1 Summary.** An aliquot of the air sample from a canister (e.g., 500 mL) is preconcentrated and analyzed by GC/MS under conditions stated in Sections 10.1 and 10.2. If using the multisorbent/dry purge approach, adjust the dry purge volume to reduce water effects in the analytical system to manageable levels.

*[Note: The analyst should be aware that pressurized samples of high humidity samples will contain condensed water. As a result, the humidity of the sample released from the canister during analysis will vary*

*in humidity, being lower at the higher canister pressures and increasing in humidity as the canister pressures decreases. Storage integrity of water soluble compounds may also be affected.]*

**10.8.2 Frequency.** If time remains in the 24-hour period in which an initial calibration is performed, samples may be analyzed without analysis of a daily calibration standard.

If time does not remain in the 24-hour period since the injection of the instrument performance check standard in which an initial calibration is performed, both the instrument performance check standard and the daily calibration standard should be analyzed before sample analysis may begin.

**10.8.3 Procedure for Instrumental Analysis.** Perform the following procedure for analysis.

**10.8.3.1** All canister samples should be at temperature equilibrium with the laboratory.

**10.8.3.2** Check and adjust the mass flow controllers to provide correct flow rates for the system.

**10.8.3.3** Connect the sample canister to the inlet of the GC/MS analytical system, as shown in Figure 15 [Figure 16 shows an alternate two stage concentrator using multisorbent traps followed by a trap cooled by a closed cycle cooler (15)]. The desired sample flow is established through the six-port chromatographic valve and the preconcentrator to the downstream flow controller. The absolute volume of sample being pulled through the trap must be consistent from run to run.

**10.8.3.4** Heat/cool the GC oven and cryogenic or adsorbent trap to their set points. Assuming a six-port valve is being used, as soon as the trap reaches its lower set point, the six-port chromatographic valve is cycled to the trap position to begin sample collection. Utilize the sample collection time which has been optimized by the analyst.

**10.8.3.5** Use the arrangement shown in Figure 13, (i.e., a gastight syringe or some alternate method) introduce an internal standard during the sample collection period. Add sufficient internal standard equivalent to 10 ppbv in the sample. For example, a 0.5 mL volume of a mixture of internal standard compounds, each at 10 ppmv concentration, added to a sample volume of 500 mL, will result in 10 ppbv of each internal standard in the sample.

**10.8.3.6** After the sample and internal standards are preconcentrated on the trap, the GC sampling valve is cycled to the inject position and the trap is swept with helium and heated. Assuming a focusing trap is being used, the trapped analytes are thermally desorbed onto a focusing trap and then onto the head of the capillary column and are separated on the column using the GC oven temperature program. The canister valve is closed and the canister is disconnected from the mass flow controller and capped. The trap is maintained at elevated temperature until the beginning of the next analysis.

**10.8.3.7** Upon sample injection onto the column, the GC/MS system is operated so that the MS scans the atomic mass range from 35 to 300 amu. At least ten scans per eluting chromatographic peak should be acquired. Scanning also allows identification of unknown compounds in the sample through searching of library spectra.

**10.8.3.8** Each analytical run must be checked for saturation. The level at which an individual compound will saturate the detection system is a function of the overall system sensitivity and the mass spectral characteristics of that compound.

**10.8.3.9** Secondary ion quantitation is allowed only when there are sample matrix interferences with the primary ion. If secondary ion quantitation is performed, document the reasons in the laboratory record book.

**10.8.4 Calculations.** The equation below is used for calculating concentrations.

$$C_x = \frac{A_x C_{is} DF}{A_{is} RRF}$$

where:  $C_x$  = Compound concentration, ppbv.

$A_x$  = Area of the characteristic ion for the compound to be measured, counts.

$A_{is}$  = Area of the characteristic ion for the specific internal standard, counts.

$C_{is}$  = Concentration of the internal standard spiking mixture, ppbv

$\overline{RRF}$  = Mean relative response factor from the initial calibration.

DF = Dilution factor calculated as described in section 2. If no dilution is performed, DF = 1.

*[Note: The equation above is valid under the condition that the volume (~500  $\mu$ L) of internal standard spiking mixture added in all field and QC analyses is the same from run to run, and that the volume (~500 mL) of field and QC sample introduced into the trap is the same for each analysis.]*

### 10.8.5 Technical Acceptance Criteria.

*[Note: If the most recent valid calibration is an initial calibration, internal standard area responses and RTs in the sample are evaluated against the corresponding internal standard area responses and RTs in the mid level standard (10 ppbv) of the initial calibration.]*

**10.8.5.1** The field sample must be analyzed on a GC/MS system meeting the BFB tuning, initial calibration, and continuing calibration technical acceptance criteria at the frequency described in Sections 10.4, 10.5 and 10.6.

**10.8.5.2** The field samples must be analyzed along with a laboratory method blank that met the blank technical acceptance criteria.

**10.8.5.3** All of the target analyte peaks should be within the initial calibration range.

**10.8.5.4** The retention time for each internal standard must be within  $\pm 0.33$  minutes of the retention time of the internal standard in the most recent valid calibration.

**10.8.6 Corrective Action.** If the on-column concentration of any compound in any sample exceeds the initial calibration range, an aliquot of the original sample must be diluted and reanalyzed. Guidance in performing dilutions and exceptions to this requirement are given below.

- Use the results of the original analysis to determine the approximate dilution factor required to get the largest analyte peak within the initial calibration range.
- The dilution factor chosen should keep the response of the largest analyte peak for a target compound in the upper half of the initial calibration range of the instrument.

*[Note: Analysis involving dilution should be reported with a dilution factor and nature of the dilution gas.]*

**10.8.6.1** Internal standard responses and retention times must be evaluated during or immediately after data acquisition. If the retention time for any internal standard changes by more than 20 sec from the latest daily (24-hour) calibration standard (or mean retention time over the initial calibration range), the GC/MS system must be inspected for malfunctions, and corrections made as required.

**10.8.6.2** If the area response for any internal standard changes by more than  $\pm 40$  percent between the sample and the most recent valid calibration, the GC/MS system must be inspected for malfunction and

corrections made as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is necessary.

**10.8.6.3** If, after reanalysis, the area responses or the RTs for all internal standards are inside the control limits, then the problem with the first analysis is considered to have been within the control of the Laboratory. Therefore, submit only data from the analysis with SICPs within the limits. This is considered the initial analysis and should be reported as such on all data deliverables.

## 11. Requirements for Demonstrating Method Acceptability for VOC Analysis from Canisters

### 11.1 Introduction

**11.1.1** There are three performance criteria which must be met for a system to qualify under Compendium Method TO-15. These criteria are: the method detection limit of  $\leq 0.5$  ppbv, replicate precision within 25 percent, and audit accuracy within 30 percent for concentrations normally expected in contaminated ambient air (0.5 to 25 ppbv).

**11.1.2** Either SIM or SCAN modes of operation can be used to achieve these criteria, and the choice of mode will depend on the number of target compounds, the decision of whether or not to determine tentatively identified compounds along with other VOCs on the target list, as well as on the analytical system characteristics.

**11.1.3** Specific criteria for each Title III compound on the target compound list must be met by the analytical system. These criteria were established by examining summary data from EPA's Toxics Air Monitoring System Network and the Urban Air Toxics Monitoring Program network. Details for the determination of each of the criteria follow.

### 11.2 Method Detection Limit

**11.2.1** The procedure chosen to define the method detection limit is that given in the *Code of Federal Regulations* (40 CFR 136 Appendix B).

**11.2.2** The method detection limit is defined for each system by making seven replicate measurements of the compound of interest at a concentration near (within a factor of five) the expected detection limit, computing the standard deviation for the seven replicate concentrations, and multiplying this value by 3.14 (i.e., the Student's t value for 99 percent confidence for seven values). Employing this approach, the detection limits given in Table 4 were obtained for some of the VOCs of interest.

### 11.3 Replicate Precision

**11.3.1** The measure of replicate precision used for this program is the absolute value of the difference between replicate measurements of the sample divided by the average value and expressed as a percentage as follows:

$$\text{percent difference} = \frac{|x_1 - x_2|}{\bar{x}} \times 100$$

where:

- $x_1$  = First measurement value.
- $x_2$  = Second measurement value.
- $\bar{x}$  = Average of the two values.

**11.3.2** There are several factors which may affect the precision of the measurement. The nature of the compound of interest itself such as molecular weight, water solubility, polarizability, etc., each have some effect on the precision, for a given sampling and analytical system. For example, styrene, which is classified as a polar VOC, generally shows slightly poorer precision than the bulk of nonpolar VOCs. A primary influence on precision is the concentration level of the compound of interest in the sample, i.e., the precision degrades as the concentration approaches the detection limit. A conservative measure was obtained from replicate analysis of "real world" canister samples from the TAMS and UATMP networks. These data are summarized in Table 5 and suggest that a replicate precision value of 25 percent can be achieved for each of the target compounds.

## 11.4 Audit Accuracy

**11.4.1** A measure of analytical accuracy is the degree of agreement with audit standards. Audit accuracy is defined as the difference between the nominal concentration of the audit compound and the measured value divided by the audit value and expressed as a percentage, as illustrated in the following equation:

$$\text{Audit Accuracy, \%} = \frac{\text{Spiked Value} - \text{Observed Value}}{\text{Spiked Value}} \times 100$$

**11.4.2** Audit accuracy results for TAMS and UATMP analyses are summarized in Table 6 and were used to form the basis for a selection of 30 percent as the performance criterion for audit accuracy.

## 12. References

1. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air: Method TO-14A, Second Edition*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA 600/625/R-96/010b, January 1997.
2. Winberry, W. T., Jr., et al., *Statement-of-Work (SOW) for the Analysis of Air Toxics From Superfund Sites*, U. S. Environmental Protection Agency, Office of Solid Waste, Contract Laboratory Program, Washington, D.C., Draft Report, June 1990.
3. Coutant, R.W., *Theoretical Evaluation of Stability of Volatile Organic Chemicals and Polar Volatile Organic Chemicals in Canisters*, U. S. Environmental Protection Agency, EPA Contract No. 68-DO-0007, Work Assignment No. 45, Subtask 2, Battelle, Columbus, OH, June 1993.
4. Kelly, T.J., Mukund, R., Gordon, S.M., and Hays, M.J., *Ambient Measurement Methods and Properties of the 189 Title III Hazardous Air Pollutants*, U. S. Environmental Protection Agency, EPA Contract No. 68-DO-0007, Work Assignment 44, Battelle, Columbus, OH, March 1994.
5. Kelly T. J. and Holdren, M.W., "Applicability of Canisters for Sample Storage in the Determination of Hazardous Air Pollutants," *Atmos. Environ.*, Vol. 29, 2595-2608, May 1995.
6. Kelly, T.J., Callahan, P.J., Pleil, J.K., and Evans, G.E., "Method Development and Field Measurements for Polar Volatile Organic Compounds in Ambient Air," *Environ. Sci. Technol.*, Vol. 27, 1146-1153, 1993.

7. McClenny, W.A., Oliver, K.D. and Daughtrey, E.H., Jr. "Dry Purging of Solid Adsorbent Traps to Remove Water Vapor Before Thermal Desorption of Trace Organic Gases," *J. Air and Waste Manag. Assoc.*, Vol. 45, 792-800, June 1995.
8. Whitaker, D.A., Fortmann, R.C. and Lindstrom, A.B. "Development and Testing of a Whole Air Sampler for Measurement of Personal Exposures to Volatile Organic Compounds," *Journal of Exposure Analysis and Environmental Epidemiology*, Vol. 5, No. 1, 89-100, January 1995.
9. Pleil, J.D. and Lindstrom, A.B., "Collection of a Single Alveolar Exhaled Breath for Volatile Organic Compound Analysis," *American Journal of Industrial Medicine*, Vol. 28, 109-121, 1995.
10. Pleil, J.D. and McClenny, W.A., "Spatially Resolved Monitoring for Volatile Organic Compounds Using Remote Sector Sampling," *Atmos. Environ.*, Vol. 27A, No. 5, 739-747, August 1993.
11. Holdren, M.W., et al., Unpublished Final Report, EPA Contract 68-DO-0007, Battelle, Columbus, OH. Available from J.D. Pleil, MD-44, U. S. Environmental Protection Agency, Research Triangle Park, NC, 27711, 919-541-4680.
12. Morris, C.M., Burkley, R.E. and Bumgarner, J.E., "Preparation of Multicomponent Volatile Organic Standards Using Dilution Bottles," *Anal. Letts.*, Vol. 16 (A20), 1585-1593, 1983.
13. Pollack, A.J., Holdren, M.W., "Multi-Adsorbent Preconcentration and Gas Chromatographic Analysis of Air Toxics With an Automated Collection/Analytical System," in the *Proceedings of the 1990 EPA/A&WMA International Symposium of Measurement of Toxic and Related Air Pollutants*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA/600/9-90-026, May 1990.
14. Stephenson, J.H.M., Allen, F., Slagle, T., "Analysis of Volatile Organics in Air via Water Methods" in *Proceedings of the 1990 EPA/A&WMA International Symposium on Measurement of Toxic and Related Air Pollutants*, U. S. Environmental Protection Agency, Research Triangle Park, NC, EPA 600/9-90-026, May 1990.
15. Oliver, K. D., Adams, J. R., Davehtrey, E. H., Jr., McClenny, W. A., Young, M. J., and Parade, M. A., "Techniques for Monitoring Toxices VOCs in Air: Sorbent Preconcentration Closed-Cycle Cooler Cryofocusing, and GC/MS Analysis," *Environ. Sci. Technol.*, Vol. 30, 1938-1945, 1996.

## APPENDIX A.

LISTING OF SOME COMMERCIAL WATER  
MANAGEMENT SYSTEMS USED WITH AUTOGC SYSTEMS

Tekmar Dohrman Company  
7143 East Kemper Road  
Post Office Box 429576  
Cincinnati, Ohio 45242-9576  
(513) 247-7000  
(513) 247-7050 (Fax)  
(800) 543-4461  
[Moisture control module]

Entech Laboratory Automation  
950 Enchanted Way No. 101  
Simi Valley, California 93065  
(805) 527-5939  
(805) 527-5687 (Fax)  
[Microscale Purge and Trap]

Dynatherm Analytical Instruments  
Post Office Box 159  
Kelton, Pennsylvania 19346  
(215) 869-8702  
(215) 869-3885 (Fax)  
[Thermal Desorption System]

XonTech Inc.  
6862 Hayenhurst Avenue  
Van Nuys, CA 91406  
(818) 787-7380  
(818) 787-4275 (Fax)  
[Multi-adsorbent trap/dry purge]

Graseby  
500 Technology Ct.  
Smyrna, Georgia 30082  
(770) 319-9999  
(770) 319-0336 (Fax)  
(800) 241-6898  
[Controlled Desorption Trap]

Varian Chromatography System  
2700 Mitchell Drive  
Walnut Creek, California 94898  
(510) 945-2196  
(510) 945-2335 (FAX)  
[Variable Temperature Adsorption Trap]

**APPENDIX B.****COMMENT ON CANISTER CLEANING PROCEDURES**

The canister cleaning procedures given in Section 8.4 require that canister pressure be reduced to  $<0.05$  mm Hg before the cleaning process is complete. Depending on the vacuum system design (diameter of connecting tubing, valve restrictions, etc.) and the placement of the vacuum gauge, the achievement of this value may take several hours. In any case, the pressure gauge should be placed near the canisters to determine pressure. The objective of requiring a low pressure evacuation during canister cleaning is to reduce contaminants. If canisters can be routinely certified ( $<0.2$  ppbv for target compounds) while using a higher vacuum, then this criteria can be relaxed. However, the ultimate vacuum achieved during cleaning should always be  $<0.2$  mm Hg.

Canister cleaning as described in Section 8.4 and illustrated in Figure 10 requires components with special features. The vacuum gauge shown in Figure 10 must be capable of measuring  $0.05$  mm Hg with less than a 20% error. The vacuum pump used for evacuating the canister must be noncontaminating while being capable of achieving the  $0.05$  mm Hg vacuum as monitored near the canisters. Thermoelectric vacuum gauges and turbomolecular drag pumps are typically being used for these two components.

An alternate to achieving the canister certification requirement of  $<0.2$  ppbv for all target compounds is the criteria used in Compendium Method TO-12 that the total carbon count be  $<10$  ppbC. This check is less expensive and typically more exacting than the current certification requirement and can be used if proven to be equivalent to the original requirement. This equivalency must be established by comparing the total nonmethane organic carbon (TNMOC) expressed in ppbC to the requirement that individual target compounds be  $<0.2$  ppbv for a series of analytical runs.

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**APPENDIX C.****LISTING OF COMMERCIAL MANUFACTURERS AND RE-SUPPLIERS OF  
SPECIALLY-PREPARED CANISTERS**

BRC/Rasmussen  
17010 NW Skyline Blvd.  
Portland, Oregon 97321  
(503) 621-1435

Meriter  
1790 Potrero Drive  
San Jose, CA 95124  
(408) 265-6482

Restek Corporation  
110 Benner Circle  
Bellefonte, PA 16823-8812  
(814) 353-1300  
(800) 356-1688

Scientific Instrumentation Specialists  
P.O. Box 8941  
815 Courtney Street  
Moscow, ID 83843  
(208) 882-3860

Graseby  
500 Technology Ct.  
Smyrna, Georgia 30082  
(404) 319-9999  
(800) 241-6898

XonTech Inc.  
6862 Hayenhurst Avenue  
Van Nuys, CA 91406  
(818) 787-7380

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**APPENDIX D.****LISTING OF COMMERCIAL SUPPLIERS OF PERMEATION TUBES AND SYSTEMS**

Kin-Tek  
504 Laurel St.  
Lamarque, Texas 77568  
(409) 938-3627  
(800) 326-3627

Vici Metronics, Inc.  
2991 Corvin Drive  
Santa Clara, CA 95051  
(408) 737-0550

Analytical Instrument Development, Inc.  
Rt. 41 and Newark Rd.  
Avondale, PA 19311  
(215) 268-3181

Ecology Board, Inc.  
9257 Independence Ave.  
Chatsworth, CA 91311  
(213) 882-6795

Tracor, Inc.  
6500 Tracor Land  
Austin, TX  
(512) 926-2800

Metronics Associates, Inc.  
3201 Porter Drive  
Standford Industrial Park  
Palo Alto, CA 94304  
(415) 493-5632

TABLE 1. VOLATILE ORGANIC COMPOUNDS ON THE TITLE III CLEAN AIR AMENDMENT LIST--  
MEMBERSHIP IN COMPENDIUM METHOD TO-14A LIST AND THE SOW-CLP LIST OF VOCs

Compound	CAS No.	BP (°C)	v.p. (mmHg) <sup>1</sup>	MW <sup>1</sup>	TO-14A	CLP-SOW
Methyl chloride (chloromethane); CH <sub>3</sub> Cl	74-87-3	-23.7	3.8 x 10	50.5	X	X
Carbonyl sulfide; COS	463-58-1	-50.0	3.7 x 10	60.1		
Vinyl chloride (chloroethene); C <sub>2</sub> H <sub>3</sub> Cl	75-01-4	-14.0	3.2 x 10	62.5	X	X
Diazomethane; CH <sub>2</sub> N <sub>2</sub>	334-88-3	-23.0	2.8 x 10	42.1		
Formaldehyde; CH <sub>2</sub> O	50-00-0	-19.5	2.7 x 10	30		
1,3-Butadiene; C <sub>4</sub> H <sub>6</sub>	106-99-0	-4.5	2.0 x 10	54		X
Methyl bromide (bromomethane); CH <sub>3</sub> Br	74-83-9	3.6	1.8 x 10	94.9	X	X
Phosgene; CCl <sub>2</sub> O	75-44-5	8.2	1.2 x 10	99		
Vinyl bromide (bromoethene); C <sub>2</sub> H <sub>3</sub> Br	593-60-2	15.8	1.1 x 10	107		
Ethylene oxide; C <sub>2</sub> H <sub>4</sub> O	75-21-8	10.7	1.1 x 10	44		
Ethyl chloride (chloroethane); C <sub>2</sub> H <sub>5</sub> Cl	75-00-3	12.5	1.0 x 10	64.5	X	X
Acetaldehyde (ethanal); C <sub>2</sub> H <sub>4</sub> O	75-07-0	21.0	952	44		
Vinylidene chloride (1,1-dichloroethylene); C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	75-35-4	31.7	500	97	X	X
Propylene oxide; C <sub>3</sub> H <sub>6</sub> O	75-56-9	34.2	445	58		
Methyl iodide (iodomethane); CH <sub>3</sub> I	74-88-4	42.4	400	141.9		
Methylene chloride; CH <sub>2</sub> Cl <sub>2</sub>	75-09-2	40.0	349	84.9	X	X
Methyl isocyanate; C <sub>2</sub> H <sub>3</sub> NO	624-83-9	59.6	348	57.1		
Allyl chloride (3-chloropropene); C <sub>3</sub> H <sub>5</sub> Cl	107-05-1	44.5	340	76.5	X	X
Carbon disulfide; CS <sub>2</sub>	75-15-0	46.5	260	76		
Methyl tert-butyl ether; C <sub>5</sub> H <sub>12</sub> O	1634-04-4	55.2	249	86		
Propionaldehyde; C <sub>2</sub> H <sub>5</sub> CHO	123-38-6	49.0	235	58.1		
Ethylidene dichloride (1,1-dichloroethane); C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	75-34-3	57.0	230	99	X	

TABLE 1. (continued)

Compound	CAS No.	BP (°C)	v.p. (mmHg)	MW <sup>1</sup>	TO-14A	CLP-SOW
Chloroprene (2-chloro-1,3-butadiene); C <sub>4</sub> H <sub>5</sub> Cl	126-99-8	59.4	226	88.5		
Chloromethyl methyl ether; C <sub>2</sub> H <sub>5</sub> ClO	107-30-2	59.0	224	80.5		
Acrolein (2-propenal); C <sub>3</sub> H <sub>4</sub> O	107-02-8	52.5	220	56		X
1,2-Epoxybutane (1,2-butylene oxide); C <sub>4</sub> H <sub>8</sub> O	106-88-7	63.0	163	72		
Chloroform; CHCl <sub>3</sub>	67-66-3	61.2	160	119	X	X
Ethyleneimine (aziridine); C <sub>2</sub> H <sub>5</sub> N	151-56-4	56	160.0	43		
1,1-Dimethylhydrazine; C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	57-14-7	63	157.0	60.0		
Hexane; C <sub>6</sub> H <sub>14</sub>	110-54-3	69.0	120	86.2	X	
1,2-Propyleneimine (2-methylaziridine); C <sub>3</sub> H <sub>7</sub> N	75-55-8	66.0	112	57.1		
Acrylonitrile (2-propenenitrile); C <sub>3</sub> H <sub>3</sub> N	107-13-1	77.3	100	53	X	
Methyl chloroform (1,1,1-trichloroethane); C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	71-55-6	74.1	100	133.4	X	X
Methanol; CH <sub>4</sub> O	67-56-1	65.0	92.0	32		X
Carbon tetrachloride; CCl <sub>4</sub>	56-23-5	76.7	90.0	153.8	X	X
Vinyl acetate; C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	108-05-4	72.2	83.0	86		X
Methyl ethyl ketone (2-butanone); C <sub>4</sub> H <sub>8</sub> O	78-93-3	79.6	77.5	72		X
Benzene; C <sub>6</sub> H <sub>6</sub>	71-43-2	80.1	76.0	78	X	X
Acetonitrile (cyanomethane); C <sub>2</sub> H <sub>3</sub> N	75-05-8	82	74.0	41.0		X
Ethylene dichloride (1,2-dichloroethane); C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	107-06-2	83.5	61.5	99	X	X
Triethylamine; C <sub>6</sub> H <sub>15</sub> N	121-44-8	89.5	54.0	101.2		
Methylhydrazine; CH <sub>6</sub> N <sub>2</sub>	60-34-4	87.8	49.6	46.1		
Propylene dichloride (1,2-dichloropropane); C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	78-87-5	97.0	42.0	113	X	X
2,2,4-Trimethyl pentane C <sub>8</sub> H <sub>18</sub>	540-84-1	99.2	40.6	114		
1,4-Dioxane (1,4-Diethylene oxide); C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	123-91-1	101	37.0	88		
Bis(chloromethyl) ether; C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	542-88-1	104	30.0	115		
Ethyl acrylate; C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	140-88-5	100	29.3	100		
Methyl methacrylate; C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-62-6	101	28.0	100.1		

TABLE 1. (continued)

Compound	CAS No.	BP (°C)	v.p. (mmHg) <sup>1</sup>	MW <sup>1</sup>	TO-14A	CLP-SOW
Methyl methacrylate; C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-62-101	101	28.0	100.1		
1,3-Dichloropropene; C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> (cis)	542-75-6	112	27.8	111	X	X
Toluene; C <sub>7</sub> H <sub>8</sub>	108-88-3	111	22.0	92	X	X
Trichloroethylene; C <sub>2</sub> HCl <sub>3</sub>	79-01-6	87.0	20.0	131.4	X	X
1,1,2-Trichloroethane; C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	79-00-5	114	19.0	133.4	X	X
Tetrachloroethylene; C <sub>2</sub> Cl <sub>4</sub>	127-18-4	121	14.0	165.8	X	X
Epichlorohydrin (1-chloro-2,3-epoxy propane); C <sub>3</sub> H <sub>5</sub> ClO	106-89-8	117	12.0	92.5		
Ethylene dibromide (1,2-dibromoethane); C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	106-93-4	132	11.0	187.9	X	X
N-Nitroso-N-methylurea; C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	684-93-5	124	10.0	103		
2-Nitropropane; C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	79-46-9	120	10.0	89		
Chlorobenzene; C <sub>6</sub> H <sub>5</sub> Cl	108-90-7	132	8.8	112.6	X	X
Ethylbenzene; C <sub>8</sub> H <sub>10</sub>	100-41-4	136	7.0	106	X	X
Xylenes (isomer & mixtures); C <sub>8</sub> H <sub>10</sub>	1330-20-7	142	6.7	106.2	X	X
Styrene; C <sub>8</sub> H <sub>8</sub>	100-42-5	145	6.6	104	X	X
p-Xylene; C <sub>8</sub> H <sub>10</sub>	106-42-3	138	6.5	106.2	X	X
m-Xylene; C <sub>8</sub> H <sub>10</sub>	108-38-3	139	6.0	106.2	X	X
Methyl isobutyl ketone (hexone); C <sub>6</sub> H <sub>12</sub> O	108-10-1	117	6.0	100.2		
Bromoform (tribromomethane); CHBr <sub>3</sub>	75-25-2	149	5.6	252.8		
1,1,2,2-Tetrachloroethane; C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	79-34-5	146	5.0	167.9	X	X
o-Xylene; C <sub>8</sub> H <sub>10</sub>	95-47-6	144	5.0	106.2	X	X
Dimethylcarbamyl chloride; C <sub>3</sub> H <sub>6</sub> ClNO	79-44-7	166	4.9	107.6		
N-Nitrosodimethylamine; C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	62-75-9	152	3.7	74		
Beta-Propiolactone; C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	57-57-8	Decomposes at 162	3.4	72		
Cumene (isopropylbenzene); C <sub>9</sub> H <sub>12</sub>	98-82-8	153	3.2	120		

TABLE 1. (continued)

Compound	CAS No.	BP (°C)	V.p. (mmHg) <sup>1</sup>	MW <sup>1</sup>	TO-14A	CLP-SOW
Cumene (isopropylbenzene); C9H12	98-82-8	153	3.2	120		
Acrylic acid; C3H4O2	79-10-7	141	3.2	72		
N,N-Dimethylformamide; C3H7NO	68-12-2	153	2.7	73		
1,3-Propane sultone; C3H6O3S	1120-71-4	180/30mm	2.0	122.1		
Acetophenone; C8H8O	98-86-2	202	1.0	120		
Dimethyl sulfate; C2H6O4S	77-78-1	188	1.0	126.1		
Benzyl chloride (a-chlorotoluene); C7H7Cl	100-44-7	179	1.0	126.6	X	X
1,2-Dibromo-3-chloropropane; C3H5Br2Cl	96-12-8	196	0.80	236.4		
Bis(2-Chloroethyl)ether; C4H8Cl2O	111-44-4	178	0.71	143		
Chloroacetic acid; C2H3ClO2	79-11-8	189	0.69	94.5		
Aniline (aminobenzene); C6H7N	62-53-3	184	0.67	93		
1,4-Dichlorobenzene (p-); C6H4Cl2	106-46-7	173	0.60	147	X	X
Ethyl carbamate (urethane); C3H7NO2	51-79-6	183	0.54	89		
Acrylamide; C3H5NO	79-06-1	125/25 mm	0.53	71		
N,N-Dimethylaniline; C8H11N	121-69-7	192	0.50	121		
Hexachloroethane; C2Cl6	67-72-1	Sublimes at 186	0.40	236.7		
Hexachlorobutadiene; C4Cl6	87-68-3	215	0.40	260.8	X	X
Isophorone; C9H14O	78-59-1	215	0.38	138.2		
N-Nitrosomorpholine; C4H8N2O2	59-89-2	225	0.32	116.1		
Styrene oxide; C8H8O	96-09-3	194	0.30	120.2		
Diethyl sulfate; C4H10O4S	64-67-5	208	0.29	154		
Cresylic acid (cresol isomer mixture); C7H8O	1319-77-3	202	0.26	108		
o-Cresol; C7H8O	95-48-7	191	0.24	108		
Catechol (o-hydroxyphenol); C6H6O2	120-80-9	240	0.22	110		
Phenol; C6H6O	108-95-2	182	0.20	94		

TABLE 1. (continued)

Compound	CAS No.	BP (°C)	v.p. (mmHg) <sup>1</sup>	MW <sup>1</sup>	TO-14A	CLP-SOW
Catechol (o-hydroxyphenol); C6H6O2	120-80-9	240	0.22	110		
Phenol; C6H6O	108-95-2	182	0.20	94		
1,2,4-Trichlorobenzene; C6H3Cl3	120-82-1	213	0.18	181.5	X	X
nitrobenzene; C6H5NO2	98-95-3	211	0.15	123		

<sup>1</sup>Vapor pressure (v.p.), boiling point (BP) and molecularweight (MW) data from:

- (a)D. L. Jones and J. bursey, "Simultaneous Control of PM-10 and Hazardous Air Pollutants II: Rationale for Selection of Hazardous Air Pollutants as Potential Particulate Matter," Report EPA-452/R-93/013, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1992;
- (b)R. C. Weber, P. A. Parker, and M. Bowser. Vapor Pressure Distribution of Selected Organic Chemicals, Report EPA-600/2-81-021, U. S. Environmental Protection Agency, Cincinnati, OH, February 1981; and
- (c)R. C. Weast, ed., "CRC Handbook of Chemistry and Physics," 59th edition, CRC Press, Boca Raton, 1979.

**TABLE 2. CHARACTERISTIC MASSES (M/Z) USED FOR QUANTIFYING  
THE TITLE III CLEAN AIR ACT AMENDMENT COMPOUNDS**

Compound	CAS No.	Primary Ion	Secondary Ion
Methyl chloride (chloromethane); CH <sub>3</sub> Cl	74-87-3	50	52
Carbonyl sulfide; COS	463-88-1	60	62
Vinyl chloride (chloroethene); C <sub>2</sub> H <sub>3</sub> Cl	75-01-4	62	64
Diazomethane; CH <sub>2</sub> N <sub>2</sub>	334-88-3	42	41
Formaldehyde; CH <sub>2</sub> O	50-00-0	29	30
1,3-Butadiene; C <sub>4</sub> H <sub>6</sub>	106-99-0	39	54
Methyl bromide (bromomethane); CH <sub>3</sub> Br	74-83-9	94	96
Phosgene; CCl <sub>2</sub> O	75-44-5	63	65
Vinyl bromide (bromoethene); C <sub>2</sub> H <sub>3</sub> Br	593-60-2	106	108
Ethylene oxide; C <sub>2</sub> H <sub>4</sub> O	75-21-8	29	44
Ethyl chloride (chloroethane); C <sub>2</sub> H <sub>5</sub> Cl	75-00-3	64	66
Acetaldehyde (ethanal); C <sub>2</sub> H <sub>4</sub> O	75-07-0	44	29, 43
Vinylidene chloride (1,1-dichloroethylene); C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	75-35-4	61	96
Propylene oxide; C <sub>3</sub> H <sub>6</sub> O	75-56-9	58	57
Methyl iodide (iodomethane); CH <sub>3</sub> I	74-88-4	142	127
Methylene chloride; CH <sub>2</sub> Cl <sub>2</sub>	75-09-2	49	84, 86
Methyl isocyanate; C <sub>2</sub> H <sub>3</sub> NO	624-83-9	57	56
Allyl chloride (3-chloropropene); C <sub>3</sub> H <sub>5</sub> Cl	107-05-1	76	41, 78
Carbon disulfide; CS <sub>2</sub>	75-15-0	76	44, 78
Methyl tert-butyl ether; C <sub>5</sub> H <sub>12</sub> O	1634-04-4	73	41, 53
Propionaldehyde; C <sub>2</sub> H <sub>5</sub> CHO	123-38-6	58	29, 57
Ethylidene dichloride (1,1-dichloroethane); C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	75-34-3	63	65, 27
Chloroprene (2-chloro-1,3-butadiene); C <sub>4</sub> H <sub>5</sub> Cl	126-99-8	88	53, 90
Chloromethyl methyl ether; C <sub>2</sub> H <sub>5</sub> ClO	107-30-2	45	29, 49
Acrolein (2-propenal); C <sub>3</sub> H <sub>4</sub> O	107-02-8	56	55
1,2-Epoxybutane (1,2-butylene oxide); C <sub>4</sub> H <sub>8</sub> O	106-88-7	42	41, 72
Chloroform; CHCl <sub>3</sub>	67-66-3	83	85, 47
Ethyleneimine (aziridine); C <sub>2</sub> H <sub>5</sub> N	151-56-4	42	43
1,1-Dimethylhydrazine; C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	57-14-7	60	45, 59
Hexane; C <sub>6</sub> H <sub>14</sub>	110-54-3	57	41, 43
1,2-Propyleneimine (2-methylaziridine); C <sub>3</sub> H <sub>7</sub> N	75-55-8	56	57, 42
Acrylonitrile (2-propenenitrile); C <sub>3</sub> H <sub>3</sub> N	107-13-1	53	52
Methyl chloroform (1,1,1 trichloroethane); C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	71-55-6	97	99, 61
Methanol; CH <sub>4</sub> O	67-56-1	31	29
Carbon tetrachloride; CCl <sub>4</sub>	56-23-5	117	119
Vinyl acetate; C <sub>4</sub> H <sub>6</sub> O <sub>2</sub>	108-05-4	43	86
Methyl ethyl ketone (2-butanone); C <sub>4</sub> H <sub>8</sub> O	78-93-3	43	72

TABLE 2. (continued)

Compound	CAS No.	Primary Ion	Secondary Ion
Benzene; C <sub>6</sub> H <sub>6</sub>	71-43-2	78	77, 50
Acetonitrile (cyanomethane); C <sub>2</sub> H <sub>3</sub> N	75-05-8	41	40
Ethylene dichloride (1,2-dichloroethane); C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	107-06-2	62	64, 27
Triethylamine; C <sub>6</sub> H <sub>15</sub> N	121-44-8	86	58, 101
Methylhydrazine; CH <sub>6</sub> N <sub>2</sub>	60-34-4	46	31, 45
Propylene dichloride (1,2-dichloropropane); C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>	78-87-5	63	41, 62
2,2,4-Trimethyl pentane; C <sub>8</sub> H <sub>18</sub>	540-84-1	57	41, 56
1,4-Dioxane (1,4 Diethylene oxide); C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	123-91-1	88	58
Bis(chloromethyl) ether; C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> O	542-88-1	79	49, 81
Ethyl acrylate; C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	140-88-5	55	73
Methyl methacrylate; C <sub>5</sub> H <sub>8</sub> O <sub>2</sub>	80-62-6	41	69, 100
1,3-Dichloropropene; C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> (cis)	542-75-6	75	39, 77
Toluene; C <sub>7</sub> H <sub>8</sub>	108-88-3	91	92
Trichloethylene; C <sub>2</sub> HCl <sub>3</sub>	79-01-6	130	132, 95
1,1,2-Trichloroethane; C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	79-00-5	97	83, 61
Tetrachloroethylene; C <sub>2</sub> Cl <sub>4</sub>	127-18-4	166	164, 131
Epichlorohydrin (1-chloro-2,3-epoxy propane); C <sub>3</sub> H <sub>5</sub> ClO	106-89-8	57	49, 62
Ethylene dibromide (1,2-dibromoethane); C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	106-93-4	107	109
N-Nitroso-N-methylurea; C <sub>2</sub> H <sub>5</sub> N <sub>3</sub> O <sub>2</sub>	684-93-5	60	44, 103
2-Nitropropane; C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	79-46-9	43	41
Chlorobenzene; C <sub>6</sub> H <sub>5</sub> Cl	108-90-7	112	77, 114
Ethylbenzene; C <sub>8</sub> H <sub>10</sub>	100-41-4	91	106
Xylenes (isomer & mixtures); C <sub>8</sub> H <sub>10</sub>	1330-20-7	91	106
Styrene; C <sub>8</sub> H <sub>8</sub>	100-42-5	104	78, 103
p-Xylene; C <sub>8</sub> H <sub>10</sub>	106-42-3	91	106
m-Xylene; C <sub>8</sub> H <sub>10</sub>	108-38-3	91	106
Methyl isobutyl ketone (hexone); C <sub>6</sub> H <sub>12</sub> O	108-10-1	43	58, 100
Bromoform (tribromomethane); CHBr <sub>3</sub>	75-25-2	173	171, 175
1,1,2,2-Tetrachloroethane; C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub>	79-34-5	83	85
o-Xylene; C <sub>8</sub> H <sub>10</sub>	95-47-6	91	106
Dimethylcarbanyl chloride; C <sub>3</sub> H <sub>6</sub> ClNO	79-44-7	72	107
N-Nitrosodimethylamine; C <sub>2</sub> H <sub>6</sub> N <sub>2</sub> O	62-75-9	74	42
Beta-Propiolactone; C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	57-57-8	42	43
Cumene (isopropylbenzene); C <sub>9</sub> H <sub>12</sub>	98-82-8	105	120
Acrylic acid; C <sub>3</sub> H <sub>4</sub> O <sub>2</sub>	79-10-7	72	45, 55
N,N-Dimethylformamide; C <sub>3</sub> H <sub>7</sub> NO	68-12-2	73	42, 44
1,3-Propane sultone; C <sub>3</sub> H <sub>6</sub> O <sub>3</sub> S	1120-71-4	58	65, 122

TABLE 2. (continued)

Compound	CAS No.	Primary Ion	Secondary Ion
Acetophenone; C <sub>8</sub> H <sub>8</sub> O	98-86-2	105	77, 120
Dimethyl sulfate; C <sub>2</sub> H <sub>6</sub> O <sub>4</sub> S	77-78-1	95	66, 96
Benzyl chloride (a-chlorotoluene); C <sub>7</sub> H <sub>7</sub> Cl	100-44-7	91	126
1,2-Dibromo-3-chloropropane; C <sub>3</sub> H <sub>5</sub> Br <sub>2</sub> Cl	96-12-8	57	155, 157
Bis(2-Chloroethyl)ether; C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> O	111-44-4	93	63, 95
Chloroacetic acid; C <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub>	79-11-8	50	45, 60
Aniline (aminobenzene); C <sub>6</sub> H <sub>7</sub> N	62-53-3	93	66
1,4-Dichlorobenzene (p-); C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>	106-46-7	146	148, 111
Ethyl carbamate (urethane); C <sub>3</sub> H <sub>7</sub> NO <sub>2</sub>	51-79-6	31	44, 62
Acrylamide; C <sub>3</sub> H <sub>5</sub> NO	79-06-1	44	55, 71
N,N-Dimethylaniline; C <sub>8</sub> H <sub>11</sub> N	121-69-7	120	77, 121
Hexachloroethane; C <sub>2</sub> Cl <sub>6</sub>	67-72-1	201	199, 203
Hexachlorobutadiene; C <sub>4</sub> Cl <sub>6</sub>	87-68-3	225	227, 223
Isophorone; C <sub>9</sub> H <sub>14</sub> O	78-59-1	82	138
N-Nitrosomorpholine; C <sub>4</sub> H <sub>8</sub> N <sub>2</sub> O <sub>2</sub>	59-89-2	56	86, 116
Styrene oxide; C <sub>8</sub> H <sub>8</sub> O	96-09-3	91	120
Diethyl sulfate; C <sub>4</sub> H <sub>10</sub> O <sub>4</sub> S	64-67-5	45	59, 139
Cresylic acid (cresol isomer mixture); C <sub>7</sub> H <sub>8</sub> O	1319-77-3		
o-Cresol; C <sub>7</sub> H <sub>8</sub> O	95-48-7	108	107
Catechol (o-hydroxyphenol); C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	120-80-9	110	64
Phenol; C <sub>6</sub> H <sub>6</sub> O	108-95-2	94	66
1,2,4-Trichlorobenzene; C <sub>6</sub> H <sub>3</sub> Cl <sub>3</sub>	120-82-1	180	182, 184
Nitrobenzene; C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	98-95-3	77	51, 123

**TABLE 3. REQUIRED BFB KEY IONS AND ION ABUNDANCE CRITERIA**

Mass	Ion Abundance Criteria <sup>1</sup>
50	8.0 to 40.0 Percent of m/e 95
75	30.0 to 66.0 Percent of m/e 95
95	Base Peak, 100 Percent Relative Abundance
96	5.0 to 9.0 Percent of m/e 95 (See note)
173	Less than 2.0 Percent of m/e 174
174	50.0 to 120.0 Percent of m/e 95
175	4.0 to 9.0 Percent of m/e 174
176	93.0 to 101.0 Percent of m/e 174
177	5.0 to 9.0 Percent of m/e 176

<sup>1</sup>All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.

