ENVIRONMENTAL ANALYSIS REPORT - PHASE VI

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

PREPARED FOR

ILLINOIS EMERGENCY MANAGEMENT AGENCY
DIVISION OF NUCLEAR SAFETY
1035 OUTER PARK DRIVE
SPRINGFIELD, IL 62704

PREPARED BY

HANSON PROFESSIONAL SERVICES INC.

IN ASSOCIATION WITH
ILLINOIS EMERGENCY MANAGEMENT AGENCY AND
INTERA INCORPORATED

NOVEMBER 2022

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EXECUTIVE SUMMARY

The Kerr-McGee West Chicago Rare Earths Facility (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 Facility was originally operated by Lindsay Chemical Company, subsequently by American Potash and Chemical Company, and finally by Kerr-McGee Chemical Corporation (Kerr-McGee), which created Tronox, LLC (Tronox) as a subsidiary company in 2004. Tronox filed for bankruptcy in 2009. Accordingly, several states and federal agencies made claims against Tronox asserting that the company was liable as a potentially responsible party for past and future response costs for contaminated areas across the United States. After months of negotiations, all parties agreed to settle their claims in the Consent Decree and Environmental Settlement Agreement signed on November 23, 2010. The Settlement Agreement specifically created the West Chicago Environmental Response Trust (WCERT).

In the West Chicago Environmental Trust Agreement, signed on February 14, 2011, Weston Solutions Inc. (Weston) was named as the trustee for the WCERT and the beneficiaries of the trust were identified as State of Illinois on behalf of the Illinois Emergency Management Agency (IEMA) for the West Chicago Rare Earths Facility and the Illinois Environmental Protection Agency (IEPA) and the United States on behalf of U.S. Environmental Protection Agency (EPA) for all other impacted areas in West Chicago not associated with the Facility.

The objective of WCERT 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, 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
- Operations – Phase VI

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). The eighth phase (Phase V) of decommissioning activities was assessed in the *Environmental Analysis Report – Phase V for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earth Facility* (Hanson Engineers, February 2013)

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. The Phase V decommissioning activities were authorized by IDNS in license amendment in January 2013. Decommissioning of the site was scheduled to be completed by December 2014; however, the decommissioning activities were not completed in the time period scheduled and modeled in the Phase V Environmental Analysis. Radiological doses from the planned activities were compared to doses modeled in the Phase V Environmental Analysis or to the doses developed for a previous year. It was concluded that potential off-site radiological doses resulting from 2013 through 2022 activities were less than regulatory dose limits.

This Environmental Analysis describes Phase VI decommissioning activities. The major activity is groundwater remediation including excavation and treatment of unsaturated zone Physical Separation Facility (PSF) material in Pond 1, Pond 2, and the South Factory East (SFE) area meant to remediate groundwater. The purpose of the treatment of the unsaturated PSF material is to reduce the residual uranium activity to levels as low as reasonably achievable (ALARA). The Phase VI decommissioning activities related to this groundwater corrective action are detailed below:

- Construction of a lined and bermed Treatment Cell in Pond 1, following excavation of the unsaturated PSF
- Stockpiling materials
- Treatment of unsaturated zone PSF material from Pond 1, Pond 2, and the SFE Area
- Removal and treatment of relatively stagnant groundwater inside the sheet piles in Pond 1 and Pond 2
- Disposal of treatment solutions and solids
- Assuring perpetual maintenance of groundwater pathway Institutional Controls
- Demolition of treatment facilities and structures
- Removal of existing sheet piles surrounding the PSF areas
- Erosion and surface water control
- Final grading and seeding

Annual radiological impacts from potential exposure pathways were assessed for planned Phase VI activities. Based on these analyses, annual radiological exposures for proposed Phase VI activities would be less than the regulatory dose limits for individual members of the public.

This Environmental Analysis for Phase VI includes the assessment and determination of impacts, including consideration of alternatives, as required by 32 IAC 332.100. Based on this analysis, the IEMA Division of Nuclear Safety, formerly known as 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.

This Environmental Analysis for Phase VI 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., formerly known as Hanson Engineers Incorporated, 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, Phase IV, and Phase V 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 1994a), the *Environmental Analysis Report - Phase IB for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, July 1994b), 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), the *Environmental Analysis Report - Phase III for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, April 1996), the *Environmental Analysis Report – Phase IV for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, January 1998), and the *Environmental Analysis Report – Phase V for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson, February 2013).

This Environmental Analysis describes the potential impacts to human health associated with Phase VI decommissioning activities. Phase VI 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 (WCERT). 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 (Tronox), 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.

