ENVIRONMENTAL ANALYSIS REPORT - PHASE V

FOR THE DECOMMISSIONING ACTIVITIES OF THE KERR-McGEE, WEST CHICAGO RARE EARTHS FACILITY

PREPARED FOR

ILLINOIS EMERGENCY MANAGMENT AGENCY

DIVISION OF NUCLEAR SAFETY
1035 OUTER PARK DRIVE
SPRINGFIELD, IL. 62704

PREPARED BY

HANSON

Hanson Professional Services Inc.

IN ASSOCIATION WITH
URS PROFESSIONAL SOLUTIONS LLC AND
INTERA INCORPORATED

URS

INTERA

FEBRUARY 2013

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EXECUTIVE SUMMARY

The Kerr-McGee West Chicago Rare Earths Facility located in West Chicago, DuPage County, Illinois produced thorium and rare earth compounds from 1932 until the Facility ceased operations in 1973. The various chemical processes used to produce radioactive materials resulted in byproduct material, as defined in 32 IAC 332.20, being present in site soils, stockpiles, and water.

The objective of Weston Solutions, Inc. as representative of West Chicago Trustee/Licensee of the West Chicago Environmental Response Trust is to decommission the Facility so that the property can be released for public use and their existing license terminated. During former decommissioning activities, licensees have included Tronox LLC, Kerr-McGee Chemical LLC, and Kerr-McGee Chemical Corporation (Kerr-McGee). In February 1994 the Illinois Department of Nuclear Safely (IDNS) informed Kerr-McGee that a phased approach to decommissioning the Site would be acceptable. To date, eight phases have been identified:

- Facilities Construction - Phase I
- Operations Facilities Construction - Phase IA
- Operations - Phase IB
- Operations - Phase II
- Operations - Phase IIA
- Operations - Phase III
- Operations - Phase IV
- Operations - Phase V

In April 1994 an *Environmental Assessment - Phase I for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, April 1994) was issued. Subsequently a second and third phase of decommissioning activities (Phase IA and Phase IB) were assessed in the *Addendum to the Environmental Assessment - Phase I for the Phase IA Decommissioning Activities of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994), and in the *Environmental Analysis Report - Phase IB for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994a). During 1995, a fourth and fifth phase of decommissioning activities (Phase II and Phase IIA) were assessed in the *Environmental Analysis Report - Phase II for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, February 1995) and in the *Addendum to the Environmental Analysis Report - Phase II for the Phase IIA Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, June 1995). A sixth phase (Phase III) of decommissioning activities was assessed in the *Environmental Analysis Report - Phase III for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, April 1996). The seventh phase (Phase IV) of decommissioning activities was assessed in the *Environmental Analysis Report – Phase IV for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earth Facility* (Hanson Engineers, January 1998).

In May 1994, IDNS issued a license amendment to Kerr-McGee authorizing Phase I activities. In August 1994 and in September 1994, IDNS issued license amendments authorizing Phase IA and Phase IB activities, respectively. Phase II and Phase IIA activities were authorized by IDNS by license amendment in April 1995 and September 1995, respectively. Phase III activities were authorized by IDNS by license amendment in February 1997. Most of the activities originally scheduled for 1996 and assessed in the Phase III Environmental Analysis Report were deferred until 1997. Therefore, a separate Environmental Analysis was not prepared for decommissioning activities performed in 1997. Instead, the activities conducted during 1997 were compared to the Phase III model developed to assess radiological impacts. It was concluded that potential off-site radiological doses resulting from 1997 activities were less than regulatory dose limits. In April 1998, IDNS issued a license amendment to Kerr-McGee authorizing Phase IV activities scheduled to be performed from 1998 through 2001. The Phase IV decommissioning activities were typically not completed in the time periods scheduled and modeled in the Phase IV Environmental Analysis. Therefore, an evaluation of planned activities for the years 1999 through 2012 was conducted prior to each construction season. Radiological doses from the planned activities were compared to doses modeled in the Phase IV Environmental Analysis or to the doses developed for a previous year. It was concluded that potential off-site radiological doses resulting from 1999 through 2012 activities were less than regulatory dose limits.

This Environmental Analysis describes Phase V decommissioning activities. Major activities are groundwater remediation; groundwater monitoring; handling contaminated materials; railcar loading of contaminated material for off-site disposal; demolition of site facilities; removal of rail spurs in the Railcar Loading Facility area; and excavation, verification and restoration of the ground underlying the site facilities. The Phase V decommissioning activities are:

- Groundwater remediation
- Erosion and surface water control
- Abandonment of the water well in the Water Treatment Plant

- Demolition of facilities including the Railcar Loading Facility, the Simplified Physical Separation Facility, the Common Facilities, the Water Treatment Plant, and the Support Zone
- Relocation of rail spurs
- Railcar loading for off-site disposal
- Excavation, verification, and backfilling and restoration of the ground underlying the site facilities
- Stockpiling materials
- Final grading and seeding
- Groundwater monitoring

Some of these activities were originally scheduled and assessed in the Phase IV Environmental Analysis Report but not completed. The project schedule has been revised to include the remaining uncompleted activities in Phase V. The Phase V Environmental Analysis is intended to cover all remaining activities necessary for closure of the site.

Annual radiological impacts from various potential exposure pathways were assessed for planned Phase V activities. The analysis considered the total annual dose from all exposure pathways to an individual standing at the fenceline for two hours per day throughout the Phase V decommissioning activities and to a hypothetical nearest resident. Based on these analyses, annual radiological exposures for proposed Phase V activities would be less than the regulatory dose limits for individual members of the public.

This Environmental Analysis for Phase V includes the assessment and determination of impacts, including consideration of alternatives, as required by 32 IAC 332.100. Based on this analysis, the Illinois Emergency Management Agency (IEMA) Division of Nuclear Safety, formerly known as the Illinois Department of Nuclear Safety (IDNS), concludes that the proposed action will satisfy all regulatory limits for radiation exposures to members of the public. The proposed activities will not be inimical to public health and safety or the environment because regulatory limits are satisfied. Evaluation of occupational health and safety concerns will be contained in a Safety Evaluation Report for Phase V activities, to be issued prior to the license amendment for Phase V.

This Environmental Analysis for Phase V was based on technical information submitted by licensees for the decommissioning of the West Chicago Facility. In addition, information was also obtained from the IEMA and from published documents. This report was prepared by Hanson Professional Services Inc. for IEMA.

1.0 INTRODUCTION

1.1 LEGAL BASIS AND ORGANIZATION OF THE DOCUMENT

This environmental analysis is conducted pursuant to the requirements of 32 Illinois Administrative Code (IAC) 332.100. In accordance with the regulatory requirements, this report provides or references sources for the following:

- An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;
- An assessment of any impact on any waterway or groundwater resulting from the activities conducted pursuant to the license or amendment;
- Consideration of alternatives, including alternative sites and engineering methods, to the activities to be conducted pursuant to the license or amendment; and
- Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts associated with activities to be conducted pursuant to the license or amendment.

1.1.1 Phased Approach to the Planned Closure Activities

To date, decommissioning activities for the Kerr-McGee Facility include Phase I, Phase IA, Phase IB, Phase II, Phase IIA, Phase III, and Phase IV activities that are described in the *Environmental Assessment - Phase I for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, April 1994), the *Addendum to the Environmental Assessment - Phase I for the Phase IA Decommissioning Activities of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994), the *Environmental Analysis Report - Phase IB for Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994a), the *Environmental Analysis Report - Phase II for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, February 1995), the *Addendum to the Environmental Analysis Report - Phase II for the Phase IIA Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, June 1995), the *Environmental Analysis Report - Phase III for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, April 1996), and the *Environmental Analysis Report – Phase IV for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, January 1998).

This Environmental Analysis describes the potential impacts to human health associated with Phase V decommissioning activities. Phase V activities are described in Section 3 of this report.

Information in this Environmental Analysis is based, in part, on information submitted by the applicant, Weston Solutions, Inc. (Weston), representative of West Chicago Trustee/Licensee of the West Chicago Environmental Response Trust. Some of the information was prepared by URS Corporation of Denver, Colorado on behalf of Kerr-McGee. In addition, information was also obtained from the Illinois Emergency Management Agency (IEMA) Division of Nuclear Safety, formerly known as the Illinois Department of Nuclear Safety (IDNS), and other documents submitted by former licensees including Tronox LLC, Kerr-McGee Chemical LLC, and Kerr-McGee Chemical Corporation (Kerr-McGee) as part of the license application for closure of the West Chicago Facility. This report was prepared and submitted to IEMA by Hanson Professional Services Inc. (Hanson) on behalf of IEMA.

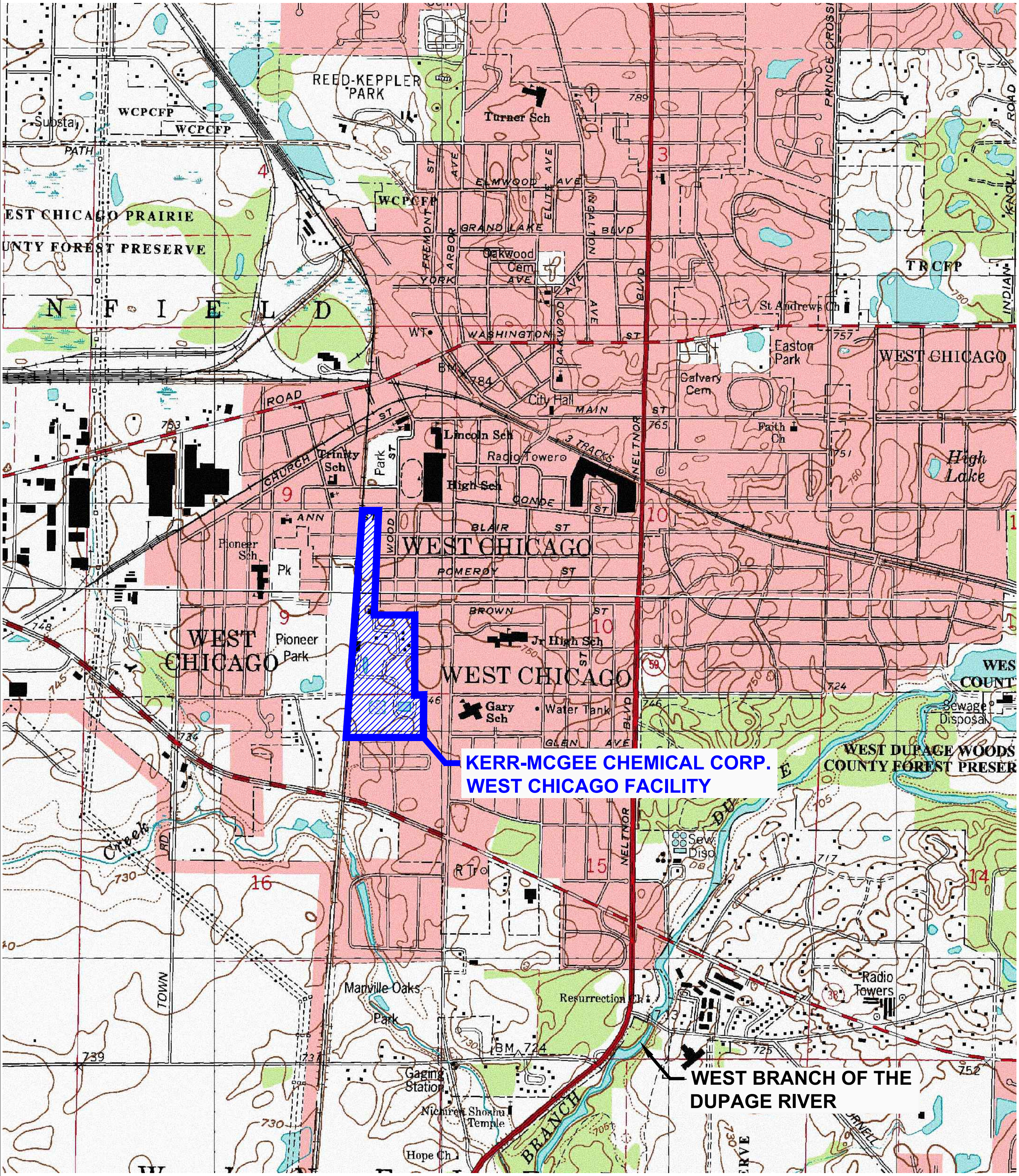
1.2 SITE LOCATION

The Kerr-McGee West Chicago Rare Earths Facility (Facility) is located in West Chicago, Illinois, about 30 miles west of Chicago, Illinois. West Chicago is situated mainly in Winfield Township and partly in Wayne Township at the western edge of DuPage County. The location of the Facility is shown in Figure 1.2-1. The Facility consists of about 43 acres of contiguous property, which has been partitioned into three sections for convenience in identifying site history and site characteristics. The first section, called the Factory Site, consists of the northern eight acres and is the location of previous manufacturing, processing, and some storage activities. The second section, known as the Disposal Site, is the location of previous waste disposal activities and encompasses the southern 27.2 acres. The third section, the Intermediate Site, is a 7.4 acre area located between the Disposal and Factory Sites. The Intermediate Site was not used in Facility activities, but rather was used to provide access between the Factory and Disposal Sites.

1.3 HISTORY AND TYPE OF ACTIVITY

1.3.1 General Site History

About five acres of the northern section of the Factory Site have been used for manufacturing activities since the mid-1880s. Union Tool, a well drilling equipment manufacturer, operated at the Site from mid-1880 until 1931 when Lindsay Light Company (Lindsay) acquired the property. In 1943, Lindsay acquired another three acres of property from a millwork plant, West Chicago Sash and Door Company. These contiguous eight acres make up the Factory Site.



Source: USGS 7.5 Minute Topographic Map West Chicago Quadrangle/Naperville Quadrangle

SCALE IN FEET

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FACILITY LOCATION PLAN

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 FIGURE 1.2-1

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Between 1952 and 1955, Lindsay acquired 27 acres of farmland south of the Factory Site, and established the Disposal Site. Between 1952 and 1954, Lindsay completed a major expansion of the West Chicago Facility to produce thorium nitrate for the Atomic Energy Commission (AEC) and later, for the General Services Administration (GSA). Lindsay was acquired by American Potash and Chemical Corporation (American Potash) in May 1958. The last thorium contract with the government ended in 1963.

American Potash was acquired by Kerr-McGee Chemical Corporation in December 1967. The Facility produced thorium and rare earths products until 1973 when Kerr-McGee determined that further operation was not economical. Kerr-McGee acquired the property referred to as the Intermediate Site in 1979. The property had been used for manufacturing by Economy Buildings, Inc. until the late 1960s when the plant was destroyed by fire.

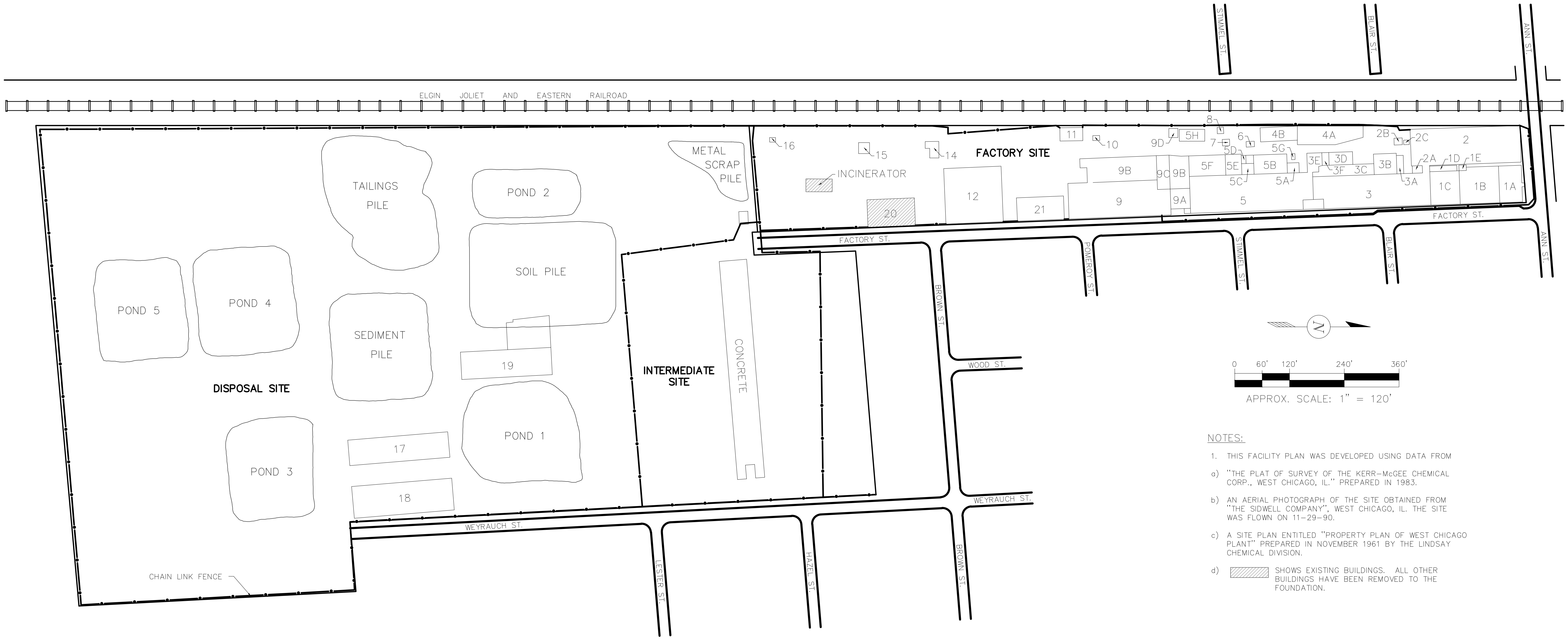
1.3.2 Previous Manufacturing Activities

The Facility began manufacturing operations involving radioactive material in 1932 and closed in 1973. During the operational period of the plant, various chemical processes were used to produce thorium and rare earth compounds. From 1932 to 1936, the main extraction procedure (the "hard pot" process) was performed in Building 5, shown on Figure 1.3.2-1. This process consisted of digesting monazite ore, a rare earth phosphate, with barium sulfate and fuming sulfuric acid in heated cast-iron pots.

The resulting residue, called pot cake, was extremely hard and required chiseling for removal. Subsequent leaching in water produced a solution of rare earth minerals with the residue retaining the radium and thorium minerals. The addition of caustic soda and hydrofluoric acid to the thorium residue initially produced a gray mud and finally a residue called black mud. Part of the gray mud was processed into finished thorium nitrate or oxide compounds required for lamp mantle production and merchant thorium needs. The remaining residues and mud were stored in piles south of Building 5.

In 1936, incandescent mantles for home and street lighting were produced at the Site. Any waste products were recycled back into the chemical operation.

During the late 1930s and early 1940s, mesothorium (radium-228) was extracted from black mud residue in Buildings 2, 3, and 3C. This material was used in the production of luminous watch dials. Also, during World War II (1940-1945) hydrofluoric acid was produced by reacting fluorspar with sulfuric acid.



NOTES:

1. THIS FACILITY PLAN WAS DEVELOPED USING DATA FROM

a) "THE PLAT OF SURVEY OF THE KERR–McGEE CHEMICAL CORP., WEST CHICAGO, IL." PREPARED IN 1983.

b) AN AERIAL PHOTOGRAPH OF THE SITE OBTAINED FROM "THE SIDWELL COMPANY", WEST CHICAGO, IL. THE SITE WAS FLOWN ON 11–29–90.

c) A SITE PLAN ENTITLED "PROPERTY PLAN OF WEST CHICAGO PLANT" PREPARED IN NOVEMBER 1961 BY THE LINDSAY CHEMICAL DIVISION.

d) SHOWS EXISTING BUILDINGS. ALL OTHER BUILDINGS HAVE BEEN REMOVED TO THE FOUNDATION.

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PRE-DECOMMISSIONING FACILITY PLAN

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.3.2-1

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Thorium nitrate was produced from 1954 through 1963 under contract to the U.S. Atomic Energy Commission (AEC). This process incorporated a new technology called the soft pot process (i.e., acid cracking using a weak sulfuric acid), which resulted in a putty-like pot cake rather than the hardened mass previously produced. Water leaching this pot cake in refrigerated tanks produced a thorium solution while the rare earth minerals were separated along with the gangue. Further recovery and separation of the rare earths were obtained by additional leaching and chemical processing.

Thorium nitrate production peaked around 1958 with the processing of about 9,000 metric tons (MT) of monazite ore per year. Following the expiration of the AEC contract, annual production decreased to approximately 4,500-5,000 MT. In 1963, ore processing activities were shut down for a period of 12 to 15 months. In 1964, monazite operations were resumed, and for a short period of time the Facility processed bastnaesite, a rare earth fluorocarbonate containing no thorium. In addition, ion exchange and solvent extraction processes were installed, which selectively separated the heavy rare earths that were used principally for color television red phosphors.

A caustic process replaced the traditional acid process in 1969. The caustic process reduced the volume of waste requiring disposal by recovering phosphates as crystalline trisodium phosphate, which could be marketed for detergent applications. The Facility continued to operate with relatively stable production until the plant was closed in 1973.

From 1954, when thorium processing under the AEC license began, until plant shutdown in 1973, the Kerr-McGee Facility in West Chicago processed about 62,000 MT of monazite ore containing about 4.8 percent thorium dioxide and about 12,000 MT of bastnaesite containing about 54 percent rare earth oxides. An estimated 75 percent of the contained rare earth oxides were recovered as product; the remaining 25 percent entered the waste stream. Solid-waste components included gangue, untreated ores, barium sulfate, and insoluble rare earth and thorium compounds. Liquid wastes were acidified to pH 3 with hydrofluoric and sulfuric acid and pumped to sedimentation ponds, where insoluble waste components were precipitated.

1.3.3 Previous Decommissioning Activities

Between 1979 and 1989, Kerr-McGee dismantled the old operations buildings on the West Chicago Site because the buildings were in a state of disrepair. The dismantling of these buildings was authorized by the United States Nuclear Regulatory Commission (USNRC) in Amendments 1, 3, 5, 6, 9, 14 and 16 to License STA-583. Dismantling of the buildings was performed according to written plans for each building. The plans consisted of Control Work packages and Special Work Permits, and contained detailed protocols for assuring safe conditions during the dismantling activities. Clean steel resulting from the activities was sold to scrap dealers, transported to other Kerr-McGee plants, or stockpiled on site. Concrete, cement, and brick rubble were stored on site and later used to improve the roadbeds at the Disposal Site, as authorized by Amendment 12. Organic debris, such as wooden beams, was incinerated in the on-site incinerator authorized in Amendments 2, 4, and 8, and under Illinois Environmental Protection Agency permit number 093090ABP.

In 1994, 1995, 1996, and 1998 seven phases of decommissioning activities were authorized. These activities are described below.

The *Environmental Assessment - Phase I for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, April 1994) describes the activities that occurred during the first phase of decommissioning. In May 1994, IDNS issued a license amendment to Kerr-McGee authorizing Phase I activities. Those activities included:

- Construction of the Support Zone
- Installation of security fencing between the railspur and the E. J. & E. railroad mainline
- Installation of sheet piling between N1546 and N2150
- Construction of the railspur from N875 to N2300 and a temporary connection to the main line from N2300 to N2500
- Construction of the railcar loading facility
- Construction of a retention pond in the southwest corner of the Disposal Site
- Site preparation (clearing, grubbing, removal of concrete foundations, and installation of utilities)
- Abandonment of 21 monitoring wells near locations where the railcar loading facility, railspur line, and retention pond were constructed
- Installation of 13 new air quality monitoring units

A second phase of decommissioning activities (Phase IA) was assessed in the Addendum to the Environmental Assessment - Phase I for the Phase IA Decommissioning Activities of the Kerr-McGee West Chicago Rare Earths Facility (Hanson Engineers, July 1994). In August 1994, IDNS issued a license amendment to Kerr-McGee authorizing Phase IA activities. Those activities included:

- Construction of the Stabilization/Neutralization (S/N) area
- Construction of haul roads
- Installation of a Temporary Dry Screening System
- Implementation of a testing and materials handling program

The *Environmental Analysis Report - Phase IB for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994a), describes Phase IB decommissioning activities. These activities included the movement of sediment, tailings, and debris piles and containerized materials (including the mixing of piles with other on-site materials as required to comply with the licensed disposal site and transportation regulations), so that loading and shipping of materials could begin when constructed facilities were ready for operation. In September 1994, IDNS issued a license amendment to Kerr-McGee authorizing Phase IB activities. The Phase IB decommissioning activities included:

- Expansion of a Stabilization/Neutralization (S/N) pad to accept materials for mixing
- Materials staging, handling, and screening
- Mixing sediment, tailings, soil and containerized materials
- Preparation and size reduction of materials, construction debris, containers, and scrap steel for rail transport
- Transporting mixtures to the railcar loading facility by truck
- Loading and transporting sediment, tailings, and soil in railcars
- Loading and transporting debris in railcars
- Staging and repackaging of asbestos materials
- Loading and transporting asbestos material in flatcars
- Abandonment of 13 wells

The *Environmental Analysis Report - Phase II for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, February 1995) describes Phase II decommissioning activities. In April 1995, IDNS issued a license amendment to Kerr-McGee authorizing Phase II activities. The Phase II decommissioning activities that were assessed included:

- Excavation of pond sediments
- Installation of sheet piling and slurry walls at Ponds 3 and 4
- Installation of dewatering piping for Ponds 3 and 4
- Receipt of a specified quantity of off-site contaminated materials

- Excavation of below-grade contaminated material at the Disposal Site, North Factory Site, and railspur
- Completion of the railspur
- Completion of Factory Site sheet piling
- Infrastructure construction along Factory Street
- Construction of the Stabilized Material Storage Building
- Haul road construction
- Installation of an off-site groundwater monitoring network
- Backfilling of excavations
- Demolition and decontamination of concrete
- Site preparation for construction of the Water Pre-Treatment Plant and the Physical Separation Facility
- Movement of above-grade contaminated materials
- Stabilization/Neutralization, screening, transporting and loading contaminated materials
- Stockpiling materials

Excavation of below-grade contaminated materials from select areas and sediment from Pond 1 and Pond 5 was begun in Phase II. About 12,500 cubic yards of contaminated soils were received from off-site locations. Haul roads and stockpiles were constructed as planned to support 1995 remediation activities. Some concrete demolition and decontamination was completed. Stabilization/Neutralization operations, screening, transporting and loading of contaminated materials occurred throughout 1995. Sheet piling was installed along the west side of the Factory Site, and some new groundwater monitoring wells were installed. Other activities, including the installation of vertical barriers and dewatering piping for Ponds 3 and 4, completion of the railspur, infrastructure construction along Factory Street, construction of the Stabilized Material Storage Building, site facility preparation work, and backfilling of excavations, were postponed until 1996.

The Addendum to the Environmental Analysis Report - Phase II for the Phase IIA Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility (Hanson Engineers, June 1995) describes Phase IIA decommissioning activities. In September 1995, IDNS issued a license amendment to Kerr-McGee authorizing Phase IIA activities. The Phase IIA activities that were assessed included:

- Construction and operation of the Batch Water Treatment Plant (BWTP)
- Construction and operation of the Water Pre-Treatment Plant (WPTP)
- Construction and operation of the Physical Separation Facility (PSF)

The Phase IIA activities planned for 1995 were not completed as scheduled. Physical separation testing conducted by Hazen Research in May through August 1995 confirmed that a gravel product meeting cleanup criteria could be produced from certain contaminated materials at the Site. Hazen testing also highlighted several potential processing problems for fill material. On the basis of these tests, Kerr-McGee opted to downscale plans for the PSF and instead construct a Simplified Physical Separation Facility (SPSF).

The *Environmental Analysis Report - Phase III for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, April 1996) describes Phase III decommissioning activities. In February 1997, IDNS issued a license amendment to Kerr-McGee authorizing Phase III activities. The Phase III decommissioning activities that were assessed included:

- Excavation of contaminated materials at Pond 1, Pond 5, and the North Factory Site
- Installation of sheet piling and slurry walls at Pond 1, Pond 5, and the North Factory Site
- Dewatering of excavations
- Erosion and surface water control
- Installation of a liner in Pond 5
- Backfilling of excavations and final grading
- Haul road construction
- Stockpiling materials
- Stabilization/Neutralization (S/N) of on-site materials
- Construction of the Stabilized Material Storage Building
- Transporting and handling contaminated materials
- Receipt of contaminated materials from off-site
- Railcar loading of material for off-site disposal
- Construction and operation of the Batch Water Treatment Plant (BWTP), the Water Treatment Plant (WTP), and the Simplified Physical Separation Facility (SPSF)
- Force main construction
- Demolition of structures
- Completion of the railspur
- Delineation drilling
- Groundwater monitoring

Only a few activities were completed as originally scheduled. Work continued into 1997. More than 40,000 cubic yards of contaminated soils were received from off-site locations during 1996 and

1997. Excavation, verification, and backfilling of the Intermediate Site and Pond 5 were completed in 1997. Excavation of Pond 1 sediment continued through 1996 and 1997. Excavation of Pond 3 sediment began in 1997. The dry screen facility and the incinerator building were demolished as planned. Stabilization/Neutralization operations and transporting and loading of contaminated materials occurred throughout 1996 and 1997. Construction of the Water Treatment Plant (WTP), the Common Facilities (CF), and the Simplified Physical Separation Facility (SPSF) was essentially completed in 1997. The railspur extension was also completed during 1997. Kerr-McGee also installed the force main and erected the Stabilized Material Storage Building during 1997. Kerr-McGee cancelled plans to construct the Batch Water Treatment Plant.

The *Environmental Analysis Report – Phase IV for the Decommissioning of the Kerr-McGee Rare Earths Facility* (Hanson Engineers, January 1998) describes Phase IV decommissioning activities. In April 1998, IDNS issued a license amendment authorizing Phase IV activities. The Phase IV decommissioning activities, scheduled to be performed from 1998 through 2001, that were assessed included:

- Excavation of contaminated materials at Pond 1, Pond 2, Pond 3, Pond 4, the South Factory Site, the North Factory Site, the E. J. & E. Railroad right-of-way, and the remainder of the Disposal Site.
- Installation of sheet piling
- Dewatering of excavations
- Erosion and surface water control
- Backfilling of excavations and final grading
- Haul road construction
- Stockpiling materials
- Stabilization/Neutralization (S/N) of on-site materials
- Transporting and handling contaminated materials
- Receipt of contaminated materials from off-site
- Railcar loading of material for off-site disposal
- Operation of the Water Treatment Plant (WTP) and the Simplified Physical Separation Facility (SPSF)
- Construction of the shoofly
- Groundwater monitoring

Most of the Phase IV activities were not completed as scheduled. Work continued into 2012. More than 1,200,000 tons of contaminated material was shipped from the site between 1998 and 2011. Pond 1 and the North Factory Site-East were remediated in 1998 through 1999. Excavation of the

South Factory Site-East was completed in 2000, and shoofly construction began in 2001. The shoofly was put into service early in 2002, and the remediation of the E. J. & E. Railroad right-of-way and the South Factory Site-West and the North Factory Site-West began. Excavation of Pond 2, Pond 3, and Pond 4 was completed in 2001 and 2002. The Retention Pond was removed from service and remediated in 2003. Operation of the SPSF and WTP continued until December 2004 and December 2011, respectively.

1.4 SITE CONDITIONS PRIOR TO DECOMMISSIONING ACTIVITIES

Site conditions prior to the commencement of decommissioning activities are shown in Figure 1.4-1. For discussion purposes, the Facility is separated into three areas based on historical use. Features within these areas before decommissioning are described below:

1. Disposal Site:

   Tailings pile. This area was located near the western boundary of the Disposal Site and consisted of mill tailings from previous operations. This pile was approximately 250 ft long, 220 ft wide, and 22 ft above ground at its highest point.

   Sediment Pile. This area was located near the center of the Disposal Site and consisted of sediments that historically were dredged from the sedimentation ponds. This pile was approximately 150 ft wide by 255 ft long by 12 ft high.

   Soil Pile. This area is located between Ponds 1 and 2 on the Disposal Site and consisted of soils brought on site from off-site sources. The soil pile was approximately 350 ft long by 225 ft wide by 35 ft high.

   Pond No. 1. This sedimentation pond is located at the northeast corner of the Disposal Site and is a closed surface impoundment. Sediments in this pond were covered with soil. The pond is approximately 220 ft wide and 250 ft long, with the maximum depth estimated at 22 ft.

   Ponds No. 2 - No. 5. These are open sedimentation ponds located on the Disposal Site. The approximate pond sizes are:

Pond 2	240 ft by 110 ft, 16 ft depth
Pond 3	180 ft by 130 ft, 13 ft depth
Pond 4	200 ft by 190 ft, 11 ft depth
Pond 5	180 ft by 170 ft, 8 ft depth

2. Intermediate Site:

Measuring approximately 7.4 acres, this area is located south of the Factory Site and north of the Disposal Site. No disposal or processing activities have taken place on the Intermediate Site. Metal scrap stored on the western end of this property was removed during previous decommissioning activities.

3. Factory Site:

Southern Portion. The southern portion of the Factory Site extends approximately 280 ft north of the south border of the Factory Site. Historical aerial photographs show that surface impoundments had been located in portions of this area and were filled in.

Northern Portion. The northern portion of the Factory Site extends 1,400 ft south of the north border of the West Chicago Facility property (Ann Street). The northern portion of the Factory Site, where the majority of the manufacturing activities took place, accounts for approximately 83 percent of the Factory Site.

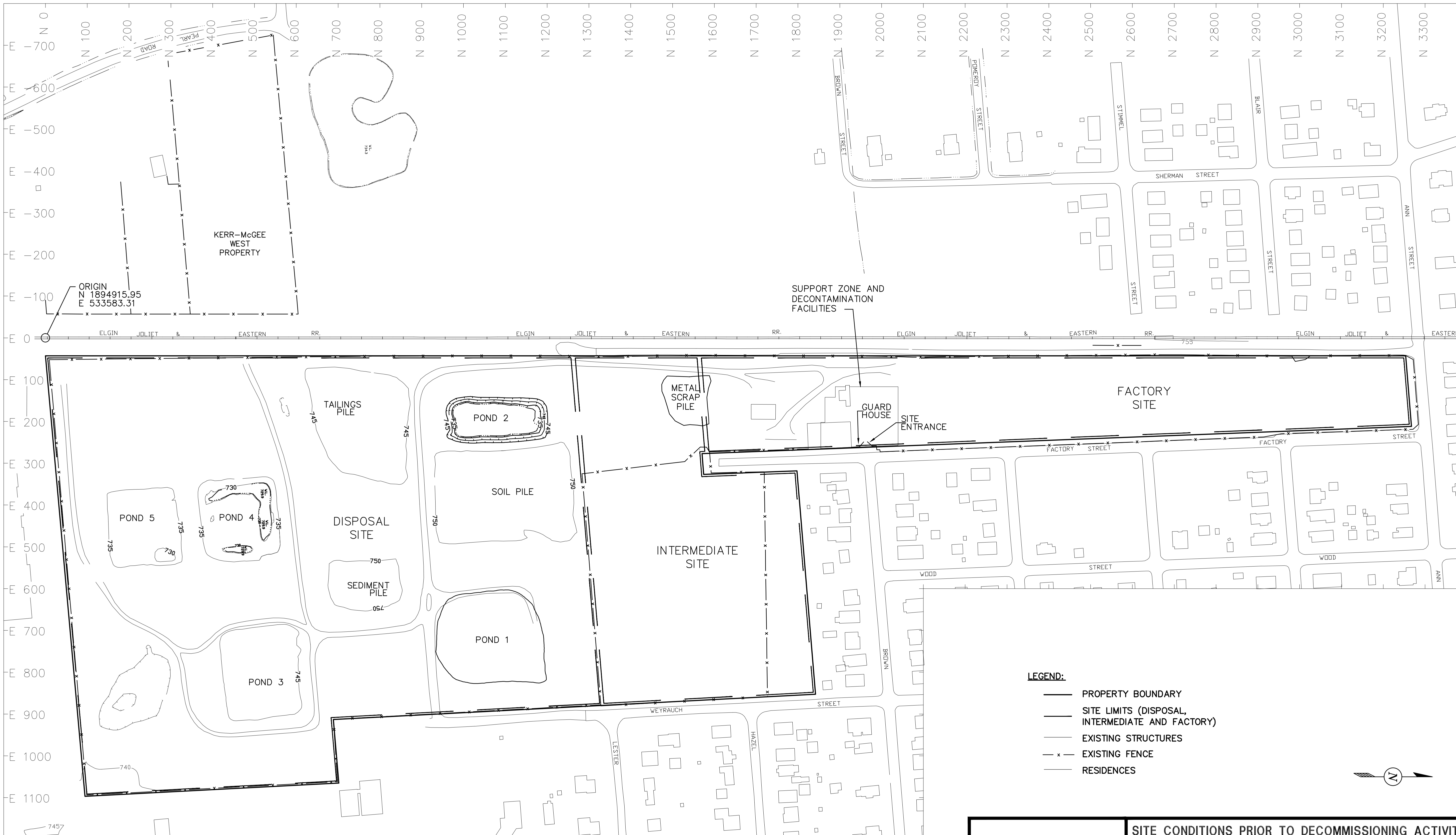
1.5 EXISTING SITE CONDITIONS

The existing site conditions for each geographical area of the Site as of August 2012 are shown on Figure 1.5-1 and described below:

1. Disposal Site:

During Phase I, a retention pond was constructed in the southwest corner of the Disposal Site, and berms and a storm sewer were constructed adjacent to the site boundaries for the purpose of collecting surface water. Security fencing was installed near the E. J. & E. rail line, and a railspur was constructed from N875 to N2300 in the Factory Site area. In addition, an uncontaminated interim materials pile and a contaminated interim materials pile were constructed during Phase I.

During Phase IA, the S/N area was cleared, and a testing and materials handling program was implemented. Haul roads were constructed throughout the Disposal Site. During Phase IB, the S/N pad was expanded to accept additional materials for mixing. A dump pad, topsoil stockpile, and uncontaminated fill stockpile area were constructed near the southeast corner of the Disposal Site. The majority of the tailings pile, the north half of the soil pile, and the sediment pile were excavated, processed, and loaded onto railcars during Phase IB.



NOTES:

1. TOPOGRAPHIC MAP GENERATED BY AEROMETRIC ENGINEERING, INC., SHEBOYGAN WI.,FROM AERIAL PHOTOGRAPHS PREPARED ON MAY 1, 1992.