**TABLE 4. METHOD DETECTION LIMITS (MDL)<sup>1</sup>**

TO-14A List	Lab #1, SCAN	Lab #2, SIM
Benzene	0.34	0.29
Benzyl Chloride	--	--
Carbon tetrachloride	0.42	0.15
Chlorobenzene	0.34	0.02
Chloroform	0.25	0.07
1,3-Dichlorobenzene	0.36	0.07
1,2-Dibromoethane	--	0.05
1,4-Dichlorobenzene	0.70	0.12
1,2-Dichlorobenzene	0.44	--
1,1-Dichloroethane	0.27	0.05
1,2-Dichloroethane	0.24	--
1,1-Dichloroethene	--	0.22
cis-1,2-Dichloroethene	--	0.06
Methylene chloride	1.38	0.84
1,2-Dichloropropane	0.21	--
cis-1,3-Dichloropropene	0.36	--
trans-1,3-Dichloropropene	0.22	--
Ethylbenzene	0.27	0.05
Chloroethane	0.19	--
Trichlorofluoromethane	--	--
1,1,2-Trichloro-1,2,2-trifluoroethane	--	--
1,2-Dichloro-1,1,2,2-tetrafluoroethane	--	--
Dichlorodifluoromethane	--	--
Hexachlorobutadiene	--	--
Bromomethane	0.53	--
Chloromethane	0.40	--
Styrene	1.64	0.06
1,1,2,2-Tetrachloroethane	0.28	0.09
Tetrachloroethene	0.75	0.10
Toluene	0.99	0.20
1,2,4-Trichlorobenzene	--	--
1,1,1-Trichloroethane	0.62	0.21
1,1,2-Trichloroethane	0.50	--
Trichloroethene	0.45	0.07
1,2,4-Trimethylbenzene	--	--
1,3,5-Trimethylbenzene	--	--
Vinyl Chloride	0.33	0.48
m,p-Xylene	0.76	0.08
o-Xylene	0.57	0.28

<sup>1</sup>Method Detection Limits (MDLs) are defined as the product of the standard deviation of seven replicate analyses and the student's "t" test value for 99% confidence. For Lab #2, the MDLs represent an average over four studies. MDLs are for MS/SCAN for Lab #1 and for MS/SIM for Lab #2.

**TABLE 5. SUMMARY OF EPA DATA ON REPLICATE PRECISION (RP)  
FROM EPA NETWORK OPERATIONS<sup>1</sup>**

Monitoring Compound Identification	EPA's Urban Air Toxics Monitoring Program (UATMP)			EPA's Toxics Air Monitoring Stations (TAMS)		
	%RP	#	ppbv	%RP	#	ppbv
Dichlorodifluoromethane	--		--	13.9	47	0.9
Methylene chloride	16.3	07	4.3	19.4	47	0.6
1,2-Dichloroethane	36.2	31	1.6	--	--	--
1,1,1-Trichloroethane	14.1	44	1.0	10.6	47	2.0
Benzene	12.3	56	1.6	4.4	47	1.5
Trichloroethene	12.8	08	1.3	--	--	--
Toluene	14.7	76	3.1	3.4	47	3.1
Tetrachloroethene	36.2	12	0.8	--	--	--
Chlorobenzene	20.3	21	0.9	--	--	--
Ethylbenzene	14.6	32	0.7	5.4	47	0.5
m-Xylene	14.7	75	4.0	5.3	47	1.5
Styrene	22.8	59 <sup>2</sup>	1.1	8.7	47	0.2 <sup>2</sup>
o-Xylene	--		--	6.0	47	0.5
p-Xylene	--					
1,3-Dichlorobenzene	49.1	06	0.6	--	--	--
1,4-Dichlorobenzene	14.7	14	6.5	--	--	--

<sup>1</sup>Denotes the number of replicate or duplicate analysis used to generate the statistic. The replicate precision is defined as the mean ratio of absolute difference to the average value.

<sup>2</sup>Styrene and o-xylene coelute from the GC column used in UATMP. For the TAMS entries, both values were below detection limits for 18 of 47 replicates and were not included in the calculation.

**TABLE 6. AUDIT ACCURACY (AA) VALUES<sup>1</sup> FOR SELECTED  
COMPENDIUM METHOD TO-14A COMPOUNDS**

Selected Compounds From TO-14A List	FY-88 TAMS AA(%), N=30	FY-88 UATMP AA(%), N=3
Vinyl chloride	4.6	17.9
Bromomethane	--	6.4
Trichlorofluoromethane	6.4	--
Methylene chloride	8.6	31.4
Chloroform	--	4.2
1,2-Dichloroethane	6.8	11.4
1,1,1-Trichloroethane	18.6	11.3
Benzene	10.3	10.1
Carbon tetrachloride	12.4	9.4
1,2-Dichloropropane	--	6.2
Trichloroethene	8.8	5.2
Toluene	8.3	12.5
Tetrachloroethene	6.2	--
Chlorobenzene	10.5	11.7
Ethylbenzene	12.4	12.4
o-Xylene	16.2	21.2

<sup>1</sup>Audit accuracy is defined as the relative difference between the audit measurement result and its nominal value divided by the nominal value. N denotes the number of audits averaged to obtain the audit accuracy value. Information is not available for other TO-14A compounds because they were not present in the audit materials.

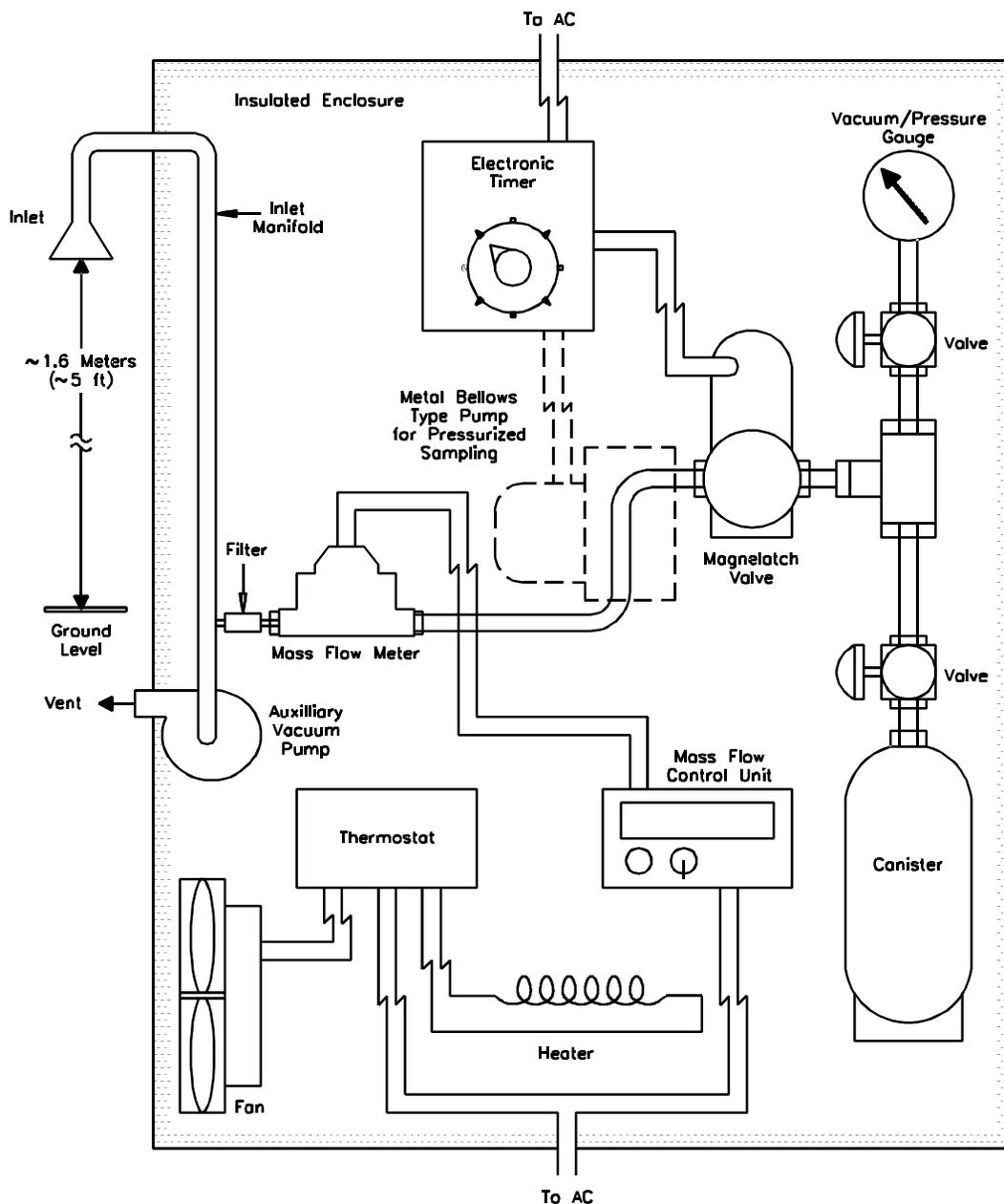
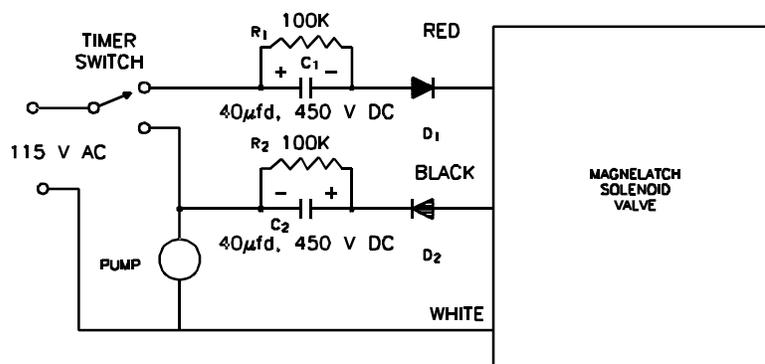
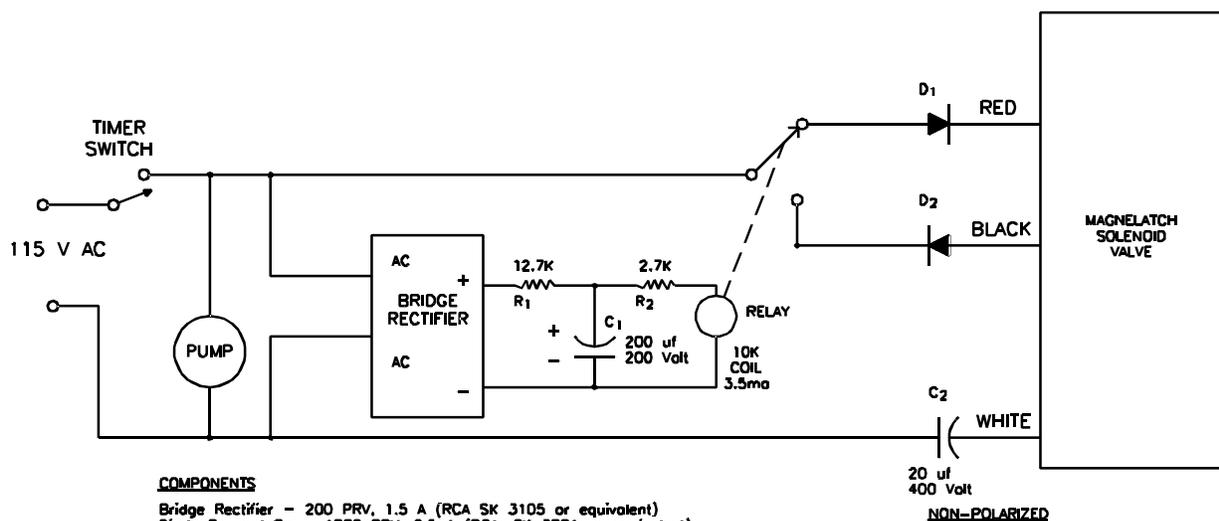


Figure 1. Sampler configuration for subatmospheric pressure or pressurized canister sampling.

**COMPONENTS**

Capacitor C<sub>1</sub> and C<sub>2</sub> - 40 µf, 450 VDC (Sprague Atom TVA 1712 or equivalent)  
 Resistor R<sub>1</sub> and R<sub>2</sub> - 0.5 watt, 5% tolerance  
 Diode D<sub>1</sub> and D<sub>2</sub> - 1000 PRV, 2.5 A (RCA, SK 3061 or equivalent)

(a). Simple Circuit for Operating Magnelatch Valve

**COMPONENTS**

Bridge Rectifier - 200 PRV, 1.5 A (RCA SK 3105 or equivalent)  
 Diode D<sub>1</sub> and D<sub>2</sub> - 1000 PRV, 2.5 A (RCA, SK 3061 or equivalent)  
 Capacitor C<sub>1</sub> - 200 µf, 250 VDC (Sprague Atom TVA 152B or equivalent)  
 Capacitor C<sub>2</sub> - 20 µf, 400 VDC Non-Polarized (Sprague Atom TVAN 1652 or equivalent)  
 Relay - 10,000 ohm coil, 3.5 ma (AMF Potter and Brumfield, KCP 5, or equivalent)  
 Resistor R<sub>1</sub> and R<sub>2</sub> - 0.5 watt, 5% tolerance

(b). Improved Circuit Designed to Handle Power Interruptions

Figure 2. Electrical pulse circuits for driving Skinner magnelatch solenoid valve with mechanical timer.

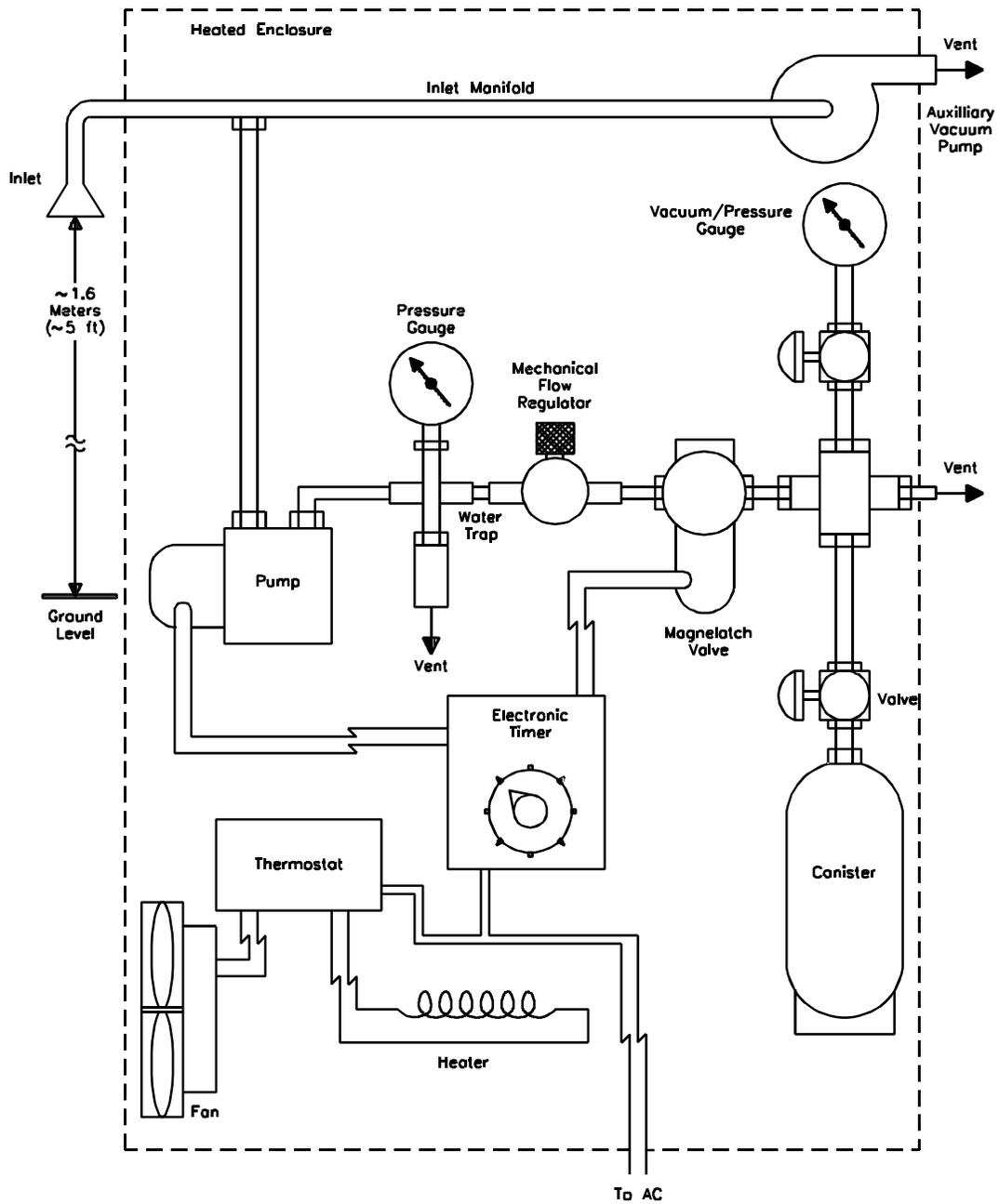


Figure 3. Alternative sampler configuration for pressurized canister sampling.

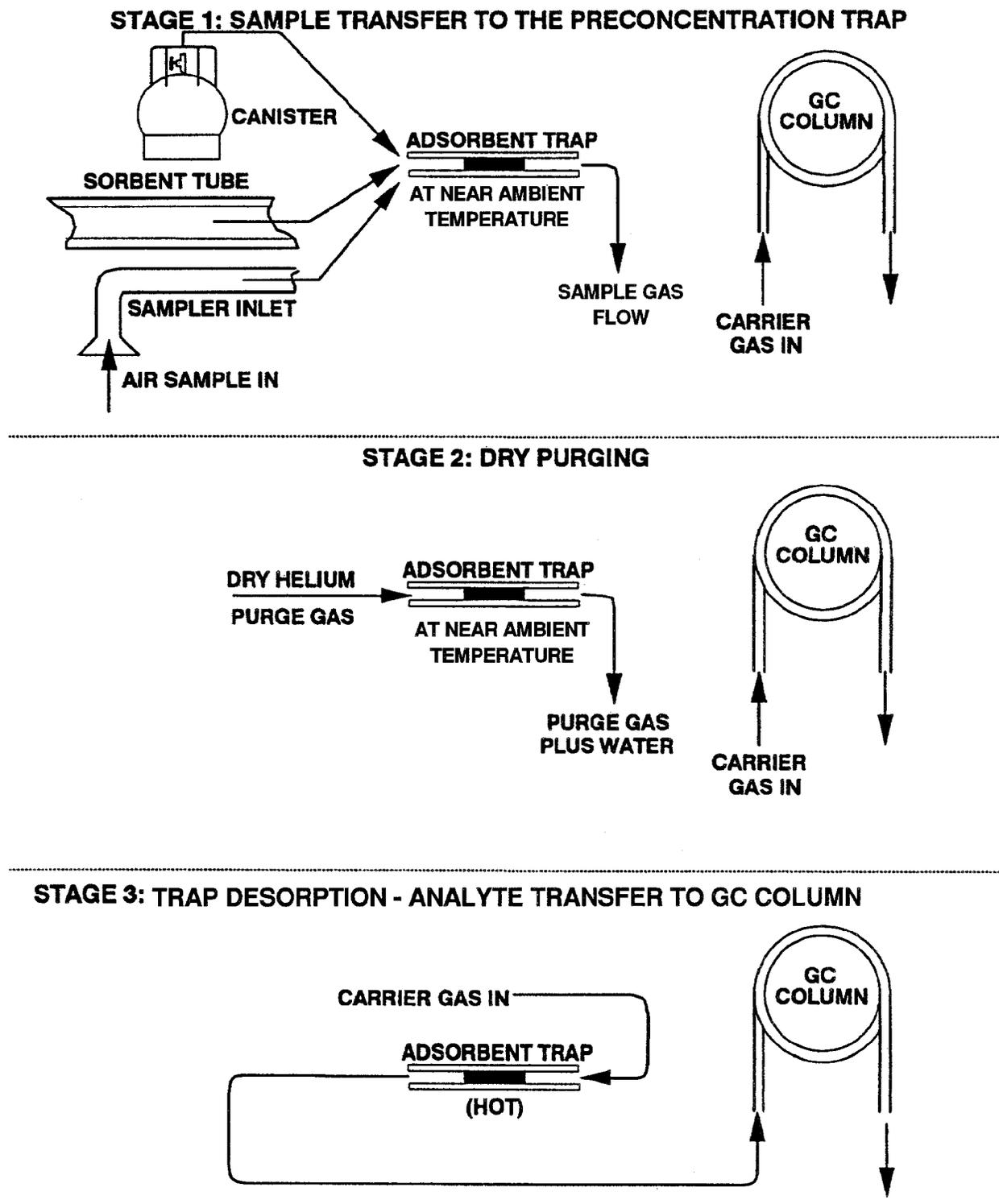


Figure 4. Illustration of three stages of dry purging of adsorbent trap.

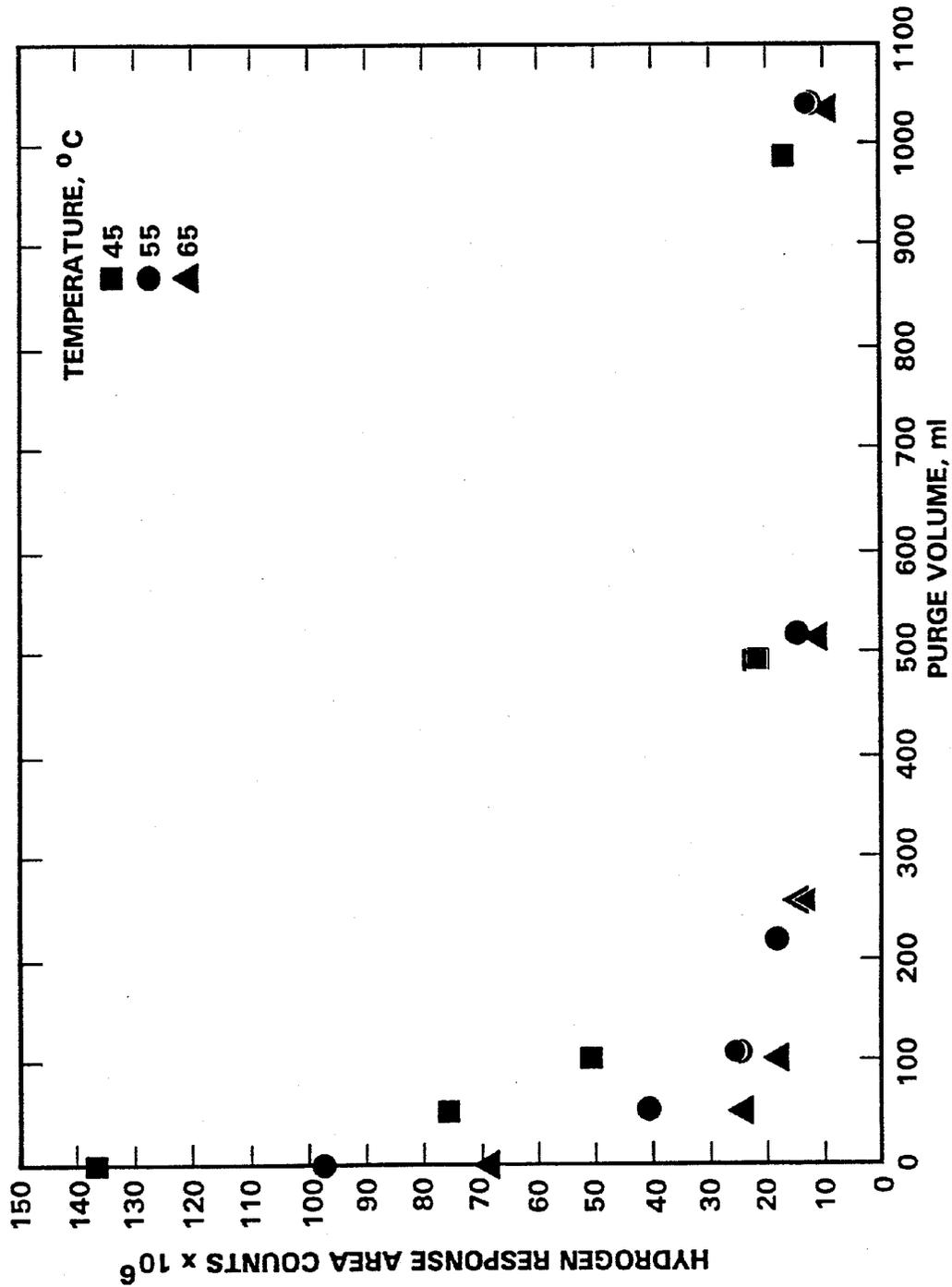


Figure 5. Residual water vapor on VOC concentrator vs. dry He purge volume.

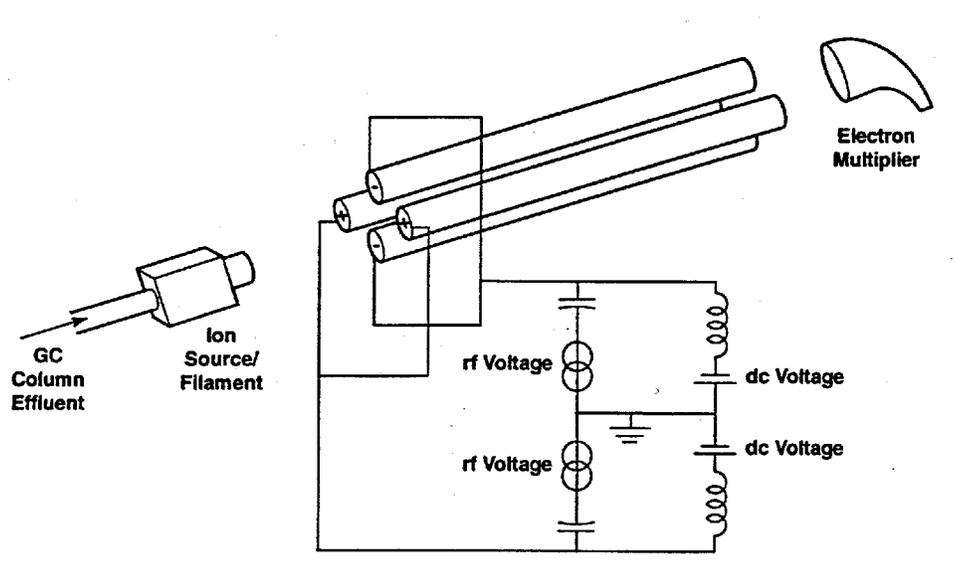


Figure 6. Simplified diagram of a quadrupole mass spectrometer.

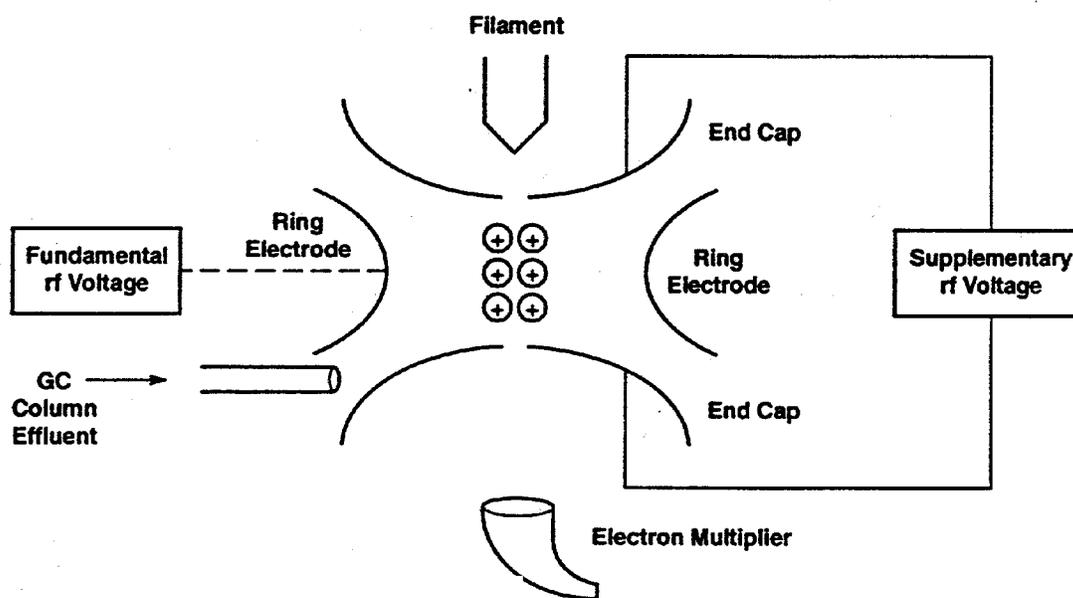


Figure 7. Simplified diagram of an ion trap mass spectrometer.

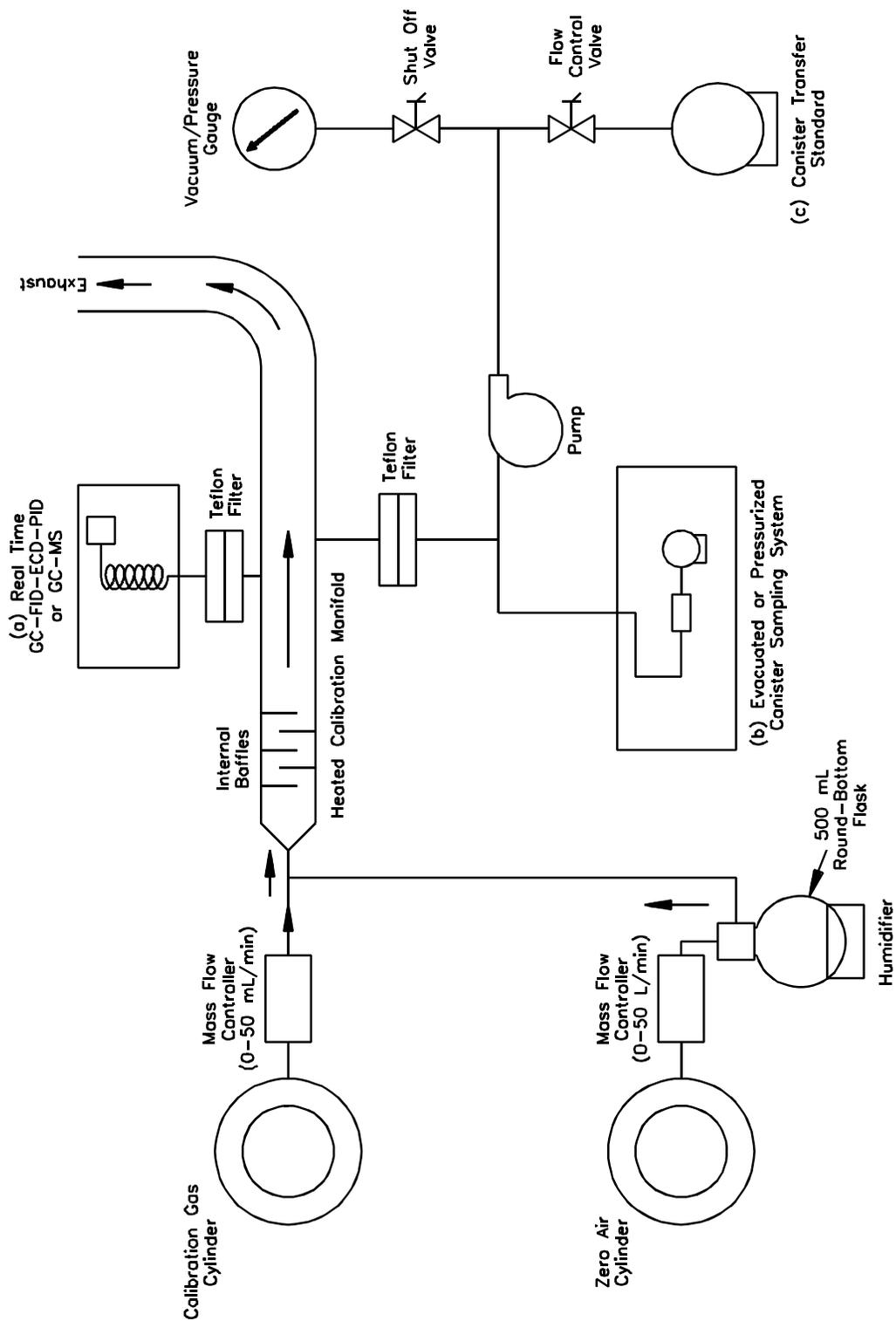


Figure 8. Schematic diagram of calibration system and manifold for (a) analytical system calibration, (b) testing canister sampling system and (c) preparing canister transfer standards.

**COMPENDIUM METHOD TO-15  
CANISTER SAMPLING FIELD TEST DATA SHEET**

**A. GENERAL INFORMATION**

SITE LOCATION: \_\_\_\_\_  
 SITE ADDRESS: \_\_\_\_\_  
 \_\_\_\_\_  
 SAMPLING DATE: \_\_\_\_\_

SHIPPING DATE: \_\_\_\_\_  
 CANISTER SERIAL NO.: \_\_\_\_\_  
 SAMPLER ID: \_\_\_\_\_  
 OPERATOR: \_\_\_\_\_  
 CANISTER LEAK  
 CHECK DATE: \_\_\_\_\_

**B. SAMPLING INFORMATION**

	TEMPERATURE				PRESSURE	
	INTERIOR	AMBIENT	MAXIMUM	MINIMUM	CANISTER PRESSURE	
START						
STOP						

	SAMPLING TIMES	
	LOCAL TIME	ELAPSED TIME METER READING
START		
STOP		

FLOW RATES		
MANIFOLD FLOW RATE	CANISTER FLOW RATE	FLOW CONTROLLER READOUT

SAMPLING SYSTEM CERTIFICATION DATE: \_\_\_\_\_  
 QUARTERLY RECERTIFICATION DATE: \_\_\_\_\_

**C. LABORATORY INFORMATION**

DATA RECEIVED: \_\_\_\_\_  
 RECEIVED BY: \_\_\_\_\_  
 INITIAL PRESSURE: \_\_\_\_\_  
 FINAL PRESSURE: \_\_\_\_\_  
 DILUTION FACTOR: \_\_\_\_\_

ANALYSIS  
 GC-FID-ECD DATE: \_\_\_\_\_  
 GC-MSD-SCAN DATE: \_\_\_\_\_  
 GC-MSD-SIM DATE: \_\_\_\_\_

RESULTS\*: \_\_\_\_\_  
 \_\_\_\_\_  
 GC-FID-ECD: \_\_\_\_\_  
 GC-MSD-SCAN: \_\_\_\_\_  
 GC-MSD-SIM: \_\_\_\_\_

\_\_\_\_\_  
 SIGNATURE/TITLE

Figure 9. Canister sampling field test data sheet (FTDS).

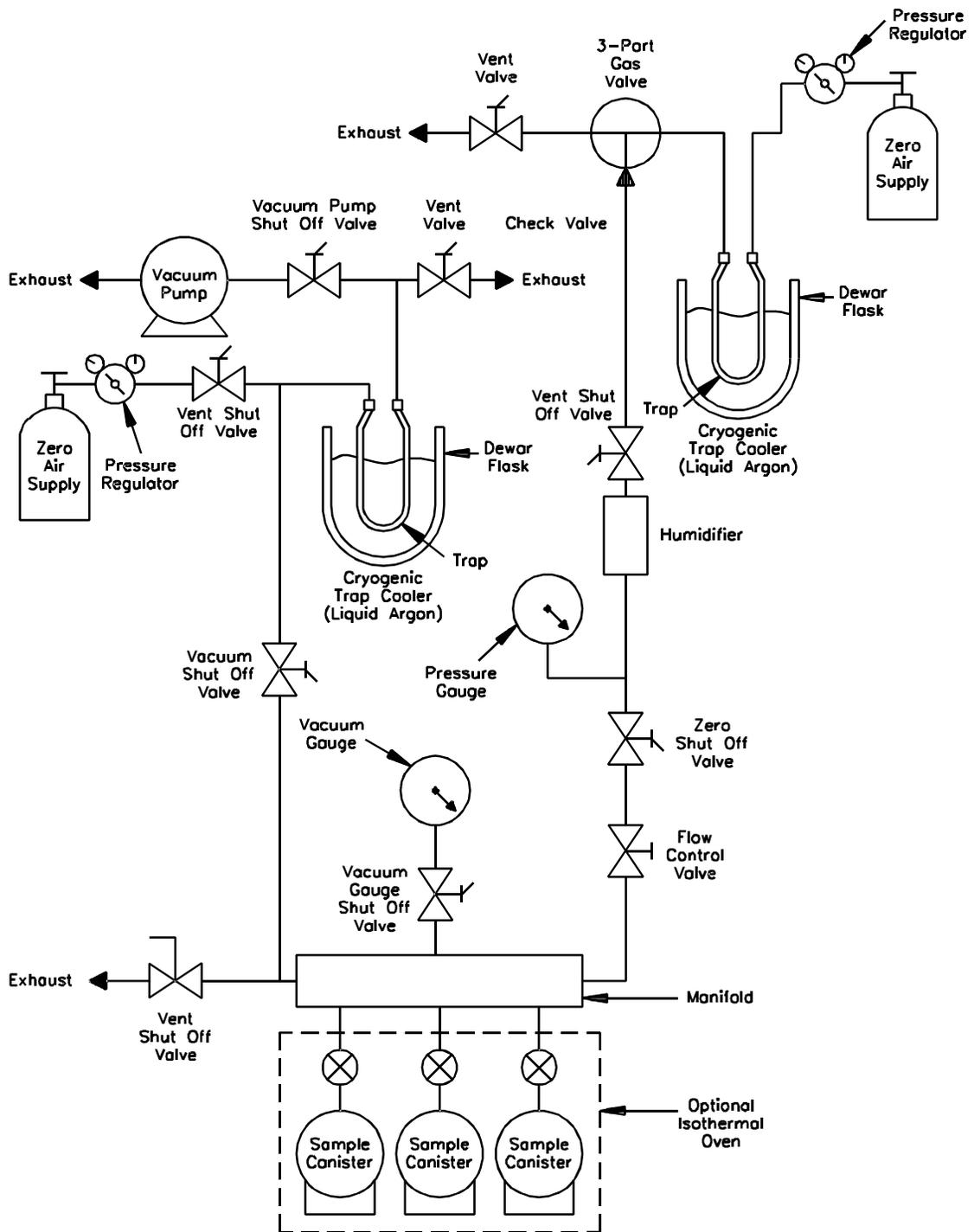


Figure 10. Canister cleaning system.

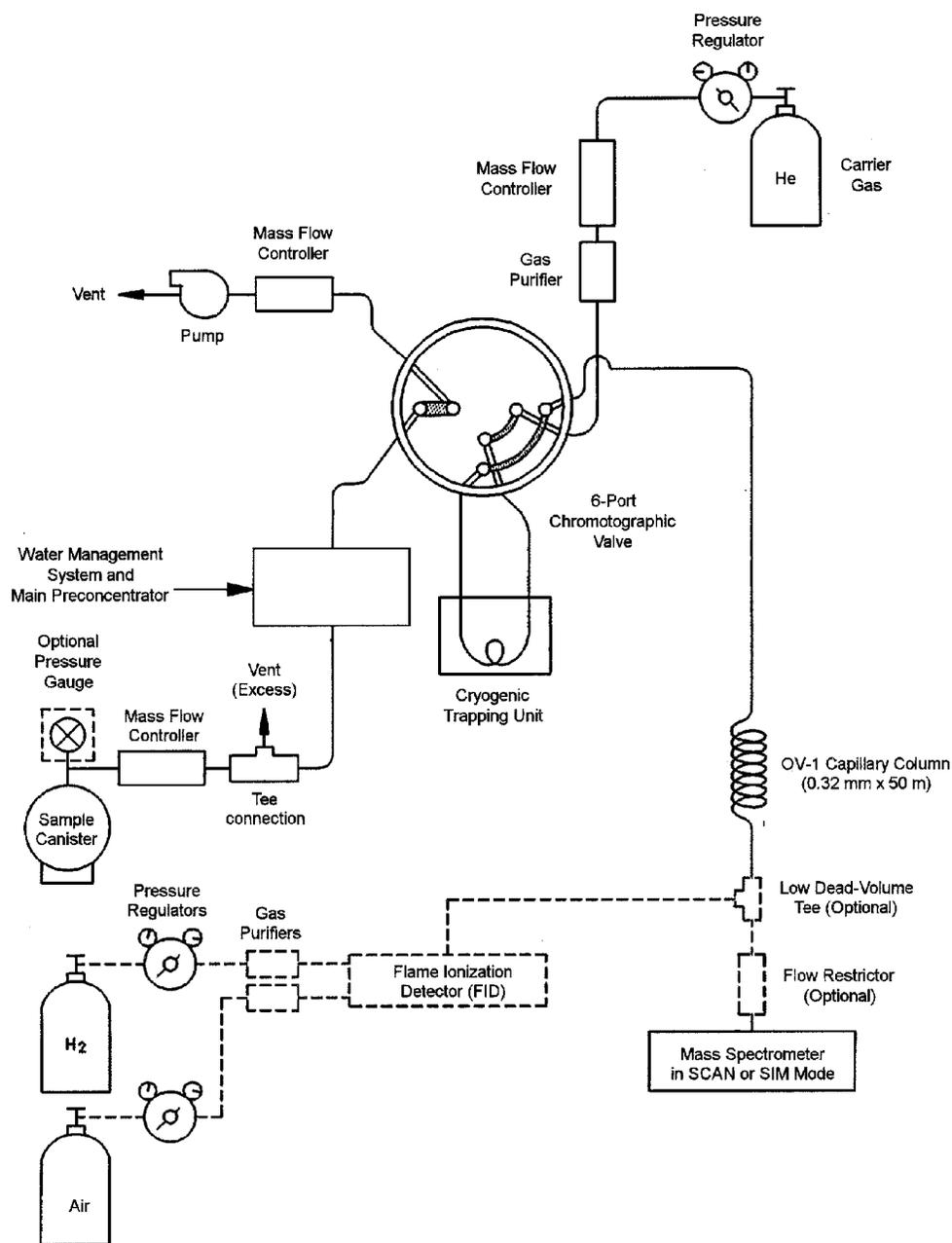
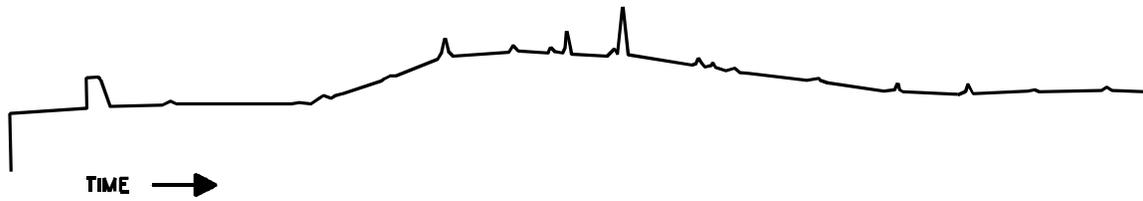
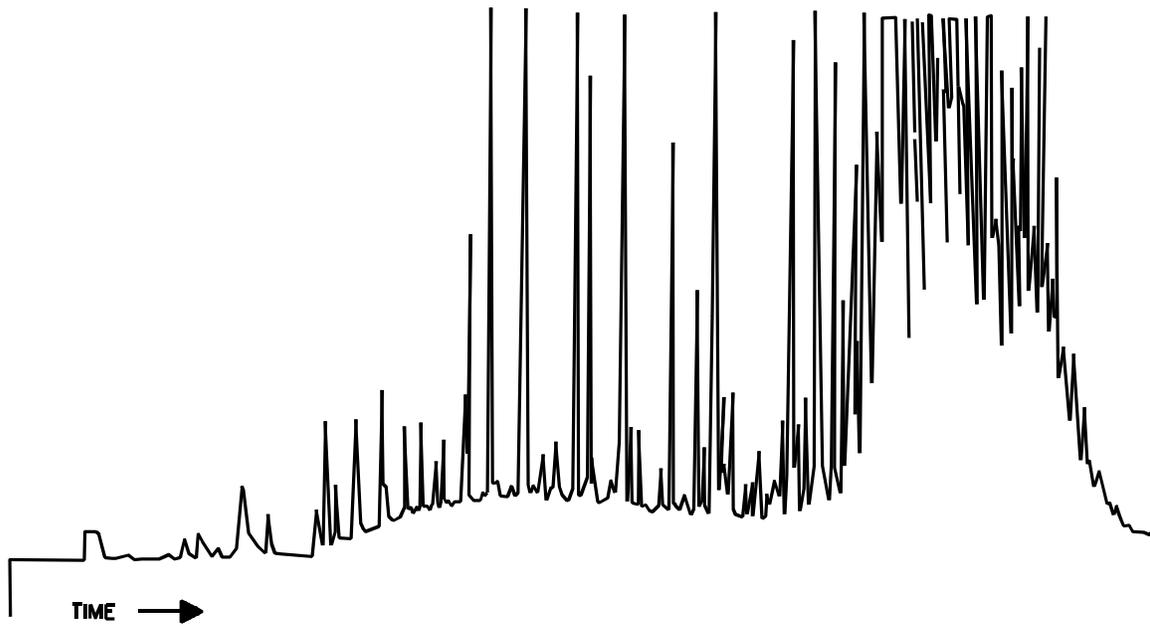


Figure 11. Canister analysis utilizing GC/MS/SCAN/SIM analytical system with optional flame ionization detector with 6-port chromatographic valve in the sample desorption mode.  
[Alternative analytical system illustrated in Figure 16.]



(a). Certified Sampler



(b). Contaminated Sampler

Figure 12. Example of humid zero air test results for a clean sample canister (a) and a contaminated sample canister (b).

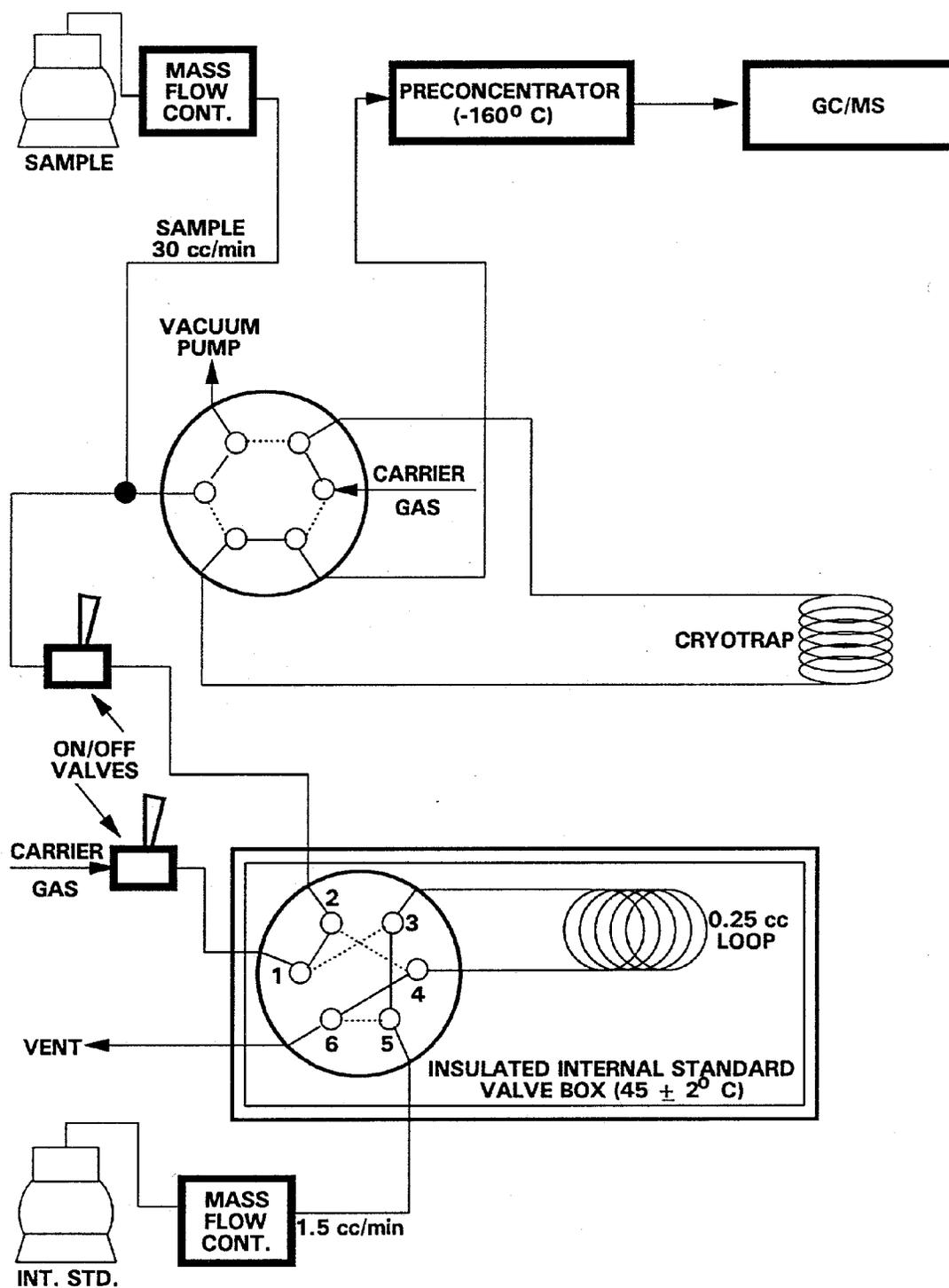


Figure 13. Diagram of design for internal standard addition.

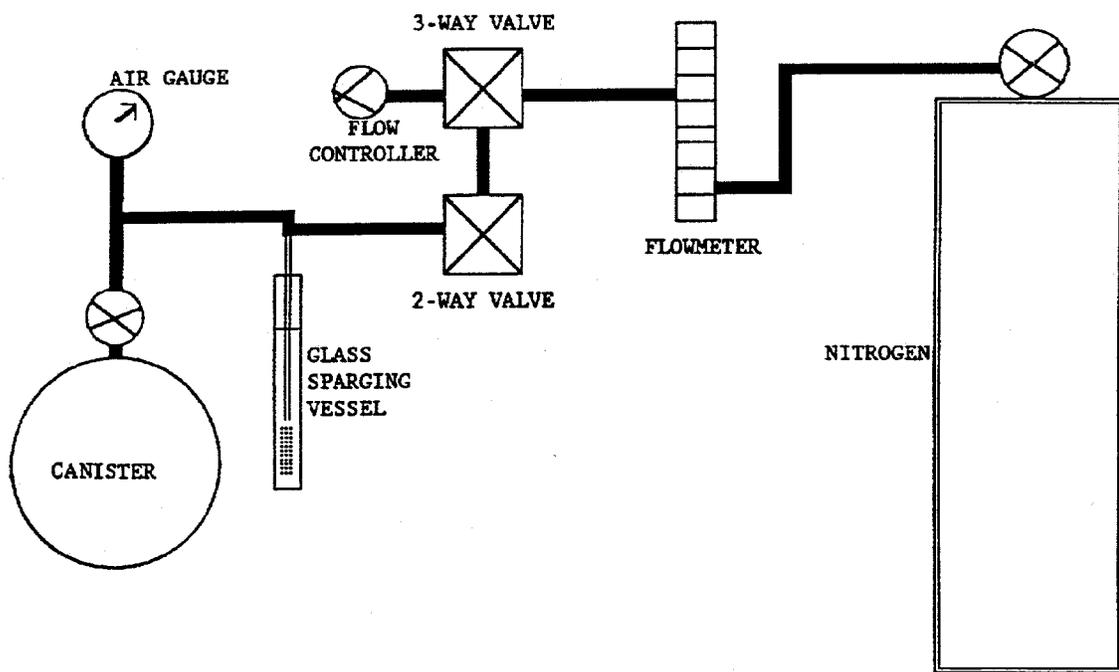


Figure 14. Water method of standard preparation in canisters.

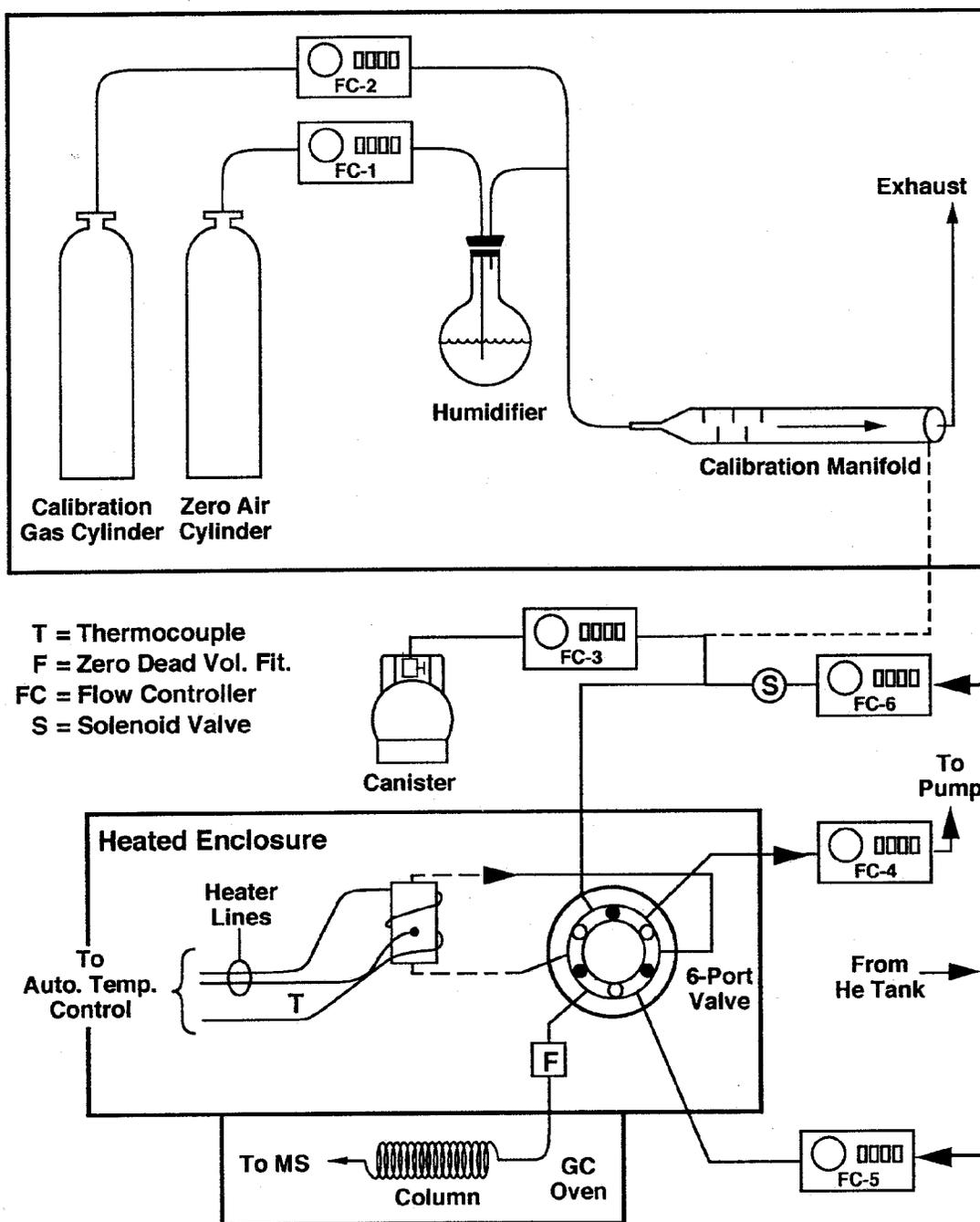


Figure 15. Diagram of the GC/MS analytical system.

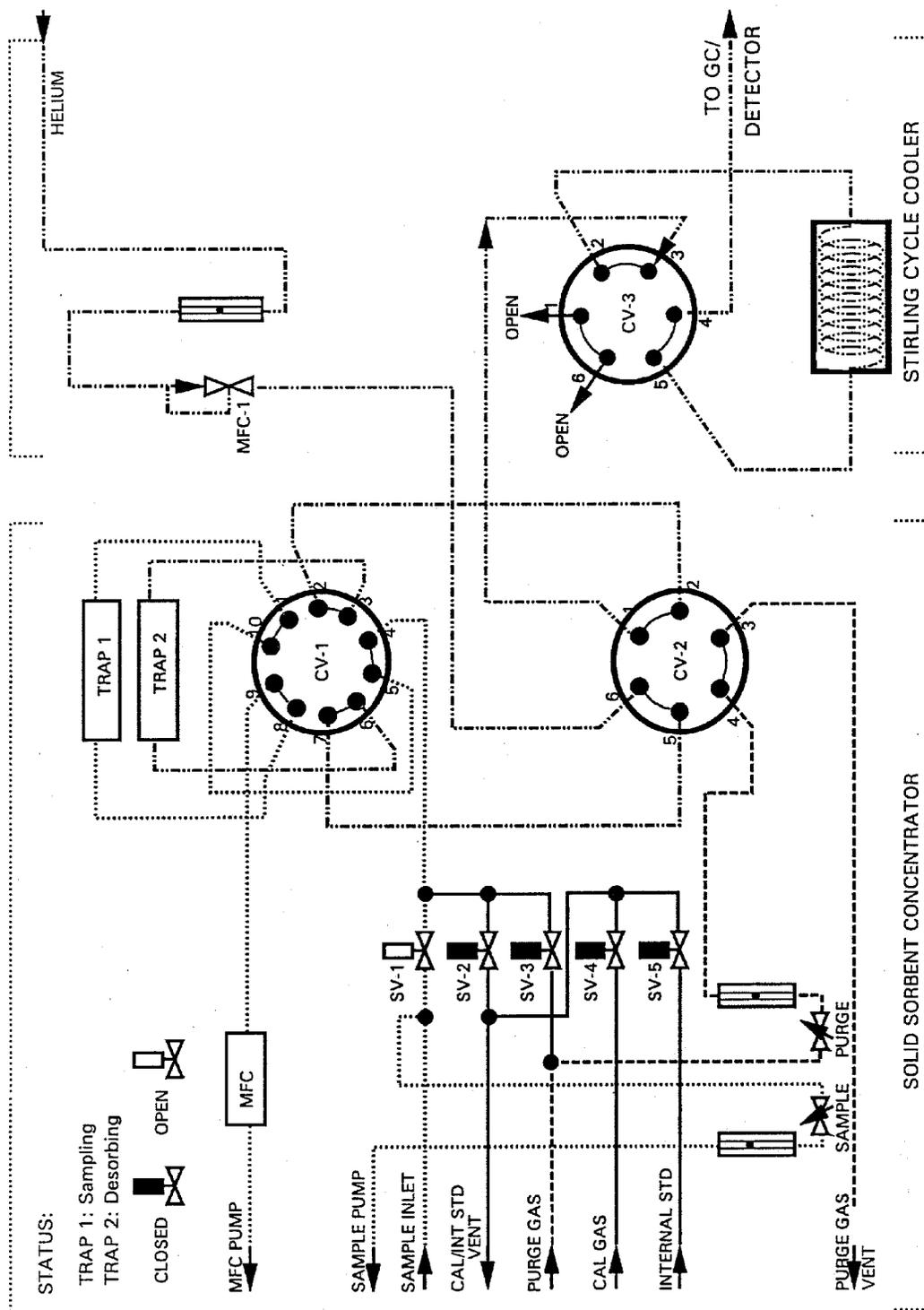


Figure 16. Sample flow diagram of a commercially available concentrator showing the combination of multisorbent tube and cooler (Trap 1 sampling; Trap 2 desorbing).



**ATTACHMENT E**

**STANDARD OPERATING PROCEDURES FOR  
GEOLOGIC/HYDRGEOLOGIC CHARACTERIZATION  
ACTIVITIES**

**ATTACHMENT F**

**RESPONSE TO MDNR COMMENTS (JULIEANN WARREN,  
E-MAIL – 11/22/2002)**

## QAPP Attachment F

### Response to MDNR Comments (Julieann Warren, E-mail – 11/22/2002)

#### **Comment**

*I had a few questions regarding the new signature pages, and Table of content pages, List of Tables, Figures and Distribution list for revised QAPP.*

#### **Comment**

1. *The previous draft QAPP is labeled page x of 98, the one you just sent me electronically including the hard copies of the pages you sent me is labeled page x of 84.*

#### **Response**

The QAPP included as part of this final Work Plan submittal (May 2003) has been revised to correct previous inconsistencies in page numbering, the Table of Contents, List of Tables, Figures and the Distribution List.

#### **Comment**

2. *List of Figures say Figure 5 of COC form, no such form is in the latest version or the previous version.*

#### **Response**

A Chain-of-Custody form is provided in the revised (final) QAPP. As different laboratories are likely to be utilized for the RI/FS, and the laboratory typically provides the COC form, this form or an equivalent will be used.

#### **Comment**

3. *Both the previous and latest version have “Document Distribution Log”, “Document Distribution Record” & “Document Transmittal Record” in the figures section although none are labeled as Figures or listed anywhere in the Table of Contents, List of Tables, Figures or attachments.*

#### **Response**

The Table of Contents has been revised to include and identify these documents as attached Figures.

#### **Comment**

4. *Page 6 of 84 Distribution List, Chuck Hooper is no longer with the Department of Health and Senior Services please change to Gale Carlson and Samuel Rauls is no longer Presiding County Commissioner I don't know the name of the new one but I would find out and put them on the list.*

#### **Response**

The distribution list in the revised (final) QAPP has been amended to identify Mark Mertens as the Presiding Commissioner of Jefferson County and that Gale Carlson replaces Chuck Hooper as the state point of contact to the Missouri Department of Health and Senior Services (DHSS). Rose Basko is also identified as the local contact for the DHSS.

***Comment***

5. *Why isn't the NRC included on the distribution list?*

**Response**

The MDNR is expected to be the lead agency with regard to the RI/FS activities. If the NRC desires to review a specific document, it may request a copy from either MDNR or Westinghouse.

***Comment***

6. *The QAPP needs to be amended to include In-Door Air samples, collection, analytical methods, reporting limits etc.*

**Response**

The RI/FS was revised (see Rev. 0) to state that appropriate in-door air sampling will be conducted according to EPA method, TO-15. That method is provided in the final QAPP.

***Comment***

7. *The QAPP should also be amended to clarify that it covers all activities, including, Time critical removal, interim investigation etc. not just the RI/FS part of the investigation.*

**Response**

The final QAPP includes a statement that it will be utilized for Removal Action activities (time and non-time critical), the Interim Investigation and the RI/FS.

***Comment***

8. *As I had previously commented the QAPP describes the duties of WPM, PM, FS, EHS Manager and QA Manager. But I still don't know who specifically is going to be or is fulfilling these roles. Please identify these people.*

**Response**

Mike Prattke is the Westinghouse Program Manager (WPM) and Kevin Hayes is the Environmental Health and Safety Manager (EHS Manager). The remainder of the roles are expected to be filled by subcontractors to Westinghouse. Those subcontractors have not yet been selected.

**ATTACHMENT G**  
**INTERNAL CLARIFICATIONS AND REVISIONS**

# **QUALITY ASSURANCE PROJECT PLAN**

## **Attachment G**

### **Internal Clarifications and Revisions (From Revision 1.0 to 1.1)**

- 1.) General formatting performed for consistency with RI/FS.
- 2.) Table and Figure names changed or edited to be consistent with table of contents.
- 3.) Page number, table number and figure number changes to table of contents
- 4.) Added the CCOPC fluoride and its analytical method to required sections.
- 5.) Added statement that TPH and Dioxin were applicable to two AOCs only.
- 6.) Added this document as Attachment G.
- 7.) Replaced trade names with generic references.
- 8.) Performed several minor edits to text.
- 9.) Revised distribution list.

**APPENDIX B**  
**Site Safety and Health Plan**

**SITE SAFETY AND HEALTH PLAN**

**Hematite Remedial Investigation/Feasibility  
Study**

**Hematite, Missouri**

Westinghouse Electric Company  
Hematite Missouri Facility  
3300 State Road P  
Hematite, MO 63047

October 2002



# PROCEDURE

## RI/FS Safety and Health Plan

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**Appendix A – Field Team Review Documentation**

**-Medical Data Sheet**

**Appendix B – Hazard Communication Program**

**Appendix C – Activity Hazard Analysis**

## PROCEDURE

### RI/FS Site Safety and Health Plan

---

#### 1.0 INTRODUCTION

This Site Safety and Health Plan (SSHP) has been developed in response to ongoing site characterization and assessment at the Westinghouse Hematite Site.

#### 1.1 Purpose/Objectives

The purpose of this document is to establish standard safety and health procedures for personnel involved in Site work, which involves potential exposure to hazardous, toxic, radiological, or other physical hazards. Project activities should be performed consistent with this SSHP. This SSHP is a working document and is subject to change based on review and the implementation of additional tasks. This document meets the requirements of OSHA 1910.120 and 1926.65, Hazardous Waste Operations and Emergency Response (HAZWOPER) and SNM-33, Hematite Special Nuclear Material License.

This SSHP establishes the safety work practices to help ensure protection of personnel assigned tasks on the Site, the local community, and the environment during Site activities. The objective of this SSHP is to anticipate, identify, evaluate, and control safety and health hazards, in addition to providing emergency response procedures relative to operations conducted at the Site. Specific hazard control methodologies have been evaluated and selected in an effort to minimize the potential for accident or injury.

The levels of personal protection and the procedures specified in this plan are based on the best information available from reference documents and current Site data. Therefore, these recommendations represent the minimum health and safety requirements. Site conditions may warrant a reassessment of protection levels and controls stated. Revisions to the SSHP must have prior approval by the Manager of Environmental Health and Safety

Onsite personnel engaged in characterization activities shall follow designated safety and health procedures, be alert to the hazards associated with working on the Site, and exercise reasonable caution at all times.

#### 1.2 Site Description and Background

A detailed Site description is provided in the RI/FS work plan in section 2.0.

#### 1.3 Contaminants of Concern (COC)

The contaminants of primary concern include radioactive compounds, volatile organic compounds (VOCs) including vinyl chloride, trichloroethylene (TCE), 1,1 – dichloroethane, 1,2 – perchloroethylene, 1,1,1 – trichloroethane, and. The principal radioactive compounds were thorium-232 and uranium. Uranium enrichment varies from depleted to natural, to fully enriched uranium.

## **2.0 HEALTH AND SAFETY ORGANIZATION**

This section presents the major roles and responsibilities of health and safety personnel assigned to work on this project.

### **2.1 General**

Operations and personnel having the potential for exposure to Site hazards associated with characterization are subject to this SSHP. Work should not be performed in a manner that conflicts with the intent of, or the inherent safety, health or environmental precautions expressed in this plan. After due warnings, personnel violating health and safety procedures will be dismissed from the Site. The individual's supervisor should take appropriate disciplinary action.

#### *2.1.1 Project Director*

The Project Director (PD) is ultimately responsible for oversight of project personnel involved in D&D activities to assure they comply with all health and safety requirements. The Project Director will:

- Oversee the Project Managers in planning, organizing, directing, and controlling project activities in a manner that safeguards all employees.
- Oversee the ES&H Manager to ensure all applicable ES&H rules, plans, instructions, and procedures are compliant.
- Approve incident reports and root cause analysis.
- Provide liaison with the client, the public, and regulators on safety and health issues, with special emphasis on license termination issues.

#### *2.1.2 Project Manager*

The D&D Project Manager and the Environmental Project Manager have primary responsibility for the health and safety of project personnel. The Project Managers are specifically responsible for:

- Coordinating activities with the ES&H Manager as they relate to planning, organizing, directing, and controlling project activities in a manner that meets the requirements of this Plan.
- Allocating the necessary time and resources to assure that the health and safety of project personnel takes precedence over the expediency of work activities.

## PROCEDURE

### RI/FS Site Safety and Health Plan

---

- Approving work packages, Enhanced Work Plans (EWP), and procedures.
- Performing formal and informal site inspections.
- Reviewing incident reports, and generating them as necessary.
- Ensuring OSHA and other regulatory requirements are being met or exceeded.
- Ensuring employees are adequately trained to the degree necessary to safely complete their assigned tasks.
- Ensuring the EWPs have the proper level of review.
- Ensuring pre-job briefings for D&D tasks are conducted and documented.
- Ensuring that safety equipment is adequate and serviceable.
- Ensuring that proper training is conducted to assure the health and safety of the workforce.
- Ensuring engineering, administrative, and/or Personal Protective Equipment (PPE) controls to mitigate hazards to personnel are adequate and implemented.
- Specify proper levels of PPE according to the specifications of this SSHP.

#### *2.1.3 Environment, Health and Safety Manager*

The Environment, Health, and Safety Manager (EH&S manager) is responsible for the acceptance and approval of SSHPs. The EH&S Manager has the authority to shut down any operation that he feels jeopardizes the health and safety of Site personnel, the environment or local personnel: No hazardous, toxic or radioactive waste (HTRW) activities should commence without written acceptance of the SSHP, from the EH&S manager. Additionally the EHS manager should:

- Ensure that the SSHP complies with federal, state, and local health and safety requirements. If necessary, modify specific aspects of the SSHP to adjust for on Site changes that affect safety.
- Evaluate and authorize changes to the SSHP.
- Implementation and oversight of the Health and Safety Program.
- Ensure that necessary numbers of trained personnel are available
- Provide sufficient training resources to meet the project staffing requirements.

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- Ensure routine safety inspections are performed.
- Ensure training of employees in Site-specific hazards, collecting and retaining of necessary training documents.
- Providing liaison with the client, the public, and the regulators on safety and health issues.
- Ensure accidents/incidents and "near misses" are investigated.
- Specify proper levels of PPE according to the specifications of this SSHP

#### *2.1.4 Radiation Safety Officer*

The Radiation Safety Officer (RSO) assists the ES&H manager in implementation of the SSHP. The RSO provides direct oversight and health and safety support of field staff ensuring that personnel adhere to the requirements of this SSHP. The RSO has the following additional responsibilities:

- Coordinate with the PM, and EHS manager in developing the SSHP for Site-specific projects. Specific projects that pose health and safety issues would typically be performed using the radiation work permit system (RWP).
- Coordinate with the EHS manager and FS for field implementation of the SSHP.
- Provide consultation to the field staff on matters pertaining to safety and radiation protection.
- Ensuring compliance with applicable regulations, procedures and license conditions concerning the handling and transportation of radioactive and hazardous material.

#### *2.1.5 Field Supervisor*

The Field Supervisor (FS) is responsible for supervising field implementation of the project. The FS provides supervision of field staff and is responsible for ensuring that personnel adhere to the requirements of the SSHP.

#### *2.1.6 Health and Safety Specialist / Health Physics Technicians*

The Health and Safety Specialist / Health Physics Technicians (HPT) provide day-to-day support of the field operations. They have the following responsibilities:

- Coordinate and participate in task specific safety analysis.
- Monitor the implementation of RWPs

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- Implement all SSHP policies and procedures.
- Set up and take down control areas as needed
- Monitor on site hazards and conditions, including environmental monitoring.
- Perform air sampling as needed
- Survey equipment for radioactivity before leaving the Site as needed
- Issue PPE and personal monitoring equipment and devices
- Ensure survey instruments are calibrated

#### *2.1.7 Personnel Assigned to the Project*

Each individual working at the Site is ultimately responsible for his or her own health and safety while working on this project.

Taking reasonable precautions to prevent injury to themselves and to their fellow employees and being alert to potentially harmful situations are primary responsibilities. Site personnel should be responsible for:

- Performing only tasks that they can do safely and in which they have been trained.
- Notify the FS of special medical conditions (i.e. allergies, contact lenses, etc.).
- Notify the FS of prescription and/or non-prescription medication the worker may be taking that might cause drowsiness, anxiety or other unfavorable affects.
- Preventing spillage and splashing of materials to the greatest extent possible.
- Practicing good housekeeping by keeping the work area neat, clean, and orderly.
- Immediately reporting injuries to the FS. .
- Complying with the SSHP and health and safety recommendations and precautions, properly using the PPE.



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### KEY PERSONNEL

TITLE	NAME	TELEPHONE
Westinghouse Project Director	Mr. Thomas Dent	(636) 937-4691 x368
Environmental Project Manager	TBA	
D&D Project Manager	Mr. Phillip Malich	(636) 937-4691 x353
EH&S Manager	Mr. Kevin R. Hayes	(636) 937-4691 x464
Field Supervisors	TBA	
Health Physics Technicians	TBA	
Radiation Safety Officer (RSO)	Mr. Cort Horton	(636) 937-4691 x327

### 3.0 TASK HAZARD/RISK ANALYSIS

Potential exposure to Site contaminants during an initial Site review is expected to be minimal. The EHS manager will make final determination of PPE levels prior to start of Site preparation and survey activities.

#### 3.1 Tasks to be Performed

	<u>Key Task</u>	<u>Initial Level Protection</u>
3.1.1	<i>Gamma Walkover Survey</i>	<i>Level D</i>
3.1.2	<i>Monitoring Well Installation</i>	<i>Level D</i>
3.1.3	<i>Groundwater Sampling</i>	<i>Level D</i>
3.1.4	<i>Field Screening of soils</i>	<i>Level D</i>
3.1.5	<i>Shallow Overburden Groundwater monitoring</i>	<i>Level D</i>
3.1.6	<i>Field Sample Collection</i>	<i>Level D</i>

#### 3.2 Chemical Contaminants of Concern

The objective of this investigation is to further evaluate sources and extent of chemicals in soil, groundwater, surface water and sediment at the Site. Based on previous investigations, VOCs may exist as chemical hazards in surface and subsurface soil, sediments, surface water and groundwater. Potential chemical hazards, as identified in section 1.3, associated with compounds are discussed below.

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#### 3.2.1 *Volatile Organic Compounds (VOCs)*

Exposure to the VOC vapors above their respective OSHA permissible exposure limits (PELs) may produce irritation of the mucous membranes of the upper respiratory tract, nose and mouth. Overexposure may also result in the depression of the central nervous system. Symptoms of such exposure include drowsiness, headache, fatigue and drunken-like behavior.

The vapor pressures of these compounds are high enough to generate significant quantities of airborne vapor. On sites where high concentrations of these compounds are present, a potential inhalation hazard to the field team during subsurface investigations can result. However, if the Site is open and the anticipated quantities of VOC contamination are minimal (i.e., part per million concentrations in the soil or groundwater), overexposure potential will also be minimal. The burial pits may contain additional hazards not identified previously. Invasive sampling in this area should be evaluated on a case by case basis.

### 3.3 Radiological Hazards

Elevated concentrations of uranium, thorium and technetium have been identified in Site soils and ground water during past investigations. The primary radiological hazard associated with these radionuclides is inhalation exposure, although ingestion and direct radiation are of potential concern. Minimal air monitoring will be undertaken, as determined by the HPTs, to assess potential for radiological exposure to project personnel. Respiratory protection will not be required for the clearing of the Site or conducting the gamma and civil surveys, unless air-monitoring results indicate such is necessary. If required respiratory protection will be in accordance with the Westinghouse program. Shoe covers, overboots, or similar, should be worn to prevent contamination of footwear. In addition, an alpha scintillation detector will be used to monitor personnel for contamination if required by the HPT or RWP. Based on previous investigations and known or expected radiation and contamination levels it is unlikely that any individual would receive a dose in excess of 10% of the 10 CFR 20 limits for occupational dose. As such monitoring is not required by regulation.

### 3.4 Physical Hazard Identification

Physical hazards that may be encountered during field activities include temperature extremes, slips/trips/falls, hand/foot/back injuries, use of power tools, etc. (see sec 10.3)

### 3.5 Biological Hazard Identification

Biological hazards that may be encountered in the field include poisonous plants, wild and/or rabid animals, snakes and insects.

### 3.6 Hazard Communication

In order to comply with the OSHA Hazard Communication Standard 29 CFR 1910.1200 (HCS), the following should apply to commercial products containing hazardous substances brought on Site:

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- Hazardous materials brought on Site shall comply with the requirements of the contractors hazard communication program. This program is available to Site personnel.
- Material Safety Data Sheets (MSDS) will be maintained for each hazardous product used on Site and project personnel informed of the hazards and the location of the MSDS;
- Containers not supplied with adequate hazard labeling shall have a hazard communication label affixed to the container displaying the health and physical hazards of the material;
- Employees working with hazardous substances shall be trained in accordance with the requirements of 29 CFR 1910.1200;
- An inventory of hazardous substances used Site related to this project will be maintained;
- Contractors are required to provide MSDSs to Westinghouse for hazardous material brought on Site.

#### **3.7 Electrical Hazards**

- Portable electrical equipment will be double insulated or grounded and connected through a ground fault circuit interrupter.
- Conductive materials (drill rigs, backhoes, cranes, etc.) will be kept clear of energized power lines. The following distances will be observed; 0-50 kV - 10 feet; 51-100 kV - 12 feet; 101-200 kV - 15 feet; 201-300 kV - 20 feet; 301-500 kV - 25 feet; 501-750 kV - 35 feet; 751-1000 kV - 45 feet.

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#### 4.0 TRAINING REQUIREMENTS

This section provides a description of training requirements for personnel assigned to conduct work at this Site.

#### 4.1 General

Personnel assigned to or regularly entering and performing work on the project Site will have received the required minimum HTRW training required in 29 CFR 1910.120 (e) and 10 CFR 19. In addition, other specific training requirements as required by applicable sections of 29 CFR 1910 and 1926 shall have been completed prior to commencement of the particular Site task. Training will be commensurate with the risks of the tasks performed and consistent with Westinghouse's training programs and procedures.

##### *4.1.1 Basic OSHA Training*

General Site workers should have the 40-hour Hazardous Waste operations and Emergency Response (HAZWOPER) training course and 3 days of documented field experience under the direct supervision of a trained experienced supervisor. Site management personnel (field supervisor) must have an additional 8 hours of specialized supervisory training. Workers must have an annual refresher (8 hours) if initial training is over 1 year old. Copies of training certificates should be readily available for review. Where there is potential exposure to contaminants with specific OSHA training requirement such as asbestos, lead, arsenic or beryllium, documentation of training is required.

##### *4.1.2 First Aid and CPR Training*

At least two employees will be certified in First Aid and CPR. The training should be equivalent to that provided by the American Red Cross. These individuals will be Site at times during which project activities are in progress.

##### *4.1.3 Site Specific Safety and Health Training*

Site-specific health and safety training will be conducted prior to field activities. The designated EHS manager will review the SSHP, work plan and other associated responsibilities with other field team members and afford them the opportunity to ask any questions. A record of this training will be maintained by the EHS manager.

##### *4.1.4 Bloodborne Pathogen (BBP) Training*

Any person who has received first aid and/or CPR, and who may need to provide emergency service to an injured/unconscious co-worker should have received awareness level training in controlling exposures to Bloodborne Pathogens (BBP). This training will consist of the following:

- Review of the bloodborne pathogen standards;

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- Requirements of the Exposure Control Plan;
- Description of the risks of exposure and how BBP are transmitted;
- Methods of protection against exposure and procedures for decontamination;
- Post-exposure procedures.

#### *4.1.5 Hearing Conservation Training*

Hearing conservation training will be provided to all personnel that require hearing protection. During drilling activities drill rigs and use of other powered equipment is likely. Such equipment generally will produce sound levels greater than 85 dBA. Hearing protection will be required where exposure may occur for several hours during the day. For individuals with documented threshold shifts, use of hearing protection is mandatory whenever powered equipment or other devices are used which produce sound levels over 85 dBA.

Casing insertion will likely generate sound levels greater than 85 dBA requiring the use of hearing protection during this activity.

#### *4.1.6 Radiation Worker Training*

Radiation worker training will be required by the EHS manager if deemed necessary. Training requirements and content will be determined by the EHS manager and will be consistent with Site radiation protection policy.

#### *4.1.7 Respiratory Protection Training*

In accordance with OSHA 29 CFR 1910 and NRC 10 CFR 20, Site personnel required to use respiratory protection devices will have received equipment specific training consistent with the Westinghouse program.

#### *4.1.8 Personal Protective Equipment*

In accordance with OSHA 29 CFR 1910, Subpart I (Personal Protective Equipment) personal protective equipment will be provided, used and maintained in a sanitary and reliable condition. Personal protective equipment (PPE) will be of construction, design, and material to provide employees protection against known or anticipated hazards. PPE will be selected which properly and appropriately fits the employee. Personnel shall be provided with training on the selection, use, and limitations of PPE in accordance with the standard. Any concerns regarding the use of appropriate PPE will be brought to the attention of the EHS manager. The contract supervisor is responsible for ensuring that necessary PPE is available on site.

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#### **4.2 Daily Safety Meetings**

Daily safety meetings should be conducted to review the day's work plan, associated activities, and any anticipated hazards. Names and topics should be documented and maintained on file.

#### **5.0 MEDICAL SURVEILLANCE PROGRAM**

##### **5.1 Medical Support Functions**

Medical Surveillance in compliance with OSHA 29 CFR 1910.120 (f) is required for personnel who will be involved in Site activities. The Field Supervisor or designee will ensure that project personnel are medically cleared for the anticipated duties. Documents that should be made available are the employee's most recent medical clearance and respirator clearance forms.

###### *5.1.1 Medical Surveillance Program*

The purpose of the medical surveillance program is to ensure suitable job placement of employees, to monitor potential health effects of hazards encountered in the work place, and to maintain and promote good health through preventative measures. Personnel assigned to work on the Site, shall provide documentation to the EHS manager demonstrating compliance with the medical surveillance requirements of 1910.120.

##### **5.2 First Aid**

At a minimum, a 16-unit first aid kit should be maintained on Site or in the Site vehicle. When an eye hazard to hazardous materials exists, a portable eyewash capable of providing 15 minutes of eye flushing should be available on Site. Any employee who becomes ill resulting from possible exposure to Site hazards should immediately notify the EHS manager or FS who will make immediate arrangements for medical consultation.

##### **5.3 Hospitals**

Routes and telephone numbers to hospitals are provided in Section 11.5 of this plan.

#### **6.0 SITE CONTROL**

##### **6.1 Control Zone (CZ)**

Control zones if necessary will be determined by the HPTs and/or the EHS Manager and will be cordoned off with caution tape or other demarcation. Only authorized personnel will be allowed access to the CZ. The HPTs will ensure that appropriate monitoring equipment is available at the CZ and that it is calibrated and operational checked. Work within the CZ is typically performed under an RWP that provide the explicit conditions of work, entry and exit.

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## 7.0 AIR MONITORING PLAN

### 7.1 Total organic vapor monitoring

Monitoring of organic vapors using a photoionization detector (PID) or flame ionization detector (FID) will be performed during intrusive operations where chemical compounds are likely to be encountered. Colorimetric indicator tubes will be used to detect the presence of benzene whenever total organic vapors in the worker's breathing zone reach or exceed 0.035 ppm. If colorimetric indicator tubes provide benzene results of 0.5 ppm or higher, consideration will be given to air monitoring with pump and charcoal tube. Organic vapor air monitoring will be conducted in the breathing zone every thirty minutes during intrusive operations.

Note: The PID operates on the basis of ionization of the contaminant, which results in a meter deflection proportional to the concentration of the contaminant. In the PID, ionization is caused by a UV light source. The strength of the UV, measured in electron volts (eV), determines which contaminants can be ionized. Most PID instruments can use three different strength light sources, including 9.6, 10.6, and 11.7 eV; only the 10.2 eV probe is available for this project. Daily calibration and maintenance will be performed in accordance with the manufacturer's instructions. The table below lists the volatile contaminants for which analyses were performed at the Site, and whether they can be detected using a PID with a 10.6 eV source. Although some semi-volatile organic compounds can be detected with a PID, it is unlikely they would become airborne and therefore are not included in the list.

<b>Volatile Organic Compounds</b>	<b>Detectable by PID - 10.6 eV source</b>
Vinyl Chloride	Yes
Carbon Disulfide	Yes
1,1-dichloroethane	No
1,2-dichloroethane	No
Trichloroethylene	Yes
Ethyl benzene	Yes
Chloroethane	No
Benzene	Yes
Toluene	Yes
Total Xylenes	Yes

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#### **7.2 Radiological air monitoring**

The Site maintains three boundary air samplers for monitoring gross alpha activity in air. Additional air sampling using fixed position or personal Lapel Air Samplers (LAS) may be used as directed by the PHP. Based on the low concentrations of radioactive material in the environment around the plant and the relative stable nature of the material, air monitoring should not be required.

#### **7.3 Dust monitoring**

Since metals were not detected to any great extent, dust monitoring will not be required during intrusive activities.

#### **7.4 Monitoring for Combustible gases or vapors**

Monitoring for combustible gases or vapors are not expected to be needed for this work effort.

#### **7.5 Frequency of monitoring and calibration**

Monitoring equipment, when used, will be calibrated at the beginning of each day in accordance with the procedures and frequency provided by the equipment manufacturers.

### **8.0 PERSONAL PROTECTIVE EQUIPMENT AND ACTION LEVELS**

Personnel performing operations Site shall be required to use the appropriate level of protection. The anticipated levels of PPE for Site activities are presented in this Section. The EHS Manager will make the final determination for PPE levels based on encountered Site conditions and activities.

#### **8.1 Level D Protection**

Level D protection will be required for Site activities. Level D protection is as follows:

- Coveralls or long sleeve shirts and long pants, unless otherwise directed by the EHS Manager.
- Outer nitrile gloves for hazardous material handling activities. Inner latex surgical gloves are recommended where practical.
- Leather boots.
- Hard Hat when working with drilling equipment.
- Safety Glasses.

Other personal protection that must be readily available for use, if necessary, includes the following:

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- Disposable outer boots.
- Hearing protection.
- Chemical-resistant gloves.

#### 8.2 Level C Protection

Work activities involving level C protection are not expected however, sustained PID readings of 10 to 500 ppm (1-50 ppm if benzene is detected) above background will require Level C protection consisting of:

- Full-face air purifying respirator equipped with appropriate organic vapor/dust canisters or cartridges.
- Chemical-resistant clothing such as Tyvek©, Poly-coated Tyvek© or Saranex©, suits will be one piece with hoods, booties and elastic wristbands.
- Outer nitrile gloves and inner latex surgical gloves.
- Leather boots with rubber overboots.
- Hard Hats.
- Safety Glasses.

Other personal protection that must be readily available for use, if necessary, includes the following:

- Coveralls.
- Disposable outer boots.
- Escape mask.
- Face shield.
- Hearing protection.
- Water-resistant tape.

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## 9.0 DECONTAMINATION

### 9.1 Decontamination

The need for decontamination is anticipated to be minimal. Disposable booties or other required PPE will be surveyed as directed by RWPs utilizing an alpha detector for radiological contamination. Equipment, PPE or personal contamination can be removed with soap and water.

Personnel should utilize handi-wipes or equivalent to practice good personal hygiene practices, washing hands and other exposed skin prior to eating. Table 1 provides the SNM-33 limits for free release of contaminated items.

*Table 1*

<b>Nuclides<sup>a</sup></b>	<b>Average<sup>bcd</sup></b>	<b>Maximum<sup>bde</sup></b>	<b>Removable<sup>bdf</sup></b>
U-nat, U-235, U-238 and associated decay products	5,000 $\alpha$ dpm/100 cm <sup>2</sup>	15,000 $\alpha$ dpm/100 cm <sup>2</sup>	1,000 $\alpha$ dpm/100 cm <sup>2</sup>
Th-nat	1,000 dpm/100 cm <sup>2</sup>	3,000 dpm/100 cm <sup>2</sup>	200 dpm/100 cm <sup>2</sup>
Beta/gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm/100 cm <sup>2</sup>	15,000 dpm/100 cm <sup>2</sup>	1,000 dpm/100 cm <sup>2</sup>

Table Notes:

<sup>a</sup> Where surface contamination by both alpha and beta/gamma emitting radionuclides exists, the limits established for both alpha and beta/gamma emitting nuclides should apply independently.

<sup>b</sup> As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

<sup>c</sup> Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

<sup>d</sup> The average and maximum radiation levels associated with surface contamination resulting from beta/gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

<sup>e</sup> The maximum contamination level applies to an area not more than 100 cm<sup>2</sup>.

<sup>f</sup> The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with dry filter paper or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable

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contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

## 10.0 GENERAL SITE SAFETY PROCEDURES

### 10.1 General

The following sections contain general Site safety information. Hazards, due to normal Site activities, can be reduced by using common sense and by following safe practices. The following practices are forbidden:

- Running and horseplay.
- Smoking, eating, drinking, applying cosmetics, or chewing gum or tobacco within the Restricted Access or Control Zone or any potentially contaminated area.
- Ignition of flammable materials in the work zone without the proper Hot-Work Permit.

### 10.2 Sanitation

Project sanitation needs will be addressed by locating the nearest toilet facilities and drinking water source. If these facilities are not located in close enough proximity to allow practical use during project activities, temporary facilities will be procured and placed in the support zone.

### 10.3 Physical Hazards

#### *10.3.1 Hand Tools*

Only tools that are in good condition should be used. Improper and defective tools contribute to accidents. The following safe practices should be observed when using hand tools:

- Use tools in the manner for which they were designed.
- Be sure of footing before using any tool.
- Do not use tools that have split handles, mushroom heads, worn jaws, or other defects.
- Do not use makeshift tools or other improper tools.
- Use spark proof tools where there are explosive vapors, gases, or residue.

#### *10.3.2 Traffic*

Vehicular traffic is not anticipated to be a concern during the review activity.

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#### 10.3.3 Illumination

Work will be conducted during daylight hours.

#### 10.3.4 Heat Stress

Workers will be trained on the signs and symptoms of the forms of heat stress and will be encouraged to monitor themselves and others. In addition, experience has shown that the following work/rest regimen (see Table below) is appropriate for field workers performing various degrees of work while wearing Level D (no protective clothing). Values are given in degrees Celsius (°C) Wet Bulb Globe Temperature (WBGT).

WBGT is defined according to the following formula (outdoors with solar load) where WB, GT, and DB are the wet bulb, globe, and dry bulb temperatures, respectively:

$$\text{WBGT} = 0.7\text{WB} + 0.2\text{GT} + 0.1\text{DB}$$

The workload classes are defined in The American Conference of Governmental Industrial Hygienists' booklet, "Threshold Limit Values and Biological Exposure Indices for 1998."

Work/Rest Regimen	Workload		
	Light	Moderate	Heavy
Continuous Work	30.0 °C	26.7 °C	25.0 °C
75% work/25% rest each hour	30.6 °C	28.0 °C	25.9 °C
50% work/50% rest each hour	31.4 °C	29.4 °C	27.9 °C
25% work/75% rest each hour	32.2 °C	31.1 °C	30.0 °C

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity.

The body's response to heat stress is reflected in the degree of symptoms. When the stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses:

Heat Cramps - a condition characterized by painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.

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Heat Exhaustion - a condition characterized by profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

Heat Stroke - a condition in which sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. **Medical attention is needed immediately.**

#### *10.3.5 Cold Stress*

Overexposure to cold environments can have serious effects on exposed body surfaces or deeper body tissues.

The effects of work in cold environments depend on factors such as air temperature and wind, duration of exposure, type of protective clothing and equipment, type of work, level of physical effort, and health status of the employee.

Information about the most common cold stress problems is presented below.

#### Hypothermia

Hypothermia results when the body loses heat faster than it can produce it. This causes the blood vessels in the skin to constrict in order to conserve important vital heat. Hands and feet are usually affected first. As the body tries to produce more heat, involuntary shivering begins. This shivering is often the first sign of hypothermia. Further heat loss produces speech difficulty, forgetfulness, loss of manual dexterity, collapse, and finally death.

#### Frostbite

Frostbite occurs when there is actual freezing of the body tissues, normally when temperatures are below freezing. The injury can result from exposure to cold wind, from prolonged exposure to cold temperatures, or from skin contact with an object whose temperature is below freezing. The tissue damage can be superficial near the skin or extend to deeper body tissues and cause gangrene. The skin may first have a prickly or tingling sensation and later become numb with cold; the appearance may range from superficial redness of the skin to white frozen-looking tissues.

#### Immersion Foot or Trench Foot

These two cold injuries occur as a result of exposure to cool or cold water. Immersion foot usually results from prolonged exposure when air temperatures are above freezing, whereas trench foot normally occurs from shorter exposure at temperatures near freezing. The symptoms for each disorder are similar and include tingling, itching, swelling, pain in some cases or numbness in others, lack of sweating, and blisters.

#### Treatment of Cold Disorders

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The intent of all treatment is to increase the deep body temperature to 98.6°F. Symptoms include heavy shivering, drowsiness, excessive fatigue, and confusion, in addition to those listed above. Cold-weather work should be discontinued for any worker with these symptoms, and the worker should be taken to a warm area. Wet clothing should be removed if possible and replaced by dry clothing. A warm, nonalcoholic, noncaffeine drink or soup may be given. Re-warming should be gradual.

For frostbite, the victim should be sheltered from the wind and cold and given warm drinks. The frozen area should be covered with warm clothing or blankets or be warmed against another person's body. Do not use direct heat and do not rub the affected area. Warming should be rapid but gentle.

#### 6.7.5 Avoidance of Cold-Related Emergencies

Adequate, appropriate clothing should be worn to keep body warmth in and cold out. Multiple layers of light clothes are best because the dead air space between layers serves as insulation. Good insulation is provided with the following layers of clothing:

- An innermost layer that traps heat and allows ventilation of perspiration (cotton is a good material);
- A wool or fiberfill insulating layer; and
- A windproof and waterproof outer protective layer (e.g. nylon or waterproof suits).

The following precautions will also be taken to avoid cold stress:

- Workers will be trained in the recognition of symptoms, treatment of cold stress disorders, and wind chill index.
- Work will be carefully scheduled to avoid heavy perspiration by workers.
- Extremities of the body will be protected adequately. Hands should be covered with gloves and, for temperatures below 0°F, mittens. Caps, hoods, or hard hats with liners should be used to cover the head and ears. Feet should be protected with insulated boots, layers of socks, or boot covers, as appropriate.
- An appropriate work-rest regime or schedule and a heated shelter for relief from the cold will be provided.
- A change of dry work clothing will be on hand for each worker.
- Warm, nonalcoholic drinks (avoid or minimize coffee or other liquid containing caffeine) and/or soups should be available.

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- Bare metal equipment controls, seats, etc., should be covered with non-conducting materials.
- The buddy system will be used at all times.
- Work will be planned to consider the additional weight and bulkiness of clothing that may affect work performance. Standing still or sitting still for long periods will be minimized.
- Work will be performed away from windy, drafty, or unprotected areas as much as possible.
- Air-purifying respirators (APRs) will not be worn at temperatures below 32°F without a nose cup.
- Powered APRs (PAPRs) will not be used in temperatures below 40°F because of the wind chill created in the face piece.

#### **10.4 Biological Hazards**

##### *10.4.1 Tick Bites*

The Center for Disease Control (CDC) has noted the increase of Lyme Disease and Rocky Mountain Spotted Fever (RMSF) that are caused by bites from infected ticks that live in and near wooded areas, tall grass, and brush. Ticks are small, ranging from the size of a comma up to about one quarter inch. They are sometimes difficult to see. The tick season extends from spring through summer.

Lyme disease has occurred in almost states, with the heaviest concentrations in the Northeast (Connecticut, Massachusetts, New Jersey, New York, Pennsylvania), the upper Midwest (Minnesota and Wisconsin), and along the northern California coast. It is caused by ticks, which have become infected with spirochetes. Deer ticks are about one quarter inch in size, and black or brick red in color. Male deer ticks are smaller, and black. The deer tick larva are extremely small [approximately the size of a period (.)].

Standard field gear (work boots, socks and light-colored coveralls) provide good protection against tick bites, particularly if the joints are taped. However, even then wearing field gear, the following precautions should be taken when working in areas that might be infested with ticks:

When in the field, check yourself often for ticks, particularly on your lower legs and areas covered with hair.

Spray outer clothing, particularly your pant legs, boots, and socks, **BUT NOT YOUR SKIN**, with an insect repellent that contains permethrin or permethrin.

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When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible.

If you suspect that a tick is present, remove it with tweezers only, and not with matches or a lit cigarette. Grasp the tick near the head with the tweezers and pull gently. Do not use nail polish or any other type of chemical. Be sure and remove parts of the tick's body. Once removed, disinfect the area with alcohol or a similar antiseptic. Keep the tick in a plastic bag and report the incident to the EHS MANAGER or Field Supervisor.

Look for signs of the onset of Lyme disease, such as a rash that looks like a bull's eye or an expanding red circle surrounding a light area, frequently with a small welt in the center. This rash can appear from several days to several weeks after the tick bite. The first symptoms of either disease are flu like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain. If immediately treated by a physician, most individuals recover fully in a short period of time. If not treated, more serious symptoms can occur.

If any of the signs and symptoms noted above appear, contact the EHS MANAGER or Field Supervisor. Consult with a physician for an examination and possible treatment.

#### *10.4.2 Poisonous Plants*

Site personnel will need to be alert to the presence of poisonous plants. The most common types of poisonous plant are poison ivy, poison oak and poison sumac. Skin contact with these plants can cause skin sensitization resulting in reddening, swelling and itching of the affected areas. Skin exposure can result from either direct contact with the plant or contact with clothing/equipment previously exposed to the plant. Site personnel will receive training in the recognition of poisonous plants and methods for preventing exposure during the site-specific safety briefing.

#### *10.4.3 Animal or Insect Bites*

Animal bites or stings are usually nuisances (localized swelling, itching, and minor pain) that can be handled by first-aid treatment. The bites of certain snakes, lizards, spiders, and scorpions contain sufficient poison to warrant medical attention. There are diseases that can be transmitted by insect and animal bites (e.g., Rocky Mountain spotted fever, Lyme disease [tick], rabies [mainly dogs, skunks, raccoons, and foxes], malaria, and equine encephalitis [mosquitoes]). The greatest hazard and most-common cause of fatalities from animal bites, particularly bees, wasps, and spiders, is from a sensitivity reaction. Shocks due to stings can lead to severe reactions in the circulatory, respiratory, and central nervous systems, which also can result in death.

If an assigned employee has a history of allergic reactions to bites, they will be required to have their prescribed treatment with them, and first aid personnel will know where it is located. Stings or bites will be taken seriously. Anyone stung or bitten will be required to stop work while that person is observed for signs of severe swelling, shortness of breath, nausea, or shock. If there is any doubt, medical attention will be obtained.

## **PROCEDURE**

### **RI/FS Site Safety and Health Plan**

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Wild animals must be avoided, particularly wild animals that are unusually passive or aggressive. Any such animals will be reported to appropriate Site personnel. Skunks, raccoons, foxes, and bats are wild animals most frequently found to be infected with rabies; however, any warm-blooded animal could be infected. If an animal bites an individual suspected of rabies infection, an attempt will be made to capture the animal without being bitten again or contact with the mouth or any saliva. If the animal cannot be captured easily, it should be kept under surveillance and appropriate assistance will be called to capture the animal. The animal should then be tested. A dead animal suspected of infection should also be preserved and tested. Health departments are often sources of testing or obtaining information about where testing can be done.

The bite area should be washed with soap and water and disinfected with 70% alcohol as quickly as possible, followed by treatment by a doctor or emergency room.

Rabies is preventable, even after being bitten, if treatment is begun soon enough. Hence, prompt medical attention and determining whether the animal that has bitten you is infected are very important. Rabies is not curable once symptoms or signs appear.

#### **11.0 EMERGENCY RESPONSE PROCEDURES AND EQUIPMENT**

##### **11.1 General**

The purpose of this section is to address potential emergency situations and to provide guidelines for emergency response procedures.

If, during the performance of this project, the presence of potentially hazardous conditions is evident in a particular area, personnel should leave the area and immediately notify the appropriate emergency response personnel.

##### **11.2 Emergency Recognition and Prevention**

The types of potential emergencies include:

- Physical injuries to Site personnel; sprains, broken bones, severe lacerations or contusion
- Possible exposure to Site contaminant or on Site hazardous materials
- Animal/insect bites

##### **11.3 Emergency Alert Procedures**

Site personnel should review the provided emergency notification numbers. Emergency plans and evacuation procedures shall be reviewed with personnel prior to commencement of Site activities. In the event that Site personnel are out of voice communication range, emergency notification will be three short blasts of an air-horn.

## PROCEDURE RI/FS Site Safety and Health Plan

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### 11.4 First Aid and Medical Treatment Procedures

General treatment procedures include:

- Removing the injured or exposed person(s) from immediate danger.
- Rendering first aid if necessary, and decontaminate affected personnel, if necessary.
- Calling an ambulance for transport to local hospital immediately.
- Evacuating other personnel Site to a safe place if necessary, until the EHS MANAGER determines that it is safe for work to resume.
- Reporting any accident to the EHS MANAGER immediately.
- A 16-unit first aid kit and a bloodborne pathogen kit will be available on site and their location will be made known to Site personnel.

Personnel who have been certified in First Aid may administer Site treatment or first aid. If medical treatment is required, the EHS MANAGER or other personnel familiar with the incident and Site contaminants must accompany the victim to the hospital.

In the event of an emergency, the following emergency equipment should be available and maintained Site:

- Air horn
- 16-unit first aid kit
- Eye wash
- BBP kit
- Cellular telephone

### 11.5 Emergency Telephone Numbers and Directions to the Local Medical Facility

Following is a list of emergency numbers. A map to Jefferson Memorial Hospital, Festus, MO the closest emergency care facility, has been attached.

<b>Emergency Service</b>	<b>Telephone Number</b>
Police Department	911
Fire Department	911

## PROCEDURE

### RI/FS Site Safety and Health Plan

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#### Jefferson Memorial Hospital

This list, along with a street map (next page) showing the possible routes to JMHS should be available with the Site copy of the health and safety plan and in each Site vehicle.

#### Directions to Jefferson Memorial Hospital:

<b>1: From the site</b> Turn Right (West) onto <b>CR-P [SR-P]</b>	1.7	0:03
<b>2:</b> Turn <b>RIGHT</b> (East) onto <b>SR-A [CR-A]</b>	2.1	0:04
<b>3:</b> Continue (East) on <b>SR-A [Veterans Blvd]</b>	0.1	0:01
<b>4:</b> At I-55 Exit 175, turn <b>RIGHT</b> (South) onto <b>I-55</b>	1.2	0:02
<b>5:</b> At I-55 Exit 174, turn <b>LEFT</b> (North-East) onto <b>US-67</b>	0.4	1min
<b>6:</b> American Legion Dr, Festus, and continue to Hospital	0.3	1min

## 12.0 RECORDKEEPING

Each employee visiting the Site is responsible for providing the following recordkeeping information. This record will become a part of the project file. The following records or logs will be incorporated into the project file:

1. Statement of HASP Acknowledgment (See Appendix A for sample form)
2. 40-hr HAZWOPER Training certificates and current 8-hr refresher.
3. Medical Approval for Site work and respirator clearance.
4. Accident Investigation Reports: in case of an accident or employee injury Site, a written accident report form must be completed and forwarded to the WPM and the EHS manager within 48 hours.
5. Revisions to the SSHP: The EHS manager, will document changes to the SSHP. Revisions will be made part of the SSHP and will be distributed to essential personnel.

## 13.0 REFERENCES

*General Industry and Construction Standards*, United States Code of Federal Regulations (CFR), 29 CFR 1910 and 1926. U.S. Department of Labor. As amended through publication date.



**PROCEDURE**  
**RI/FS Site Safety and Health Plan**

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Leggette, Brashears & Graham, Inc., *Combustion Engineering, Second Sampling Event Report in Conjunction with the Hydrogeologic Investigation and Ground-water, Soil and Stream Characterization*, May 26, 1999.

NRC Special Nuclear Material License SNM-33, July 1994.

**APPENDIX A**  
**FIELD TEAM REVIEW**  
**DOCUMENTATION**





**PROCEDURE**  
**RI/FS Site Safety and Health Plan**

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**Medical Data Sheet**

This Medical Data Sheet or equivalent will be completed by Site personnel and kept in the Support Zone during Site operations. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. If more space is required, use the back of this sheet.

Project: \_\_\_\_\_

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Home Telephone: Area Code ( ) \_\_\_\_\_

Age: \_\_\_\_\_ Height: \_\_\_\_\_ Weight: \_\_\_\_\_

In case of emergency, contact: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: Area Code ( ) \_\_\_\_\_

Do you wear contact lenses? Yes ( ) No ( )

Allergies: \_\_\_\_\_

List medication(s) taken regularly: \_\_\_\_\_

Particular sensitivities: \_\_\_\_\_

Previous/current medical conditions or exposures to hazardous chemicals: \_\_\_\_\_

Name of Personal Physician: \_\_\_\_\_

Telephone: Area Code ( ) \_\_\_\_\_

## **APPENDIX B**

# **HAZARD COMMUNICATION PROGRAM**

**APPENDIX C**  
**ACTIVITY HAZARD**  
**ANALYSIS**

## ACTIVITY HAZARD ANALYSIS

Activity: Gamma surveys (non-intrusive)

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> </ul>
Eye Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> </ul>
Head Injury	Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required if falling tree limb hazard or low branches are present</li> </ul>
Foot Injury	Very Low/Very Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required</li> </ul>
Radiological Hazards	Very Low/Very low	<ul style="list-style-type: none"> <li>• Non-intrusive activity. No exposure expected. Booties and work gloves required while clearing Site vegetation. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Very low/Very low	<ul style="list-style-type: none"> <li>• Non-intrusive activity. No exposure is anticipated during this activity. Level D PPE</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>



## ACTIVITY HAZARD ANALYSIS

Activity: Ground water sampling

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> <li>• Protect exposed skin as much as practical. Tape sleeves and pant legs</li> </ul>
Back Injury	Low/Low	<ul style="list-style-type: none"> <li>• Practice safe lifting techniques.</li> <li>• Ensure sampling equipment which is carried by or strapped to the field technician is secure and properly located on the individual..</li> </ul>
Eye Injury	Very Low/Very Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> </ul>
Head Injury	Very Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required if measurements are being made near operating machinery</li> </ul>
Foot Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required. Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.</li> </ul>
Radiological Hazards	Low/low	<ul style="list-style-type: none"> <li>• Non-intrusive activity. No exposure expected. Booties and work gloves required while walking the Site. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Low/Low	<ul style="list-style-type: none"> <li>• Non-intrusive activity. No exposure is anticipated during this activity. Level D PPE</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>

## ACTIVITY HAZARD ANALYSIS

Activity: Shallow Overburden Groundwater monitoring

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> <li>• Protect exposed skin as much as practical. Tape sleeves and pant legs</li> </ul>
Eye Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> <li>• Care must be taken when collecting or transferring samples as there may be enough contamination to cause an eye injury</li> </ul>
Head Injury	Very Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required if collecting samples near operating machinery</li> </ul>
Foot Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required.</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.</li> </ul>
Radiological Hazards	Low/low	<ul style="list-style-type: none"> <li>• No exposure expected. Booties and work gloves required while collecting samples. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Low/Low	<ul style="list-style-type: none"> <li>• No significant exposure is anticipated during this activity. Level D PPE</li> <li>• PID may be used to determine if there is any contaminant off gassing.</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>

## ACTIVITY HAZARD ANALYSIS

Activity: Monitoring Well Installation

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> <li>• Protect exposed skin as much as practical. Tape sleeves and pant legs</li> </ul>
Noise	Moderate/Low	<ul style="list-style-type: none"> <li>• Use hearing protection while working around operating drill rigs</li> </ul>
Back Injury	Low/Low	<ul style="list-style-type: none"> <li>• Practice safe lifting techniques.</li> <li>• Know the weight of any rigging component before lifting or moving.</li> </ul>
Eye Injury	Very Low/Very Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> </ul>
Head Injury	Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required during this activity.</li> </ul>
Foot Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required.</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.</li> </ul>
Radiological Hazards	Low/low	<ul style="list-style-type: none"> <li>• No exposure expected. Booties and work gloves required while collecting smear samples from equipment. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Low/Low	<ul style="list-style-type: none"> <li>• Minimal exposure is anticipated during this activity. Level D PPE</li> <li>• PID measurements will be made during this activity to ensure vapors which may be released from below ground surface are maintained within acceptable limits</li> <li>• Depending on whether airborne contaminants are detected, PPE may be upgraded to modified Level D or Level C</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>

## ACTIVITY HAZARD ANALYSIS

Activity: Field screening of soils

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> <li>• Protect exposed skin as much as practical. Tape sleeves and pant legs</li> </ul>
Back Injury	Low/Low	<ul style="list-style-type: none"> <li>• Practice safe lifting techniques.</li> <li>• Get help in moving equipment from one location to another over rough terrain.</li> </ul>
Eye Injury	Very Low/Very Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> </ul>
Head Injury	Very Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required if measurements are being made near operating machinery</li> </ul>
Foot Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required.</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.</li> </ul>
Radiological Hazards	Low/low	<ul style="list-style-type: none"> <li>• No exposure expected. Booties and work gloves required while walking the Site. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Very low/Very low	<ul style="list-style-type: none"> <li>• No exposure is anticipated during this activity. Level D PPE</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>

## ACTIVITY HAZARD ANALYSIS

Activity: Field Sample Collection

POTENTIAL HAZARDS	PROBABILITY/ SEVERITY	RECOMMENDED CONTROLS
Slips/Trips/Falls	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Work will be performed during daylight hours</li> <li>• Heavily wooded areas will be evaluated prior to entry with tripping hazards removed if possible</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards</li> </ul>
Insect bites	Moderate/Moderate	<ul style="list-style-type: none"> <li>• Insect repellent will be available, if needed</li> <li>• Protect exposed skin as much as practical. Tape sleeves and pant legs</li> </ul>
Eye Injury	Very Low/Very Low	<ul style="list-style-type: none"> <li>• ANSI approved eye protection will be required</li> </ul>
Head Injury	Very Low/Low	<ul style="list-style-type: none"> <li>• Head protection will be required if measurements are being made near machinery</li> </ul>
Foot Injury	Low/Low	<ul style="list-style-type: none"> <li>• ANSI approved safety shoes/boots required.</li> <li>• Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.</li> </ul>
Radiological Hazards	Low/low	<ul style="list-style-type: none"> <li>• No exposure expected. Booties and work gloves required while walking the Site. Respiratory protection will not be required.</li> <li>• Minimal contact, step-off decon, radiological frisk. Wash face and hands after leaving Site.</li> </ul>
Chemical Exposures	Low/Low	<ul style="list-style-type: none"> <li>• Minimal exposure is anticipated during this activity. Level D PPE</li> <li>• PID will be used to monitor whether any vapors are being released from soil samples.</li> </ul>
Temperature Extremes	Seasonally Dependent	<ul style="list-style-type: none"> <li>• Heat or cold stress evaluations will be made at the start of each day's activity. Control measures will be determined at that time.</li> </ul>

## **APPENDIX C**

**Environmental Data Resources, Inc., The EDR Radius Map with Geocheck®**



"Linking Technology with Tradition"

## Sanborn® Map Report

**Ship to:** Kerry L. Nikolaisen

Leggette Brashears & Graham

4175 Crescent Drive

St Louis, MO 63129

**Order Date:** 1/29/2002

**Completion Date:** 01/29/2002

**Inquiry #:** 728637.2S

**P.O. #:** NA

**Site Name:** Westinghouse Electric Company

**Address:** 3300 State Route P

**City/State:** Festus, MO 63028

1091889TWC

314-845-0535

**Cross Streets:**

This document reports that the largest and most complete collection of Sanborn fire insurance maps has been reviewed based on client-supplied information, and fire insurance maps depicting the target property at the specified address were not identified.

**NO COVERAGE**

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## **The EDR Radius Map with GeoCheck<sup>®</sup>**

**Westinghouse Electric Company  
3300 State Route P  
Festus, MO 63028**

**Inquiry Number: 728637.1s**

**January 29, 2002**

## ***The Source For Environmental Risk Management Data***

3530 Post Road  
Southport, Connecticut 06490

### **Nationwide Customer Service**

Telephone: 1-800-352-0050  
Fax: 1-800-231-6802  
Internet: [www.edrnet.com](http://www.edrnet.com)

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***Thank you for your business.***  
 Please contact EDR at 1-800-352-0050  
 with any questions or comments.

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## EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

### TARGET PROPERTY INFORMATION

#### ADDRESS

3300 STATE ROUTE P  
FESTUS, MO 63028

#### COORDINATES

Latitude (North): 38.208500 - 38° 12' 30.6"  
Longitude (West): 90.476200 - 90° 28' 34.3"  
Universal Transverse Mercator: Zone 15  
UTM X (Meters): 720976.6  
UTM Y (Meters): 4231754.0

### USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property: 2438090-B4 FESTUS, MO  
Source: USGS 7.5 min quad index

### TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

### DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ( "reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

#### FEDERAL ASTM STANDARD

**NPL**..... National Priority List  
**Proposed NPL**..... Proposed National Priority List Sites  
**CERCLIS**..... Comprehensive Environmental Response, Compensation, and Liability Information System  
**CERC-NFRAP**..... CERCLIS No Further Remedial Action Planned  
**CORRACTS**..... Corrective Action Report  
**RCRIS-TSD**..... Resource Conservation and Recovery Information System  
**RCRIS-LQG**..... Resource Conservation and Recovery Information System  
**RCRIS-SQG**..... Resource Conservation and Recovery Information System  
**ERNS**..... Emergency Response Notification System

#### STATE ASTM STANDARD

**SHWS**..... Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites  
**SWF/LF**..... Solid Waste Facility List  
**UST**..... Petroleum Storage Tanks  
**VCP**..... Sites Participating in the Voluntary Cleanup Program

# EXECUTIVE SUMMARY

## FEDERAL ASTM SUPPLEMENTAL

<b>CONSENT</b> .....	Superfund (CERCLA) Consent Decrees
<b>ROD</b> .....	Records Of Decision
<b>Delisted NPL</b> .....	National Priority List Deletions
<b>FINDS</b> .....	Facility Index System/Facility Identification Initiative Program Summary Report
<b>HMIRS</b> .....	Hazardous Materials Information Reporting System
<b>MLTS</b> .....	Material Licensing Tracking System
<b>MINES</b> .....	Mines Master Index File
<b>NPL Liens</b> .....	Federal Superfund Liens
<b>PADS</b> .....	PCB Activity Database System
<b>RAATS</b> .....	RCRA Administrative Action Tracking System
<b>TRIS</b> .....	Toxic Chemical Release Inventory System
<b>TSCA</b> .....	Toxic Substances Control Act
<b>FTTS</b> .....	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

## STATE OR LOCAL ASTM SUPPLEMENTAL

<b>AST</b> .....	Aboveground Petroleum Storage Tanks
<b>MO RRC</b> .....	Certified Hazardous Waste Resource Recovery Facilities

## SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Elevations have been determined from the USGS 1 degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. EDR's definition of a site with an elevation equal to the target property includes a tolerance of +/- 10 feet. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property (by more than 10 feet). Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

## STATE ASTM STANDARD

**LUST:** Leaking Underground Storage Tanks.

A review of the LUST list, as provided by EDR, and dated 08/23/2001 has revealed that there is 1 LUST site within approximately 0.5 miles of the target property.

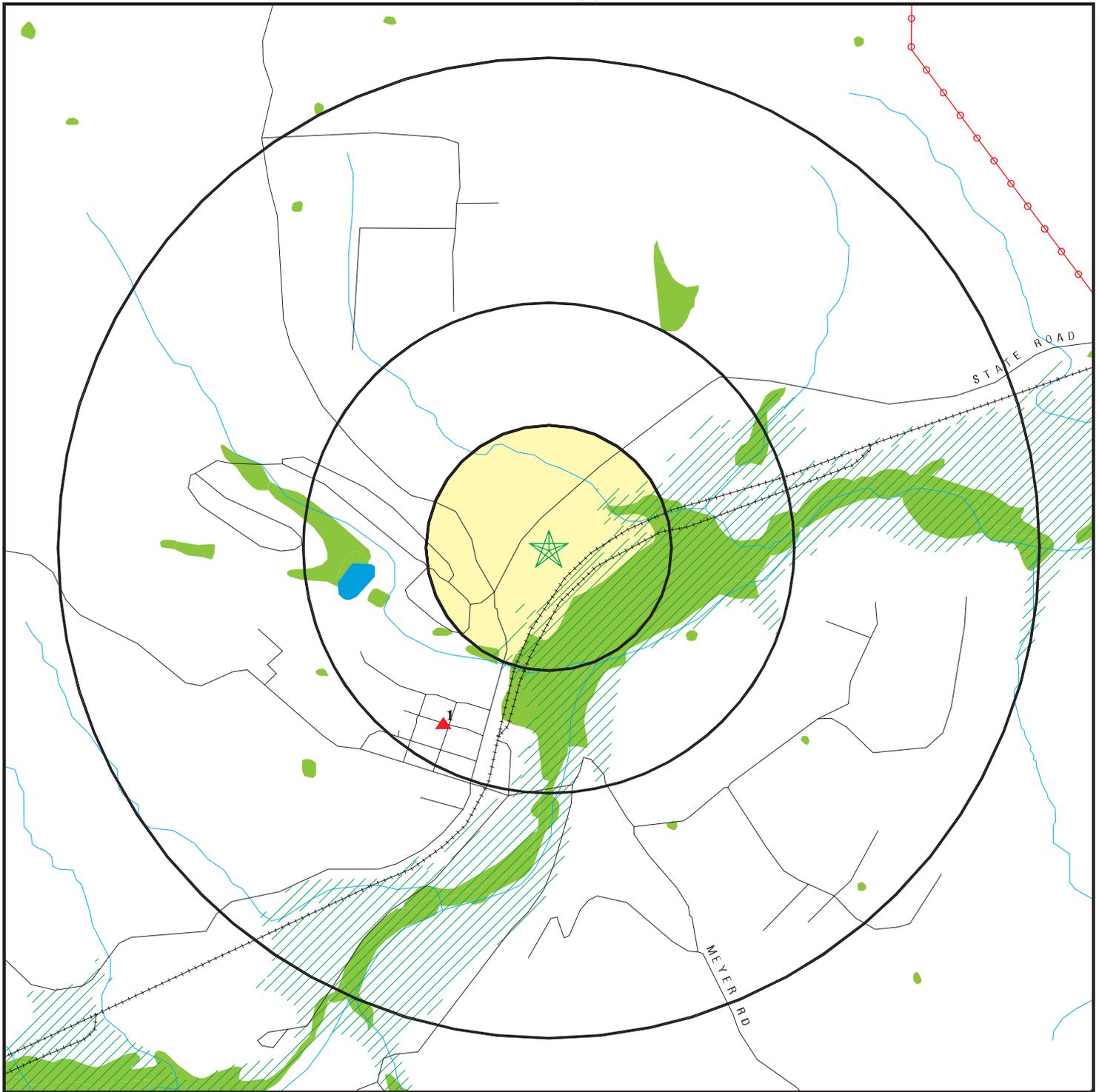
<u>Equal/Higher Elevation</u>	<u>Address</u>	<u>Dist / Dir</u>	<u>Map ID</u>	<u>Page</u>
<b><i>SINCLAIR RETAIL #24072</i></b>	<b><i>319 MAIN ST</i></b>	<b><i>1/4 - 1/2SSW 1</i></b>	<b><i>1</i></b>	<b><i>5</i></b>

## EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

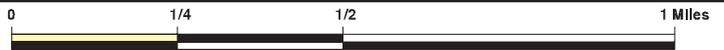
<u>Site Name</u>	<u>Database(s)</u>
CRYSTAL CITY DUMP	CERCLIS
RUSH ISLAND PLANT	LUST, UST
UNITED ELECTRIC SUPPLY	LUST, UST
RIVER CEMENT COMPANY	LUST
COOPER OIL DBA COASTAL	UST
SPORTSMENS CLUB	UST
LA ROCHE INDUSTRIES INC	UST
REORGANIZED SCHOOL DISTRICT R-VII	UST
FESTUS STATION	UST
BUFF'S DISCOUNT CENTER INC	UST
STOCKHAM'S GAS MART (CITGO)	UST
U S S AFRI CHEMICALS	RCRIS-SQG, FINDS
FRED WEBER INC FESTUS STONE	RCRIS-SQG, FINDS
COOPER OIL CO	RCRIS-SQG, FINDS
COOPER OIL CO INC	RCRIS-SQG, FINDS

# OVERVIEW MAP - 728637.1s - Leggette Brashears & Graham



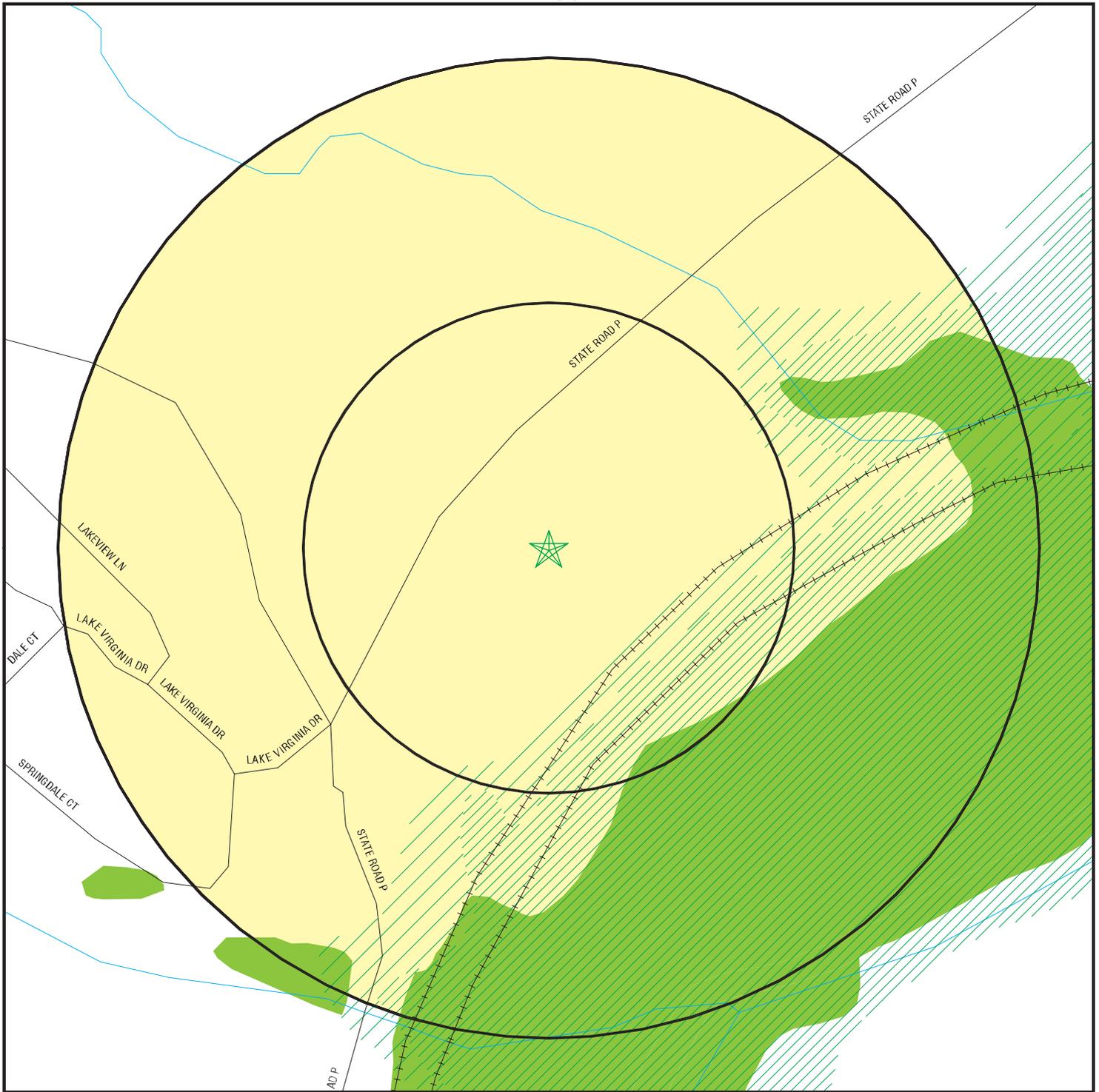
- ★ Target Property
- ▲ Sites at elevations higher than or equal to the target property
- ◆ Sites at elevations lower than the target property
- ▲ Coal Gasification Sites
- ☒ National Priority List Sites
- ☒ Landfill Sites

- ⚡ Power transmission lines
- ⚡ Oil & Gas pipelines
- ▨ 100-year flood zone
- ▩ 500-year flood zone
- Wetlands



TARGET PROPERTY:	Westinghouse Electric Company	CUSTOMER:	Leggette Brashears & Graham
ADDRESS:	3300 State Route P	CONTACT:	Kerry L. Nikolaisen
CITY/STATE/ZIP:	Festus MO 63028	INQUIRY #:	728637.1s
LAT/LONG:	38.2085 / 90.4762	DATE:	January 29, 2002 11:48 am

# DETAIL MAP - 728637.1s - Leggette Brashears & Graham



- ★ Target Property
- ▲ Sites at elevations higher than or equal to the target property
- ◆ Sites at elevations lower than the target property
- ▲ Coal Gasification Sites
- ⚡ Sensitive Receptors
- ☒ National Priority List Sites
- ☒ Landfill Sites

- ⚡ Power transmission lines
- ⚡ Oil & Gas pipelines
- ▨ 100-year flood zone
- ▨ 500-year flood zone
- Wetlands



<p><b>TARGET PROPERTY:</b> Westinghouse Electric Company  <b>ADDRESS:</b> 3300 State Route P  <b>CITY/STATE/ZIP:</b> Festus MO 63028  <b>LAT/LONG:</b> 38.2085 / 90.4762</p>	<p><b>CUSTOMER:</b> Leggette Brashears &amp; Graham  <b>CONTACT:</b> Kerry L. Nikolaisen  <b>INQUIRY #:</b> 728637.1s  <b>DATE:</b> January 29, 2002 11:48 am</p>
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## MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
<b><u>FEDERAL ASTM STANDARD</u></b>								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
CERCLIS		0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.250	0	0	NR	NR	NR	0
CORRACTS		1.000	0	0	0	0	NR	0
RCRIS-TSD		0.500	0	0	0	NR	NR	0
RCRIS Lg. Quan. Gen.		0.250	0	0	NR	NR	NR	0
RCRIS Sm. Quan. Gen.		0.250	0	0	NR	NR	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
<b><u>STATE ASTM STANDARD</u></b>								
State Haz. Waste		1.000	0	0	0	0	NR	0
State Landfill		0.500	0	0	0	NR	NR	0
LUST		0.500	0	0	1	NR	NR	1
UST		0.250	0	0	NR	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0
<b><u>FEDERAL ASTM SUPPLEMENTAL</u></b>								
CONSENT		1.000	0	0	0	0	NR	0
ROD		1.000	0	0	0	0	NR	0
Delisted NPL		1.000	0	0	0	0	NR	0
FINDS		TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		0.250	0	0	NR	NR	NR	0
NPL Liens		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
<b><u>STATE OR LOCAL ASTM SUPPLEMENTAL</u></b>								
AST		TP	NR	NR	NR	NR	NR	0
MO RRC		TP	NR	NR	NR	NR	NR	0
<b><u>EDR PROPRIETARY HISTORICAL DATABASES</u></b>								
AQUIFLOW - see EDR Physical Setting Source Addendum								

TP = Target Property

NR = Not Requested at this Search Distance

\* Sites may be listed in more than one database

Map ID  
 Direction  
 Distance  
 Distance (ft.)  
 Elevation

MAP FINDINGS

Site

Database(s)

EDR ID Number  
 EPA ID Number

**Coal Gas Site Search: EDR does not presently have coal gas site information available in this state.**

**1**  
**SSW**  
**1/4-1/2**  
**2200**  
**Higher**

**SINCLAIR RETAIL #24072**  
**319 MAIN ST**  
**FESTUS, MO 63078**

**LUST U000753133**  
**UST N/A**

**LUST:**

Facility ID:	ST0013019	Lust ID:	R004763
Owner ID:	OW10315	Region:	SL - St. Louis Regional Office
Release Date:	12/01/1993	Active:	TRUE
Tank Type:	UNDERGROUND STORAGE TANK		
Site Type:	Not reported		
Remediation Techniques:	Excavation		
Media:	Not reported		
Emergency Reponse Date:	/ /		
Emergency Cleanup Start:	/ /		
Spill Cleanup Start:	/ /		
Spill Cleanup Finish:	/ /		
Date Added:	06/30/1995		

**UST:**

Facility ID:	ST0013019	Owner ID:	OW10315
Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	1	Tank Status:	Removed
Tank Type:	Below Ground	Substance:	Gasoline, including blends
Capacity:	6000	Active Tanks:	0
Total Tanks:	6	Number AST's:	0
Number UST's:	6	Meet 98	False
Lust ID:	R004763		
Facility ID:	ST0013019	Owner ID:	OW10315
Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	2	Tank Status:	Removed
Tank Type:	Below Ground	Substance:	Gasoline, including blends
Capacity:	2000	Active Tanks:	0
Total Tanks:	6	Number AST's:	0
Number UST's:	6	Meet 98	False
Lust ID:	R004763		
Facility ID:	ST0013019	Owner ID:	OW10315
Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	3	Tank Status:	Removed
Tank Type:	Below Ground	Substance:	Gasoline, including blends
Capacity:	2000	Active Tanks:	0
Total Tanks:	6	Number AST's:	0
Number UST's:	6	Meet 98	False
Lust ID:	R004763		
Facility ID:	ST0013019		

Map ID  
Direction  
Distance  
Distance (ft.)  
Elevation Site

MAP FINDINGS

Database(s)  
EDR ID Number  
EPA ID Number

**SINCLAIR RETAIL #24072 (Continued)**

**U000753133**

Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	4	Owner ID:	OW10315
Tank Type:	Below Ground	Tank Status:	Removed
Capacity:	3000	Substance:	Gasoline, including blends
Total Tanks:	6	Active Tanks:	0
Number UST's:	6	Number AST's:	0
Lust ID:	R004763	Meet 98	False
Facility ID:	ST0013019		
Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	5	Owner ID:	OW10315
Tank Type:	Below Ground	Tank Status:	Removed
Capacity:	3000	Substance:	Gasoline, including blends
Total Tanks:	6	Active Tanks:	0
Number UST's:	6	Number AST's:	0
Lust ID:	R004763	Meet 98	False
Facility ID:	ST0013019		
Owner:	SINCLAIR OIL CORPORATION 550 EAST SOUTH TEMPLE SALT LAKE CITY, UT 84102		
Tank ID:	6	Owner ID:	OW10315
Tank Type:	Below Ground	Tank Status:	Removed
Capacity:	560	Substance:	Other
Total Tanks:	6	Active Tanks:	0
Number UST's:	6	Number AST's:	0
Lust ID:	R004763	Meet 98	False

## ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)	Facility ID
CRYSTAL CITY	1001404245	CRYSTAL CITY DUMP	COUNTY ROAD	63028	CERCLIS	
FESTUS	U003403150	COOPER OIL DBA COASTAL	I-55 & A HWY	63028	UST	ST0006813
FESTUS	U001159121	RUSH ISLAND PLANT	RT 1	63028	LUST, UST	ST0013418
FESTUS	U000281922	SPORTSMENS CLUB	RT 1 BOX 367	63028	UST	ST0001126
FESTUS	U000281360	LA ROCHE INDUSTRIES INC	RT 1	63028	UST	ST0000280
FESTUS	1000101367	U S S AFRI CHEMICALS	RT 1	63028	RCRIS-SQG, FINDS	
FESTUS	U001162186	REORGANIZED SCHOOL DISTRICT R-VII	RT 4 BOX 207	63028	UST	ST0002754
FESTUS	1000184176	FRED WEBER INC FESTUS STONE	RT 5 BOX 72 BUCK KNOB RD	63028	RCRIS-SQG, FINDS	
FESTUS	U001159112	FESTUS STATION	HWY 61 S	63028	UST	ST0010712
FESTUS	U001159115	BUFF'S DISCOUNT CENTER INC	2085 HWY 67	63028	UST	ST0001119
FESTUS	1001600732	COOPER OIL CO	2559 HWY 67	63028	RCRIS-SQG, FINDS	
FESTUS	1001600733	COOPER OIL CO INC	1300 HWY A	63028	RCRIS-SQG, FINDS	
FESTUS	U001159119	UNITED ELECTRIC SUPPLY	AMERICAN LEGION DR	63028	LUST, UST	ST0001120
FESTUS	U001159109	STOCKHAM'S GAS MART (CITGO)	HWY CC & 67 11845 COUNTY RD CC	63028	UST	ST0012476
FESTUS	S105060415	RIVER CEMENT COMPANY	OUTER RD N AT HWY 61 / I-55	63028	LUST	ST3902000

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

**Elapsed ASTM days:** Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

## **FEDERAL ASTM STANDARD RECORDS**

### **NPL: National Priority List**

Source: EPA

Telephone: N/A

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 10/22/01

Date Made Active at EDR: 12/11/01

Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 11/05/01

Elapsed ASTM days: 36

Date of Last EDR Contact: 11/05/01

### **NPL Site Boundaries**

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)

Telephone: 202-564-7333

EPA Region 1

Telephone 617-918-1143

EPA Region 3

Telephone 215-814-5418

EPA Region 4

Telephone 404-562-8033

EPA Region 6

Telephone: 214-655-6659

EPA Region 8

Telephone: 303-312-6774

### **Proposed NPL: Proposed National Priority List Sites**

Source: EPA

Telephone: N/A

Date of Government Version: 10/22/01

Date Made Active at EDR: 12/11/01

Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 11/05/01

Elapsed ASTM days: 36

Date of Last EDR Contact: 11/05/01

### **CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System**

Source: EPA

Telephone: 703-413-0223

CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 07/12/01

Date Made Active at EDR: 10/16/01

Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 09/24/01

Elapsed ASTM days: 22

Date of Last EDR Contact: 12/26/01

### **CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned**

Source: EPA

Telephone: 703-413-0223

As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 07/12/01  
Date Made Active at EDR: 10/16/01  
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 09/24/01  
Elapsed ASTM days: 22  
Date of Last EDR Contact: 12/16/01

**CORRACTS:** Corrective Action Report

Source: EPA  
Telephone: 800-424-9346

CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 11/14/01  
Date Made Active at EDR: 01/14/02  
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 11/14/01  
Elapsed ASTM days: 61  
Date of Last EDR Contact: 11/14/01

**RCRIS:** Resource Conservation and Recovery Information System

Source: EPA/NTIS  
Telephone: 800-424-9346

Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 06/21/00  
Date Made Active at EDR: 07/31/00  
Database Release Frequency: Varies

Date of Data Arrival at EDR: 07/10/00  
Elapsed ASTM days: 21  
Date of Last EDR Contact: 11/07/01

**ERNS:** Emergency Response Notification System

Source: EPA/NTIS  
Telephone: 202-260-2342

Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 08/08/00  
Date Made Active at EDR: 09/06/00  
Database Release Frequency: Varies

Date of Data Arrival at EDR: 08/11/00  
Elapsed ASTM days: 26  
Date of Last EDR Contact: 10/25/01

**FEDERAL ASTM SUPPLEMENTAL RECORDS**

**BRS:** Biennial Reporting System

Source: EPA/NTIS  
Telephone: 800-424-9346

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/99  
Database Release Frequency: Biennially

Date of Last EDR Contact: 12/17/01  
Date of Next Scheduled EDR Contact: 03/18/02

**CONSENT:** Superfund (CERCLA) Consent Decrees

Source: EPA Regional Offices  
Telephone: Varies

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A  
Database Release Frequency: Varies

Date of Last EDR Contact: N/A  
Date of Next Scheduled EDR Contact: N/A

**ROD:** Records Of Decision

Source: NTIS  
Telephone: 703-416-0223

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 09/30/00  
Database Release Frequency: Annually

Date of Last EDR Contact: 01/07/02  
Date of Next Scheduled EDR Contact: 04/08/02

## **DELISTED NPL:** National Priority List Deletions

Source: EPA  
Telephone: N/A

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 11/13/01  
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 11/05/01  
Date of Next Scheduled EDR Contact: 02/04/02

## **FINDS:** Facility Index System/Facility Identification Initiative Program Summary Report

Source: EPA  
Telephone: N/A

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 10/29/01  
Database Release Frequency: Quarterly

Date of Last EDR Contact: 01/07/02  
Date of Next Scheduled EDR Contact: 04/08/02

## **HMIRS:** Hazardous Materials Information Reporting System

Source: U.S. Department of Transportation  
Telephone: 202-366-4526

Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 05/31/01  
Database Release Frequency: Annually

Date of Last EDR Contact: 10/22/01  
Date of Next Scheduled EDR Contact: 01/21/02

## **MLTS:** Material Licensing Tracking System

Source: Nuclear Regulatory Commission  
Telephone: 301-415-7169

MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/25/01  
Database Release Frequency: Quarterly

Date of Last EDR Contact: 01/07/02  
Date of Next Scheduled EDR Contact: 04/08/02

## **MINES:** Mines Master Index File

Source: Department of Labor, Mine Safety and Health Administration  
Telephone: 303-231-5959

Date of Government Version: 08/24/01  
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 01/02/02  
Date of Next Scheduled EDR Contact: 04/01/02

## **NPL LIENS:** Federal Superfund Liens

Source: EPA  
Telephone: 205-564-4267

Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 10/15/91  
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 11/19/01  
Date of Next Scheduled EDR Contact: 02/18/02

**PADS:** PCB Activity Database System

Source: EPA  
Telephone: 202-260-3936

PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 09/30/01  
Database Release Frequency: Annually

Date of Last EDR Contact: 11/13/01  
Date of Next Scheduled EDR Contact: 02/12/02

**RAATS:** RCRA Administrative Action Tracking System

Source: EPA  
Telephone: 202-564-4104

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95  
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 12/11/01  
Date of Next Scheduled EDR Contact: 03/11/02

**TRIS:** Toxic Chemical Release Inventory System

Source: EPA  
Telephone: 202-260-1531

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/99  
Database Release Frequency: Annually

Date of Last EDR Contact: 12/26/01  
Date of Next Scheduled EDR Contact: 03/25/02

**TSCA:** Toxic Substances Control Act

Source: EPA  
Telephone: 202-260-5521

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/98  
Database Release Frequency: Every 4 Years

Date of Last EDR Contact: 10/24/01  
Date of Next Scheduled EDR Contact: 01/21/02

**FTTS:** FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

Source: EPA/Office of Prevention, Pesticides and Toxic Substances  
Telephone: 202-564-2501

FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/25/01  
Database Release Frequency: Quarterly

Date of Last EDR Contact: 12/26/01  
Date of Next Scheduled EDR Contact: 03/25/02

**FTTS INSP:** FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

Source: EPA  
Telephone: 202-564-2501

Date of Government Version: 10/25/01  
Database Release Frequency: Quarterly

Date of Last EDR Contact: 12/26/01  
Date of Next Scheduled EDR Contact: 03/25/02

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

## STATE OF MISSOURI ASTM STANDARD RECORDS

### **SHWS:** Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites

Source: Department of Natural Resources

Telephone: 573-751-1990

State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 12/31/01

Date Made Active at EDR: 01/21/02

Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 01/07/02

Elapsed ASTM days: 14

Date of Last EDR Contact: 01/07/02

### **SWF/LF:** Solid Waste Facility List

Source: Department of Natural Resources

Telephone: 573-751-5401

Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 10/01/01

Date Made Active at EDR: 11/13/01

Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 10/24/01

Elapsed ASTM days: 20

Date of Last EDR Contact: 10/24/01

### **LUST:** Leaking Underground Storage Tanks

Source: Department of Natural Resources

Telephone: 573-751-0135

Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 08/23/01

Date Made Active at EDR: 09/19/01

Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 09/04/01

Elapsed ASTM days: 15

Date of Last EDR Contact: 10/16/01

### **UST:** Petroleum Storage Tanks

Source: Department of Natural Resources

Telephone: 573-751-0135

Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 08/23/01

Date Made Active at EDR: 09/24/01

Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 09/04/01

Elapsed ASTM days: 20

Date of Last EDR Contact: 10/16/01

### **VCP:** Sites Participating in the Voluntary Cleanup Program

Source: Department of Natural Resources

Telephone: 573-526-8913

Date of Government Version: 10/16/01

Date Made Active at EDR: 11/30/01

Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 10/19/01

Elapsed ASTM days: 42

Date of Last EDR Contact: 10/16/01

## STATE OF MISSOURI ASTM SUPPLEMENTAL RECORDS

### **AST:** Aboveground Petroleum Storage Tanks

Source: Department of Natural Resources

Telephone: 573-751-3176

Registered Aboveground Storage Tanks.

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 08/23/01  
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 10/16/01  
Date of Next Scheduled EDR Contact: 01/14/02

**RRC:** Certified Hazardous Waste Resource Recovery Facilities  
Source: Department of Natural Resources  
Telephone: 573-751-3176

Date of Government Version: 12/19/01  
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 12/18/01  
Date of Next Scheduled EDR Contact: 03/18/02

## EDR PROPRIETARY HISTORICAL DATABASES

**Former Manufactured Gas (Coal Gas) Sites:** The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

### **Disclaimer Provided by Real Property Scan, Inc.**

The information contained in this report has predominantly been obtained from publicly available sources produced by entities other than Real Property Scan. While reasonable steps have been taken to insure the accuracy of this report, Real Property Scan does not guarantee the accuracy of this report. Any liability on the part of Real Property Scan is strictly limited to a refund of the amount paid. No claim is made for the actual existence of toxins at any site. This report does not constitute a legal opinion.

## OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

**Oil/Gas Pipelines/Electrical Transmission Lines:** This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines and electrical transmission lines.

**Sensitive Receptors:** There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

**Flood Zone Data:** This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

**NWI:** National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 1999 from the U.S. Fish and Wildlife Service.

## GEOCHECK<sup>®</sup> - PHYSICAL SETTING SOURCE ADDENDUM

### TARGET PROPERTY ADDRESS

WESTINGHOUSE ELECTRIC COMPANY  
3300 STATE ROUTE P  
FESTUS, MO 63028

### TARGET PROPERTY COORDINATES

Latitude (North):	38.208500 - 38° 12' 30.6"
Longitude (West):	90.476196 - 90° 28' 34.3"
Universal Transverse Mercator:	Zone 15
UTM X (Meters):	720976.6
UTM Y (Meters):	4231754.0

EDR's GeoCheck Physical Setting Source Addendum has been developed to assist the environmental professional with the collection of physical setting source information in accordance with ASTM 1527-00, Section 7.2.3. Section 7.2.3 requires that a current USGS 7.5 Minute Topographic Map (or equivalent, such as the USGS Digital Elevation Model) be reviewed. It also requires that one or more additional physical setting sources be sought when (1) conditions have been identified in which hazardous substances or petroleum products are likely to migrate to or from the property, and (2) more information than is provided in the current USGS 7.5 Minute Topographic Map (or equivalent) is generally obtained, pursuant to local good commercial or customary practice, to assess the impact of migration of recognized environmental conditions in connection with the property. Such additional physical setting sources generally include information about the topographic, hydrologic, hydrogeologic, and geologic characteristics of a site, and wells in the area.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata. EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## **GROUNDWATER FLOW DIRECTION INFORMATION**

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

## **TOPOGRAPHIC INFORMATION**

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

## **USGS TOPOGRAPHIC MAP ASSOCIATED WITH THIS SITE**

Target Property: 2438090-B4 FESTUS, MO  
Source: USGS 7.5 min quad index

## **GENERAL TOPOGRAPHIC GRADIENT AT TARGET PROPERTY**

Target Property: General SE

Source: General Topographic Gradient has been determined from the USGS 1 Degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

## **HYDROLOGIC INFORMATION**

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

## **FEMA FLOOD ZONE**

<u>Target Property County</u> JEFFERSON, MO	<u>FEMA Flood Electronic Data</u> YES - refer to the Overview Map and Detail Map
Flood Plain Panel at Target Property:	2908080110B / CBPP
Additional Panels in search area:	2908080120C / CBPP

## **NATIONAL WETLAND INVENTORY**

<u>NWI Quad at Target Property</u> FESTUS	<u>NWI Electronic Data Coverage</u> YES - refer to the Overview Map and Detail Map
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## **HYDROGEOLOGIC INFORMATION**

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## AQUIFLOW®

Search Radius: 2.000 Miles.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

<u>MAP ID</u>	<u>LOCATION FROM TP</u>	<u>GENERAL DIRECTION GROUNDWATER FLOW</u>
Not Reported		

## GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

## GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

### ROCK STRATIGRAPHIC UNIT

Era:	Paleozoic
System:	Ordovician
Series:	Lower Ordovician (Canadian)
Code:	O1b(decoded above as Era, System & Series)

### GEOLOGIC AGE IDENTIFICATION

Category: Stratified Sequence

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

## DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

Soil Component Name:	GATEWOOD
Soil Surface Texture:	cherty - silt loam
Hydrologic Group:	Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.
Soil Drainage Class:	Moderately well drained. Soils have a layer of low hydraulic conductivity, wet state high in the profile. Depth to water table is 3 to 6 feet.

## GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Hydric Status: Soil does not meet the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel: HIGH

Depth to Bedrock Min: > 20 inches

Depth to Bedrock Max: > 40 inches

Soil Layer Information							
Layer	Boundary		Soil Texture Class	Classification		Permeability Rate (in/hr)	Soil Reaction (pH)
	Upper	Lower		AASHTO Group	Unified Soil		
1	0 inches	5 inches	cherty - silt loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 2.00 Min: 0.60	Max: 7.30 Min: 5.10
2	5 inches	29 inches	cherty - silty clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Fat Clay.	Max: 0.20 Min: 0.06	Max: 7.30 Min: 5.10
3	29 inches	36 inches	very channery - clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Fat Clay.	Max: 0.20 Min: 0.06	Max: 7.80 Min: 6.10
4	36 inches	40 inches	unweathered bedrock	Not reported	Not reported	Max: 0.06 Min: 0.01	Max: 0.00 Min: 0.00

### OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: flaggy - silty clay loam  
silt loam  
loam  
cherty - loam

Surficial Soil Types: flaggy - silty clay loam  
silt loam  
loam  
cherty - loam

Shallow Soil Types: silty clay  
silty clay loam  
very cherty - silty clay loam  
silt loam  
very cherty - loam  
extremely cherty - loam

Deeper Soil Types: silty clay

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

fine sandy loam  
 clay loam  
 very cherty - loam  
 very cherty - silty clay loam  
 very cherty - silty clay  
 very cherty - clay

## ADDITIONAL ENVIRONMENTAL RECORD SOURCES

According to ASTM E 1527-00, Section 7.2.2, "one or more additional state or local sources of environmental records may be checked, in the discretion of the environmental professional, to enhance and supplement federal and state sources... Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are reasonably ascertainable, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the records review (see 7.1.1), and (3) whether they are obtained, pursuant to local, good commercial or customary practice." One of the record sources listed in Section 7.2.2 is water well information. Water well information can be used to assist the environmental professional in assessing sources that may impact groundwater flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

## WELL SEARCH DISTANCE INFORMATION

<u>DATABASE</u>	<u>SEARCH DISTANCE (miles)</u>
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

## **FEDERAL USGS WELL INFORMATION**

<u>MAP ID</u>	<u>WELL ID</u>	<u>LOCATION FROM TP</u>
A1	381231090283201	0 - 1/8 Mile ENE
A4	381229090284001	0 - 1/8 Mile WSW
5	381227090284401	1/8 - 1/4 Mile WSW
6	381207090284101	1/4 - 1/2 Mile SSW
7	381209090285201	1/4 - 1/2 Mile SSW
8	381153090281301	1/2 - 1 Mile SSE
9	381144090281301	1/2 - 1 Mile SSE

## **FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION**

<u>MAP ID</u>	<u>WELL ID</u>	<u>LOCATION FROM TP</u>
A3	MO6182293	0 - 1/8 Mile ENE

Note: PWS System location is not always the same as well location.

## **STATE DATABASE WELL INFORMATION**

<u>MAP ID</u>	<u>WELL ID</u>	<u>LOCATION FROM TP</u>
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# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## STATE DATABASE WELL INFORMATION

MAP ID

A2

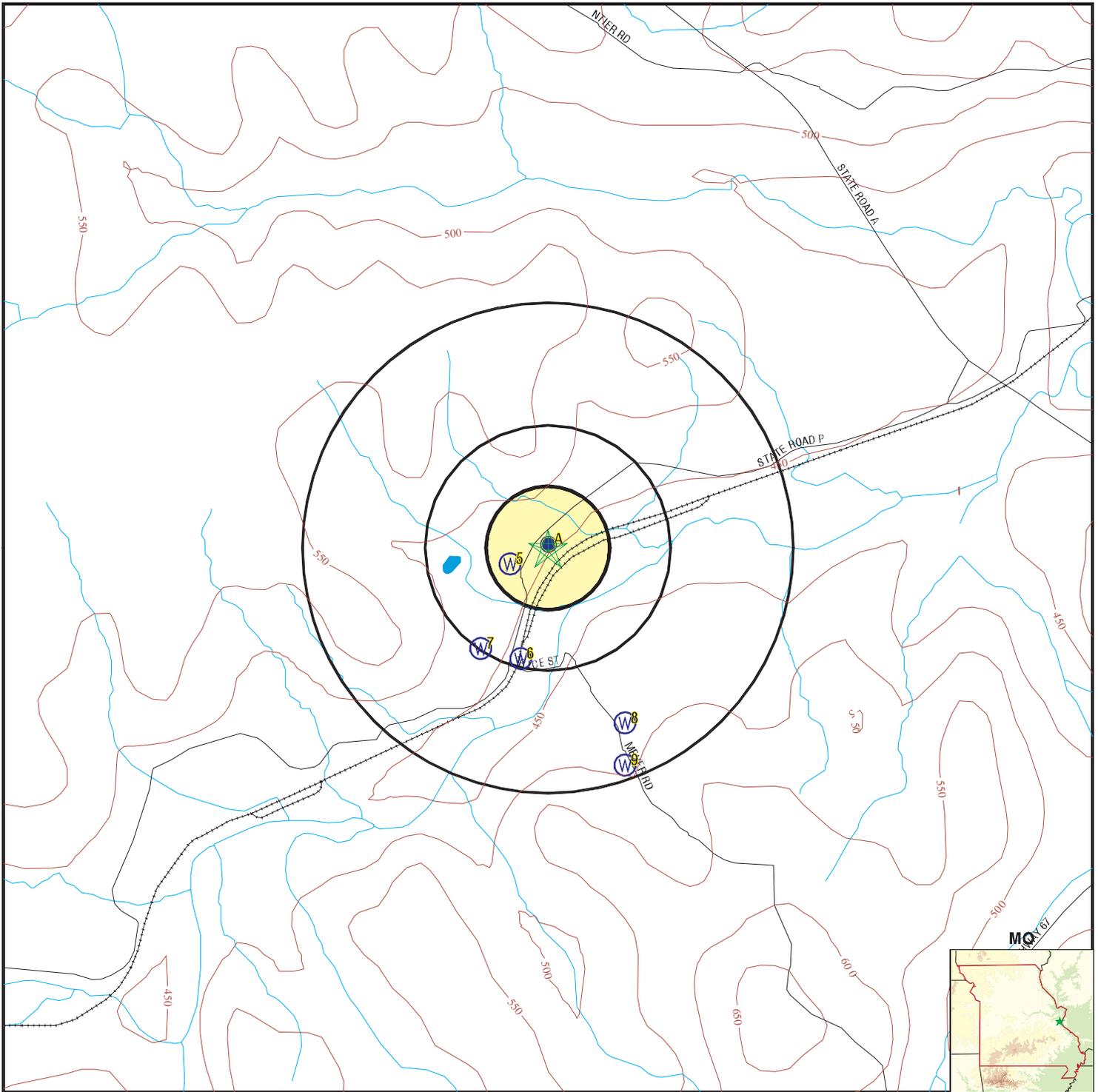
WELL ID

767

LOCATION  
FROM TP

0 - 1/8 Mile NNE

# PHYSICAL SETTING SOURCE MAP - 728637.1s



- Major Roads
- Contour Lines
- Water Wells
- Public Water Supply Wells
- Groundwater Flow Direction
- Indeterminate Groundwater Flow at Location
- Groundwater Flow Varies at Location
- Cluster of Multiple Icons



Earthquake epicenter, Richter 5 or greater



**TARGET PROPERTY:** Westinghouse Electric Company  
**ADDRESS:** 3300 State Route P  
**CITY/STATE/ZIP:** Festus MO 63028  
**LAT/LONG:** 38.2085 / 90.4762

**CUSTOMER:** Leggette Brashears & Graham  
**CONTACT:** Kerry L. Nikolaisen  
**INQUIRY #:** 728637.1s  
**DATE:** January 29, 2002 11:48 am

# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID  
Direction  
Distance  
Elevation

Database      EDR ID Number

**A1**  
**ENE**  
**0 - 1/8 Mile**  
**Higher**

**FED USGS      381231090283201**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1956	County:	Jefferson
Altitude:	436.00 ft.	State:	Missouri
Well Depth:	600.00 ft.	Topographic Setting:	Valley flat
Depth to Water Table:	13.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	01011956	Prim. Use of Water:	Industrial

**A2**  
**NNE**  
**0 - 1/8 Mile**  
**Higher**

**MO WELLS      767**

PWS Well Number:	767		
Public Water Supply Wells ID:	40535		
PWS Name:	Hematite	PWS ID:	MO 6050357 101
Wells ID:	40535	Well Number:	1
Area:	0.000000	Perimeter:	0.000000
Local Name:	Not Reported	Establishment Num:	357
Facility Num:	5	Facility Type:	Service
Lat/Long:	38.209080 -90.475680	X,Y Coord:	721019.900000 / 4.231820e+006
Degrees Lat/Long:	38 12 32.7 N / 90 28 32.5 W	Map Name:	Festus
Federal IPS:	29099	County:	Jefferson
Region:	St. Louis	Region Num:	6
Drill Date:	0	Total Depth (Feet):	0.000
Casing Depth (Feet):	0.000000	Casing Diameter (Inches):	0.000000
Casing Type:	Not Reported	Drawdown (Feet):	0.0
Screen Size:	0.0	Screen Length:	0.0
Yield Gal/Min:	0	Static Level:	0.0
Material:	Not Reported	Head (Feet):	0.0
Top Seal Condition:	Not Reported	Bottom Seal Condition:	Not Reported
Pump Type:	Not Reported	Pump Manufacturer:	Not Reported
Pump Capacity (Gal/Min):	0	Pump Depth (Feet):	0
Pump Test Date:	0	Well Is Metered:	Not Reported
Standby Power:	Not Reported	Surface Drain Condition:	Not Reported
Chlorinated:	No	Filtered:	No
Volatile Organic Chemicals:	No	Nitrates:	No
Surface Water Influenced:	Not Reported	State Approved Well:	Not Reported
Distribution System:	Yes	Num Wells Abandoned:	0
Num Wells Plugged:	0	Date of Data Entry:	03/23/93
Geological Formation Yielding Water:	Not Reported		

**A3**  
**ENE**  
**0 - 1/8 Mile**  
**Higher**

**FRDS PWS      MO6182293**

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

PWS ID: MO6182293      PWS Status: Active  
 Date Initiated: April / 92      Date Deactivated: Not Reported  
 PWS Name: ABB COMBUSTION ENGINE  
 BOX 107  
 3300 STATE RD P  
 HEMITITE, MO 63047

Addressee / Facility: Not Reported

Facility Latitude: 38 12 32      Facility Longitude: 090 28 30  
 City Served: ABB COMBUSTION  
 Treatment Class: Untreated      Population: 112

PWS currently has or had major violation(s) or enforcement: Yes

### VIOLATIONS INFORMATION:

Violation ID:	9412124	Source ID:	Not Reported	PWS Phone:	Not Reported
Vio. beginning Date:	12/01/93	Vio. end Date:	12/31/93	Vio. Period:	1 Month
Num required Samples:	Not Reported	Number of Samples Taken:	Not Reported		
Analysis Result:	Not Reported	Maximum Contaminant Level:	Not Reported		
Analysis Method:	Not Reported				
Violation Type:	Monitoring, Routine Major (TCR)				
Contaminant:	COLIFORM (TCR)				
Vio. Awareness Date:	Not Reported				

### ENFORCEMENT INFORMATION:

System Name:	ABB COMBUSTION	EN		
Violation Type:	Monitoring, Routine Major (TCR)			
Contaminant:	COLIFORM (TCR)			
Compliance Period:	1995-01-01 - 1995-01-31		Analytical Value:	00000000.00
Violation ID:	9500149	Enforcement ID:	9500001E	
Enforcement Date:	1995-03-30	Enf. Action:	State Public Notif Requested	
System Name:	ABB COMBUSTION	EN		
Violation Type:	Monitoring, Routine Major (TCR)			
Contaminant:	COLIFORM (TCR)			
Compliance Period:	1995-01-01 - 1995-01-31		Analytical Value:	00000000.00
Violation ID:	9500149	Enforcement ID:	9500002E	
Enforcement Date:	1995-03-30	Enf. Action:	State Violation/Reminder Notice	
System Name:	ABB COMBUSTION ENG NUCLEAR			
Violation Type:	Monitoring, Routine Major (TCR)			
Contaminant:	COLIFORM (TCR)			
Compliance Period:	1999-09-01 - 1999-09-30		Analytical Value:	0000000.000000000
Violation ID:	9900001	Enforcement ID:	99E0001	
Enforcement Date:	1999-10-29	Enf. Action:	State Violation/Reminder Notice	
System Name:	ABB COMBUSTION ENG NUCLEAR			
Violation Type:	Monitoring, Routine Major (TCR)			
Contaminant:	COLIFORM (TCR)			
Compliance Period:	1999-09-01 - 1999-09-30		Analytical Value:	0000000.000000000
Violation ID:	9900001	Enforcement ID:	99E0002	
Enforcement Date:	1999-10-29	Enf. Action:	State Public Notif Requested	
System Name:	ABB COMBUSTION ENG NUCLEAR			
Violation Type:	Monitoring, Routine Major (TCR)			
Contaminant:	COLIFORM (TCR)			
Compliance Period:	1999-09-01 - 1999-09-30		Analytical Value:	0000000.000000000
Violation ID:	9900001	Enforcement ID:	00E0001	
Enforcement Date:	1999-11-22	Enf. Action:	State Public Notif Received	

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

### ENFORCEMENT INFORMATION:

System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	ALUMINUM	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000020		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	ARSENIC	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000021		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	BARIUM	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000022		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CADMIUM	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000023		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CHLORIDE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000024		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CHROMIUM	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000025		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CYANIDE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000026		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	FLUORIDE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000027		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	IRON	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000028		
Enforcement Date:	Not Reported		

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

### ENFORCEMENT INFORMATION:

System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	MANGANESE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000029		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	MERCURY	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000030		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	NICKEL	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000031		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	SELENIUM	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000032		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	SILVER	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000033		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	SULFATE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000034		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	ANTIMONY, TOTAL	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000035		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	BERYLLIUM, TOTAL	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000036		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	THALLIUM, TOTAL	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000037		
Enforcement Date:	Not Reported		

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

### ENFORCEMENT INFORMATION:

System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	ZINC	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000038		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	PH	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000039		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	TOTAL DISSOLVED SOLIDS (TDS)	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000040		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,2,4-TRICHLOROBENZENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000041		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CIS-1,2-DICHLOROETHYLENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000042		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	XYLENES, TOTAL	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000043		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	METHYLENE CHLORIDE (DICHLOROMETHANE)	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000044		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	O-DICHLOROBENZENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000045		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	P-DICHLOROBENZENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000046		
Enforcement Date:	Not Reported		

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

### ENFORCEMENT INFORMATION:

System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	VINYL CHLORIDE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000047		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,1-DICHLOROETHYLENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000048		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	TRANS-1,2-DICHLOROETHYLENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000049		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,2-DICHLOROETHANE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000050		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,1,1-TRICHLOROETHANE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000051		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	CARBON TETRACHLORIDE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000052		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,2-DICHLOROPROPANE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000053		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	TRICHLOROETHYLENE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000054		
Enforcement Date:	Not Reported		
System Name:	ABB COMBUSTION ENG NUCLEAR	Analytical Value:	0000000.000000000
Violation Type:	Monitoring, Regular	Enforcement ID:	Not Reported
Contaminant:	1,1,2-TRICHLOROETHANE	Enf. Action:	Not Reported
Compliance Period:	1999-01-01 - 1999-12-31		
Violation ID:	0000055		
Enforcement Date:	Not Reported		

# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

**ENFORCEMENT INFORMATION:**

System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	TETRACHLOROETHYLENE		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000056	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	MONOCHLOROBENZENE (CHLOROBENZENE)		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000057	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	BENZENE		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000058	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	TOLUENE		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000059	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	ETHYLBENZENE		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000060	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Regular		
Contaminant:	STYRENE		
Compliance Period:	1999-01-01 - 1999-12-31	Analytical Value:	0000000.000000000
Violation ID:	0000061	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported
System Name:	ABB COMBUSTION ENG NUCLEAR		
Violation Type:	Monitoring, Routine Major (TCR)		
Contaminant:	COLIFORM (TCR)		
Compliance Period:	1999-09-01 - 1999-09-30	Analytical Value:	0000000.000000000
Violation ID:	9900001	Enforcement ID:	Not Reported
Enforcement Date:	Not Reported	Enf. Action:	Not Reported

**A4**  
**WSW**  
**0 - 1/8 Mile**  
**Higher**

**FED USGS      381229090284001**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1931	County:	Jefferson
Altitude:	430.00 ft.	State:	Missouri
Well Depth:	528.00 ft.	Topographic Setting:	Valley flat
Depth to Water Table:	Not Reported	Prim. Use of Site:	Unused
Date Measured:	Not Reported	Prim. Use of Water:	Unused

## GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID  
Direction  
Distance  
Elevation

Database      EDR ID Number

**5**  
**WSW**  
**1/8 - 1/4 Mile**  
**Higher**

**FED USGS      381227090284401**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1957	County:	Jefferson
Altitude:	447.00 ft.	State:	Missouri
Well Depth:	390.00 ft.	Topographic Setting:	Valley flat
Depth to Water Table:	13.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	09011957	Prim. Use of Water:	Not Reported

**6**  
**SSW**  
**1/4 - 1/2 Mile**  
**Lower**

**FED USGS      381207090284101**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1939	County:	Jefferson
Altitude:	440.00 ft.	State:	Missouri
Well Depth:	67.00 ft.	Topographic Setting:	Valley flat
Depth to Water Table:	18.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	01011939	Prim. Use of Water:	Domestic

**7**  
**SSW**  
**1/4 - 1/2 Mile**  
**Higher**

**FED USGS      381209090285201**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1957	County:	Jefferson
Altitude:	485.00 ft.	State:	Missouri
Well Depth:	140.00 ft.	Topographic Setting:	Hillside (slope)
Depth to Water Table:	55.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	05011957	Prim. Use of Water:	Domestic

**8**  
**SSE**  
**1/2 - 1 Mile**  
**Higher**

**FED USGS      381153090281301**

**BASIC WELL DATA**

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1939	County:	Jefferson
Altitude:	480.00 ft.	State:	Missouri
Well Depth:	70.00 ft.	Topographic Setting:	Hillside (slope)
Depth to Water Table:	35.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	01011939	Prim. Use of Water:	Domestic

# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID  
Direction  
Distance  
Elevation

Database

EDR ID Number

**9**

**SSE**  
**1/2 - 1 Mile**  
**Higher**

**FED USGS**

**381144090281301**

## BASIC WELL DATA

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1954	County:	Jefferson
Altitude:	470.00 ft.	State:	Missouri
Well Depth:	195.00 ft.	Topographic Setting:	Hillside (slope)
Depth to Water Table:	30.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	01011954	Prim. Use of Water:	Unused

# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS RADON

## AREA RADON INFORMATION

Federal EPA Radon Zone for JEFFERSON County: 2

Note: Zone 1 indoor average level > 4 pCi/L.  
 : Zone 2 indoor average level  $\geq$  2 pCi/L and  $\leq$  4 pCi/L.  
 : Zone 3 indoor average level < 2 pCi/L.

Zip Code: 63028

Number of sites tested: 3

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	0.900 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	2.067 pCi/L	67%	33%	0%

# PHYSICAL SETTING SOURCE RECORDS SEARCHED

## HYDROLOGIC INFORMATION

**Flood Zone Data:** This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

**NWI:** National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 1999 from the U.S. Fish and Wildlife Service.

## HYDROGEOLOGIC INFORMATION

### **AQUIFLOW<sup>R</sup> Information System**

Source: EDR proprietary database of groundwater flow information

EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

## GEOLOGIC INFORMATION

### **Geologic Age and Rock Stratigraphic Unit**

Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

### **STATSGO: State Soil Geographic Database**

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the national Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

## ADDITIONAL ENVIRONMENTAL RECORD SOURCES

### **FEDERAL WATER WELLS**

#### **PWS: Public Water Systems**

Source: EPA/Office of Drinking Water

Telephone: 202-260-2805

Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

#### **PWS ENF: Public Water Systems Violation and Enforcement Data**

Source: EPA/Office of Drinking Water

Telephone: 202-260-2805

Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

**USGS Water Wells:** In November 1971 the United States Geological Survey (USGS) implemented a national water resource information tracking system. This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on more than 900,000 wells, springs, and other sources of groundwater.

# PHYSICAL SETTING SOURCE RECORDS SEARCHED

## STATE RECORDS

### Missouri Public Drinking Water Wells

Source: Department of Natural Resources  
Telephone: 573-526-5448

## RADON

**Area Radon Information:** The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

**EPA Radon Zones:** Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

## OTHER

**Epicenters:** World earthquake epicenters, Richter 5 or greater

Source: Department of Commerce, National Oceanic and Atmospheric Administration

**APPENDIX D**  
**Community Relations Plan**

# **COMMUNITY RELATIONS PLAN**

## **Hematite Remedial Investigation/Feasibility Study**

**Hematite, Missouri**

Westinghouse Electric Company  
Hematite Missouri Facility  
3300 State Road P  
Hematite, MO 63047





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## POLICY

### Community Relations Plan

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#### 1.0 Overview of Plan

This Community Relations Plan (“Plan”) describes community interests and concerns related to the investigation and decommissioning of Westinghouse Electric Company’s Hematite, Missouri plant site (the “Plant”). The Plant is located in Hematite, Jefferson County.

The Plan outlines the community relations activities to be completed by Westinghouse at this facility to support the upcoming project to characterize and address contamination at the plant’s buildings and other areas of the property.

A series of interviews were conducted with residential neighbors, adjoining property owners, neighbors and other community leaders and officials during the week of November 5, 2001 (Community Interview Program, Appendix A). Information provided at these interviews was used to determine the interests and concerns of the community before commencing the decommissioning project. That information was reviewed to create a Community Relations Plan specific to the local community and the project to be undertaken.

The community representatives interviewed for the creation of the Plan expressed an interest in the following issues as the project moves forward:

- The communication of accurate and timely information regarding the progress and results of the project, and the plans for upcoming work,
- The development of informational materials that explain the project in easy-to-understand terms,
- The potential use of the property at the conclusion of the decommissioning project, and the options available to re-develop the former plant and buffer areas,
- The protection of ground and surface water resources in the area,
- The need to manage the project safely and prevent the potential for off-site impacts from ongoing work,
- The safe transport of material removed from the property for disposal off-site, and
- The management of the project to ensure all contamination is identified and removed.

Westinghouse is undertaking the project in conformance with regulations and licensing requirements established by the United States Nuclear Regulatory Commission (“NRC”). These activities will be conducted under the auspices of, and with oversight by, both the NRC and the Missouri Department of Natural Resources (“MDNR”). To the extent applicable, the work will be conducted in a manner consistent with the Comprehensive

## POLICY

### Community Relations Plan

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Environmental Response, Compensation, and Liability Act of 1980 (“CERCLA” or “Superfund”) and its implementing regulations, the National Contingency Plan (“NCP”). To that end, Westinghouse will coordinate its activities with appropriate federal, state, and local agencies and officials (Public Official Contacts, Appendix B)

The Community Relations Plan is intended to keep the public informed of site-related developments and to give residents and local officials the opportunity to review and comment on plans for the decommissioning effort. It will be reviewed and updated at least annually.

The Plan is divided into the following sections:

- Overview of Plan
- Capsule site description
- Community background
- Highlights of the community relations program
- Activities and timing

## 2.0 Capsule Site Description

The Plant is located approximately four miles west of Festus, Missouri and 35 miles south of St. Louis. Occupying 137,000 square feet (approximately 8 acres) on 228 contiguous acres, the Plant is located in the southeastern portion of Jefferson County. State Highway P dissects the Westinghouse property. The plant footprint is bounded by the West Creek, the East Creek and Joachim Creek, along with a Union Pacific Railroad right of way located immediately to the southeast of the plant security fence. The West and East creeks are tributaries of Joachim Creek.

The Plant was the oldest nuclear fuel cycle facility in the United States. It first opened in 1956 as a nuclear fuels research and development facility for the Mallinkrodt Nuclear Corporation. Mallinkrodt entered a joint venture with two other companies to create the United Nuclear Corporation (“UNC”) in April 1961. Given this venture, the Plant was transferred to UNC on May 31, 1961. This joint venture created the nation’s first nuclear service organization, manufacturing nuclear fuel for both the federal government and commercial customers.

In 1970 the Plant began operating under the Gulf United Nuclear Fuels Corporation (“Gulf”), which was formed by the Gulf Corporation and UNC. After discontinuing aspects of its nuclear fuel business in 1974, Gulf sold the plant to Combustion Engineering, Inc.

The ownership of the facility changed again in 1989 when ABB purchased the stock of Combustion Engineering, forming ABB/Combustion Engineering. Finally, Westinghouse purchased the nuclear operations of ABB in April 2000, and consolidated nuclear fuel manufacturing work at its Columbia, South Carolina facility.

## POLICY

### Community Relations Plan

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The Plant has processed various forms of uranium throughout its history, including uranium hexafluoride, uranium metal, and uranium oxides. Perchloroethylene (PCE) was used as a process catalyst until the early 1970s. Trichloroethane (TCE) was used as a manufacturing aid until the late 1980s, and as a degreaser until the early 1990s. Other chemicals used at the Plant include ammonia, hydrogen peroxide, nitric acid, and sodium hydroxide. Hydrogen fluoride (HF) gas was generated as a by-product of converting uranium hexafluoride into uranium dioxide. Limestone scrubbers were used to control HF emissions until 1997, when they were replaced with wet scrubbers that produced hydrofluoric acid.

Since purchasing the Plant, Westinghouse has learned of PCE and TCE contamination in groundwater in and around the Plant property, most notably in eight drinking water wells to the south and east. Westinghouse and its consultants have also determined the potential for radiological and chemical contamination in specific areas of the Plant and property. These areas include former burial pits and evaporation ponds, production areas, limestone storage piles and other portions of the plant and property immediately surrounding the plant.

Currently, Westinghouse is implementing an emergency action to promptly address the contaminated drinking water wells. The action includes provision of bottled water to potentially affected residents, filtration systems for wells with measurable chemical contamination, and a hydrogeologic investigation to determine the scope of the problem and potential long-term solutions. Westinghouse is also implementing its demobilization program, relocating equipment to the company's Columbia facility and preparing the Plant for site characterization. Once the equipment is removed and relocated, Westinghouse employees and contractors will begin characterizing both the buildings and property for radiological and non-radiological contamination.

### **3.0 Community Background**

#### **3.1. Community Profile**

The origin of Jefferson County is rooted in the Louisiana Purchase of 1803. Established on December 8, 1818 by an "Act of the Territory", Jefferson County was formed out of portions of St. Louis and St. Genevieve counties. Named after Thomas Jefferson, the third President of the United States and the father of the Louisiana Purchase, the county supported the economy of St. Louis.

Jefferson County, in particular the town of Herculaneum, produced bushels of flour and barrels of whiskey that was sent to the growing city of St. Louis. In 1821 it is estimated that over 150,000 bushels of wheat were produced in the Herculaneum area.

Missouri gained statehood that same year, and Jefferson County's local government began to take shape. In 1825 the first county court was established in Herculaneum to serve the nation's newest frontier. By 1831 the lead smelting business in Herculaneum

## POLICY

### Community Relations Plan

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began to decline, and the county seat was moved to a more central location, the town of Hillsboro.

As the county laid its judicial foundation, its residents continued using land for agricultural use. Industrial and manufacturing facilities were soon developed in several communities. In 1857, the Iron Mountain Railroad entered the county from St. Louis. The arrival of railroads provided the establishment of railroad shops and solidified the county's industrial potential.

In the mid-1800's, the sand of Jefferson County was found to be of sufficient quality to support plate glass manufacturing. In addition to sand mining operations, lead smelting entered a period of increased production. By 1880, Jefferson County was a key to the opening of the west, as railroads and other industry were established.

Industry prospered in Jefferson County at the turn of the century as the county's population steadily increased. During the 1930's the county constructed an extensive road system that was the foundation for the current transportation system. Residents of St. Louis began to relocate in suburban areas such as Jefferson County in greater numbers after World War II.

Jefferson County now serves as a suburb to St. Louis and houses several industrial facilities, including Doe Run Lead Company, American Can Company, Foster Forbes Glass Company, Union Pacific Railroad, Anheuser Busch/Metal Container, Imperial Plastics, Dow Chemical Company, United Engineering, and River Cement Company. Commercial, service, professional and retail businesses also support the county's economy. The county's residential population has increased over the past several decades, with many residents working in both northern Jefferson County and in the greater St. Louis area.

Several towns and unincorporated settlements are wholly or partly within a 5-mile radius of the Plant. Hematite is the closest settlement, and is a bedroom community having about 125 people. Festus and Crystal City, located 3.5 miles east of the site and having a combined population of about 13,900 people, are the nearest towns of significant size. They are the county's second largest incorporated community, and include a substantial amount of commercial and retail businesses.

Town or Settlement	Direction from Plant	Distance from Plant	1990 Census	2000 Census
Crystal City	E	4.5	4,088	4,247
DeSoto	SW	5	5,993	6,375
Festus	E	3.5	8,105	9,660
Hematite	SW	0.5	125	
Hillsboro	NW	5	1,625	1,675
Horine	NE	5	1,043	923
Mapaville	N	3.5	100	

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Town or Settlement	Direction from Plant	Distance from Plant	1990 Census	2000 Census
Olympian Village	S	5	669	669
Victoria	SW	3	100	

The county's average population density is 301 people per square mile based on the total estimated 2000 census population of 198,099 persons and an area of 657 square miles. Most of the population is White (193,102), followed by Black or African American (1,354), Asian (708), American Indian or Alaska Native (577), and other races. The median annual income is approximately \$45,000. Owner-occupied housing units outnumber renter-occupied units by a ratio of approximately 6 to 1. The average size of an owner-occupied household is 2.81 people; the average size of a renter-occupied household is 2.42 people (see additional demographic information for Jefferson County, Appendix C)

### **3.2. Community Environmental Concerns**

The people interviewed for the creation of this Community Relations Plan had a general understanding of the operations of the plant and the need to address contamination from previous operations. The specific scope of the decommissioning project and the current condition of the property was less clear among residents and community leaders. The managers of the plant were consistently credited with establishing better communications over recent years to inform the residents of Hematite and local government about the facility's operations.

Environmental concerns in the community are related to both former and active industrial facilities, along with concerns over groundwater contamination from inadequate on-lot septic systems. People were aware of contamination on a former plant owned by PPG Industries in Crystal City, and expressed concern over elevated lead emissions from an operating smelter in Herculaneum. Concerns over air emissions also focused on cement manufacturing operations, including a contentious plan to construct a new cement kiln just over the southern border with St. Genevieve County. Air emissions as they relate to automobiles and trucks were also raised as a public health concern.

Community leaders also cited several past or ongoing environmental cleanup projects in the St. Louis area. Cited most frequently was the removal of PCBs from Times Beach, and the Weldon Spring Site Remedial Action Project in St. Charles County, being undertaken by the U.S. Department of Energy.

### **3.3. Key Community Concerns Relating to the Project**

Concerns regarding the Hematite decommissioning project focused on several general topics. While the plant's recent efforts to provide information to community leaders and residents was cited as helpful, a number of people expressed a concern about unknown types and amounts of contamination that might be present from past operations. In a

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similar vein, residents expressed concern that the site characterization and decommissioning effort may not identify all areas of contamination around the plant, resulting in some continued contamination.

The potential impact to groundwater and streams from any contamination was also cited as a concern, given the use of groundwater by many people as their primary drinking water source.

The subsequent discovery of solvents in some off-site private drinking water wells, found in early 2002, resulted in concern among area residents. The need for ongoing communication regarding the status of Westinghouse's groundwater investigation and plans to address groundwater conditions was raised during community meetings hosted by government regulators and Westinghouse.

The logistics of transporting materials off-site was raised as a concern, particularly regarding the safety systems in place to prevent rail or truck accidents. The transport of radioactive materials through St. Louis has been a contentious issue among some leaders of that county. In Hematite, residents and community leaders cited the use of State Highway P as a primary school bus route for the Festus R-6 School District, and concerns over transportation safety during the hours buses would drive on the highway.

Given the need to dismantle buildings and disturb earth during removal operations, residents expressed concern about measures available to prevent fugitive dust emissions and other construction-related off-site impacts.

Finally, while not directly related to environmental concerns, residents expressed significant interest in the potential that the property might be used for another purpose following the decommissioning project. The options ranged from the construction of a new industrial park to the use of some land for agricultural purposes.

#### **4.0 Highlights of the Community Relations Program**

The Plan for the Hematite Project is intended to provide information and seek community input as the project is conducted and completed. Among the elements included in the plan are the following:

- Information Repository: A repository has been established for use by the public in the Festus Public Library. The repository will contain relevant project documents and will be available by appointment during normal business hours.
- Project Contact: A single point of contact will be established for the public to call with questions regarding the project. Kevin Hayes, Environment, Health and Safety Manager will serve as the project contact. Contact information will be included in project communications to the public.

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- Mailing List: A mailing list consisting of nearby residents, elected officials, adjacent property owners, and other interested individuals will be maintained and updated during the course of the project.
- Informational Letters/Updates: Informational updates will be distributed to people on the project mailing list according to a milestone-based schedule. Project updates will be written in a clear and simplified manner, and distributed as needed to report the project's progress, the results of previous work and plans for upcoming work. These materials may be presented as Fact Sheets for public meetings/availability sessions, public speaking engagements, or mailings.
- Newspaper Notice: A newspaper notice will be published in *The St. Louis Post-Dispatch – Jefferson County* edition (the local newspaper of general circulation for the Hematite area) to announce the availability of the proposed plan(s) for the Plant. Each notice will provide a summary of the proposed decommissioning project, advise of the availability of the information repository to the public, and announce the opportunity to provide written or oral comments to the proposed plan.
- Informational meetings/availability sessions: Public meetings or availability sessions will be conducted, at a minimum, in concurrence with all public comment periods. In addition, public meetings or availability sessions will be conducted to present significant plans for the decommissioning project, or to report significant results of environmental investigations undertaken at the facility. These activities allow community members to receive and provide input regarding the plans to address each area at the plant before implementation of the remedy.
- Community Advisory Group: Attendance or presentations with a Community Advisory Group may be conducted, upon request of the group or Westinghouse, to discuss the results of completed work and upcoming plans under the decommissioning project. These activities allow the group's members to receive and provide input regarding the plans to address each area at the plant before implementation of the remedy.
- Community speaking engagements: Opportunities for informational meetings and presentations include a monthly "Need to Know" community event at the First Christian Church in Hematite, a monthly Twin Cities Chamber of Commerce breakfast meeting, civic groups such as Rotary and Kiwanis, and regular meetings of the Jefferson County Commission.
- Media Relations: Project managers will maintain communication with local news media through the distribution of project updates and other information sent to the mailing list, and will be available to answer questions from local reporters (Media Contact List, Appendix D).

## **5.0 Environmental Process**

Areas at and around the Plant that require investigation and cleanup may be subject to two federal environmental processes. One is conducted under decommissioning and decontamination (D&D) rules issued by the NRC for radiological contaminants. The other is the Comprehensive environmental Response, Compensation, and Liability Act (CERCLA) under rules issued by the MDNR for chemical contaminants. The basic sequence of events for these processes is as follows:

- Remedial investigation, which consists of comprehensive environmental monitoring and sampling programs for potential contaminants of concern
- Feasibility study, which determines credible corrective actions for contaminants that are discovered during remedial investigation
- Obtain License amendments or decommissioning plans through the NRC, which includes opportunities for public review and comment
- Obtain permits and remedy selection through the DNR, which includes opportunities for public review and comment
- Implement the approved remedies
- Verify the remedies were effective

## **6.0 Activities and Timing**

The actions described below provide a framework for conducting community relations during the Hematite decommissioning project. The specific communications activities needed to support D&D and CERCLA activities will remain flexible, however, based on the results of work completed and additional sampling or technical review to address site conditions during the course of the project.

The following elements of the community relations plan have been implemented:

- Community interviews
- Creation of the information repository
- Designation of the project contact
- Establishment of a project mailing list
- Development of a general project summary for distribution to the mailing list

The following elements will be implemented as warranted based on project developments, and in conjunction with required public comment periods, during the course of conducting the site characterization and the emergency removal action for groundwater contamination:

- Distribution of project updates and status reports on results of characterization and plans for upcoming work at public meetings or availability sessions,
- Presentations to community and business groups, local government and others if requested

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- Interviews with local reporters regarding the status of the project

The following elements will be implemented upon the development of a proposed remedy for the buildings and plant grounds:

- Development of a proposed decommissioning plan, along with a public notice of availability of that plan for review and comment
- Notification of the proposed decommissioning plan to the project mailing list
- Presentations to update community, business and government groups
- Solicitation of public comment on the plan for each area of the plant through ongoing project updates, telephone discussions with the designated project contact, and a public meeting to accept community input regarding the project.

The following elements will be implemented upon the selection of the proposed decommissioning for the buildings and grounds:

- Development of a record of decision (“ROD”) or other appropriate decision document, including a summary of responses to comments raised by the public
- Availability of Westinghouse Electric Company representatives to answer questions of community officials, nearby residents and the news media
- Distribution of a project update to the mailing list summarizing the plans and schedule for each phase of the decommissioning work to be completed

#### **7.0 Forms**

None

#### **8.0 Appendices**

Appendix A, Community Interview Program  
Appendix B, Public Official Contacts  
Appendix C, Jefferson County, Missouri Demographics  
Appendix D, News Media Contacts

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**APPENDIX A**

**COMMUNITY INTERVIEW PROGRAM**

Westinghouse conducted a series of interviews with more than 20 people in the area of the Hematite Plant in November 2001 for the development of the Community Relations Plan. Descriptions of the individuals interviewed are provided below.