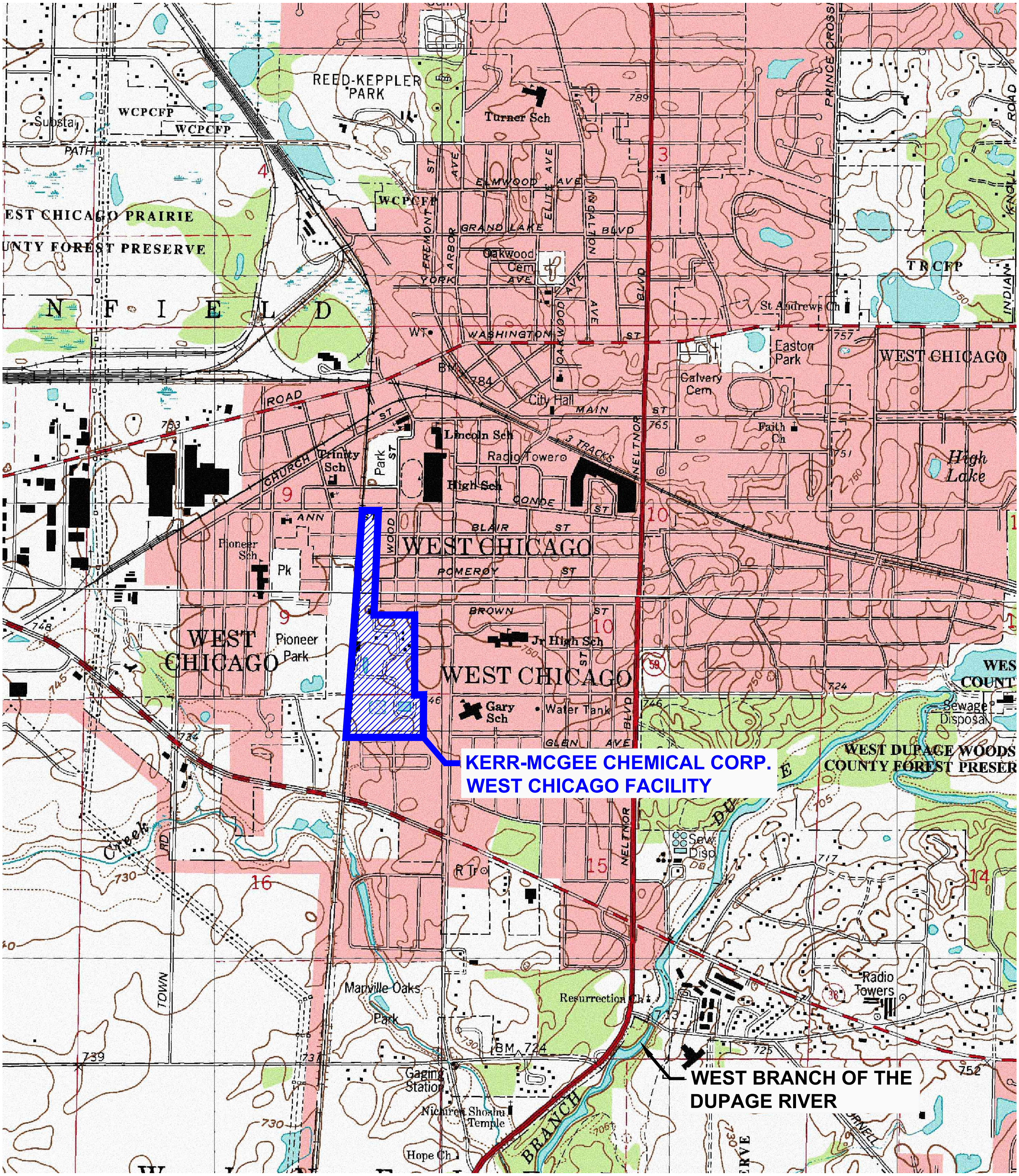
1.2 SITE LOCATION

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 VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.2-1

JUL 28, 2022 3:35 PM BRANS00939
I:\93JOBS\93S7001\PHASE VI EA\FIGURES\FIGURE_1.2-1.DWG

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.

