February 11, 2011

U.S. Nuclear Regulatory Commission
ATTN: Mr. James Shepherd, Project Manager
Decommissioning Branch, Division of Waste Management
Washington D.C. 20555

Reference: Plan for Additional Site Characterization
License Condition 31.a
FMRI, License SMB-911, Docket 40-7580

Dear Mr. Shepherd:

Please find enclosed FMRIs Plan for Additional Site Characterization, February 2011 (Plan). The Plan was developed pursuant to FMRI License SMB-911, License Condition 31.a.

Should you have any questions on this matter, please contact James Burgess of FMRI at 918 687 6303.

Sincerely,

Robert Compernolle
President, FMRI

Enclosure FMRI, Plan for Additional Site Characterization, February 2011

Copy to: James Burgess (FMRI)
Document Control (02112011)

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Plan for Additional Site Characterization

License Condition 31.a

February 2011

FMRI
#10 Tantalum Place
Muskogee, OK 74402
Docket No. 40-7580

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1 INTRODUCTION

1.1 Background

The FMRI site (site) is about 4 kilometers (2.5 miles) east of the city center of Muskogee, OK, with the Arkansas River (Mile 395) on the east, Highway US-62 on the south, and the Muskogee Turnpike on the west. The current site comprises about 38 ha (75 a). The site produced tantalum and columbium metals from 1957 until it ceased operations in 1989. The raw materials (ore) used for tantalum and columbium production contained uranium and thorium as naturally occurring trace constituents. The concentrations of natural uranium and natural thorium were sufficient to cause the ores and slags to be classified as source materials by the Atomic Energy Commission, which originally issued License No. SMB-911 in 1967 to Fansteel, Inc.

In November, 2001, Fansteel suspended all operations at the Muskogee site. Fansteel subsequently filed for bankruptcy protection under Chapter 11 (reorganization). In conjunction with the bankruptcy proceedings, in July, 2003, Fansteel submitted:

i) a revised decommissioning plan,

ii) a request for exemption from financial assurance requirements, and

iii) a request for authorization to transfer the site license to a subsidiary to be formed as part of the bankruptcy reorganization plan.

On November 17, 2003, the bankruptcy court approved Fansteel's corporate reorganization plan. FMRI, a new subsidiary of Reorganized Fansteel, became the licensee for the Muskogee site on the effective date of the reorganization. On December 4, 2003, NRC approved the revised decommissioning plan, the request for exemption to financial assurance requirements, and the license transfer authorization, subject to the bankruptcy reorganization.

The FMRI Muskogee, Oklahoma site is currently being decommissioned under the authority of the U.S. Nuclear Regulatory Commission (NRC) pursuant to FMRI Source Materials License SMB-911 (License) and approved Decommissioning Plan.

1.2 Purpose

The purpose of this site characterization plan (Plan) is as described in FMRI License at Condition 31.a:

> 31. Licensee shall conduct an additional characterization of any additional contaminants at the site, including all soils, buildings and groundwater on the site, using guidance in NUREG-1757, Vol. 2. ... Work shall be performed according to the following schedule:
>
> a. Submit a site characterization plan not later than February 28, 2011.

1.3 Objective

The objective of the Plan is to provide for supplementing and/or completing a description of extent and concentration of contaminants in areas for which information in the Decommissioning Plan was insufficient or not available. Completing the existing description is reasonable to support planning remediation activities including health and safety, costs, material volumes, and final surveys.

2 APPROACH TO SITE CHARACTERIZATION

2.1 Condition

A radiological characterization survey was completed at the FMRI site in 1993. The scope of the characterization survey included interior and exterior of site structures, surface soils, subsurface soils, and groundwater. The characterization survey and associated results are described in the DP.

In 2002 the NRC requested ICF Consulting (ICF) develop an independent decommissioning cost analysis for the FMRI site. ICF's report included review of prior characterization data, including a summary of the data, an evaluation of the completeness of these data, and suggestions regarding additional data that could increase the current understanding of the site. The scope of the review included the 1993 characterization survey and the DP.

In 2003 the NRC issued a Safety Evaluation Report (SER) in support of the license amendment to approve the DP. The SER included a summary of the radiological status of the facility. The SER included proposed license conditions for additional characterization of radiological contamination.

2.2 Requirement

The requirement for site characterization is as described previously in Section 1.2; i.e., FMRI Source Materials License SMB-911, Condition 31.a.

2.3 Implementation

FMRI will complete site characterization activities described in this plan with the assistance of contractors, subcontractors, and consultants.

FMRI intends to complete site characterization activities described in this plan on a schedule to support development of a site characterization report, as identified in Section 2.4, but schedule may be otherwise controlled by available funding.

2.4 Report

After completion of the characterization activities and subsequent assessment of the results, FMRI will submit a site characterization report to the NRC. The site characterization report is described in FMRI License at Condition 31.b:

> 31. Licensee shall conduct an additional characterization ... at the site, ... Work shall be performed according to the following schedule:
>
> b. Submit a site characterization report (SCR) not later than December 29, 2011.

3 GENERAL INFORMATION

3.1 Site Description and History

3.1.1 Site Description

The Decommissioning Plan, Section 3.0 *Facility Description*, provides information describing the specific site location.

3.1.2 Site History

The Decommissioning Plan (DP), Section 2.0 *Facility Operating History*, provides background information describing the site history including previous investigations with respect to licensed activities.

FMRI began Phase 1 decommissioning in 2005 in accordance with the DP. Phase 1 includes removal of work-in-progress (WIP) material from ponds 2 and 3, and transfer of the material to an out-of-state uranium mill for use as alternate feed material. All residual WIP material has been removed from Pond 3: the berms and interior of Pond 3 have been reshaped for erosion control. About 200 tons of bulk WIP material remains in a drying bed near the southeast corner of Pond 3. Approximately 180 two-ton bags of WIP material from Pond 3 remain staged for shipment in the Thermite Building.

There have been no other DP activities conducted at the site.

3.2 General Physical Setting

The Decommissioning Plan, Section 3.0 *Facility Description*, summarizes the general-physical setting of the site, including general physical characteristics of the site and its proximity to people who could be affected by existing contamination or decommissioning activities.

4 NATURE AND EXTENT OF CONTAMINATION

4.1 Nature of Contamination

Natural uranium and natural thorium were present in the ores and slags used for tantalum and columbium production at an approximate concentration of 0.1 percent uranium oxide and 0.25 percent thorium oxide. These raw materials were digested in a hydrofluoric acid (HF) solution. The uranium and thorium were not extracted from the raw materials by the digestion process. The byproduct of the process - residues from the work in progress (WIP) - was disposed in Pond Nos. 2, 3, and 5. Water from the process and from the french drain that was constructed around Pond No.3 was collected and treated. It was then passed on to Pond Nos. 6, 7, 8, and 9 for solids precipitation prior to discharge through a National Pollutant Discharge Elimination System (NPDES) discharge outfall to the Arkansas River. In the 1990s, Fansteel constructed an interceptor trench along the east and south sides of the site. The interceptor trench captures ground water from the site, which is then processed through the wastewater treatment facility and discharged through the permitted outfall.

Radioactive contaminants at the site are natural uranium, natural thorium, and associated transformation products.

4.2 Extent of Contamination

In 1993, a characterization survey was performed to determine existing conditions site wide. Radiological survey activities were conducted over the interior and exterior of the site structures and the open land areas of the site. Structures and equipment associated with the ore-processing activities include the Chemical "C" Building, the Chemical "A" Building, and the R&D Building. The Chemical "C" Building is contaminated throughout by radioactive ore residues. Isolated areas of radioactive contamination were also identified in the Chemical "A" Building and some of the other site structures. Surface and subsurface soils at the site appear locally contaminated at low concentrations of natural uranium and natural thorium; i.e. a few or several 10's of pCi/g total activity. Further, the characterization surveys identified the highest concentrations of radiological contaminants in Pond Nos. 2 and 3, to the east and north respectively of the "Chem C" building. The average concentration of radiological contaminants in Pond Nos. 2 and 3 are 360 and 640 picocuries per gram (pCi/g) of U-238 respectively, and 360 and 440 pCi/g of Th-232 respectively. The surveys also determined that the average concentration of radiological contaminants in Pond Nos. 5 through 9, at the southern end of the site are less than 0.05% source material by weight. Survey data indicate that the natural uranium and natural thorium are present with their radioactive progeny in secular equilibrium.

Further description of extent of contamination at the site is provided in the DP.

5 PLANS FOR ADDITIONAL SITE CHARACTERIZATION

5.1 Structures

Several structures currently exist on site. They currently and/or historically housed administration, process, and support activities.

5.1.1 Summary of Existing Characterization of Structures

A radiological status of structures is provided in the DP. Except as indicated below, it is sufficiently representative of site conditions for purpose of decommissioning planning.

No significant process activities involving ores or WIP have occurred at the site since completion of the characterization survey. Process activities since 1993 were sporadic and short-lived until late 2001, and then have been non-existent. The process activities since 1993 predominantly used the calcium fluoride stored on site which includes negligible concentrations of radioactive material with respect to potential for contamination; e.g., less than 0.05% source material by weight. Otherwise, activities have been largely limited to asset maintenance and preservation. Thus the data are sufficiently representative of site conditions for the purpose of decommissioning planning.[1]

Historical and periodic surveys of radiation and radioactivity for structures are readily accessible at the FMRI facility. The survey data has been reviewed in detail during NRC inspections since year 2000. Review of the survey results by FMRI personnel and NRC inspection have not identified any remarkable condition.

[1] See Section 8.2; the Safety Evaluation Report at Section 4 includes the statement "Except for groundwater transport of soluble radionuclides, the staff agrees that there have been no activities on site that would significantly alter the distribution of the contamination." The context of site activities and condition against which this statement was developed has not changed with regard to structures.

5.1.2 Identification of Gaps in Characterization of Structures

ICF Consulting

The ICF report included the following recommendations for additional characterization of structures (the parenthetical following each recommendation is a brief response of FMRI with respect to current conditions on site):

- Additional survey of buildings involved in reprocessing operations including: R&D Building, White House, Thermite Building, and Sodium Reduction Building.
    - (R&D Building is included in routine radiation and contamination surveys, either weekly or biweekly. The results indicate that the structure would be expected to satisfy conditions for release for unrestricted use.)
    - (White House has been included in routine radiation and contamination surveys, either weekly or biweekly. The results indicate that the structure would be expected to satisfy conditions for release for unrestricted use.)
    - (Thermite Building currently stores bags of WIP; it is effectively inaccessible for conduct of radiation surveys. Prior to current use it was included in routine radiation and contamination surveys. The results indicate that the structure would be expected to satisfy conditions for release for unrestricted use.)
    - (Sodium Reduction Building currently stores bags of WIP and other process materials or contaminated soils; it is effectively inaccessible for conduct of radiation surveys.)
- Collection of wipe samples on moderately contaminated surfaces to assess removable contamination.
    - (Contamination surveys conducted to support maintenance and/or removal of equipment and systems for salvage consistently indicate the absence of removable radioactivity.)
- Survey of the ore storage pad and transportation areas.
    - (Ore storage pad and transportation areas have been and continue to be included in routine radiation and contamination surveys. The results indicate that these areas would not satisfy conditions for release for unrestricted use with respect to direct alpha and direct beta-gamma. The results indicate that these areas would satisfy conditions for release for unrestricted use with respect to removable radioactivity.)
- Survey of the areas in and around the wastewater treatment plant.
    - (Wastewater treatment areas have been and continue to be included in routine radiation and contamination surveys. The results indicate that these areas would not satisfy conditions for release for unrestricted use with respect to direct alpha and direct beta-gamma. The results indicate that these areas would satisfy conditions for release for unrestricted use with respect to removable radioactivity.)

- Initial survey of the Control Station, Maintenance Shop, Evaporator Building, and [Interceptor Trench] Sump Houses.
    - (These structures are considered nonimpacted by process operations.)

U.S. NRC Safety Evaluation Report

The SER included the following statements with regard to contaminated structures (the parenthetical following each statement is a brief response of FMRI with respect to current conditions on site):

- No radionuclide-specific analyses were performed during the survey, ...
    - (The License particularly authorizes the type of radioactive material used on site. The 1993 radiological characterization survey definitively identified the radionuclides of interest or concern at the FMRI site. NRC inspection has accepted this information as complete and accurate in contexts of documenting personnel exposure and shipping radioactive materials. No further assessment or characterization is necessary of this matter.)
- ... nor were exposure rates measured inside structures.
    - (Exposure rate measurements have been and continue to be included in radiation surveys to support maintenance or decommissioning activities. The results are generally at or near background (10 to 20 μR/h) except near bags of stored WIP where exposure rate may approach 1000 μR/h.

      FMRI does not monitor individual for external dose. This practice is made with respect to 10CFR20.1502(a)(1). FMRI continues to document radiation surveys that substantiate this practice.)

- ... there was no characterization beneath building floors, such as around floor drains and joints.
    - (The characterization plan for beneath building floors is included herein with subsurface soils.)
    - (The characterization plan for floor drains and joints is described in the following section.)

5.1.3 Survey Design for Additional Characterization of Structures

Information gaps have been identified in the existing radiological characterization of structures. However, the information gaps can be addressed at the time of structure decontamination and decommissioning; i.e. surveys of radiation and radioactivity to support radiation safety planning and assessment, disposal, or to establish conformance with requirements for release for unrestricted use will be sufficient and timely. Additional planned characterization of structures is not necessary to support decommissioning activities. Nonetheless, there are a few cases for which a radiation survey will be performed prior to decommissioning activities.

The radiation survey will include direct alpha, direct beta-gamma, removable alpha, removable beta-gamma, and exposure rate. The radiation survey will be performed in accordance with existing site procedures and instructions regarding calibration and use of radiation survey instruments, and recording results. A summary of radiation survey techniques is as follows:

- Locations will be referenced to prominent structural features.
- Direct alpha will be determined using a handheld ZnS(Tl) probe connected to a scaler/ratemeter.
- Direct beta-gamma will be determined using a handheld G-M probe connected to a scaler/ratemeter.
- Removable radioactivity will be determined by use of a common smear paper wiped across the surface of interest. The smear paper will be counted on site with a gas-flow proportional counter.
- Exposure rate will be determined using a handheld NaI(Tl) detector calibrated by the manufacturer to display μR/h.
- Results will be recorded as:
  - dpm/100cm^2 for direct and removable measurements, and
  - μR/h for exposure rate.

General
Results of routine radiation and contamination surveys will be included in the site characterization report.

Sewers, waste systems, and floor drains
A radiation survey will be made to determine whether there are unusual or unexpected levels of residual radioactivity in sewers, waste systems, and floor drains. The detector will be placed in near contact with the entry point of the system and then as far into the system as reasonable. Removable radioactivity will also be determined of the interior of the system. Exposure rate will be determined interior of the system and at 30cm (one foot) on exterior of the system.

Ventillation Ducts
A radiation survey will be made to determine whether there are unusual or unexpected levels of residual radioactivity inside ventilation ducts. The detector will be placed in near contact with the interior walls of the system and then as far into the system as reasonable. Removable radioactivity will also be determined of the interior of the system. Exposure rate will be determined interior of the system and at 30cm (one foot) on exterior of the system.

Piping and embedded piping
No process piping will remain in the structures.

Embedded piping is limited to wastewater transport from floor drains. These will be assessed as described previously for floor drains.

Floor Joints
A radiation survey will be made to determine whether there are unusual or unexpected levels of residual radioactivity associated with floor joints. The detector will be placed in near contact with the floor joint. Removable radioactivity will be determined along the surface of the floor joint. Exposure rate will be determined at 30cm (one foot) from surface of the floor joint.

5.2 Systems and Equipment

Currently, several of the buildings contain systems and/or equipment that was directly or indirectly involved with processing radioactive material; i.e. work-in-progress (WIP) material. These systems and equipment are generally comprised of tanks, piping, and associated mixers and pumps. The systems and equipment have been emptied of bulk material but not cleaned or decontaminated.

5.2.1 Summary of Existing Characterization of Systems and Equipment

Historical and periodic surveys of radiation and radioactivity for systems and equipment are readily accessible at the FMRI facility. The survey data has been reviewed in detail during NRC inspections since year 2000. Review of the results by FMRI personnel and NRC staff have not identified any remarkable condition.

5.2.2 Identification of Gaps in Characterization of Systems and Equipment

Activities at the FMRI facility over the past several years have included salvage of systems and equipment. The scale of salvage has ranged from small individual items such as pumps to large equipment including process tanks, storage vessels, and several filter presses. These systems and equipment were used directly in the processing of licensed material at the site. In each case, the system or equipment was decontaminated to satisfy requirements for release for unrestricted use. The predominant method of decontamination was low pressure water wash. Rarely was an aggressive decontamination technique required, and then not on a significant scale.

The information available from historical and routine surveys of radiation and radioactivity have shown sufficient to allow FMRI personnel to evaluate the potential safety issues associated with decommissioning or decontaminating systems and equipment. Review of decommissioning activities by NRC staff during routine site inspections allows that decommissioning and radiation control measures as conducted by FMRI are appropriate for the type of radiation, radioactivity, and radioactive material associated with the systems and equipment.

5.2.3 Survey Design for Additional Characterization of Systems and Equipment

Surveys of radiation and radioactivity for systems and equipment to support radiation safety, disposal, or to establish conformance with requirements for release for unrestricted use will be sufficient and timely. Additional planned characterization of systems and equipment is not necessary to support decommissioning activities.

5.3 Surface Soil

Surface soils are those soils less than or equal to one meter below ground surface.[2]

5.3.1 Summary of Existing Characterization of Surface Soils

A radiological status of surface soils is provided in the DP. Except as indicated below, it is sufficiently representative of site conditions for the purpose of decommissioning planning.

Phase 1 decommissioning of Pond 3 as removal of WIP material began in 2005 and predominantly concluded in 2008: about 200 tons of bulk WIP material remains in a drying bed near Pond 3. An unpublished characterization survey was conducted in 2007 to determine the impacts of Phase 1 decommissioning to surface soils. The characterization consisted of gross gamma survey and biased soil sampling. The characterization survey identified four impacted areas. These areas and a few others are specifically addressed in the following section.

5.3.2 Identification of Gaps in Characterization of Surface Soils

ICF Consulting

The ICF report included the following recommendations for additional characterization of surface soils (the parenthetical following each recommendation is a brief remark of FMRI with respect to current conditions on site):

- Beneath and immediately adjacent to ponds. ...
  - (The survey design described in Section 5.3.3 provides for seven surface soil sample locations north, west and south of Pond 3 to address this characterization gap of Pond 3.)
- Between the Sodium Reduction Building, the Thermite Building, and the Ore Storage Pad. Approximately three borings are needed.
  - (The survey design described in Section 5.3.3 provides for three surface soil sample locations south of the White House to address this characterization gap.)
- Between the R&D building and the Ore Storage Pad ... Approximately six soil borings are needed.
  - (The survey design described in Section 5.3.3 provides for six surface soil sample locations to address this characterization gap. Sampling will not be performed within the footprint of the soil storage pile until those soils are removed.)

[2] Section 8.1 at Table 5-10 shows that the proposed release criteria for soils are insensitive to thickness of contamination over a range of 0.085m to 8.5m. Section 8.2 at pages 19 and 20 acknowledges this condition of insensitivity. Then surface soils are reasonably approximated as one meter below ground surface and subsurface soils beneath.

- Between the rail spur and the Pond 3 french drain. Approximately five soil borings are needed.
    - (The survey design described in Section 5.3.3 provides for five surface soil sample locations to address this characterization gap. These five locations are a subset of the seven locations described previously around Pond 3.)

- Within the Pond 3 french drain area … . Approximately six soil borings are needed.
    - (Section 5.4 describes the additional characterization plan for subsurface soil.)

- Between the Chemical C Building and former Pond 2. Approximately two soil borings are needed.
    - (Section 5.4 describes the additional characterization plan for subsurface soil.)

- Outside the property boundary northeast of former Pond 2. Approximately six soil borings are needed.
    - (The survey design described in Section 5.3.3 provides for six surface soil samples outside the east property fence to address this characterization gap.)

- In the borrow pit … . Approximately six soil borings are needed.
    - (The survey design described in Section 5.3.3 provides for six surface soil sample locations to address this characterization gap.)

- In the "non-impacted area" north of Pond 3 … . Approximately 25 surface soil samples are needed.
    - (The survey design described in Section 5.3.3 provides for 22 zero-to-six inch surface soil samples to address this characterization gap. The survey design described in Section 5.3.3 provides for three surface soil samples outside the east property fence to also address this characterization gap.)

U.S. NRC Safety Evaluation Report

The SER included the following statement with regard to surface soil contamination (the parenthetical is a brief response of FMRI with respect to current conditions on site):

- The instrument surveys of open land soil surfaces were not conclusive. …
    - (The survey design described in Section 5.3.3 provides for gamma scan of surface soils.)

FMRI – Phase 1 Decommissioning Pond 3

Areas identified as impacted by a recent characterization survey are (the parenthetical is a brief response of FMRI with respect to current conditions on site):

- General Area of Temporary Staging Area 2A – Storm water drainage swale off the northwest corner of the equipment storage pad and on either side of the road.
    - (The survey design described in Section 5.3.3 provides for surface soil sampling to address this area. These locations are previously described in this subsection at ICF Consulting, third bullet.)
- Material Bagging Station Area and Associated On-Site Transportation Routes – North of equipment storage pad, along dirt road on north side of railroad tracks.
    - (Impacts are known here due to spillage and recent characterization survey; no additional characterization is necessary.)
- Pond No. 3 Material Handling/Transfer Area – North of railroad tracks and south of Pond 3..
    - (Impacts are known here due to spillage, recent characterization survey, and remaining drying bed with bulk WIP; additional characterization is not appropriate at this time since decommissioning activities here are not complete.)
- The staging areas for storage of dried and bagged WIP material from Pond 3: west of equipment storage pad, west of Machine Shop, and west of Sodium Reduction Building.
    - (The surface soils in these areas are expected to be unimpacted based on either survey or sampling, or that the surface material comprising the staging bed have been removed; no additional characterization is necessary.)
- Footprint of Pond 3
    - (The survey design described in Section 5.3.3 provides for six surface soil sample locations to address this area.)

5.3.3 Survey Design for Additional Characterization of Surface Soils

Sample Locations

Locations of additional site characterization surface samples are shown in Figure 1.

Reference Coordinate System

Sample and measurement locations will be referenced to the Oklahoma State Plane (NAD 83(OK83-NF) horizontal, NAVD 88 vertical).

Gamma Scan

Gamma scanning, as gross gamma measurements, will be used to support the surface soil sampling plan for additional site characterization. The intent is to provide an integrated survey strategy of gamma scanning and soil sampling to describe the radiological status of surface soils at the FMRI site.

Use of the gamma scan will not be based on a quantitative correlation but as a qualitative assessment by comparison to background. The scan is intended to find areas of elevated activity not detected by soil sampling or to provide a qualitative level of confidence that no areas of elevated activity were missed by sampling on a random pattern.

The gamma scan will be performed with a NaI(Tl) radiation detector coupled to a handheld scaler/ratemeter. Measurements will be collected by keeping the detector within one foot of ground surface while walking over the area at a rate comparable to a casual pace. In open areas, the measurements will be made along a straight path between opposite borders of the area being surveyed and the distance between paths will be approximately five feet. In wooded areas, the measurements will be made along paths allowed by brush and trees.

The scaler/ratemeter, along with global positioning system (GPS) equipment, will be coupled to a data logger. A gamma measurement taken from the scaler/ratemeter and a location reading from the GPS equipment will be recorded approximately every two seconds by the data logger. Each measurement will be recorded as gross counts per minute. The location will be recorded with respect to the aforementioned reference coordinate system. The expected density of measurements for an area is 60 to 80 measurements per 100 square meters.

Exposure Rate

Exposure rate one meter from surface will be determined at locations of surface soil samples. Exposure rate will be determined using a handheld NaI(Tl) detector calibrated by the manufacturer to display μR/h. Results will be recorded as μR/h.

Surface Soil

Sampling of surface soil will be conducted in accordance with written operating procedures. The soil will be collected by mechanized auger or tube. Soil will be retrieved beginning at ground surface and continuing until one meter belowground surface at each survey location. The soil from a depth interval will be mixed by hand and then an aliquot collected as the soil sample.

The soil samples at the north end of the site will typically be collected by hand auger from the top 15cm of soil. A single soil plug will be collected from each sample location. The single soil plug will create one soil sample.

Sample collection activities will include documentation of sampling activities on a field log, decontamination of equipment between sample locations, and collection of a duplicate sample at a rate of one per 20 or at least one per day. Chain-of-custody will be conducted in accordance with written operating procedures.

Soil samples will be sent to a laboratory for preparation and analysis. The preparation will include removing rocks and vegetation, drying, grinding, mixing/blending, and then acid leaching an aliquot of the prepared soil. These preparation techniques will be carried out in accordance with laboratory-specific procedures.

Samples of soil will be analyzed for the radionuclides indentified in Table 1. The analysis technique and typical detection limit for each analyses are also provided in Table 1.

Biased surface soil samples will be collected for gamma scan locations exhibiting results greater than three times background.

5.4 Subsurface Soil

Subsurface soils are those soils greater than one meter below ground surface.[3]

5.4.1 Summary of Existing Characterization of Subsurface Soils

A radiological status of subsurface soils is provided in the DP. Except as indicated below, it is sufficiently representative of site conditions for the purpose of decommissioning planning.

5.4.2 Identification of Gaps in Characterization of Subsurface Soils

ICF Consulting

The ICF report included the following recommendations for additional characterization of subsurface soils (the parenthetical following each recommendation is a brief remark of FMRI with respect to current conditions on site):

- Beneath and immediately adjacent to ponds. ...
  - (The survey design described in Section 5.4.3 provides for six subsurface soil sample locations within the footprint of Pond 3. Subsurface sampling will not be performed within the footprint of other ponds until those ponds are emptied of content.)
- Between the Sodium Reduction Building, the Thermite Building, and the Ore Storage Pad. Approximately three borings are needed.
  - (The survey design described in Section 5.4.3 provides for three subsurface soil sample locations to address this characterization gap.)
- Between the R&D building and the Ore Storage Pad ... Approximately six soil borings are needed.
  - (The survey design described in Section 5.3.3 provides for surface soil sampling to address this characterization gap.)
- Between the rail spur and the Pond 3 french drain. Approximately five soil borings are needed.
  - (The survey design described in Section 5.3.3 provides for surface soil sampling to address this characterization gap.)
- Within the Pond 3 french drain area .... Approximately six soil borings are needed.
  - (The survey design described in Section 5.4.3 provides for six subsurface soil sample locations within the Pond 3 french drain area.)

[3] Section 8.1 at Table 5-10 shows that the proposed release criteria for soils are insensitive to thickness of contamination over a range of 0.085m to 8.5m. Section 8.2 at pages 19 and 20 acknowledges this condition of insensitivity. Then surface soils are reasonably approximated as one meter below ground surface and subsurface soils beneath.

- Between the Chemical C Building and former Pond 2. Approximately two soil borings are needed.
    - (The survey design described in Section 5.4.3 provides for two subsurface soil sample locations to address this characterization gap.)

- Outside the property boundary northeast of former Pond 2. Approximately six soil borings are needed.
    - (The minimal surface area and steepness of the terrain do not support reasonable access of drilling equipment. No subsurface soil sampling will be completed in this area.)

- In the borrow pit … . Approximately six soil borings are needed.
    - (The survey design described in Section 5.3.3 provides for surface soil sampling to address this characterization gap.)

U.S. NRC Safety Evaluation Report

The SER included the following statement related to subsurface soil (the parenthetical following the statement is a brief response of FMRI with respect to current conditions on site):

- … there was no characterization beneath building floors, …
    - (The survey design described in Section 5.4.3 provides for one subsurface soil sample location beneath Chem C and two subsurface soil sample locations beneath Chem A to address this characterization gap. Knowledge of process and history of site operations allow that contamination of subsurface soils beneath other structures is improbable.)

FMRI – Phase 1 Decommissioning Pond 3

Areas identified as impacted by a recent characterization survey are (the parenthetical is a brief response of FMRI with respect to current conditions on site):

- General Area of Temporary Staging Area 2A – Storm water drainage swale off the northwest corner of the equipment storage pad and on either side of the road.
    - (The survey design described in Section 5.3.3 provides for surface soil sampling to address this area. Subsurface impacts are not likely.)
- Material Bagging Station Area and Associated On-Site Transportation Routes – North of equipment storage pad, along dirt road on north side of railroad tracks.
    - (Impacts are known here due to spillage and recent characterization survey; no additional characterization is necessary. Subsurface impacts are not likely.)
- Pond No. 3 Material Handling/Transfer Area – North of railroad tracks and south of Pond 3.
    - (Impacts are known here due to spillage, recent characterization survey, and remaining drying bed with bulk WIP; additional characterization is not appropriate at this time since decommissioning activities here are not complete. Subsurface impacts are not likely.)
- The staging areas for storage of dried and bagged WIP material from Pond 3: west of equipment storage pad, west of Machine Shop, and west of Sodium Reduction Building.
    - (The surface soils in these areas are expected to be unimpacted based on either survey or sampling, or that the surface material comprising the staging bed have been removed. Subsurface impacts are not likely.)
- Footprint of Pond 3
    - (The survey design described in Section 5.4.3 provides for subsurface soil sampling to address this area. These locations are previously described in this subsection at ICF Consulting, first bullet.)

5.4.3 Survey Design for Additional Characterization of Subsurface Soils

Sample Locations

Locations of additional site characterization subsurface soil samples are shown in Figure 2.

Reference Coordinate System

Subsurface sample locations will be referenced to the Oklahoma State Plane (NAD 83(OK83-NF) horizontal, NAVD 88 vertical). Sample depth will be recorded to the nearest tenth meter measured from ground surface.

Subsurface Soil

Sampling of subsurface soil will be conducted in accordance with written operating procedures. The soil will be collected by mechanized auger or tube. Soil will be retrieved from successive one meter intervals beginning one meter below ground surface and continuing until first occurrence of bedrock or groundwater at each survey location. The soil from a depth interval will be mixed by hand and then an aliquot collected as the soil sample.

Sample collection activities will include documentation of sampling activities on a field log, decontamination of equipment between sample locations, and collection of a duplicate sample at a rate of one per 20 or at least one per day. Chain-of-custody will be conducted in accordance with written operating procedure.

Soil samples will be sent to a laboratory for preparation and analysis. The preparation will include removing rocks and vegetation, drying, grinding, mixing/blending, and then acid leaching an aliquot of the prepared soil. These preparation techniques will be carried out in accordance with laboratory-specific procedures.

Samples of soil will be analyzed for the radionuclides indentified in Table 1. The analysis technique and typical detection limit for each analyses are also provided in Table 1.

5.5 Surface Water and Sediments

The FMRI facility treats and discharges wastewater, and discharges storm water pursuant to Oklahoma Pollution Discharge Elimination System Permit OK0001643 (OPDES Permit). The OPDES Permit is managed by the Oklahoma Department of Environmental Quality. The FMRI facility is required to monitor its discharges to include radiological parameters as specified in FMRIs NRC License. Currently the OPDES Permit is in the process of renewal.

5.5.1 Summary of Existing Characterization of Surface Water and Sediments

A radiological status of surface water and sediments is provided in the DP.

Historical and periodic sampling of surface waters in accordance with the OPDES Permit is readily accessible at the FMRI facility. The data has been reviewed in detail during NRC inspections since year 2000. Review of the results by FMRI personnel and NRC staff have not identified any remarkable condition.

The FMRI facility has been and continues to be in compliance with the terms of its OPDES Permit was well as the related discharge and monitoring requirements of its NRC License.

5.5.2 Identification of Gaps in Characterization of Surface Water and Sediments

ICF Consulting

The ICF report did not include recommendations for additional characterization of surface water. The ICF report did not include recommendations for additional characterization of sediment associated with any outfall.

U.S. NRC Safety Evaluation Report

The SER did not include any specific statement with regard to incomplete characterization of surface water or sediments.

5.5.3 Survey Design for Additional Characterization of Surface Water and Sediments

Surface Water

The ongoing surface water sampling conducted pursuant to the OPDES Permit is sufficiently representative of site conditions for the purpose of decommissioning planning. Reassessment during the ongoing renewal process will identify any requirements for additional sampling. Additional planned characterization of surface water is not necessary to support decommissioning activities.

Sediments

The sampling of sediments described in the DP is representative of site conditions for the purpose of decommissioning planning. Remedial action surveys and final status surveys will be sufficient to identify any requirements for additional sampling. Additional planned characterization of sediments is not necessary to support decommissioning activities.

5.6 Groundwater

5.6.1 Existing Characterization of Groundwater

A comprehensive Remediation Assessment (RA) was conducted by Earth Sciences from 1991 to 1993. The RA included the installation of 67 soil borings, 25 shallow monitoring wells, 4 bedrock monitoring wells, and 13 test pits. Samples were collected and analyzed from soil, sediment, surface water, ground water, and pond residues for inorganic, organic, and radiological constituents. The hydraulic properties of the shallow (unconsolidated) water-bearing zone and bedrock were determined through slug tests and pumping tests to determine the hydraulic conductivity, storativity, specific yield, and transmissivity.

The results of the investigation are summarized in the RA. At the time of the 1993 investigation, groundwater in the shallow unconsolidated zone exhibited elevated radioactivity in the south and east portion of the site. Radionuclide concentrations in bedrock were determined to be well below the applicable water quality criteria, and the bedrock wells were subsequently properly abandoned and sealed.

An extensive Groundwater Interceptor Trench System was installed around the south and east perimeter of the property in 1999 to collect and treat groundwater in the shallow alluvium. The trench was excavated to the top of bedrock and backfilled with coarse aggregate surrounding perforated HDPE pipe. The system intercepts groundwater in the shallow alluvium and routes it toward a series of four sumps (Sump 1, Sump 2, Sump 3, and Sump 4) shown in Figure 3. Water is pumped from the sumps to the wastewater treatment system, where it is treated and discharged at NPDES-permitted Outfall 001. With regard to the Groundwater Interceptor Trench System, the IFC report stated that "when IFC conducted its site visit in June 2002, all sumps and other visible portions of the system appeared to be well maintained, and site employees stated that the system performance was meeting expectations."

Extensive routine monitoring has continued in the years since the RA was completed, interceptor trench installed, and DP prepared. Water levels in site monitoring wells have been monitored approximately weekly. Water quality samples have been collected and analyzed quarterly, and flow and water quality from the sumps through the water treatment plant have been monitored routinely. Consistent monitoring has provided significant additional information to augment the previous conceptual model of the hydrogeologic system.

5.6.2 Identification of Gaps in Characterization of Groundwater

ICF Consulting

The ICF report included the following recommendations for additional characterization of groundwater (the parenthetical following each recommendation is a brief remark of FMRI with respect to current conditions on site):

- The IFC report summarized the groundwater flow directions described in the RA, and stated that "the groundwater flow map appears to be based on data from only one set of water level measurements, and as such, the accuracy of the groundwater flow maps generated by Earth Sciences is suspect." The IFC report also questioned the water level in MW-70S and whether the radial flow pattern contoured around the well represented steady-state or transient flow conditions.
    - (The survey design described in Section 5.6.3 provides for address of this characterization gap.)
- The IFC report called for an additional monitoring well downgradient of the Chemical C Building, stating that "the closest well is about 75 feet away, and may not be downgradient."
    - (The survey design described in Section 5.6.3 provides for address of this characterization gap.)
- The IFC report called for two additional monitoring wells in the borrow pit area "to further delineate contamination in this area" and recommended that one well be place upgradient and one downgradient of monitoring well MW-56S.
    - (The survey design described in Section 5.6.3 provides for address of this characterization gap.)

U.S. NRC Safety Evaluation Report

The SER did not include any specific statement with regard to incomplete characterization of groundwater.

Other

The effectiveness of the Groundwater Interceptor Trench System has not been questioned by regulatory agencies in contexts other than the DP (the parenthetical following is a brief remark of FMRI):

- The NRC conducted a site inspection in February, 2007 and concluded that "...the site groundwater intercept trench and the sump pump systems were operating as designed. Accordingly, the contaminated groundwater was likely being captured by the intercept trench and was routed to the wastewater treatment facility for processing prior to release to the environment" (NRC Inspection Report No. 040-07580/07-001, February, 2007).
    - (The survey design described in Section 5.6.3 provides for evaluation of the effectiveness of the Groundwater Interceptor Trench System.)

5.6.3 Survey Design for Additional Characterization of Groundwater

Groundwater

Considerable information has been gathered via routine groundwater monitoring since the initial groundwater investigations conducted from 1991 to 1993 and the ICF review in 2002. The plan for additional characterization of groundwater will include a comprehensive program to compile, present, and interpret this additional water quality and water level information. The compilation will include the following tasks:

- Develop potentiometric surface (contour) maps for the shallow unconsolidated water-bearing zone from 1993 to 2010.
- Prepare hypsographic map of top of bedrock and plot changes in saturated thickness over time.
- Prepare and present tables and time-series plots of water chemistry in monitoring wells and sumps from 1993 to 2010.
- Prepare plan view post plots of showing groundwater concentrations in monitoring wells and sumps for selected time periods from 1993 to 2010
- Compile climate data to support water balance evaluations and potential infiltration modeling and unsaturated/saturated zone fate and transport modeling.
- Determine the need for the additional three monitoring wells requested in the IFC report, based on eight years of additional data collected since the IFC report was prepared. Groundwater near the Chemical "C" building is believed to report to the interceptor trench and MWOW4, because of the dominant hydraulic gradient imparted by the Groundwater Interceptor Trench. Based on groundwater travel times, additional (more closely spaced) monitoring wells downgradient of the Chemical "C" Building may not be necessary. Water quality in GW-56S has changed over time. The need for such additional monitoring wells will be further evaluated, and a conclusion will be provided in the site characterization report.

The compilation may also include the following tasks:

- Re-analyze the hydraulic conductivity (slug test) data for shallow monitoring wells, calculate hydraulic conductivity (K) using geometric mean, conduct additional slug testing if necessary.
- Prepare tables of updated hydraulic properties for use in groundwater velocity calculations and potential fate and transport modeling.

Groundwater Interceptor Trench System

An evaluation of the effectiveness of the Groundwater Interceptor Trench System will include the following tasks:

- Review and describe the interceptor trench plans and as-built construction report(s).
- Evaluate groundwater level elevations in shallow monitoring wells before installation, during construction, and during operation of the interceptor trench. Develop hydrographs (time-series plots of water levels) for all wells and sumps.
- Review pumping rates and groundwater levels in the interceptor trench sumps.
- Evaluate the potentiometric surface (contour) maps for the shallow unconsolidated water-bearing zone from 1993 to 2010 relative to sump locations and pumping rates.
- Draw cross sections to characterize the interface between the shale bedrock, saturated alluvium, interceptor trench, and the Arkansas River.
- Prepare time-series plots for water quality in the interceptor trench sumps.
- Compare sump pumping rates to precipitation, determining lag time, estimated infiltration, and percent capture.

The evaluation of the Groundwater Interceptor Trench System may also include the following tasks:

- Compare changes in saturated thickness over time to sump pumping rates and precipitation.
- Develop a flow net or 2D groundwater flow model to determine hydraulic capture effectiveness.

6 PHYSICAL CHARACTERISTICS OF THE SITE

The Decommissioning Plan, Section 3.0 *Facility Description*, provides a description of the physical characteristics of the site.

7 DOSE ASSESSMENT

The Decommissioning Plan, Section 5.0 *Dose Modeling Evaluations*, provides a demonstration that decommissioning can ultimately allow release of the site for unrestricted use.