1. Residential neighbors (7)
2. Local religious leader (1)
3. Local school district superintendent (1)
4. Local and county government officials (4)
5. County public health managers (2)
6. State and federal elected officials (3)
7. Local emergency response and fire protection officials (2)
8. Local business leader (1)

Each person interviewed had the opportunity to present their concerns about the plans to decommission the plant and provide input regarding the needs and interests of the community. A list of questions raised during these meetings is provided below:

1. How long have you lived in the area?
2. What do you know about the former fuel manufacturing plant in Hematite?
3. Are you aware of any potential environmental concerns related to the plant?; if aware, when and how did you become aware of them?
4. Are you aware of any other environmental or health concerns in the area? If aware, how do you think those concerns might impact or influence this decommissioning project?
5. What types of issues or concerns do you have about the plan to conduct this decommissioning project?
6. What methods of communication do you believe would be most effective in reaching the community and involving them in this project?
7. How would you like to be involved in the project, and how do you think others might like to be involved?
8. Do government agencies in Jefferson County use any public communication tools to provide information to the community? If so, what are they and how are they received?
9. How would you prefer to receive information about the decommissioning project?
10. What information or news sources do you feel are viewed as reliable and credible in the community?
11. How do you feel the current and previous owners of the plant have communicated with people in the community?

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**COMMUNITY INTERVIEW PROGRAM**

12. Would you be interested in attending public meetings about the project? Do you believe other people in the community would take an interest in attending these meetings?
13. What location would be most convenient and appropriate for any project-related meetings?
14. Do you have any other thoughts regarding the project or our efforts to provide information that would be useful to us?
15. Do you know of any other people that might be interested in talking with us as we develop this plan?

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**APPENDIX B**

**PUBLIC OFFICIAL CONTACTS**

<b>County</b>	<b>State</b>	<b>Federal</b>
<p><u>Presiding Commissioner</u> Mark Mertens (R)</p> <p><u>1<sup>st</sup> District Commissioner</u> Patrick Lamping (D)</p> <p><u>2<sup>nd</sup> District Commissioner</u> Edward Kemp (D) 300 Second Street P.O. Box 100 Hillsboro, MO 63050 Phone (636) 797-5400 Fax (636) 797-5506</p> <p><u>Jefferson County Health Dept.</u> Dennis Diehl, Director 405 Main Street P.O. Box 437 Hillsboro, MO 63050 Phone (636) 789-3372 Fax (636) 797-4631</p>	<p><u>Governor</u> Bob Holden (D) State Capital, Executive Office Jefferson City, MO 65101 Phone (573) 751-3222 Fax (573) 751-4458</p> <p><u>Senator, 22<sup>nd</sup> District</u> Steve Stoll (D) 3685 West Outer Road Arnold, MO 63010 Phone (636) 282-7622 Fax (636) 287-1887</p> <p><u>Representative, 103<sup>rd</sup> District</u> Mark Abel (D) 508 North Truman Blvd. Crystal City, MO 63019 Phone (636) 933-3911 Fax (636) 937-3507</p> <p><u>Missouri Department of Natural Resources</u> Ben Moore, Project Manager P.O. Box 176 Jefferson City, MO 65102 Phone (636) 441-8030 Fax (636) 447-0729</p> <p><u>Missouri Department of Health and Senior Services</u> Scott Clardy, Section Chief P.O. Box 570 Jefferson City, MO 65102 Phone (573) 751-6435 Fax (573) 526-7377</p>	<p><u>Senator</u> James Talent (R) 111 South 10<sup>th</sup> Street Suite 23.360 St. Louis, MO 63102 Phone (314) 436-3416 Fax (314) 436-9640</p> <p><u>Representative, 3<sup>rd</sup> District</u> Richard Gephardt (D) 998 East Gannon Drive P.O. Box 392 Festus, MO 63028 Phone( 636) 937-6399</p> <p><u>Nuclear Regulatory Commission</u> Chris Miller, Section Chief 801 Warrenville, Road Lisle, IL 60532 Phone (630) 829-9633 Fax (630) 515-1259</p>

**APPENDIX C**

**JEFFERSON COUNTY, MISSOURI DEMOGRAPHICS**

**Population**

Total Population (2000 Census): 198,099

Male: 98,490

Female: 99,609

White: 193,102

African American: 1,354

American Indian: 577

Asian and Pacific Islander: 736

Multi-race: 1,851

**Housing**

Total Housing Units: 75,586

Urban: 49,801

Rural: 25,785

Total Occupied Units: 71,499

Owned: 59,615

Rented: 11,884

Vacant: 4,087

Median Value of Owned Units: \$93,300.

Mean Value of Owned Units: \$104,619.

Median Household Income (Owned and Rented): \$46,206.

Mean Household Income (Owned and Rented): \$53,175.

**Employment**

Total Population Over Age 16: 149,213

Employed: 99,837

Unemployed: 4,776 (4.6%)

Armed Forces: 112

Not in Labor Force: 44,488

**APPENDIX C**

**JEFFERSON COUNTY, MISSOURI DEMOGRAPHICS**

**Income**

Annual Income for 71,567 households (1999 Census):

\$10,000 to \$14,999	-----	3,578 households
\$15,000 to \$19,999	-----	3,502 households
\$20,000 to \$24,999	-----	4,587 households
\$25,000 to \$29,999	-----	4,432 households
\$30,000 to \$34,999	-----	4,982 households
\$35,000 to \$39,999	-----	4,549 households
\$40,000 to \$44,999	-----	4,810 households
\$45,000 to \$49,999	-----	4,048 households
\$50,000 to \$59,999	-----	8,319 households
\$60,000 to \$74,999	-----	9,935 households
\$75,000 to \$99,999	-----	8,939 households
\$100,000 to \$124,999	-----	3,429 households
\$125,000 to \$149,999	-----	1,164 households
\$150,000 to \$199,999	-----	749 households
\$200,000 or more	-----	480 households

Median Household Income: \$46,338.

Mean Household Income: \$53,136.

**Education**

Total Population Over Age 25: 125,956

No Schooling	-----	405
Completed 4 <sup>th</sup> Grade	-----	216
Completed 5 <sup>th</sup> or 6 <sup>th</sup> Grade	-----	876
Completed 7 <sup>th</sup> or 8 <sup>th</sup> Grade	-----	6,750
Completed 9 <sup>th</sup> Grade	-----	3,478
Completed 10 <sup>th</sup> Grade	-----	5,167
Completed 11 <sup>th</sup> Grade	-----	4,805
Completed 12 <sup>th</sup> Grade (no diploma)	-----	4,299
High School Graduates (or GED)	-----	45,773
Attended College Less Than 1 Year	-----	12,562
Attended College More than 1 year (no degree) --		17,613
Earned Associate's Degree	-----	8,722
Earned Bachelor's Degree	-----	10,650
Earned Master's Degree	-----	3,540
Earned Professional School Degree	-----	790
Earned Doctoral Degree	-----	310

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**APPENDIX D**

**NEWS MEDIA CONTACTS**

**Television**

KTVI, Channel 2 (Fox)  
5915 Berthold Avenue  
St. Louis, MO 63110  
Phone (314) 647-2222  
Fax (314) 644-7419

KMOV, Channel 4 (CBS)  
1 Memorial Drive  
St. Louis, MO 63102  
Phone (314) 621-4444  
Fax (314) 444-3367

KSDK, Channel 5 (NBC)  
1000 Market Street  
St. Louis, MO 63101  
Phone (314) 421-5055  
Fax (314) 444-5164

KETC, Channel 9 (Public)  
3655 Olive Street  
St. Louis, MO 63108  
Phone (314) 512-9000  
Fax (314) 512-9005

KPLR, Channel 11 (WB)  
2250 Ball Drive  
St. Louis, MO 63146  
Phone (314) 447-1111  
Fax (314) 447-6433

Metro Networks Fax  
(314) 862-9865

**Newspapers**

St. Louis Post-Dispatch  
Tim Rowden  
1159 West Gannon Drive  
Festus, MO 63028  
Phone (636) 931-1017  
Fax (636) 931-5783

Suburban Journal  
Kevin Carbery  
1405 North Truman Blvd.  
P.O. Box 309  
Festus, MO 63028  
Phone (636) 296-1800  
Fax (636) 931-2638

Jefferson County Leader  
Peggy Scott  
503 North 2<sup>nd</sup>  
P.O. Box 159  
Festus, MO 63028  
Phone (636) 937-7501  
Fax (636) 931-2226

**Radio**

KJFF, 1400 AM (ABC)  
Hal Neisler  
1026 Scenic Drive  
Festus, MO 63028  
Phone (636) 937-7642  
Fax (636) 937-3636

KMOX, 1120 AM  
Jackie Paulus  
1 Memorial Drive  
St. Louis, MO 63102  
Phone (314) 621-2345  
Fax (314) 444-3230

KTRS, 550 AM  
Brian Kelly  
638 Westport Plaza  
St. Louis, MO 63146  
Phone (314) 453-5500  
Fax (314) 453-9704

Metro News Service  
Mary Ann Bargaen  
8251 Maryland Ave, Suite 108  
St. Louis, MO 63105  
Phone (314) 862-5267  
Fax (314) 862-9865

## **ATTACHMENTS**

## **ATTACHMENT 1**

**Responsiveness Summary to MDNR Comments of November 27, 2002 and Previous**

## RI/FS Work Plan Attachment 1

### Responsiveness Summary to MDNR Comments of November 27, 2002 and Previous

**This Document provides responses to the Missouri Department of Natural Resources (MoDNR, DNR or Agency) comments dated November 27, 2002 regarding the revised draft Remedial Investigation/Feasibility Study (RI/FS) work plan (Work Plan or Plan) dated September 12, 2002 for the Hematite site (Site) in Jefferson County Missouri. The MoDNR comments, including any prior comments from the previous draft, are presented in italics for reference. Previous responses by Westinghouse Electric Company LLC (Westinghouse) dated September 12, 2002 are also provided for reference.**

- 1. The document does not bear the seal of a geologist who is registered in the State of Missouri. The document incorporates or is based on a geologic study or on geologic data that had a bearing on conclusions or recommendation reached after January 1, 1997. The Missouri Board of Geologist Registration Law includes the requirement that geologic work, where public health, safety or welfare is at risk or potentially at risk, be completed by or under direct supervision of a geologist registered in Missouri. The following review comments and/or recommendations convey no endorsement as to the validity of the work being completed in accordance with the Missouri Geologist Registration Law or the Board of Geologist Registration. Furthermore, the review comments and/or recommendations cannot be accepted as being fully complete until properly sealed/stamped by a geologist registered in Missouri in accordance with the law and the rules as administered by the Board.*

**Westinghouse Previous Response:** The plan submitted to the DNR was a draft and therefore not sealed and stamped. The final draft will be signed and sealed by a state registered geologist.

*Missouri regulations require the seal of registered geologists on draft documents as well as final documents. Also, the plan includes engineering evaluations/interpretation and should be sealed by Missouri registered professional engineer.*

**Westinghouse Response:** A revised Work Plan, which includes the seal of a Missouri Registered Geologist, is being transmitted to the MoDNR with this response. A Missouri registered professional engineer has not been directly involved in the preparation of this document. As such, we believe that additional time for a complete engineering review of the Plan, to support an unqualified engineering seal, is not warranted at this time. If there are specific issues (or sections) of the report which the Agency believes should be reviewed by a Missouri professional engineer, please identify them and we will facilitate a focused engineering review of those issues or sections. The focused engineering review is not expected to cause a significant delay to the overall schedule. We acknowledge that subsequent documents that involve engineering analyses or engineering interpretation will be provided with the seal of a Missouri registered professional engineer.

- 2. Important procedures are often described in general terms, or references are made to methods or protocols in generic terms (i.e. "EPA chain-of-custody" or "Missouri Well Construction Rules"). The work plan would be more understandable if detailed procedures and references are more specific.*

**Westinghouse Previous Response:** Standard operating procedures for important operations are included in the QAPP. These or equivalent will be followed during the remedial investigation. Generic references to EPA methods or protocols have been removed from the RI/FS workplan text.

*No comment.*

3. *A list or table identifying specific RCOCs and CCOC for each AOC should be included.*

**Westinghouse Previous Response:** Table Q4 “Radionuclides of Potential Concern by Area of Potential Concern” from the QAPP was added to the workplan. A similar table was added for CCOC for each AOC.

*Thorium has been listed as a RCOC for only two of the listed areas. Please provide technical justification for the omissions or include in the list for other areas. Also, Tc-99 has been listed as a RCOC but other radioactive elements commonly associated with recycled uranium (the likely source of Tc-99) have not been included. We request technical justification for this omission or inclusion of additional elements.*

**Westinghouse Response:** We understand that thorium oxide was used only in limited quantities at the plant as part of a fuel research program designed to test the efficacy of using thorium in the fuel cycle. Thus, we had only identified thorium as a potential RCOC in the burial pits and former leach field AOCs. In response to the comment, we have revised Table 1 and added thorium to the potential RCOC list for the following AOCs: surface water, former evaporation ponds, soil beneath buildings, limestone storage areas, outdoor areas, gas pipeline, red room roof burial area, Deul’s Mountain, and cistern burn pit area. We note that Table 3 already identifies gamma spectroscopy of samples by EPA 901.1M from these AOCs, thus thorium concentrations will be reported and no revisions are necessary to Table 3. The proposed analytical methodology is also expected to provide information regarding the potential presence of other radioactive elements commonly associated with recycled uranium. If anomalies are identified in the radioactivity data, subsequent specific analyses can be performed to confirm the presence of other radioactive elements.

4. *In-door air sampling in the basement of houses with wells impacted by VOC contamination should be added as part of the RI/FS Work Plan.*

**Westinghouse Previous Response:** Indoor air sampling has been added to section 4.4.1.3.1.1. Ground water (AOC #1).

*No comment.*

5. *Considering that not all the activities that occurred at the Hematite facility are known, it may be appropriate to evaluate, as potential contaminants, those that were present at other sites operated by Mallinckrodt Chemical Works during the 1950s and 1960s.*

**Westinghouse Previous Response:** Westinghouse is currently investigating the past operations of the facility. The plan specifies that TAL and TCL constituents be analyzed. The radioactivity analyses will also be capable of identifying potential radionuclides of concern.

*Please reevaluate the third sentence in the response in consideration of comment 3 above.*

**Westinghouse Response:** See response to question 3 above.

6. *Executive Summary- Fifth paragraph please add “risk to human health and the environment.*

**Westinghouse Previous Response:** The fifth paragraph of the Executive Summary has been revised to include risk to human health and the environment.

*No comment.*

7. *Page 8, Section 2.4.1 second paragraph states “The Jefferson City Dolomite, typically is 125 to 325 feet thick. Is bounded by the overlying Cotter Formation also mostly a dolomite, and beneath by the Roubidoux Formation which mostly is known as sandstone.” According to well logs within one mile of the site, the Roubidoux is dominantly a sandy dolomite with lesser beds of dolomitic sandstone and dolomite.*

**Westinghouse Previous Response:** Text has been revised to change the phrase to “ the Roubidoux Formation that is dominantly a sandy dolomite with lesser beds of dolomitic sandstone and dolomite.”

*No comment.*

8. *Page 12, Section 2.5.3 states “... the Missouri Geologic Survey (currently DGLS),... ”. The DGLS is currently (as of October 2001) named the Geological Survey and Resources Assessment Division (GSRAD).*

**Westinghouse Previous Response:** Missouri Geologic Survey (DGLS) has been replaced with ‘Geological Survey and Resources Assessment Division (GSRAD)’.

*No comment.*

9. *Page 15, Section 2.6.6.1 Is the disposal location for the soil removed from the pond known?*

**Westinghouse Previous Response:** The material from the retention ponds was disposed at a Low Level Waste Disposal facility.

*Please identify the specific off-site facility(s) used for waste disposal during past operations to the extent they are known.*

**Westinghouse Response:** The text has been revised to indicate that Westinghouse is not aware of specific off-site facilities that were used for waste disposal by previous owners.

Westinghouse has used Envirocare of Utah for disposal of wastes during its ownership of the facility.

*10. Page 17, Section 3.1 Is there a reason to eliminate wind-borne particulates as a potential historic pathway of contaminant migration?*

**Westinghouse Previous Response:** There may be depositional material from the facilities past operations. The sampling plan recognizes this potential. This section will be revised to state: “Windborne particulates from plant operations.”

*No comment.*

*11. Page 23, Section 3.2.6.2 Is it known if there was a time before the installation of the septic system when sanitary waste waters were directly discharged?*

**Westinghouse Previous Response:** Prior to the current system, sanitary waste was discharged to the leach field as described in section 3.2.5. Sanitary wastes were always discharged to a septic system. Text has been revised in section 3.2.6.2.

*Throughout the work plan, factual statements often imply that they apply to all historic operations at the plant. Please qualify these statements by identifying specific period of applicability, indicate the source of information, and note that information is not available or not known for those years that are undocumented at this time.*

**Westinghouse Response:** Our efforts in the Work Plan were targeted at identifying the former processes and practices that may have impacted the environment, so that any impacts could be defined during the remedial investigation (RI). Westinghouse recognizes that operations and practices changed over the course of the facility history and that the facility history may be incomplete. We expect that the facility history will be more clearly defined as the RI progresses, and that a more complete and accurate description of the historic operations at the plant can be presented in the RI report.

*12. Pages 24 and 25, Section 3.2.6.2 provides estimated values of volume and weight and of chemical use and storage for eight out of ten chemicals used at the facility. Why are no use or storage areas provided for trichloroethylene (TCE) and perchloroethylene (PCE)?*

**Westinghouse Previous Response:** The list provided in section 3.2.6.2 was based on the more recent operation of the facility. TCE was used as a thinner for a binding agent in the uranium powder operation. PCE was used in a historic uranium processing operation. The text has been revised in these sections.

*Please specify where TCE and PCE product and wastes were stored. If not known, how will this be evaluated in the investigation?*

**Westinghouse Response:** The specific location of TCE and PCE product and waste storage within the plant is not known. The Work Plan has been designed to provide data to delineate volatile organic compound (VOC) contamination (including TCE and PCE) at the site.

13. Section 2.5.2 Identifies five intermittent streams including North Tributary. Section 3.5.2 List McKee Pond Tributary. Please clarify which are the five intermittent streams for this investigation.

**Westinghouse Previous Response:** The point of section 3.5.2 is to identify the jurisdictional issues of the USACE for these bodies. Any remedial or construction activity associated with these bodies may require mitigative or compensatory actions in addition to approval from the USACE.

*No comment.*

14. Page 26, Section 3.2.7 The chemical formula,  $\text{CaF}_2$  is technically Calcium Fluoride not spent limestone. Also it has been common practice at some other manufacturing facilities to use aggregate waste products for both on and off-site road surfacing. Is there any historical record or anecdotal information of this?

**Westinghouse Previous Response:** Spent limestone has been used as fill on site. There is no anecdotal evidence that the material was used off site.

*Considering the uranium hexafluoride processed at the plant and generation of hydrofluoric acid please add fluoride to the list of potential CCOCs. If known, identify where spent limestone was used as fill on site?*

**Westinghouse Response:** Fluoride has been added to the list of potential CCOCs for the AOCs associated with spent limestone. The known areas where spent limestone was used as fill on site are identified in Plate 10.

15. Page 30 and 31 Section 3.3.2 Remedial Alternatives It is unclear why it is sediments and not soil or both listed in alternatives 4 and 5. It also unclear why institutional controls are not included in alternative 3 since this would have to include some kind of stabilization and/or capping of contaminated soils.

**Westinghouse Previous Response:** Section 3.3.2 alternatives 2, 4 and 5 have been revised to use the terminology soils/sediments rather than soils or sediments. Institutional controls are covered by alternative 2.

*Institutional controls will be a required remedy for any area not cleaned up to free release criteria under a residential farmer risk scenario. Your response to our original comment seems to indicate that Alternatives 1, 3, 4, 5, and 6 will meet this free release condition. This is clearly not the case and a proper evaluation of each alternative must include the impact of institutional controls where indicated.*

**Westinghouse Response:** Section 3.3.2 of the Work Plan has been revised to include the statement “Alternatives 3 through 6 may also require institutional controls, which would be evaluated in conjunction with the identified remedial components.”

16. Page 37, Section 4.1 In addition to the ARARs identified in this section, Westinghouse should also formally request that the department provide a list of ARARs we consider appropriate for this project.

**Westinghouse Previous Response:** Westinghouse will formally request that the department provide a list of ARARs they consider appropriate for this project.

*No comment.*

17. Page 46, Section 4.3 states the QAPP is a stand-alone document. Section 4.4 states the QAPP is part of the Sampling and Analysis Plan (SAP). The Field Sampling Plan is part of the RI/FS work plan.

**Westinghouse Previous Response:** Text has been revised to clarify that the QAPP is a stand-alone document and part of the SAP.

*Please identify the accuracy and precision to be applied to the “appropriate survey method” (indicated in the sampling plan) for various components of the investigation?*

**Westinghouse Response:** The Plan reflects that all wells and borings will be installed according to Missouri Code and comply with accuracy requirement of the code. The location of other samples will be identified by typical methods including field measurements, handheld GPS, or survey where appropriate.

18. Page 49 the section on Public/Private Water Quality Analysis needs to be updated to reflect current activities.

**Westinghouse Previous Response:** Section has been revised to “Private Water Supply Well Water Quality Analysis. In December 2001, the DHSS conducted annual radiological monitoring of the four private wells near the site. DHSS elected to include VOC monitoring during this event. Results of that sampling revealed one of the private drinking water wells had VOCs, including tetrachloroethylene (PCE), and trichloroethene (TCE) significantly above drinking water standards. This well had been last sampled in 1996 and found to be clean at that time. The MDNR informed Westinghouse of the results and directed Westinghouse to conduct follow-up testing. In March 2002, 20 additional wells were tested and sampling and analysis to date has shown that six private wells have been impacted with VOC contamination. In April 2002, the MDNR and DHSS sampled a total of 51 additional private wells; while Westinghouse conducted repeat sampling of those previously sampled. Analytical results showed no additional private well contamination.

An inventory of private water wells within a 2-mile radius of the site was completed in May 2002. The survey was completed using three sources; (1) MDNR well log library, (2) MDNR Well-head Protection Division Water Well certification and Pump records, and (3) information obtained from private well owners.

Westinghouse supplied drinking water to those residences most likely to be affected by contaminated drinking water. In addition, for those homes that demonstrated detectable levels of VOCs potentially related to site operations, Westinghouse arranged for the installation of activated carbon filter canisters. A total of six homes have been affected and have filtration systems installed. The canister filtration systems are being monitored monthly to check for breakthrough of contaminants. In addition, Westinghouse conducts quarterly monitoring for a network of residences in the area to assist in monitoring potential movement of the VOC plume in the off-site groundwater.”

*No comment.*

19. Page 53 Section 4.4.1.3.1.4 Subsurface soil samples should be included.

**Westinghouse Previous Response:** Section 4.4.1.3.1.4 has been revised to reflect the collection of ten Subsurface soil samples.

*No comment.*

20. Page 54 Section 4.4.1.3.1.7 paragraph 3. Be more specific about the size and depth of the limestone disposal fill areas. Be more specific based on size and depth why 20 random samples was selected and the range of varying depths to be sampled from these areas.

**Westinghouse Previous Response:** 20 samples of random depth and location was selected for statistical significance.

*Please be as specific as possible about the size and depth of the limestone disposal fill areas and explain the reasoning for selecting 20 samples of random depth and location as statistically significant. What will constitute “random” for this effort?*

**Westinghouse Response:** The approximate location and dimensions of the two limestone fill areas and limestone pile are identified on Plate 10. The depth of limestone beneath the surface in the identified areas is not known. Based on our current understanding of the dimensions of these areas, and the consistent use of the limestone at the facility, we believe that 20 random samples/area or pile will be sufficient to adequately define the characteristics of the material in those areas. The sampling locations are not specified so that the field technician that is collecting the samples can select the appropriate “random” locations throughout the area or pile to adequately characterize the material. In response to the comment, additional text has been added to the Plan to provide for appropriate sampling locations.

21. Page 54 Section 4.4.1.3.1.9 Disposal of waste oil and degreasing solvents should also be considered, possibly via a sanitary waste system.

**Westinghouse Previous Response:** Text has been added to include the possibility of characterizing for waste oil and degreasing solvents.

*Does not appear to respond to the “sanitary waste system” part of the question.*

**Westinghouse Response:** Additional text had been added to clarify the intent of the investigation in the vicinity of the former “gas station”, including the statement: “Characterization efforts will include areas where waste oil and degreasing solvents may have been disposed, including potential sanitary waste systems.”

*22. Page 54 Section 4.4.1.3.1.9 Waste oil and degreasing solvent may have been used at the former Service Station AOC.*

**Westinghouse Previous Response:** Text has been added to include the possibility of characterizing for waste oil and degreasing solvents.

*Why only the “possibility” of characterizing? How will one know if solvents or waste oil are a concern if the AOC is not characterized?*

**Westinghouse Response:** The text has been revised to acknowledge that this AOC will be characterized for the potential presence of solvents and waste oil. See response to comment 21. A boring will be installed and soil sample(s) taken for solvent (VOCs) and oil analyses (TPH) at this location. Other tables and plates have been revised as appropriate.

*23. Page 55, Section 4.4.1.3.1.10 Paragraph 1 states that the pipeline may be acting as a pathway; for contaminant migration, presumably via waterborne contaminants moving through the bedding or trench backfill. This seems to be inconsistent with Paragraph 3, which lists only soil and trench fill materials as media of concern. Investigation of this AOC should include an evaluation of the extent, if any, to which the pipe trench is acting as a hydraulic sink for the adjacent plant property. The nature and fate of groundwater found in the trench should also be evaluated.*

**Westinghouse Previous Response:** When the plan was written it was speculated that the pipeline was placed on a sand or gravel saddle that could act as a contamination migration pathway. Subsequent to this it has been determined that the pipeline was backfilled with the native removed material. Given the nature of the backfill material the likelihood of this acting as a conduit is less than originally thought. The plan has been revised to reduce the number of sample locations to reflect this new information.

*No comment.*

*24. Page 56 Section 4.4.1.3.1.13 Should be revised appropriately to reflect the approved Action Memo.*

**Westinghouse Previous Response:** This section has been rewritten to reflect the as found condition.

*No comment.*

25. Page 56 Section 4.4.1.3.1.13 Be more specific about the size and depth of Deul's mountain area and the rationale for the number of surface and subsurface samples collected and appropriate depths of subsurface samples.

**Westinghouse Previous Response:** An action memorandum has been prepared to address "Deul's Mountain". The area under Deul's Mountain will be surveyed as part of the gamma walkover survey. Two surface soil samples will be collected.

*We have had no communication (other than this response) or discussion regarding this approach to Deul's Mountain. What is the justification and reason for approaching this area in an Action Memorandum rather than the RI/FS? We are willing to give this approach consideration but need to know the justification and rationale for separating this from the RI/FS investigation.*

**Westinghouse Response:** We believe, based on existing information, that the approximate 1,100 cubic yards of material that is currently referred to as Deul's Mountain is primarily a potential radiologic concern. We are evaluating options (on-site and off-site) for management of this material. If an off-site option is pursued, we believe that timely regulatory approval for disposal could be obtained from the NRC through the plant decommissioning process. We also note that this feature may be located over the burial pits or atop impacted soil, thus there may be a benefit to removing this material to facilitate the remedial investigation at the site. We continue to evaluate our options for management of this material and will keep the Agency informed of our efforts toward that end.

26. Page 58, Section 4.4.1.3.3 Specify what instrument will be used to conduct the Gross Gamma walk-over survey and what radioactive isotopes the instrument will detect.

**Westinghouse Previous Response:** A NaI detector will be used for this survey and is capable of detecting uranium and thorium as well as any other gamma emitting nuclides.

*No comment.*

27. Page 59, Section 4.4.1.3.5 Determining background values is one of the more critical aspects of a remediation effort. More detail is needed on the number of samples to be collected relative to the strata to be sampled, and description of the method to be used to establish background concentration. From the information provided it is not clear if a single value or range of values will be considered as background for all strata encountered or if different values will be applied to different materials.

**Westinghouse Previous Response:** More detail regarding background samples has been provided in section 4.4.1.3.5. For the terrace and alluvial soil strata about 15 samples should be collected from each unit and analyzed using the same analysis proposed for the samples. For background in water in the two unconsolidated hydrostratigraphic units, which are the alluvial, and terrace, in-situ direct push sampling techniques will be used. Three water samples from each unit will be collected and analyzed.

*The revised plan proposes to rely on a single sample to determine background values for surface water locations and the upper Jefferson City Dolomite. Please explain how a single sample will provide a statistical basis for this determination. Also, is there a*

*statistically defensible reason for the selection of 3 samples from each unconsolidated unit?*

**Westinghouse Response:** We agree that establishing background conditions is likely to be a critical aspect relative to the interpretation of site conditions and assessment of remedial options, from both a radiologic and conventional contaminant standpoint. But, prior to reviewing specific baseline data from the site, we cannot fully assess the potential background data needs for the various media at this time. We suggest that the initial samples be collected in accordance with the Work Plan and then Westinghouse will evaluate and propose additional data needs to determine background in the various media at the site. The subsequent data needs may include additional monitoring points or additional samples from the existing monitoring points.

*28. Page 60 Section 4.4.1.3.5 Need to clarify that these wells are not going to be sampled just once, but that first round of sample results will determine the need and frequency of future sampling to establish appropriate background levels.*

**Westinghouse Previous Response:** Section 4.4.1.3.5 of the plan has been revised to clarify background sampling. The plan is to sample once for background.

*Please provide the technical basis for relying on a single sample of groundwater or surface water for background constituent determinations.*

**Westinghouse Response:** Our proposal for background sampling is described above, in response to comment #27.

*29. Page 61 Section 4.4.1.5.1 Should cite appropriate Missouri Well Construction Regulations for the different types of boring installation and temporary and permanent monitoring wells.*

**Westinghouse Previous Response:** Section 4.4.1.5.1 has been revised to state: “Regulated borings shall be constructed and if abandoned, will be done in accordance with Missouri Well Construction Code.”

*No comment.*

*30. Page 62 Section 4.4.1.5.1 paragraph 2, Please identify the location and construction details for the decontamination area.*

**Westinghouse Previous Response:** Section 4.4.1.5.1 paragraph 2 has been revised to state: “The specific location has not been determined but will likely be near the tile barn. The construction will be temporary in nature and likely consist of straw bale dikes and an impermeable membrane.”

*Considering the nature and extent of the proposed investigation and subsequent remediation we recommend that a more substantial decontamination area be considered.*

**Westinghouse Response:** The proposed decontamination area is only for the field investigation activities and is expected to be sufficient for that phase of the project. Furthermore, given the

ongoing decommissioning activities at the site, a potential location for a more “substantial” decontamination area is difficult to identify at this time. As remedial measures for the site are finalized, construction of a more significant decontamination area will be evaluated.

*31. Page 63 Section 4.4.1.5.3, VOC What is the expected detection range for the MIP and how do the measured levels correlate to in-situ concentrations?*

**Westinghouse Previous Response:** Section 4.4.1.5.3 has been revised to state: “The MIP has the capability to detect VOCs in the micro gram per liter range for water and micrograms per kilogram in soil. The MIP is used qualitatively to correlate field conditions to laboratory conditions.”

*How many micrograms...? 1 ug/l or 1000 ug/l; 1ug/kg or 100 ug/kg?*

**Westinghouse Response:** According to vendors, the MIP has the ability to detect VOCs at levels as low as approximately 500 ug/kg in soil and 500 ug/l in water. The actual sensitivity will depend on soil conditions (i.e. porosity and moisture content) and potential interferences. These factors can reportedly cause the sensitivity to rise to approximately 1,000 ug/kg (or ug/l). Thus, the actual sensitivity will not be known until the work is performed. The text in this section has been revised to state; “The MIP has the capability to detect VOCs in soil to approximately 500 µg/kg, but the instrument can be affected by soil conditions or interferences which could raise the sensitivity by several orders of magnitude.”

*32. Page 64, Section 4.4.1.5.3 Radionuclides paragraph 1 Please provide an explanation of how the beta/gamma screening will detect the presence of RCOC's that are alpha emitters. Other screening may be appropriate based on re-evaluation of potential RCOCs. Paragraphs 2 & 3 A more detailed description of how statistically significant “reference” levels will be established and then used to screen core samples should be provided.*

**Westinghouse Previous Response:** Alpha emitters on site are all associated with beta/gamma emitters and can be inferred by measuring beta/gamma radiation. No change to the text has been made.

*Response does not appear to address the last question of the comment.*

**Westinghouse Response:** Additional text has been added to describe the qualitative screening nature of the instrument and its proposed use at this site. We believe the instrument may be useful to identify appropriate sections of core samples to be submitted for analyses. As such, we proposed to screen the cores, count the highest response area for one minute, and submit that area of the core sample (with the highest response) for analyses. We note that all of the principal radionuclides are both alpha and beta emitters and that field screening techniques are more appropriate for the beta emissions.

The method by which specific readings are found to be statistically significant is not yet known, but may be selected based upon the number of data points and the range of values in the data set. Inasmuch as these data are used for screening, a thorough statistical assessment may not be needed to understand their relation to reference levels, validity or other appropriate applications.

33. Page 65 & 66 Section 4.4.1.5.4 Figures or drawings depicting typical well construction details should be provided.

**Westinghouse Previous Response:** Figure 3 “Typical Monitoring Well Construction Diagram” has been added to the plan and is referenced in section 4.4.1.5.4.

*No comment.*

34. Page 66 Section 4.4.1.5.4, paragraph 6 The specific method to be used to develop each type of well in each strata should be provided, including the criteria for determining that proper development has been achieved.

**Westinghouse Previous Response:** The method will be reserved based on the conditions in the well (i.e. depth, capacity, turbidity etc.).

*There are a limited number of methods available for well development, which of these methods will be considered for this project. Also, what criteria will be applied to determine that proper development has been achieved. Section 4.4.1.5.4 covers this issue but it is too general to elicit meaningful comment. For instance, at what time or volumetric interval will the various parameters be measured for comparison. 30 seconds, 5 minutes, one hour? How will the issue of water added during well construction be addressed? What criteria will be used to support the statement that “unsuitable materials” will be removed?*

**Westinghouse Response:** The intent of the previous response was to acknowledge that different well development methods may be appropriate to address different well characteristics, i.e. a deep well that recharges quickly may be developed using a pump, where a shallow well that recovers slower may be developed using a bailer. In any case, the status of well development will be assessed using the criteria for purging a well prior to sampling (i.e. procedure 3-6 provided in the QAPP). Indicator parameters will be measured on a well volume basis. If water is added during well construction, at least 3 times the volume of added water will be removed from the well. The goal of the well development effort is to remove fines from the well, thus the word “unsuitable” has been replaced with “geologic” in this section.

35. Page 67, Section 67 Section 4.4.1.5.5.1 What depth will surface soils be collected? (i.e. 0” to 2”)

**Westinghouse Previous Response:** Section 4.4.1.5.5.1 has been revised to reflect that surface samples will be collected from zero to six to twelve inches below the ground surface. Sampling is described in the QAPP.

*No comment.*

36. Page 67, Section 4.4.1.5.5.2 What method(s) will be used to collect groundwater samples?

**Westinghouse Previous Response:** The method will be reserved based on the conditions in the well (i.e. depth, capacity, turbidity etc.).

*It should be possible to provide specific procedures for the “typical” methods expected to be used or to reference specific previously approved standard methods.*

**Westinghouse Response:** Ground water samples will be collected in accordance with procedure 3-2 provided in the QAPP. It is likely that initial groundwater samples will be collected by bailer.

37. Page 68, Section 4.4.1.5.5.3 What EPA protocol is being referenced here.

**Westinghouse Previous Response:** See response to comment 2.

*No comment.*

38. Page 68, Section 4.4.1.5.6 Location and specific details for storage areas should be described, including a description of how hazardous waste and mixed waste will be handled.

**Westinghouse Previous Response:** An IDW SOP is being developed to address hazardous waste.

*The IDW SOP is a critical component of the investigation and must be a part of the RI/FS work plan.*

**Westinghouse Response:** Westinghouse has developed an IDW SOP that is included in the QAPP.

39. Page 76 Section 4.5.4 Repeats what is in QAPP so does not need to be included here.

**Westinghouse Previous Response:** This section is repeated for readability.

*No comment.*

40. Figure 5 The Voluntary Cleanup Program is not separate from the Hazardous Waste Program (HWP) and they are not involved. The HWP is the lead program within the Department. The GSRAD and the WPCP, plus the Missouri Department of Health and Senior Services provide support to the HWP.

**Westinghouse Previous Response:** Figure 5 has been revised to reflect the comment.

*No comment.*

## Responsiveness Summary to Previous MDNR Comments

### General and Specific Comments on the September 12, 2002 Draft (Redline/Strikeout) RI/FS Work Plan for Westinghouse Electric Company Hematite Facility

1. *The stratigraphic nomenclature within the subject document is not consistent with modern usage of names. The text should be corrected with current stratigraphic names taken from "The Stratigraphic Succession in Missouri, Volume 40," by Tom Thompson.*

**Westinghouse Response:** The Work Plan has been revised as requested.

2. *It is presumed that more specific work plans will be developed to implement certain investigative tasks and subsequent evaluative tasks contemplated in the RI/FS. Draft versions of these work plans should be submitted to the department for review and comment prior to being finalized. If our presumption is not correct then this RI/FS work plan will require significant additional detail before it can be considered for approved.*

**Westinghouse Response:** We acknowledge that there will be additional efforts needed to identify background conditions (as described above) and finalize the investigative and evaluative tasks needed to complete the RI report. There will also be issues that will need to be addressed during the implementation of the scope of the Work Plan. We anticipate that submittal of subsequent specific work plans or other documents will be necessary to complete the RI.

To that end, we have engaged the services of Mr. Michael Prattke of Civil & Environmental Consultants, Inc. to assist in implementing the RI/FS work plan. Mr. Prattke will be the primary point of contact for the Agency. His contact information is as follows:

Mail: Mr. Michael J. Prattke  
C/o Westinghouse Electric Company  
3300 State Road P  
Festus, MO 63028

Phone: (636) 937-4691, Ext. 423

Fax: (636) 937-7308

3. *An electronic database for technical information should be developed for this site. An Access-type database containing all analytical data would be a good start to be followed by a more comprehensive system incorporating various investigative work plans, reports, and supporting documents, and possibly referenced to a GIS system.*

**Westinghouse Response:** We concur that an electronic database is a necessary tool for RI data presentation and management. We anticipate that historical site monitoring and evaluation data,

as well as data gathered during the RI, will be presented in the RI report. As such, we expect that a database will be utilized to support the RI. At this time, we have not selected the specific data management software.

4. *All reports and summaries of previous off-site radiological analyses of private well water samples shall be submitted to the department for review.*

**Westinghouse Response:** There is some radiological data that was generated through the recent sampling of private wells and some historical data from private well sampling required under the site permit. Westinghouse is compiling the data, which will be provided to the Agency under separate cover letter.

5. *Please provide copies of the following documents referenced in the work plan.*
  - a. *American Society of Testing Materials, 2002, D5490-93 (2002), Standard Guide for Comparing Ground-Water Flow Model Simulations to Site Specific Information.*
  - b. *Gateway Environmental Associates, Inc., April 1997, Exploratory Probe-Hole Investigation for the Evaporation Ponds at the ABB Combustion Engineering Hematite Facility.*
  - c. *Global Environmental, Inc., December 1992, Building Inspection Summary:*
  - d. *United States Nuclear Regulatory Commission, NMSS Decommissioning Standard Review Plan, NUREG-1727.*

**Westinghouse Response:** The document identified in reference (a) is copyrighted and available from ASTM, thus we cannot make a copy as requested. Copies of the documents identified in references (b) and (c) are provided with the revised Work Plan. The document identified in reference (d) is available from the Nuclear Regulatory Commission.

6. *Where reference is made to other documents or standards in this workplan, or future reports or workplans to be submitted, the reference should be specific as to section(s), page(s) or paragraph(s) that are applicable to the issue under consideration.*

**Westinghouse Response:** The author produced the Work Plan in accordance with its standard manuscript form, thus specific references were not included. References in future documents will be specific as to applicable section(s), pages(s) or paragraph(s). If there is a question regarding a reference in the existing Plan, please contact us and we will identify the specific source.

7. *Section 2.4.1 Bedrock and Structures, second paragraph states: “The Jefferson City Dolomite, typically is 125 to 325 feet thick, ...” It is not clear whether the thickness*

*variation is for the area, region, or state wide. Cross-section presented in Plate 8 & 9 indicate a uniform 165-foot thickness of the formations. This should be addressed in this section or Section 2.4.1.1 Four bedrock coreholes were drilled across the site during the summer of 2002. The data from these cores should be incorporated into this section.*

**Westinghouse Response:** The text in the Work Plan has been revised to show the Jefferson City-Cotter Dolomite averages 400 feet thick across the state. A statement has been added to acknowledge that site specific information gained from the interim hydrogeologic investigations matches previously known information.

8. *Section 2.4.2 Unconsolidated Sediments (Pleistocene and Quaternary), fourth paragraph states: “Specifically, five unique hydrostratigraphic units are located beneath the Plant portion of the Site: ...” Six units are listed. The numerical value in the text should correlate with the number of units listed. Also, unconsolidated materials are discussed in this section; however, Jefferson City Dolomite and Roubidoux Formation, which are solid rock units, are listed with the unconsolidated units. The rock units should not be listed as unconsolidated units. It is not clear which of these units are considered “near-surface.”*

**Westinghouse Response:** The fourth paragraph of the text of Section 2.4.2, Unconsolidated Sediments (Pleistocene and Quaternary), has been revised to identify four units. The Jefferson City Dolomite has been deleted from the list.

9. *Section 2.5.1 Hydrogeology, second paragraph states: “Single-well testing of the Jefferson City Dolomite showed a hydraulic conductivity of  $8 \times 10^{-4}$  cm/sec.” Hydraulic testing conducted on boreholes during the summer of 2002 demonstrated the great variations on permeability occur in the Jefferson City Dolomite. This paragraph should indicate that such variation exists and to what portion of the Jefferson City Dolomite the stated hydraulic conductivity applies; the entire formation or some portion of it.*

**Westinghouse Response:** The text has been revised to identify that the permeability of the Jefferson City-Cotter Dolomite varies greatly and where the specific permeability value was determined.

10. *Section 2.5.2 Hydrology, Precipitation and Stream Characteristics, second paragraph, third and fourth bullet state: “The streams flow intermittently” and “The Joachim Creek is perennial,” respectively. Since Joachim Creek is a stream, the two bullets appear to contradict. It should be clarified as to which streams are considered intermittent.*

**Westinghouse Response:** The text has been revised to address the comment.

11. *Section 2.6.5 Interim Hydrogeologic Investigation to Address Impacted Private Wells, first paragraph states: “In summer of 2002, Westinghouse retained LBG to perform an interim hydrogeologic investigation to address findings from the sampling of private*

*water wells in the vicinity of the Plant.” There is no description of the private well contamination findings within the work plan document. A summary of the private well contamination findings should be incorporated into the document to provide a context for this discussion.*

**Westinghouse Response:** A summary of the private well contamination findings is included in Section 4.4.1.3.1.1, Ground Water (AOC#1)

*12. Section 3.1 Site Conceptual Model – Potential Pathways of Contaminant Migration, second paragraph states: “Previous investigations identified the following contaminant migration pathways as being of potential concern to public health and the environment.” Groundwater migration within the unconsolidated overburden and Jefferson City Dolomite are included among the list. Migration within the Roubidoux Formation is not listed. Private wells open from the Jefferson City Dolomite to the Roubidoux Formation have shown contamination. Therefore, it is possible that contaminants are migrating down the wells and affecting the Roubidoux Formation. Based on this possibility the Roubidoux Formation should be added to the list for investigation as a potential groundwater migration pathway.*

**Westinghouse Response:** The Roubidoux Formation has been added to the list in the text as requested.

*13. Section 3.2.6.1 Buildings, subsection Building 240 Recycle Recovery (Red Room, Green Room) states: “Past operations included the conversion of HEU using a wet conversion process and wet recovery of scrap.” The acronym HEU (high enriched uranium) does not appear to be defined previous to its usage within the document. HEU should be defined within the text.*

**Westinghouse Response:** The 1<sup>st</sup> reference to HEU in the text, in Section 2.2, has been revised to define the acronym to address this comment. The acronym HEU (high enriched uranium) is also defined in the list of acronyms in the Plan.

*14. Section 3.2.6.2 Is there factual evidence to support the statement that “Chemicals were stored in accordance with applicable...regulations”? If not, please delete or qualify this statement. Estimated usage/storage volumes are noticeably absent from the TCE and PCE discussions. Is there no information on the amount of solvents used at the plant?*

**Westinghouse Response:** Information obtained from interviews with site personnel indicated that chemicals were stored in accordance with applicable regulations. As this information is not critical to the Plan, we have deleted the first sentence in this section, “Chemicals were stored in accordance with applicable...regulations” as requested. We have no information at this time regarding estimated usage/storage volumes of these chemicals, as they were used during the earlier operations of the facility.

15. Section 3.2.6.2 Infrastructure, first paragraph states: “This package plant was a 1989 replacement for the septic tank originally installed in 1977.” The struck out “and leachfield system at the same location” should remain in the sentence or the location of the former leachfield should elsewhere be described.

**Westinghouse Response:** Section 3.2.5 includes a description of the former leach field as a potential AOC, thus this section was not modified.

16. Section 3.2.6.2 Infrastructure, subsection Chemical Storage, sub-subsection Trichloroethylene (TCE) and Perchloroethylene (PCE) state: “TCE was used at the facility as a thinner for a binding agent used in pellet manufacturing. Records indicate that one drum of TCE was buried in the burial pits.” And, “PCE was used at the facility in a historic uranium processing operation.” respectively. If the beginning or end dates of usage are known for TCE and PCE, they should be stated in the section. Also, there is anecdotal evidence that TCE was used for cleaning hands, clothing, various equipment, and possibly product. Please discuss these other uses.

**Westinghouse Response:** Trichloroethylene (TCE) was used as a manufacturing aid until the late 1980’s, and as a degreaser until the early 1990’s. Specific beginning and end dates for the use of this chemical is unknown. If credible information regarding other uses of these chemicals is identified during the RI, it will be included in the RI report.

17. Section 3.2.6.3 What does the term “effluent release limits” mean relative to “off-site for disposal” and how does this off-site disposal differ from disposal at a low-level radioactive waste burial site? A list of all known historic effluent release limits for various media should be included in the workplan.

**Westinghouse Response:** The waste water filtrate (liquid) from the wet recovery process was collected in tanks and historically characterized by its uranium concentration. If the concentrations were less than the 10 CFR 20 Appendix B limits ( $3E10^{-7}$   $\mu$ Ci/ml uranium), the wastewater was reportedly shipped and disposed as non-regulated material at a Publicly Owned Treatment Works (POTW). Other typical liquid plant wastes were collected separately and evaporated. The remaining solid was analyzed for uranium content and if not recoverable, the solid was disposed off-site at a low level waste disposal facility. The text has been revised to clarify that the waste water filtrate was collected, and that the residual from the evaporation process was the waste that was typically managed by disposal off-site.

18. Section 3.2.13 Domestic Well #3, states: “Groundwater sampling of a domestic well (hereafter referred to as Domestic Well #3) located on the north portion of the property was recently preformed by the Missouri Department of Health.” Should say the well was sampled by Department of Health and Senior Services December 2001 at the request of the department.

**Westinghouse Response:** The text has been revised to state “the well was sampled by the Department of Health and Senior Services in December 2001 at the request of the department”.

*19. Section 3.3.2 Preliminary and Conceptual Remedial Action Alternatives. Under Alternative 3 please define “intrinsic bioremediation”. It’s unclear if this is referring to in-situ bioremediation of groundwater or monitored natural attenuation of groundwater. Also if this alternative only address groundwater then institutional controls and long term stewardship of contaminated soils/sediment would have to be a part of it. Under Alternative 6 if only sources of sediment and soil contamination are addressed then monitored natural attenuation of the groundwater would have to be included as part of this remedial alternative.*

**Westinghouse Response:** The text has been revised to state, “monitored natural attenuation” rather than “intrinsic bioremediation”. To address the second part of the comment, the words “and possibly combined” have been inserted to describe that a combination of these alternatives may be applied.

*20. Section 3.4.1 Investigation and Evaluation Procedures, makes three references to “Site.” The use of “Site” within this section should not be capitalized.*

**Westinghouse Response:** The text has been revised as requested.

*21. Section 3.5.2.1 Investigative and Evaluative Procedure, first bullet states: classify the surface waters on site according to the MDNR Division of Environmental Quality, Water Pollution Control Program;” The Division of Environmental Quality has been divided and renamed. The Water Pollution Control Program is now within the Water Protection and Soil Conservation Division (WPSCD). The appropriate changes should be made within the subject document.*

**Westinghouse Response:** The text has been revised as requested.

*22. Section 4.1.3.2 State and Local ARARs, fourth paragraph states: “ Other State of Missouri ARARs potentially include: Missouri Clean Water Law; Missouri Drinking Water Act; Missouri Water Pollution Control Program Regulations; Missouri Water Quality Standards; and Missouri Well Construction Code.” This list should include the Missouri Solid and Hazardous Waste Regulations and Cave Resources Act (Chapter 578.200 – 578.225 RSMo). Westinghouse needs to make a formal ARARs request to the department.*

**Westinghouse Response:** The text has been revised as requested. Westinghouse will make a formal ARARs request to the department in a separate submittal.

*23. Section 4.4.1.3 Last sentence, the table numbers are struck out. Identify the appropriate table. (Table 3).*

**Westinghouse Response:** Table 4 as indicated in the Plan is correct.

24. *Section 4.4.1.3.1.1 Ground water (AOC #1), subsection Baseline Ground-Water Analysis, states: “There are thirty-four existing monitoring wells and piezometers installed to monitor the unconsolidated and bedrock aquifers at the Site.” Table 5 lists thirty-six wells and piezometers. The proper number of wells listed within the text and the table should be consistent.*

**Westinghouse Response:** The text has been revised to indicate 36 wells and piezometers rather than 34.

25. *Section 4.4.1.3.1.1 Ground water (AOC #1), subsection Baseline Ground-Water Analysis, states: “Table 5 summarizes existing monitoring well/piezometer construction.” Table 5 should include more data on the construction of the wells/piezometers, including screen or open borehole length, diameter of well, and construction material (PVC or stainless steel).*

**Westinghouse Response:** The table has been revised to include the available identified well construction information.

26. *Section 4.4.1.3.1.1 Ground water (AOC #1), subsection Baseline Ground-Water Analysis, states: “Plate 14 shows the location of the existing monitoring well/piezometer network.” Plate 14 does not illustrate the locations of OB-1, OB-2, BR2-JC, BR2-RB, BR3-OB, BR3-RB, BR4-JC, and BR4-RB. These should be shown if Plate 14 is labeled as “Existing Monitoring Well/Piezometer Network and Previous Investigative Boring Location.”*

**Westinghouse Response:** The identified monitoring well/piezometer locations are off the map at this scale. These monitoring points are shown on plate 17. A footnote was added to Plate 14 indicating that these points are not identified on this drawing.

27. *Section 4.4.1.3.1.1 Ground water (AOC #1) Private Water Supply Well Quality Analysis. DHSS collected annual radiological and VOC samples at private wells off site at MDNR request. Later in the paragraph it states “In March 2002, 20 additional wells were tested and analysis to date has shown that six private wells have been impacted with VOC contamination.” Would change that to read “..20 additional wells were tested and six private wells were shown to be impacted with VOC contamination.” In the third paragraph on this subsection need to add “ A total of eight private wells to date, have been affected and have filtration systems installed. Also why is there no mention of radiological analysis of private wells that was conducted in this subsection?”*

**Westinghouse Response:** The text has been revised as requested. As previously indicated, Westinghouse is compiling the private well data which will be transmitted by separate cover letter.

*28. Section 4.4.1.3.1.1 Verbal descriptions of burial pit construction indicate that they often ended at a gravel layer one to two feet thick (we assume the CSSG) and that water would flow into the open pit to the approximate level of the top of the gravel. Based on the description of this zone (both anecdotal and in historic technical investigations) it seems to be a likely path of rapid water and contaminant migration, possibly draining into surface water features. Yet the hydraulic conductivity of this zone was not determined during historic investigation and it is not clear that the proposed investigation focuses on this pathway. Please clarify.*

**Westinghouse Response:** The hydraulic conductivity of well WS-32, which is screened distinctly across the CSSG, was previously measured. The investigative activities in the Work Plan take into account that this zone may be a migration pathway.

*29. Section 4.4.1.3.1.1 Ground water (AOC #1), subsection Sequence of Ground-water Characterization/Monitoring states: "Locations of all proposed temporary wells are shown on Plate 16." The proposed well locations appear appropriate. However, plume delineation/monitoring is not fully defined at the Roubidoux Formation depth near Domestic Well #3. Also, extra overburden wells placed close to BR3-OB where contaminants were discovered in the alluvium would provide better plume delineation.*

**Westinghouse Response:** In response to the comment, we have relocated a proposed well location in the Roubidoux Formation closer to Domestic Well #3. Also, as described on Plate 16, an additional overburden well is to be installed southwest of BR3-OB to provide better plume delineation in that area.

*30. Contaminants were discovered in private wells on the south side of Joachim Creek. Further plume delineation within the Jefferson City Dolomite and Roubidoux Formation on the southeast side of Joachim Creek in proximity to the impacted private wells is needed.*

**Westinghouse Response:** Specific contaminated zones will be determined on the plant side of the creek, near the Rivers Bends subdivision. Once this information is known, additional monitoring wells are expected to be installed within the Jefferson City-Cotter Dolomite and Roubidoux Formation on the southeast side of Joachim Creek in proximity to the impacted private wells.

*31. Section 4.4.1.3.1.3 Burial Pits (AOC #3) does not state the media of concern. The previous – AOC sections state the media of concern. This section should include similar information.*

**Westinghouse Response:** The media of concern is soil. The text has been modified accordingly.

*32. Section 4.4.1.3.1.3 Burial Pits (AOC #3), first paragraph states: “No sampling of the trench will be performed.” It is not clear how the influence of the evaporation ponds will be separated from the burial trenches if additional samples are not collected or additional overburden wells installed. Also, groundwater sampling should be planned if the pits are a potential contamination source.*

**Westinghouse Response:** Sampling of the trench is not planned because data exists from the burial logs regarding the content and quantity of radioactive material buried in the pits. The focus of the trench investigation in the RI will be to confirm the location of the burial pits. There are numerous wells in and around the burial area including the overburden. The Plan also indicates sampling wells around the former evaporation ponds. The data derived from these wells is expected to be sufficient to characterize the two areas. In response to the comment, the text is revised to state, “The ground water monitoring wells from this area will be sampled as described in AOC#1 to determine impacts resulting from the burial pits.”

*33. Section 4.4.1.3.1.3 Burial Pits (AOC#3), second paragraph states: “ Additional geophysical characterization is planned.” The type of geophysical characterization planned should be stated.*

**Westinghouse Response:** There are numerous technologies and vendors available for geophysical characterization. Westinghouse is currently evaluating potential subcontractors (and methods) for this work, thus the selected type of geophysical characterization is not known at this time. The proposed geophysical method will be identified in a subsequent correspondence (i.e. work plan) to the Agency.

*34. Section 4.4.1.3.1.4 Evaporation Ponds (AOC#4), third paragraph states: “Groundwater samples will be collected and analyzed from all ten wells.” And “Boring locations are noted on Plate 20.” Plate 20 indicates fourteen boring locations.*

**Westinghouse Response:** The text has been revised to describe that nine wells will be temporarily completed and water samples collected. Plate 20 has been revised to color code samples collected for the evaporation pond versus the leach field to avoid confusion to their purpose. A symbol was added to show surface soil and boring locations.

*35. Section 4.4.1.3.1.5 Former Leach Field (AOC #5), second paragraph states: “A direct push rig will be used to advance five borings in the vicinity of the Former Leach Field. Boring locations are noted on Plate 20.” Since the leach field and evaporation ponds are located next to each other, it is not distinct as to which borings are considered part of the leach field on Plate 20.*

**Westinghouse Response:** Refer to response to comment 34 above.

36. Section 4.4.1.3.1.6 Soils Beneath Building(s) (AOC #6), second paragraph states: “All 134 borings ... The analytes of concern for fill, soil and groundwater are provided in Table 3. Boring locations are noted on Plate 21.” The text states 134 borings. Table 13 indicates 13 borings. Plate 21 shows 16 borings. There appears to be a discrepancy in the number of borings.

**Westinghouse Response:** The text, Plate 21 and Table 23 have been modified to identify 15 borings.

37. Section 4.4.1.3.1.8 Outdoor and Shallow Surface Areas (AOC #8) states: “The medium of concern for the Outdoor and Shallow Surface Area is soil. ... The analytes of concern for soil and groundwater are provided in Table 3.” It appears that groundwater is considered a medium of concern by the text of the last sentence but not by the first. This should be clarified.

**Westinghouse Response:** In response to the comment, the phrase “and groundwater” has been eliminated from the last sentence.

38. Section 4.4.1.3.1.10 Gas Pipeline (AOC #10), third paragraph states: “A direct push drilling rig will advance as many as 9 borings within the natural gas pipeline trench, to a depth of approximately 15 feet bgs (i.e., to bedrock).” Previous investigations have indicated that bedrock is sometimes 20 to 40 feet deep in the Joachim Creek valley. It is not clear if the borings will be advanced to bedrock or to 15 feet of depth. If possible, the depth to the pipeline should be given within the text also.

**Westinghouse Response:** Based on recent investigations the gas pipeline is 3 to 5 feet bgs. The borings are designed to characterize the potential impact of the pipeline trench. In response to the comment, the words “(i.e., to bedrock)” have been deleted from the text as the borings are not intended to go to bedrock. The text has also been revised to include the identified depth of the gas pipeline.

39. Section 4.4.1.3.1.11 Is it possible that this potential disposal area might have been covered with clean soil? If so, surface samples might not identify the presence of subsurface contaminated materials. Subsurface sampling is recommended.

**Westinghouse Response:** It is likely that the soil placed on top of the pits was clean. However, it is possible that the construction activities disturbed the surface soil in this area and potentially spread contamination. To address the potential for subsurface contamination, two direct push samples at approximately 10 feet have been added to the Plan.

40. Section 4.4.1.3.1.12 Domestic Well #3 (AOC #12), states: “Domestic Well #3 has very recently been found to contain VOCs.” Since Domestic Well #3 is contaminated and is likely open to the Jefferson City Dolomite and Roubidoux Formation, additional

*investigation is warranted around it in order to determine if it is acting as a path of migration of VOCs. Down- and up-gradient wells within the Jefferson City Dolomite and Roubidoux Formation are needed in order to define the extent.*

**Westinghouse Response:** Upgradient wells have been installed as part of the interim hydrogeologic investigation and downgradient wells are planned. The text in this section has been revised to clarify the purpose of these downgradient wells.

*41. Section 4.4.1.3.1.14 Cistern Burn Pit Area (AOC #14), states: “One soil sample will be collected from the surface and at depth from the boring, ... The boring location is noted on Plate 23.” A surface soil sample location is not shown for the cistern burn pit area on Plate 23.*

**Westinghouse Response:** A surface soil sample is now shown for the cistern burn pit area on Plate 23.

*42. Section 4.4.1.3.1.14 Cistern Burn Pit Area indicates radionuclides of potential concern on Table 1. Table 2 indicates that there are no chemicals of potential concern. How is this known? Was this area sampled for dioxins, metals, and SVOCs? If so, it should be mentioned within the document.*

**Westinghouse Response:** Table 2 has been revised to include dioxins, metals, and SVOCs as chemicals of potential concern for this AOC because of the historic burning operation. Table 3 has also been revised to include analyses for dioxins in the pit area.

*43. Section 4.4.1.3.1.2 Depositional features of the various streams included in this section should be considered when identifying sediment sample locations. It is not clear that the indicated locations take this into account. Regarding proposed surface water samples, it is not understood how one water sample from each location at a single time / flow condition would be sufficient to fully characterize actual conditions and no technical justification has been provided to indicate otherwise. We recommend quarterly sampling at a minimum until a baseline is established.*

**Westinghouse Response:** Depositional features of the various streams will be considered when identifying sediment sample locations and the Plan has been revised to reflect this. Four monthly surface water samples have also been added to the Plan.

*44. Section 4.4.1.3.2 refers to one unconsolidated unit. Section 4.4.1.3.5 The “Ground Water” section refers to two unconsolidated units. Previous sections identify three zones in the unconsolidated unit as being of concern, however, there is no distinction indicated in this section. Will the individual zones in the unconsolidated unit be evaluated separately or is this now being considered a homogenous material?*

**Westinghouse Response:** Section 4.4.1.3.2 of the Plan does not make a distinction of any identifiable members of the unconsolidated material since we do not know what exists at those locations. The individual zones in the unconsolidated units, if identified, may be evaluated separately or may be considered a homogenous material. Section 4.4.1.3.5 for background sample locations indicates two units that contain various lithologic units. Since we do not know what those units are at those locations, we plan to investigate two distinct geomorphic features, the terrace and the alluvium. Depending on what is discovered those units may be sub-divided and treated in more detail. The text of the Plan has been revised to clarify this approach.

*45. Section 4.4.1.3.3 Please provide specific criteria to be followed in conducting the proposed walk-over radiological survey. Trees, brush, fences, equipment, and other obstructions will provide significant detriment to proper execution and the criteria should take this into account. Also, creek channels adjacent to and downstream of the site and areas proposed for magnetometer survey should be covered at the 100% rate. How will “hot-spot” locations & results be recorded? It is not clear from the “scan rate” description in the QAPP that this applies to the rate of the scanning device, not the pace rate. Also, it is our understanding that MARSSIM requires that the grid be walked in two generally perpendicular directions to be considered a 100% scan. This is not clear in the description. Also, please explain the justification for setting the investigation level at three standard deviations greater than the average readings from the each AOC as described in the QAPP rather than background readings for bias sampling locations. Finally, are the detection limits sufficient to be meaningful in light of the NRC interim soil surface screening values for  $^{238}\text{U}$  as referenced in the QAPP? If this information is to be provided in a separate work plan please indicate so.*

**Westinghouse Response:** Trees, brush, fences, equipment, and other obstructions will have to be worked around during the survey. Creek channels adjacent to and downstream of the site and areas proposed for magnetometer survey will be covered at the 100% rate and the plan has been revised to reflect this. Gross gamma walkover surveys “hot-spot” locations & results will be recorded using position-correlated GPS. Count rates will be translated into Z-scores and graphically plotted on color maps contoured by the z-score of count rates. The justification for setting the investigation level at three standard deviations greater than the average readings for the each AOC as described in the QAPP rather than background readings for bias sampling locations is to minimize the number of false positive readings. The proposed gamma walkover survey uses the best available technology. The detection limits provide meaningful information in light of the NRC interim soil surface screening values for  $^{238}\text{U}$  as referenced in the QAPP. These surveys are a valuable tool for site investigation and recommended by MARSSIM. Additional detail regarding the GWS has been added to the text of the Work Plan.

*46. Section 4.4.1.3.5 Determination of Background Concentrations, subsection Groundwater, second paragraph states: “To determine background of water quality from the upper bedrock aquifer, an air rotary drilling rig will advance a boring to a depth equal to the bottom elevation of the existing upper bedrock monitoring well WS-30 (approximately*

380' above mean sea level)." It is unclear why the bottom elevation of WS-30 was chosen instead of a zone corresponding to the permeable zones in BR1, BR2, BR3, or BR4.

**Westinghouse Response:** The Plan has been revised to install an open rock well rather than a screened well in the Jefferson City-Cotter Dolomite formation. There are a number of permeable zones in this unit that were identified as a result of investigation at BR1, BR2, BR3 and BR4.

47. Section 4.4.1.5.3 What will constitute GM detector "reference measurements"? Also, the department recommends an investigative level of 1.5 times the average reference value rather than 2 times as indicated. The last paragraph of this section is confusing and seems to say that the minimum detection limit of the on-site laboratory equipment will dictate the investigative level regardless of the calculated investigative level. Please provide the rationale for establishing the investigative level for RCOPC at 3 standard deviation above the average background values.

**Westinghouse Response:** The text has been revised to more appropriately describe the qualitative screening nature of the measurement. Instead of comparing field measurements to a reference area for GM surveys, samples will be screened and discrete samples selected based on the highest observed count rate. The reference to establishing an investigative level for RCOPC at 3 standard deviations above background values has been deleted.

48. Section 4.4.1.5.3 Field Screening, subsection Radionuclides, last paragraph states: "The results of on-site sample screening analyses will be evaluated based on comparison to background RCOPC activity concentrations established during reference area survey." The acronym RCOPC has not been previously defined in the document. It should be defined within the text.

**Westinghouse Response:** RCOPC is defined in the List of Acronyms Cited and the text has been revised to define the acronym where first used.

49. Section 4.4.1.5.4 Monitoring Well Installation, Survey and Development states: "Three and one-quarter inch O.D. probe rods are advanced through the open borehole to just above bedrock. A two and one-half inch O.D. pre-packed well screen assembly will then be lowered ... With the barrier in place to a minimum of two feet above the top of the screen, bentonite granules or bentonite slurry is then installed in the annulus ..." Considering that the annular space will be less than one inch wide, bentonite slurry should be used and not bentonite granules.

**Westinghouse Response:** The text has been revised to reflect that the barrier will be bentonite slurry.

50. On Pages 75 and 82, references are made to outside diameter (O.D.) for augers and PVC. These tools and materials are typically specified based on inside diameter (I.D.). The text should be checked to be sure it is correct.

**Westinghouse Response:** To clarify the text, the word “nominal” has been substituted for O.D. on pages 75 and 82. The remaining text as presented appears to be correct.

*51. Section 4.4.1.5.4 Monitoring Well Installation, Survey and Development, fourth paragraph discusses conventional monitoring well construction. There is no mention of the bentonite seal or annular seal. This should be listed.*

**Westinghouse Response:** The text has been revised to include the bentonite annular seal.

*52. Section 4.4.1.5.4 Monitoring Well Installation, Survey and Development, sixth paragraph states: “Development will continue until pH, temperature, and conductivity stabilizes on three consecutive readings, or three well volumes are removed.” The purpose of =developing a well is to regain formation quality water after drilling the borehole. This is best achieved by reaching stable parameters, even if the volume of water extracted exceeds three well volumes.*

**Westinghouse Response:** The phrase “or three well volumes are removed” has been deleted from the text.

*53. Section 4.4.1.5.5.2 Ground-water Elevation Gauging and Sampling states: “After the wells have been installed, developed, purged and recharged, groundwater elevations will be gauged using and electronic water level meter.” Since static water levels are desired, groundwater elevations should be gauged after development but before purging for sampling.*

**Westinghouse Response:** The text has been revised to address that water levels are measured during static conditions.

*54. Section 4.4.1.5.5.3 Surface Water Sampling states: “Care should be exercised while collecting the surface water sample to reduce or eliminate entrainment.” This can best be accomplished by taking downstream samples first and working upstream.*

**Westinghouse Response:** The text has been revised to describe that downstream samples are collected first.

*55. Section 4.4.1.5.7 Two unconsolidated hydrostratigraphic units are referenced in Section 4.4.1.3.5 . One is considered for investigation in this section. Please clarify.*

**Westinghouse Response:** The Plan does not make a distinction between the identifiable members of the unconsolidated material, since we do not know what exists at those locations. The individual zones in the unconsolidated units, if identified, may be evaluated separately or may be considered a homogenous material.

56. Section 4.4.1.5.7 Aquifer Testing, subsection In-Situ Hydraulic Conductivity Test, first paragraph states: “In-situ hydraulic conductivity aquifer tests (slug test) will be performed on all pumping test wells and observation wells.” Pumping tests are considered more accurate for aquifer testing than slug test. Therefore, it is not clear why slug tests are to be performed on pumping test wells.

**Westinghouse Response:** The slug tests will be performed to determine how individual wells respond, the results of which will be incorporated into the aquifer characteristics analysis as determined by interpreting the pumping test data.

57. Section 4.5.6.1 Groundwater Flow and Transport Model, subsection Task B – Construct a Ground-water Flow Model states: “Previous hydrogeologic investigations and new information gained will be used as a basis for developing a simple numerical model for the Site. ... Generally, the geologic information collected to date shows five unique hydrostratigraphic units are located beneath the Plant: a near surface silt, silty-clay (NSSSC); a fat clay; a deeper, silty clay/clay (DSCC); a clayey, silty, sandy-gravel; and Jefferson City Dolomite.” The list does not include Roubidoux Formation that is listed in Section 2.4.2. The Roubidoux Formation should be included in this list.

**Westinghouse Response:** The text has been modified to include the Roubidoux Formation in this list.

58. Section 4.6 Costs and Key Assumption and Section 4.7 Schedule state: “...are provided in Table 47.” And “Figure 45 provides ...,” respectively. Table 47 and Figure 45 do not exist within the subject document.

**Westinghouse Response:** The text has been revised to identify Table 4 and Figure 4.

59. Section 5.0 References Cited does not include the Bedrock Geologic Map of the Festus 7.5 Minute Quadrangle. The reference is Whitfield and Middendorf, 1993, Geologic Map of the Festus 7.5 Minute Quadrangle, Jefferson County, Missouri, OFM-92-296, SL-9301.

**Westinghouse Response:** The text has been modified to include this reference.

60. Table 2 Chemical Constituents of Potential Concern by Area of Concern, AOC #14 Cistern Burn Pit Area is listed as having no potential concern chemicals. However, Table 3, Proposed Drilling, Sampling and Analytical Requirements, lists the cistern area as getting screened for VOCs.

**Westinghouse Response:** The tables have been revised as discussed in response to comment 42.

61. *Table 2 Chemical Constituents of Potential Concern by Area of Concern, AOC #7 indicates that there are no chemical constituents of potential concern.*

**Westinghouse Response:** Based on the known use of the spent limestone, the only COPC is fluoride which has been added to Table 2 as previously requested.

62. *Table 3, Proposed Drilling, Sampling and Analytical Requirements, sublisting Analytical Parameters/Methods, does not have a #9. Since “9” is used in the Limestone Storage row, a corresponding explanation should be given for it.*

**Westinghouse Response:** The text has been revised so that Number 9 now refers to fluoride.

63. *Figure 3 shows a 2-foot bentonite seal and no centralizers for an 80 foot well. According to the MDNR Monitoring Well Construction Rules, the bentonite seal must be 3 to 5 feet thick and centralizers must be placed every 50 feet of well depth.*

**Westinghouse Response:** Figure 3 has been amended to incorporate the comment.

64. *Figure 6, RI/FS Process Project Management Diagram requires a few corrections. The Division of Environmental Quality has been renamed the Air and Land Protection Division (ALPD). The Division of Health and Senior Services is the Department of Health and Senior Services.*

**Westinghouse Response:** The text and Figure 6 has been modified pursuant to the comment.

65. *Plates 8 Schematic Geologic Cross-Section X-X' and Plate 9 Schematic Geologic Cross-Section Y-Y' show vertical scales of 1"=100' and horizontal scales of 1"=200', respectively. Plate 8 is incorrect by a factor of 2 and Plate 9 is off by a factor of 1.26. The scales should be corrected for the plates.*

**Westinghouse Response:** Plate 8 has been revised to address the comment.

66. *Plate 10 Potential Areas of Concern requires a few corrections. Limestone Area A does not have the fill pattern. The Evaporation Ponds are not clearly labeled. These should be corrected and added.*

**Westinghouse Response:** A fill pattern has been added to Limestone Area A and a label has been added for the evaporation ponds on Plate 10 as requested.

67. *Plate 20 Proposed Boring Locations for Evaporation Ponds, Former Septic Leach Field & Former Gas Station, the legend states: “X Proposed surface soil sample locations only” Some of the surface sample locations are marked with proposed boring locations. In order to avoid confusion, the “only” should be removed from the legend entry.*

**Westinghouse Response:** Plate 20 has been modified to incorporate the comment.

*68. The subject document interprets geological data, but is not sealed by a Missouri Registered Geologist (RG). Missouri law requires that geological work affecting or potentially affecting public health, safety or welfare be performed by or under the supervision of an RG. Because the subject document was not sealed by an RG, the foregoing review should not be construed as an endorsement of the validity of the document. This review cannot be considered complete until the document is properly sealed.*

**Westinghouse Response:** Comment noted. The revised Work Plan includes the seal of a Missouri Registered Geologist.

**ATTACHMENT 2**  
**Internal Clarifications and Revisions**

## **RI/FS Work Plan Attachment 2**

### **Internal Clarifications and Revisions**

- 1.) Title Page – Remove Cabrera Services.
- 2.) Inside Title Page – Remove Cabrera Services and Cabrera signature lines; change date.
- 3.) In Table of Contents, under “List of Plates”, sixth plate added “Cotter”.
- 4.) Added a list of attachments at end of Table of Contents.
- 5.) Section 2.6.6.1, last sentence, provided clarification of historic off-site waste disposal.
- 6.) Section 4.4.1.3.1.1, Baseline Ground-water Analysis, first sentence, revised to “34 of 36”.
- 7.) Section 4.4.1.3.1.1, Baseline Ground-water Analysis, last sentence. Clarified that piezometers BR1-JC and BR2-JC do not require sampling.
- 8.) Section 4.1.1.3.1.1, Private Water Supply Well Water Quality Analysis, ninth line, provided clarification.
- 9.) Section 4.4.1.3.1.1, Private Water Supply Well Water Quality Analysis, last sentence, provided clarification.
- 10.) Section 4.4.1.3.1.1, at end of section, added a new subsection “In-door Air Sampling”.
- 11.) Section 4.4.1.3.1.2, first paragraph, delete last sentence.
- 12.) Section 4.4.1.3.1.2, Joachim Creek, first paragraph, delete reference to background location to avoid confusion.
- 13.) Section 4.4.1.3.1.4, second paragraph, adjust number of sampling/boring locations to match tables/plates.
- 14.) Section 4.4.1.3.1.7, second paragraph, second sentence edited for clarification.
- 15.) Section 4.4.1.3.1.12, first sentence edited for clarification.
- 16.) Section 4.4.3.1.13, second sentence deleted.
- 17.) Section 4.4.1.3.2, first paragraph, second sentence edited to reflect proper plate numbers.
- 18.) Section 4.4.1.3.2, first paragraph, third sentence, adjusted number of borings/locations to match tables/plates and provide clarification.
- 19.) Section 4.4.1.3.5, Ground water, inserted new first paragraph for clarification.
- 20.) Section 4.4.1.5.3, VOCs, second paragraph, third sentence edited for clarification.
- 21.) Section 4.4.1.5.6, section rewritten to introduce IDW plan.
- 22.) Section 4.5.6.1, Task B, first paragraph, last sentence edited to reflect correct number.
- 23.) Section 4.8.2, delete Cabrera Services. Add new second paragraph.