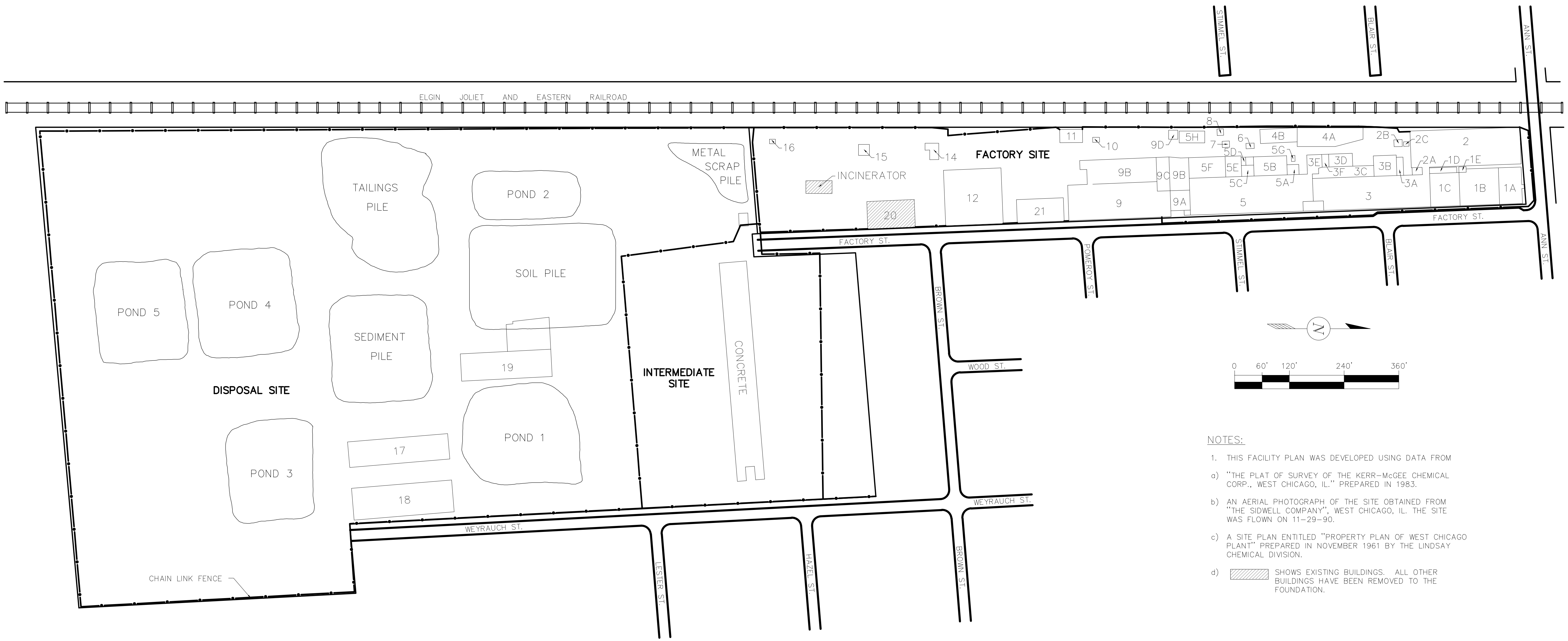
1.3.2 Previous Manufacturing Activities

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) [hatched box] SHOWS EXISTING BUILDINGS. ALL OTHER BUILDINGS HAVE BEEN REMOVED TO THE FOUNDATION.

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PRE-DECOMMISSIONING FACILITY PLAN

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.3.2-1

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 (U.S. NRC) 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 (IEPA) permit number 093090ABP.

In 1994, 1995, 1996, 1998, and 2013 eight 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 1994a). 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 Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, July 1994b), 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 Activities 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 (CY) 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 Activities 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 CY 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 Activities of the Kerr-McGee, West Chicago 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.

The *Environmental Analysis Report – Phase V for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson, February 2013) describes Phase V decommissioning activities. In January 2013, IDNS issued a license amendment authorizing Phase V activities Phase V activities, scheduled to be performed from 2013 through 2014, that were assessed included:

- Monitor natural attenuation of groundwater
- Investigate PSF area immobilization through grouting
- Investigate PSF area chemical immobilization
- Investigate Hot Spot pumping
- Investigate localized grouting in non-PSF sheet pile areas
- Erosion and surface water control
- Abandon water well in the Water Treatment Plant
- Demolition of structures
- Relocation of rail spurs
- Excavation, verification, and restoration
- Manage stockpiles
- Final grading and seeding
- Groundwater monitoring

The Phase V activities, particularly the groundwater investigation activities, were not completed as scheduled. The water well was abandoned in 2013. Most support facilities were dismantled and disposed of between 2013 and 2015. Approximately 25,000 tons of contaminated soil was excavated and shipped to the licensed landfill in Utah during this period. The site was regraded, covered with topsoil, and seeded in 2016. Investigation work continued through 2022 and resulted in a recommendation to remediate the groundwater by treating the shallow, unsaturated PSF material in Pond 1, Pond 2 and the SFE to reduce the residual uranium activity of the PSF material to levels as low as reasonably achievable (ALARA).