8 REFERENCES

8.1 Fansteel, Inc., Decommissioning Plan, January 15, 2003. [ML030240051]

8.2 U.S. Nuclear Regulatory Commission, Safety Evaluation Report for License Amendment Application to Approve Decommissioning, July 24, 2003, October 31, 2003. [ML033250083]

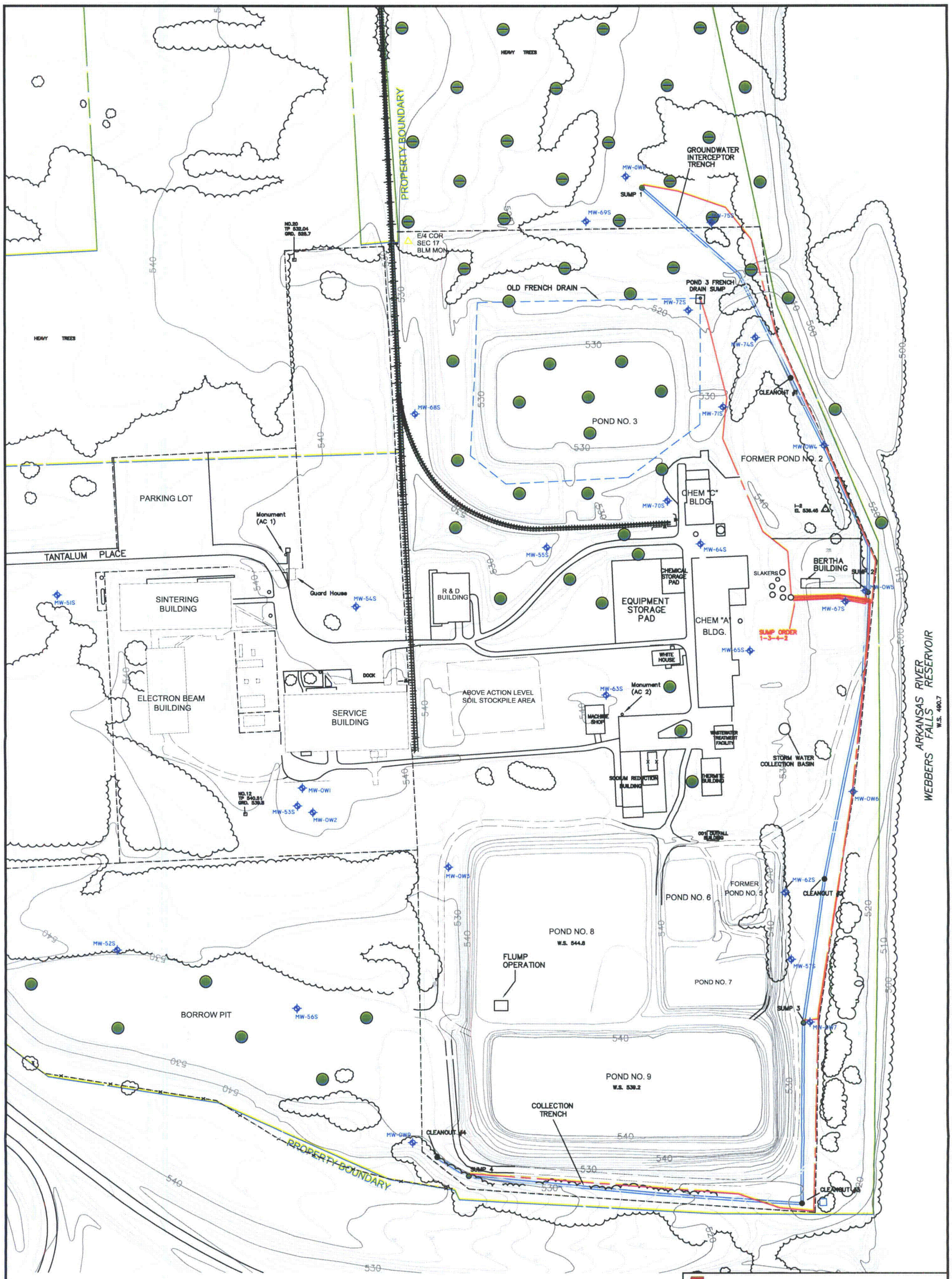
8.3 ICF Consulting, Review and Evaluation of Characterization Data Provided for Fansteel Corporation, Muskogee, Oklahoma, November 15, 2002. [ML023510442]

8.4 U.S. Nuclear Regulatory Commission, Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria, Final Report, NUREG-1757, Vol 2, Rev 1, September 2006. [ML063000252]

Table 1 Final Status Survey Radioanalytical Methods Subsurface Soils

Radionuclide	Analytical Method	Detection Limit[1] (pCi/g)
Total Uranium	kinetic phosphorescence analysis	1
Isotopic Thorium	alpha spectrometry	1
Radium-226, 228	co-precipitation gross alpha and gross beta	1

[1] nominal values



EXPLANATION

- MW-56S — MONITORING WELL
- SURFACE SOIL SAMPLE LOCATION, 0 - 15 cm bgs (n = 22)
- SURFACE SOIL SAMPLE LOCATION, 0 - 1 m bgs (n = 34)

NORTH

0 200 400
Scale (ft)

CONTOUR INTERVAL = 2 ft

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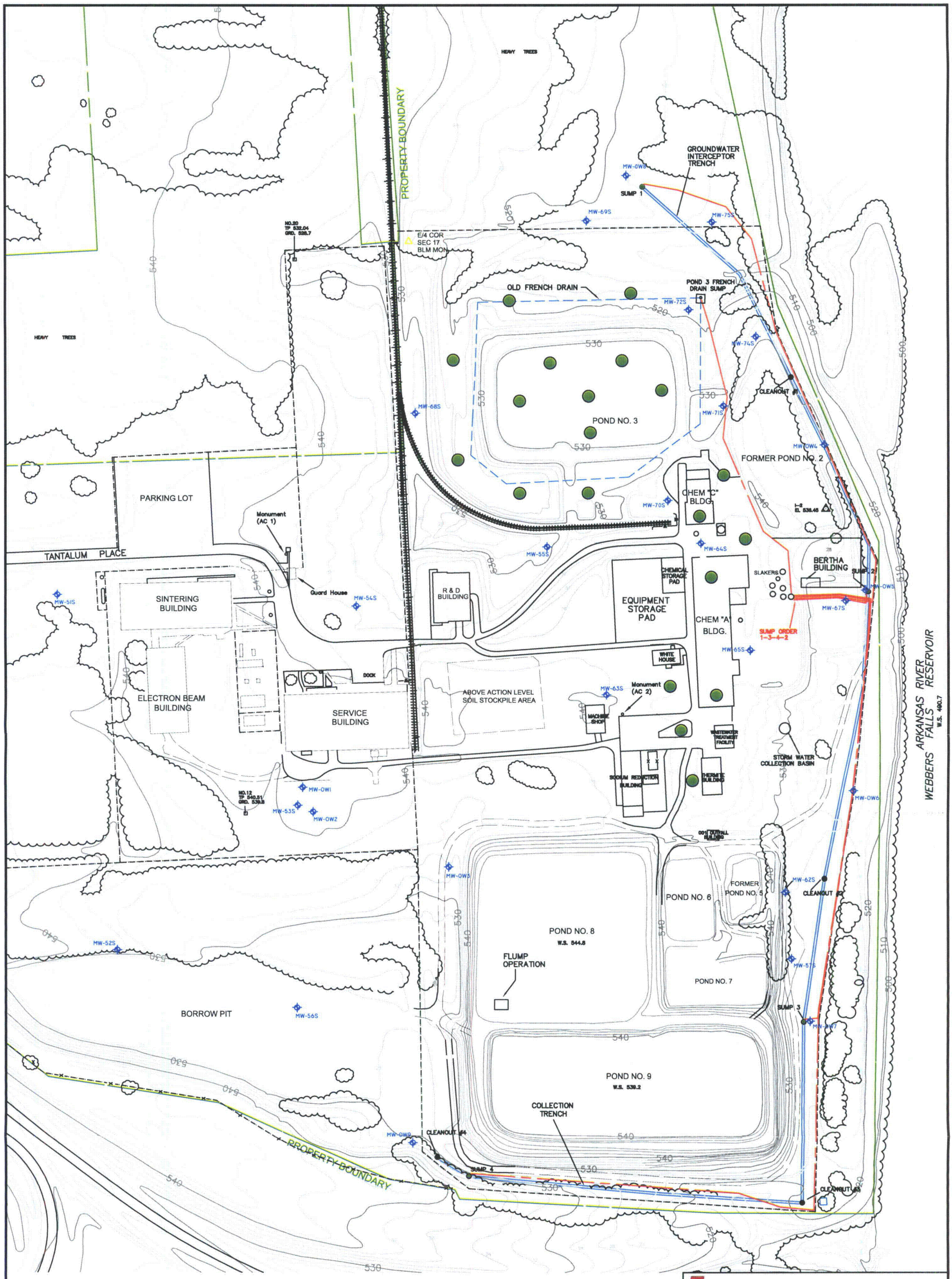
FIGURE 1.
SURFACE SAMPLE LOCATIONS

Scale: 1" = 200' 1:2,400	Date: February 2011
Project No: 4145A	County: Muskogee County, OK
Whetstone Associates	File: FMRI-BaseMap_9.dwg
	Drawn/Checked By: NP/SW



EXPLANATION

MW-56S MONITORING WELL

SUBSURFACE SOIL SAMPLE LOCATION
1 m - BEDROCK OR GROUNDWATER (n = 20)

NORTH

0 200 400
Scale (ft)

CONTOUR INTERVAL = 2 ft

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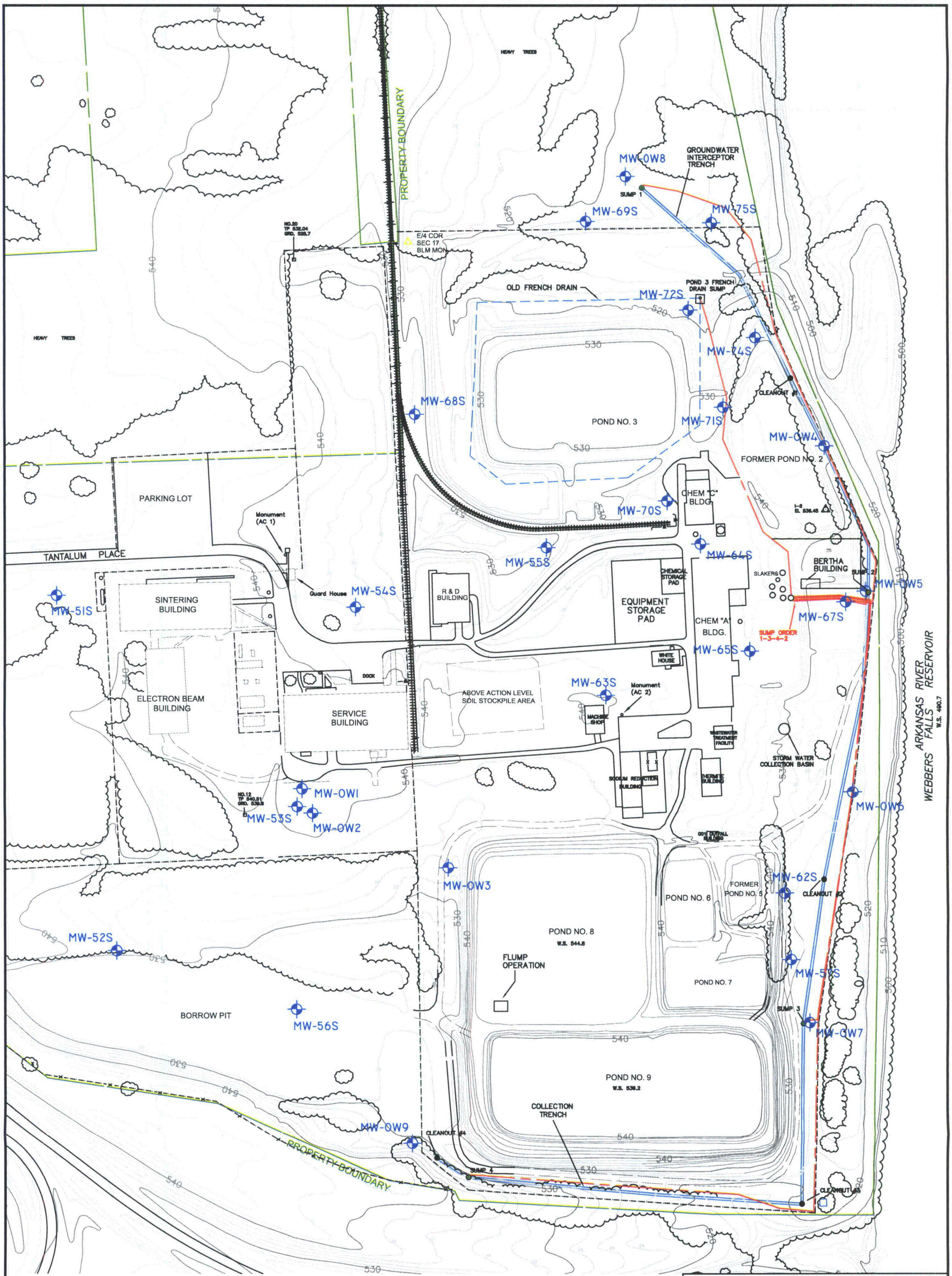
FIGURE 2.
SUBSURFACE SAMPLE LOCATIONS

Scale: 1" = 200' 1:2,400	Date: February 2011
Project No: 4145A	County: Muskogee County, OK
Whetstone Associates	File: FMRI-BaseMap_9.dwg
	Drawn/Checked By: NP/SW



EXPLANATION

MW-56S — MONITORING WELL

GROUNDWATER INTERCEPTOR TRENCH

NORTH

0 200 400

Scale (ft)

CONTOUR INTERVAL = 2 ft

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FIGURE 3.
MONITORING WELL LOCATIONS AND GROUNDWATER INTERCEPTOR TRENCH

Scale: 1" = 200' 1:2,400	Date: February 2011
Project No: 4145A	County: Muskogee County, OK
Whetstone Associates	File: FMRI-BaseMap_8.dwg
	Drawn/Checked By: NP/SW