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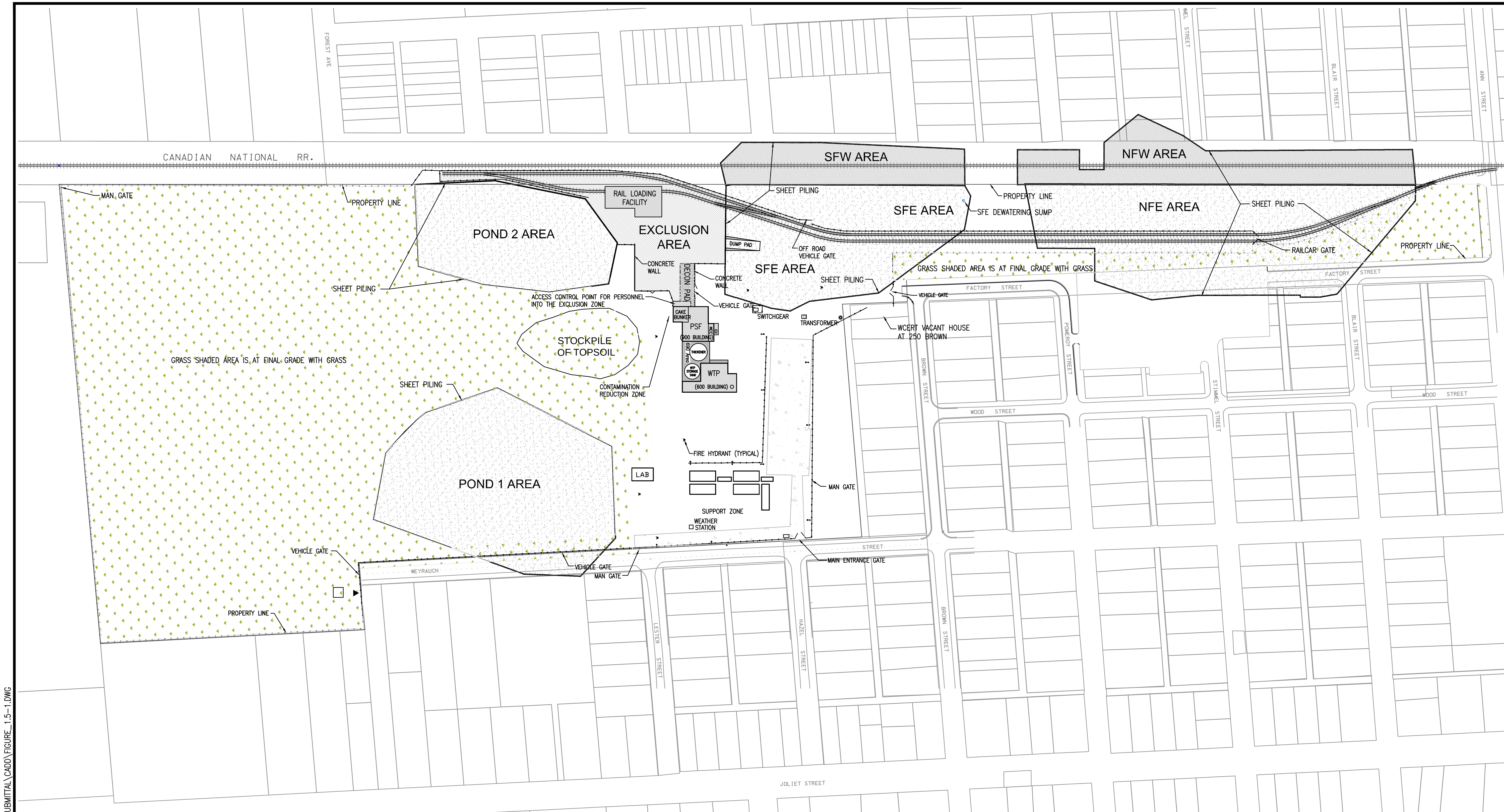
SITE CONDITIONS PRIOR TO DECOMMISSIONING ACTIVITIES

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.4-1

I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_1.4-1.DWG FEB 05, 2013 2:06PM MADAU00223



NOTE:
SMALL SOIL STOCKPILES ARE PRESENT ON SITE
BUT NOT DEPICTED ON THE DRAWING.

N

SCALE IN FEET

220 0 220 440

Hanson Professional Services Inc.

CURRENT SITE CONDITIONS

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.5-1

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_1.5-1.DWG

During Phase II, the remainder of the former tailings pile and the contaminated stockpile was excavated, processed, and loaded onto railcars. Part of the remaining soil pile was also excavated, processed, and loaded. A temporary ramp was constructed adjacent to the northwest corner of the Dump Pad to facilitate movement of the uncontaminated stockpile from its existing location south of Pond 1 to an area west of the Dump Pad. Excavation of the Pond 1 and Pond 5 areas was initiated during Phase II. About 75 percent of the Pond 1 sediment was removed. Approximately 90 percent of Pond 5 and the area south of Pond 5 were remediated.

During Phase III, remediation, verification, and backfilling of Pond 5 and the area south of Pond 5 were completed. Excavation of Pond 1 sediment continued and excavation of Pond 3 sediment was initiated. The southeast corner of the Disposal Site was remediated and converted into a parking area for the off-site contractor.

During Phase IV, remediation, verification, and backfilling of Pond 1, Pond 2, Pond 3, Pond 4, the Retention Pond, and the remainder of the Disposal Site were completed. Haul roads and stockpiles constructed and operated to accommodate site remediation activities in accordance with annual updates to the 1997 excavation plan submitted by Kerr-McGee have been removed. With the exception of the Pond 1 and Pond 2 areas, the Disposal Site has been graded and seeded.

2. Intermediate Site:

The Support Zone, associated parking lots, and infrastructure were constructed during Phase I. Within the Support Zone, a guard house, fences, construction offices for Kerr McGee, IDNS and their consultants, a meteorological station, walkways, restrooms, a decontamination pad for equipment, fuel and water tanks, laboratory storage buildings, and a personnel decontamination facility were installed. A Railcar Loading Facility was constructed at the western edge of the Intermediate Site, and storm sewer and water line replacement activities were performed during Phase I. The metal scrap pile was removed during Phase IB.

During Phase II, selected equipment and associated support steel at the Railcar Loading Facility were demolished. Phase II activities also included clearing vegetation at the proposed Simplified Physical Separation Facility and Water Treatment Plant sites.

During Phase III, a portion of the Intermediate Site was excavated, verified, and backfilled for construction of the Water Treatment Plant (WTP), the Common Facilities (CF), and the

Simplified Physical Separation Plant (SPSF). Construction of the WTP/CF/SPSF was essentially completed and the Stabilized Material Storage Building was erected during Phase III.

The Water Treatment Plant (WTP) and the Simplified Physical Separation Facility (SPSF) were operated throughout Phase IV. The SPSF was shut down at the end of 2004, and the WTP ceased operation in December 2010.

3. <u>Factory Site</u>:

During Phase I, a railspur was constructed from N875 to N2300, and a temporary connection to the mainline was constructed from N2300 to N2500. Sheet piling was installed from N1546 to N2150 to support soils near the railspur, and a security fence was installed between the railspur and the E. J. & E. rail line. Utilities were installed along Factory Street, and a water line hookup was completed.

Haul roads and a temporary dry screen facility were installed during Phase IA. Containerized and palletized materials were removed from the Factory Site during Phase IB.

During Phase II, sheet piling was installed from N2150 to N3150 along the west side of the Factory Site to support soils near the future railspur extension. Concrete slabs located along the west side of the Factory Site were excavated and stockpiled in the central portion of the Factory Site.

During Phase III, the railspur was completed. The temporary dry screen facility, constructed during Phase IA, and the incinerator were dismantled. Miscellaneous equipment was decontaminated and/or shipped off-site. The incinerator building was demolished.

During Phase IV, remediation, verification, and backfilling of the North Factory Site, the South Factory Site, and the E. J. & E Railroad, now the Canadian National Railway, right-of-way were completed. The railroad shoofly was constructed and operated during excavation activities on the western portion of the Factory Site. Haul roads and stockpiles constructed and operated to accommodate site remediation activities in accordance with annual updates to the excavation plan submitted by Kerr-McGee have been removed. The Factory Site has been remediated; however, the rail spur remains on the Factory Site.

2.0 AREA INFORMATION

2.1 CLIMATE

The climate of Illinois is typically continental, with cold winters, warm summers, and frequent short-period fluctuations in temperature, humidity, cloudiness, and wind direction. Storm systems move through the area most frequently during the winter and spring months. In winter, snow falls frequently and temperatures drop below 0° Fahrenheit (F) several times each year. During the summer, the average number of days with temperatures at 90°F is near 20. The highest temperature reached was 117°F in the southern region of the state, and the lowest temperature reached was -35°F in the northern region of the state.

The climate at the West Chicago Facility can be represented by data taken at the nearest National Weather Service Station, Chicago O'Hare Airport (15 miles northeast of the Facility). The coldest month is January, with an average minimum temperature of 16.5°F; the warmest month is July, with an average maximum temperature of 84.1°F.

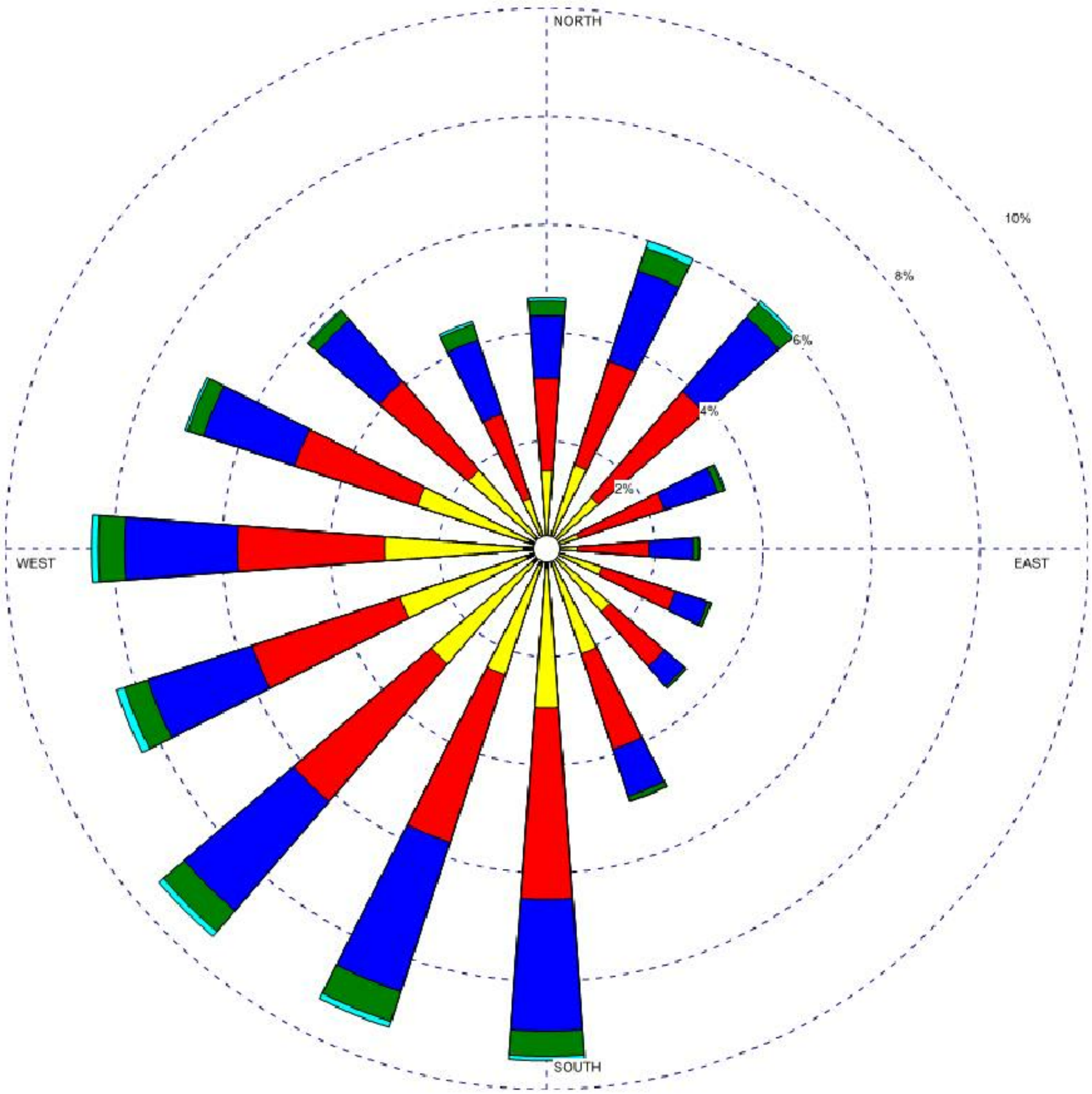
The average wind speed is 10.6 miles per hour. The prevailing wind direction varies from westerly in January to southerly in September and then swings back again to westerly in December. Figure 2.1-1 is a wind rose applicable to the Site. This wind rose was developed using data from the Chicago O'Hare Airport for the period 1961-1990.

The mean monthly precipitation is smallest in January and greatest in August. The average annual precipitation between 1981 and 2010 at the Chicago O’Hare National Weather Service Station was 36.89 inches.

There are numerous thunderstorms near Lake Michigan and West Chicago annually. These thunderstorms occasionally bring hail, damaging wind, and tornadoes. From 1953 through 2004, the annually tornado average incidence rate for the state was 35 (U.S. Dept. Commerce, 2012). More than 65 percent of Illinois tornadoes occur between March and June. The probability of a tornado striking the Facility is 8.54×10^{-4} occurrences per year, or about once every 1,200 years (U.S. AEC, 1974).

WIND ROSE PLOT

Station #94846 - CHICAGO/O'HARE INT'L ARPT, IL



Wind Speed (Knots)	MODELER	DATE **10/7/2004**	COMPANY NAME **Illinois State Climatologist Office**
> 21 17 - 21 11 - 16 7 - 10 4 - 6 1 - 3	DISPLAY **Wind Speed**	UNIT **Knots**	COMMENTS **1961-1990 Annual Average**
	AVG. WIND SPEED **9.25 Knots**	CALM WINDS **3.10%**	
	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **Jan 1 - Dec 31** **Midnight - 11 PM**	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

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WIND ROSE

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 FIGURE 2.1-1

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.1-1.DWG

2.2 AIR QUALITY

The Facility is located in DuPage County, Illinois. DuPage County is part of the larger Chicago Metropolitan statistical area, which has been designated a non-attainment area for ozone. Local ambient air concentrations for criteria pollutants, lead, and the applicable federal and state air quality standards are summarized in Table 2.2-1. Primary standards are to protect public health. Secondary standards are to ensure public welfare and environmental protection (state and federal air quality standards are identical). Data were not available for the Facility; therefore, data available for locations nearest the Facility are given to provide some indication of ambient air quality at the Facility. These locations meet the ozone standard despite being part of the designated non-attainment area for ozone.

2.3 REGIONAL DEMOGRAPHY, SOCIOECONOMICS AND TRANSPORTATION

2.3.1 Demography

West Chicago is located within Winfield and Wayne townships in DuPage County. Data from the 2010 United States Census Bureau website indicate that DuPage County's population is 916,924, an increase of 1.4 percent from 2000. According to the DuPage County Department of Economic Development and Planning (DuPage County, 2011), the population rate of increase has slowed down in the last decade. From 1990 to 2000, the population increased by 15.7 percent. Population projections made by the DuPage County Department of Economic Development and Planning (DuPage County, 2011) indicate that the DuPage County population will increase to about 1,150,000 by the year 2040. The City of West Chicago's 2010 population is 27,086, an increase of 15.4 percent from 2000. Approximately 51 percent of West Chicago's population is Hispanic. The majority of growth occurred in areas more than one to two miles from the Facility. The land in the vicinity of the Facility is already developed with respect to housing, and there is little room for additional growth. The number of households in DuPage County has increased 6.1 percent, while that of West Chicago has increased 18.2 percent. The average household size in DuPage County is 2.68 individuals; in West Chicago the average household size is 3.39 individuals.

The average per capita income in 2010 for West Chicago was $24,498, with a median household income of $64,795. City residents 25 years old and over have the following educational profile: 71.4 percent are high school graduates and 26.1 percent have a bachelor’s degree or more. The median age of residents was 30.1 years in 2010.

Housing for the City of West Chicago has increased 18.2 percent from 2000 to 2010. A total of 7,801 housing units can be found in West Chicago, with the majority being detached single-family units.

TABLE 2.2-1

AMBIENT AIR CONCENTRATIONS AND APPLICABLE AIR QUALITY STANDARDS

	Particulate Matter (PM_{10}) (ug/m^3)	Sulfur Dioxide (ppm)		Nitrogen Dioxide (ppm)		Carbon Monoxide (ppm)		Ozone (ppm)	Lead (ug/m^3)
Site	**24-hour**	**1-hour**	**3-hour average**	**Annual**	**1-hour**	**1-hour**	**8-hour**	**1-hour average**	**Rolling 3-month mean**
Alsip	53							0.091	0.02
Cicero		0.033	0.027	0.020	0.080	3.1	1.5	0.081	
Des Plaines								0.079	
Lisle								0.087	
State and Federal Primary Standards	150	0.075	none	0.053	0.1	35	9	0.12	0.15
State and Federal Secondary Standards	150	none	0.5	0.053	none	none	none	0.12	0.15

Notes: (1) Annual means the annual arithmetic mean.
(2) The PM_{10}, sulfur dioxide (1-hour), nitrogen dioxide (1-hour), carbon monoxide, and ozone concentrations were the highest samples (worst case) for 2010.

Source: Illinois Environmental Protection Agency, Bureau of Air, Springfield, Illinois, "Illinois Annual Air Quality Report 2010".

2.3.2 Socioeconomics

2.3.2.1 Employment

The City of West Chicago is home to over 900 businesses with a total workforce of 16,039 employees and has an additional 350 home businesses. The top eight largest employers in West Chicago are:

Jel Sert

West Chicago Elementary School District

General Mills

Ball Horticultural Co.

Siemans Energy & Automation

Aspen Marketing Services

Buick Services

Community High School District

The occupations of West Chicago residents can be categorized as follows:

Managerial/Professional	25.7 %
Sales/Administrative Support	23.3 %
Services	17.6 %
Operator/Laborer	33.0 %
Farming/Fishing/Forestry	0.5 %

The majority of West Chicago residents are employed in the manufacturing sector.

2.3.2.2 Property Values

The 2010 median housing value for West Chicago was $260,500, in comparison to the median value for DuPage County of $316,900. Surrounding communities of Warrenville, Winfield, and Carol Stream have median home values of $245,100, $308,700, and $261,200, respectively. A total of 2,268 renter-occupied units are located in the City of West Chicago with a median monthly rent of $746.

2.3.2.3 Taxes

Property owners in West Chicago pay into the following taxing entities: DuPage County, DuPage Forest Preserve District, DuPage Water Commission, Winfield Township, Winfield Township Road District, City of West Chicago, West Chicago Library, West Chicago Streets and Bridges-Winfield, West Chicago Park District, West Chicago Fire District, West Chicago Mosquito Abatement District, Fox Valley Airport, College of DuPage, High School District No. 94, and Grade School District No. 33.

2.3.3 Transportation

The community is serviced by one Regional Transportation Authority bus route and three commuter and freight train lines. The Chicago and North Western railroad provides both commuter and freight service; the Canadian National Railway and the Burlington Northern railroads provide freight service only. Highway transportation for trucks and automobiles is enhanced by West Chicago's proximity to I-88. DuPage County Airport, which provides charter flight service and is the third busiest airport in Illinois, is also located in West Chicago.

2.4 LAND USE

2.4.1 Land Use and Zoning

The City of West Chicago is predominantly urban residential, as is the majority of DuPage County. However, there are more than 80 industrial firms in the West Chicago area, with over 900 businesses ranging from specialty retail stores to equipment manufacturing and food processing. The city has industrial parks located in the north and west portions of the city. Three commercial zoning districts allow for a wide range of businesses at various locations in the city. Located along the Interstate Highway 88 (I-88) Research and Development Corridor, the City of West Chicago is located in an area that will probably expand its commercial and industrial businesses in the coming years. Currently, economic development and zoning plans for West Chicago include revitalizing the downtown area, encouraging business retention and expansion, and promoting new annexation.

2.4.2 Cultural and Recreational Resources

West Chicago was founded in 1849 at the junction of three railroads. Four museums are located in West Chicago to preserve the pioneer railroad history and memorabilia. West Chicago is also home to a public library that houses 105,775 items including 5,468 Audio books, 4,435 e-books, 3,900 DVDs, and 3,525 CDs and serves as the public document room for the decommissioning of the Kerr-McGee West Chicago Rare Earths Facility. The city has eight recreational parks totaling 214 acres and features sports playing fields, picnic grounds, playgrounds, hiking trails, and a community center. Several DuPage County forest preserves are also located in West Chicago, as well as three DuPage County golf courses and the Illinois Prairie Path.

2.5 ARCHAEOLOGICAL, HISTORIC, AND SCENIC RESOURCES

2.5.1 Archaeological Sites

A review of available literature and regulatory information was conducted to determine if there are known archaeological resources within the Kerr-McGee West Chicago Rare Earths Facility. This review included the National Register of Historic Places, the Illinois Historic Preservation Agency's Archaeological Site Location Files, and the Archaeological Site Files of the Illinois Archaeological Survey. These files show no known archaeological sites on the Kerr-McGee property. Prehistoric archaeological sites are located within the vicinity of the subject property. Such sites include the Winfield Mound site (11-Du-33) on the DuPage River approximately 2 miles east of the Site and a number of prehistoric archaeological sites within the Fermi Lab National Accelerator Property south of the Facility.

No known historic archaeological sites have been reported at the Site or within the vicinity of the property. The Site has been occupied at least since the 1880s. Historic occupation of the property prior to 1880 is unknown.

2.5.2 Historic Sites

No historic structures listed on the National Register of Historic Places, the Illinois Register of Historic Places, or the Illinois Rural Structure Survey are located on the Kerr-McGee property. Significant historic structures are present in the project vicinity. They include the Turner Town Hall located at 132 Main Street and the McAuley School Building on Roosevelt Road. Both of these structures are listed on the National Register of Historic Places.

2.5.3 Scenic Resources

The subject property is situated in an area of industrial, commercial, and residential development. The area surrounding the Kerr-McGee Facility would not generally be considered a scenic resource. The National Registry of National Landmarks contains no entries in the vicinity of the Kerr-McGee Facility.

2.6 GEOLOGY

The West Chicago Site and most of DuPage County are underlain by geologic strata ranging in age from the Pleistocene surficial deposits to the Precambrian basement. The uppermost sediments are Pleistocene in age and were deposited as the result of the advance and retreat of several continental glaciers. These sediments generally consist of unconsolidated sand, gravel, silt, and clay. The glacial sediments unconformably overlie an eroded Silurian bedrock surface. The Paleozoic sediments underlying most of DuPage County are of Cambrian, Ordovician, and Silurian age. Late Paleozoic sediments as young as the Pennsylvanian occur in an isolated area associated with the Des Plaines Disturbance (Kerr-McGee, 1986). In most parts of DuPage County, however, Paleozoic rocks younger than the Silurian are not found. The Paleozoic rocks are approximately 3,500 ft thick and consist of consolidated, stratified sedimentary rocks (Zeizel et al., 1962). The Paleozoic rocks rest unconformably on the Precambrian basement, which is granite in the vicinity of West Chicago (U.S. NRC, 1989).

The regional geology and local site geology are reviewed in the following sections. The site stratigraphy is also discussed based on the geologic and stratigraphic characterization studies performed at and in the vicinity of the Site.

2.6.1 Regional Geology

The region of DuPage County that contains the West Chicago area lies within the Central Stable Platform region of the mid-continental United States. The Site lies on the Kankakee Arch between the Michigan basin to the northeast and the Illinois Basin to the south-southwest. The Kankakee Arch is an asymmetrical anticline whose axis trends northwest and plunges to the southeast. The Kankakee Arch connects the Wisconsin and Cincinnati Arches. The rocks of Paleozoic age in DuPage County lie unconformably on the Precambrian granite basement. The Precambrian is overlain by 3,500 to 4,000 ft of Paleozoic sediments, which are generally no younger than Silurian in DuPage County. These sediments were deposited in shallow cratonic seas. The Paleozoic Strata dip to the southeast at approximately 10 ft per mile (gradient of 1.9×10^{-3}). The Paleozoic Strata have been folded into a series of gentle anticlines and synclines (Zeizel et al., 1962). The uppermost sediments of Paleozoic age in the West Chicago region are Niagaran and Alexandrian dolomites of the Silurian System. It is thought that sedimentary rocks were deposited in shallow seas in DuPage County during the Devonian, and potentially in Mississippian and Pennsylvanian times (Zeizel et al., 1962). However, in DuPage County most of these deposits were eroded after the Carboniferous. Today, Devonian sediments are only found locally in Silurian bedrock surface depressions. After the Paleozoic, the rocks of the Niagaran Series were subjected to an extended period of erosion, which created a low-relief, weathered, bedrock surface. In most areas of DuPage County, the dolomitic bedrock is unconformably overlain by a series of Pleistocene sediments, which were deposited as a result of the advance and retreat of several glaciers over the region. Figure 2.6.1-1 presents a stratigraphic column for the West Chicago region from the Precambrian basement to the Pleistocene glacial sediments.

The Precambrian rocks in the vicinity of West Chicago can be classified lithologically as granitic, as determined in a deep borehole completed to the Precambrian basement drilled at the West Chicago Site. The Precambrian crystalline rocks are part of the craton and are 3,500 to 4,000 ft deep in DuPage County. Cambrian sediments unconformably overlie the Precambrian basement. The Cambrian sequence is up to 2,970 ft thick in portions of DuPage County including the West Chicago vicinity. Cambrian sediments are primarily composed of sandstone. However, some shale and dolomite occurs in the upper 800 ft of the Cambrian System. The following rock units comprise the Cambrian in DuPage County from oldest to youngest: the Mt. Simon Sandstone, the Eau Claire Formation, the Galesville Sandstone, the Ironton Sandstone, the Franconia Formation, the Potosi Dolomite, and the Eminence Formation.

The dominant lithologies of Ordovician rocks in DuPage County are dolomite, limestone, and sandstones. The following rock units comprise the Ordovician in DuPage County from oldest to youngest: the Prairie du Chien Group, the St. Peter Sandstone, the Glenwood Formation, the Platteville Group, the Galena Group, and the Maquoketa Shale Group. The Prairie du Chien Group reaches a thickness of 200 ft in southern DuPage County but is missing in areas of northern DuPage County. The Prairie du Chien consists almost entirely of dolomite with sandstone lenses. The St. Peter and Glenwood Formations are sandstones. The Glenwood Formation is a fine to coarse-grained sandstone containing lenses of dolomite and shale. The Platteville and Galena Groups are similar in lithology and are primarily made up of dolomite and limestone beds. Their combined

SYSTEM	SERIES AND MEGAGROUP	GROUP AND FORMATION	HYDROSTRATIGRAPHIC UNITS Aquigroup	HYDROSTRATIGRAPHIC UNITS aquifer/aquitard	THICKNESS (ft)	DESCRIPTION
Quaternary	Pleistocene		Prairie	Pleistocene	0–600	Unconsolidated glacial deposits— pebbly clay (till) silt, and gravel. Loess(windblown silt), and alluvial silts, sands and gravels.
Silurian	Niagaran	Port Byron Fm Racine Fm Waukesha Ls Joliet Ls	Upper Bedrock; Mississippi Valley	Silurian dolomite aquifer	0–465	Dolomite, silty at base, locally cherty
	Alexandrian	Kankakee Ls Edgewood Ls	Upper Bedrock; Mississippi Valley			
Ordovician	Cincinnatian	Maquoketa Shale Group	Upper Bedrock; Midwest Bedrock	Maquoketa confining unit	0–250	Shale, grey or brown: locally dolomite and/or limestone, argillaceous.
	Mohawkian; Ottawa Ls Megagroup	Galena Group Decorah Subgroup Platteville Group	Upper Bedrock; Midwest Bedrock	Galena–Platteville unit	0–450	Dolomite and/or limestone, cherty. Dolomite, shale partings, speckled. Dolomite and/or limestone, cherty, sandy at base.
	Mohawkian; Ancell Gr	Glenwood Fm	Upper Bedrock; Midwest Bedrock	Ancell aquifer	100–650	Sandstone, fine – and coarse – grained: little dolomite: shale at top. Sandstone, fine – to medium – grained: locally cherty red shale at base.
	Charyan; Ancell Gr	St. Peter Ss	Upper Bedrock; Midwest Bedrock			
	Canadian; Knox Megagroup; Prairie du Chien Group	Shakopee Dol New Richmond Ss Oneota Dol Gunter Ss	Midwest Bedrock	Middle confining unit: Prairie du Chien	100–1300	Dolomite, sandy, cherty (oolitic), sandstone. Sandstone, interbedded with dolomite. Dolomite, white to pink, coarse – grained, cherty (oolitic), sandy at base.
Cambrian	St. Croixian; Knox Megagroup	Jordan Ss Eminence Fm– Potosi Dolomite	Midwest Bedrock	Middle confining unit: Eminence – Potosi		Dolomite, white, fine – grained, geodic quartz, sandy at base.
	St. Croixian; Knox Megagroup	Franconia Fm	Midwest Bedrock	Middle confining unit: Franconia		Dolomite, sandstone, and shale glauconitic, green to red, micaceous.
	St. Croixian	Ironton Ss	Midwest Bedrock	Ironton – Galesville aquifer	0–270	Sandstone, fine – to medium – grained, well sorted, upper part dolomitic.
	St. Croixian	Galesville Ss	Midwest Bedrock			
	St. Croixian	Eau Claire Fm	Basal Bedrock	Eau Claire	0–450	Shale and siltstone: dolomite, glauconitic: sandstone, dolomitic, glauconitic.
	St. Croixian	Mt. Simon Fm	Basal Bedrock	Elmhurst – Mt. Simon aquifer	0–2600	Sandstone, coarse – grained, white, red in lower half: lenses of shale and siltstone, red micaceous.
Pre–Cambrian			Crystalline			No aquifers in Illinois

(AFTER VISOCKY et al, 1985)

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STRATIGRAPHIC COLUMN FOR NORTHERN ILLINOIS

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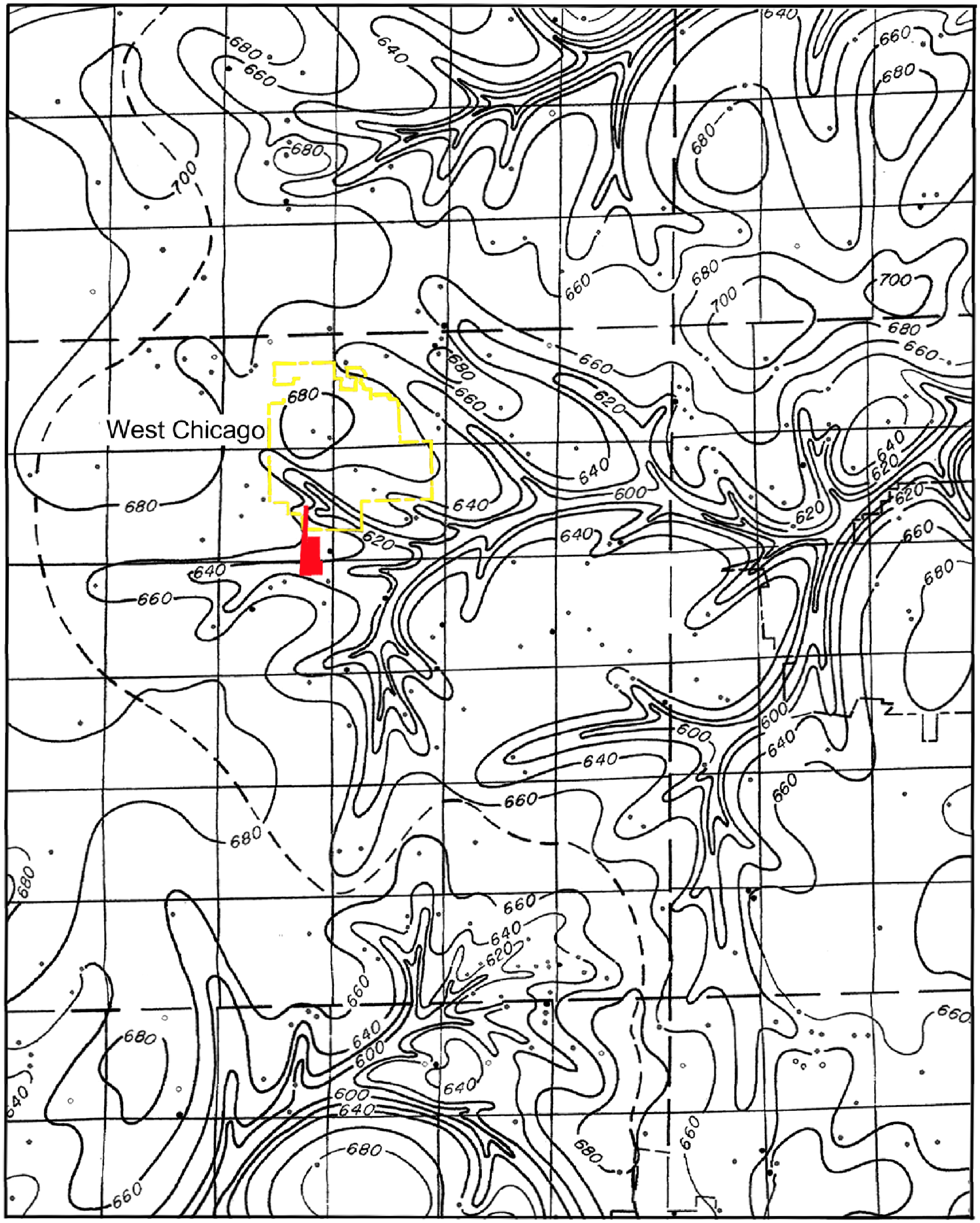
FIGURE 2.6.1-1

thickness ranges from 300 to 350 ft across DuPage County. The Maquoketa Formation is lithologically composed of a dolomitic shale. A thin hematitic red (sometimes green and yellow) shale called the Neda Formation overlies the Maquoketa Formation in parts of DuPage County where it was not removed by erosion. The Neda Formation ranges from 5 to 15 ft thick.

The rocks of the Silurian System in DuPage County include the Alexandrian and Niagaran Series. These rocks comprise the bedrock surface in DuPage County on which unconsolidated glacial sediments were deposited in the Pleistocene Epoch. The Alexandrian Series is primarily composed of dolomite with a clastic content which decreases upward. The Niagaran Series is composed primarily of dolomite with interbeds of dolomitic shale. The Niagaran Series is divided into three formations: the Joliet, the Waukesha, and the Racine Formations.

The Niagaran Series is heavily eroded at the upper surface, and erosional thinning can be great in deep valleys that have been eroded out of the Silurian bedrock from Paleozoic through to Pleistocene times. It is thought that sedimentary rocks were deposited in shallow seas during the Devonian and, potentially, the Mississippian and Pennsylvanian times in DuPage County (Zeizel et al., 1962). Devonian sediments are found locally in Silurian bedrock surface depressions (i.e., depositional lows). From the Devonian to the Pleistocene, the rocks of the Niagaran Series were subjected to erosion, which created a low-relief, weathered, dissected bedrock surface. A structure contour map of the Silurian bedrock surface in the West Chicago region is shown in Figure 2.6.1-2 (after Zeizel et al., 1962). The Silurian bedrock surface is part of the Central Illinois Peneplain and is generally highest in elevation in the western portion of DuPage County. A dendritic, paleo-drainage system can be seen from the topography of the Silurian bedrock with streams flowing from the west to the east. A paleo-drainage divide occurs to the west and south of the Site in the region of West Chicago.