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:

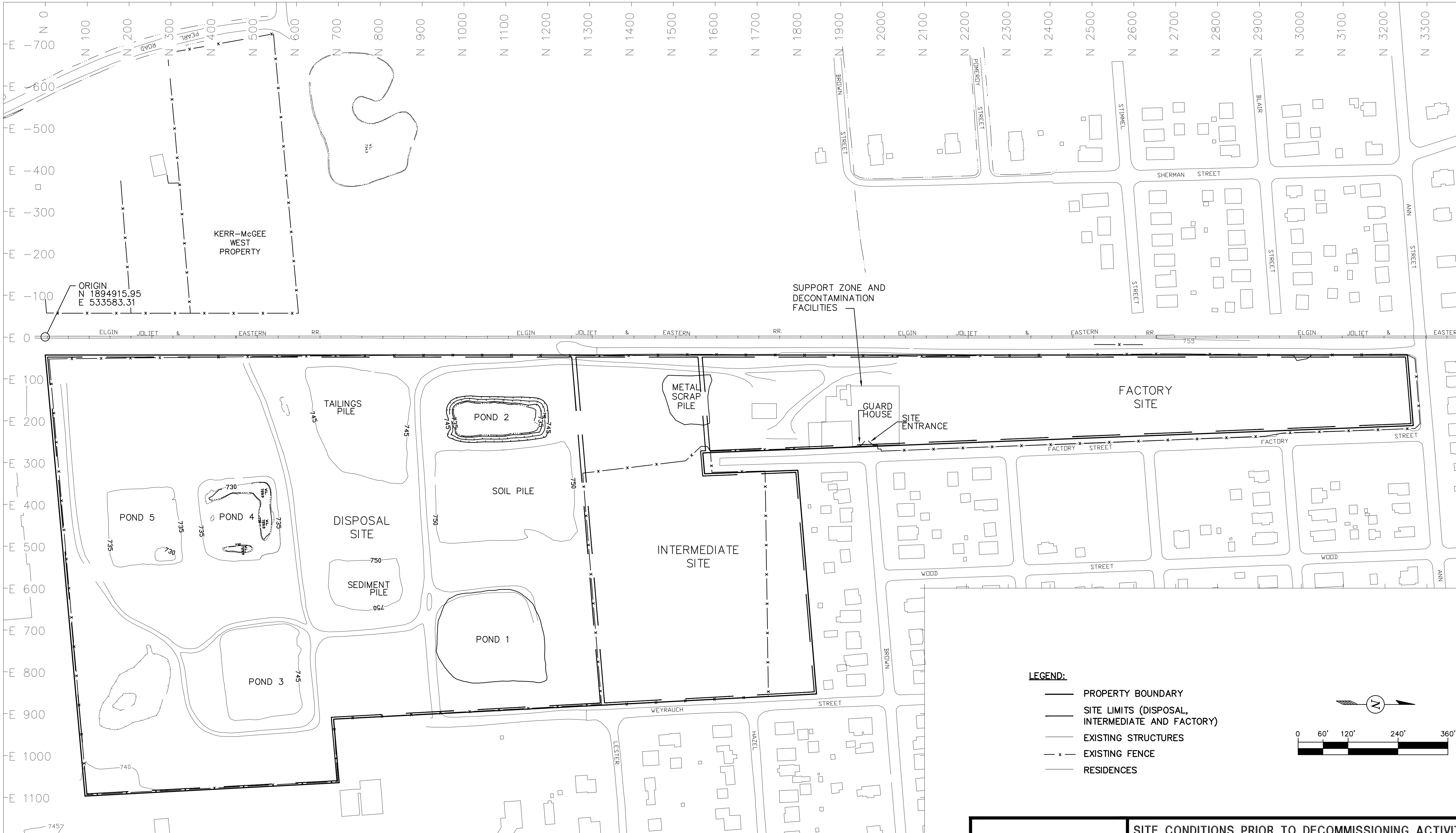
Pond 2	240 ft by 110 ft, 16 ft depth
Pond 3	180 ft by 130 ft, 13 ft depth
Pond 4	200 ft by 190 ft, 11 ft depth
Pond 5	180 ft by 170 ft, 8 ft depth

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.



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 VI
KERR-McGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.4-1

I:\93JOBS\93S7001\PHASE VI EA\FIGURES\FIGURE_1.4-1.DWG AUG 04, 2022 9:58AM BRANS00939

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 are shown on Figure 1.5-1. The Phase I through V activities have resulted in the existing site conditions summarized 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 (see Figure 1.4-1 for site coordinates) 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.

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.

During Phase V, the water well was abandoned, support facilities were dismantled and disposed of, and contaminated soil was excavated and shipped to the licensed landfill in Utah during this period. The Pond 1 and Pond 2 areas were regraded, covered with topsoil, 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)

CURRENT SITE CONDITIONS

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 1.5-1

were operated throughout Phase IV. The SPSF was shut down at the end of 2004, and the WTP ceased operation in December 2010.

During Phase V, the water well was abandoned, the support facilities, including the modular offices, guard shack, site laboratory, