Westinghouse

Hematite Decommissioning Project

DO-08-005

HISTORICAL SITE ASSESSMENT

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ACRONYMS AND ABBREVIATIONS

ABB	Asea Brown Boveri
ADAMS	Agencywide Documents Access And Management System
ADU	Ammonium Diuranate
AEC	Atomic Energy Commission
AIT	Augmented Inspection Team
Am-241	Americium-241
AMSL	Above Mean Sea Level
ARAR	Applicable Or Relevant And Appropriate Regulation
BNFL	British Nuclear Fuels Limited
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAL	Confirmatory Action Letter
CAP	Corrective Action Program
CE	Combustion Engineering
CERCLA	Comprehensive Environmental Response, Compensation, And Liability Act
CFR	Code Of Federal Regulations
DA	Disassociated Ammonia
DCAS	Defense Contract Administration Services
DOE	U.S. Department Of Energy
EP 1	Primary Evaporation Pond
EP 2	Secondary Evaporation Pond
EPA	United States (U.S.) Environmental Protection Agency
GAC	General Atomic Company
gpm	gallons per minute
GUNFC	Gulf United Nuclear Fuels Corporation
HDP	Hematite Decommissioning Project
HEU	High Enriched Uranium
HSA	Historical Site Assessment
HSU	Hydrostratigraphic Unit
IGMP	Interim Groundwater Monitoring Program
LANL	Los Alamos National Laboratory
LLRW	Low Level Radioactive Waste
MARRSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MC&A	Material Control And Accounting
MCW	Mallinckrodt Chemical Works
MDNR	Missouri Department Of Natural Resources
mph	miles per hour
NERVA	Nuclear Engine For Rocket Vehicle Application
NMSS	Nuclear Material Safety And Safeguards

ACRONYMS AND ABBREVIATIONS
(Continued)

Np-237	Neptunium-237
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
PCE	Perchloroethylene
pCi/g	picoCuries per gram
Pu-239/240	Plutonium-239/240
RI/FS	Remedial Investigation/Feasibility Study
SALP	Systematic Assessment Of Licensee Performance
SER	Safety Evaluation Report
SNM	Special Nuclear Material
Tc-99	Technetium-99
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
Th-232	Thorium-232
U-234	Uranium-234
U-235	Uranium-235
U-236	Uranium-236
U-238	Uranium-238
UF_4	Uranium Tetrafluoride
UF_6	Uranium Hexafluoride
UO_2	Uranium Oxide
UO_2F_2	Uranyl Fluoride
U_3O_8	Uranium Oxide Or Black Oxide
UNC	United Nuclear Corporation
USGS	United States Geological Service
VOC	Volatile Organic Compound
WEC	Westinghouse Electric Company LLC
ZrO_2	Zirconium Oxide

1.0 EXECUTIVE SUMMARY

The Historical Site Assessment (HSA) provides a description of the Hematite facility historical operations with potential to impact site areas. These activities began with the start of fuel fabrication operations in 1956, and following the cessation of fuel fabrication in 2001, continued with decommissioning and site maintenance activities through the present. This HSA has been prepared to aid in assessing the present radiological and environmental status of the site. The HSA was developed following the methodology provided in NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM; Reference 1-1) and NUREG-1757, Consolidated NMSS Decommissioning Guidance (Reference 1-2).

The Hematite facility was involved in fuel fabrication primarily for government use utilizing a wide range of Uranium enrichments from 1956 through 1974. From 1974 until plant closure in 2001, the Hematite facility produced nuclear fuel assemblies of low Uranium enrichment for commercial nuclear power plants. Over the lifetime of the facility there have been several owners. Mallinckrodt Chemical Works, Inc. (MCW), United Nuclear Corporation (UNC), Gulf United Nuclear Fuel Corporation (GUNFC) and General Atomic Company (GAC) owned the facility during the government contracts phase of operations. Combustion Engineering, Inc. (CE; whose stock was later acquired by Asea Brown Boveri (ABB)), and Westinghouse Electric Company LLC (WEC) owned and operated the facility during the commercial nuclear phase of operations. WEC has owned and operated the facility since April 2000.

The entire Hematite Site includes approximately 228 acres, some of which have been radiologically impacted by facility operations. The impacted areas are primarily centralized in and around buildings where facility operations were conducted. Likely or known sources of residual radioactivity include contaminated building materials, soils in and around buildings, and on-site waste burial pits.

Environmental media known or suspected to be contaminated by residual radioactivity include soils, sediments and groundwater. Radioactive isotopes known to be present at the site include Uranium isotopes (U-234, U-235 and U-238) and Technetium (Tc-99). Review of the facility's operational history indicates that the U-236 isotope, Thorium (Th-232), Neptunium (Np-237), Plutonium (Pu-239/240) and Americium (Am-241) are only expected to be present at the site in trace quantities. In addition to residual radioactivity, these media are also known or suspected to be contaminated with metals and the volatile organic compounds (VOCs) perchloroethylene (PCE), trichloroethylene (TCE) and their degradation products.

1.1 REFERENCES FOR SECTION 1.0

1-1 U.S. Nuclear Regulatory Commission, NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," Revision 1, August 2000, includes the June 2001 updates.

1-2 U.S. Nuclear Regulatory Commission, NUREG-1757, "Consolidated NMSS Decommissioning Guidance," Volumes 1 and 2, September 2006.

2.0 PURPOSE OF HISTORICAL SITE ASSESSMENT

The HSA was developed in accordance with guidance contained in NUREG-1575 (MARSSIM; Reference 1-1) and NUREG-1757 (Reference 1-2). Consistent with NUREG-1575, Section 3.1, the primary objectives of this HSA are to:

1. Identify potential, likely or known sources of radioactive material and radioactive contamination, based on existing or derived information;
2. Identify potential, likely or known sources of non-radiological contamination (organics and metals), based on existing or derived information;
3. Identify site areas that potentially require remedial action;
4. Provide an assessment for the likelihood of contaminant migration;
5. Provide information useful for scoping and characterization surveys; and
6. Provide initial classification of site areas as impacted or non-impacted.

The HSA provides a description of the Hematite facility historical operations from the start of facility activities in 1956 to the cessation of fuel fabrication operations in 2001, and continuing through decommissioning and site maintenance activities conducted from 2001 through mid-2008.

Decommissioning activities conducted at the Hematite Site include planning for decommissioning, uranium recovery/removal, process equipment removal and off-site shipment, and site characterization. The information contained in this HSA provides a basis for understanding historical operations that may have resulted in known or potential sources of residual radioactivity at the site. This assessment also describes the current status of the site and provides a basis for identifying and evaluating additional characterization and remediation activities which may be required for decommissioning.

3.0 PROPERTY DESCRIPTION

This section provides a description of the physical and environmental characteristics to be considered, in conjunction with historical operating information described in this HSA.

3.1 PHYSICAL CHARACTERISTICS

3.1.1 NAME

The site is named the Hematite Decommissioning Project (HDP) and is currently owned by Westinghouse Electric Company LLC.

3.1.2 LOCATION

The Hematite Decommissioning Project is located in Jefferson County, Missouri, approximately ¾ mile northeast of the unincorporated town of Hematite, Missouri, four miles southwest of the town of Festus, Missouri, and 35 miles south of the city of St. Louis, Missouri. Figure 3-1 shows a site location map for the facility. The site address is:

Westinghouse Electric Company LLC
Hematite Decommissioning Project
3300 State Road P
Festus, Missouri 63028

3.1.3 TOPOGRAPHY

The topography in the region of the Hematite Site consists of gently rolling hills dissected by streams (see Figure 3-2). The site sits on a transitional grade between rolling hills directly to the north and Joachim Creek to the south. In the immediate vicinity of the Hematite Decommissioning Project site, Joachim Creek is at an elevation of approximately 410 feet above mean sea level (AMSL) and occupies a narrow valley (approximately 2000 feet wide) that trends east-northeast. The valley is bounded both to the north and south by uplands that reach elevations in excess of 600 feet AMSL. A number of intermittent streams exist as tributaries to Joachim Creek resulting in the distinctive dissected topography characteristic of this region.

3.1.4 STRATIGRAPHY

The quadrangle geologic map provided in Figure 3-3 shows Holocene alluvium and terrace deposits in the vicinity of Joachim Creek to be closely associated with Joachim Creek and its tributaries. Holocene alluvium is described 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 inter-bedded with silt and clay.

The overall thickness of alluvium/terrace deposits underlying the Joachim Creek valley, near the facility, varies from 20 to 35 ft. These deposits consist of 10 to 20 ft of fine-grain silts and clay that overlies coarser-grain material (sands, gravels) near the bedrock surface. The thickness of the coarse-grain units is highly variable in this region and ranges from 0 to greater than 20 ft.

The local soil profile generated during the site hydrogeologic investigation indicates upper alluvial soils of stiff, very silty clays containing some sand, underlain by silty clays of firm to stiff consistency to depths of 10 to 13.5 ft. Beneath this surface unit lies very stiff, highly plastic clay with limestone fragments to depths of approximately 22 ft. Firm to stiff, sandy, silty clay was then found, until auger refusal occurred on boulders or limestone bedrock, at an approximate depth of 36 ft. The overburden consists of quaternary alluvial and colluvial deposits of silts, clays, sands, gravels and cobbles. Overburden depths vary across the site from 8.5 to 45 ft below ground surface, being deeper near Joachim Creek and shallower towards State Road P.

3.2 ENVIRONMENTAL SETTING

This section contains general descriptions of site and area geology, hydrogeology, hydrology and meteorology. Additional detail regarding the Hematite Decommissioning Project site environmental setting is provided in the Environmental Report for Hematite Site Decommissioning.

3.2.1 GEOLOGY

The geologic framework of the Hematite Site is dominated by two key bedrock formations, the Jefferson City-Cotter Dolomite Formation and the Roubidoux Formation (sandy dolostone and sandstone) that underlie the Hematite Site. The Jefferson City Dolomite is described as mostly light-brown to medium-brown, medium to finely-crystalline dolomite and argillaceous dolomite. The Jefferson City Dolomite is typically 125 to 325 feet thick and is bounded above by the Cotter Formation, also mostly dolomite; and below by the Roubidoux Formation, predominately a sandy dolomite with lesser beds of dolomite sandstone and dolomite. These formations dip gently toward the northeast. The regional landscape is highly dissected by streams yielding topographic relief in excess of 150 ft. locally. The Hematite facility is built upon terrace/alluvial flood plain sediments overlying bedrock within the valley carved by Joachim Creek.

The shallowest and most relevant components of the bedrock geology in the vicinity of the site are dominated by (in descending stratigraphic order) the Cotter Dolomite, Jefferson City Dolomite and Roubidoux Formations. Figure 3-3 shows the upland regions to the north and south of Joachim Creek are underlain by the Cotter Dolomite. The Jefferson City Dolomite is exposed in the valley walls of the tributaries to Joachim Creek. The nearest outcropping of the Roubidoux Formation is in the city of Desoto, Missouri, approximately 6 miles to the southwest of the Hematite Site.

3.2.2 HYDROGEOLOGY

In the unconsolidated terrace/alluvial flood plain sediments (herein referred to as the overburden), groundwater flow is chiefly confined to the basal, coarse-grain unit in a southeastward direction from the Hematite facility, and discharges into Joachim Creek. Flow and transport in a southeasterly direction within the overburden is facilitated by a hydraulic gradient, caused by groundwater mounding under the Hematite Facility and discharging into the surface of Joachim Creek. With increasing depth below the surface, flow/transport directions gradually shift from southeasterly (overburden), to a blend of southeasterly and a regionally-imposed northeasterly component (Jefferson City-Cotter Hydrostratigraphic Unit [HSU]); and finally, to a regional northeasterly direction (Jefferson City-Roubidoux contact zone and Roubidoux HSUs). Northeasterly groundwater flow is consistent with the regional groundwater flow direction in the Roubidoux Formation.

Vertical head gradients are downward from the shallow to deep overburden. Between the deep overburden and Jefferson City-Cotter HSU, gradients are downward in the vicinity of the Hematite facility and generally upward near Joachim Creek. Vertical gradients tend to be upward from the Jefferson City-Cotter HSU and deeper HSUs. However, until approximately mid-2004, this gradient was reversed (i.e., downward) as a result of the significant lowering of heads in the Roubidoux Formation. A possible reason for lower heads in the deeper HSUs was the pumping of groundwater from the Roubidoux Formation by water supply wells in the nearby city of Festus.

There are two distinct groundwater monitoring programs at the Hematite Site. The first is based on the U.S. Nuclear Regulatory Commission (NRC) license requirements and includes nine wells that are sampled quarterly for radiological parameters. The other program is the Interim Groundwater Monitoring Program (IGMP) which is based on requirements from Missouri Department of Natural Resources (MDNR). There are seventy-two (72) wells that were sampled on a quarterly basis, the majority of which were sampled for both VOCs and radiological contaminants. Going forward, a modified IGMP will be conducted to continue the necessary collection of groundwater data.

There is a VOC plume (primarily perchloroethylene [PCE] and trichloroethylene [TCE] and degradation products) which has migrated into the bedrock zone and crossed beneath the Joachim creek. As a result of this, twenty-three (23) residences have been supplied with public water.

3.2.3 HYDROLOGY

In general, most infiltration from precipitation in the vicinity of the Hematite Site follows short, subsurface flow paths in soils and alluvial sediments, and discharges into local streams. Remaining flow enters the bedrock recharging bedrock aquifers. Shallow groundwater in bedrock formations is influenced by local topography, with short flow paths followed by discharge into seeps and springs or alluvium.

Referring to Figure 3-4, there are several surface water features present on the Hematite Site. Surface water tributaries generally flow southeast or northwest from the highlands to their points of confluence with Joachim Creek. Descriptions of these surface water features are summarized below:

1. The site spring flows at an estimated 10 gpm most of the year; however, flows from this spring can be significantly greater depending on seasonal precipitation levels. The spring is likely a result of fracture flow in the Jefferson City-Cotter Dolomite that receives its source water from the hills northwest of the Hematite Site.

2. The Site Pond is a small concrete dam impoundment southwest of the facility. It receives flow from the site spring and storm water runoff from the facility area.

3. The Site Creek is effluent from below the dam of the Site Pond. It receives discharge from the Hematite facility's sanitary water system. It flows through a culvert beneath the railroad track and joins effluent from the Lake Virginia drainage basin.

4. The combined Lake Virginia/Site Creek tributary flows east to Joachim Creek.

5. The northeast Site Creek flows southeast, then east to its confluence with the effluent from East Lake tributary, and then to Joachim Creek.

6. East Lake, located east of the Hematite facility, is an earth impoundment lake used as water supply for cattle. There is no evidence that East Lake was ever used in conjunction with Hematite facility operations.

7. North Lake Tributary is the effluent drainage from North Lake and North Tributary. This tributary crosses the terrace west of East Lake.

8. North Tributary is an intermittent stream west of North Lake.

A wetland and surface water assessment was conducted in November 2003 to delineate and classify potential jurisdictional wetlands and surface water bodies at the Hematite Site (Reference 3-1). The single potential wetland identified within the site boundary is located in a small depression south of the facility buildings between the railroad berm and a gravel road that extends from the facility south towards Joachim Creek. This identified wetland is a small, isolated, forested/scrub area confined to the south and southwest by the gravel road, and to the north by the railroad berm. The primary source of recharge into this wetland appears to be storm water runoff from the surrounding areas.

3.2.4 METEOROLOGY

General climatological characteristics of the site area can be inferred from those of St. Louis, Missouri, the location of the nearest U.S. Weather Bureau recording station. The region experiences a modified continental climate without prolonged periods of extreme cold, extreme heat or high humidity. Generally, air masses moving northward from the Gulf of Mexico bring warm, moist air; while colder, drier air masses typically approach from the north. These air masses, along with local weather phenomena, produce a variety of weather conditions. Winters are brisk but seldom severe. Minimum temperatures remain as cold as 32°F or lower for fewer than 20 to 25 days annually. Summers are warm with a maximum temperature of 90°F or higher for an average of 35 to 40 days per year. Prevailing winds are generally from the south at 8 mph

to 9 mph average, from May to October; and from the west-northwest at 10 mph to 11 mph average, from November to April.

Snowfall has averaged less than 20 in. per winter season since 1930. December, January and February are the driest months, while April and May are normally the wettest. It is not unusual to have extended periods (1 to 2 weeks or more) without appreciable rainfall, from the middle of summer into the fall. Thunderstorms occur on average between 40 and 50 days per year, mostly between May and August (Reference 3-2).

3.3 REFERENCES FOR SECTION 3.0

3-1 Science Applications International Corporation (SAIC), "Wetland and Surface Water Assessment," January 23, 2004.

3-2 United States Department of Agriculture, "Soil Survey for Jefferson County, Missouri," 2003.

Figure 3-1 **Page 1 of 1**

Location Map - Hematite Decommissioning Project, Jefferson County, Missouri

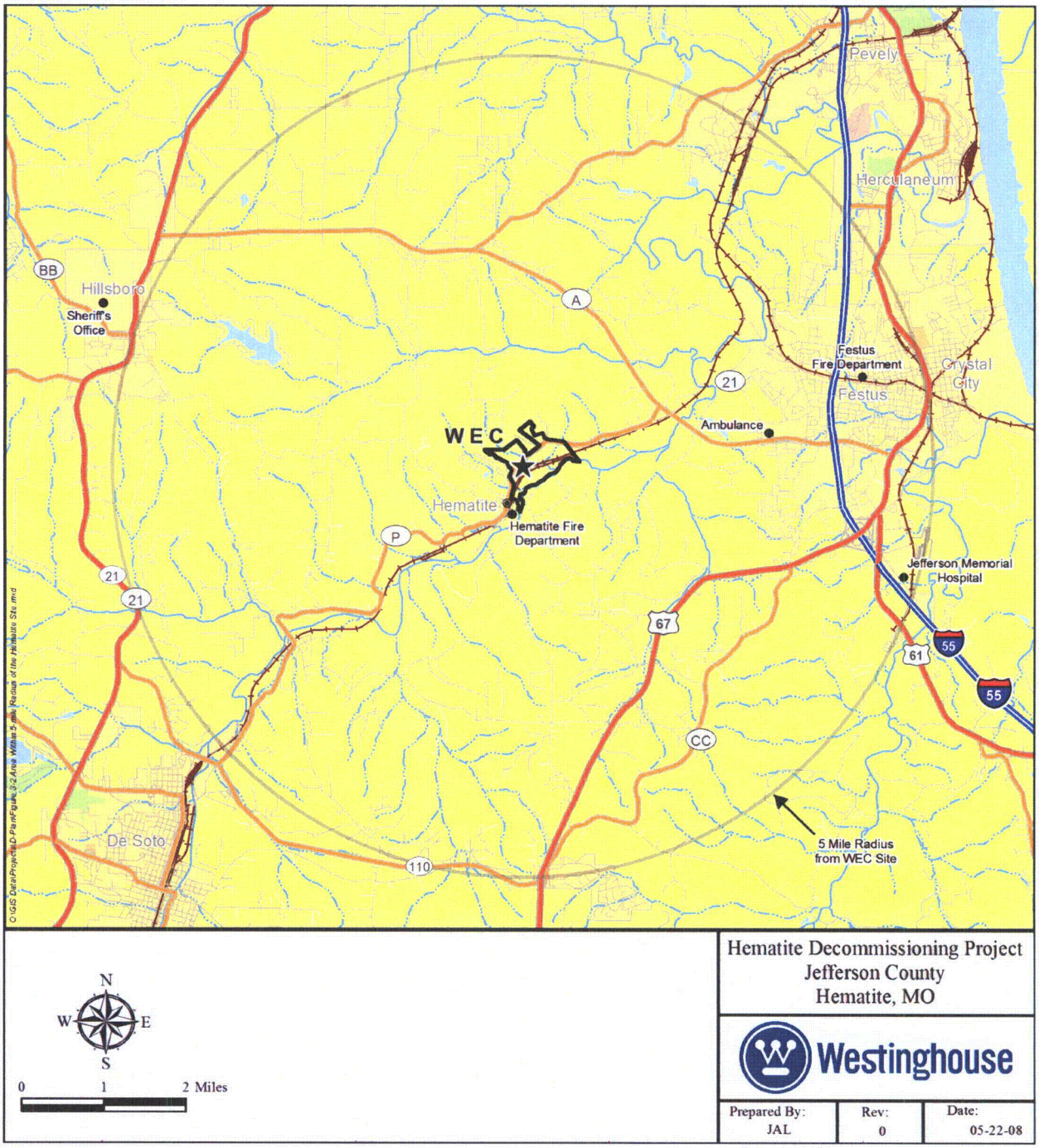


Figure 3-2

Hematite Site Regional Topography

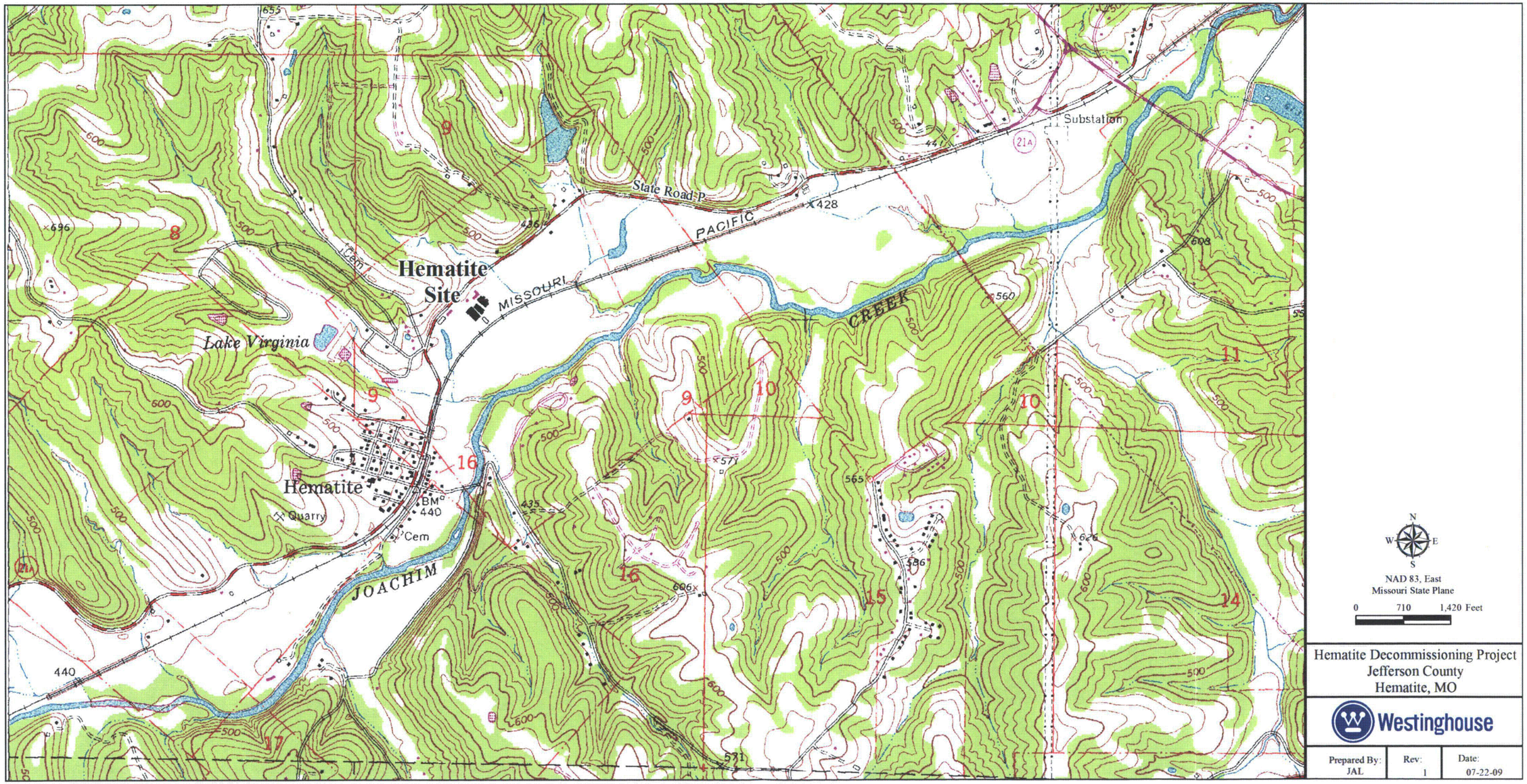


Figure 3-3 **Page 1 of 1**

Bedrock Geologic Map Of Festus 7.5' Quadrangle

LEGEND:

Qal.....ALLUVIUM
Qt.....TERRACE
Oc.....COTTER DOLOMITE
Ojc.... JEFFERSON CITY DOLOMITE
Or.....ROUBIDOUX (DOES NOT SUBCROP IN THIS LOCATION

SOURCE:

ADAPTED FROM THE BEDROCK GEOLOGIC MAP OF FESTUS 7.5' QUADRANGLE JEFFERSON COUNTY, MISSOURI AND MARK A. MICKLEDORF (1992).

N

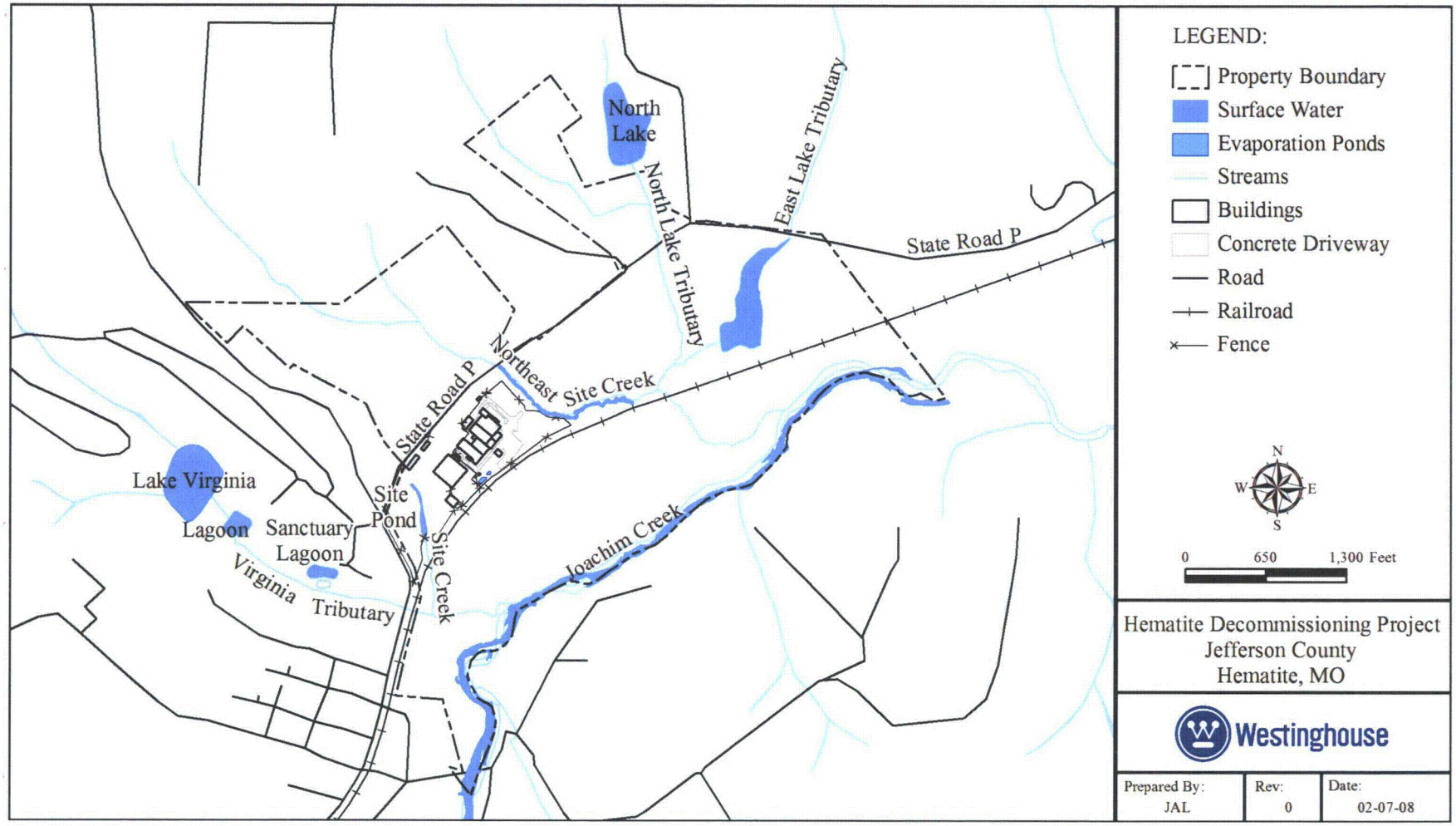
0 1250 2500 5000'

GRAPHIC SCALE IN FEET

GEOLOGIC MAP OF HEMATITE	Westinghouse
HEMATITE SITE FESTUS, MO	DATE: MARCH 2006

Figure 3-4

Hematite Site Surface Water Features



4.0 HISTORICAL SITE ASSESSMENT METHODOLOGY

4.1 APPROACH AND RATIONALE

It is the objective of Westinghouse to decommission the Hematite facility in a manner that reduces residual radioactivity to levels that facilitate release of the site for unrestricted use, in accordance with criteria in 10 CFR 20, Subpart E (Reference 4-1). License termination and free release will be conducted in accordance with site license requirements and commitments, NRC regulations and applicable guidance documents.

Guidance contained in NUREG-1575 (MARRSIM; Reference 1-1) and NUREG-1757 (Reference 1-2) were used as a framework for development of the HSA. Information compiled in this HSA was obtained through reviews of available site historical records, historical records located on the NRC Agencywide Documents Access and Management System (ADAMS) website, interviews with former employees and characterization data.

The review of Hematite facility historical documentation encompassed the time period from 1956 through June 2008, and included both operational and decommissioning activities of significance in determining the degree of potential site impacts. The Hematite facility has experienced a diverse history of site operations and ownership. Given this varied history, every effort has been made to provide reasonable assurance that site operations and events with the potential to contribute residual radioactivity at the Hematite Site have been captured in this HSA.

The review of plant records consisted of radiological surveys and environmental monitoring data, available Corrective Action records, burial logs, waste shipment manifest logs, operational procedures, as well as regulatory and license history files. Additionally, documents pertaining to historical licensing and operation of the Hematite Site available from the NRC ADAMS website were reviewed for this HSA. The information obtained through this process is a source of data to records maintained on site to satisfy the requirements of 10 CFR 70.25(g)(1) (Reference 4-2).

4.2 BOUNDARIES OF SITE

The Hematite Site consists of approximately 228 acres. Figure 4-1 depicts the site boundary and specific features discussed in this section. The portion of the site where operational activities historically were conducted is referred to as the "Central Tract." This area is approximately bounded by State Road P to the north, the northeast Site Creek to the east, the Union-Pacific railroad tracks to the south, and the Site Creek/Pond to the west.

The Central Tract encompasses facility operational and administrative building locations, two Evaporation Ponds, the Site Pond and legacy waste burial areas. A buried, 8-inch natural gas line transverses the site from the southwest to the northeast. The remaining site area is predominantly pasture or woodland.

There are three residential properties located within the site boundary as shown in Figure 4-1. As of mid-2008, the closest residence closest to the Central Tract (#1 on Figure 4-1) is occupied and supports a small number of livestock. The second residence (#2) is currently unoccupied, while the third residence (#3) is occupied.

4.3 DOCUMENTS REVIEWED

Following is a listing of the historical documents reviewed for development of this HSA:

1. Pre-construction survey records;
2. Site photos (1954 – 1998);
3. Commercial and government contracts;
4. Burial area logs;
5. Regulatory and license history files;
6. Operational procedures (Operating Sheets);
7. Radiological survey and environmental monitoring data;
8. Waste shipment manifest logs; and
9. Available Corrective Action records (2000 – 2008).

Additionally, documents pertaining to historical licensing and operation of the Hematite Site available from the NRC ADAMS website were also reviewed for this HSA. ADAMS documents reviewed included:

1. Correspondence associated with past amendments to NRC Special Nuclear Material License No. SNM-33;
2. NRC Source Material and Byproduct Material license history relating to the Hematite facility; and
3. NRC files regarding regulatory action and license history related to the Hematite facility.

4.4 PROPERTY INSPECTIONS

4.4.1 AERIAL PHOTOGRAPHY REVIEW

Successive aerial photographs of the Hematite Site area were reviewed to provide a general idea of the evolutionary context of the Hematite facility (Reference 4-3). The photographs encompass the period from 1954 to 1998. Appendix A contains these photographs and a summary of observed changes between sequential photographs.

In general, the photographic evidence shows a progressive increase in the number of structures within the Central Tract area used for facility operations. The outlying land areas were relatively unaffected by site operations and have remained grazing pasture and woodland since the facility began fuel fabrication operations. Section 5.1 provides additional information regarding historical usage of site areas and buildings.

4.4.2 SITE INSPECTIONS

Site inspections have been performed in conjunction with characterization investigation efforts conducted between 1988 and 2007 (Reference 4-4). Access to the Central Tract area of the site has been controlled by a site security program throughout its operating and decommissioning periods, thereby minimizing opportunities for unauthorized or unknown impacts to the site.

4.5 PERSONNEL INTERVIEWS

As part of the HSA investigation process, interviews with employees were performed to collect first-hand information about the site and to verify or clarify information gathered from existing records. Between 2000 and 2008 (Reference 4-5), interviews were conducted with former Hematite plant employees involved in facility operations during the government contracts and research era (1956 to 1974) and the commercial nuclear fuel production era (1974 to 2001). The primary goals of these interviews were to: (1) formulate an understanding of waste materials that were purportedly buried pursuant to 10 CFR 20.304 (1964); (2) obtain an understanding of fuel fabrication operations and materials used in those operations; and (3) identify events or operational practices that had the potential to result in residual radioactivity within the site boundary.

4.6 REFERENCES FOR SECTION 4.0

4-1 Code of Federal Regulations, Title 10, Part 20, Subpart E, "Radiological Criteria for License Termination."

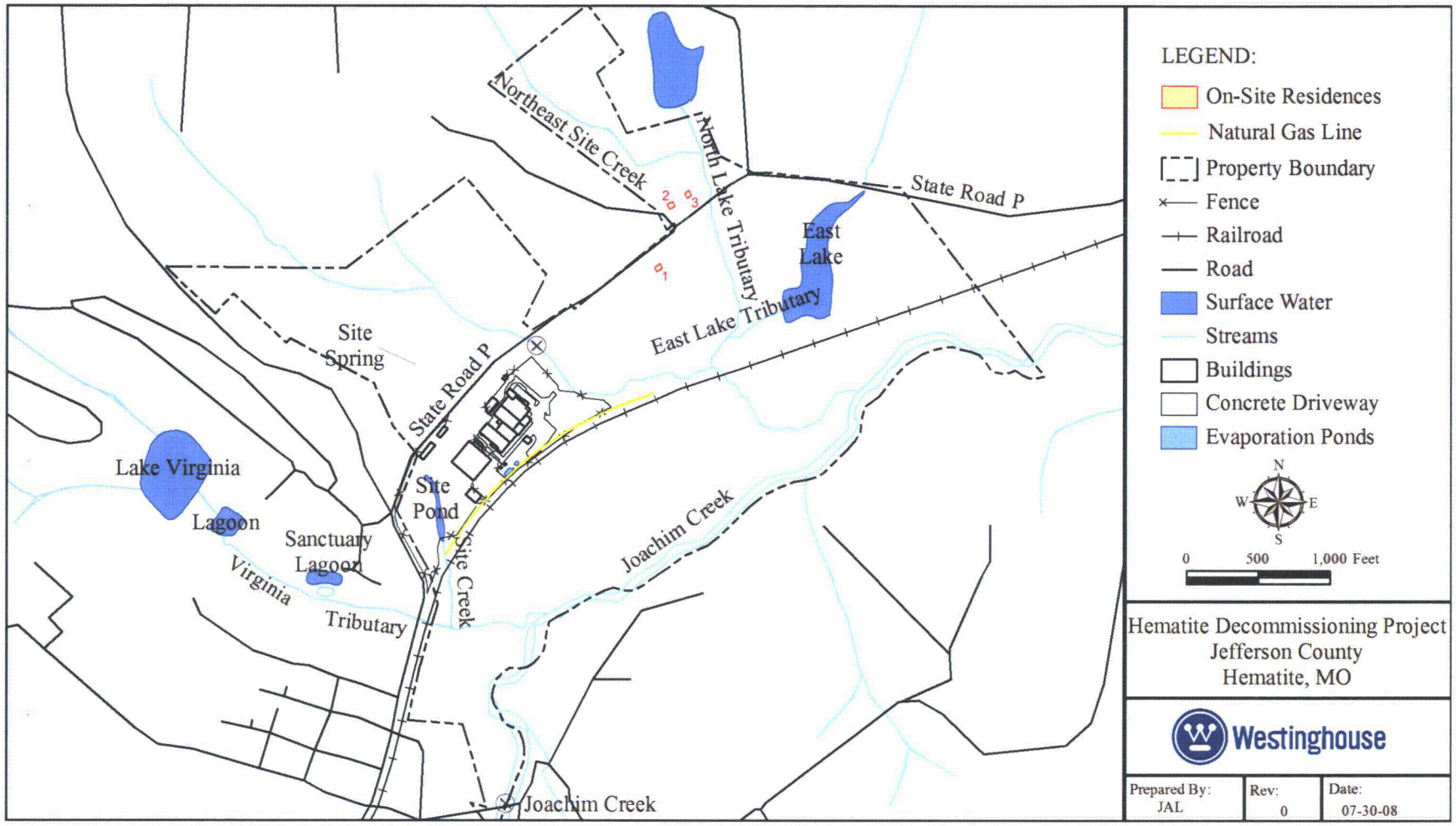
4-2 Code of Federal Regulations, Title 10, Part 70.25, "Financial Assurance and Recordkeeping for Decommissioning."

4-3 Aero-Data Corporation, Hematite Aerial Photographs, 1954-1998.

4-4 Westinghouse Electric Company Document No. DO-08-003, "Hematite Radiological Characterization Report," Revision 0.

4-5 Westinghouse Electric Company, "Hematite Employee Interview Records," 2000 to 2008.

Figure 4-1
Hematite Site Boundary And Features (As Of June 2008)



5.0 HISTORY AND CURRENT USAGE

Consistent with the guidance of NUREG-1575 (MARSSIM; Reference 1-1) and NUREG-1757 (Reference 1-2), information regarding historical facility operation, regulatory involvement, permits and licenses, and waste handling procedures is provided in this section. Figure 5-1 depicts building locations and site area impacts as described in the following sections.

5.1 FACILITY HISTORY

This section contains a summary of historical operations and events that contributed to site impacted areas. Section 2.0 of Appendix B provides additional detailed operational history of the Hematite facility.

Mallinckrodt Chemical Works purchased the initial parcel of farm land for the Hematite Site. There are two distinct time periods that characterize operations at the Hematite Site. The first time period included primarily government operations that began in 1956 and continued through 1974. Mallinckrodt Chemical Works owned and operated the Hematite facility until May 1961 when ownership was transferred to United Nuclear Corporation. UNC operated the site until 1971 when UNC and Gulf Nuclear Corporation entered into a joint venture forming Gulf United Nuclear Fuels Corporation (GUNFC). GUNFC operated the site until January 1974. In January 1974, the facility was transferred to General Atomic Company. The focus of operations during this period was Uranium fuel research and production of fuels for various government applications. Research reactor fuels, United States Navy/Army reactor fuels, and some commercial nuclear reactor fuels were produced.

The second period supported primarily commercial nuclear operations and began in April 1974 when the site was purchased by Combustion Engineering. Asea Brown Boveri (ABB) purchased the stock of CE in 1989 and began operating the facility under the name "ABB Combustion Engineering Nuclear Power" which was a division of CE. In April 2000, the Hematite Site was acquired from ABB by the then parent company of WEC, British Nuclear Fuels Limited (BNFL), as part of the purchase of ABB's nuclear operations, and merged into WEC. Westinghouse operated the facility until mid-2001, when Westinghouse permanently ceased fuel fabrication at the facility. The ownership of the Hematite facility since its inception is summarized in the Table 5-1.

The Hematite facility received UF_6 from the U.S. Department of Energy (DOE) that was produced using recycled Uranium. This resulted in the introduction of Tc-99 and the potential for the presence of trace quantities of U-236, Am-241, Pu-239/240 and Np-237. Additional details on this period are provided in Appendix B.

Since the permanent cessation of fuel fabrication activities in mid-2001, the activities at the site have been limited to minor decommissioning activities (e.g., Special Nuclear Material [SNM] inventory removal, process system and equipment removal, etc.) and facility maintenance.

5.1.1 HISTORICAL BUILDING USE AND FACILITY MODIFICATIONS

Initial site construction in 1956 included one process building (Building 240), a utilities building (Building 250) and a material storage building (Building 235). Hematite facility operations evolved from 1956 through 1998 in response to process changes and technology advances. For the operational period from 1956 to 1998, process changes and corresponding building use and modifications are summarized in Table 5-2.

5.1.2 CHEMICALS AND HAZARDOUS MATERIAL USAGE

Table 5-3 provides a list of typical process chemicals used at Hematite. This list was compiled from a CE submittal to the NRC and an independent study by Los Alamos National Laboratory (LANL) (Reference 5-1 and Reference 5-2, respectively).

5.1.3 RADIOLOGICAL WASTE BURIALS AND SHIPMENTS

The following sections contain a summary of waste burials conducted at the Hematite Site. Section 3.0 of Appendix B contains additional detail associated with the Burial Pits.

5.1.3.1 Documented Burial Pit Area

On-site burial was used as a disposal method for contaminated materials and wastes at Hematite from 1965 until 1970. This burial area is documented to contain 40 unlined pits, in an area east of the facility buildings as shown on Figure 5-1. These Burial Pits were used to dispose of materials and waste generated by research and fuel fabrication processes.

On-site burials were authorized by the Atomic Energy Commission (AEC) regulations found at 10 CFR 20.304 (1964; Reference 5-3). The Burial Pits purportedly were constructed pursuant to 10 CFR 20.304 (1964) regulatory requirements and a policy describing the size and spacing of the pits, the thickness of soil cover and the quantity of radioactive material that could be buried in each pit (Reference 5-3 and Reference 5-4). The nominal dimensions of each Burial Pit are approximately 20 ft wide by 40 ft long, and 12 ft deep, with a nominal soil cover depth of 4 ft. However, interviews indicate that these requirements and procedures were not necessarily followed with respect to depth or cover or distance between burials. Also, as discussed below, limits on the amount of material were not followed for several pits.

United Nuclear Corporation (and later GUNFC) maintained detailed logs of burials for the period of July of 1965 through November of 1970. Each logbook entry contains a date, a description of the waste buried, the weight of the Uranium measured for that waste and a cumulative total of the Uranium buried in that particular pit. The weight of the contaminated item measured or estimated was determined to the nominal value of one (1) gram which likely resulted in an over-estimate of the actual amount. Some entries also list percent enrichment for the Uranium (Reference 5-5).

Operational Uranium recovery processes utilized during this time period consistently show efforts to recover and utilize Uranium material to the maximum extent possible, rather than dispose of recoverable material in the Burial Pits. The Burial Pit logbook records and employee interviews provide support for this approach.

On-site burial of radioactive material was terminated in November of 1970, as a result of an AEC citation for failure to adhere to revised AEC regulations reducing the quantity of material which could be buried on-site.

The Burial Pit logs show a wide variety of wastes being buried in the pits. A list of waste material categories was compiled from both the Burial Pit logs and interviews of previous employees. Based on this information, the types of waste materials that may be present in the Burial Pits are summarized in Table 5-4.

5.1.3.2 Undocumented On-Site Waste Burials

Interviews with former employees indicate undocumented on-site burials, other than those purportedly done under 10 CFR 20.304 [1964], may have occurred as early as 1958 or 1959. Specifically, evidence exists that three or four burials may have been performed each year, prior to 1965, for disposal of general trash and items with limited contamination relative to then current radiological free-release standards (Reference 4-5). Accordingly it is estimated that 20-25 burials may exist for which there are no records. Burials prior to 1965 were not documented (logged), as they were not considered to contain significant quantities of SNM (Reference 5-6).

These undocumented burials are believed to have been in the same general area as the documented Burial Pits, and/or in the proximity of site buildings in the eastern portion of the Central Tract (see Figure 5-1). No specific information has been located to indicate the specific nature of the waste material buried in these undocumented burial pits. Additionally, no evidence has been found to indicate that burial of known Uranium-bearing materials (i.e., levels greater than free-release criteria) occurred during this time period.

5.1.3.3 Red Room Roof

The roof of Building 240-1, also known as the "Red Room," was buried in an area south of Building 101 (the Tile Barn). The Red Room area of Building 240 was used for UF_6 conversion of high enriched Uranium. Soil contamination was discovered in 1993 during renovations to the Tile Barn. The area where the roof is buried is shown in Figure 5-1. This general area is also known to have been used for temporary storage of scrap materials.

5.1.3.4 Waste Shipments from 1966 to 1971

Off-site shipments of radioactive waste occurred throughout the period during which on-site burial of contaminated trash occurred. Off-site shipping records indicate a relatively significant amount of radioactive waste products were shipped off-site for disposal during the on-site burial period. Table 5-5 summarizes waste shipments during the time period when active use of the Burial Pits occurred (Reference 5-7).

5.1.4 EVAPORATION POND USAGE

The Hematite facility has two Evaporation Ponds that were used for on-site disposal of process filtrates, low-level contaminants, and high-enriched and low-enriched Uranium materials. The Ponds were originally designed to receive filtrates from the low-enriched Ammonium Diuranate (ADU) conversion facility. Section 4.0 of Appendix B contains additional historical detail pertaining to Evaporation Pond usage. The logs from the Burial Pits also contain a number of entries reflecting disposal of various materials in the Ponds (see Table 5-6).

The Evaporation Ponds consisted of a primary Pond (EP 1) and a larger, secondary/overflow Pond (EP 2) with a 1.5 foot berm around each Pond. The Ponds were originally lined with approximately 10 in. of rock (nominal diameter of 0.5 to 3 in.). The size of the primary Pond was approximately 30 ft by 40 ft, and the secondary Pond was 30 ft by 85 ft. Figure 5-1 shows the location of the Evaporation Ponds.

While the Evaporation Ponds were designed and built to receive filtrates from the low-enrichment processes, they were also used for the retention of both high- and low-enrichment recovery waste liquids. Historical documentation also indicates retention of other liquid waste solutions in the Evaporation Ponds. Examples of these waste liquids include acidic cleanup solutions, organic solvent solutions (perchloroethylene and trichloroethylene), oils, building sump contents and mop water. The precipitates and solids were allowed to settle and the water evaporated naturally. As additional liquids were added to the primary Pond, the overflow flowed through a pipe into the secondary Pond.

After CE purchased the Hematite facility in 1974, use of the Evaporation Ponds was curtailed to allow only the retention of spent potassium hydroxide scrubber solution from the Uranium dry recycle process and liquids from startup testing of the wet recovery process. Use of the Ponds was discontinued altogether in September 1978.

In 1979, 700 ft^3 of sludge was pumped out of the primary Pond. The sludge was dried and shipped to a licensed burial facility between 1982 and 1984 (Reference 5-8). In Additional decommissioning efforts for the Evaporation Ponds were undertaken by CE in 1984 in response to NRC directives (References 5-8 and 5-9). As a result, CE removed approximately 2,800 ft^3 of sludge, rock and soil from the primary Evaporation Pond in 1985. Detailed sampling following the remediation effort determined the average total Uranium contamination of the soil in the Pond was below the 250 pCi/g total Uranium decontamination limit set by the NRC, however, spot contamination levels in excess of the limit remained. Approximately 1,200 ft^3 of soil and rock were also removed from the secondary Evaporation Pond in 1987. Subsequent soil/sediment samples collected from the Evaporation Ponds following these remediation efforts revealed an average concentration of Uranium in the Evaporation Ponds below the 250 pCi/g limit; however, individual sample results showed soil/sediment contamination levels in excess of the limit remained (Reference 5-10).

On May 4, 1995, a decommissioning plan for the Evaporation Ponds was incorporated by amendment into the site license. Following additional characterization of the Evaporation Ponds, this decommissioning plan was revised based on more extensive characterization results (References 5-11 and 5-12). The Evaporation Pond decommissioning plan was implemented over the next four years and resulted in the removal of approximately 6,000 ft^3 of additional soil/sediment for disposal. Surveys and sampling of the Pond area conducted in 1999 indicated an average concentration of 170 pCi/g U-235, with several samples yielding higher, up to 745 pCi/g U-235. In addition, Uranium concentrations of approximately 100 pCi/g were detected at depths of 10 ft below ground surface (Reference 5-13). Remediation efforts associated with the Evaporation Ponds were suspended in 1999 to evaluate additional remediation techniques and options.

The Ponds have been known to overflow during periods of high precipitation, thereby impacting the soils around the Ponds. Employee interviews and recent experience confirm overflows have occurred, and it is expected remediation of this area will be required.

5.1.5 ON-SITE WASTE TREATMENT, HANDLING AND STORAGE PRACTICES

5.1.5.1 Process Waste Handling

Documentation of waste handling processes and operating procedures indicate that during manufacturing operations there was a planned effort to recover as much SNM as practicable, through scrap recycling. The recovery process generally described evaporating liquid contents to reduce volume, then the 'bottoms' material was processed through wet recovery. Liquid process wastes included solutions from acid clean-up, TCE clean-up, and clean-up water. Incinerator and UF_6 scrubber liquor was analyzed and then concentrated by evaporation. The concentrate was solidified with cement and the solid mass was shipped to off-site burial. Spills in Building 260 (Oxide Conversion) were generally washed into the building sump, and the contents of the sump were then processed in accordance with scrap recycle operating procedures. Spills in other areas were mopped up and the mop water was processed through scrap recycle operating procedures (References 5-14, 5-15 and 5-16).

However, not all distillate was placed back into the recycle process. One interview with an employee who worked on-site from 1992 until plant closure, revealed that distillate was also stored in drums in an outside lay down area, south of Building 240 and west of Building 252. These drums were not protected from the weather, and although the distillate was treated to neutralize pH, some drum liquids exhibited corrosive characteristics. The employee stated that some drums leaked onto the ground in this area.

During the late 1990s there was a concerted effort to process these drums and remove them from the site. An employee interview indicated that a cement mixer existed on site which was used to solidify distillates for shipment and disposal (Reference 4-5).

5.1.5.2 Incineration

In the 1960s, contaminated trash (filters, rags, paper, etc.) was incinerated to concentrate Uranium, prior to chemical recovery in Building 240. Incinerating waste to reduce the volume of combustible, low-level Uranium-contaminated waste products, and bulk materials containing Uranium, occurred beginning in the late 1970s (Reference 5-17). Incineration was a controlled process that included routine air monitoring, and took place in Building 240-3 (Reference 5-18).

The Cistern Burn Pit Area outside and southwest of Building 101 (Tile Barn) was used to burn wooden pallets and other combustible waste that may have contained radioactive materials. Burning of waste material took place in this area between the mid-1960s and 1974 (Reference 4-5).

5.1.5.3 Sewage Treatment

The original facility Sewage Treatment System was designed such that drains inside buildings were directed to a buried septic tank connected to a leach field (see Figure 5-1). Liquid wastes from personnel showers and mop water was directed into various floor drains leading to the leach field of the former Sewage Treatment System.

Between 1977 and 1978, the on site treatment of sewage was modified to bypass the hold-up tank and connect to a new Sewage Treatment System located just northwest of the Evaporation Ponds. In 1991, a more modern sewage treatment control system was installed. This modified Sewage Treatment System is still in use and discharges to the Site Creek at Outfall No. 001 as shown in Figure 5-2).

Remediation efforts were undertaken by CE after discovery that a portion of the Site Creek, between the site dam and the railroad tracks, had been contaminated with insoluble Uranium-bearing sludge from upsets in the Sewage Treatment System. An internal CE report dated January 22, 1996 (Reference 5-19) confirms that the results of surveys, taken prior to remediation, indicate Uranium contamination in the silt layer at levels between 40 and 800 pCi/g. Additionally, the clay liner of the creek was found to contain Uranium with concentrations between 2 and 35 pCi/g.

Remediation was accomplished by diverting the creek and removing the silt with a backhoe, to a depth of 0.5 to 3 ft, between the dam and the railroad tracks. Subsequent sampling verified residual levels to be below the post-remediation action level of 30 pCi/g. The material was then dried and disposed of at a licensed disposal facility (Reference 5-19 and Reference 5-20).

Degradation of the existing buried Sewage Treatment System discharge pipe was identified in 2007 when it was discovered that no flow existed at the effluent sampling point (00 No. 1, see Figure 5-2). Degradation of the effluent pipe had progressed to the point that the majority of the liquid effluent entering this line did not reach the discharge point at the Site Creek (Reference 5-21). It is surmised that liquids from the degraded pipe leaked through cracks or breaks in the pipe, resulting in effluent migrating into the surrounding soils. Since the effluent of the Sewage Treatment System contains residual radioactivity (within approved regulatory release limits), it is expected that accumulation over time may require remediation of the soils in this area during decommissioning of this system and associated effluent piping.

5.1.6 OUTSIDE AFFECTED AREAS

5.1.6.1 General Outside Storage and Lay Down Areas

Due to the small industrial footprint of the facility and comparatively large throughput of materials, outside storage of materials and equipment was utilized routinely throughout the operation period of the Hematite facility. Concrete pads immediately outside of Building 240 were used for material storage, as were concrete pads adjacent to Buildings 250 and 251. The areas directly east and west of Building 252 were utilized as outside storage for drums filled with filtrates from the wet recovery process, awaiting solidification and off-site disposal. The grassy area south of the barns is known to have been utilized for heavy equipment storage for significant time periods. The potential exists that some of this material may have contained residual contamination.

5.1.6.2 Spent Limestone

In 1967, five chemical scrubber columns were installed in Building 260 (Oxide Building) for removal of hydrogen fluoride from the off-gas associated with the conversion of UF_6 to UO_2. These dry scrubber columns used limestone rock chips as the off-gas scrubber media which became contaminated with trace amounts of Uranium, other volatile contaminants and Tc-99. The limestone was replaced periodically and the "spent" limestone was placed outside Building 260, and subsequently used as fill in other on-site areas as shown in Figure 5-1.

In 1989 and 1990, CE requested and was granted permission from the NRC to allow spent limestone, meeting the release criteria of 30 pCi/g, to be used for backfill during the construction of Building 253. Use of this material as backfill was allowed with the understanding that remediation of the fill area may be required during decommissioning (Reference 5-22 and Reference 5-23). An employee interview confirmed that the spent limestone was used as backfill under the floor slab of Building 253 (Reference 4-5).

The presence of Tc-99 was originally discovered in the spent limestone. The facility received UF_6 stock from spent nuclear fuel that had been recycled and used as feed in the Uranium enrichment (gaseous diffusion) process. Use of this UF_6 enriched from recycled fuel, resulted in the potential for trace amounts of both transuranic radionuclides (elements with an atomic number greater than the atomic number of Uranium) and Tc-99 (Reference 5-24).

The Hematite Site license contains specific conditions which address monitoring of Tc-99 and historic on-site burial of waste limestone from off-gas scrubbers (Reference 5-25 and Reference 5-26). In a September 29, 1997 letter to CE, the NRC stated that at the time of plant decommissioning, the licensee will be required to fully

characterize the extent of Tc-99 contamination in soil and groundwater, and remediate if the levels are above established release criteria (Reference 5-27).

5.1.6.3 Building 256 Excavation (Former Deul's Mountain)

During construction of a truck bay for Building 256 in 1989, a large area of contaminated soil was excavated and stored along the southeast corner of the central tract, near the fence line (see Figure 5-1). This soil pile became known as "Deul's Mountain," using the last name of the employee who planned the construction and soil removal. This soil is considered characteristic of soil within the plant facility footprint, especially adjacent to Building 255.