During the Pleistocene, glaciers advanced and retreated many times in northern Illinois. This cycle of advance and retreat deposited a complex series of unconsolidated sediments composed of sands, gravels, clays, silts, and windblown deposits (loess). The unconsolidated Pleistocene sediments range in thickness from 50 to 200 ft in DuPage County. Glacial drift locally can be thicker than 200 ft in bedrock valleys. Pleistocene glacial deposits in DuPage County were deposited as part of the Woodfordian Substage of the Wisconsin Glacial Stage. The sediments were deposited approximately 12,000 to 20,000 years before present (Willman and Frye, 1970). The glacial drift in DuPage County consists primarily of three types of deposits with lithological differences: till, glaciofluvial deposits, and glaciolacustrine deposits (Zeizel et al., 1962). Till is deposited directly by glacial ice with a minimum of sorting as a result of flowing surface water. For



Structure Contour Map of Silurian Bedrock Surface in the West Chicago Region (After Zeizel et al., 1962)

Miles
0 1/2 1 2

EXPLANATION

- Well penetrating bedrock
- Well completed above bedrock
- 660 Contour interval 20 feet datum sea level
- Bedrock exposure
- Preglacial St. Lawrence and Mississippi divide

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SILURIAN BEDROCK STRUCTURE CONTOUR MAP

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KERR-MCGEE, WEST CHICAGO

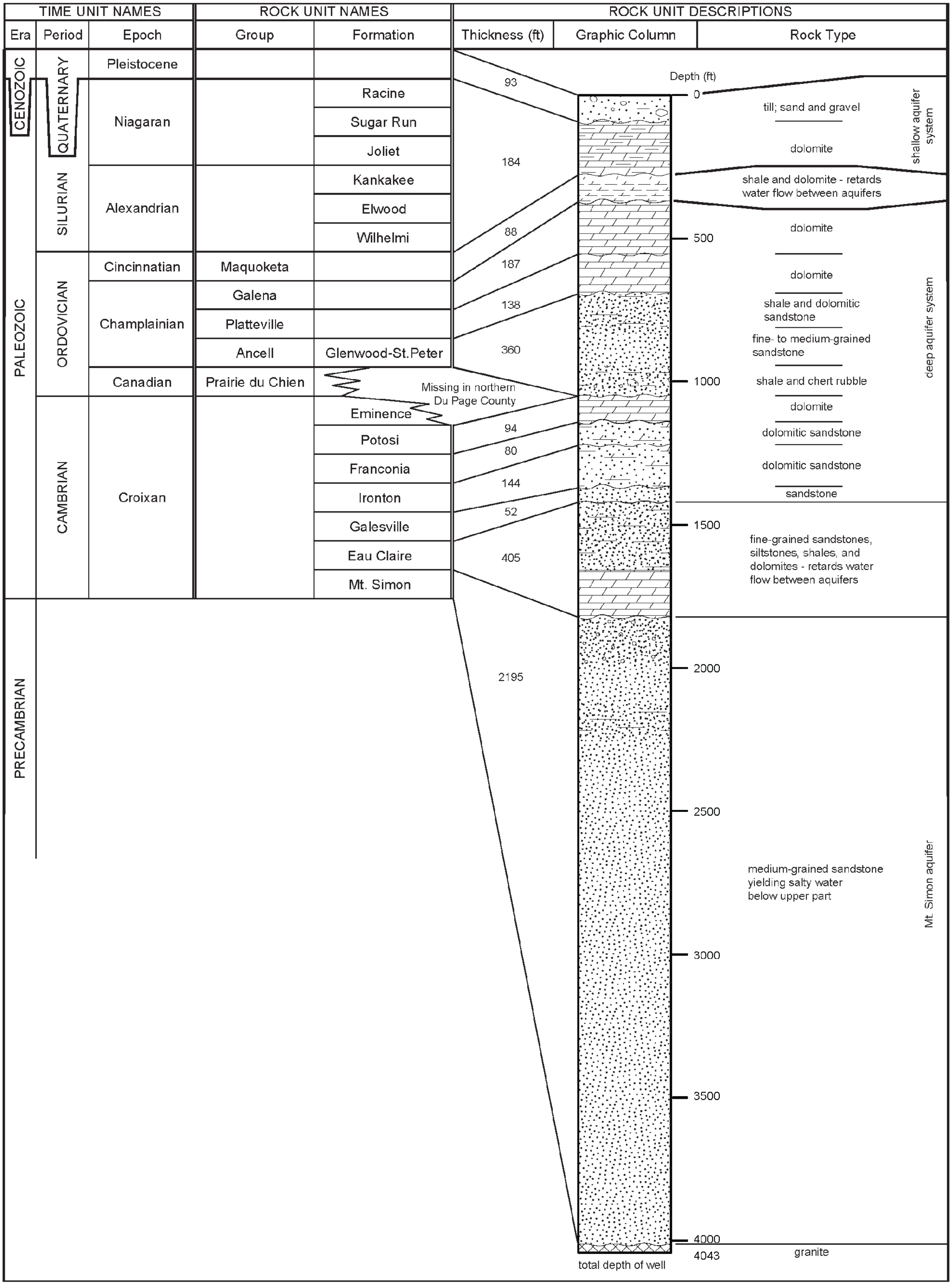
JOB NO. 93S7001 FIGURE 2.6.1-2

this reason the till is very heterogeneous in lithology ranging from dense clay to gravelly, sandy sediments. Glaciofluvial deposits are generally lenticular, discontinuous, erratic in nature, and exhibit extensive particle-size sorting. These deposits may range from clay to gravel and are generally interbedded with till. Glaciolacustrine deposits are strongly laminated sediments composed of clay and silt. These sediments are generally deposited in pro-glacial lakes.

2.6.2 Site Geology

The site geology is similar to the regional geology described in the previous section. Sediments at the Site are resting on a Precambrian granitic basement. The Paleozoic sediments are fairly well characterized at the West Chicago Site because of a deep well drilled on the Disposal Site. In 1967, American Potash (owners of the West Chicago Facility at that time) drilled a deep test borehole to determine the feasibility of completing a waste injection well at the Site. The well was never used for liquid waste injection and was ultimately plugged, but it did provide a good description of the geologic units underlying the West Chicago Site. Figure 2.6.2-1 shows the stratigraphic sequence encountered by the American Potash deep well that was drilled at the Site (U.S. NRC, 1989). The Precambrian granite basement was encountered at a depth of 4,020 ft and is overlain by approximately 2,970 ft of Cambrian sediments at the Site. The Ordovician Prairie du Chien Group was not encountered at the West Chicago Site, which is consistent with the fact that this group is known to thin in the northern half of DuPage County. The Ordovician Glenwood and St. Peter Sandstones were 360 ft thick. The borehole encountered 325 ft of Ordovician dolomites, represented by the Galena and Platteville Groups. The Upper Ordovician Maquoketa shale and dolomite was 88 ft thick. The Silurian dolomites were 184 ft thick and were representative of the Wilhelmi, Elwood, Kankakee, Joliet, Sugar Run, and Racine Formations. The Racine Formation is the youngest, and the Pleistocene glacial drift unconformably overlies the Racine Formation at the Site. The borehole drilled through 93 ft of unconsolidated glacial drift.

Pleistocene glacial deposits in the vicinity of the West Chicago Site, like those in most areas of DuPage County, were deposited as part of the Woodfordian Substage of the Wisconsin Glacial Stage. The Wisconsin glacial stage was the latest glacial period in northern Illinois. The Woodfordian glaciers advanced on two primary lobes, the Erie Lobe and the Michigan Lobe. The glacial drift deposits in DuPage County almost exclusively originate from the Michigan Lobe. On maximum advance, the Michigan Lobe divided into three sublobes: the Princeton, Harvard, and Joliet Sublobes (Willman and Frye, 1970). The Joliet Sublobe conforms to the outline of Lake Michigan and has only local and low-angle overlap. The Joliet Sublobe contains two morainic systems: the Valparaiso and the Marseilles. The Joliet Sublobe has 19 moraines, thought to represent 15 glacial retreats (Kerr-McGee, 1986). Of these moraines, the Site is located at the



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GEOLOGIC LOG OF DEEP TEST WELL

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 FIGURE 2.6.2-1

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western edge of the West Chicago moraine, which is the front ridge of the Valparaiso Morainic System of the Joliet Sublobe. The West Chicago moraine is composed of clayey till, which is part of the Wadsworth Till Member of the Wedron Formation (Kerr-McGee, 1986). The Wadsworth Till Member and the Yorkville Till Member of the Wedron Formation are present at the Site. The Yorkville till is differentiated from the Wadsworth till based on an increase in silt content and a greater abundance of gravel lenses. To the east and southeast of the Site, the Henry Formation is deposited along the west branch of the DuPage River. The Henry Formation is a glacial outwash deposit composed of well sorted sands and gravels.

2.6.2.1 Site Stratigraphy

The stratigraphy and geology of the glacial sediments below the West Chicago Site have been well characterized through a series of subsurface investigations. The following is a list of investigations to date:

- 1976 Five soil borings were drilled and later completed as monitor wells (B-1 through B-5) in the Strata C and E.

- 1980 An additional 8 monitor wells were completed, two in the uppermost sand of the glacial aquifer and six in the Silurian dolomite. In 1981, Law Engineering Co. quantified soil samples taken from all the borings and reported in Law (1981a) and Law (1981b).

- 1982 Kerr-McGee completed an additional 6 monitoring wells in the Factory Site portion of the facility (F-1 through F-6) in the uppermost sand in the glacial aquifer.

- 1984 From 1984 through 1986, an extensive investigation program was conducted to obtain a permit from the NRC to dispose of the contaminated media on-site. Investigations included 23 monitor wells, 10 piezometers to study vertical gradients, and 311 soil borings. Soil samples were collected with either Shelby tube or split-spoon samplers. Soil properties and gamma activity for selected nuclides were determined.

- 1985 Illinois Attorney General's Office installed 16 monitor wells on and around the Site.

- 1987 Kerr-McGee drilled and logged approximately 25 soil borings on the north end of the Factory Site to determine the extent of radiologically impacted media.

- 1992 An extensive investigation program (1992-1993) was conducted to develop a closure plan. The program included a non-intrusive surface geophysical program, an extensive soil-boring program (163 borings), and a bulk sampling program to support the design of a physical separation facility. The soil borings were continuously logged for total gamma activity expressed as combined radium-226 plus radium-228.

- 1995 Kerr-McGee installed 23 new monitoring wells during 1995 as part of Phase II decommissioning activities.

- 1995 Kerr-McGee completed Delineation Drilling activities (1995-1996), which included approximately 493 borings to delineate the extent of radium and uranium affected soils requiring excavation.

- 1997 Kerr-McGee completed installation of five new monitor wells (EF-5R, EF-7R, EB-4R, CB-4, and KMB-4R) as part of Phase III decommissioning activities.

- 1997 Kerr-McGee drilled and logged 31 soil borings near the south end of the site as part of the Groundwater Barrier Investigation.

- 1997 Kerr-McGee drilled and completed 9 monitoring wells, four of which were background wells.

- 1997 Kerr-McGee drilled and completed (12-11-97 to 1-22-98) a water supply well to a depth of 331 feet in the Silurian dolomite.

- 1999 From 1999 through 2001, Kerr-McGee Environmental Management Corporation conducted an off-site groundwater investigation that included installation of 15 off-site monitoring wells (CD and ED wells) and a CPT-EC program (42 locations) to sample groundwater and assess off-site stratigraphy.

- 2001 In late-2001and early-2002, KMEMC drilled and logged 4 borings west of the Factory Site as part of the Silurian Dolomite Investigation. These borings extended to the Silurian dolomite, which was cored at all 4 locations.

- 2002 KMEMC drilled and completed 3 replacement monitoring wells (EF-7B, EF-9A and KMF-8R).

- 2010 Weston drilled and completed 16 additional monitoring wells.

- 2011 Weston drilled and completed 9 additional monitoring wells.

The stratigraphy of the Pleistocene glacial sediments at the Site was initially investigated in the early 1980s (Law 1981b). These early investigations were based on a small number of on-site borings installed in 1976 and 1980 and from nearby water wells. To date, there have been over 1,000 soil borings and approximately 138 monitor wells completed for the Site. Based on these subsurface characterization activities, the shallow site glacial stratigraphy is relatively well characterized given the heterogeneous nature of glacial drift deposits. The bulk of the characterization data is for the shallow glacial drift sediments. From the perspective of an environmental assessment, the shallow sediments are the most important sediments to be characterized. The shallow sediments are the most likely sediments to be impacted by Phase V activities. Accordingly, the following discussion of site stratigraphy will be limited to the glacial drift and the underlying Silurian dolomite bedrock.

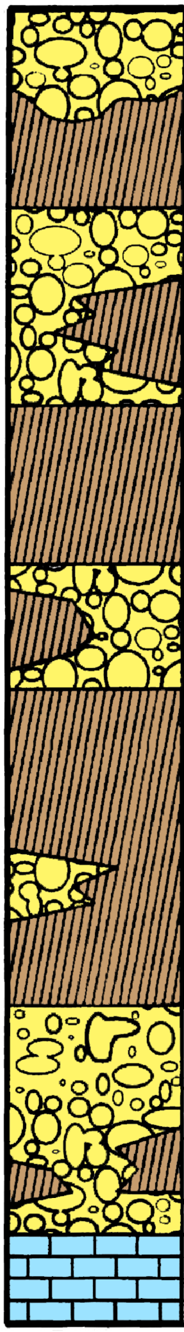
The Racine Formation is the uppermost Silurian dolomite under the Site and can be characterized as being an interbedded, light-gray to white, fine- to medium-crystalline dolomite, cherty dolomite, and argillaceous dolomite (Zeizel et al., 1962). Two major joint systems are present in the dolomite which trend North 50° East and North 47° West. The Racine formation is heavily eroded and shows pre-Pleistocene paleo-drainage patterns, as can be seen by examining the structure contour of the Silurian dolomite (see Figure 2.6.1-2). The two joint systems apparently controlled the orientation of pre-glacial drainage. A paleo-channel occurs to the south of the Site (in the approximate location of Kress Creek) and to the north and northeast of the Site. Solution cavities are also common along the Silurian bedrock surface (Zeizel et al., 1962). The Silurian bedrock dips to the east, southeast. The Silurian dolomite varies from approximately 668 ft Above Mean Sea Level (AMSL) below the Intermediate Site to 651 ft AMSL at the southeast corner of the Disposal Site.

The stratigraphy of the Pleistocene glacial sediments at the Site was initially investigated with a small number of on-site borings and information from nearby water wells. In these early investigations, the stratigraphic units in the Pleistocene were designated by letter rather than by formal stratigraphic nomenclature for the Wedron Formation. By convention, this description of site stratigraphy will use the letter stratigraphic unit classification as described in previous studies. The glacial strata at the Site have been differentiated based on lithology and divided into six strata designated A through F. The A-Stratum directly overlies the Silurian dolomite and the F-Stratum is at the ground surface locally across the Site. Figure 2.6.2.1-1 shows a generalized stratigraphic section for the glacial sediments at the Site. The D-Stratum is not present under the entire Site. As is typical of glacial deposits, lithological heterogeneity exists both vertically and horizontally within the drift. This heterogeneity in lithologic units will strongly influence groundwater flow. The following information regarding the glacial sediment stratigraphic units was taken from Kerr-McGee (1986) and Weston (2012a). Thickness estimates for the A-Stratum through the E-Stratum are based on elevation surfaces interpreted from site borings for development of the Site flow and transport model (Weston, 2012a).

The A-Stratum is a dense, gray to brown, poorly sorted, silty, fine- to coarse-grained sand and gravel outwash. The A-Stratum is not laterally continuous across the Site, but where present, usually grades upward from a silty gravel to a silty sand. Based on 19 samples, the A-Stratum averages 56 percent sand, 21 percent silt, 20 percent gravel, and 3 percent clay. Kerr-McGee (1986) reported on the ratio of coarse clastics (gravel and sand) to fine clastics (silt and clay) for several samples from the stratum present beneath the Site. The ratio, designated C/F ratio, ranges from 1.1 to 9 and averages 4.2 for the A-Stratum for a sample size of 17. The A-Stratum, as defined under the Intermediate and Disposal Sites, reflects the topography of the underlying Silurian Racine Formation. The A-Stratum dips to the southeast and, where present, ranges in thickness from about a foot to about 53 feet, with a mean thickness of 25.6 feet. The A-Stratum is interpreted to be a combination of glacial outwash and a residual soil accumulation on top of the Silurian dolomite.

The B-Stratum is a glacial till unit composed of a very stiff, gray to blue, silty and sandy clay with sand and gravel locally intercalated (Kerr-McGee, 1986). The B-Stratum is composed of approximately equal fractions of clay, silt, and sand, with gravel comprising less than 10 percent of the clastics. Because of a different clay mineralogy occurring in the top as opposed to the bottom of the B-Stratum, it has been suggested that the Wadsworth Formation-Yorkville Formation contact may occur within the B-Stratum at the Site (Kerr-McGee, 1986). Because of the coarse material found within the B-Stratum, particularly at the base, the stratum can be defined as having two populations based on grain size fractions. Based on 35 samples, the population characterized as

STRATIGRAPHIC COLUMN



STRATIGRAPHIC UNIT	LITHOLOGIC DESCRIPTION
FILL	A mixture of gravelly, sandy and silty clay topsoil with man-made materials such as concrete,bricks, and asphalt.
F STRATUM	Stiff to very stiff, black, brown, and gray, clayey silt with gravel and sand, grading upwards to organic-rich topsoil. Depositional Environment: wind-blown loess and topsoil
E STRATUM	Firm to very dense, brown to gray, moderately-sorted, fine-to coarse-grained, silty sand with local fine-to medium-grained gravel intercalations. Depositional Environment: glacial outwash
D STRATUM	Very stiff dense, brown to gray, poorly-sorted, sandy clay and clayey silt with traces of gravel. Depositional Environment: glacial till
C STRATUM	Dense to very dense, brown to gray, moderately well-sorted, fine- to coarse-grained, silty sand and gravel with minor clay content. The unit grades upward from a basal silty sand to a sandy gravel. Rarely the C stratum contains varved silts and clays of glacio-lacustrine origin. Depositional Environment: glacial outwash
B STRATUM	Very stiff to very hard, gray to blue, silty and sandy clay with local silt-and sand-rich horizons. Locally, the lower portion of the B stratum consists of a fine-to coarse-grained clayey sand unit. Depositional Environment: glacial till
A STRATUM	Dense to extremely dense, gray to brown, poorly sorted, fine-to coarse-grained silty sand and gravel. The stratum generally grades upward from a silty gravel to a silty sand. Depositional Environment: glacial outwash
SILURIAN DOLOMITE	Light gray to white, fine-to medium-crystalline dolomitic limestone.

LITHOLOGY

	Coarse-Grained Sediments:	Includes well-graded to poorly-graded sands and gravels and silty to clayey sands and gravels.
	Fine-Grained Sediments:	Inorganic silts. clays, and very-fine sands.
	Silurian Dolomite	

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GLACIAL STRATIGRAPHY

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being more fine grained (i.e., C/F < 1) has an average C/F ratio of 0.5, ranging from 0.04 to 0.9. The population characterized as being more coarse grained (i.e., C/F > 1) has an average C/F ratio of 3.7 for 11 samples, ranging from 1.2 to 10.1. The B-Stratum exhibits an irregular, undulating topography at the Site. The B-Stratum averages 20.7 feet in thickness and ranges from 6.2 feet to about 38 feet.

The C-Stratum at the Site can be characterized as being composed of dense to very dense, brown to gray, moderately-well sorted, silty, fine to coarse sand and gravel with a minor clay content (Kerr-McGee, 1986). The C-Stratum averages 51 percent sand, 23 percent gravel, and 21 percent silt. The unit grades upward from a basal silty sand to a silty gravel. Based on 22 samples, the C/F ratio varies from 0.2 to 32. For samples with a C/F ratio of 1 or greater (n=18) the average C/F ratio is 8.1, reflecting the coarse nature of this stratum. Texturally, the C-Stratum and the A-Stratum are very similar and both are interpreted to be predominantly glacial outwash deposits. The structure contour of the C-Stratum is very irregular, and the thickness of the C-Stratum varies significantly over the Site. In the Intermediate Site and in southern portions of the Factory Site, the upper contact of the C-Stratum is poorly defined because the overlying D-Stratum is thin or absent. In these areas, the upper surface of the C-Stratum is in contact with the overlying E-Stratum. The C-Stratum ranges in thickness from 6.3 feet to about 33 feet, with a mean thickness of 15.4 feet.

The D-Stratum can be characterized at the Site as being a very stiff, dense, brown to gray, very poorly sorted, sandy clay and clayey silt till (Kerr-McGee, 1986). The D-Stratum averages 49 percent silt, 29 percent clay, 17 percent sand, and 5 percent gravel. The C/F ratio for the D-Stratum averages 0.5 and ranges from 0.02 to 3 in 38 samples tested. The sediments are characteristic of a till deposit. The D-Stratum is absent over areas of the Intermediate Site and the southern portion of the Factory Site and ranges up to a maximum thickness of about 23 feet. Where the D-Stratum is absent, Strata C and E, which are of nearly identical lithologies, are in contact. The area where the D-Stratum is thin or missing appears to extend off-site from the disposal area toward the northeast as determined by wells drilled off-site to the north-northeast of the Intermediate Site and east of the Factory Site (N-Series). This zone where the D-Stratum is missing has been interpreted to be an outwash channel (Kerr-McGee, 1986).

The E-Stratum can be characterized at the Site as being a dense to very dense, brown to gray, moderately sorted silty sand (Kerr-McGee, 1986). Locally, areas of silty gravel also occur within the E-Stratum. Like Strata A and C, the E-Stratum is interpreted to be an outwash deposit. The E-Stratum averages 44 percent sand, 36 percent gravel, 16 percent silt, and 4 percent clay. The C/F ratio for the E-Stratum averaged 8.7 and ranged from 1.1 to 49 in 61 samples tested. The E-Stratum lithology is very similar in textural content to both Strata A and C. The undisturbed E-

Stratum ranges in thickness from about a foot to a maximum thickness of about 53 feet, with a mean thickness of 20.5 feet. The E-Stratum was removed in some portions of the Site, such as in Pond 2, due to Facility operations. In other areas, the E-Stratum was physically altered by activities at the Site. Kerr-McGee (1993) reported on a "cemented E-Stratum" being present under some of the disposal ponds in the Disposal Site and in areas suspected of being disposal areas in the Factory Site. This cemented E-Stratum was reported to be very indurated, which is very different from the natural unconsolidated nature of the glacial deposits. During source removal, portions of the E-Stratum were removed from the Pond 1, North Factory Site and South Factory Site excavation areas, including most of the cemented E-Stratum.

The F-Stratum at the Site can be characterized as being a stiff to very stiff black, brown, and gray clayey silt with gravel and sand (Kerr-McGee, 1986). The F-Stratum, which averages 48 percent silt, 33 percent clay, 13 percent sand, and 6 percent gravel, grades upward into an organic rich topsoil. The F-Stratum is interpreted to be a combination of till, loess deposits, and topsoil, and has a high plasticity relative to the other tills encountered at the Site. The C/F ratio for the F-Stratum averages 0.2. The F-Stratum varies significantly in thickness across the Site from being absent to a maximum thickness of about 10 feet. The average thickness is less than 3 feet.

Kerr-McGee (1986) attempted to correlate the site stratigraphy to regionally defined formations through grain size and clay mineralogy comparisons. Their study found that the A-Stratum and the lower B-Stratum were part of the Yorkville Till Member of the Wedron Formation. The upper B-Stratum through the D-Stratum was correlated to the Wadsworth Till Member of the Wedron Formation. The E-Stratum was correlated to the Henry Formation, which is considered a glacial outwash deposit. The F-Stratum was correlated with the Richland Loess Formation.

2.6.3 Geologic Hazards

Geologic hazards can be grouped into several categories including mass wasting (slope instability), subsidence, active faulting, seismicity (earthquakes), and volcanic activity. The West Chicago Facility is in a stable geologic location and geologic hazards are not expected to be among the environmental risks that may result from the implementation of Phase V activities at the Site. Each of the geologic hazards listed above will be discussed briefly below.

Mass wasting is commonly referred to as landslides or other forms of slope instability. These types of hazards are generally common in areas of steeply sloping topography. The West Chicago Facility is located in an area of moderate topographic relief.

Mass wasting can be classified as a slide, a fall, a flow, or as a complex movement which is a combination of slides and flows. Slope stability is a function of several factors, i.e., the type of geologic material, the slope or topography, climate, vegetation, and hydrology. Two of the most important contributing factors to slope instability are slope lithology and slope angle. Typically, shale, volcanic clastic rocks (pyroclastic), and unconsolidated sediments have more potential for failure than indurated rocks. An exception to this is when the indurated rock is fractured. The geologic material at the surface at the West Chicago Site generally consists of unconsolidated sediments ranging from clays to gravels. The local natural topography has a relatively low slope, minimizing the potential for mass wasting. High water contents or pore pressures also promote mass wasting. Because of underlying gravel outwash deposits (E-Stratum) under the surficial clay stratum (F-Stratum) at the Site, the surface soils should drain well, preventing pore pressures from increasing. Specifications for man-made piles and excavations at the Site contain provisions intended to maintain slope stability. Mass wasting is not expected to be a geologic hazard at the West Chicago Site.

Subsidence is another form of mass wasting which is generally caused by the excessive withdrawal of fluids from subsurface reservoirs or the collapse of overlying materials into subsurface voids. Generally, subsidence is associated with extreme pressure decreases associated with excessive pumping over small areas. Subsidence is often associated with oil fields or municipal water well fields. The Site is not in an oil-producing area. The water levels in the deep aquifers have been significantly lowered over the past 75 years, due to pumping for municipal and industrial purposes. However, there is no reported subsidence in the West Chicago area. Therefore, pumping-related subsidence is not expected to be a geologic hazard at the Site. The Silurian dolomite bedrock aquifer underlying the glacial drift at the Site has solution channels, cavities, and paleo-drainage channels at the upper bedrock surface. However, these depressions have been filled with glacial drift deposits and are presently stable.

Subsidence can also occur as a result of past underground mining. However, coal-bearing bedrock, which is principally Pennsylvanian in age in the region, is not present under the Site. Consequently, subsidence due to underground mining in the Site vicinity is not expected.

Fault movement is also a potential geologic hazard. No faults have been identified in the glacial drift sediments at the Site (Kerr-McGee, 1986). Bedrock faulting is evident in the Paleozoic Strata in the counties contiguous with DuPage County. The nearest major fault zone to the Site is the Sandwich Fault Zone, which is located approximately 30 miles southwest of the West Chicago Site. The fault is considered younger than the Niagaran Silurian Bedrock Aquifer underlying the Site (Middle Silurian) and older than the Pleistocene glacial drift at the Site. The fault zone is 85 miles long and from 0.5 to 2 miles in width. The maximum fault displacement is 800 ft at the fault zone center. Because of the fault's distance from the Site, it is not considered a potential geologic hazard for the Site.

Seismic activity, or earthquake, is another form of geologic hazard. Structural engineers and emergency response agencies have a need for a method to estimate the seismic risk for specific geographic areas of the country. The seismicity of a given region is typically quantified based on the potential peak ground acceleration estimated for that region over a given time period. The peak ground acceleration is usually expressed as a percentage of the acceleration of gravity.

Most seismic zone maps are based on work by the U.S. Geological Survey (USGS). Algermissen and Perkins (1976) contoured peak ground acceleration based on a uniform probability for the United States. The contour plot depicted the peak ground acceleration at a 90 percent confidence level, which would not be exceeded in a 50-year period. Several interpretations of the USGS data have been used to produce seismic zone maps for the U.S. Figure 2.6.3-1 shows a contour plot of peak horizontal acceleration with probabilities of exceedance of 10 percent in 50 years (USGS, 2011). The West Chicago Site is located in the background seismic risk zone where the expected peak ground acceleration is less than 3 percent of the acceleration of gravity.

Volcanic hazards are not applicable to the West Chicago Site.

2.7 HYDROLOGY

2.7.1 Regional Groundwater Hydrology

Zeizel et al., (1962) provide a complete description of the relationship of regional geology and groundwater resources in DuPage County. These authors have identified four principal geohydrologic units that are used as aquifers. From the deepest to the shallowest, the aquifers are known as the Mt. Simon aquifer, the Cambrian-Ordovician aquifer, the Silurian dolomite aquifer, and the glacial drift aquifers. The glacial drift aquifers and the Silurian dolomite aquifers receive most of their recharge from precipitation which falls within the county limits (Zeizel et al., 1962). The Cambrian-Ordovician aquifer is separated from the overlying Silurian aquifer by relatively impermeable shale beds of the Maquoketa Formation. The total potential yields of the four aquifer systems are 3 million gallons per day (mgd), 38 mgd, 4.3 mgd, and 2.1 mgd for the glacial drift aquifers, the Silurian dolomite aquifer, the Cambrian-Ordovician aquifer, and the Mt. Simon aquifer, respectively. Because decommissioning activities at the West Chicago Site can only be

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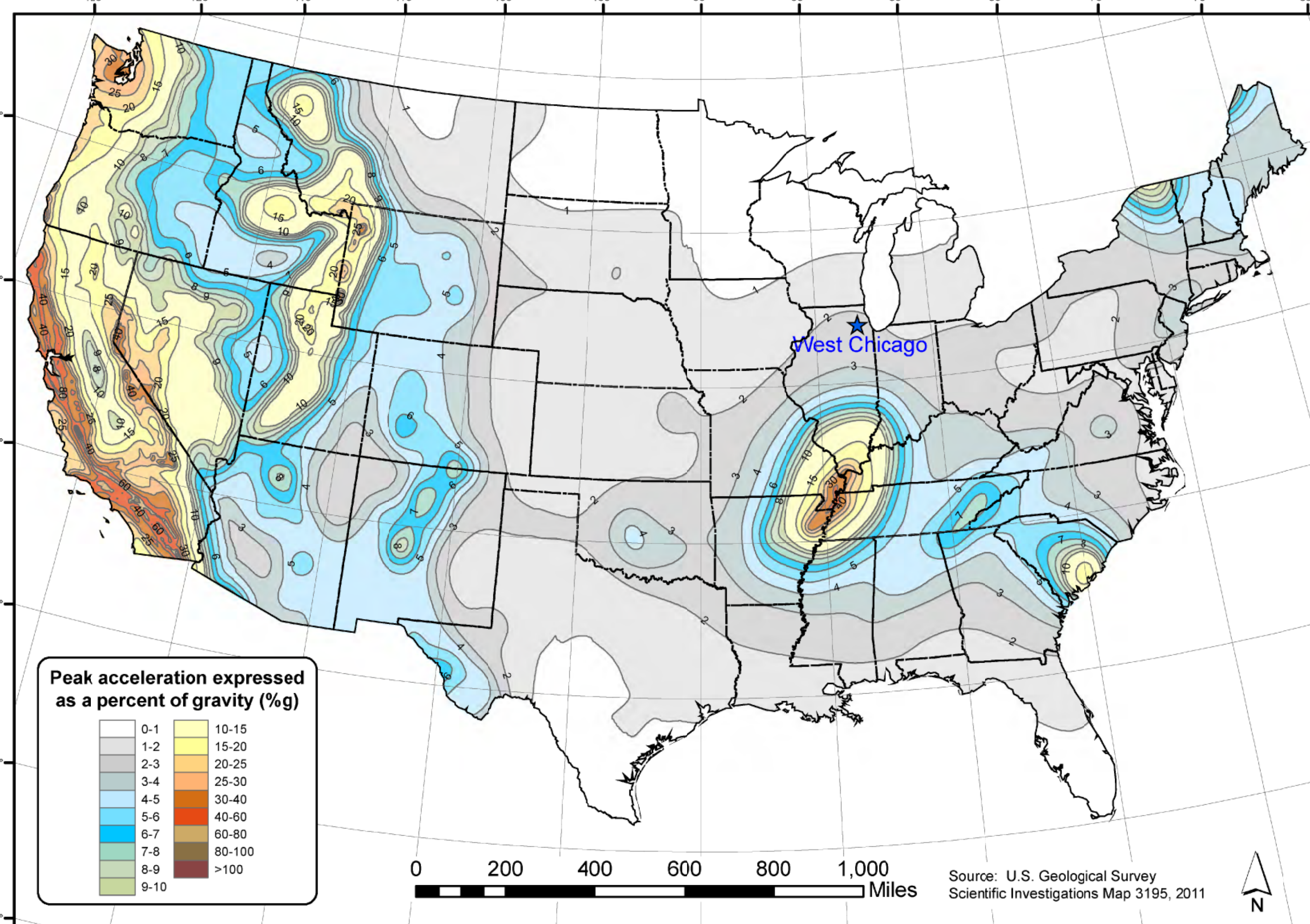

PEAK HORIZONTAL ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS

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PEAK ACCELERATION MAP

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PHASE V
KERR-MCGEE, WEST CHICAGO

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FIGURE 2.6.3-1

expected to potentially impact local shallow aquifer units, the discussion of hydrology will focus on the two uppermost aquifer units below the Site. However, the lower two aquifer units will be discussed briefly for completeness.

The deepest aquifer unit in the area of the facility is known as the Mt. Simon aquifer. The Mt. Simon aquifer consists of the sandstones of the Mt. Simon Formation and the lower Eau Claire Formation (Zeizel et al., 1962). The top of the Mt. Simon aquifer ranges from about 1,700 to 2,000 ft below the ground surface in DuPage County. The aquifer unit dips gently to the southeast and is estimated to be about 2,000 ft thick. The shale beds of the middle and upper Eau Claire Formation act as a confining unit between the Mt. Simon and Cambrian-Ordovician aquifers. The piezometric levels in the Mt. Simon aquifer were reported in 1960 to be significantly higher (50 ft) than the overlying Cambrian-Ordovician aquifer over many portions of DuPage County (Zeizel et al., 1962).

The Cambrian-Ordovician aquifer lies above the Mt. Simon aquifer system. The aquifer consists of several dolomite and sandstone units which regionally behave hydraulically as one aquifer unit. These units typically dip to the southeast from the northwest. Recharge to the Cambrian-Ordovician aquifer is thought to occur in counties west of DuPage County (Kane, McHenry, Kendall, DeKalb, and Boone counties) where the Galena-Platteville Dolomite is the local bedrock formation which unconformably underlies glacial drift. Recharge to the Galena-Platteville is derived from local precipitation in the western counties. The piezometric surface of the Cambrian-Ordovician aquifer dips to the east-southeast. The hydraulic head of the Cambrian-Ordovician aquifer near the Site was approximately 350 ft above mean sea level in 1960 (Zeizel et al., 1962).

The next shallowest aquifer unit is the Silurian dolomite aquifer. The Silurian dolomite aquifer is separated from the underlying Cambrian-Ordovician Aquifer System by the Maquoketa Confining Unit. The Maquoketa confining unit is about 88 ft thick at the Site. The relatively impermeable shales of the Maquoketa formation act as a partial barrier to downward movement of the groundwater from the Silurian dolomite aquifer to the Cambrian-Ordovician aquifer (Sasman et al., 1981). The Silurian dolomite aquifer, also referred to as the bedrock aquifer at the Site, is the deepest aquifer of interest for the present study. It occurs above the Cambrian-Ordovician aquifer and lies directly below the shallowest aquifer (known as the glacial drift aquifer). The Silurian dolomites which make up the Silurian dolomite aquifer range in thickness from about 50 to 200 ft in DuPage County. The Silurian dolomites are generally thinner in the western areas of DuPage County and generally thicker in the eastern areas of DuPage County. The depth to the top of the Silurian dolomite aquifer ranges from less than 50 ft to about 200 ft in the region of the West Chicago Facility and changes abruptly throughout the region due to erosional thinning. In the vicinity of the West Chicago Facility, the Silurian dolomite aquifer is approximately 100 ft below ground surface (bgs). The piezometric levels in the Silurian dolomite aquifer are higher in western DuPage County and lower in eastern DuPage County. The regional flow direction within the Silurian dolomite aquifer (measured in 1979) is generally from the west-northwest to the east-southeast (Sasman et al., 1981). The Silurian dolomite aquifer is an important aquifer in DuPage County with 95 percent of the shallow aquifer pumpage in 1978 being derived from the Silurian formation (Sasman et al., 1981). Because the Silurian dolomite aquifer is an important regional aquifer, the piezometric surface has many closed drawdown features. Therefore, the local hydraulic gradient may vary significantly from the regional trend.

Within DuPage County, two distinct aquifer units are recognized within the Silurian dolomite aquifer based on productivity of the wells: the Niagaran aquifer and the Alexandrian aquifer. The Niagaran aquifer consists of Silurian aged rocks of the Niagaran Series and forms most of the bedrock surface in the vicinity of the Facility. The Niagaran aquifer ranges from absent in the southwestern part of the county up to a maximum thickness of 175 ft in the southeastern part of the county. The Niagaran aquifer is about 40 ft thick in the vicinity of the West Chicago Facility, and the top elevation averages approximately 660 ft above sea level. Because the Niagaran aquifer is relatively transmissive due to the solution-enlarged openings, most water production wells in the region terminate in the Niagaran aquifer. Sasman et al. (1981) provide a complete description of the shallow dolomite aquifer in DuPage County. These investigators found that hydraulic head changes in the aquifer ranged from increases of greater than 10 ft to decreases of over 30 ft between 1966 and 1979.

The Alexandrian aquifer exists below the Niagaran aquifer and consists of all formations in the Alexandrian Series of Silurian age. The thickness of the Alexandrian aquifer, as reported in 49 wells, averages 57 ft and reaches a maximum of about 90 ft in DuPage County (Zeizel et al., 1962). The thickness of the Alexandrian aquifer is about 90 ft at the West Chicago Site. This Alexandrian aquifer zone is typically less transmissive than the Niagaran aquifer. Therefore, most wells are completed in the upper part of the Silurian.

Pumping tests in the Silurian dolomite aquifer (Zeizel et al., 1962) indicated that fractures in the dolomite are connected over large areas. Transmissivity values from two pumping tests averaged 53,000 gallons per day per foot (gpd/ft) (7,085 ft^2/day). Well logs indicate the pumping well for one test was screened through 65 ft of dolomite, resulting in a calculated hydraulic conductivity of 109 ft/day. The storage coefficient determined from one of the pumping tests was estimated to be 3.5×10^{-4}. Zeizel et al. (1962) reported that the estimated specific capacity of the Silurian aquifer in DuPage County ranged from less than 10 to 80 gallons per minute per foot (gpm/ft). Kerr-McGee (1986) reports that, based on 31 wells completed in the Silurian aquifer in DuPage County, the average specific capacity of the aquifer is 55 gpm/ft.

The shallowest aquifers in the region are the coarse-textured sand and gravel deposits of the glacial drift. Most of the glacial deposits are saturated. The glacial drift deposits vary widely in texture throughout the region. As a result of this heterogeneity, some portions of the drift do not yield significant water due to low permeability. Glacial deposits can be typified as being strongly heterogeneous, with deposits ranging in lithology from stiff clays to gravel outwash. Because the glacial drift is a shallow aquifer system, the hydraulic heads are expected to mimic the local topography, with higher heads at topographic highs and lower heads at topographic lows (streams). Correspondingly, the shallow aquifer system will be typified by enhanced recharge in higher elevation regions with discharge to local streams at lower elevations. This flow system will be strongly influenced by the heterogeneity of the glacial deposits. The sands and clays are not always laterally extensive and tend to pinch out over short distances. Therefore, flow paths and flow velocities will be complicated by permeability variations which result from lithological variations associated with aquifer/aquitard depositional origin.

Zeizel et al. (1962) reported on the groundwater resources of DuPage County, including the glacial drift aquifer. Because the occurrence of glacial drift aquifers is very irregular, Zeizel et al. (1962) chose to regionally categorize glacial drift aquifers in DuPage County on the basis of their mode of occurrence. The three categories are: (1) surficial, (2) interbedded, and (3) basal.

Surficial aquifers are composed of coarse-textured sand and gravel and occur just below the land surface. These aquifers are primarily glacial outwash deposits and occur in the river valleys of the West and East branches of the DuPage River and as an outwash plain in front of the West Chicago end moraine. The water-yielding capacity of these aquifers varies widely, due to the changes in texture and sorting of the deposits. The interbedded glacial drift aquifers are sand and gravel deposits which occur as sheet-like deposits, or exhibit a lenticular and discontinuous shape, scattered throughout the glacial drift. Although limited data preclude precise regional mapping of the interbedded aquifers, one principal interbedded aquifer lies in the western portion of DuPage County and is known as the West Chicago Outwash. These deposits, interbedded with the tills of end moraines, are believed to represent extensive buried sheets of outwash deposits. Basal glacial drift aquifers are the sand and gravel deposits directly above the Silurian dolomite. Zeizel et al. (1962) report that these deposits are typically coarse-grained and relatively permeable. The thickness of these deposits seems to correlate with the overall thickness of the glacial drift. Based on scattered data, the thickness of the basal sand and gravel deposits ranges from less than 20 ft to over 60 ft in DuPage County.

According to Zeizel et al. (1962), no surficial glacial drift aquifers are present at the West Chicago Site. This is consistent with the presence of a surficial loess deposit at the Site. At the West Chicago Site, the first aquifer occurs below fill and surficial loess and clay deposits. Surficial glacial drift aquifers are constrained to the river valleys of the east and west branches of the DuPage River. The glacial drift aquifer at the West Chicago Site can be classified as an interbedded glacial drift aquifer. The interbedded glacial drift aquifer beneath the Site is composed of glacial till and outwash deposits of the Wedron Formation and Henry Formation (Kerr McGee, 1986). Zeizel et al. (1962) report that the basal glacial drift aquifer near the Site is composed of sand and gravel deposits which are less than 20 ft thick. Zeizel et al. (1962) made no estimates of the interbedded glacial aquifer thickness in DuPage County, although they did estimate that the combined thickness of sand and gravel deposits within the glacial drift over DuPage County ranged from greater than 60 ft to less than 20 ft. The Zeizel et al. (1962) map of total sand and gravel thickness in the glacial drift shows the West Chicago Site in a region that is considered to have less than 20 ft of sand and gravel deposits within the glacial drift aquifer. Subsurface investigations beneath and in the vicinity of the Site have found that the sand and gravel deposits in the glacial drift aquifer generally exceed 20 ft in thickness. This is contrary to Zeizel et al. (1962).

The glacial drift aquifer beneath the West Chicago Site can be divided into three transmissive glacial drift strata. These three strata are predominantly composed of sand and gravel. They are, in ascending order, the A-Stratum, the C-Stratum, and the E-Stratum. The E-Stratum is the uppermost transmissive zone at the Site and is unconfined. The E- and C-Strata are outwash deposits. The A-Stratum directly overlies the Silurian dolomite aquifer at the Site and may be considered a basal glacial drift aquifer, according to Zeizel et al. (1962). The three transmissive strata are separated at the Site by two semi-confining strata predominantly composed of silt and clay with some sand and gravel. These strata are, in ascending order, the B-Stratum and the D-Stratum. Both the B- and D-Strata are glacial till deposits. The F-Stratum is the surficial unit at the Site in most areas. The F-Stratum is not saturated and is a low permeability stiff, clayey-silt. The F-Stratum is predominately a loess wind-blown deposit.

Regionally, heads in the glacial drift aquifer are higher than heads in the Silurian dolomite aquifer which indicates that the glacial drift aquifer recharges the Silurian dolomite aquifer. Zeizel et al. (1962) estimated that the regional recharge rate to the Silurian dolomite aquifer ranges from about 60,000 to 140,000 gallons per day per square mile, which corresponds to a range from 1.3 to 2.9 inches per year.

2.7.2 Local Hydrology

2.7.2.1 Surface Water

The Facility and the drainage area in the vicinity of the Facility are included on the USGS 7.5-minute quadrangle maps for West Chicago and Naperville, Illinois. The Facility area map (Figure 2.7.2.1-1) shows the location of the Facility with respect to major drainage features.

The West Chicago Facility is situated near the divide that directs surface drainage either to Kress Creek or to the West Branch of the DuPage River. The West Branch of the DuPage River flows generally south and is located about one mile east of the Facility. Kress Creek is located about 1,300 ft southwest of the Facility, at its nearest point, and flows generally southeast from the vicinity of the Site. Kress Creek joins with the West Branch of the DuPage River about 1.5 miles south-southeast of the center of the Site. Surface water drainage from the area surrounding the Facility moves southwest toward Kress Creek. In addition to the natural surface drainage, there is a storm sewer which drains to the south, adjacent to the Facility, along the bed of the Canadian National Railway railroad.

The Facility is located in a developed area of West Chicago. There are existing storm water drainage systems within the area surrounding the Facility. These drainage systems include surface ditches and subsurface storm sewers. The municipal storm water system directs water toward Kress Creek.

The USGS maintains stream-gaging stations along the West Branch of the DuPage River. Two of these locations are located near West Chicago. One station is located about 2 miles northeast of West Chicago, and the other station is located downstream of West Chicago at the convergence with Kress Creek. According to the USGS Water Resources Data, Kress Creek has an 18.1 square mile drainage area with a maximum flow of 1,210 cubic ft per second (ft^3/sec), a minimum flow of 0 ft^3/sec, and an average flow of 17.0 ft^3/sec over the period of record.

Historically, most surface water from the Site drained toward Kress Creek. During the period when manufacturing operations were active, precipitation falling on the Facility was directed to one of two sumps, and the collected runoff was then pumped to various ponds on the Disposal Site. When manufacturing operations ceased at the end of 1973, the ponds were no longer needed. At that time, the use of the sump pumps was discontinued and the sump overflow was connected to the city storm sewer at the Factory Site. In 1982, the overflow connection was blocked so that no flow collected on-site could enter the storm sewer.

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.7.2.1-1.DWG

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FACILITY LOCATION MAP

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PHASE V
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FIGURE 2.7.2.1-1

During source removal, surface water at the Site flowed into two storage areas located at the Factory Site or into a retention pond located in the southwest corner of the Disposal Site. Now that source removal is, for the most part, complete, the retention pond has been removed and large portions of the Site have been contoured to final grade and grassed for future recreational use. In the future, surface water will drain into low-lying grassed areas on the Site and then enter a storm sewer. The parking lot areas will also drain into the storm sewer. The storm sewer will discharge to Kress Creek.

2.7.2.2 Groundwater

Descriptions of the hydrologic conditions at the West Chicago Site are primarily based on information collected from borings and wells that have been drilled on site and at nearby off-site locations. Section 2.6.2.1 lists the separate tasks that have been completed to characterize the geology and hydrogeology of the Site. The occurrence of shallow groundwater below the Site is consistent with the regional hydrology described in Section 2.7.1. Four aquifer systems occur at the Site. They are, from deepest to shallowest: the Mt. Simon aquifer, the Cambrian-Ordovician aquifer, the Silurian dolomite aquifer, and the glacial drift aquifer. All groundwater characterization data at the Site have been derived from the two uppermost aquifer units, the Silurian dolomite aquifer and the glacial drift aquifer. This is because these aquifers are the most likely to be impacted by the Site. Therefore, this discussion of site groundwater will not extend to aquifers beneath the Silurian dolomite aquifer.

Since 1976, the glacial aquifer has been monitored at the Site. Many of the original groundwater monitor wells have been abandoned as a result of decommissioning activities. A corrective action monitoring network has been proposed, approved by IEMA, and is partially in place at this time. The corrective action monitoring network will be used to assess the effectiveness of corrective actions and to determine when the Site meets the groundwater protection standards set forth in the Radioactive Material License. Since the point of compliance at License termination is everywhere on the site, the monitoring well network must be sufficient to insure compliance with the groundwater protection standards everywhere on site and in affected off-site areas.

The corrective action monitoring network includes 74 monitoring wells, three dewatering sumps for former excavation areas (Pond 1, Pond 2 and Pond 4) and an underdrain riser (South Factory Site East). An additional 12 on-site monitoring wells will be installed after final grading of the site is complete. Of the 74 currently installed monitoring wells, 35 are completed in the E Stratum, 28 in the C Stratum, 10 in the upper portion of the Silurian dolomite aquifer, and one monitor well (ECI-1) is completed across both the E and C Strata. Five of the E Stratum wells monitor non-PSF sheet pile areas. Pond 1, Pond 2, and the South Factory Site East contain PSF fill material. Table 2.7.2.2-1 lists the current wells in the corrective action monitoring network along with the additional wells that will be added to the corrective action monitoring network. Additional monitoring well information can be found in Section 3.3.10. The locations of the wells are shown in Figure 2.7.2.2-1. Locations for the proposed additional wells are approximate.

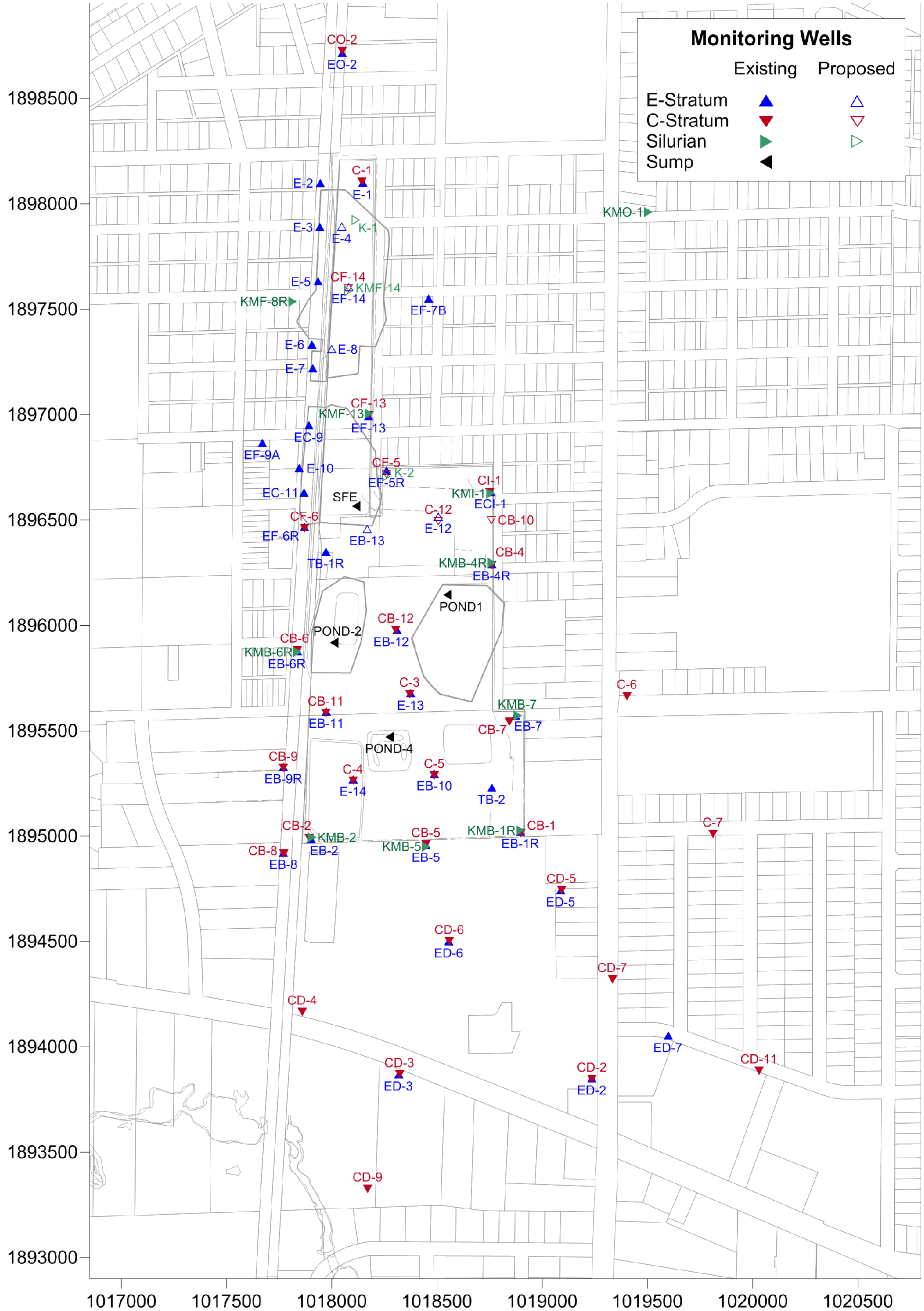
The deepest aquifer of concern at the Site is the Silurian dolomite aquifer. Locations of site monitoring wells completed in the Silurian dolomite aquifer are shown in Figure 2.7.2.2-2. The Silurian dolomite aquifer is unconformably overlain by the glacial drift aquifer at the Site, and ranges in thickness near the West Chicago Site from 50 to 200 ft. The dolomite aquifer is approximately 184 ft thick at the Site as determined from a deep test well drilled at the Site. Zeizel et al. (1962) report that the upper portion of this aquifer has the highest density of water production wells of any aquifer zones in the West Chicago area. The uppermost dolomite at the Site is the Racine Formation (Niagaran), which is a fractured dolomite. Secondary porosity (fractures, joints, and solution cavities) within the dolomite is an important factor in controlling aquifer transmissivity. Solution cavities are also present at the contact between the Silurian and glacial aquifers, but these cavities are presently filled with glacial drift. Regionally, the Silurian dolomite receives recharge from precipitation infiltrating through the glacial drift aquifer. Zeizel et al. (1962) report that, in the West Chicago area, the Silurian receives approximately 64,000 gallons per day per square mile (1.35 inches per year) of recharge from the glacial drift aquifer. Law (1981b) reports that recharge to the glacial drift aquifers ranges from 5 to 15 percent of the annual precipitation. Kerr-McGee (1993) reported that the average annual precipitation for West Chicago is 31.7 inches per year. Therefore, the average recharge to the glacial aquifer in the West Chicago region is between 1.6 and 4.8 inches per year. However, because the Site is near a glacial aquifer discharge boundary (Kress Creek), it could be expected that the amount of recharge to the Silurian from the glacial aquifer would be lower than a regional estimate.

Figure 2.7.2.2-3 illustrates the piezometric surface in the Silurian dolomite aquifer based on water-level measurements taken in site monitor wells in June 2012. Flow directions across the Site within the dolomite aquifer are generally toward the northwest. Based on second quarter 2012 water level measurements, hydraulic gradients in the dolomite aquifer at the Site vary from almost flat in the southern part of the Site up to almost 0.013 ft/ft between wells KMI-1 and KMF-13. Weston (2003) estimates hydraulic conductivity for the upper part of the Silurian dolomite as 1.0E-3 cm/sec (2.8 ft/day) based on pressure testing and 3.6E-3 cm/sec (10.3 ft/day) based on slug testing. Assuming a porosity of 0.12, the estimated average linear groundwater velocity in the dolomite aquifer could range from 0.01 ft/day (4.6 ft/yr) to 1.10 ft/day (400.9 ft/yr). Actual linear velocities

TABLE 2.7.2.2-1
SITE MONITORING WELLS

Well[a]	Status	Well[a]	Status	Well[a]	Status
E-Stratum					
E-1	Current	EB-8	Current	EF-7B	Current
E-2	Current	EB-9R	Current	EF-9A	Current
E-3[g]	Current	EB-10	Current	EF-13	Current
E-5[g]	Current	EB-11	Current	EO-2[b]	Current
E-6	Current	EB-12	Current	TB-1R	Current
E-7[g]	Current	EC-9[fg]	Current	TB-2	Current
E-10	Current	EC-11[fg]	Current	POND-1[c]	Current
E-13	Current	ECI-1[e]	Current	POND-2[c]	Current
E-14	Current	ED-2	Current	POND-4[c]	Current
EB-1R	Current	ED-3	Current	SFE[d]	Current
EB-2	Current	ED-5	Current	E-4	Proposed
EB-4R	Current	ED-6	Current	E-8	Proposed
EB-5	Current	ED-7	Current	E-12	Proposed
EB-6R	Current	EF-5R	Current	EB-13	Proposed
EB-7	Current	EF-6R	Current	EF-14	Proposed
C-Stratum					
C-1	Current	CB-7	Current	CD-9	Current
C-3	Current	CB-8	Current	CD-11	Current
C-4	Current	CB-9	Current	CF-6	Current
C-5	Current	CB-11	Current	CF-13	Current
C-6	Current	CB-12	Current	CI-1	Current
C-7	Current	CD-2	Current	CO-2[b]	Current
CB-1	Current	CD-3	Current	C-12	Proposed
CB-2	Current	CD-4	Current	CB-10	Proposed
CB-4	Current	CD-5	Current	CF-5	Proposed
CB-5	Current	CD-6	Current	CF-14	Proposed
CB-6	Current	CD-7	Current		
Silurian					
KMB-1R	Current	KMB-7	Current	K-1	Proposed
KMB-2	Current	KMF-8R	Current	K-2	Proposed
KMB-4R	Current	KMF-13	Current	KMF-14	Proposed
KMB-5	Current	KMI-1	Current		
KMB-6R	Current	KMO-1[b]	Current		

a) Well data was obtained from Table 5.1, Weston 2012a.
b) Background well.
c) Dewatering sump.
d) Under-drain riser.
e) Well ECI-1 is completed across both the E- and C-Strata.
f) Wells EC-9 and EC-11 may be completed across both the E- and C-Strata.
g) Well located inside a sheet pile enclosure with no under-drain.



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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.7.2.2-1.DWG

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MONITORING WELL LOCATION MAP

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FIGURE 2.7.2.2-1

SITE MONITOR WELLS IN THE SILURIAN DOLOMITE

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JOB NO. 93S7001 | FIGURE 2.7.2.2-2

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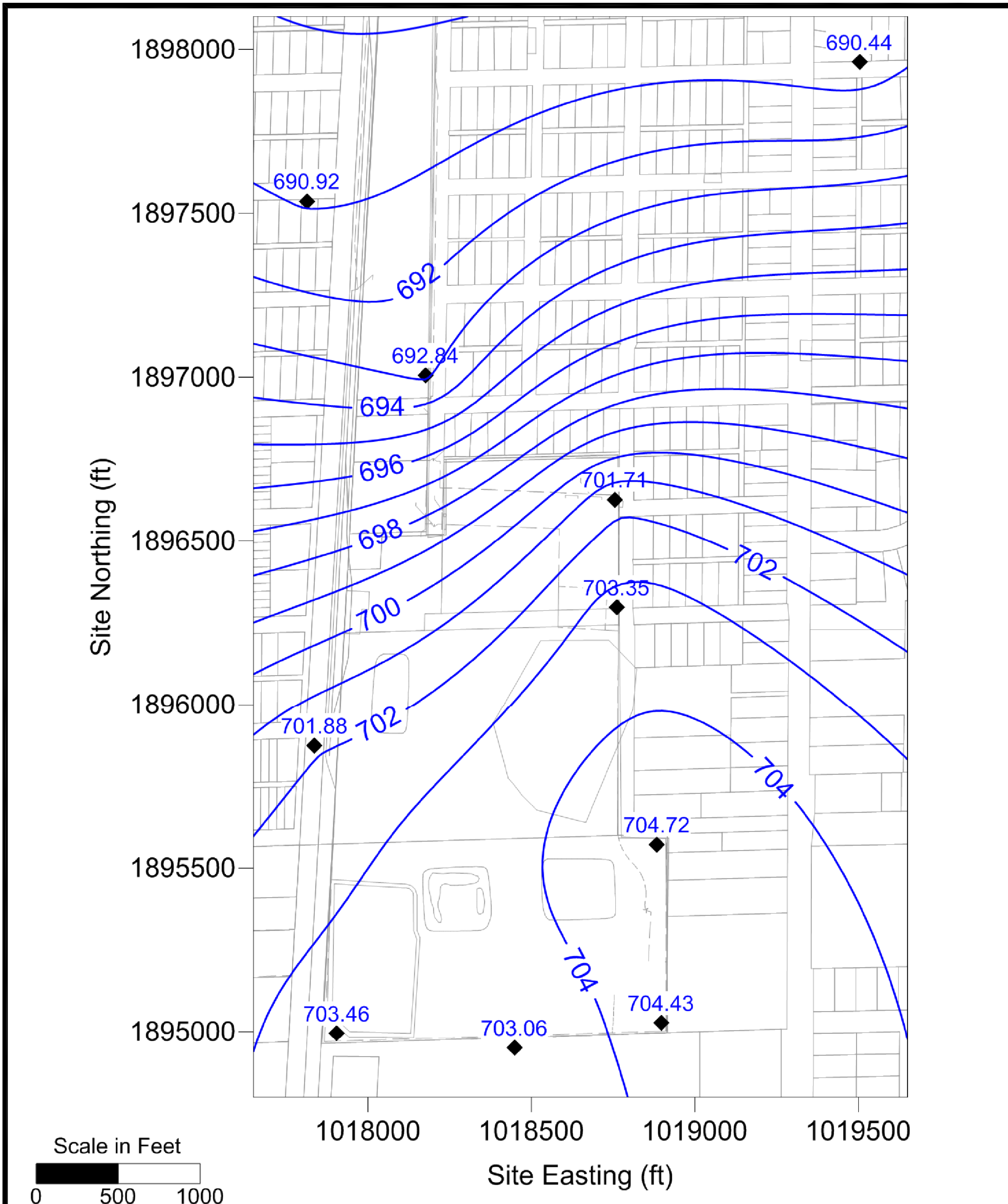

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.7.2.2-3.DWG

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PIEZOMETRIC SURFACE FOR THE SILURIAN DOLOMITE

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FIGURE 2.7.2.2-3

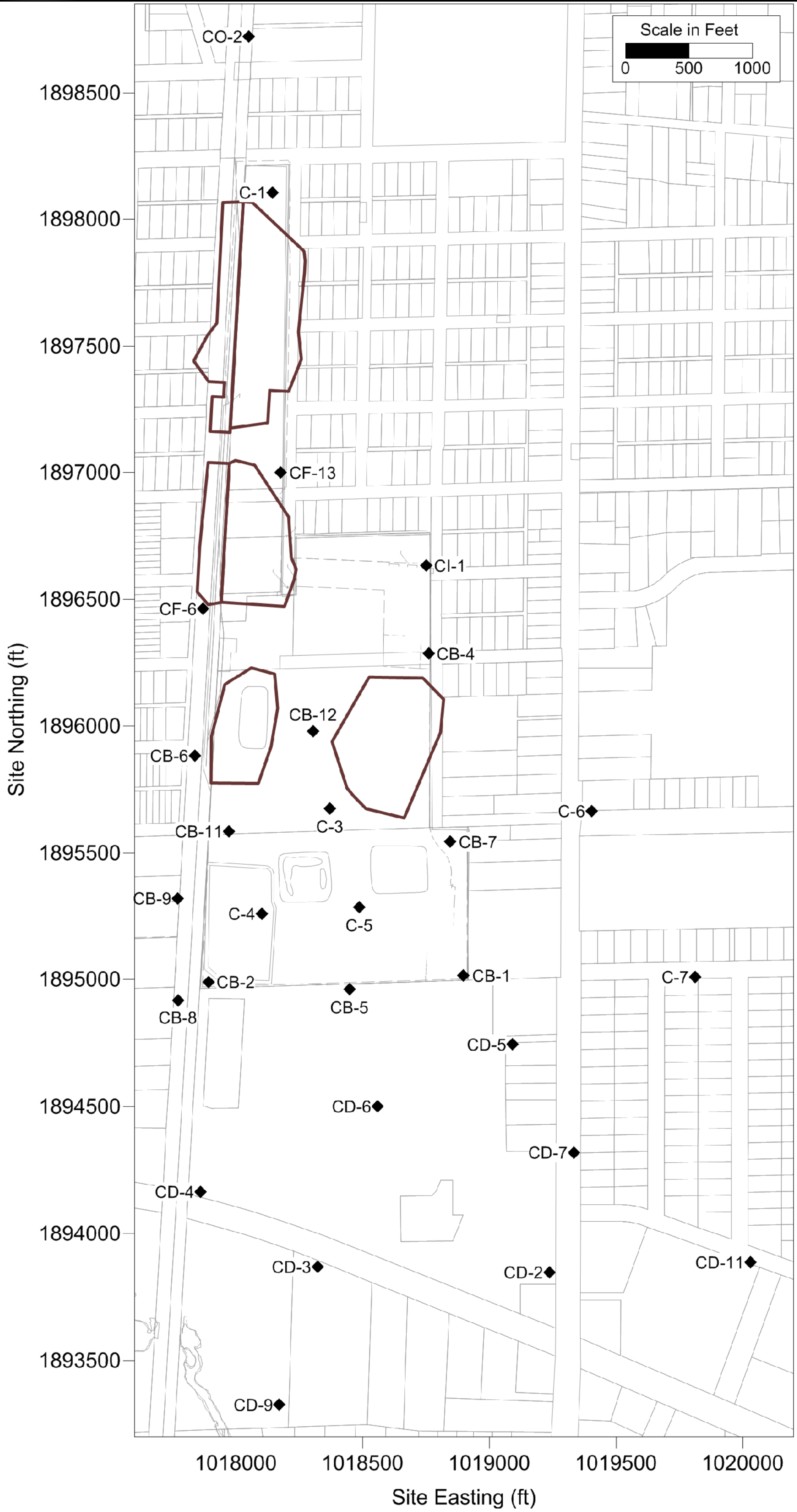
within the Silurian dolomite aquifer are very uncertain because of the unknown role secondary porosity (fractures and solution cavities) may have on controlling local-scale flow and transport within the dolomite.

As described in Section 2.6.2.1, the glacial drift aquifer at the Site can be divided into six strata, based on lithological differences. These strata are designated from deepest to shallowest as Stratum A through Stratum F. The strata that are considered aquifer units at the Site are Stratum A, Stratum C, and Stratum E. These strata are glacial outwash deposits which are dominantly composed of sands and gravels. Strata B and D are composed dominantly of clay and silt and consequently are considered confining units within the glacial drift aquifer at the Site. Although Strata B and D are dominantly fine-grained sediments, they do have zones within them where the sand and gravel content is comparable to the aquifer strata. The D-Stratum is not present over the entire Site. In areas of the Intermediate Site and the Southern Factory Site, the D-Stratum is very thin or missing. In those areas where the D-Stratum is absent, Strata E and C merge to make one large aquifer unit. The heterogeneous nature of the glacial drift sediments impacts the groundwater flow regime significantly. The F-Stratum occurs at the surface and is not a fully saturated medium. The thickness of the glacial drift ranges from about 69 to 94 ft and averages about 80 ft at the Site, based on monitor wells completed in the Silurian and boreholes for the Silurian Investigation Program (Weston, 2003).

The A-Stratum is not monitored as a discrete hydrogeologic zone at the Site. The A-Stratum is hydraulically connected to the permeable Silurian dolomite aquifer, which it overlies unconformably. It is expected that the hydraulic gradients within the A-Stratum are similar to those in the Silurian dolomite.

Over some portions of the Intermediate Site, the D-Stratum is absent or very thin, and in these locations, Strata E and C are connected and hydraulic heads are probably similar.

Figure 2.7.2.2-4 shows the location of site monitoring wells completed in the C-Stratum. Figure 2.7.2.2-5 plots the piezometric surface for the C-Stratum in the southern portion of the Site in June 2012. The hydraulic gradient within the C-Stratum was generally toward the south-southeast in June 2012. Interpretation of a single-well pumping test for well B-2 gave a hydraulic conductivity for the C-Stratum of 348 ft/day. Hydraulic conductivity values for the C-Stratum, determined from slug tests, range from 82 to 669 ft/day, with an arithmetic average of 274 ft/day (Kerr-McGee, 1993).



SITE MONITOR WELLS IN THE C-STRATUM

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FIGURE 2.7.2.2-4

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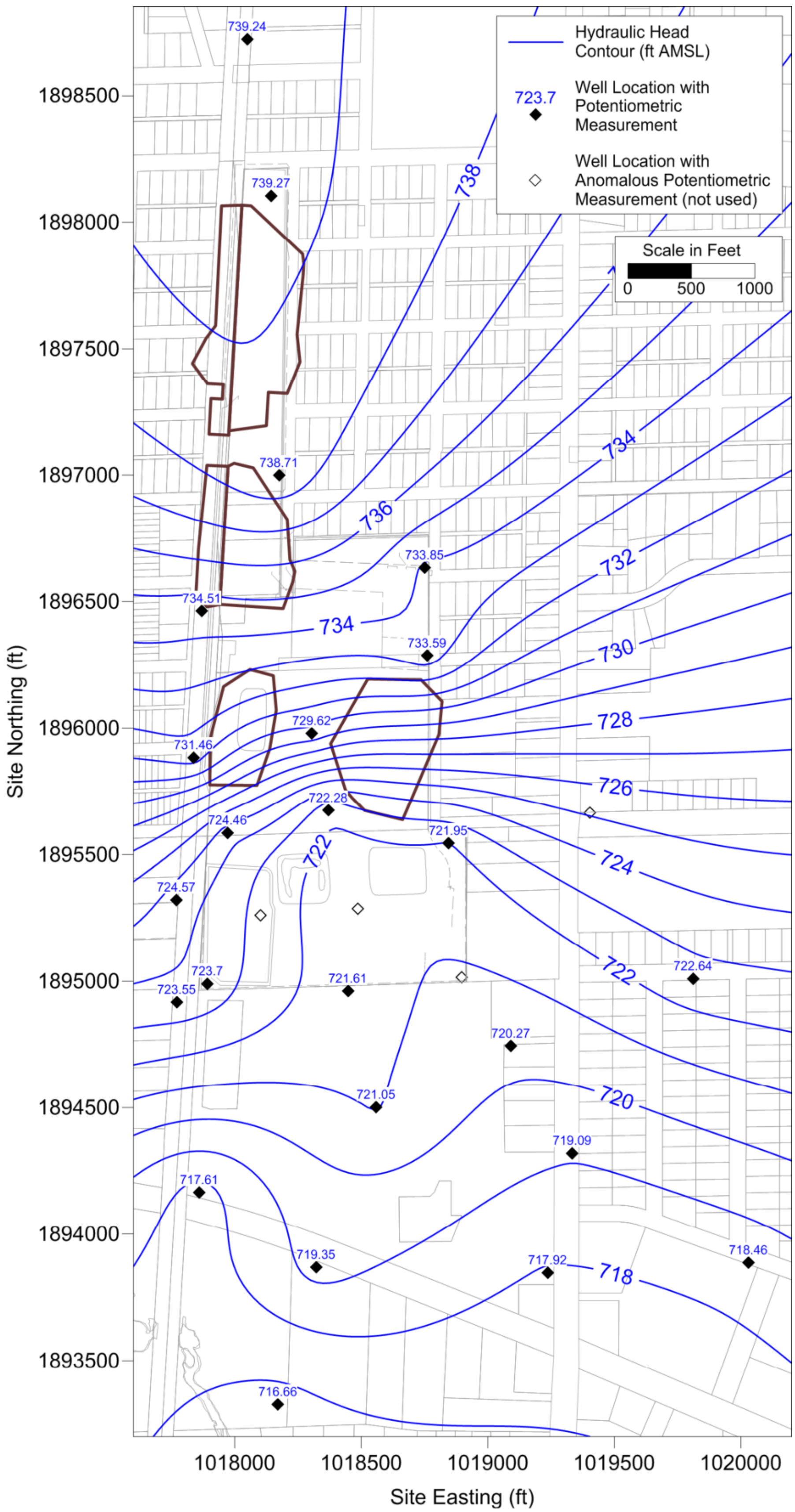

PIEZOMETRIC SURFACE FOR THE C-STRATUM	
ENVIRONMENTAL ANALYSIS PHASE V KERR-MCGEE, WEST CHICAGO	
JOB NO. 93S7001	FIGURE 2.7.2.2-5

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.7.2.2-5.DWG

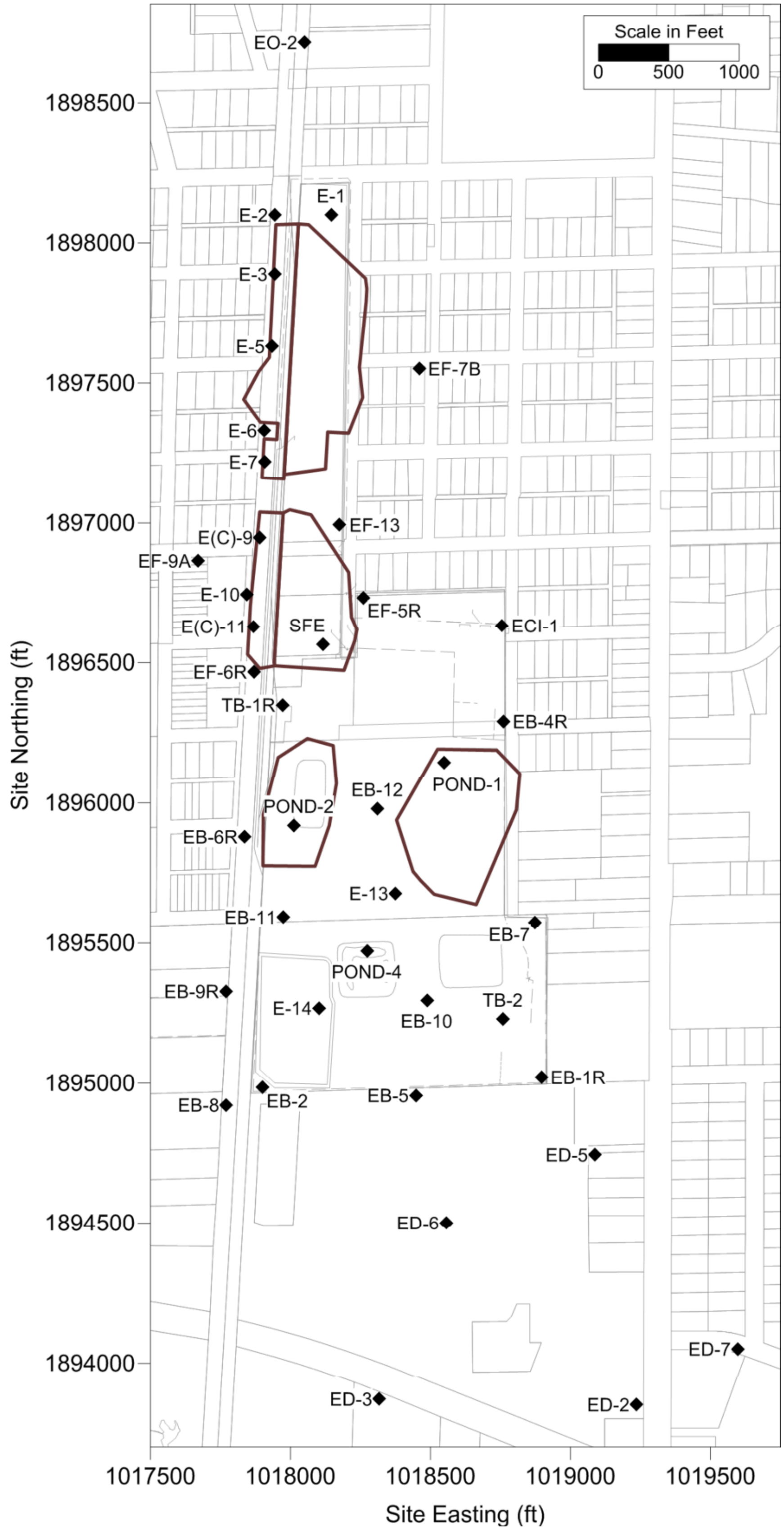
Figure 2.7.2.2-6 shows the current E-Stratum monitor well array at the Site. Well ECI-1, which has a 28 ft screen, is completed in both the C-Stratum and the E-Stratum is included on this location map. Figure 2.7.2.2-7 plots the piezometric surface for the E-Stratum aquifer in June 2012. Groundwater flow in the aquifer is generally from the north to the south. In the southern portion of the Site, groundwater flow diverges to the southeast and southwest around a structural high in the D-Stratum. Groundwater within the E-Stratum discharges to Kress Creek to the south and southwest of the Site.

Head measurements collected in June 2012 (Figure 2.7.2.2-7) indicate that the horizontal hydraulic gradient in the E-Stratum averages approximately 0.005 and ranges from about 0.001 to 0.016 ft/ft. Kerr-McGee (1993) provided hydraulic conductivity values estimated from slug tests and pumping tests performed in wells screened in the E-Stratum. The range in hydraulic conductivity determined from slug tests was from 83 to 510 ft/day, with an arithmetic average of 210 ft/day. For the pumping tests, hydraulic conductivity values ranged from 22 to 570 ft/day, with an arithmetic average of 293 ft/day. Kerr-McGee (1986) reported an average porosity for the E-Stratum of 0.25. Based on the average hydraulic conductivity values, a porosity of 0.25, and the hydraulic gradient range reported above, the average linear groundwater velocity in the E-Stratum ranges from about 1 ft/day to about 19 ft/day.

The hydraulic head maps for each of the strata provided above describe the potential for horizontal flow within each of the strata. There is also a vertical potential for flow at the site from the glacial aquifer (E and C-Stratum) to the Silurian which is indicated by the higher heads in the E and C-Strata relative to the Silurian. Regionally, this vertical downward gradient provides recharge to the Silurian dolomite aquifer.

2.8 ECOLOGY

Ecological communities in the vicinity of West Chicago are those found in predominantly urban areas. The dominant ecological community in the residential parts of West Chicago is mowed lawn, characterized by clipped grass with a tree cover of less than 30 percent. Commonly occurring trees in this community include sugar maple, oaks, basswood, box elder, willows, and conifers. Gardens and ornamental shrubs are also common components of this type of community. Animal species found in this type of habitat include robins, house sparrows, house finches, starlings, cardinals, rabbits, squirrels, dogs, and cats.



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SITE MONITOR WELLS IN THE E-STRATUM

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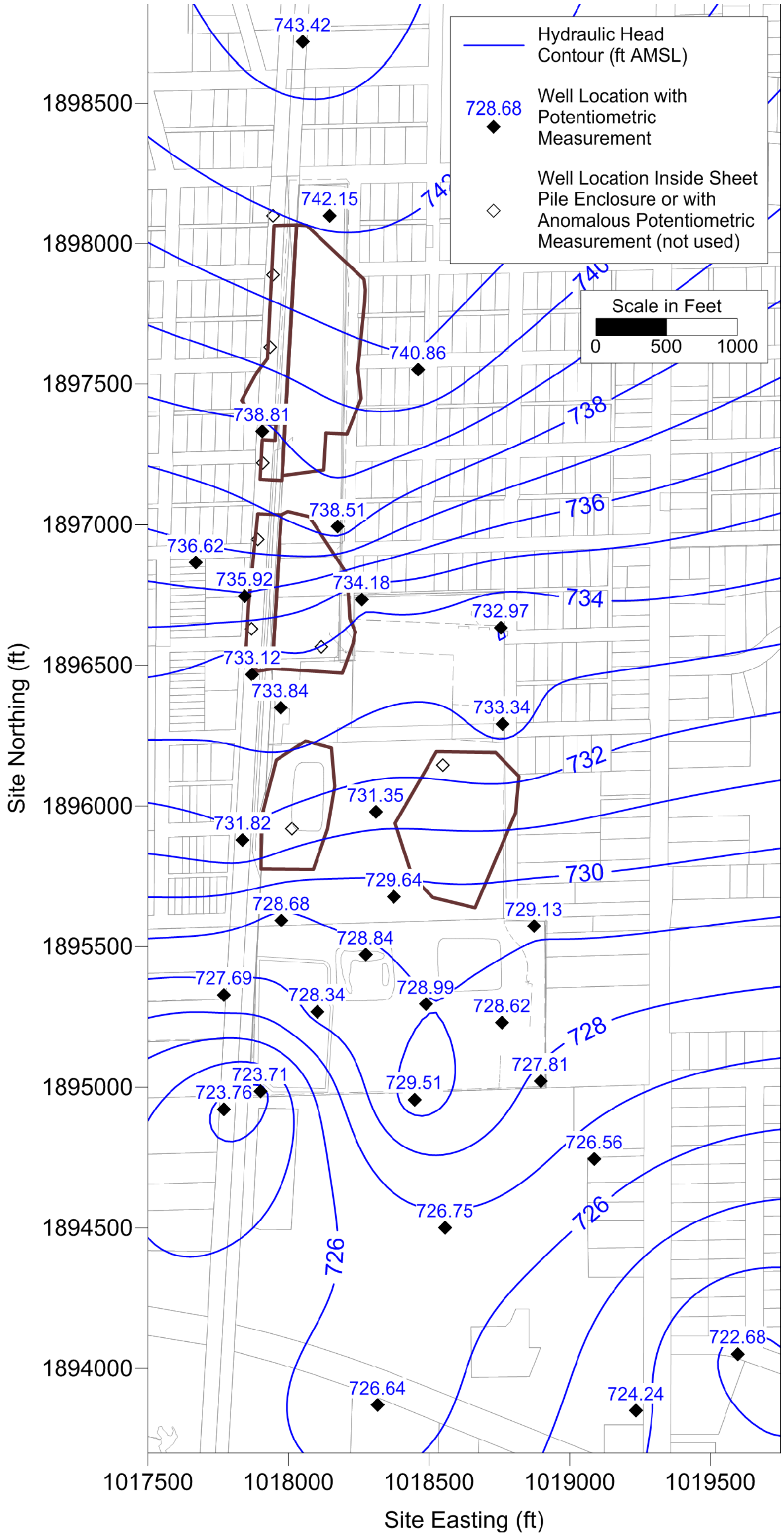
FIGURE 2.7.2.2-6



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PIEZOMETRIC SURFACE FOR THE E-STRATUM

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KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 2.7.2.2-7

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_2.7.2.2-7.DWG

2.8.1 Biota

2.8.1.1 Terrestrial

Prior to the start of remediation activities, the dominant ecological community at the Facility was successional old field and successional shrubland. The vegetational structure at the Site typified that of an early stage of succession, i.e., a mixture of disturbance-related aggressive species, prairie species, and remnants of landscape plantings. Predominant vegetation included common grasses (foxtail, bluegrass, ryegrass) and forbs (thistle, asters, goldenrod, cocklebur, Queen Anne's lace), with grasses and forbs typically associated with marshes and banks (cattails, reed canary grass) surrounding the ponds.

The fauna community typifies one associated with the above flora. Common species of mammals, birds, amphibians, and reptiles are present at the Facility.

2.8.1.2 Aquatic

The primary aquatic biota present at the Facility are species associated with small temporary and permanent ponds. The predominant vegetative species are duckweed and cattail. The benthic invertebrate fauna were plentiful but not diverse in previously conducted investigations, and included mayflies, damselflies, dragonflies, midges, mosquitoes, water scavenger beetles, and snails. The most abundant species present are those typical of urban or developed sites.

The aquatic habitats near the Facility, Kress Creek and the West Branch of the DuPage River, are typical of an agricultural or urban stream. The most abundant species present are those tolerant, or moderately tolerant, of organic enrichment and sedimentation.

2.8.1.3 Threatened and Endangered Species

No endangered or threatened species are known to be present at the West Chicago Facility.

2.8.2 Wetlands

A wetland survey was conducted at the Site in September 1993 by Rust Environment and Infrastructure. Seven potential wetland areas identified by the National Wetland Inventory Map for the Site were investigated. Six small areas were determined to meet the criteria for jurisdictional wetlands. Impacts to these areas have been coordinated with the Chicago District of the U.S. Army Corps of Engineers.

2.9 RADIOLOGICAL AND CHEMICAL CHARACTERISTICS

Environmental monitoring programs for the West Chicago Facility began in the late 1970s under the auspices of the USNRC. Since then, a routine sampling program for defined locations around the licensed area has been in operation. The most recent full year of environmental monitoring data is for 2011. The following sections summarize the 2011 environmental data and show the current sampling locations for radiological environmental monitoring at the West Chicago Facility.

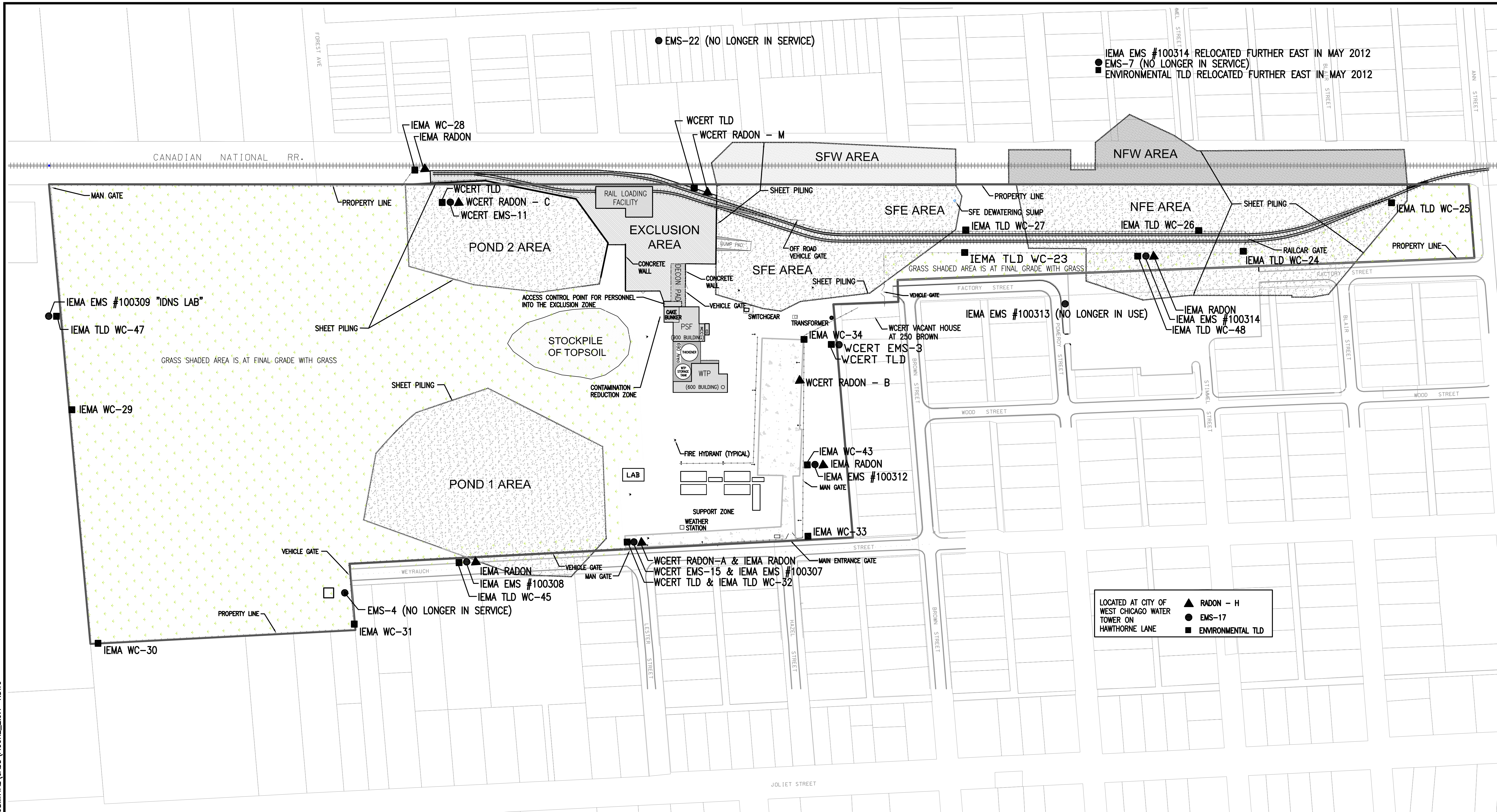
2.9.1 Air

The licensee presently operates an ambient radiological particulate monitoring network. The network consists of four Environmental Monitoring Stations (EMS) with total particulate air samplers. Sampling locations for airborne particulates as of December 2011 are shown in Figure 2.9.1-1 (Weston, 2012b). The particulate samplers measure the concentrations of several different radionuclides that may be released from the Facility. Filters are changed and analyzed weekly for natural thorium (Th-232). The weekly results are averaged by month and are shown in Table 2.9.1-1, along with the annual average concentrations. At the end of each quarter, the filters are composited and analyzed by gamma spectroscopy for natural uranium, Th-228, Th-232, Ra-226, Ra-228, and Pb-210. Table 2.9.1-2 provides the gamma spectroscopy results for the 2011 quarterly airborne particulate samples as well as the annual averages for 2011 (Weston, 2012b).

In addition to airborne particulates, radon (Rn-222 and Rn-220) is sampled and analyzed on a quarterly basis using co-located Type M and Type F track-etch detectors. The existing network consists of five radon detector locations, which can found on Figure 2.9.1-1. The Type M detectors measure the concentration of radon-222. The Type F detectors monitor total radon, that is, both radon-222 and radon-220, also known as thoron. Table 2.9.1-3 presents the 2011 radon-222 monitoring data for Type M detectors and Table 2.9.1-4 presents the total radon data for Type F detectors (Weston, 2012b).

2.9.2 Surface Water

The licensee presently conducts a surface water/storm sewer sampling program for chemical and radiological constituents. Table 2.9.2-1 lists the five locations that were sampled in 2011. These sampling locations are shown in Figure 2.9.2-1. Surface water samples are collected and analyzed quarterly for gross alpha activity. If the gross alpha measurement exceeds 10 pCi/L, the



NOTE:

SMALL SOIL STOCKPILES ARE PRESENT ON SITE BUT NOT DEPICTED ON THE DRAWING.

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EXISTING SITE PLAN & MONITORING LOCATIONS

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 2.9.1-1

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TABLE 2.9.1-1

2011 AIR PARTICULATE MONITORING DATA

EMS	Isotope	January	February	March	April	May	June	July	August	September	October	November	December	Annual Average
3	Th-alpha	2.7E-15	1.7E-15	1.9E-15	1.3E-15	2.0E-15	2.5E-15	2.4E-15	2.4E-15	2.5E-15	2.7E-15	2.7E-15	2.8E-15	2.3E-15
11	Th-alpha	1.8E-15	1.4E-15	1.3E-15	1.6E-15	1.6E-15	1.7E-15	2.8E-15	1.8E-15	2.0E-15	2.5E-15	2.8E-15	2.8E-15	2.0E-15
15	Th-alpha	1.9E-15	1.2E-15	2.5E-15	2.1E-15	1.8E-15	1.8E-15	2.2E-15	2.8E-15	2.5E-15	2.7E-15	3.0E-15	3.7E-15	3.7E-15
17	Th-alpha	1.7E-15	1.2E-15	1.7E-15	1.3E-15	1.4E-15	2.1E-15	2.3E-15	2.1E-15	2.3E-15	2.6E-15	2.5E-15	2.9E-15	2.0E-15

All activities in micro-Ci/ml

TABLE 2.9.1-2

2011 AIR SAMPLING GAMMA SPECTROSCOPY DATA

Isotope	**EMS-3 micro-Ci/ml**	**EMS-11 micro-Ci/ml**	**EMS-15 micro-Ci/ml**	**EMS-17 micro-Ci/ml**
Pb-210	2.4E-14	1.9E-14	2.2E-14	1.9E-14
Ra-226	5.7E-16	5.9E-16	7.2E-16	6.8E-16
Ra-228	2.8E-16	2.8E-16	2.9E-16	3.0E-16
Th-228 (a)	2.8E-16	2.8E-16	2.9E-16	3.0E-16
Th-232	2.8E-16	2.8E-16	2.9E-16	3.0E-16
U-234	3.6E-16	3.5E-16	3.5E-16	3.5E-16
U-235	1.6E-16	1.6E-16	1.6E-16	1.6E-17
U-238	3.6E-16	3.5E-16	3.5E-16	3.5E-16

(a) Assumed to be in equilibrium with Ra-228

TABLE 2.9.1-3

2011 RADON MONITORING DATA, TYPE M DETECTORS FOR RN-222

Location	First Quarter pCi/L	Second Quarter pCi/L	Third Quarter pCi/L	Fourth Quarter pCi/L	Annual Average pCi/L
A1	< 0.3	< 0.3	< 0.3	< 0.3	A
A2	< 0.3	< 0.3	< 0.3	< 0.3	0.3
B1	< 0.3	< 0.3	< 0.3	< 0.3	B
B2	< 0.3	< 0.3	< 0.3	0.4	0.3
C1	< 0.3	< 0.3	< 0.3	< 0.3	C
C2	< 0.3	< 0.3	< 0.3	< 0.3	0.3
H1	< 0.3	< 0.3	< 0.3	< 0.3	H
H2	< 0.3	< 0.3	< 0.3	< 0.3	0.3
M1	< 0.3	< 0.3	< 0.3	< 0.3	M
M2	< 0.3	< 0.3	< 0.3	< 0.3	0.3

TABLE 2.9.1-4

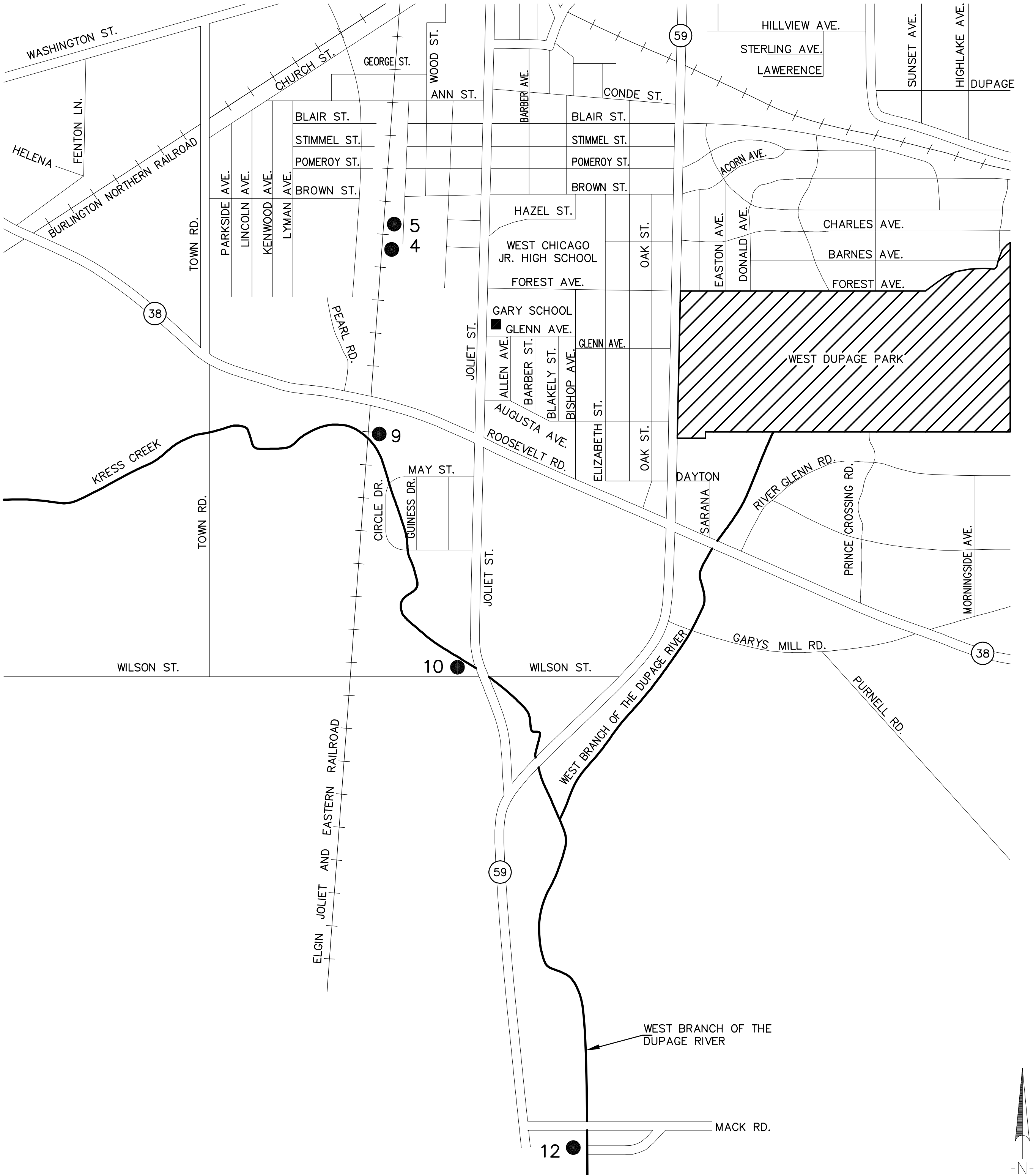
2011 RADON MONITORING DATA, TYPE F DETECTORS FOR RN-222 AND RN-220

Location	First Quarter pCi/L	Second Quarter pCi/L	Third Quarter pCi/L	Fourth Quarter pCi/L	Annual Average pCi/L
A1	< 0.3	0.7	0.4	< 0.3	A 0.4
A2	< 0.3	< 0.3	0.4	< 0.3	
B1	< 0.3	< 0.3	0.5	< 0.3	B 0.4
B2	< 0.3	0.5	0.5	< 0.3	
C1	0.4	1.6	0.4	< 0.3	C 0.8
C2	< 0.3	1.3	1.4	< 0.3	
H1	< 0.3	< 0.3	< 0.3	0.4	H 0.3
H2	< 0.3	< 0.3	< 0.3	< 0.3	
M1	< 0.3	0.8	1.2	1.1	M 1.0
M2	0.7	1.5	1.0	1.0	

TABLE 2.9.2-1

STORM SEWER AND SURFACE WATER SAMPLING LOCATIONS

Site	Type	Location
4	Storm Sewer	Intersection of Factory Street and Lester Street
5	Storm Sewer	Southern end of storm sewer extension under RR
9	Storm Water Outfall	East of EJ&E RR at Kress Creek
10	Creek	Joliet Street and Wilson Street
12	River	W. Branch DuPage River at Mack Road



● Surface Water Sampling Locations
West Chicago Facility

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SURFACE WATER SAMPLING LOCATIONS

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 | FIGURE 2.9.2-1

sample is further analyzed for natural uranium, Th-232, Th-228, Ra-228, and Ra-226. Table 2.9.2-2 summarizes the surface water radiological monitoring data for 2011 (Weston, 2012b).

2.9.3 Groundwater

During the operation of the Facility, a liquid waste stream was disposed of in settling ponds. Before the purchase of the Disposal Site, it is assumed that settling ponds were located within the Factory Site. After the purchase of the Disposal Site, effluent was routed to Pond 1 through Pond 5. The waste stream had a large load of suspended solids and is reported to have been discharged at a low pH. Table 2.9.3-1 lists the chemicals discarded at the Facility (NRC, 1989). The waste stream can be characterized as being high in total dissolved solids, sulfate rich, and fluoride rich. The raw material processed by the Facility was composed of rare earth oxides, monazite (a rare earth phosphate), and bastnaesite (a fluorocarbonate). Barium sulfate and sulfuric acid were used in the milling process. The settling ponds were unlined and provided a steady source of infiltrating water high in total dissolved solids to the glacial drift aquifer at the Site. The Site has not been operational since 1973. Until removed, the settling ponds, tailing piles, sediment piles, and contaminated soil and aquifer matrix material (with sorbed constituents) provided a source for contaminant loading to the aquifers underlying the Site.

The two aquifers at the Site that are of interest from an environmental impact perspective are the surficial glacial drift aquifer and the bedrock Silurian dolomite aquifer. These two aquifers receive their recharge from surface infiltration (precipitation) and therefore can potentially be impacted by surface contaminants. Aquifers below the Silurian dolomite aquifer receive little recharge from the overlying Silurian dolomite aquifer. The glacial drift aquifer at the Site contains three locally mappable transmissive zones. These are, from shallowest to deepest, the E-Stratum, the C-Stratum, and the A-Stratum.

Groundwater below the Site has been and is currently impacted by past operations and conditions at the Facility. Since groundwater samples have been collected (as early as 1976) in the glacial drift and Silurian aquifers, concentrations of conservative inorganic analytes and total dissolved solids have been declining. The decline in concentrations in the glacial drift wells has been attributed to the termination of site operations in 1973.

The first monitor wells at the Facility, designated B-1 through B-5, were installed in 1976 at the Disposal Site. Four wells were completed in the E-Stratum and one (B-2) was completed in the C-Stratum. Since that time, over 100 monitor wells have been completed in and around the Site.

TABLE 2.9.2-2

2011 ANNUAL AVERAGE SURFACE WATER SAMPLING DATA

	Surface Water Sampling Location				
	4	**5**	**9**	**10**	**12**
Gross alpha (pCi/L)	72	77	54	1.5	1.4
Ra-226 (pCi/L)	0.19	0.26	0.19	(a)	(a)
Ra-228 (pCi/L)	0.61	0.94	1.2	(a)	(a)
Th-228 (pCi/L)	0.014	< 0.01	0.014	(a)	(a)
Th-232 (pCi/L)	0.011	< 0.01	< 0.01	(a)	(a)
Uranium (pCi/L)	114	114	66	(a)	(a)

(a) Not analyzed unless gross alpha is greater than 10 pCi/L.

TABLE 2.9.3-1
CHEMICALS DISCARDED
AS WASTES FROM 1954 TO 1973 (NRC, 1989)

SOLID WASTES
Rare earth oxides
Barium sulfate
LIQUID WASTES
Sodium sulfate
Sodium chloride
Sodium fluoride
Monosodium phosphate
Ammonium chloride
Ammonium sulfate
Calcium chloride
Ethylenediaminetetraacetic acid
20% solution of 2-ethylhexylphosphate in kerosene

Currently, the corrective action monitoring network includes 74 monitoring wells and four dewatering sumps for sheet pile enclosed areas. An additional 12 on-site monitoring wells will be installed after final grading of the site is complete. Historically, N-series wells, completed in the E-Stratum off-site, were used as background wells for compliance purposes. The N-series wells were abandoned and background concentrations are now monitored at wells, EO-2, CO-2 and KMO-1.

Groundwater protection standards were developed for 20 constituents that were found to be elevated in the groundwater beneath the Site and are classified as hazardous constituents consistent with 10 CFR 40, Appendix A, Criterion 5B(2), or are regulated constituents according to 35 IAC 620 Class I groundwater standards. These constituents are: arsenic, boron, copper, chromium, cobalt, fluoride, adjusted gross alpha, iron, manganese, molybdenum, nickel, nitrate, combined radium-226 and radium-228, selenium, silver, sulfate, total dissolved solids, uranium-total, thorium-230, and zinc. Although elevated in concentration relative to background, many of these constituents do not currently exceed the respective groundwater protection standard at the site. In 2011, fluoride, adjusted gross alpha, iron, manganese, nickel, radium-226 and radium-228, sulfate, total dissolved solids and uranium exceeded their respective groundwater protection standards in one or more wells at the Site.

For those groundwater constituents that are above the respective groundwater protection standards, Kerr-McGee has implemented a corrective action program that will serve to return regulated constituent concentrations to the groundwater protection standards set by IEMA. The groundwater corrective action program includes: (a) source removal (completed in 2004 except for the area in the vicinity of the Railcar Loading Facility), (b) monitored natural attenuation, (c) hot spot pumping (as necessary), (d) PSF area grouting and/or flushing, (e) institutional controls and (f) groundwater monitoring.

Groundwater monitoring is governed by License Condition 6 of the Weston Solutions Inc. Radioactive Material License (STA-583), which requires quarterly sampling and analyses for nine constituents: fluoride, adjusted gross alpha activity, iron, manganese, nickel, combined radium-226 and radium 228, sulfate, total dissolved solids and total uranium. License Condition 6 allows annual analysis for a constituent in a well if the constituent has not exceeded the groundwater protection standard for three consecutive quarterly sampling events. Additionally, for constituents that have qualified for annual sampling at a well, License Condition 6 allows triennial analysis if the constituent does not exceed the groundwater protection standards for three annual sampling events. All wells must be sampled and analyzed for all 20 constituents at least once every three years. The first sample from a new well is analyzed for all 20 constituents, and the following three quarterly samples are analyzed for nine quarterly constituents.

Currently, 35 monitor wells are completed in the E-Stratum, and 28 monitor wells are completed in the C-Stratum at the Site. Five of the E-Stratum wells monitor non-PSF sheet pile areas. Monitor well ECI-1 is completed across both the E-Stratum and the C-Stratum and is not included in the monitor well totals above. The E- and C-strata merge over portions of the Intermediate Site, producing a thicker upper transmissive unit. The A-Stratum is not monitored at the Site but is hydraulically connected to the Silurian aquifer. Currently, there are 10 monitor wells completed in the upper portion of the Silurian dolomite aquifer at the Site.

Table 2.9.3-2 presents groundwater monitoring data for 2011. The data presented are the annual averages for 2011. The number of analyses for each constituent is shown in parentheses. A blank field for a well indicates that the constituent has qualified for triennial analysis and, therefore, no analyses were performed in 2011. Only the nine quarterly constituents (fluoride, adjusted gross alpha activity, iron, manganese, nickel, combined radium-226 and radium 228, sulfate, total dissolved solids and total uranium) are shown in Table 2.9.3-2. None of the other eleven constituents has exceeded the groundwater protection standard since 2003, and only nitrate in background well EO-2 was exceeded at that time.

2.9.4 Soils

Prior to 2006, the licensee conducted a sediment and depositional soil sampling program for radiological constituents. With the majority of the decommissioning activities completed, there was little or no ongoing source term for sediment or soil contamination. Therefore, the sediment and soil sampling program was discontinued by License Amendment 67, issued on February 27, 2006.

2.9.5 Biota

Biota sampling was not performed by the licensee.

2.9.6 Direct Gamma Radiation

Direct gamma radiation is monitored using thermoluminescent dosimeters (TLD) at three locations on the West Chicago Facility and one offsite uncontaminated location. The four locations currently monitored by the Licensee, which are depicted in Figure 2.9.1-1, are EMS-3, 11, 15, 17, and radon station M. The dosimeters are analyzed quarterly to determine the gamma exposure rate. The results of the direct gamma radiation monitoring for 2011 are provided in Table 2.9.6-1 (Weston, 2012b). The Closure Plan (Kerr-McGee, 1993) indicates that the background gamma radiation level for the West Chicago area is 10 ± 9 micro-Roentgens per hour.

TABLE 2.9.3-2

ANNUAL AVERAGE CONCENTRATIONS FOR 2011 GROUNDWATER SAMPLING DATA

Well	Fluoride (mg/L)	Gross Alpha (pCi/L)	Iron (mg/L)	Manganese (mg/L)	Nickel (mg/L)	Ra-226 + Ra-228 (pCi/L)	Sulfate (mg/L)	TDS (mg/L)	Uranium (pCi/L)
Groundwater Protection Standards									
	4	15 (adjusted)	5	0.61	0.1	5	400	1200	30
E-Stratum									
E-1[a]	3.55 (4)	34.03 (4)	0.76 (4)	0.051 (4)	0.002 (4)	1.62 (4)	133 (4)	726 (4)	34.95 (4)
E-2[b]	1.55 (2)	7.87 (2)	0.50 (2)	0.072 (2)	0.003 (2)	1.77 (2)	69 (2)	446 (2)	0.98 (2)
E-3[bh]	8.35 (2)	297.00 (2)	0.70 (2)	0.608 (2)	0.005 (2)	1.62 (2)	207 (2)	589 (2)	268.87 (2)
E-5[ch]	6.60 (1)	69.10 (1)	0.05 (1)	0.087 (1)	0.006 (1)	2.10 (1)	241 (1)	645 (1)	54.51 (1)
E-6[b]	7.10 (2)	11.26 (2)	0.01 (2)	0.575 (2)	0.013 (2)	1.54 (2)	239 (2)	713 (2)	14.80 (2)
E-7[bh]	2.85 (2)	11.65 (2)	0.65 (2)	0.355 (2)	0.013 (2)	1.32 (2)	588 (2)	1555 (2)	18.64 (2)
E-10[a]	7.43 (4)	41.95 (4)	0.99 (4)	0.212 (4)	0.017 (4)	1.21 (4)	194 (4)	1039 (4)	44.57 (4)
E-13[a]	10.48 (4)	15.64 (4)	0.03 (4)	0.042 (4)	0.006 (4)	1.43 (4)	139 (4)	859 (4)	18.00 (4)
E-14[a]	10.25 (4)	17.50 (4)	0.95 (4)	0.251 (4)	0.009 (4)	1.11 (4)	200 (4)	812 (4)	17.55 (4)
EB-1R	12.10 (4)	82.43 (4)							84.67 (4)
EB-2	0.40 (1)								5.97 (1)
EB-4R								1180 (1)	
EB-5	8.90 (4)							715 (2)	
EB-6R									
EB-7	3.78 (4)								
EB-8							266 (1)		
EB-9R									
EB-10[a]	9.85 (4)	8.61 (4)	0.33 (4)	0.221 (4)	0.004 (4)	1.35 (4)	132 (4)	414 (4)	4.46 (4)
EB-11[a]	11.75 (4)	105.23 (4)	0.07 (4)	0.025 (4)	0.013 (4)	1.18 (4)	277 (4)	1055 (4)	131.43 (4)
EB-12[a]	7.30 (4)	8.67 (4)	0.03 (4)	0.089 (4)	0.006 (4)	1.48 (4)	135 (4)	897 (4)	2.62 (4)
EC-9[bgh]	5.05 (2)	19.10 (2)	0.09 (2)	0.058 (2)	0.015 (2)	1.29 (2)	421 (2)	1230 (2)	22.14 (2)
EC-11[bgh]	7.45 (2)	69.30 (2)	0.02 (2)	0.075 (2)	0.007 (2)	1.43 (2)	290 (2)	1016 (2)	61.76 (2)
ECI-1[f]									
ED-2								2440 (1)	
ED-3									
ED-5	7.53 (4)		0.01 (1)						46.83 (4)
ED-6								1150 (1)	
ED-7	0.40 (1)		4.92 (4)					2063 (3)	
EF-5R	4.35 (4)								61.96 (4)
EF-6R	3.57 (3)								19.71 (1)
EF-7B	10.40 (3)							1110 (1)	
EF-9A								1070 (1)	
EF-13[a]	0.80 (4)	8.95 (4)	1.46 (4)	0.293 (4)	0.022 (4)	1.37 (4)	115 (4)	883 (4)	4.00 (4)
EO-2	0.40 (1)	7.72 (1)	0.01 (1)	0.003 (1)	0.001 (1)	1.38 (1)	63 (1)	619 (1)	3.36 (1)
TB-1R	6.38 (4)	56.90 (1)							52.72 (4)
TB-2	10.17 (3)	40.00 (1)							69.09 (4)
POND-1[d]	12.93 (4)						367 (3)	902 (3)	182.36 (4)
POND-2[d]	7.65 (4)							975 (1)	99.20 (4)
POND-4[d]	1.40 (1)								
SFEe	9.75 (4)						490 (4)	1278 (4)	136.31 (4)
C-Stratum									
C-1[a]	1.83 (4)	26.31 (4)	2.08 (4)	0.152 (4)	0.002 (4)	2.21 (4)	113 (4)	950 (4)	16.11 (4)
C-3[a]	2.13 (4)	6.37 (4)	6.66 (4)	0.159 (4)	0.144 (4)	1.45 (4)	867 (4)	2008 (4)	1.14 (4)
C-4[a]	1.35 (4)	8.21 (4)	1.72 (4)	0.120 (4)	0.011 (4)	1.56 (4)	212 (4)	640 (4)	0.23 (4)
C-5[a]	1.17 (4)	7.56 (4)	0.31 (4)	0.026 (4)	0.076 (4)	1.30 (4)	433 (4)	824 (4)	1.09 (4)
C-6[b]	0.40 (2)	9.93 (2)	13.20 (2)	0.138 (2)	0.134 (2)	2.87 (2)	1510 (2)	2780 (2)	0.25 (2)
C-7[b]	0.40 (2)	13.57 (2)	0.30 (2)	0.218 (2)	0.107 (2)	2.36 (2)	1255 (2)	3075 (2)	5.04 (2)
CB-1	13.03 (4)						452 (4)	1176 (4)	
CB-2			4.44 (1)						
CB-4			5.97 (4)					1120 (1)	
CB-5			4.84 (1)		0.076 (1)		676 (4)	1475 (4)	
CB-6									
CB-7			6.26 (3)		0.089 (3)		1072 (4)	2035 (4)	
CB-8			5.23 (4)				337 (1)	939 (1)	
CB-9									
CB-11[a]	1.63 (4)	7.35 (4)	3.79 (4)	0.213 (4)	0.035 (4)	1.39 (4)	316 (4)	946 (4)	0.26 (4)
CB-12[a]	2.33 (4)	7.03 (4)	5.27 (4)	0.304 (4)	0.039 (4)	1.27 (4)	333 (4)	1223 (4)	0.27 (4)
CD-2			7.20 (4)					1223 (4)	
CD-3									
CD-4			6.67 (4)			4.86 (4)		1788 (4)	
CD-5			8.28 (4)				675 (4)	1628 (4)	
CD-6							462 (4)	1210 (4)	
CD-7			5.82 (4)				770 (4)	1645 (4)	
CD-9							440 (3)	1167 (3)	
CD-11								1155 (4)	
CF-6								1050 (1)	
CF-13[a]	0.79 (4)	9.46 (4)	2.24 (4)	0.164 (4)	0.004 (4)	2.15 (4)	132 (4)	1140 (4)	0.45 (4)
CI-1									
CO-2	0.40 (1)	7.90 (1)	2.65 (1)	0.049 (1)	0.001 (1)	2.94 (1)	121 (1)	1170 (1)	0.32 (1)
Silurian									
KMB-1R									
KMB-2								1225 (4)	
KMB-4R									
KMB-5								1320 (4)	
KMB-6R									
KMB-7									
KMF-8R							1935 (4)	2953 (4)	
KMF-13[a]	0.98 (4)	6.63 (4)	3.59 (4)	0.044 (4)	0.037 (4)	1.79 (4)	442 (4)	1448 (4)	0.23 (4)
KMI-1								1368 (4)	
KMO-1	0.40 (1)	6.52 (1)	1.62 (1)	0.020 (1)	0.007 (1)	1.41 (1)	155 (1)	791 (1)	0.42 (1)

a) New well. First sampled first quarter 2011.
b) New well. First sampled third quarter 2011.
c) New well. First sampled fourth quarter 2011.
d) Dewatering sump.
e) Under-drain riser.
f) Well ECI-1 is completed across both the E- and C-Strata.
g) Wells EC-9 and EC-11 may be completed across both the E- and C-Strata.
h) Well located inside a sheet pile enclosure with no under-drain.

TABLE 2.9.6-1

2011 TLD EXPOSURE DATA

Location	**First Quarter (mrem)**		**Second Quarter (mrem)**		**Third Quarter (mrem)**		**Fourth Quarter (mrem)**		**Cumulative Annual (mrem)**	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
EMS-3	30.6	13.7	32.0	11.7	35.7	16.7	30.1	10.9	128.4	53.0
EMS-11	21.7	4.8	25.1	4.8	27.0	8.0	26.1	6.9	99.9	24.5
EMS-15	20.6	3.7	24.2	3.9	24.0	5.0	23.1	3.9	91.9	16.5
Radon Station M	17.3	0.4	18.7	-1.7	20.1	1.0	18.7	-0.5	74.8	-0.8
EMS-17 (Background)	24.5	7.6	26.4	6.1	30.2	11.1	27.7	8.5	108.8	33.3
Deploy Control	16.9	0.0	20.4	0.0	19.0	0.0	19.2	0.0	75.5	0.0

3.0 PLANNED CLOSURE ACTIVITIES

3.1 STRATEGY

The licensee's objective is to decommission the Facility so that the property can be released for public use and License STA-583 can be terminated. Excavated material that, after segregation, does not meet the decontamination criteria will be transported for permanent disposal at the EnergySolutions disposal facility near Clive, Utah. Decommissioning activities to date consist of seven phases: Phase I, Phase IA, Phase IB, Phase II, Phase IIA, Phase III, and Phase IV. Phase V activities, assessed in this Environmental Analysis Report, are scheduled for 2013 through 2014. Decommissioning of the site is expected to be complete by December 2014 with the exception of groundwater remediation.

Phase I consisted primarily of facilities construction and infrastructure improvements. These activities are described in *Phase I Remediation West Chicago Rare Earths Facility* (Kerr-McGee 1994a) and the *Environmental Assessment - Phase I for the Decommissioning of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, April 1994). In May 1994 IDNS issued a license amendment to Kerr-McGee authorizing Phase I activities.

Phase IA decommissioning activities included preparatory work to assess materials handling techniques and equipment performance in anticipation of subsequent loading and shipping operations. *Operating Facilities Construction* (Kerr-McGee 1994b) describes these activities. An *Addendum to the Environmental Assessment - Phase I for the Phase IA Decommissioning Activities of the Kerr-McGee West Chicago Rare Earths Facility* (Hanson Engineers, July 1994) provides an assessment of the proposed Phase IA operations.

West Chicago Rare Earths Facility Program for 1994/1995 (Kerr-McGee, 1994c) describes Phase IB activities. These activities are assessed in the *Environmental Analysis Report - Phase IB for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, July 1994a). Phase IB decommissioning activities included the excavation and processing of aboveground contaminated material piles and the preparation of containerized material, construction debris, and asbestos materials for loading and shipping to a licensed disposal facility. Up to 80,000 tons of contaminated material and debris were originally authorized to be shipped by railcar in Phase IB. This was subsequently amended to allow an additional 5,000 tons of contaminated material and debris to be shipped.

Phase II decommissioning activities included the excavation of on-site contaminated material above the water table, the receipt of a specified quantity of contaminated materials from off-site, installation of cutoff walls and dewatering systems, installation of an off-site groundwater monitoring network, the completion of the railspur and sheet piling, utility work, haul road construction, and the construction of the Stabilized Material Storage Building. These activities are assessed in the *Environmental Analysis Report - Phase II for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, February 1995).

The *Addendum to the Environmental Analysis Report - Phase II for the Phase IIA Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, June 1995) provides an assessment of the proposed Phase IIA activities. Phase IIA decommissioning activities included construction and operation of the Batch Water Treatment Plant (BWTP), construction and operation of the Water Treatment Plant (WTP), and construction and operation of the Physical Separation Facility (PSF).

Phase III decommissioning activities are described in the *Site Excavation Plan for the Kerr-McGee West Chicago Rare Earths Facility* (Kerr-McGee, December 1995) and the *Site Excavation Plan Amended Documents* (Kerr-McGee, April 1996). These activities are assessed in the *Environmental Analysis Report - Phase III for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, April 1996). Phase III decommissioning activities included excavation of contaminated material, installation of sheet piling, slurry walls, and dewatering systems, receipt of contaminated materials from off-site, completion of the railspur, construction of the Stabilized Material Storage Building, and construction and operation of the Batch Water Treatment Plant (BWTP), the Water Treatment Plant (WTP), the force main, and the Simplified Physical Separation Facility (SPSF). The SPSF assessed in Phase III is a downscaled version of the PSF originally contemplated by Kerr-McGee. The PSF redesign was undertaken as a result of physical separation testing conducted by Hazen Research in May through August 1995.

The *Site Excavation Plan for the Kerr-McGee West Chicago Rare Earths Facility* (June 1997) describes Phase IV activities. Phase IV decommissioning activities, originally scheduled for 1998 through 2002, are assessed in the *Environmental Analysis Report - Phase IV for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, January 1998). The activities assessed were excavation to remove all remaining contaminated material for the Site, installation of sheet pile, installation and operation of dewatering systems, backfilling of excavation and final grading, Stabilization/Neutralization (S/N) of on-site materials, transporting and handing contaminated materials, receipt of contaminated materials from off-site, loading of contaminated materials for off-site disposal, operation of the WTP and the SPSF, construction of a shoofly to allow excavation of contaminated material in the E. J. & E. right-of-way, and groundwater monitoring. Although the majority of Phase IV activities were completed, several tasks were not completed as originally scheduled. Uncompleted activities are addressed in this document.

The Plan and Cost Estimate for REF Completion (Weston, 2012c) describes Phase V activities. Phase V decommissioning activities scheduled from 2012 through license termination include:

- Groundwater remediation
- Erosion and surface water control
- Abandonment of water well in the Water Treatment Plant (WTP)
- Demolition of facilities including the Railcar Loading Facility (RLF), the Simplified Physical Separation Facility (SPSF), the Common Facilities (CF), the WTP, and the Support Zone
- Relocation of rail spurs
- Railcar loading of material for off-site disposal
- Excavation, verification, and restoration of the ground underlying the site facilities
- Stockpiling materials
- Final grading and seeding
- Groundwater monitoring

Quarterly groundwater monitoring is continuing. Over 100 monitor wells have been installed at and around the REF. Currently, the corrective action monitoring network includes 74 monitor wells, three dewatering sumps, and an underdrain riser. Groundwater monitoring is governed by the Radioactive Materials License STA-583.

3.2 SITE ACCESS AND SECURITY

The entire site is surrounded by a chain-link fence with three strands of barbed wire on top. The main entrance gate is always closed; however, authorized personnel are issued a device to open the motorized gate. A call box located outside the gate allows visitors to contact authorized personnel inside the Facility. During periods of high traffic in and out of the Site, a guard may be stationed at the main entrance and the gate left open. The Facility is equipped with 24-hour video monitoring and three separate alarm systems. The video monitors can be accessed with an internet-based viewer by authorized personnel. The alarm systems are monitored after normal business hours by Alarm Detection Systems in Aurora, Illinois.

Restricted areas at the Site have controlled access to protect individuals from exposure to radiation and radioactive materials. Training and personnel monitoring records are maintained for all employees and visitors.

3.3 DECOMMISSIONING ELEMENTS

3.3.1 Work Hours and Schedule

Phase V activities are scheduled to begin upon the issuance of a license amendment by IEMA. Decommissioning of the Site is scheduled to be complete by December 2014, with the exception of groundwater remediation.

The planned work hours for various activities are detailed below. Reporting activities, including safety meetings and other worker preparation activities, may occur outside of the times listed.

- 24 hours per day, Monday through Sunday
  - Groundwater and Dewatering System Operation
  - Indoor Maintenance
  - Inspection Including Verification
  - Laboratory Operation
  - Administration

- 6:20 am to 8:00 pm, Monday through Saturday
  - Opening and Closing of Stockpiles
  - Material Movement to and from Stockpiles

- 6:50 a.m. to 7:30 p.m., Monday through Saturday
  - Excavation
  - Railcar loading
  - All other activities not specifically listed elsewhere

- 8:00 a.m. to 6:00 p.m., Monday through Friday
  - Concrete demolition

The following sections detail the various Phase V decommissioning activities. These sections are formatted to first give a general description of the activity and then to discuss the specific task(s) that will be performed.

3.3.2 Groundwater Remediation

Groundwater remediation is addressed in the Corrective Action Program (CAP) (Weston, 2012a). The CAP indicates that monitored natural attenuation will be the primary groundwater corrective action at the Site. Several alternative corrective actions have also been proposed for areas that may not meet the groundwater protection standards within a reasonable time frame. These possible corrective actions include immobilization and/or flushing of constituents inside the sheet pile areas containing Physical Separation Facility (PSF) material (i.e., Pond 1, Pond 2 and South Factory Site East), hot-spot pumping, and immobilization of constituents through grouting inside the sheet pile areas that do not contain PSF material. Since any of these alternative corrective actions may be used based on the effectiveness of monitored natural attenuation and the results of PSF material grouting pilot tests, all options will be evaluated.

For remediation purposes, the Site can be divided into three types of areas: sheet pile enclosed areas that received PSF backfill material, sheet pile enclosed areas that did not receive PSF material backfill, and the remainder of the site which is outside the sheet pile enclosures. Figure 3.3.2-1 shows the sheet pile areas. Areas within the sheet pile enclosures are generally isolated from the local flow system and, therefore, essentially stagnant. As a result, these enclosed areas experience very limited natural attenuation. Some type of active remediation will likely be required in the sheet pile areas where concentrations exceed groundwater standards.

3.3.2.1 Monitored Natural Attenuation

Monitored natural attenuation is proposed as the primary groundwater corrective action at the Site. Monitored natural attenuation relies on natural processes to reduce constituent concentrations to the groundwater standards. These processes include advection, adsorption, dispersion, redox reactions, and precipitation. Groundwater monitoring (see Section 3.3.10) is the only action required for monitored natural attenuation.

3.3.2.2 PSF Area Flushing

Between 2005 and 2010, water was periodically pumped from the PSF areas in an attempt to reduce concentrations to the groundwater protection standards. Although concentrations fell over that time period, Weston decided that remediation through flushing may not be the best option for remediating the PSF areas. Weston is currently investigating the option to immobilize constituents by grouting the PSF material but has retained flushing as an option if grouting proves unfeasible.

Water is not currently being extracted from the PSF areas. During the time that water was being pumped from the PSF areas, the extracted groundwater was pumped to the on-site Water Treatment Plant (WTP). Treated groundwater was then discharged via a force main to a storm sewer, which conveyed the treated effluent to the West Branch of the DuPage River. Under the current plan for decommissioning the Site (Weston, 2012c), the WTP is scheduled for demolition. If flushing of the PSF areas is reinstated, a new water treatment plant will be needed.

3.3.2.3 PSF Area Immobilization through Grouting

The CAP (Weston, 2012a) indicates that constituent immobilization by grouting is the preferred method of groundwater remediation inside the PSF areas. Laboratory and field testing for PSF grouting is proposed prior to implementation of a grouting program. Various conventional grouting techniques will be evaluated and refined during lab testing and field trials. These techniques may be used independently or in combination. A brief description of standard industry grouting techniques potentially applicable to constituent immobilization is provided below.

Permeation Grouting

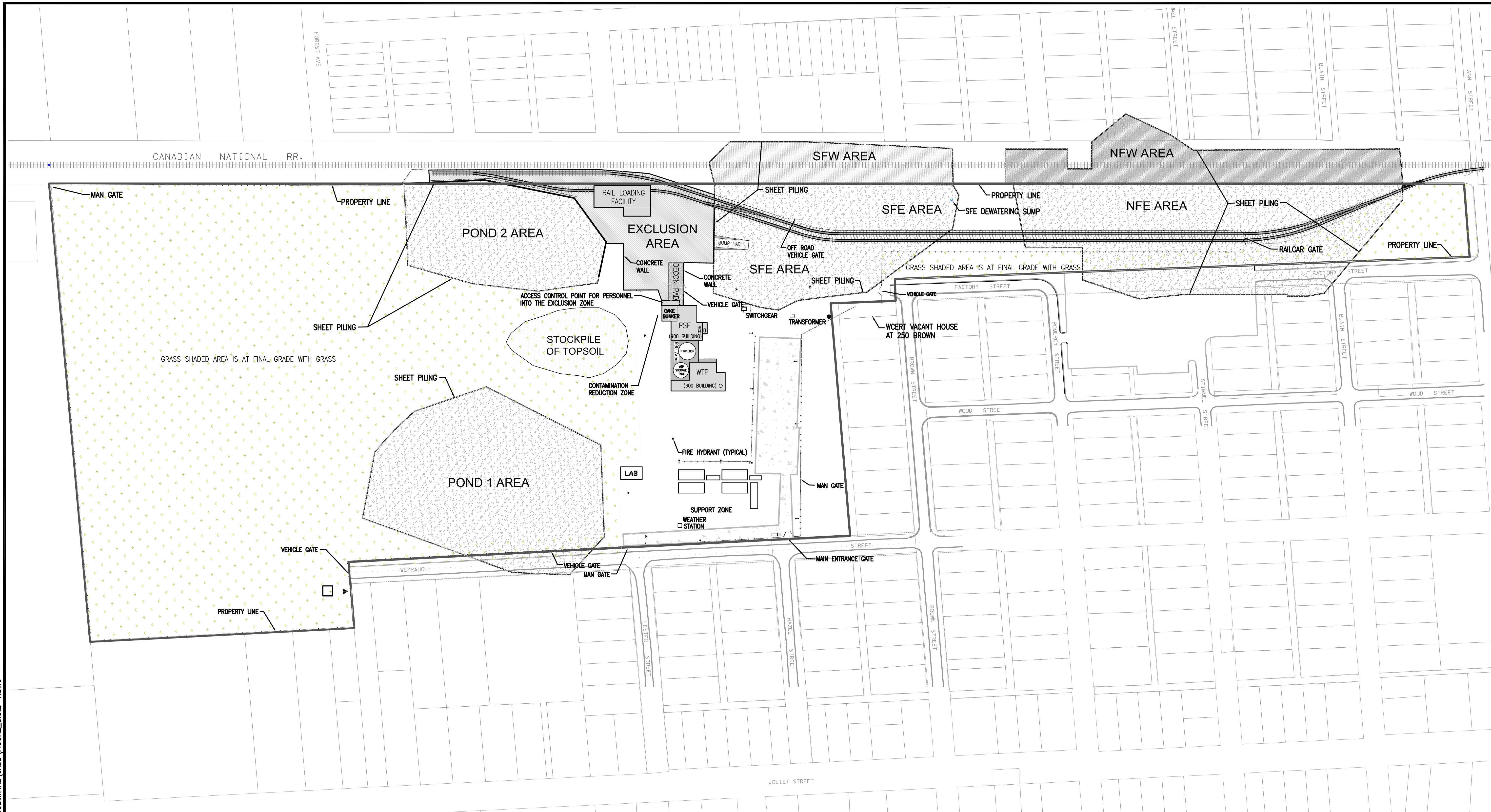
Permeation grouting uses grout pipes installed in a grid pattern throughout areas to be treated. Grout pipes are spaced so that grout zones will overlap, thus ensuring proper grout permeation throughout the entire treatment area. The grout would fill the pore spaces in the PSF material, displacing the groundwater gradually. This water may be treated and discharged or may be used in the grouting process. Permeation grouting would not produce a significant amount of spoil.

Jet Grouting

Jet grouting uses high-pressure injection to force grout into the material to be grouted. As with permeation grouting, injection locations would be spaced so that grout columns will overlap, thus ensuring proper grouting of the entire treatment area. Jet grouting produces a significant amount of spoil material that would require disposal. However, the grout slurry will mix with groundwater, thus reducing the amount of water that will need to be treated.

Soil Mixing

Soil mixing involves the mechanical homogenization of in-situ material with a grout slurry. Soil mixing would produce very little spoil or groundwater that would require treatment or disposal.



NOTE:
SMALL SOIL STOCKPILES ARE PRESENT ON SITE BUT NOT DEPICTED ON THE DRAWING.

SCALE IN FEET
220 0 220 440

HANSON
Hanson Professional Services Inc.

SHEET PILE ENCLOSURES

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 3.3.2-1

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_3.3.2-1.DWG

3.3.2.4 PSF Area Chemical Immobilization

The CAP (Weston, 2012a) included chemical immobilization as an option for remediation in the PSF areas. Chemical immobilization involves injecting chemical additives into the PSF areas to immobilize constituents through chemical reactions. For example, phosphate could be added to immobilize uranium. The phosphate would react with uranium to form insoluble species such as uranyl phosphate, which would precipitate out of solution and, thus, immobilize the uranium.

3.3.2.5 Hot-Spot Pumping

Hot-spot pumping was proposed in the CAP (Weston, 2012a) for areas that do not improve within a reasonable time period under natural attenuation alone. This pump and treat option will be used in the E-Stratum, C-Stratum and/or Silurian as needed. Low flow or stagnant areas inside and down gradient of the sheet pile enclosures may require hot-spot pumping where concentrations exceed the standards. The Site transport model (Appendix G of Weston, 2012a) will be used to determine the optimal locations and pumping rates for hot-spot pumping wells.

Hot-spot pumping may also be used if analysis suggests that hot-spot pumping will cost effectively reduce constituent concentrations to below the groundwater standards and achieve license termination in an earlier timeframe. The CAP (Weston, 2012a) states that hot-spot pumping is anticipated to be of relatively brief duration, continuing until the concentrations within the hot spots are compatible with those in the surrounding areas.

Extracted groundwater that exceeds NPDES permit limits or limits in the Radioactive Material License will require treatment before discharge. Under the current plan for decommissioning the Site (Weston, 2012c), the WTP is scheduled for demolition. If hot-spot pumping is used, a facility for treating the extracted water will be needed.

3.3.2.6 Immobilization in non-PSF Sheet Pile Areas

For areas inside sheet pile enclosures that do not contain PSF material, the CAP (Weston, 2012a) proposes localized grouting at locations where constituents exceed the groundwater standards. This grouting would be followed by additional sampling all around the grouted area to verify that the groundwater is no longer being impacted. Currently, three such locations have been identified: a geoprobe sampling point in the North Factory Site East, wells E-3 and E-7 in the North Factory Site West, and wells E(C)-9 and E(C)-11 in the South Factory Site West.

3.3.3 Erosion and Surface Water Control

Surface water will be controlled to accomplish the following:

- Prevent any contaminated water from leaving the Site
- Prevent the contamination of uncontaminated areas by water migration from contaminated areas
- Minimize the migration of water generated in uncontaminated areas into contaminated areas
- Minimize erosion of excavation and stockpile slopes

This type of control will result in a more efficient operation by eliminating re-excavation of previously cleaned areas and reducing the amount of water requiring treatment.

Any water that comes in contact with an area not verified as uncontaminated is designated contact water. Non-contact water is any water that comes in contact only with areas verified to be uncontaminated. As much as possible, non-contact water will be contained in the uncontaminated area where it has collected so that it does not become contact water. Water control berms and ditches will be constructed as required to prevent areas that have been verified as uncontaminated from becoming contaminated by runoff from excavation areas or stockpiles.

Within excavations during the course of normal excavation activities, backfill will be protected by backfill protection berms. These temporary berms will be constructed of clean material. Water collected within the excavation will be pumped out.

Berms will also be constructed around stockpiles to prevent fine particles in storm water runoff from migrating. Since none of these piles will exist without redistribution for more than a few months, there will be little time available to generate a significant quantity of eroded material.

All contact water generated on-site by surface water runoff coming in contact with potentially contaminated material will be collected in a tank. The contact water collected in the RLF area will be used for dust suppression.

All erosion and surface water control will be maintained pursuant to permits from Illinois EPA (General NPDES Permit No. ILR10-2578) and DuPage County (Permit #94-34-0071).

3.3.4 Water Well

The water well in the WTP will be abandoned prior to demolition of the WTP. Alternately, Weston may decide to repair the water well pump and configure it for generator operation. The well would then be used as a water source for Phase V decommissioning activities.

3.3.5 Demolition of Structures

Decommissioning of the Site will require that several structures be demolished. Existing structures to be demolished include the modular offices, the guard shack and the site laboratory. In addition, facilities constructed for the purpose of site remediation will be demolished. These include the Simplified Physical Separation Facility (SPSF), the Common Facilities (CF), the Water Treatment Plant (WTP), the Railcar Loading Facility (RLF), and railspurs in the RLF area. Concurrent with demolition of the RLF, the existing dump pad will be removed. Service utilities will be disconnected and abandoned in accordance with City of West Chicago requirements prior to demolition of structures. The SPSF was shut down and decommissioned in 2004. The WTP was shut down and decommissioned in December 2010. Demolition of all structures is scheduled in 2013.

Weston will salvage, resell, or dispose of all chemicals and waste materials at the WTP. A washdown of the interior surfaces of the SPSF and the CF will be performed to remove potential surface contamination. Then a pre-demolition radiological survey will be performed in the SPSF/CF/WTP facilities including the cake bunker, motor control center, generator enclosure, steel platforms, and the RLF to determine the extent of radiological contamination.

If the pre-demolition survey indicates significant contamination such that specialized dismantling and demolition will be needed, a special contract will likely be awarded for those areas.

If the pre-demolition survey indicates that contamination is not extensive such that specialized dismantlement and demolition is not needed for most of the work, a plan will be developed that specifies the extent of surveying required during demolition. The project could then be approached primarily as a radiologically clean demolition, with any pre-identified contaminated components addressed on a case-by-case basis.

After demolition of the SPSF/CF/WTP buildings and the RLF building, the associated concrete slabs, walls, footings, and piers will be removed. The material condition of concrete removed will be evaluated and one of the following three disposal options selected:

- Competent concrete, which is easy to decontaminate, will be utilized as uncontaminated backfill.
- Crumbly, contaminated material that can not be effectively decontaminated will be sent to the EnergySolutions facility near Clive, Utah for disposal.
- Cracked slabs will be crushed, judged on a bulk basis as to whether they meet the decontamination criteria, and be sent to the EnergySolutions disposal facility in Utah or to backfill accordingly.

Concrete that is verified to be uncontaminated will be stockpiled in an uncontaminated fill area until an excavation area is ready for backfilling. Concrete that remains contaminated after decontamination and/or testing will be transferred to a stockpile in a contaminated area for shipment. Concrete decontamination and on-site disposal will be performed in accordance with procedures outlined in the Closure Plan (Kerr-McGee, 1997f)

The demolition contractor will provide pumps and tanks for temporary storage of runoff water from the RLF area as well as wash water and water from dewatering excavations. The pumps and tanks will continue to be used after demobilization of the demolition contractor while the rail spur is relocated and during verification excavation of the RLF area.

3.3.6 Relocation of Rail Spurs

The existing rail turn out and crossover will be relocated to a new alignment by a rail contractor. The new alignment will be straight south from the existing rail curve to approximately 30-ft north of the south sheet pile wall. Existing embankment from the dump pad and rail spur will be re-used for the new rail spur embankment and a new loading ramp. The rail bumper will also be salvaged and re-used. Temporary scaffolding will be erected to facilitate rail car loading operations.

A mobile crane will be used to lift off and set on car lids. The temporary scaffolding will be used to monitor loading progress, clean sidewall tops, latch lids and survey cars.

3.3.7 Excavation, Verification, Restoration

Weston estimates there is approximately 24,200 bank cubic yards of soil to be excavated. The majority of the soil to be excavated is in the RLF area where excavation will occur to the D-stratum. Excavation depth will be approximately 25-feet on the north side of the Pond 2 sheet pile. Active excavation areas will be radiologically surveyed during excavation to determine if exposed surfaces are contaminated. Removal of material will continue to the City of West Chicago verification points and until the base of the excavation is below the radiological cleanup standard based on field surveying.

A laydown area for verification will be established within the Pond 2 sheet pile area. The verification area will have an 8-inch gravel base if the sheet pile area is not grouted and will be large enough to accommodate soil from one day of excavation. The excavated material will be spread in 6-inch lifts for walkover verification. Localized removal of material in each lift may be performed if elevated walkover readings are obtained. Verified lifts can be overlain with a new lift to be verified. Health physicists will collect soil samples for laboratory analysis every three lifts.

Verified excavated material will be re-used as backfill if determined to be clean. Material that does not meet cleanup standards will be shipped by rail to the EnergySolutions facility near Clive, Utah for disposal.

3.3.8 Stockpiles

Materials to be shipped by rail will be stockpiled separately near the railcar loading area. The stockpile area will be bermed to prevent runoff from flowing into clean areas. Stockpiles will be tarped at the end of each day and the tarps extended to the clean side of berms to minimize the volume of runoff from contaminated materials and the contaminated area.

3.3.9 Final Grading and Seeding

It is estimated that after excavation and verification, 8,500 cubic yards of fill will remain to be placed across the site. After backfilling, 6-inches of top soil will be placed in the RLF area, north of the RLF area, in the Pond 1 and Pond 2 areas, and in the Support Zone. An estimated 16,450 cubic yards of top soil will be required, 9,850 cubic yards of which will be imported. A total of 20.4 acres will be seeded.

Final backfill grades are shown on Figure 3.3.9-1. The final grade is designed to direct surface water toward the southern section of the Disposal Site which will provide 31 acre-feet of detention capacity as required by the City of West Chicago.

3.3.10 Groundwater Monitoring

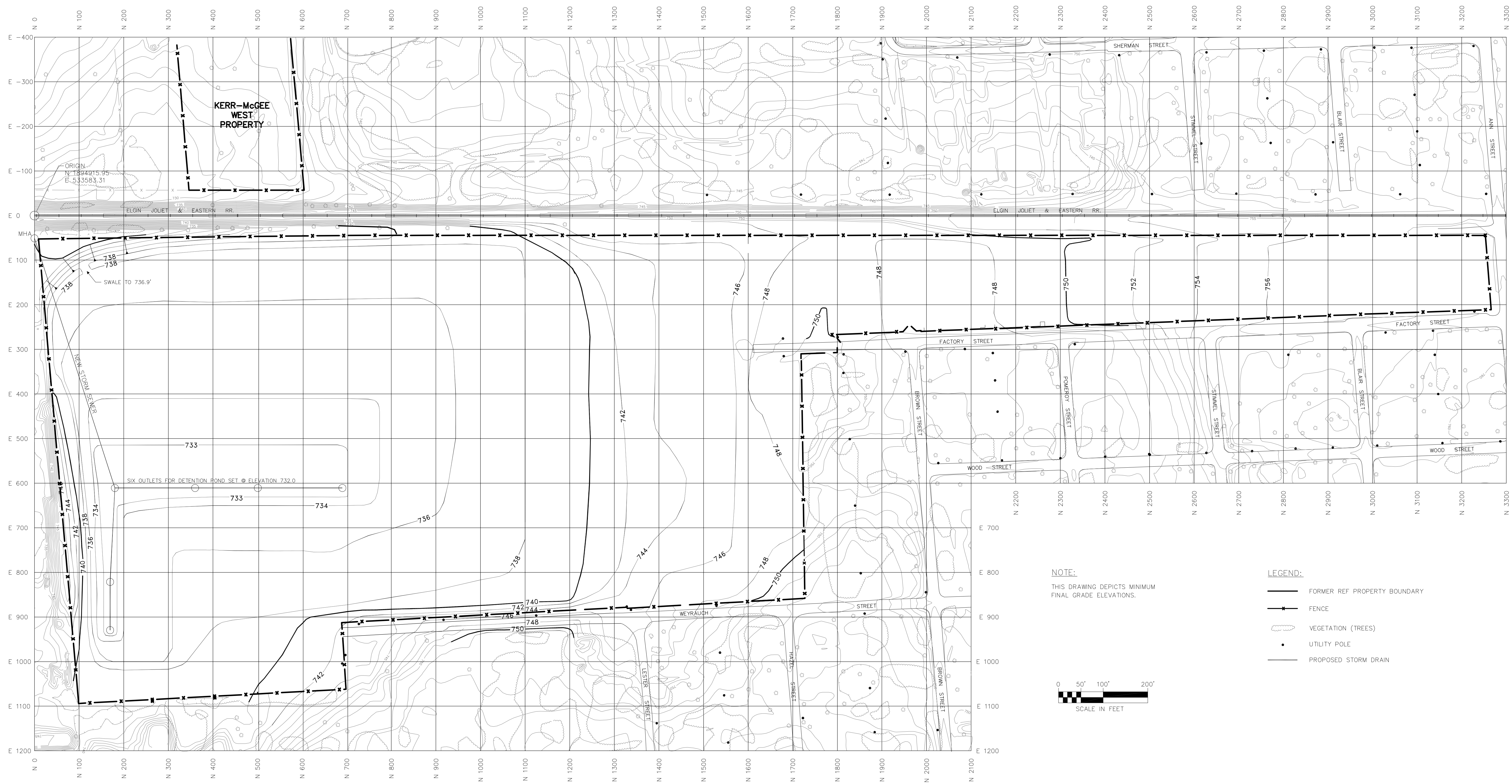
The first monitor wells at the Facility were installed in 1976 at the Disposal Site. Since that time, over 100 monitor wells have been completed in and around the Site. Currently, the corrective action monitoring network includes 74 monitoring wells, three dewatering sumps for former excavation areas (Pond-1, Pond-2 and Pond-4) and an underdrain riser (South Factory Site East). An additional 12 on-site monitoring wells will be installed after final grading of the site is complete.

Three of the monitoring wells, EO-2, CO-2 and KMO-1, are used to determine background groundwater quality in the vicinity of the Site in the E-Stratum, the C-Stratum, and the Silurian dolomite aquifer. These wells allow for groundwater sampling either upgradient (EO-2 and CO-2) or sidegradient (KMO-1) to the site in areas considered to be unaffected by site activities.

Groundwater protection standards were developed for 20 constituents that were found to be elevated in the groundwater beneath the Site and are classified as hazardous constituents consistent with 10 CFR 40, Appendix A, Criterion 5B(2), or are regulated constituents according to 35 IAC 620 Class I groundwater standards. These constituents are: arsenic, boron, copper, chromium, cobalt, fluoride, adjusted gross alpha, iron, manganese, molybdenum, nickel, nitrate, combined radium-226 and radium-228, selenium, silver, sulfate, total dissolved solids, uranium-total, thorium-230, and zinc.

Groundwater monitoring is governed by License Condition 6 of the Weston Solutions Inc. Radioactive Material License (STA-583), which requires quarterly sampling and analyses for nine constituents: fluoride, adjusted gross alpha activity, iron, manganese, nickel, combined radium-226 and radium 228, sulfate, total dissolved solids and total uranium. License Condition 6 allows annual analysis for a constituent in a well if the constituent has not exceeded the groundwater protection standard for three consecutive quarterly sampling events. Additionally, for constituents that have qualified for annual sampling at a well, License Condition 6 allows triennial analysis if the constituent does not exceed the GWPS for three annual sampling events. All wells must be sampled and analyzed for all 20 constituents with groundwater protection standards at least once every three years. For new wells, the first sample must be analyzed for all 20 constituents and the following three quarterly samples are analyzed for the list of nine quarterly constituents. Background wells must be sampled annually.

Currently, there are 35 monitor wells completed in the E-Stratum, 28 monitor wells completed in the C-Stratum, 10 monitor wells completed in the upper portion of the Silurian dolomite aquifer, and one monitor well (ECI-1) completed across both the E- and C-Strata. Five of the E-Stratum wells monitor non-PSF sheet pile areas. The three sheet pile areas with PSF fill (Pond 1, Pond 2, and South Factory Site East) and Pond 4 are also monitored. The A-Stratum is not monitored at the Site but is hydraulically connected to the Silurian aquifer.



NOTE:

THIS DRAWING DEPICTS MINIMUM FINAL GRADE ELEVATIONS.

LEGEND:

FORMER REF PROPERTY BOUNDARY
FENCE
VEGETATION (TREES)
UTILITY POLE
PROPOSED STORM DRAIN

0 50' 100' 200'
SCALE IN FEET

HANSON
Hanson Professional Services Inc.

FINAL GRADING PLAN

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 3.3.9-1

I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_3.3.9-1.DWG FEB 05, 2013 2:58PM MADAU00223

Table 3.3.10-1 lists the current wells in the corrective action monitoring network along with coordinates and completion information. Table 3.3.10-2 lists additional wells that will be added to the corrective action monitoring network. The locations of the wells are shown in Figure 3.3.10-1. Locations for the proposed additional wells are approximate.

TABLE 3.3.10-1

CURRENT MONITORING WELLS

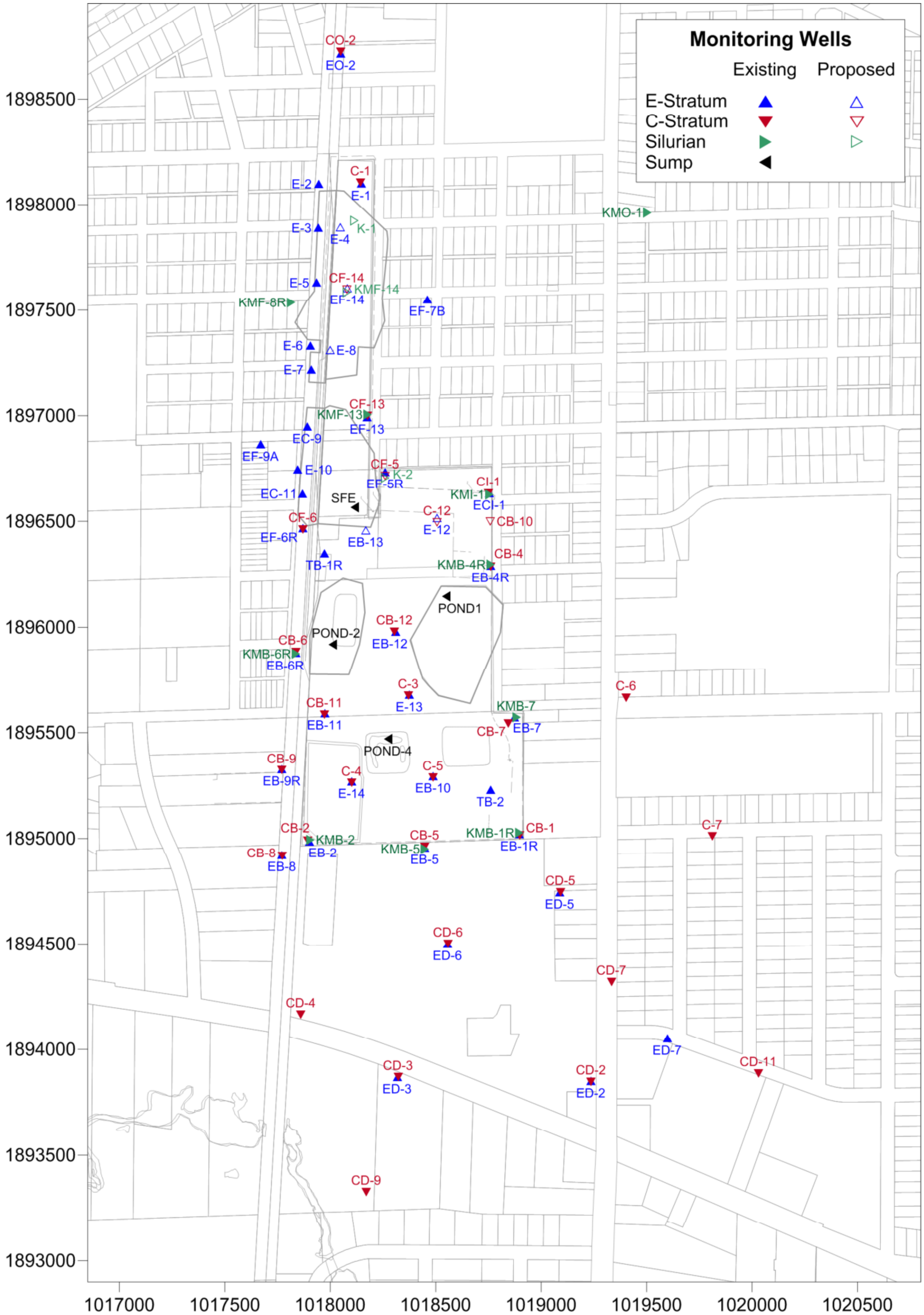
Well[a]	Easting (NAD83-1997)	Northing (NAD83-1997)	Ground Elevation (NGVD29)	Top of Well (NGVD29)	Top of Screen (NGVD29)	Bottom of Well (NGVD29)
E-Stratum						
E-1	1018147.14	1898099.99	757.85	757.56	744.9	739.9
E-2	1017945.18	1898098.92	756.80	756.50	740.2	734.8
E-3[g]	1017944.06	1897889.33	754.60	754.30	743.0	732.6
E-5[g]	1017933.91	1897631.07	753.43	753.22	749.8	739.4
E-6	1017906.28	1897331.40	747.29	749.53	738.7	728.3
E-7[g]	1017909.12	1897219.33	747.01	749.74	737.9	727.5
E-10	1017844.65	1896746.25	745.46	748.07	737.5	727.5
E-13	1018375.49	1895678.02	733.69	733.40	722.7	712.7
E-14	1018102.29	1895268.05	735.36	735.02	725.4	720.4
EB-1R	1018896.79	1895021.10	738.30	742.09	728.0	718.0
EB-2	1017900.64	1894985.30	730.75	730.81	727.0	717.5
EB-4R	1018760.14	1896291.69	746.98	749.61	731.6	716.3
EB-5	1018448.02	1894956.04	735.44	736.61	733.0	728.2
EB-6R	1017837.02	1895878.89	739.32	741.84	734.3	724.1
EB-7	1018872.65	1895572.39	742.42	744.55	739.0	714.0
EB-8	1017771.04	1894921.73	728.97	731.26	720.8	710.6
EB-9R	1017770.46	1895327.53	730.49	732.72	724.9	719.9
EB-10	1018488.21	1895294.28	733.93	733.48	729.4	724.4
EB-11	1017974.93	1895592.43	737.04	736.66	726.0	716.0
EB-12	1018309.85	1895978.37	737.80	740.51	720.8	715.8
EC-9[fg]	1017890.58	1896948.13	745.95	748.37	726.5	716.1
EC-11[fg]	1017867.97	1896630.32	745.01	747.16	733.4	723.0
ECI-1[e]	1018755.41	1896632.92	752.52	753.72	743.9	715.5
ED-2	1019236.41	1893850.15	735.55	736.49	728.8	720.5
ED-3	1018317.56	1893870.07	735.69	736.49	728.9	718.6
ED-5	1019088.00	1894744.58	738.42	740.94	730.6	720.3
ED-6	1018556.44	1894500.87	735.60	736.13	729.8	724.5
ED-7	1019598.20	1894051.84	733.42	732.86	722.8	717.0
EF-5R	1018260.04	1896733.96	752.30	754.98	734.7	724.4
EF-6R	1017870.51	1896467.32	743.71	746.54	733.8	723.9
EF-7B	1018460.61	1897551.11	753.41	756.06	746.2	736.0
EF-9A	1017669.84	1896865.24	747.45	748.08	741.3	731.2
EF-13	1018175.48	1896992.64	747.17	746.92	734.2	729.2
EO-2b	1018050.12	1898715.54	751.28	752.77	744.7	739.5
TB-1R	1017971.47	1896350.00	750.92	753.57	737.0	726.6
TB-2	1018759.71	1895228.97	736.47	736.14	728.5	718.5
POND-1[c]	1018549.71	1896144.53	N/A	N/A	N/A	N/A
POND-2[c]	1018011.90	1895919.02	N/A	N/A	N/A	N/A
POND-4[c]	1018274.05	1895470.31	N/A	N/A	N/A	N/A
SFEd	1018116.34	1896565.83	N/A	N/A	N/A	N/A
C-Stratum						
C-1	1018144.20	1898104.68	757.78	757.58	719.8	714.8
C-3	1018370.68	1895674.94	733.76	733.48	709.8	699.8
C-4	1018101.98	1895261.69	735.16	734.98	699.2	689.2
C-5	1018487.31	1895287.39	733.81	733.46	680.8	675.8
C-6	1019402.70	1895665.44	746.46	746.15	689.6	679.0
C-7	1019811.37	1895009.64	747.08	746.75	702.1	691.5
CB-1	1018897.22	1895015.50	738.41	742.19	700.9	690.9
CB-2	1017892.65	1894989.80	730.81	733.33	705.3	700.3
CB-4	1018760.45	1896286.47	746.75	749.48	706.5	696.2
CB-5	1018447.76	1894960.88	736.06	736.77	698.8	694.0
CB-6	1017837.73	1895883.92	739.28	742.12	709.4	699.2
CB-7	1018844.11	1895544.29	741.74	741.43	703.2	693.3
CB-8	1017771.20	1894916.75	728.48	731.40	702.8	697.6
CB-9	1017770.15	1895322.05	730.42	732.45	709.9	704.9
CB-11	1017973.01	1895585.86	737.08	736.58	707.1	697.1
CB-12	1018304.79	1895979.10	737.87	740.59	704.9	699.9
CD-2	1019236.73	1893847.31	735.69	736.44	709.0	688.7
CD-3	1018321.99	1893868.67	735.74	736.55	705.6	695.3
CD-4	1017860.77	1894165.36	731.15	731.96	710.9	700.6
CD-5	1019091.59	1894744.19	738.49	741.02	693.6	686.4
CD-6	1018559.04	1894500.84	735.66	736.39	705.6	691.3
CD-7	1019333.84	1894319.64	734.41	734.09	700.7	690.0
CD-9	1018171.25	1893326.34	732.52	734.98	703.8	693.0
CD-11	1020030.07	1893886.38	734.91	734.61	708.4	703.2
CF-6	1017870.62	1896462.61	743.94	746.13	703.8	693.9
CF-13	1018175.74	1896998.98	747.43	747.20	713.4	703.4
CI-1	1018750.87	1896633.07	752.62	755.54	710.9	700.9
CO-2[b]	1018050.12	1898722.27	751.20	753.27	720.8	710.7
Silurian						
KMB-1R	1018896.53	1895026.40	738.70	742.09	651.4	646.4
KMB-2	1017904.98	1894994.40	730.77	731.34	653.0	648.0
KMB-4R	1018760.23	1896296.80	746.83	749.65	651.1	645.8
KMB-5	1018448.16	1894950.75	735.30	736.56	658.8	654.0
KMB-6R	1017836.78	1895873.78	739.37	741.65	660.0	655.0
KMB-7	1018883.76	1895571.79	742.62	745.32	657.3	652.3
KMF-8R	1017813.63	1897536.85	753.76	756.22	670.1	665.0
KMF-13	1018176.69	1897005.39	747.55	747.43	668.6	663.6
KMI-1	1018755.12	1896626.60	752.63	754.61	665.3	660.3
KMO-1[b]	1019503.60	1897961.13	749.54	749.29	677.3	672.3

a) Well data was obtained from Table 5.1 of the Corrective Action Program, Revision 5, Former Rare Earths Facility, West Chicago, Illinois.
b) Background well.
c) Dewatering sump.
d) Under-drain riser.
e) Well ECI-1 is completed across both the E- and C-Strata.
f) Wells EC-9 and EC-11 may be completed across both the E- and C-Strata.
g) Well located inside a sheet pile enclosure with no under-drain.

TABLE 3.3.10-2

PROPOSED ADDITIONAL MONITORING WELLS

Well
E-Stratum
E-4
E-8
E-12
EB-13
EF-14
C-Stratum
C-12
CB-10
CF-5
CF-14
Silurian
K-1
K-2
KMF-14



MONITORING WELL LOCATION MAP

HANSON

Hanson Professional Services Inc.

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 3.3.10-1

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_3.3.10-1.DWG

4.0 CLOSURE MONITORING

4.1 LICENSEE'S PROGRAM

During Phase V operations, Weston will monitor on-site and off-site levels of radiation and radioactive material emissions. Weston's operational monitoring program will include sampling of air particulates, radon and thoron gas, groundwater, surface water, and direct gamma radiation. Weston's current operational monitoring program is summarized in Table 4.1-1.

In general, samples will be analyzed for uranium, thorium, radium, and some of their decay products, depending on the sample type and gross alpha activity. Air particulate activity is sampled and analyzed on a weekly basis and other media are analyzed on a quarterly basis. Additionally, groundwater is analyzed for various non-radiological constituents.

Four air sampling points are monitored for suspended particulates. Three of the four Environmental Monitoring Stations (EMS) are shown in Figure 4.1-1. The fourth (EMS-17) is a background station located about two miles north-northwest of the Site. For Phase V activities, air particulate sampling will be conducted weekly at each location. Samples will be analyzed weekly for natural thorium. In addition, quarterly composites of these daily samples will be analyzed for the constituents listed in Table 4.1-1. The results will be compared with the effluent release values referenced in 32 IAC 340.320.

Radon and thoron gas will continue to be measured at five locations during Phase V activities. These include radon stations A, B, C, H, and M, as indicated in Figure 4.1-1. Radon station H is the background monitor and is co-located with EMS-17, about two miles north-northwest of the Site. Each sampling location has two types of alpha track-etch detectors that monitor Rn-222 and total radon (Rn-222 plus Rn-220). The detectors are changed and analyzed quarterly.

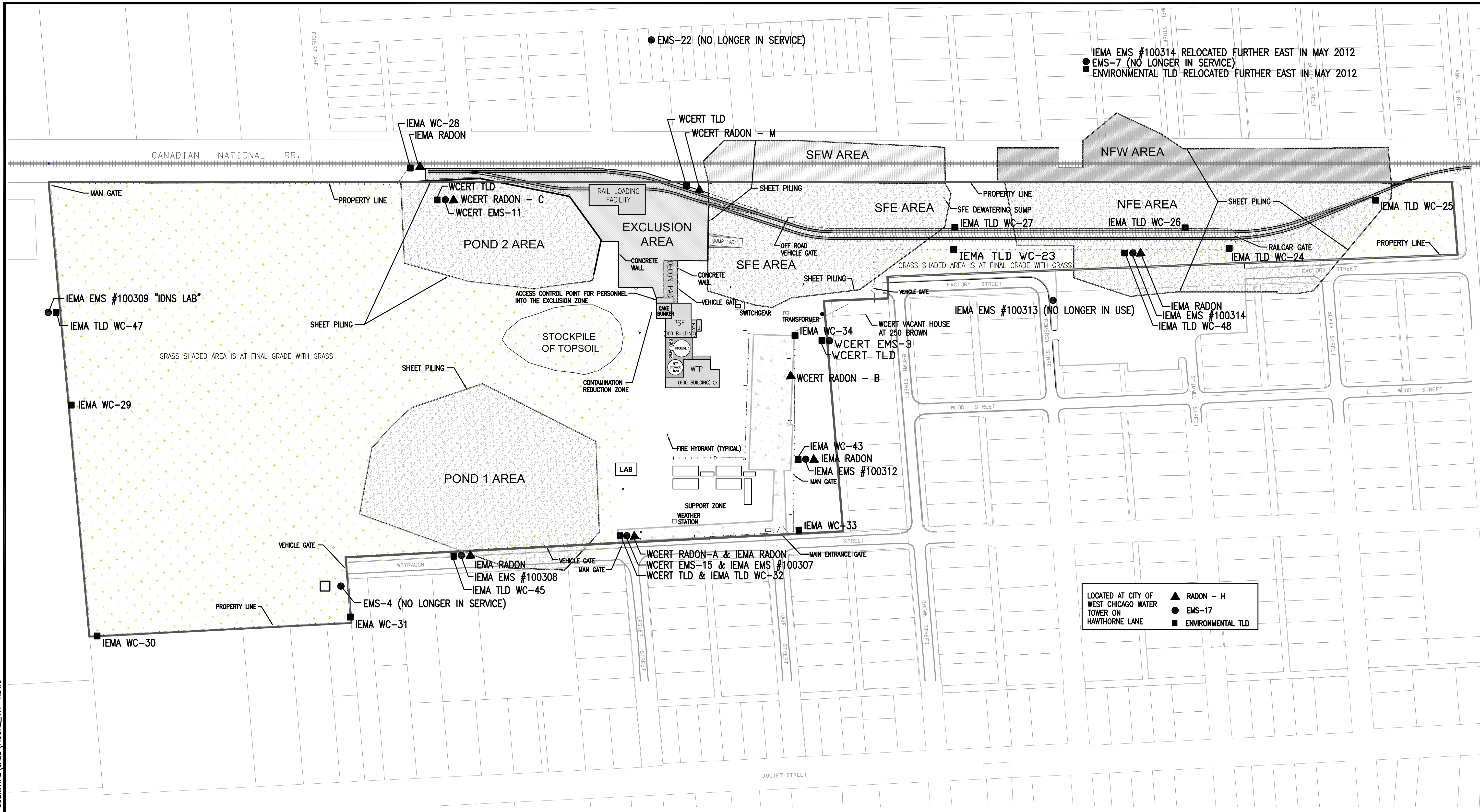
Surface water and storm sewer samples are collected from five locations (see Table 2.9.2-1 and Figure 2.9.2-1). The licensee obtains samples on a quarterly basis and analyzes them for the parameters shown in Table 4.1-1. For each sample, the gross alpha concentration is measured to determine if it exceeds 10 pCi/L. If it does, the sample is further analyzed for the specific radioisotopes listed in Table 4.1-1.

TABLE 4.1-1

OPERATIONAL RADIOLOGICAL MONITORING PROGRAM FOR THE WEST CHICAGO FACILITY

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
Air Particulates	4	EMS-3, 11, 15, 17 See Figure 4.1-1	Continuous	Weekly	Weekly and Quarterly composite	Weekly: Th-nat Quarterly: Th-nat, Th-232, Th-228, Ra-228, Ra-226, and Pb-210
Radon and Thoron Gas	5	Radon stations A, B, C, H, and M See Figure 4.1-1	Continuous	Quarterly	Quarterly	Rn-222 and Rn-220
Surface Water	5	See Table 2.9.2-1 and Figure 2.9.2-1	Grab	Quarterly	Quarterly	Gross alpha and, if gross alpha > 10 pCi/L, natural uranium, Th-232, Th-228, Ra-228, and Ra-226
Groundwater	78	See Table 3.3.8-1 and Figure 3.3.8-1	Grab	Quarterly (a)	Quarterly (a)	Ra-226, Ra-228, total uranium
Direct Radiation	5	EMS-3, 11, 15, 17 and Radon Station M See Figure 4.1-1	Continuous passive integrating device	Quarterly	Quarterly	Gamma exposure rate

(a) Samples are collected and analyzed annually at any well that has not exceeded the GWPS for three consecutive quarters.



NOTE:
SMALL SOIL STOCKPILES ARE PRESENT ON SITE
BUT NOT DEPICTED ON THE DRAWING.

N

SCALE IN FEET

220 0 220 440

HANSON
Hanson Professional Services Inc.

EXISTING MONITORING LOCATIONS

ENVIRONMENTAL ANALYSIS
PHASE V
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 4.1-1

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I:\DRAWINGS\93S7001\AUGUST 2012 SUBMITTAL\CADD\FIGURE_4.1-1.DWG

Weston maintains a comprehensive groundwater monitoring program at the Site, which currently includes 74 monitoring wells, three dewatering sumps and one underdrain riser. Groundwater samples are collected quarterly from these monitoring wells. The quarterly groundwater samples are analyzed for various radiological and non-radiological constituents. Table 4.1-1 lists the radiological constituents analyzed in groundwater. Weston compares the monitoring data to the Groundwater Protection Standards (GWPS) and reports the data to IEMA quarterly. Any constituent that remains below the GWPS for three consecutive quarters may subsequently be analyzed annually, provided it remains below the GWPS.

Direct external radiation is monitored at five locations. These include the four location at which air particulates are monitored (EMS-3, 11, 15, and 17) plus an additional location at Radon Station M near the Railcar Loading Facility. External gamma radiation is measured by thermoluminescence detectors (TLD) that provide continuous passive integration of the ambient external radiation. Detectors are retrieved and analyzed quarterly. Results are reported in terms of the total radiation exposure for the quarter.

4.2 IEMA EFFLUENT MONITORING PROGRAM

The IEMA currently operates an effluent monitoring program for the Site. Prior to 1994, the former IDNS monitored the Site under a limited program. However, in mid-1994, the IDNS Office of Radiation Safety (ORS) issued a license amendment to the Kerr-McGee Chemical Corporation authorizing them to begin the construction activities necessary to decommission the Facility. With the increased potential for effluents from construction, remediation, and restoration activities on the site, the program was modified to its current level. The existing program is designed to more effectively track effluents from the Site during decommissioning activities and evaluate site conditions for compliance with regulatory limits. All program enhancements described below remain in place.

Program modifications, through January 1995, included the addition of six environmental monitoring stations (EMS) at locations near the Facility fence line. Around 2005, all EMS locations at local school facilities were removed due to accessibility, weather concerns and other hazards, and need. One station was removed due to residential construction and another was relocated because an electrical drop needed to be removed. There are currently six EMS stations operating at locations at or near the Site fence line. Each EMS includes a low volume air particulate sampling pump, a radon/thoron detector configuration, and an optically stimulated luminescent dosimeter (OSL).

Air particulate filters for each EMS are exchanged on a weekly basis and are analyzed for gross alpha/beta activity at a IEMA radiochemistry laboratory. An array of alpha-track detectors is also located at each EMS. These devices are used to detect and/or measure the gaseous effluents radon and thoron. These detectors are exchanged quarterly and processed by the vendor that provides the units. Results are used to calculate the estimated radon/thoron concentrations for each EMS location. There are also six other locations for radon/thoron detection around the perimeter of the site, near the closest residence in each direction, and behind city hall (used for background).

The OSLs located at each EMS are exchanged and processed quarterly. OSL results provide an integrated gamma dose value for each EMS location. In addition to the OSLs co-located with each EMS, IEMA maintains an OSL network of 23 other locations along the Site fence and at several nearby residences. These OSLs are exchanged quarterly also, and results are reported in units of millirem per day (mR/d). IEMA personnel continue to perform quarterly gamma surveys, at 50 ft intervals around the Site fence line, using low energy organic scintillation type mirco-R meters. Results for these surveys are reported in units of micro-R per hour.

Prior to 1994, Site groundwater wells were sampled on an annual basis, with approximately 25 percent sampled per quarter. In 1994, at the beginning of on-site remedial activities, over half of the existing on-site wells were closed, and some new wells were developed. IEMA staffers now sample approximately 10 percent of the wells total 78 groundwater monitoring locations with 12 more monitoring wells scheduled to be installed in the year 2013. IEMA staffers sample wells on a quarterly basis. A sample from down-stream Kress Creek is also obtained once a quarter as well. Water well samples are screened for gross alpha/beta activity, and those exceeding the USEPA drinking water standard are further analyzed for radium and/or uranium.

A final enhancement to the routine effluent monitoring program was the addition of an annual soil sample collection routine. In September 1994, the first set of baseline soil samples were collected from locations off-site near EMS stations. Samples were collected on an annual basis and analyzed by gamma spectroscopy at the IEMA radiochemistry laboratory in West Chicago. Since 2004, these samples have no longer been collected.

5.0 IMPACTS OF ACCIDENTS

5.1 IMPACT ASSESSMENT

An assessment of the radiological impacts of an accidental (unplanned) release of contaminated material was performed for the Phase V activities. During Phase V, Weston will excavate contaminated material from the vicinity of the Railcar Loading Facility (RLF). Additional contaminated sediments will be removed from Kress Creek, the West Branch of the DuPage River, the adjacent floodplains, and several other off-site properties. According to the Phase V plan and cost estimate (Weston, 2012c) about 21,600 bcy will be excavated from the RLF area. An additional 2,600 bcy will be excavated from D-Stratum in the same area. The volume of off-site soil brought to the Site for loading and shipment is expected to be relatively small. The contaminated material will be radiologically surveyed and sorted. Approximately 6,600 tons (66 railcars at about 100 tons each) are expected to be shipped by rail to EnergySolutions in Utah for permanent disposal.

Four potential accident scenarios were postulated for the Phase V decommissioning activities. These accidents include the overturning of a truck hauling contaminated material, an on-site fire, the overturning of a truck and a subsequent fire, and a train derailment. Each accident scenario involves the possibility of contaminated material being released into the air and dispersed with the prevailing winds. Accident probabilities were not included in the analysis. The accident analysis determined the potential doses that may occur due to inhalation of contaminated material by members of the general population.

5.2 ON-SITE ACCIDENTS

The RADE3 computer code (EPA, 1987) was used to compute the dust inhalation doses for the four accident scenarios. This approach is used to obtain upper-bound estimates of the potential doses from accident scenarios. The three on-site accident scenarios are described in this section, and the train derailment scenario is presented in Section 5.3. The concentrations of uranium-238, thorium-232, and radium-226 in the contaminated material involved in the on-site accident scenarios were assumed to be 160 pCi/g, 3200 pCi/g, and 620 pCi/g, respectively. These are the average activity concentrations for the sediment excavated from the Disposal Site during Phase IV. These concentrations bound the concentrations that will be encountered in Phase V and lead to conservatively high dose estimates. All progeny of these radionuclides were assumed to be in secular equilibrium. Concentrations of uranium-235 and progeny were determined based on the naturally occurring ratio of uranium-238 to uranium-235 (1 pCi/g to 0.046 pCi/g).

The dust resuspension rates used in the on-site accident analyses were $1x10^{-6}$ g/m^2-sec, $1x10^{-7}$ g/m^2-sec, and $1x10^{-5}$ g/m^2-sec for the overturned truck, on-site fire, and overturned truck with subsequent fire scenarios, respectively. The first two of these resuspension rates are based on work conducted by the NRC (NRC, 1987). The highest resuspension rate, used for the accident in which the truck overturns and catches on fire, is an assumed value that conservatively accounts for the synergistic effects of the simultaneous rollover and fire.

All three accidents were assumed to release airborne dust for a period of two hours. Atmospheric conditions for the analysis assumed a Class D stability category and an average wind speed of 4.5 m/sec (Kerr-McGee, 1993c). The particulate deposition velocity was assumed to be 0.01 m/sec. A nonuniform population density of 9.0 million persons within an 80-kilometer radius of the Facility was assumed. The inhalation dose conversion factors used in the accident analysis were taken from Federal Guidance Report No. 11 (EPA, 1988). The area affected at the site of the accident was assumed to be 100 square meters. Based on an individual inhalation rate of 20 m^3/day, it was assumed that an off-site individual would inhale 1.67 cubic meters of air during the two-hour accident duration.

Table 5.2-1 shows the doses for the bounding accident in which a truck overturns and catches fire. The projected doses for this scenario are the greatest of the three postulated on-site accidents because the dust resuspension rate is the highest. The doses are given in terms of distance from the accident. The results include the total dose to the population and the average dose to a member of the population.

The maximum projected dose for the truck overturn and fire accident occurs at the fenceline of the Facility. The fenceline dose is 0.0022 mrem, which is much less than the 100-mrem standard from section 340.310(a)(3) of the Illinois regulations. The average dose to an individual within 80 kilometers of the Facility is $2.8x10^{-7}$ mrem. Based on these results, an accident during Phase V operations would cause negligible radiological impact to individuals.

5.3 TRAIN DERAILMENT ACCIDENT

Part of the accident analysis assessed the potential radiological impacts of a train derailment while transporting waste from the West Chicago Facility to EnergySolutions in Utah. A derailment was assumed in which five railcars overturned and spilled their entire contents. A fire was assumed to coincide with the spill. This accident scenario may result in the release of contaminated material into the air, with subsequent dispersal downwind of the accident site.

TABLE 5.2-1

UPPER BOUND ACCIDENT DOSES FOR PHASE V

Distance from Accident (m)	Dust Inhalation Doses (mrem)			
	U-238 (a) Series	**Th-232 Series**	**Ra-226 Series**	**Total**
Fenceline Observer	3.3E-05	2.1E-03	7.3E-05	2.2E-03
Hypothetical Nearest Resident	2.9E-05	1.8E-03	6.4E-05	1.9E-03
300	1.0E-05	6.5E-04	2.2E-05	6.8E-04
400	6.5E-06	4.2E-04	1.4E-05	4.4E-04
500	4.6E-06	2.9E-04	1.0E-05	3.1E-04
600	3.4E-06	2.2E-04	7.5E-06	2.3E-04
700	2.6E-06	1.7E-04	5.8E-06	1.8E-04
800	2.0E-06	1.3E-04	4.5E-06	1.4E-04
900	1.7E-06	1.1E-04	3.7E-06	1.1E-04
1,000	1.4E-06	9.0E-05	3.1E-06	9.4E-05
10,000	3.4E-08	2.1E-06	7.5E-08	2.3E-06
20,000	1.1E-08	6.8E-07	2.4E-08	7.2E-07
30,000	5.4E-09	3.4E-07	1.2E-08	3.6E-07
40,000	3.6E-09	2.3E-07	8.0E-09	2.4E-07
50,000	2.7E-09	1.7E-07	6.0E-09	1.8E-07
60,000	2.1E-09	1.4E-07	4.7E-09	1.4E-07
70,000	1.7E-09	1.1E-07	3.8E-09	1.1E-07
80,000	1.4E-09	8.9E-08	3.1E-09	9.4E-08
Average Dose to Member of Population				2.8E-07
Total Population Dose (person-mrem)				2.2E+00

(a) U-238 dose includes dose from U-235 and its decay products.

The train derailment analysis predicted potential doses for a general population living within 80 kilometers of the accident. The dose calculations included only inhalation doses to the general population, as doses from direct gamma radiation would be negligible due to the low concentrations of contamination downwind of the accident.

The RADE3 computer code (EPA, 1987) was used to assess doses from the train derailment scenario. The concentrations of uranium-238 and thorium-232 in the contaminated material involved in the accident were assumed to be 2,000 pCi/g and 6,000 pCi/g, respectively. Uranium-235 was assumed to be present in the natural ratio to uranium-238. All progeny of these radionuclides were assumed to be in secular equilibrium. These concentrations conservatively bound the concentrations encountered at the Facility during Phase V and are the same concentrations assumed for train derailment accident in previous Environmental Analysis reports.

The dust resuspension rates used in the accident analysis were $1x10^{-5}$ g/m^2-sec during the fire and $1x10^{-6}$ g/m^2-sec during cleanup of the contaminated material. The first of these resuspension rates is an assumed value, designed to account for the synergistic effects of the spill and fire occurring at the same time. The resuspension rate during the cleanup period is based on work conducted by the NRC (NRC, 1987).

The fire following the derailment was assumed to last for two hours. Cleanup of the contaminated material following the fire was assumed to require 336 hours (14 days, 24 hours per day). Atmospheric conditions for the analysis assumed a Class D stability category and an average wind speed of 4.5 m/sec. The particulate deposition velocity was assumed to be 0.01 m/sec. Because a generic location of a derailment was modeled, a uniform population density of one million persons within an 80-kilometer radius of the site of the accident was assumed, yielding an average population density of 50 persons/km^2. The inhalation dose conversion factors used in the accident analysis were taken from Federal Guidance Report No. 11 (EPA, 1988). The area affected at the site of the accident was assumed to be 500 square meters. The individual inhalation rate was assumed to be 20 m^3/day.

The population living within the vicinity of the accident would be exposed to dust suspended during the two-hour fire and the time required to clean up the spilled material. At the beginning of the cleanup period, dust would be suspended from the entire area affected by the accident. As the cleanup progressed, however, the area from which dust would be suspended would decline. To account for the change in the area of contamination, it was assumed that the population was exposed to the original area of contamination for a period of 168 hours, one half of the total cleanup period. It was assumed that the closest a member of the population could approach the spilled material was 100 meters.

The maximum projected inhalation dose to an individual 100 meters from the train derailment accident is 0.33 mrem. This dose is much less than the 100-mrem standard from section 340.310(a)(3) of the Illinois regulations. Based on these results, there is no significant radiological impact to a member of the public from a train derailment during the transport of waste from the West Chicago Facility.

6.0 IMPACTS OF CLOSURE OPERATIONS

6.1 AIR QUALITY AND NOISE LEVELS

6.1.1 Air Quality

Short-term air quality impacts are expected to occur during Phase V decommissioning at the Facility. Internal combustion engines powering heavy, earth moving machinery will emit carbon monoxide, sulfur dioxide, and nitrogen dioxide. Ambient air concentrations will not be significantly altered by operation of construction vehicles and machinery. The potential for fugitive dust results from a range of activities including loading, excavation of contaminated materials, backfilling of excavations, demolition of concrete, and vehicular traffic at the Facility. The rate of dust generation will depend on several variables including the type of equipment being used, soil grain size distribution and moisture content, and dust control methods used. Traffic along Facility roadways may cause resuspension of particulates. Stockpiles of contaminated soils exposed during Phase V activities at the Site create an opportunity for wind erosion and dust generation. Dust suppression methods will be used to keep the potential low.

Mitigative Measures: A variety of dust suppression techniques may be used during Phase V decommissioning to prevent, mitigate, or reduce dust resulting from construction activities, and traffic. Water sprays will be used on stockpiles, roads, and other areas with dust-generating potential. Traffic speeds of vehicles and equipment will not exceed 20 mph on access roads, and exposed surfaces to minimize dust generation. Material stockpiles will be constructed with flat slopes and with their length perpendicular to the prevailing wind direction. Contaminated stockpiles will be covered with geomembrane covers to minimize dust generation. Water trucks and hoses will be available for use on-site during the loading of soils and sediments. A water spray will be used for dust suppression during loading operations. Dust abatement procedures will be used at the West Chicago Facility during any activities that might be expected to generate visible dust.

6.1.2 Noise Levels

Short-term increases in noise levels are expected at the West Chicago Facility during Phase V decommissioning activities.

Mitigative Measures: Noise impacts will be kept to a minimum whenever possible. The decommissioning program has been designed to meet applicable regulations. Planned work hours are between 6:20 a.m. and 8:00 p.m., Monday through Saturday.

Those Phase V activities that generate the greatest amount of noise will be limited to the hours of 8:00 a.m. to 6:00 p.m., Monday through Friday. No construction work is scheduled on Sundays. Workers will use equipment and methods that minimize noise.

6.2 REGIONAL DEMOGRAPHY, SOCIOECONOMICS, AND TRANSPORTATION

6.2.1 Demography

Phase V decommissioning activities will have little impact on the population density of West Chicago.

Mitigative Measures: Since impacts from Phase V activities are not expected to be significant, no mitigation efforts are necessary to minimize or avoid impacts to the area's demography. Efforts to reduce other impacts, such as dust, noise, and transportation impacts will in turn mitigate potential impacts to property values.

6.2.2 Socioeconomics

The Phase V decommissioning activities will not adversely impact any city services (e.g., police or fire department) and will consume few community resources; utilities and emergency services will not be adversely impacted. All residences will still be accessible to emergency services. Power needs should not exceed levels easily supplied by existing services. Although water will be required for dust control and decontamination procedures, much of this water will be generated on-site from storm water management. This demand for water will not be great enough to impact area streams. Gas lines will be avoided and there are no public electric, telephone, or cable television lines buried at the Facility.

Mitigative Measures: Since impacts from Phase V activities are not expected to be significant, no mitigation efforts are necessary to minimize or avoid impacts to city resources.

6.2.3 Transportation

Minimal off-site transportation impacts are expected as a result of Phase V activities. The railspur will facilitate rail movement of contaminated materials during decommissioning activities. Since the railspur will be removed following completion of the closure activities, this railroad spur will not have a long-term impact on the rail facilities in the West Chicago area.

Contaminated materials will be shipped by train to Utah during Phase V. Section 5.3 addresses potential off-site impacts from a transportation accident during rail shipment and concludes that impacts would be negligible. Section 6.9.2.3 addresses off-site impacts from the transport of contaminated material from West Chicago to Utah. It is concluded that impacts would be minimal.

A slight increase in traffic to the Facility is expected primarily from the shipment of clean demolition waste, and contractors' personnel arriving and departing from the Site. Increased traffic on Joliet, Factory, Brown, and Weyrauch Streets is expected. Trucks leaving the Site may deposit a minimal amount of uncontaminated soil on local streets in the vicinity of the Facility.

Mitigative Measures: Off-site transportation impacts are minimal. Soil material deposited on local streets will be cleaned up on a routine basis.

6.3 LAND USE

Groundwater remediation activities will continue after Phase V decommissioning activities have been completed. Once soil remediation and site restoration activities are complete, the property is planned to be converted to a city park or other recreational use. Groundwater remediation will continue without disruption to the public facility. After groundwater remediation is completed, the IEMA license can be terminated.

Mitigative Measures: There are no impacts from Phase V activities; therefore, no mitigation efforts are necessary.

6.4 ARCHAEOLOGICAL, HISTORIC, AND SCENIC RESOURCES

There are no known historic or archaeological sites in the immediate vicinity of the Facility, and no impacts are expected.

Mitigative Measures: Impacts on historic or archaeological resources are not expected, and no mitigation efforts are necessary.

6.5 SOILS AND SEDIMENTS

During Phase V decommissioning activities, the site topography will be changed by grading of site soils and excavation and stockpiling of contaminated materials. Surfaces of stockpiles and excavation sidewalls will be exposed, increasing soil erosion. Stockpiles will be covered with geomembranes after work on the working face is completed each day. Erosion at excavations will be contained within the excavations.

Mitigative Measures: Storm water management techniques used to mitigate impacts at the Site for Phase V were introduced during Phase I activities and include construction of perimeter berms. A berm will be placed around the perimeter of the loadout piles to act as erosion protection device.

Erosion and surface runoff will be controlled through the use of surface-water control ditches and berms, and geotextile covers. All material piles and temporary stockpiles will be covered with tarps during non-working hours and during inclement weather. The site drainage around excavations will be directed to a storm water sump.

6.6 SURFACE WATER

Surface water will be controlled through the use of surface water control berms and ditches. Surface water management is designed to control, prevent, and minimize the volume of surface water from remediated areas migrating into radiologically contaminated areas, and contact water in radiologically impacted areas from migrating into remediated areas. By controlling surface water drainage, areas that have been verified as remediated will be protected from becoming contaminated by runoff from excavation areas or stockpiles.

Mitigative Measures: Surface water collected in excavations will be removed through the excavation dewatering system. Only water that has been verified as radiologically uncontaminated can be used in the remediated areas of the Site. Water trucks will be used to transfer water. The water can be used for dust suppression. During peak rainfall periods or in large drainage areas where the water truck will not have the required holding capacity, portable pumps, hoses, and controls will deliver water to temporary tanks.

Collected stormwater may be used for on-site dust suppression; however stormwater from radiologically contaminated areas can only be used for dust suppression in radiologically contaminated areas of the Site. Surface water from remediated areas can be used for dust control anywhere on the Site. No runoff from radiologically contaminated areas to remediated areas will be permitted.

6.7 GROUNDWATER

This section reviews the Phase V activities, with emphasis on their potential groundwater impact, and provides a description of the mitigative measures Weston will employ to prevent significant groundwater impacts. A complete listing of the Phase V activities can be found in

Section 3.0 of this report. Phase V activities with potential to impact groundwater at the Site include:

- Limited excavation below the water table north of the Pond 2 sheet pile wall
- Hot-spot pumping
- Grouting, chemical immobilization, or pump and treat of PSF sheet pile areas
- Groundwater remediation in non-PSF sheet pile areas

6.7.1 Excavation below the Water Table

A small area of D-Stratum material will be excavated just outside the Pond 2 sheet pile wall on the northwest edge of Pond 2. This excavation will require dewatering since the expected elevation of the D-Stratum is about 727 feet and the water table should be at about 733 feet. There are no plans for low permeability barriers since the excavation is relatively small.

Excavation into the saturated zone has the potential to disturb current groundwater geochemical conditions and mobilize contaminants in the groundwater. The potential effects on groundwater were discussed extensively in the Phase IV Environmental Analysis Report (Hanson Engineers, January 1998). However, the volume to be excavated is small (approximately 2,600 cubic yards) and, therefore, any effects on groundwater should be very limited and highly localized.

Mitigative Measures: The best mitigative approach is to prevent release of groundwater from the excavation. If groundwater does not exit the excavation, then potential impacts on the surrounding groundwater will be minimal. Weston will minimize groundwater release from the excavation by dewatering during excavation and backfilling (Weston, 2012c). By dewatering the excavation, the potential for the release of groundwater from the excavation is reduced because the hydraulic gradient is always toward the excavation (i.e., the head in the excavation is maintained at an elevation lower than the natural local water-table elevation). Weston plans to minimize the area of open excavation and volume of water to be managed by making cuts to the D-Stratum target areas with a combination of trench boxes and sloping.

Weston will prevent the release of contaminated water from the excavation by treating or containerizing all groundwater or surface water that is collected from the excavation. Some water may be used for dust control within Exclusion Zone areas. Surface water runoff will be controlled to prevent runoff to other areas. Finally, Weston will continue groundwater monitoring to detect potential groundwater impacts.

6.7.2 Hot-Spot Pumping

Hot-spot pumping was proposed in the CAP (Weston, 2012a) for areas that do not improve under natural attenuation alone. This pump and treat option will be used in the E-Stratum, C-Stratum and/or Silurian as required. Low flow or stagnant areas inside and down gradient of the sheet pile enclosures may require hot-spot pumping where concentrations exceed the standards. Hot-spot pumping may also be used if analysis suggests that hot-spot pumping will cost effectively reduce constituent concentrations to below the groundwater protection standards and achieve license termination in an earlier timeframe.

Hot-spot pumping is designed to reduce constituent concentrations in groundwater at the site and, therefore, should not have any negative impacts on the groundwater.

Mitigative Measures: Extracted groundwater that exceeds NPDES permit limits or limits in the Radioactive Material License will be treated before discharge.

6.7.3 Grouting of PSF Sheet Pile Areas

The CAP (Weston, 2012a) indicates that immobilization by grouting is the preferred method for groundwater remediation inside the PSF areas. Various conventional grouting options for the PSF areas have been proposed.

The grouting operation will be confined by the sheet pile walls surrounding the PSF materials. Although some groundwater may leak through the sheet pile walls, the amount should be minimal. Therefore, groundwater outside the PSF areas should not be significantly impacted by grouting.

Mitigative Measures: Grouting, depending on the option(s) chosen, may produce contaminated groundwater and/or spoil material (mixed grout and PSF material). Groundwater that is displaced by the grout will be collected. Some of the groundwater that is collected may be used in the grout preparation. Any groundwater that is not reused will be treated, if it exceeds NPDES permit limits or limits in the Radioactive Material License, and discharged. Some spoil material may be reused in the grouting operation. Any spoil material that is not reused will be disposed of properly.

Additionally, the grout will be required to have no components that would cause Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater (35 IAC 620.410) or the site specific groundwater protection standards to be exceeded as a result of leaching by the natural groundwater at the site.

6.7.4 Chemical Immobilization of PSF Sheet Pile Areas

The CAP (Weston, 2012a) included chemical immobilization as an option for remediation in the PSF areas. Chemical immobilization involves injecting chemical additives into the PSF areas to immobilize constituents through chemical reactions.

Chemical immobilization will be confined by the sheet pile walls surrounding the PSF materials. Although some groundwater and the associated immobilization chemicals may leak through the sheet pile walls, the amount should be minimal. Since any chemical that leaks out of the PSF areas should tend to reduce constituent concentrations, groundwater outside the PSF areas would not be negatively impacted.

Mitigative Measures: Chemical immobilization should not cause any negative effects on groundwater. Therefore, no mitigation efforts are necessary.

6.7.5 Groundwater Extraction from the PSF Sheet Pile Areas

If this option is implemented, groundwater will be pumped from the PSF sheet pile enclosures to reduce constituent concentrations in the PSF material. Extracted water will be treated and discharged.

Extracting groundwater from the PSF areas should not adversely affect groundwater outside the sheet pile enclosures. During groundwater extraction, any leakage through the sheet pile walls will be inward and, therefore, not affect concentrations outside the PSF areas. Between 2005 and 2010, water was pumped from the PSF areas and groundwater concentrations fell inside the enclosures. There was no noticeable effect on groundwater outside the PSF areas.

Mitigative Measures: Extracted groundwater that exceeds NPDES permit limits or limits in the Radioactive Material License will be treated before discharge.

6.7.6 Groundwater Remediation in non-PSF Sheet Pile Areas

For areas inside sheet pile enclosures that do not contain PSF material, the CAP (Weston, 2012a) proposes localized grouting at locations where constituents exceed the groundwater standards. This grouting would be followed by additional sampling around the grouted area to verify that the groundwater inside the sheet pile is no longer being impacted.

The grouting operation will be confined by the sheet pile walls and will be very limited in extent. Although some groundwater may leak through the sheet pile walls, the amount should be minimal. Therefore, groundwater outside the sheet pile enclosures should not be significantly impacted by grouting.

Mitigative Measures: Limited grouting inside the sheet pile enclosures that do not contain PSF material should not cause any negative effects on groundwater. Therefore, no mitigation efforts are necessary.

6.7.7 Groundwater Monitoring Program

An IEMA approved groundwater monitoring program (described in Section 3.3.10) has been developed for the Site. The monitoring well network will provide groundwater data to assess the impact of Phase V activities on groundwater beneath and downgradient from the Site.

The net result from all the mitigative measures listed above is that Phase V decommissioning activities should have a minimal negative impact on groundwater beneath the Site. However, Weston must be prepared to implement corrective measures if the groundwater monitoring data demonstrate that Phase V activities are negatively impacting groundwater.

6.8 ECOLOGY

6.8.1 Biota

Phase V decommissioning activities will impact ecological communities and individual inhabitants at the Facility on a short-term basis. Successional field plant species will be destroyed during Phase V excavation and final grading, but these plant species are not unique or threatened and their destruction will not be significant to the area. Destruction of habitat will force small mammals and birds into neighboring communities. This relocation may create increased resource demands in the new communities and may be detrimental to some individuals, but there should be no significant impact to species populations as a whole. Some smaller animals such as arthropods, mice, snakes, and frogs may not be able to relocate to new habitats. However, since there are no unique or threatened animal species at the Facility, this short-term impact will not affect species' populations as a whole.

Flora and fauna in areas adjacent to the Facility may experience minimal short-term impacts from Phase V decommissioning activities at the Site. Increased traffic, site grading, and construction activities may affect animals within visual or auditory range of the activities.

However, the effects are expected to be minimal since individual animals living in these urban habitats are accustomed to human activities.

Mitigative Measures: Impacts to the ecology of the Facility from Phase V activities are unavoidable, but will be minimized wherever possible. The loss of flora associated wildlife is not considered significant to populations as a whole since the species present are not unique or rare. Impacts to the ecological systems in the area will be minimized wherever possible. Dust control measures employed at the Facility during Phase V decommissioning activities will minimize fugitive dust and the resulting potentials for wildlife ingestions and decrease in photosynthesis.

6.8.2 Wetlands

The only jurisdictional wetlands at the Facility are in the sedimentation ponds previously used for waste management. All areas described as wetlands have been radiologically impacted and were excavated during site remediation. Decommissioning activities included the excavation of pond sediments from six potential jurisdictional wetlands (1.2 acres total) having little functional value. The excavation of Ponds 1, 2, 3, 4, and 5 involved the complete removal of all sediment sludge from the interior depths and sidewalls of the ponds. Excavation of Pond 5 was completed in 1997. Excavation of Ponds 1, 2, 3, and 4 was completed during Phase IV.

Mitigative Measures: Impacts to jurisdictional wetlands resulting from the remediation at this Site have been coordinated with the Chicago District of the Corps of Engineers. No mitigation is required.

6.9 RADIOLOGICAL IMPACTS

An assessment of the radiological impacts of Phase V activities at the Site was performed to determine radiological doses to off-site individuals and the surrounding general population. Phase V decommissioning operations are discussed in Section 3. The activities that could potentially cause radiological impacts to off-site individuals and populations include:

- building demolition
- excavating contaminated material
- stockpiling and staging of contaminated material at the railcar loading facility
- loading and off-site transport of contaminated materials

The Phase V activities that involve earth moving are expected to continue through late 2014. Refer to Section 3 for a complete discussion of Phase V activities.

The analyses discussed in this section identify potential sources and magnitudes of radiation and radioactive material emissions, determine the possible direction and distribution of the radiation and radioactive material emissions using site geometry and local meteorological data, identify significant transport and exposure pathways, and estimate the annual radiation doses to hypothetical off-site individuals.

The radiological analyses described in this section were based on information and data provided by Weston in the Phase V Plan and Cost Estimate (Weston, 2012c). In addition to a list of Phase V activities, Weston has also estimated the material volumes to be excavated and shipped off-site for disposal.

6.9.1 Sources of Exposure and Exposure Pathways

The Phase V activities described in Section 3 were reviewed to identify sources of potential radiological exposure to off-site individuals and populations. The radiological impact analyses focus on the potential Phase V sources. The potential Phase V sources are summarized in Table 6.9.1-1. Excavation and stockpile volumes were estimated based on information provided in the Phase V Plan and Cost Estimate (Weston, 2012c).

Excavations and operations were assumed to be conducted within the time periods shown in Table 6.9.1-1. The contaminated material stockpile was assumed to be present only during the excavation and loading that occurs in the fourth quarter of 2013. The stockpile volume in Table 6.9.1-1 is based on the stockpile area given in the Phase V Plan and Cost Estimate (Weston, 2012c) (1,100 square yards) and an assumed maximum height of three yards.

The radionuclides found in the contaminated soils are contained in three naturally occurring decay series: uranium-238, uranium-235, and thorium-232. The radionuclides of these decay series are shown in Table 6.9.1-2. Thorium-230, radium-226 and its decay products, which are part of the uranium-238 decay series, were modeled separately from the rest of the uranium-238 series. Concentrations of decay products were assumed to be in secular equilibrium with parent radionuclides.

Prior to the Phase IV Environmental Analysis (EA), Kerr-McGee conducted a Delineation Drilling Program (Grant Environmental, 1996) to determine the concentrations of uranium-238, thorium-232, and radium-226 in subsurface contaminated materials. The materials to be excavated during Phase V are the same materials that were characterized in the Phase IV EA. The radionuclide concentrations for excavated material were taken from the Phase IV EA. If multiple concentration

TABLE 6.9.1-1

PHASE V SOURCES

Source	Volume (cy)	Time and Duration
RLF Excavation	21,600	4Q2013, 3 months
D-Stratum Excavation	2,600	4Q2013, 2 weeks
Support Zone Grading	10,500 (a)	2Q2014, 3 weeks
Cut and Fill North of RLF	14,800 (a)	3Q2014, 3 months
Contaminated Material Stockpile	10,800 (b)	4Q2013, 3 months

(a) This material expected to be free of contamination.
(b) Estimated based on area of 1,100 square yards and 3 yards high.

TABLE 6.9.1-2

RADIONUCLIDE DECAY SERIES

Uranium-238 Chain	Uranium-235 Chain	Radium-226 Chain	Thorium-232 Chain
U-238	U-235	Th-230	Th-232
Th-234	Th-231	Ra-226	Ra-228
Pa-234m	Pa-231	Rn-222	Ac-228
Pa-234	Ac-227	Po-218	Th-228
U-234	Th-227	Pb-214	Ra-224
	Fr-223	Bi-214	Rn-220
	Ra-223	Po-214	Po-216
	Rn-219	Pb-210	Pb-212
	Po-215	Bi-210	Bi-212
	Pb-211	Po-210	Po-212
	Bi-211		Tl-208
	Po-211		
	Tl-207		

values were given in the Phase IV EA, the highest values were used here. Concentrations of uranium-235 were calculated based on the naturally occurring ratio of uranium-238 to uranium-235 (1 pCi/g to 0.046 pCi/g). Radionuclide concentrations in the excavated materials for Phase V are given in Table 6.9.1-3.

During Phase V operations, Weston will continue to transfer contaminated material from off-site locations to the Site. The material may be temporarily staged prior to loading and off-site shipment with other contaminated material. The volume of off-site soil is not precisely known but is expected to be small compared to the volume of excavated material. In addition, the radionuclide concentrations in the off-site soil are expected to be lower than those in the excavated material. Radionuclide concentrations in off-site soil were taken from the Phase IV EA and are shown in Table 6.9.1-3. Since the off-site soil concentrations and volumes are small compared to the excavated material, the off-site soil was not evaluated as a separate radiological source; its impacts will be bounded by those of the excavated material.

The radiological assessment evaluated three primary exposure pathways. These are: (a) inhalation of contaminated dust, (b) inhalation of radon and thoron gas, and (c) direct exposure to gamma radiation.

Contaminated dust will likely be generated during excavation activities and material handling. The atmospheric transport of suspended dust to off-site locations is controlled by meteorological conditions, material composition, and physical characteristics. Off-site individuals in the path of the dust transported off-site may inhale some quantity of the contaminated dust and may incur some radiological exposure. Doses due to this exposure were evaluated.

Naturally occurring radon and thoron gas will also be released from excavated soils during Phase V activities. Radon (radon-222) and thoron (radon-220) gases are formed by the decay of radium (radium-226 and radium-224). Radon formed in the top few meters of soil and thoron formed in the top few centimeters of soil can be released to the atmosphere. While release of radon and thoron gas from soils is a natural and ongoing process, the rate of release is expected to increase during Phase V activities. The atmospheric transport of radon and thoron gas to off-site locations is controlled almost entirely by meteorological conditions. An off-site individual in the path of the radon/thoron transport may inhale some quantity of the gas and may incur some radiological exposure. Doses due to this exposure were evaluated.

TABLE 6.9.1-3

RADIONUCLIDE CONCENTRATIONS

Source	U-238 (pCi/g)	Th-232 (pCi/g)	Ra-226 (pCi/g)
Excavated Material	32	210	47
Off-Site Soil	4	120	24

As with radon and thoron release, the emission of gamma radiation from soils is a natural and ongoing process. However, the above-grade stockpiling of excavated, contaminated soil is expected to increase the magnitude of gamma radiation. Off-site individuals may be close enough to on-site sources of gamma radiation during Phase V activities to receive some dose from this radiation. These doses were evaluated.

Doses due to dust inhalation, radon/thoron inhalation, and direct gamma exposure were calculated for a hypothetical individual standing at the fenceline and for a hypothetical nearest resident. The fenceline observer was assumed to stand at the fence watching the decommissioning operations for 2 hours per day on days of operation (26 days per month). The fenceline observer would, thus, be exposed to contaminated dust, radon/thoron, and direct gamma radiation 52 hours per month during months of operation.

The hypothetical nearest resident scenario was conservatively modeled to reflect worst-case conditions. The hypothetical residence was assumed to be 15 meters from the fenceline of the Site. The hypothetical nearest resident was assumed to be outside an average of 2 hours per day and inside an average of 18 hours per day. Based on meteorological data, the wind was assumed to blow from the Site in the direction of the hypothetical nearest resident an average of 6 hours per day, which was modeled to include the entire 2-hour period that the resident was assumed to spend outside each day and 4 of the 18 hours the resident was assumed to spend indoors.

Phase V activities may include subsurface grouting of areas backfilled with PSF material. Depending on the particular grouting procedure selected, the grouting may cause quantities of contaminated groundwater to be displaced to the ground surface. Management options for displaced groundwater include treatment and discharge.

Potential doses from displaced contaminated groundwater are negligibly small for several reasons. The potential exposures to contaminated water are minimal and the radionuclide concentrations in groundwater are not high enough to pose a hazard, other than from direct ingestion. Ingestion and inhalation pathways are not possible. Ingestion is prevented by administrative procedures on the controlled site. There is no inhalation pathway because the radionuclides in the water are non-volatile and do not become airborne. Direct contact with contaminated water is also prevented by administrative procedures.

Potential external exposures and doses from contaminated groundwater are very small compared to other doses evaluated in Phase V. To illustrate this point, consider that some of the highest recently measured natural uranium concentrations in groundwater are in the range of 200 to

300 pCi/L. The uranium concentrations in water can be converted to a mass basis, since one liter of water has a mass of one kilogram. On a mass basis, the maximum uranium concentration is 300 pCi/kg or 0.3 pCi/g. This is small compared to the cleanup criterion for uranium in soil, which is 20 pCi/g above background (License Condition 33B). It is also less than the background uranium concentration in soil, which is considered to be 2 pCi/g (License Condition 33B). Considering that the soil criterion was based on multiple exposure pathways (inhalation, ingestion, external) and that contaminated water has only one likely exposure pathway (external), the doses from contaminated groundwater are immaterial. As an added measure of confidence, recent measurements from the third quarter of 2012 shows that the average uranium concentration in groundwater is about a factor of ten below the maximum.

6.9.2 Modeling of Dust Inhalation, Radon/Thoron Inhalation, and Direct Gamma Exposure

6.9.2.1 Dust Inhalation Doses

Doses due to the inhalation of contaminated dust were calculated for off-site individuals and the general population during Phase V operations. Dust resuspension rates from the various sources were calculated. Atmospheric dust concentrations were then estimated for off-site locations. These concentrations were used to calculate the expected dose to the fenceline observer, the hypothetical nearest resident, and the general population during Phase V activities.

The RADE3 computer code (EPA, 1987) was used to model atmospheric transport of contaminated dust to off-site locations. RADE3 performs standard Gaussian-Plume atmospheric dispersion calculations and air-pathway unit response analyses.

The RADE3 dust inhalation analysis used the uranium-238, thorium-232, and radium-226 concentrations shown in Table 6.9.1-3. The dust resuspension rate for operations involving excavation of contaminated materials was assumed to be 1×10^{-6} g/m^2-sec. Indoor dust levels were assumed to be 40 percent of outdoor levels, since dust particles settle more rapidly indoors than outdoors.

Assumed atmospheric conditions for the analyses were Class D stability and an average wind speed of 4.5 m/sec. The particulate deposition velocity was assumed to be 0.01 m/sec. The inhalation dose conversion factors utilized in the analysis were taken from Federal Guidance Report No. 11 (EPA, 1988). The adult inhalation rate was assumed to be 20 m^3/day.

Table 6.9.2.1-1 presents the dust inhalation doses for the Phase V activities for the fenceline observer, hypothetical nearest resident, and the general population within an 80-kilometer radius.

TABLE 6.9.2.1-1

DUST INHALATION DOSES FROM PHASE V OPERATIONS

Fenceline Observer (mrem/yr)	Hypothetical Nearest Resident (mrem/yr)	Average Dose to Member of Population (mrem/yr)	Collective Population Dose (person-mrem)
1.0E-02	1.6E-02	1.3E-06	21

The dust inhalation doses to the fenceline observer and the hypothetical nearest resident are projected to be 0.01 mrem/yr and 0.016 mrem/yr, respectively. The average dose to a member of the population within 80 kilometers is 1.3E-06 mrem/yr and the total dose summed over the entire population within 80 kilometers is 21 person-mrem. In order to determine regulatory compliance, dust inhalation doses were calculated with and without the inclusion of radon and its progeny. There is no significant decrease in dust inhalation doses with the exclusion of radon, thoron, and their progeny.

6.9.2.2 Radon Inhalation Doses

Doses due to the inhalation of radon and thoron gas were calculated for off-site individuals and the general population during Phase V operations. Radon and thoron release rates from the various sources were calculated. Atmospheric radon and thoron concentrations were then estimated for off-site locations. These concentrations were used to calculate the expected dose to the fenceline observer, the hypothetical nearest resident, and the general population due to Phase V activities.

The rates of radon and thoron release from contaminated soils to the atmosphere during Phase V were based on the RAECOM code (NRC, 1984) calculations that were conducted for the Phase IV activities. Fluxes and source concentrations were scaled to represent the Phase V activities. RAECOM determines the radon and thoron fluxes and concentrations in multi-layer systems. RAECOM solves the radon and thoron generation and transport equations to obtain the rates at which radon and thoron exit the soil surface to the atmosphere. Then the RADE3 atmospheric dispersion results were used to characterize the transport of radon and thoron gas to off-site individuals and the general population. An average wind speed of 4.5 m/sec was assumed (Kerr-McGee, 1993c).

The radon and thoron fluxes from the excavation and the loading stockpile were computed. The fluxes for both sources were combined with the atmospheric dispersion factors to calculate airborne concentrations at off-site locations. Radon and thoron were assumed to be dispersed in a Gaussian plume to the fenceline observer, the hypothetical nearest resident, and the general population within an 80-kilometer radius.

The doses due to radon and thoron inhalation were then calculated for the fenceline observer and the hypothetical nearest resident. It was assumed that the fenceline observer would inhale radon and thoron for 2 hours per day while watching Phase V activities. Radon and thoron were assumed to be transported toward the hypothetical nearest resident 6 hours per day. The resident was assumed to be outdoors 2 of the 6 hours, and to be indoors during the remaining 4 hours.

One air change per hour was assumed inside the residence. The indoor radon concentration was assumed to be comparable to the outdoor radon concentration. Outdoors, radon progeny were assumed to be at 10 percent equilibrium. Indoors, radon progeny were assumed to be at 50 percent equilibrium. The indoor concentration of thoron was assumed to be much lower than the outdoor concentration, due to thoron's short half-life (approximately 56 seconds). The indoor thoron dose is approximately 1 percent of the calculated outdoor thoron dose. Indoors, lead-212, a thoron decay product with a 10.6-hour half-life, does not reach secular equilibrium with thoron because the residence time of thoron in the home is much less than the lead-212 half-life.

Table 6.9.2.2-1 presents the Phase V combined radon/thoron inhalation doses for the fenceline observer, hypothetical nearest resident, and the general population within an 80-kilometer radius. The combined radon/thoron inhalation doses to the fenceline observer and the hypothetical nearest resident are 0.40 mrem/yr and 0.42 mrem/yr, respectively. The radon/thoron dose to an average member of the population within 80 kilometers is 6.4E-05 mrem/yr and the combined dose to the entire population is 1,040 person-mrem.

6.9.2.3 External Gamma Radiation Doses

The MicroShield computer code, Version 9 (Grove 2011), was used to calculate external exposure rates and doses from gamma radiation to off-site individuals during Phase V operations. MicroShield has been widely used for many years to assess reactor radiation shielding problems. MicroShield uses standard methods to calculate radiation attenuation and scattering. The data and methods used by the code are documented and widely accepted.

The MicroShield code has several options for specifying the geometry of the source and shielding materials. For simple problem geometries, MicroShield uses analytical expressions to calculate exposure rates. For more complex geometries, MicroShield utilizes a numerical integration method in which the source material (in this case, the contaminated soil) is approximated by an array of many individual points. Each point within the source material contributes a small amount to the total dose rate. The total dose rate is the summation of dose rates for all of the individual points.

The contaminated material stockpile was the only source of gamma radiation in Phase V. Consistent with previous EAs, no gamma radiation doses were calculated for excavations, since they are below grade and do not cause exposures at off-site locations.

TABLE 6.9.2.2-1

RADON AND THORON INHALATION DOSES FROM PHASE V OPERATIONS

Fenceline Observer (mrem/yr)	Hypothetical Nearest Resident (mrem/yr)	Average Dose to Member of Population (mrem/yr)	Collective Population Dose (person-mrem)
0.40	0.42	6.4E-05	1,040

Table 6.9.2.3-1 presents the doses due to direct gamma radiation from Phase V activities for the fenceline observer and the hypothetical nearest resident. Gamma exposure from the site to the population outside the vicinity of the site is negligible due to natural attenuation. The doses to the fenceline observer and the hypothetical nearest resident were projected to be 0.10 mrem/yr and 0.66 mrem/yr, respectively. In order to determine regulatory compliance, direct gamma doses were calculated with and without the inclusion of radon, thoron and their progeny. The exclusion of radon, thoron, and their progeny reduces the doses to the fenceline observer and the hypothetical nearest resident by about a factor of three, to 0.031 mrem/yr and 0.21 mrem/yr, respectively.

The general population living along the railway corridor between the West Chicago Facility and the EnergySolutions disposal facility may also be exposed to gamma radiation from the passing loaded railcars; doses from the inhalation of dust and radon/thoron will be negligible since the railcars will be tightly covered. For purposes of calculating upper-bound population doses, the concentrations of thorium-232 and uranium-238 in the railcars were assumed to be 6,000 and 2,000 pCi/g, respectively. These are the same concentrations used in the Phase IV EA and are higher than any of the concentrations expected to be shipped during Phase V. All progeny of these radionuclides were assumed to be in secular equilibrium.

The volume of contaminated material transported to EnergySolutions' facility in Utah is expected to be approximately 66 railcars (Weston, 2012c), each with a capacity of about 100 tons. The distance from the West Chicago Facility to the EnergySolutions disposal facility is about 1,560 miles. The time in transit ranges from 7 to 10 days. The most probable transit time is 8 days. The train was assumed to be in transit only a small portion of this time, with the remainder of the time spent on rail sidings. An average train speed was assumed to be 30 miles per hour.

Based on an average speed of 30 miles per hour, less than one hour will be required for 66 railcars to pass an individual standing at the side of the tracks. In order to account for the possibility that an individual may spend additional time next to loaded railcars parked on a rail siding, this time was conservatively increased to 24 hours. The individual was assumed to be a minimum of 30 meters from the parked or moving train.

A uniform population density of 50 persons per square kilometer was assumed to calculate total population doses from direct radiation from the passing trains. This population density is expected to overestimate exposures for the majority of the trip from West Chicago to the EnergySolutions facility. The population was assumed to be a minimum of 30 meters from the train tracks.

TABLE 6.9.2.3-1

EXTERNAL RADIATION DOSES FROM PHASE V OPERATIONS

Fenceline Observer		Hypothetical Nearest Resident	
Including radon, thoron, and progeny (mrem/yr)	Excluding radon, thoron, and progeny (mrem/yr)	Including radon, thoron, and progeny (mrem/yr)	Excluding radon, thoron, and progeny (mrem/yr)
0.10	0.031	0.66	0.21

Using these bounding assumptions, the total calculated dose to the individual at the side of the train tracks is 0.0014 mrem, about 0.001 percent of the 100-mrem standard from 32 IAC 340.310(a)(3). The projected dose to the total population is approximately 8 person-rem.

6.9.3 Radiation Dose to Individuals

Section 6.9.2 described the various assessments of radiological exposure and dose to off-site individuals that may result from Phase V activities. In summary, an individual observer standing at the fenceline and a hypothetical resident residing 15 meters from the facility may incur radiological doses during Phase V operations from inhalation of contaminated dust, inhalation of radon and thoron gas, and exposure to gamma radiation. Doses to these individuals are summarized in Table 6.9.3-1.

Total doses to the fenceline observer and the hypothetical resident are projected to be 0.51 mrem/yr and 1.1 mrem/yr, respectively, including the effects of radon, thoron, and their progeny. Excluding the effects of radon, thoron, and their progeny, the total doses to the fenceline observer and the hypothetical resident are projected to be 0.041 mrem/year and 0.23 mrem/year, respectively.

6.9.4 Radiation Dose to Populations

The estimated radiation doses to the general public via atmospheric transport were computed for the entire population within an 80-kilometer radius of the Facility, estimated to be approximately 9.0 million persons non-uniformly distributed. The total dust and radon dose summed over this population is projected to be 1.06 person-rem. The population dose due to dust is 0.02 person-rem, and the dose due to radon and thoron is 1.04 person-rem, as presented in Section 6.9.2.

6.9.5 Compliance with 32 IAC Parts 332 and 340

Illinois regulations, specifically 32 IAC 332 and 340, contain requirements that address doses to an individual member of the public. Title 32, Part 332, "Licensing Requirements for Source Material Milling Facilities," describes the requirements for licensing, operating, and decommissioning a source material milling facility. Part 332 applies to the Phase V activities.

TABLE 6.9.3-1

SUMMARY OF PHASE V DOSES

	Dust (mrem/yr)	**Radon/Thoron (mrem/yr)**	**Gamma (mrem/yr)**	**Total (mrem/yr)**
Including radon, thoron, and progeny				
Fenceline Observer	0.010	0.40	0.10	0.51
Hypothetical Nearest Resident	0.016	0.42	0.66	1.1
Excluding radon, thoron, and progeny				
Fenceline Observer	0.010	0	0.031	0.041
Hypothetical Nearest Resident	0.016	0	0.21	0.23

Section 332.170, "Protection of the General Population from Radiation," describes dose standards that are applicable to the facility. Subsection (a) and (b) read as follows:

a) At all times, concentrations of radioactive material, excluding radon, thoron, and their progeny, which may be released to the general environment in groundwater, surface water, air, soil, or other means:

   1) Shall not result in an annual dose equivalent in excess of 25 millirem (0.25 mSv) to the whole body of any member of the public; and

   2) Shall not result in an annual dose equivalent in excess of 75 millirem (0.75 mSv) to the thyroid or 25 millirem (0.25 mSv) to any other organ of any member of the public.

b) Releases of radionuclides in effluents to the general environment shall be maintained as low as is reasonably achievable.

Subsection (a) prescribes dose limits that may not be exceeded at any time, and Subsection (b) requires that releases of radioactive effluents be maintained as low as reasonably achievable. It is important to understand that the dose limitation specifically excludes any dose associated with radon, thoron, and their progeny.

Section 6.9.1 of this report describes the various potential exposure pathways associated with Phase V activities. For comparison with the 25-mrem dose standard described in 332.170 (a), the applicable exposure pathways are dust inhalation and exposure to gamma radiation. Table 6.9.3-1 summarizes these doses for Phase V operations, excluding the effects of radon and its progeny. The calculated doses to a fenceline observer and to the hypothetical nearest resident during Phase V were projected to be less than the 25-mrem standard from 332.170(a).

Title 32, Part 340, "Standards for Protection Against Radiation," describes the requirements for all radiation protection programs for IEMA licensees. Section 340.310 of Subpart D, "Dose Limits for Individual Members of the Public," states:

a) Each licensee or registrant shall conduct operations so that:

   3) The total effective dose equivalent to individual members of the public from a licensed operation, exclusive of the dose contribution from a licensee's disposal of radioactive material into sanitary sewerage in accordance with Section 340.1030, does not exceed 1 mSv (0.1 rem) in any year.

Two exclusions must be considered when determining compliance with the 1-mSv (100-mrem) annual dose. The first can be found in Section 340.310(a)(2), which excludes any dose from the "... disposal of radioactive material into sanitary sewerage ...." The second exclusion is found in Section 340.20, which states, "... The limits in this Part do not apply to doses due to background radiation ...." This means that the 1-mSv dose limitation does not include the dose that an individual would receive from natural background radiation. Specifically, in this case, it would not include the dose attributable to radionuclides that occur naturally in the soil, irrespective of the West Chicago Facility.

Table 6.9.3-1 summarizes the doses to an individual standing at the fenceline and to a hypothetical nearest resident from the Phase V activities. During Phase V operations, these doses were projected to be less than the 100-mrem dose standard from 340.310(a)(3).

6.9.6 Regional Radiological Impacts

Analyses conducted to assess the radiological impacts of Kerr-McGee's Phase V site operations indicate that there is no reason to believe the region would suffer any adverse impacts. The focus of the analyses was to provide reasonable worst-case estimates of radiation doses that might be received by the general population due to Phase V activities. These radiological analyses showed with reasonable assurance that there will be no adverse regional radiological impacts from the proposed Phase V activities.

7.0 RESOURCES COMMITTED

7.1 LAND AND SOIL

Approximately 20.4 acres of the West Chicago Facility will be disturbed by Phase V decommissioning activities. Excavation and site grading operations associated with demolition of the RLF/SPSF/CF/WTP and Support Zone will be performed during Phase V decommissioning.

It is intended to convert the property to a city park or other recreational use after soil remediation and site restoration activities are completed.

7.2 WATER

No groundwater or surface water resources will be irretrievably committed by Phase V decommissioning activities.

7.3 AIR

The non-radiological emissions released to the atmosphere will be dispersed and recycled into natural biochemical cycles. The background air quality will not be permanently altered by Phase V decommissioning activities.

7.4 BIOTA

Vegetation will be eliminated, and animal habitat will be compromised in areas being remediated during Phase V decommissioning activities.

7.5 MATERIALS AND ENERGY

During the Phase V decommissioning activities, the following resources will be consumed: petroleum fuels (diesel, fuel oil, gasoline) for operation of earth-moving and heavy equipment, and utilities such as electricity and water.

8.0 ALTERNATIVES

8.1 BACKGROUND AND PREVIOUS CONSIDERATIONS

In 1979, Kerr-McGee submitted a stabilization plan to NRC to decommission the Site and stabilize the waste and tailings. A *Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois* (FES) was issued by NRC in May 1983 (NRC, 1983). This document discusses alternatives for decommissioning in detail. Eight alternatives are identified, and a preferred alternative was selected by NRC staff. The selected alternative proposed licensed storage on-site in a secure manner for an indeterminate period. Under this alternative, the decision on ultimate disposal of the radioactive wastes would be deferred. However, the Atomic Safety and Licensing Board ruled that NRC must supplement the FES to further evaluate impacts of the proposed decommissioning and disposal alternative. Permanent disposal was also to be considered.

A Supplement to the Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois (SFES) was issued by NRC in April 1989 (NRC, 1989). The assessments presented in the SFES augment and update those described in the FES. Also, additional alternatives were analyzed, the analysis was more detailed, and the suitability of sites for permanent waste disposal was expressly considered. Five alternative permanent disposal sites in Illinois were assessed. Permanent disposal of the waste materials at the West Chicago Site was identified as the Proposed Action. Post-closure activities for the Proposed Action consisted of controlling access to the disposal area, monitoring and surveillance, maintenance and, if necessary, additional remedial action. Long-term site surveillance would be required by the government agency retaining ultimate custody.

The NRC's conclusion in the SFES that the Proposed Action of on-site disposal was the preferred alternative and should be licensed was challenged before the NRC's Atomic Safety and Licensing Board (ASLB). The State of Illinois and the City of West Chicago argued that permanent disposal of the materials at the West Chicago location was inappropriate and did not meet the requirements of applicable law and regulations. The ASLB rejected the position of the State and the City and authorized the NRC staff to license on-site disposal (NRC, 1990). The ASLB's decision was appealed to the NRC's Atomic Safety and Licensing Appeal Board (Appeal Board). In March of 1991, the Appeal Board reversed the decision of the ASLB (NRC, 1991). Following the Appeal Board's decision, the NRC staff withdrew the license amendment authorizing on-site disposal.

Kerr-McGee petitioned the Nuclear Regulatory Commission to review the Appeal Board's decision and then requested the Commission to terminate the proceeding and vacate the underlying decisions of the ASLB and the Appeal Board. The State of Illinois and the City of West Chicago opposed vacation of the underlying decisions. On February 21, 1996, the NRC terminated the proceeding as moot and vacated the ASLB and the Appeal Board decisions. The State of Illinois and the City of West Chicago appealed NRC's decision to the U.S. Court of Appeals on April 22, 1996. The case was dismissed upon the motion of the State and the City in May 1997.

In November 1990, NRC discontinued regulatory authority in the State of Illinois over byproduct material as defined in Section 11e.(2) of the Atomic Energy Act. Kerr-McGee appealed NRC's action to the U.S. Court of Appeals. The State of Illinois and the City of West Chicago were allowed to intervene in the appeal. The case was dismissed upon Kerr-McGee's motion in August 1995.

In March of 1991, IDNS informed Kerr-McGee that its license had expired, that it was authorized only to possess the wastes, and that it would have to apply to IDNS for authorization of any other activities. In May 1991, Kerr-McGee, and State and local officials announced an agreement in principle that Kerr-McGee would abandon plans to dispose of materials at the West Chicago Site, and would begin to provide financial assurances to show good faith efforts to search for a disposal site elsewhere. All parties agreed to end pending litigation upon entry of a formal court decree embodying these principles. In May 1992, Kerr-McGee and Envirocare of Utah, Inc. announced they had signed a binding contract whereby the wastes would be disposed of at Envirocare's Facility near Clive, Utah.

In September 1993, Kerr-McGee submitted a decommissioning plan to IDNS for the removal of the byproduct material from the Facility and disposal of it at Envirocare. Upon review of the decommissioning plan, IDNS amended Kerr-McGee's Radioactive Material License to allow limited decommissioning activities under a phased approach. Amendments were issued in May 1994, August 1994, September 1994, April 1995, September 1995, February 1997, and April 1998 authorizing Phase I, Phase IA, Phase IB, Phase II, Phase IIA, Phase III, and Phase IV activities, respectively.

A complete discussion of decommissioning alternatives and the phased approach is contained in the *Environmental Analysis Report - Phase IB for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility* (Phase IB EA) (Hanson Engineers, July 1994a). Each consideration discussed in that report is briefly summarized in the following sections.

8.2 NO ACTION ALTERNATIVE

The no action alternative is discussed in the FES wherein it is concluded that this alternative is technically unacceptable. Consideration of no action was discarded by NRC staff. The Phase IB EA supplements and updates the discussion in the FES.

Taking no action toward decommissioning would not comply with IDNS regulations requiring containment and stabilization of the byproduct material and closure of the Site. The byproduct material would continue to pose the hazard of direct radiation as well as airborne and groundwater pollution. Cleanup of the groundwater would be impossible without removing the source of the contamination.

The only advantages of leaving the Site in its present state are avoiding the cost of the Site decommissioning and waste disposal and avoiding the potential occupational and public radiologic exposures during decommissioning.

Kerr-McGee submitted a decommissioning plan to remove the byproduct material from the Site and to dispose of it at a site near Clive, Utah operated by Envirocare of Utah, Inc. No entity supported a no action alternative. IDNS authorized commencement of decommissioning activities in May 1994.

8.3 DISPOSAL ALTERNATIVES

A complete discussion presenting the long-term radiation doses from two disposal options for the contaminated materials at the Kerr-McGee West Chicago Rare Earths Facility can be found in the Phase IB EA.

Long-term individual and collective population doses were estimated for disposal of the contaminated materials that are at the Kerr-McGee Facility in West Chicago. The two disposal options analyzed were the commercial disposal facility near Clive, Utah, and in-place disposal at the West Chicago Facility. Doses were also estimated for transporting the contaminated materials to the Utah site.

Although short-term doses during decommissioning would be higher for disposal at the Utah site due to doses during transportation, long-term doses would be lower for disposal at the Utah site. Applicable regulations of both IDNS and NRC require that, in evaluation of disposal sites, emphasis be placed on long-term impacts over short-term impacts (32 IAC 332.210 c) and 332.240; 10 CFR Part 40, Appendix A, Criteria 1 and 6). The transportation doses for disposal at the Utah site are within regulatory limits and are expected to cause no excess health impacts. Disposal at the Utah site is the preferred alternative because of the lower long-term doses.

8.4 PHASED APPROACH TO DECOMMISSIONING

The advantages and disadvantages of a phased and non-phased decommissioning approach are fully discussed in the Phase IB EA.

The main advantage of the non-phased approach is that it follows the expressed requirements of IDNS regulations. These regulations allow for a complete review by IDNS and the public of the entire decommissioning project before any decommissioning activities are authorized. However, the non-phased approach would have delayed the commencement of decommissioning operations, and these delays could have jeopardized contractual arrangements for disposal.

It is within the authority of the IDNS Director to grant exceptions to the rules for a phased decommissioning approach. A phased approach allowed commencement of decommissioning activities at least one construction season sooner than under a non-phased approach. The phased approach will not result in any significant worker and public radiological doses greater than those that would occur under a non-phased approach. Phased activities were fully reviewed by IDNS and its consultants, as well as by consultants of the City of West Chicago. While the public review and comment period was reduced from that provided in the rules for Phase I and Phase IA operations, those activities were also considerably reduced in scope from the entire decommissioning project. For subsequent phases, an environmental analysis has been performed in accordance with 32 IAC 332.100, and a full public review and public comment period were provided in accordance with IDNS regulations.

Both Kerr-McGee and the community favored a phased approach. The disadvantages to the phased approach are procedural in nature and do not jeopardize protection of the public health and safety. Therefore, the phased approach is preferred as it allows expeditious commencement of site decommissioning without compromising technical review or the public health.

8.5 PHYSICAL SEPARATION FACILITY ALTERNATIVES

Alternatives to use of the Physical Separation Facility (PSF) for processing contaminated materials to lower radioactive concentration are fully discussed in the *Addendum to the Environmental Analysis Report - Phase II for the Phase IIA Decommissioning activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Phase IIA EA) (Hanson Engineers, June 1995). Subsequent to this discussion, Kerr-McGee opted to revise and simplify the PSF design on the basis of testing at Hazen Research in May through August of 1995. The Simplified Physical Separation Facility (SPSF) concentrated on the recovery of E-Stratum and other non-cohesive coarse materials from the West Chicago Site. Dry screening was not to be a component of the SPSF. Material was processed through two attrition scrubbers in series, and then wet screened.

Although the PSF as discussed in the Phase IIA EA has been redesigned, revised estimates by Kerr-McGee predict that the quantity of SPSF product that can be returned to the Site as backfill is greater than originally forecast. Therefore, the discussion of the alternative of not constructing the PSF in the Phase IIA EA is valid. However, based on the Hazen Research test results, the discussion relating to a modified PSF using only dry screening may not be accurate. The Hazen Research studies indicate that dry screening alone would not be effective in product recovery and may be an infeasible alternative.

Conclusions regarding Physical Separation Facility alternatives remain unchanged.

8.6 WATER TREATMENT PLANT ALTERNATIVE

The alternative of not constructing a Water Treatment Plant (WTP) is fully discussed in the Phase IIA EA. In general, the discussion in the Phase IIA EA is valid; however, because a dry-screen only PSF process appears infeasible, the effect of not constructing the WTP on the physical separation operations would be even more pronounced.

Discussion relating to wastewater discharge alternatives remains unchanged, and the doses estimated in the Phase IIA EA are valid.

The conclusion regarding WTP alternatives contained in the Phase IIA EA remains unchanged.

8.7 GROUNDWATER REMEDIATION ALTERNATIVES

Various options are being considered for groundwater remediation. The following sections discuss alternatives for 1) the sheet pile areas that contain PSF backfill, 2) the sheet pile areas that do not contain PSF backfill, 3) portions of the glacial drift aquifer outside the sheet pile enclosures, and 4) the Silurian dolomite. All of these areas contain groundwater zones with constituent concentrations that exceed the groundwater protection standards for the Site.

8.7.1 PSF Area Alternatives

The sheet pile areas that contain PSF backfill are generally isolated from the local flow system and, therefore, essentially stagnant. As a result, these enclosed areas experience very limited natural attenuation. As discussed in Section 3.3.2, three alternatives have been proposed for the PSF areas: 1) physical immobilization through grouting, 2) chemical immobilization, and 3) continued pump and treat (PSF Flushing).

Groundwater was pumped from the PSF areas periodically for a period of about six years following the completion of source removal in late 2004. Although concentrations fell over that time period, Weston concluded that a pump and treat option might not be the best alternative for remediating the PSF areas (Weston, 2012a). Weston is currently investigating the option to immobilize constituents by grouting the PSF material. Laboratory scale and pilot testing for the grouting option should begin in late 2012, or early 2013.

Chemical immobilization was included as an alternative in the CAP (Weston, 2012a), but Weston has not proposed any plans for testing beyond the limited testing previously performed at the WTP (Tronox, 2009).

At this time, immobilization through grouting is the preferred alternative for groundwater remediation in the PSF areas. Results of the grouting test program will determine whether this alternative is chosen. If grouting proves unfeasible or if it is cost prohibitive, flushing of the PSF areas will likely resume, possibly in combination with a limited grouting program.

8.7.2 Non-PSF Sheet Pile Area Alternatives

Weston (2012a) lists four options for addressing groundwater contamination inside the sheet pile areas that do not contain PSF material: 1) monitored natural attenuation, 2) pump and treat, 3) in-situ remediation, and 4) alternate concentration limits (ACLs). Although ACLs are not considered groundwater remediation, they could provide a regulatory method of addressing concentrations that exceed the Site groundwater protection standards if remedial alternatives fail to reduce those concentrations to the standards.

Remediation through natural attenuation within these areas is not likely to reduce concentrations to the groundwater protection standards within a reasonable time period since material inside the sheet pile walls is generally isolated from the local flow system and, therefore, experiences very limited natural attenuation.

The CAP (Weston, 2012a) proposes localized grouting inside the non-PSF sheet pile enclosures where constituents exceed the groundwater protection standards.

8.7.3 Glacial Aquifer outside Sheet Pile Alternatives

Weston (2012a) lists the same four options for addressing groundwater contamination outside the sheet pile areas: 1) monitored natural attenuation, 2) pump and treat, 3) in-situ remediation, and 4) ACLs. As noted previously, ACLs are not considered groundwater remediation, but they could provide a regulatory method of addressing concentrations that exceed the standards if remedial alternatives fail to reduce those concentrations to the standards.

The CAP (Weston, 2012a) indicates that monitored natural attenuation is the preferred alternative for groundwater remediation outside the sheet pile areas. Pump and treat, or hot-spot pumping, is proposed by the CAP to augment natural attenuation in limited areas, if needed.

8.7.4 Silurian Sulfate and TDS Alternatives

Weston (2012a) lists the same four options for addressing groundwater contamination in the Silurian dolomite: 1) monitored natural attenuation, 2) pump and treat, 3) in-situ remediation, and 4) ACLs. As noted previously, ACLs are not considered groundwater remediation, but they could provide a regulatory method of addressing concentrations that exceed the standards if remedial alternatives fail to reduce those concentrations to the standards. Weston (2012c) shows grouting as an in-situ option for the Silurian dolomite, but the likelihood of successfully grouting a fractured and weathered dolomite is low.

The CAP (Weston, 2012a) indicates that monitored natural attenuation is the preferred alternative for groundwater remediation of the Silurian dolomite. Hot-spot pumping is proposed by the CAP to augment natural attenuation if it is needed and feasible.

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