The volume of the soil pile was approximately 1,100 yd^3, with an above ground footprint of approximately 90 ft by 68 ft. The pile appeared to be primarily native soils, but included some rock and building debris such as cement and asphalt. The soil and debris in the pile were removed (Work Package No. LVI-EWP-009-04-003) to original grade level and shipped for off-site disposal at a licensed facility (Reference 5-28).

A characterization study for this area concluded: (1) Toxicity Characteristic Leaching Procedure (TCLP) analysis yielded no hazardous constituents within the soil samples; (2) U-234, U-235 and U-238 were the only radiological isotopes of concern in this area; and (3) laboratory analysis results yielded Uranium concentrations in excavated soil ranged from 0.3 pCi/g to 22.8 pCi/g U-235, and from 1.4 pCi/g to 33.5 pCi/g U-238 (Reference 5-29).

5.1.6.4 Floor Drains, Storm Drains and Outfalls

The Process drains for site buildings still remain in place and will be removed during decommissioning. However, due to incomplete ground piping information during the early periods of operation, it is possible that building drains and storm water drains are interconnected at unknown points below grade. This possibility, in conjunction with known historical events (e.g., spills, leaks, etc.), results in the potential for residual radioactivity to have entered and potentially leaked to soil surrounding these buried piping systems. Thus, areas containing building floor drains or storm water piping are conservatively considered to be impacted by site operations.

Based on interviews of former employees, construction photographs and remaining physical evidence (e.g., abandoned manhole stubs and relocation of Outfall #003), it was established that a former storm drain extended from the Process Building area to the Site Pond (Reference 5-30). A portion of this storm drain was removed prior to the construction of Building 230. A portion of the piping was shipped off-site for disposal as low-level radioactive waste. With limited records regarding surveys or disposition of the

soil surrounding this former storm drain, the subsurface soil along the estimated path of the drain is considered to be potentially impacted.

5.1.6.5 Other Spills, Materials in Outside Areas

Spills inside process buildings may have entered floor drains and connected building sumps; however, small liquid spills did also occur outside of the plant structures. In 1984, an unknown quantity of acid insolubles from the wet recovery system was spilled onto the ground outside of Building 240. A description of this event stated that the residues were vacuumed off the ground and transferred to an empty drum. Barrels of spill material were staged behind (south of) Building 240 (Reference 5-31). Additionally, prior to construction of Building 253, the wet Uranium recovery process was conducted outside in the area where Building 253 was eventually constructed (see above). Occasional spills from the process were absorbed into the soil below through joints in the concrete slab (Reference 5-32).

In addition, an off-site low level radioactive liquid spill may have occurred around 1962. The incident has been mentioned during some interviews with past employees and was identified as the Blue Goose spill. The spill occurred as a result of a truck hauling low level contaminated filtrate to an off-site facility, overturning at a road curve and spilling filtrate off-site. According to the interviews, the filtrate liquid would have been authorized for release for such off-site disposal only if the liquid met the effluent release standards in existence at the time. Research of early site records has not provided any additional information on this incident.

More recently, three events were identified in 2008 that involved the presence of surface contaminated tools and equipment located outside of the Site restricted area. In 2008 and 2009, locations were identified outside of the Site restricted area as having residual radioactivity in soil. In all cases, event evaluations indicate that the contamination and activity posed no significant risk to the health and safety of the workers or members of the general public.

5.1.7 FIRES

A Burial Pit trash fire occurred on June 23, 1966, in Burial Pit No. 4. The fire was extinguished in approximately two hours utilizing both water and soil to control the fire. Investigation into the cause of the fire resulted in three possible initiators: (1) spontaneous combustion; (2) ignition by chemical means; or (3) ignition by pyrophoric materials (Reference 5-33). A review of the Burial Pit logs indicates Burial Pit No. 4 was open at the time of this fire, and a list of possible materials in the Burial Pit at the time of the fire included: pot hood cleanout; acid insolubles; glass wool; metal flakes; wood from filters; and, sample bottles. It is possible that "metal flakes" of Uranium could exhibit pyrophoric behavior, given an oxygenated environment.

Another fire occurred on November 1, 1966 in Burial Pit No. 6; the fire was subdued in about three hours using water and soil, but continued to smolder for another three hours. Investigation revealed that, again, the fire appeared to be the result of some spontaneous reaction in the discarded waste. Potential waste in the pit at the time of the fire included: Red Room trash; Recycle Room trash; used gloves; research and development trash; item (plant) trash; lab sample bottles; and, significant amounts of glass wool (Reference 5-34). A review of documentation for both 1966 fires did not provide any indication that either fire resulted in significant radiological contamination on-site or off-site.

A chemical fire occurred on August 22, 1996, resulting from an improper valve lineup that caused a vigorous chemical reaction in one of the evaporation tanks, located directly outside Building 240. The reaction caused chemicals to be expelled from the evaporation tank, igniting a small fire in an adjacent tank that was used to evaporate mop water and other clean-up liquids. An NRC Augmented Inspection Team (AIT) was sent to investigate this incident and concluded that there was no indication of adverse chemical or radiological consequences to plant employees, members of the public or the environment (Reference 5-35).

5.1.8 RELEASES

Controlled releases of gaseous and liquid effluents have occurred routinely during facility operational and decommissioning time periods. Sampling and monitoring of these effluent pathways is specified in Chapter 5 of License No. SNM-33 (Reference 5-36).

There is verbal evidence that at least for a short period in the mid-1970's CE released spent limestone off site to some employees (Reference 5-37). The known use of that spent limestone by the employees was as fill for holes in home gravel driveways. The evidence is that, based on the health physics and management practices at the time, the spent limestone was surveyed and only released to the employees if no contamination above background was detected. WEC evaluated the evidence and determined that no credible potential exists for measurable exposure as a result of the previous practice of releasing spent limestone.

An unplanned Uranium release occurred on August 28, 1989. The event was caused when the plant started up with a nitrogen admission valve improperly left open, causing UF_6 to be released through particulate filters in the scrubbers. Most of the UF_6 gas reacted with moisture and hydrogen in the exhaust lines and calcium carbonate (limestone) in the scrubber system; however, a small amount escaped into the atmosphere (Reference 5-38). The quantity of Uranium released during this event was estimated to be approximately 275 grams (10 ounces). Radiological surveys conducted after this event did not identify any environmental contamination (on-site or off-site). Calculation of whole body dose to the nearest resident was conservatively estimated at less than 1 mrem attributable to this release.

5.1.9 HISTORICAL REGULATORY INVOLVEMENT

5.1.9.1 Atomic Energy Commission /Nuclear Regulatory Commission

The AEC, and later the NRC, heavily regulated licensed operations at the Hematite Site throughout its history. AEC/NRC inspectors regularly visited the site, and the government had at least one Defense Contract Administration Services (DCAS) resident inspector at the facility for a time.

Federal regulations applicable to Hematite operations from 1956 to present include, but are not limited to, those contained in 10 CFR, Parts 30 through 36, 40, 70, 71, 73 and 74. The SNM License for the Hematite facility (License No. SNM-33) was issued by the AEC to Mallinckrodt Chemical Works on June 18, 1956.

A review of SNM-33 license amendments indicates three distinct amendment periods. The first amendment period spanned the years from 1956 to 1977, and included 93 issued amendments. The second amendment period spanned from 1978 to 1994, and included 25 issued amendments. The final amendment period spans from 1994 to the present, and as of this writing, covers 52 issued amendments.

The original License No. SNM-33 at times covered activities at the Mallinckrodt facility in St. Louis, Missouri, as well as the UNC location in New Haven, Connecticut. License No. SNM-230, issued to Mallinckrodt for the St. Louis facility in the same timeframe as License No. SNM-33 (1950s), covered some operations at Hematite in the late 1950s and early 1960s. License No. SNM-33 currently covers only licensed activities at the Hematite facility.

5.1.9.2 Missouri Department of Natural Resources

The State of Missouri did not exercise regulatory oversight of fuel fabrication. However, impact on the environment by the site was a State regulatory concern, and the MDNR, Missouri Clean Water Commission, has regulated Hematite liquid effluent discharges under the National Pollutant Discharge Elimination System (NPDES) of the Federal Clean Water Act (see Section 5.2.3).

5.2 CURRENT USAGE

5.2.1 TYPE OF FACILITY

The Hematite Decommissioning Project is a former nuclear fuel fabrication facility licensed under 10 CFR 70. Currently, the facility is only authorized to conduct activities related to and in support of decommissioning.

5.2.2 DESCRIPTION OF OPERATIONS

In support of decommissioning, operations at Hematite are focused on decommissioning planning, site characterization and building and facility maintenance. With the exception of Buildings 110, 230 and 231, remaining buildings are vacant with the majority of process systems and equipment removed. Continued site characterization, ground water monitoring and shipment of remaining waste materials describe ongoing decommissioning activities at the Hematite Site. Current facility building use and conditions are summarized in Table 5-7.

5.2.3 CURRENT PERMITS AND LICENSES

License No. SNM-33 issued by the NRC governs activities for the Hematite Site.

A Missouri State Operating Permit number MO-0000761 was issued by the MDNR, Missouri Clean Water Commission, under the NPDES regulations of the Federal Clean Water Act. This NPDES permit for the site was re-issued on February 24, 2006. The permit authorizes wastewater discharges from Outfalls 001, 002, 003, 004, 005 and 006. The permit requires discharges to be controlled, limited and monitored in accordance with the permit conditions (Reference 5-39).

Westinghouse is a large quantity hazardous waste generator under ID number MOR-000012724. Asbestos work (if necessary) will be conducted by a properly licensed asbestos abatement/disposal contractor.

The current water treatment system has an Applicable or Relevant and Appropriate Regulation (ARAR) letter (MO-ARAR-013) that lists sample requirements and discharge criteria for treated water. This will also be necessary for the large scale system that will be used during remediation.

A Generator Site Access permit (no. 0111001122) allows WEC to transport and dispose of radioactive material in the State of Utah.

A Radioactive Waste-License-for-Delivery (no. T-MO002-L09) allows WEC to transport radioactive material to a licensed disposal/processing facility in the State of Tennessee.

5.2.4 RADIONUCLIDE INVENTORIES

As of April 2009, the Hematite Material Control and Accounting (MC&A) Program database listed 4,843 grams of U-235 under Material Awaiting Disposition. This inventory resides within waste material containers awaiting off-site shipment.

As the Hematite Site is currently in the decommissioning planning and preparation process, and fuel fabrication equipment has been removed from the site, there are no known significant sources of SNM remaining in recoverable form. Table 5-8 provides a detailed description of radioactive sources maintained on-site.

5.2.5 WASTE MANIFESTS

Waste shipments of facility equipment and materials, generated from decommissioning activities are summarized in Table 5-9. Table 5-5 provides a historical summary of waste shipments from available records during the time period when active use of the documented Burial Pits occurred.

5.3 ADJACENT LAND USAGE

Jefferson County is predominately rural and characterized by rolling hills with many sizable woodland tracts. The land area is classified as 51 percent forest, 33 percent agricultural, with crops such as grain and hay, and approximately 16 percent urban, suburban, commercial, and unused or undeveloped. Although extensive development in the county has resulted from urban growth around St. Louis, agricultural land use is still predominant in the vicinity of the Hematite Site. There are several small- to moderate-sized subdivisions within one-half to five miles from the site. It is anticipated that future uses of the land in and around the site will likely remain consistent with past and current use, i.e., residential, agricultural and light industrial.

There are no known environmentally-sensitive areas in the immediate vicinity of the Hematite Site, other than a previously identified wetland (see Section 3.2). This wetland is located southeast of the railroad tracks, and no impacts associated with the remaining site decommissioning activities are anticipated.

5.4 REFERENCES FOR SECTION 5.0

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5-19 Combustion Engineering, Memorandum, "Remediation of Site Creek," January 22, 1996.

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5-39 Missouri Department of Natural Resources, Clean Water Commission, NPDES Missouri State Operating Permit, MO-0000761, February 24, 2006.

Table 5-1

Summary Of Hematite Owners/Operators

Hematite Owner/Operator	Time Period
Mallinckrodt Chemical Works	1956 - May 31, 1961
United Nuclear Corporation	June 1, 1961 - July 1, 1971
Gulf United Nuclear Fuels Corporation	July 2, 1971 - January 1, 1974
General Atomic Company	January 2, 1974 – May 17, 1974
Combustion Engineering Inc.	May 18, 1974 – Dec 14, 1989
CE (ABB acquired CE stock)	Dec 14, 1989 – April 11, 2000
Westinghouse Electric Company LLC	April 12, 2000 – Present

Table 5-2

Summary Of Building Usage And Modifications

Building	Description of Historical Use and Modifications
Building 240	Building 240 was originally constructed with three separate rooms or areas. Within the building, Area 240-1 housed a lunchroom, offices, locker rooms, and laundry. Area 240-2 (the Red Room) was used for high enriched conversion processes (≥20 percent U-235). The Red Room housed a general products line primarily used with high-fired Uranium dioxide for fuel elements. It also housed a process line for the manufacture of Uranium metal, specifically the reduction of UF_6 to Uranium tetrafluoride (UF_4) and conversion of UF_4 to Uranium metal. Operating in conjunction with high assay production unit were two auxiliary areas, one containing special equipment used in solvent extraction of high enriched Uranium from scrap materials and UO_2 shot production. The other, a soluble products area, was used for preparing crystals or solutions of uranyl nitrate, uranyl sulfate, and uranyl fluoride. Area 240-3 (the Green Room) contained equipment necessary for producing low-enriched materials, up to 5 percent enrichment. The main product was a ceramic-grade Uranium dioxide. The equipment in this area, like that in the Red Room, was also housed in special hoods for dust control and consisted of standard chemical plant equipment, i.e., tanks, pumps, filter processes, resistance dryers, resistance furnace, etc. An addition to Building 240 was constructed in 1958-1959 on the south end of the building and is known as Area 240-4 (the Blue Room). This area was further divided into three sections: one contained equipment for solvent extraction of low enriched Uranium from scrap; another section was used for manufacturing low enriched Uranium compounds with enrichments between 5 and 20 percent; the third section contained the research and development activities and a pilot plant for pressing and firing ceramic pellets of UO_2. An AEC Inspection Report dated October 3, 1974, stated that "all equipment was removed from the Item Plant (Area 255-3), the Red Room (Area 240-2), and the South Vault (Building 252), and these areas were thoroughly decontaminated." During the commercial nuclear era, Building 240 was used as follows: Area 240-1 - offices and cafeteria; Area 240-2 - recycle and recovery area; Area 240-3 - incinerator and storage; and Area 240-4 - laboratory and maintenance shop. The Area 240-2, Red Room, roof was replaced in the late 1984-85. The removed roofing materials were buried on-site near Building 101.

Table 5-2 (continued)

Summary Of Building Usage And Modifications

Building	Description of Historical Use and Modifications
Building 250	Original building constructed in 1956. Housed a boiler, cooling tower pumps, a recycle hopper, a blending area, and a storage area. During the commercial nuclear era this building was utilized for the boiler room and warehouse, steam supply, and storage.
Building 235 (West Storage Area)	Original building constructed in 1956. Housed the west storage are and utilized as the outgoing storage building. It was used to store final Uranium products. In a letter to the AEC dated July 17, 1964, UNC discussed plans for adding two concrete walls to Building 235 for additional storage. During the commercial nuclear era this building stored source material.
Building 101 (Tile Barn)	This building existed on the property prior to purchase by Mallinckrodt. It was used to store both clean and radiologically-contaminated equipment. The former dairy barn was designated as a temporary storage facility. The Tile Barn's main floor is concrete. The walls are constructed of hollow tile to an elevation about 12 ft. off the floor. This building was also used to store emergency equipment during the commercial nuclear phase of operations.
Building 120 (Wood Barn)	This building existed on the property prior to purchase by Mallinckrodt. It was used to store both clean and contaminated equipment throughout the facility's operating period.
Building 251	Building was constructed in 1957-1958 and included a shipping/receiving dock. During the commercial nuclear era this building was used as warehouse, shipping and receiving, and storage area(s).

Table 5-2 (continued)

Summary Of Building Usage And Modifications

Building	Description of Historical Use and Modifications
Building 252 (South Storage Area)	Constructed in 1960 in response to an increased need for storage. It was to be used for storing process materials as well as final product storage. In 1974 all equipment was removed from the South Storage Area and this area was decontaminated. During the commercial nuclear era this building was used for radioactive waste storage.
Building 255	Building was constructed in 1958-1959 with three separate areas housing the UO_2 pellet production facility. The majority of research and development activities occurred there. Area 255-1 contained research and development offices, the pilot plant, and storage. Area 255-2 housed the low-enrichment UO_2 pellet plant. Area 255-3 contained a maintenance shop, general materials supply storage, depleted materials storage, and a laundry. A security fence was built around the facility footprint sometime after the construction of Building 255. In 1967 and 1968, increased plant automation led to the addition of Building 260, the Oxide Building, and loading dock to Building 255. In AEC Inspection Report dated October 3, 1974, it was stated that "all equipment was removed from the Item Plant (Area 255-3), the Red Room (Area 240-2), and the South Vault (Building 252), and these areas were thoroughly decontaminated." During the commercial nuclear era this building housed the Pellet Plant used for pellet fabrication, storage, and packaging.
Building 260 (Oxide Building)	In 1967 and 1968, increased plant automation led to the addition of Building 260, the Oxide Building. Building 260 housed the chemical reactors and process equipment used for converting UF_6 to UO_2 granules. During the commercial nuclear era this building was the Oxide Building and dock used for UF_6 to UO_2 conversion and UF_6 receiving.

Table 5-2 (continued)

Summary Of Building Usage And Modifications

Building	Description of Historical Use and Modifications
Building 110 Office / Security	Office Building 110 was constructed in 1972. It was used for administrative functions and as a security point ingress/egress for the site.
Building 253	Building 253 was constructed in 1988 along with Building 254 in order to upgrade the facility with automated equipment replacing Buildings 250 and 251. Building 253 included an operational area on the first floor that encompassed the original Building 250 area. This area included processing and decontamination facilities. The second floor contained an office administrative area and building utilities such as HVAC and electrical panels.
Building 254	Building 254 was constructed in 1989 following Building 253 in order to upgrade the facility with automated equipment replacing Building 251. Uranium powder was processed into pellets in Building 254.
Building 256	This structure was originally constructed as warehouse space in 1988. Building Area 256-1 was also utilized for pellet drying. Pellet trays were loaded into pans, dried in an electric oven using Disassociated Ammonia (DA) as a cover gas, then either stored or transferred to Building 230. Building Area 256-2 was the main site warehouse for shipping pellets and powder and for receiving site supplies. It replaced the original receiving area and loading dock of Building 251.
Building 115	Building 115 was constructed in 1992 and contained a diesel fire pump. The diesel fire pump was removed from the building in 2003. No work with radioactive materials was ever performed in this building.

Table 5-2 (continued)

Summary Of Building Usage And Modifications

Building	Description of Historical Use and Modifications
Building 230	Building 230 was constructed in 1992 and housed the fuel assembly fabrication equipment. This Building currently houses offices and material storage areas. Prior to construction of Building 230, soil under this building was sampled and determined to be less than an average of 13 pCi/g (Reference 6-2).
Building 231	Building 231 was added southwest of Building 230 sometime between 1996 and 1998. It was used for covered storage of plant materials and equipment.

Table 5-3

Summary Of Process Chemicals Used At The Hematite Facility

Chemical Name	Description
Acetic Acid ($C_2H_4O_2$)	Colorless pungent liquid acid, chief acid of vinegar; used to clean Uranium metal
Ammonia	Approximately 420,000 pounds used per year as a reducing gas in the production of UO_2 powder and in preparation of material for recycle
Boiler Treatment Chemicals	2,600 lbs/yr used in boiler water treatment, discharged to site pond
Detergents	400 lbs/yr for laundry, discharged to site sewage treatment system
Hydrogen	5,500 lbs/yr, used as a reductant in operations
Hydrochloric Acid	Approximately 850 lbs/yr, for cleaning heat exchanger tubes in the steam boiler, discharged to site pond
Hydrogen Peroxide	Approximately 20,100 lbs/yr, used to adjust pH in the wet recovery process
Hydrophobic Starch	1,500 lbs/yr, used for lubrication during pellet pressing, volatized during de-waxing
Methyl Methacrylate	9,000 lbs/yr for powder preparation, volatized during pellet de-waxing, trade name: Cranko®
Nitric Acid	Approximately 9,850 lbs/yr, used to dissolve U_3O_8 wet recovery process feed material
Nitrogen	500,000 lbs/yr, inert gas used for processing, discharged to ambient air
Perchloroethylene (PCE)	No estimate for amount, used in the 1960s for converting of 20 percent enriched UF_6 to Uranium oxide or Uranium metal; trade name: Perclean
Potassium Hydroxide (KOH)	Approximately 3,500 lbs/yr, mixed with process water and used as wet scrubber liquor to remove hydrofluoric acid from the recycle pyrohydrolysis process effluent
Salt (NaCl)	7,500 lbs/yr, used in regeneration demineralizer resins, discharged to site creek after neutralization
Sodium Hydroxide	4,500 lbs/yr, used in regeneration demineralizer resins, discharged to site pond after neutralization
Sulfuric Acid	Approximately 5,000 lbs/yr, used for regenerating demineralizer resins, discharged to site creek after neutralization
Trichloroethylene (TCE)	Approximately 9,500 lbs/yr, used in preparing UO_2 powder for pelletizing
UF_6	Varying amounts based on contracts, used to convert to UO_2, 90 percent of fluoride discharged into limestone as solid waste

Table 5-4

Burial Pit Waste Types

Process Metals and Metal Wastes	
• High enriched Uranium (93-98 percent) • Depleted and natural Uranium • Beryllium compounds[1] • Uranium-aluminum • Uranium-zirconium • Thorium UO_2	• UO_2 samarium oxide • UO_2 gadolinium • Molybdenum • Uranium dicarbide • CUNO filter scrap • Niobium pentachloride
Chemical Wastes	
• Chlorinated solvents, cleaners and residues (perchloroethylene, trichloroethylene) • Acids and acid residues • Potassium hydroxide (KOH) insoluble • Ammonium nitrate • Oxidyne • Ethylene glycol	• Ammonium bichloride • Sulfuric acid • Uranyl sulfate • Acetone • Methyl-alcohol • Chlorafine • Pickling solution • Liquid organics
Other Wastes	
• Tiles from Red Room floor • Process equipment waste oils • Oily rags • TCE/PCE rags • Used sample bottles • Green salt (UF_4) • Calcium metal	• Contaminated limestone • UO_2 THO_2 Paper Towels • Pentachloride from vaporizer • Used Magnorite • $NbCl_5$ vaporizer Cleanout • Item 51 Poison equipment • Asbestos and asbestos-containing materials (ACM)

[1] Beryllium was present at the site during a brief, two-month period of fuel research. When the research proved to be unsuccessful, the use of beryllium was discontinued and all materials cleaned up and associated wastes sent for off-site disposal.

Table 5-5

Known Waste Shipments From 1966 To 1970

Shipment Date	Waste Description	Activity (Ci)
	Shipment to Y-12:	
08/11/1966	6 containers of scrap material	0.002
	Shipments to Maxie Flats:	
02/21/1967	20 containers of 93 percent / 97 percent enriched material	0.014
05/10/1967	21 containers of scrap materials	0.010
12/05/1967	22 containers of scrap	0.057
10/07/1968	16 containers of scrap	0.352
11/04/1968	21 containers of depleted material	0.216
01/02/1969	2 containers of material	0.020
07/14/1969	7 containers of 52 percent enriched material	0.026
08/25/1969	6 containers of 52 percent enriched material	0.018
10/06/1969	9 containers of 52 percent enriched materials	0.024
11/03/1969	5 containers of thorium materials	0.035
11/17/1969	10 containers of depleted Uranium	0.217
12/01/1969	5 containers of 52/93/97 percent enriched materials	0.038
01/26/1970	4 containers of 97 percent enriched materials	0.30
02/09/1970	7 containers of 97 percent enriched materials	0.041
02/09/1970	6 containers of 97 percent enriched materials	0.029
02/26/1970	3 containers of 52/2.54 percent enriched materials	0.003
04/27/1970	4 containers of 97 percent enriched material	0.009
05/11/1970	12 containers of depleted Uranium material	0.408
05/25/1970	3 containers of 70 percent enriched material	0.024
06/08/1970	9 containers of depleted Uranium material	0.092
06/22/1970	11 containers of scrap materials	0.047
08/03/1970	3 containers of residues	0.020
08/31/1970	8 containers of residues	0.016
09/28/1970	2 containers of depleted Uranium material	0.005
10/26/1970	4 containers of scrap material	0.008
12/07/1970	16 containers of scrap material	0.034

Table 5-6

Evaporation Pond Waste Types

Evaporation Pond Wastes Identified In Burial Pit Logs

- Filtered PCE
- Liquid from sumps
- Filtered reactor cleanout
- Filtered KOH solution
- Acid water cleanup
- TCE/oil mixtures
- TCE from metal wash
- Trichloroethane (TCA)
- HCl solution
- Acetic acid and water
- PCE and water
- Filtrates
- Nitric acid wash water
- TCE cleanup solution
- Oil from vacuum pump
- Pickling hood cleanup
- Mop water

Table 5-7

Current Building Use And Condition (As of July 2009)

Building Number/Name	Description Of Current Use and Condition
Building 101 Tile Barn	Current not used, posted as a radioactive material area, partially decontaminated, access restricted by lock
Building 110 Office and Security	Used for security access control and as an administrative office area for site decommissioning personnel and security personnel, unrestricted area, mostly uncontaminated
Building 115 Pump House	Currently not used, an unrestricted area access to building within an area posted for radioactive material, access through the Controlled Access Area (CAA), fire pump removed, building empty, mostly uncontaminated
Building 120 Wood Barn	Currently not used, posted as a radioactive material area, partially decontaminated, access restricted by lock
Building 230 Rod Loading	Building used for decommissioning personnel, offices for administrative, engineering, health physics, document control, and others, in Controlled Access Area, mostly decontaminated
Building 231 Warehouse	Used for storage of facility equipment and supplies, in Controlled Access Area, mostly decontaminated
Building 235 West Storage Area	Used for storage of some contaminated equipment and occasionally as source storage, located within a radioactive material area and CAA, some fixed contamination on floor
Building 240 Process Building	Currently unused, some areas within posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA, access restricted
Building 245 Well House	Building housed the site well, no longer in use and abandoned in accordance with state regulations, within CAA
Building 252 South Storage Area	Currently unused, posted as a contaminated area, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA, access restricted

Table 5-7 (continued)

Current Building Use And Condition (As Of July 2009)

Building Number/Name	Description Of Current Status
Building 253 Process Building	Currently unused, some areas within posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA
Building 254 Process Building	Currently unused, some areas within posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA
Building 255 Pellet Plant	Currently unused, some areas within posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA
Building 256 Process Warehouse	Currently unused, areas within are posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA
Building 260 Oxide Building	Currently unused, areas within are posted as contamination areas, process equipment removed, a penetrating and lockdown encapsulant applied throughout, located within a radioactive material area and CAA
Waste Water Treatment Shed	Currently used Sewage Treatment System equipment for on-site treatment of site sewage, within CAA.

Table 5-8

Hematite Radioactive Check Sources

Serial Number	Isotope	Activity (μCi)	Location
5921-08	Tc-99	1.09E-02	Count Room
5922-08	Tc-99	1.05E-02	Count Room
ZZ-451	Th-230	1.15E-01	Count Room
ZZ-454	Th-230	1.08E-01	Count Room
10043419	Na-22 / Eu-155	2.00E+00	Instrument Room
301E17-21	Na-22 / Eu-155	2.00E+00	Instrument Room
1217-12	Co-60 / Cs-137	2.97E+00	Instrument Room
5920-08	Tc-99	9.19E-03	Instrument Room
C300-90	Cs-137	8.00E+00	Instrument Room
ZZ-452	Th-230	1.09E-01	Instrument Room
603	Co-60	1.32E+04	West Storage Area
ATOM-4.3	U-234 / U-235 / U-238	1.03E+01	West Storage Area
ATOM-4.9	U-234 / U-235 / U-238	1.15E+01	West Storage Area
WEC-007	U-234 / U-235 / U-238	3.18E+00	West Storage Area
WEC-008	U-234 / U-235 / U-238	3.09E+00	West Storage Area
WEC-009	U-234 / U-235 / U-238	2.98E+00	West Storage Area
WEC-010	U-234 / U-235 / U-238	2.99E+00	West Storage Area
WEC-011	U-234 / U-235 / U-238	1.71E+01	West Storage Area
WEC-012	U-234 / U-235 / U-238	1.71E+01	West Storage Area
WEC-013BX	U-234 / U-235 / U-238	1.72E+01	West Storage Area
WEC-014BX	U-234 / U-235 / U-238	1.72E+01	West Storage Area
WEC-015AM	U-234 / U-235 / U-238	9.79E+00	West Storage Area
WEC-016AP	U-234 / U-235 / U-238	1.04E+01	West Storage Area
WEC-017WS	U-234 / U-235 / U-238	9.52E+00	West Storage Area

Table 5-8

Hematite Radioactive Check Sources (continued)

Serial Number	Isotope	Activity (μCi)	Location
WEC-018DK	U-234 / U-235 / U-238	1.12E+01	West Storage Area
WEC-019PCh	U-234 / U-235 / U-238	8.41E+00	West Storage Area
WEC-020SR-Prt	U-234 / U-235 / U-238	7.22E+00	West Storage Area
WEC-021-4.5Prt	U-234 / U-235 / U-238	7.64E+00	West Storage Area
WEC-022S	U-234 / U-235 / U-238	1.05E+01	West Storage Area
WEC-023D1	U-234 / U-235 / U-238	3.03E+00	West Storage Area
WEC-024D3	U-234 / U-235 / U-238	3.00E+00	West Storage Area
WEC-025D7	U-234 / U-235 / U-238	2.99E+00	West Storage Area
WEC-026D8	U-234 / U-235 / U-238	3.00E+00	West Storage Area
WEC-027D14	U-234 / U-235 / U-238	2.97E+00	West Storage Area
WEC-028D16-3	U-234 / U-235 / U-238	2.97E+00	West Storage Area
WEC-029D16-8	U-234 / U-235 / U-238	2.99E+00	West Storage Area
A3-079	Sr-90	1.10E-01	Count Room
ZZ-458	Sr-90	1.25E-01	Count Room
A2-040	Sr-90	1.06E-01	Instrument Room
MGS-5 1072	Eu-155, Co-57, Sn-113, Cs-137, Mn-54, Zn-65, K-40	1.31E+00	Instrument Room
7041544	Na-22 / Eu-155	2.00E+00	Instrument Room
1033	Sb-125, Eu-155, Mn-54, Zn-65, K-40	1.23E+00	Instrument Room
B403	Th-230	2.59E-03	Instrument Room
B632	Tc-99	1.02E-02	Instrument Room
6035-09	Th-230	6.08E-03	Count Room
6036-09	Th-230	6.14E-03	Count Room
6038-09	Th-230	1.42E-02	Count Room
6039-09	Tc-99	1.43E-02	Count Room

Table 5-9

Summary Of Decommissioning Waste Shipments

Time Period	Description of Material Shipped
Uranium Removal and Waste Reduction:	
July 2001 to March 2003	40 Tons Enriched Uranium for Reuse
	75 Tons (300 Drums) of Solidified LLRW Liquids to Disposal
	66 Tons LLRW Trash to Disposal
	630 Tons of LLRW Solids to Disposal
	21 Tons of Depleted and Source Material to Disposal
Interference Removal – Phase 1:	
March 2003 to June 2004	240 Cubic Yards of Slightly Contaminated Equipment and Debris to Volumetric Clearance for Disposal (VCD)
	30 Tons of Clean Scrap Metal to Recycle
Interference Removal – Phase 2:	
July 2004 to February 2006	360 Pounds of Enriched Uranium for Re-use
	775 Tons of Contaminated Equipment to Disposal
	637 Tons of Contaminated Soil for Disposal
	239 Tons of Contaminated Scrap Metal for Recycle
	73 Tons of Clean Scrap Metal for Recycle
	17 Tons of Miscellaneous Clean Scrap to Disposal
	13 Tons of Hazardous Waste to Disposal

Figure 5-1

Hematite Site Central Tract Area (As Of July 2009)

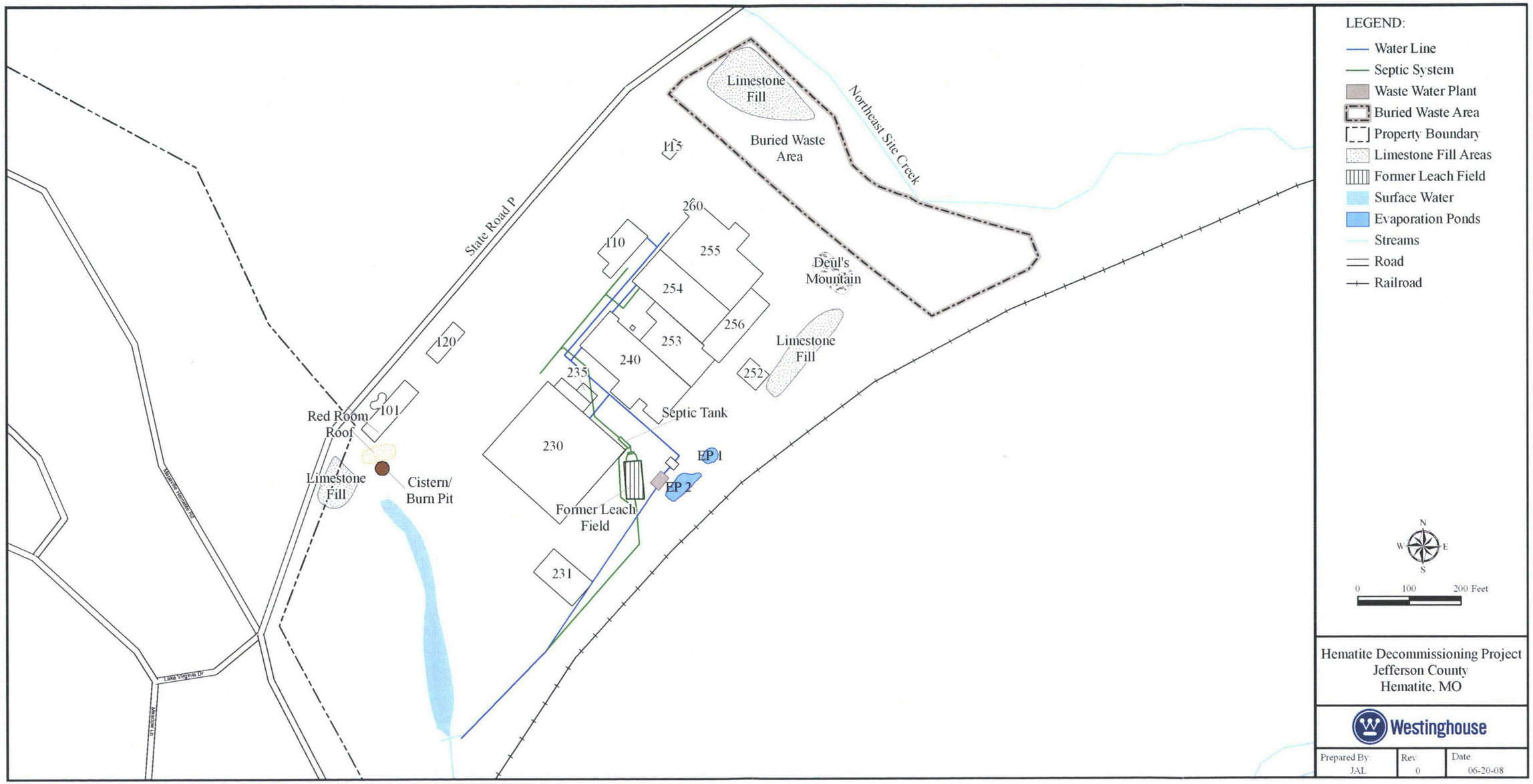
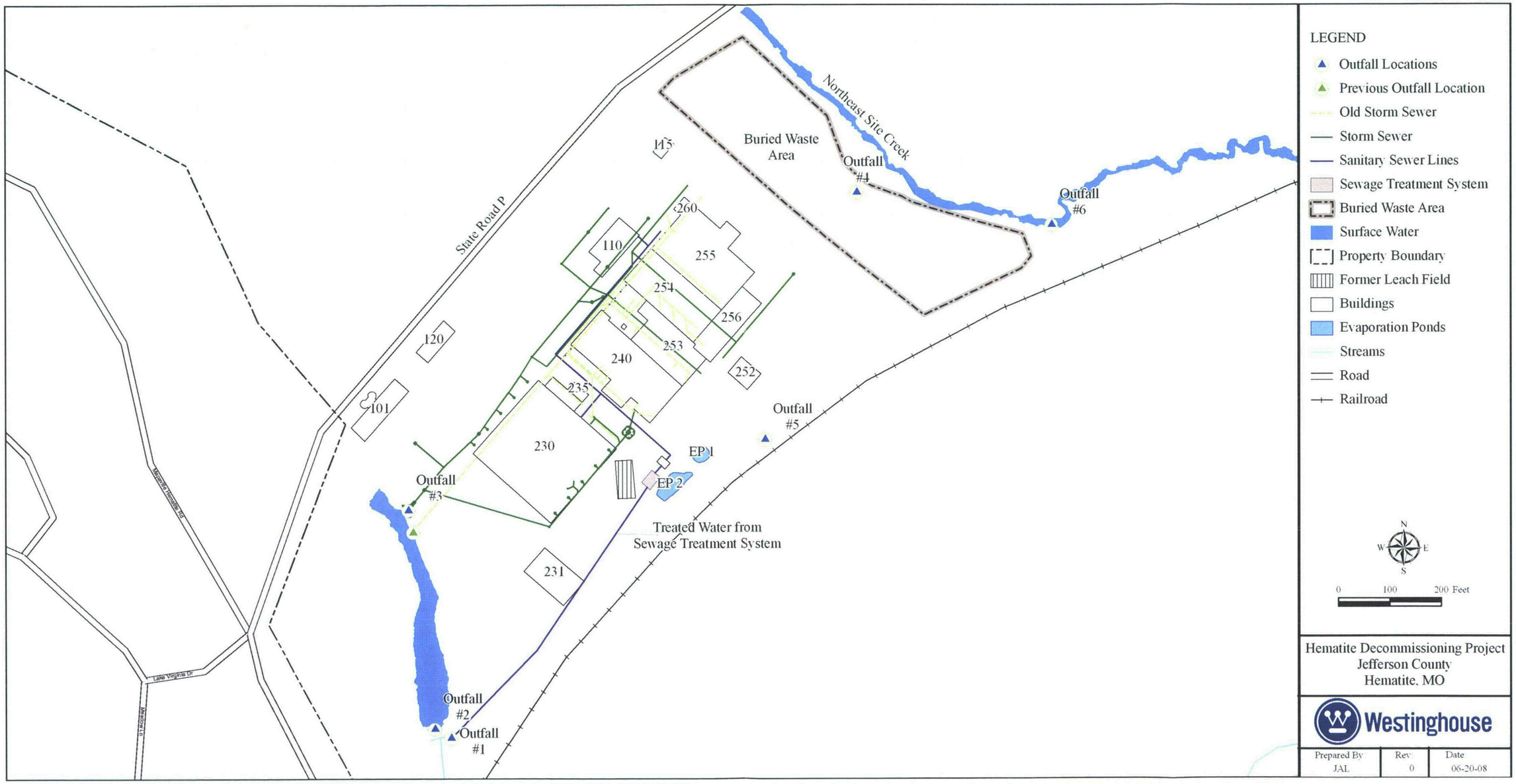


Figure 5-2

Hematite Storm Drains And Outfall Piping



6.0 FINDINGS

6.1 POTENTIAL CONTAMINANTS

As facility operations were centered on Uranium fuel fabrication and historically on related research, the primary radionuclides of concern are the Uranium isotopes U-234, U-235 and U-238. As discussed previously, the introduction of recycled fuel as enrichment feed into the UF_6 production facilities has resulted in Tc-99 contamination in both soils and groundwater at the Hematite Site. Other radionuclides to be considered include U-236, Am-241, Np-237 and Pu-239/240, which may also have been introduced to the site within the supplied UF_6. Thorium (Th-232) is a radionuclide of concern based on the early research with and fabrication of thorium fuels conducted on the site. Radium-226 was also identified as a radionuclide of concern at two locations within the area of the buried waste. Daughter products of all these radionuclides are considered in site characterization.

Potential non-radiological contaminants include oils, PCE and TCE. Further details regarding the nature and extent of non-radiological contaminants of concern are contained below and in the Remedial Investigation/Feasibility Study (RI/FS) conducted for the Hematite Site (Reference 6-1). Remediation of the Site will also address these constituents.

6.2 POTENTIAL CONTAMINATED AREAS

6.2.1 IMPACTED AREAS

The MARSSIM (Reference 1-1) guidance defines an impacted area as any area that possesses a reasonable possibility of containing residual radioactivity in excess of natural background or fallout levels. Based on the available documentation regarding past site operations, it may be concluded that the area within the historic definition of the site Central Tract is an impacted area.

As indicated in Figure 6-1, the impacted site Central Tract is approximately bounded as site property south of State Road P, west of the Northeast Site Creek, north of the railroad track, and the area immediately west of the Site Creek/Pond. The Site Creek from the railroad tracks to Joachim Creek is considered impacted from site effluent flows.

Joachim Creek would be classified as non-impacted based on both historical and characterization data; however, as described in the Hematite Radiological Characterization Report (Reference 4-4), an impacted (Class 3) buffer zone is conservatively proposed to extend along a short distance of the Joachim Creek, up to the first radiological characterization sample location east of the confluence of the Site Creek. The impacted area is approximately 19 acres in size. Specific impacted areas within the Central Tract are summarized in the sections below.

6.2.1.1 Process Buildings and Storage Areas

Buildings 101, 102, 230, 231, 235, 240, 252, 253, 254, 255, 260 and the Sewage Treatment System shed, should be considered impacted due to fuel fabrication operations, storage and/or presence of SNM within those structures. The soil area under Buildings 253 and 254 should be considered contaminated as evidenced by the decommissioning activities surrounding Buildings 250 and 251 and the use of spent limestone as fill beneath Building 253. Historical material storage areas outside of Buildings 240, 250, 251, 252, 255, 256 (as discussed previously) are areas likely to contain residual radioactivity from site operations.

As detailed previously, areas containing building drains, storm drains and outfall piping are conservatively considered to be impacted by site operations. This includes what is thought to be a former storm drain running from the Process Building area to the Site Pond. The available records regarding surveys and disposition of soil surrounding the former storm drain indicate residual radioactivity is present in subsurface soil along the former path of this drain; and therefore, the soil is considered to be potentially impacted.

6.2.1.2 Documented and Undocumented On-Site Burials

The eastern portion of the Central Tract is the location of Burial Pits used between 1965 and 1970, for the documented burial of radiological waste under the governance of the Atomic Energy Commission's regulations in 10 CFR 20.304 (1964). As described in previously, the

Burial Pit area and/or areas surrounding site buildings in the eastern portion of the Central Tract, is where pre-1965 undocumented waste burials are thought to have occurred. In general, Burial Pit logbook records, employee interviews and the operational Uranium recovery process support efforts to maximize the recovery and utilization of Uranium material whenever possible. Based on these records, Westinghouse believes there is no reasonable likelihood that the Burial Pits contain significant quantities of recoverable SNM.

6.2.1.3 Evaporation Ponds

The two Evaporation Ponds that were used to dispose of filtrate with low levels of Uranium are known to be impacted. Although the Ponds were addressed in 1979 and 1987, it is expected that remediation will be required for the Ponds and the surrounding Pond area.

6.2.1.4 Spent Limestone Areas

The spent limestone areas within the Central Tract were contaminated with low levels of Uranium and Tc-99 as a result of the scrubber process. Thus, the spent limestone areas contain residual radioactivity and are known to be impacted by site operations.

6.2.1.5 Sewage Treatment System

As detailed above, the current Sewage Treatment System and the former system, including an abandoned buried septic tank and former leach field, are considered to be impacted. These systems historically received contaminated water from personnel showers, minor spills and mop water sent to building drains. Based on the results of effluent sampling performed as part of the Hematite Effluent Control and Monitoring Program, as well as remediation of the Site Creek conducted in 1995 due to sewage treatment upsets, it is concluded that the Sewage Treatment System and effluent points downstream potentially contain residual radioactivity from site operations.

6.2.1.6 Site Creek/Pond

The Site Creek and Site Pond represent the release point for the process liquid effluent waste stream, from fuel fabrication and decommissioning operations. The Site Pond was remediated in 1972 and the dam was replaced at that time. The Site Creek, downstream of the dam to the railroad, was remediated in 1995. However, final sample data from the 1995 remediation shows total Uranium concentrations above background, which will require additional evaluation during decommissioning.

6.2.1.7 Joachim Creek

As discussed above, Joachim Creek would be classified as non-impacted based on historical and characterization data; however, as described in the Hematite Radiological Characterization Report (Reference 4-4), an impacted (Class 3) buffer zone will be conservatively established along a short distance of the Joachim Creek up to the first radiological characterization sample location east of the confluence of the Site Creek.

6.2.1.8 Red Room Roof Burial

The Red Room Roof Burial Area southwest of Building 101 (Tile Barn) is likely to contain residual radioactivity in excess of natural background due to the high enriched Uranium processing that took place within the Red Room.

6.2.1.9 Cistern Burn Pit Area

The Cistern Burn Pit Area southwest of Building 101 (Tile Barn) was used to burn wooden pallets that may have been contaminated. Therefore, this area is considered impacted and potentially contains residual radioactivity.

6.2.2 NON-IMPACTED AREAS

MARSSIM defines non-impacted areas as those areas where there is no reasonable possibility of residual contamination. Based on the discussion of impacted areas above, it is concluded that the site land area outside of the site Central Tract may be considered non-impacted. Specifically, land on the north side of State Road P, land east of the Northeast Site Creek, land south of the railroad tracks (not including the site stream and the portion of Joachim Creek discussed above), and land west of the Site Creek/Pond are non-impacted areas.

6.3 POTENTIAL CONTAMINATED MEDIA

6.3.1 BUILDING MATERIALS

The process and storage buildings are considered potentially contaminated with radioactive materials from the fuel fabrication processes that took place within those buildings. Thus, the building materials making up those buildings are considered potentially contaminated with radioactive materials. These materials include but are not necessarily limited to steel, concrete, wood, rubber membrane, tar/pitch, insulation, vinyl and other metals.

6.3.2 BURIED WASTE MATERIALS

All Burial Pit and other buried waste materials and adjacent soils are considered potentially contaminated with radioactive materials resulting from fuel fabrication research and processes from within the process buildings.

6.3.3 SOIL AND SEDIMENT

Soil and sediment within the Central Tract are considered potentially impacted by site operations. Waste burials, Evaporation Pond disposals, liquid effluent releases, on-site storage locations and outside letdown areas directly contribute to potential soil contamination. On-site movement of process materials and wastes during historical site operations required traversing nearly all areas of the Central Tract; therefore, the potential for soil contamination exists throughout the Central Tract.

6.3.4 SURFACE WATER AND GROUNDWATER

Surface water, and groundwater in the overburden sand and gravel aquifer and bedrock aquifer, are potentially contaminated with radioactive materials. Surface water has been potentially exposed to contaminants through plant liquid effluent releases to the Site Creek/Pond and discharges to the Evaporation Ponds. Groundwater has been potentially exposed to contaminants through the vertical migration of leachate from buried contaminated waste and contaminated soils in the overburden clay aquitard.

6.4 RELATED ENVIRONMENTAL CONCERNS

Contamination from non-radiological constituents (organics and metals) at the Hematite Site is closely associated with the footprint of the Central Tract and burial areas within the Hematite facility. The following sections summarize known chemical contamination issues at the Hematite facility; detailed information regarding the nature and extent of this contamination are compiled in a Remedial Investigation Report (Reference 6-1) prepared as part of the CERCLA process.

6.4.1 CONTAMINATION FROM ORGANIC COMPOUNDS

The principal organic constituents in soil, sediment and groundwater are the chlorinated solvents PCE and TCE, also referred to as VOCs. Distribution of PCE and TCE in the groundwater and subsurface soil samples appears to reflect one or more sources associated with the Hematite facility disposal areas. Subsurface soils contaminated with PCE and TCE extend in a southeasterly direction from the facility toward Joachim Creek and likely reflect migration of contaminated groundwater in this general direction. Groundwater contamination with VOCs (PCE and TCE) has been found in both on-site and off-site monitoring wells installed to monitor various groundwater strata and typically extends from the Hematite Site in a southeasterly direction.

6.4.2 CONTAMINATION FROM INORGANIC COMPOUNDS

Elevated concentrations of inorganic constituents (metals) are present in surface, subsurface and groundwater in localized areas near the Burial Pits. Metals concentrations in the groundwater and surface waters are localized, suggesting that groundwater migration of inorganics is limited and not as extensive as that of the chlorinated solvents. Elevated metals concentrations have been found in on-site sediments of the Site Pond, Site Creek and Northeast Site Creek.

6.4.3 LOCALIZED CHEMICAL CONTAMINATION

Localized occurrences of dioxins, polychlorinated biphenyls and petroleum contamination have been discovered at the Hematite Site. Sources for these constituents are thought to be products of fuel combustion, asphalt-paving materials and the site former gas station. The former gas station was an abandoned commercial facility located within the site boundary on the north side of Missouri State Road P. A 550 gallon steel underground gasoline storage tank was removed in 2003; BTEX[1] contamination was not found in soils surrounding this tank (Reference 6-1).

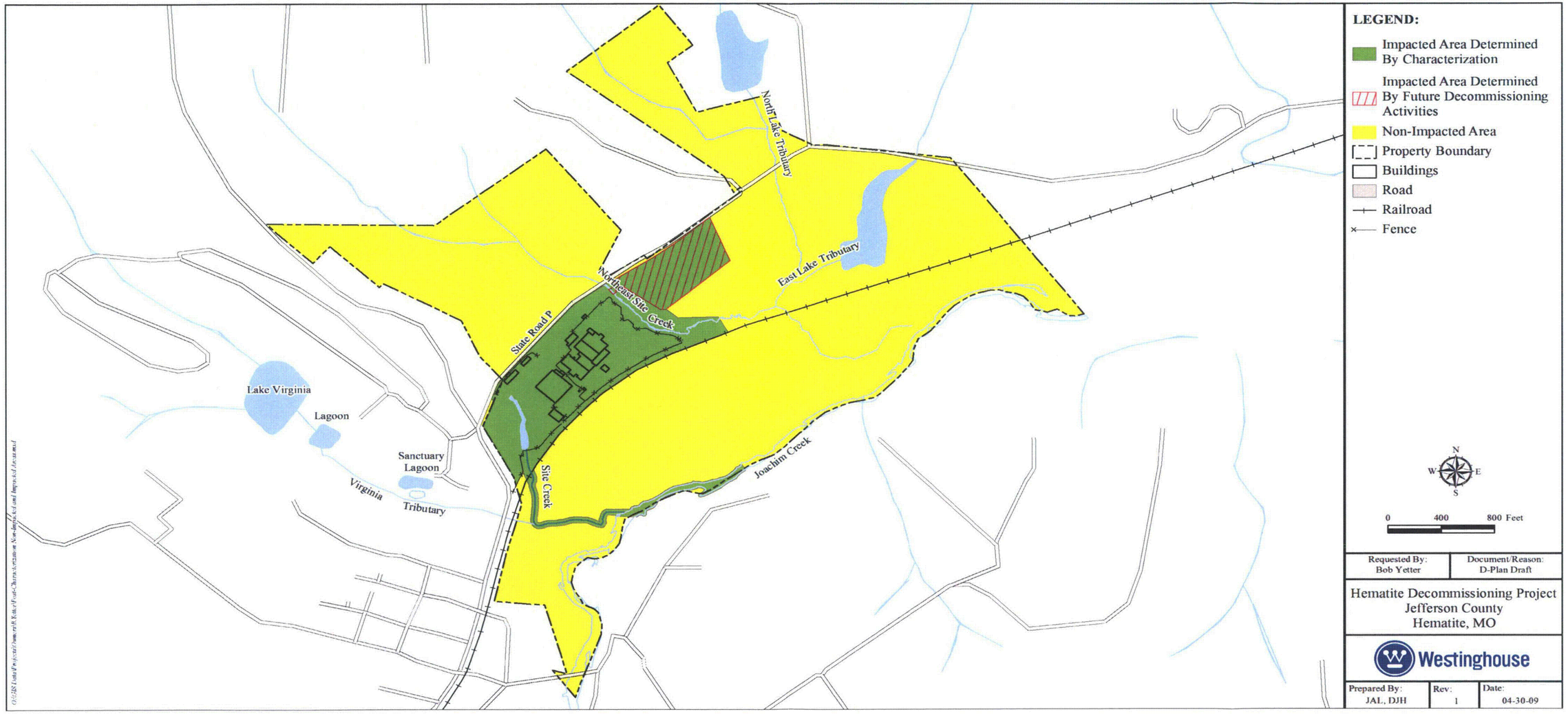
[1] BTEX – Benzene, Toluene, Ethylbenzene, Xylene compounds

6.5 REFERENCES FOR SECTION 6.0

6-1 Science Applications International Corporation (SAIC), "Remedial Investigation Report for the Westinghouse Hematite Site," January 2007.

Figure 6-1

Hematite Site Impacted And Non-Impacted Areas



NOTE: With regard to Joachim Creek, the Historical Site Assessment (HSA) and radiological characterization results did not indicate the presence of residual radioactivity in excess of background levels, and thus Joachim Creek and the area immediately adjacent could be considered non-impacted. However, Tc-99 was detected in samples collected at locations just below the confluence of the Site Creek with the Virginia Tributary, and thus the Site Creek has been designated as an impacted area. Consistent with NUREG-1575 (MARSSIM), Section 4.4, regarding the use of impacted area buffer zones, a reasonably conservative and prudent approach has been taken by establishing an impacted (Class 3) buffer zone along a portion of the Joachim Creek. This buffer zone extends from the confluence of the Site Creek and the Joachim Creek eastward along the Joachim Creek to the location of the nearest radiological characterization sample collected on the Joachim Creek.

7.0 CONCLUSIONS

The Hematite Central Tract area and the Site Creek down to Joachim Creek are considered impacted and may contain residual activities from site operations. Joachim Creek would be classified as non-impacted based on historical and characterization data; however, as described in the Hematite Radiological Characterization Report (Reference 4-4), an impacted (Class 3) buffer zone is conservatively established along a short distance of the Joachim Creek up to the first radiological characterization sample location east of the confluence of the Site Creek.

The Central Tract area is bounded by State Road P to the north, the Northeast Site Creek to the east, the Union Pacific railroad tracks to the south, and the Site Creek/Pond to the west. The remaining areas of the site have been determined to be non-impacted by site operations. The majority of this area within the Central Tract requires further evaluation and characterization as decommissioning activities progress.

On-site waste Burial Pits located east of the facility buildings are known to be a significant source of both radiological and chemical contamination impacting the Hematite Site. Burial Pit logbook records, employee interviews and the operational Uranium recovery process support efforts to maximize the recovery and utilization of Uranium material whenever possible. Based on these records, Westinghouse believes there is no reasonable likelihood that the Burial Pits contain significant quantities of recoverable SNM.

Likely or known sources of radioactive media include building materials, buried waste materials, soils (surface and subsurface) and groundwater. These media are known to be, or are potentially contaminated with radioactive materials and/or volatile organic compounds. Known radioactive materials include: Uranium isotopes U-234, U-235, U-238 and Tc-99; U-236, Am-241, Np-237, Pu-239/240 and Th-232 are expected in trace quantities only. Perchloroethylene and trichloroethylene contamination in groundwater extends from the area where facility operations occurred in a southeasterly direction.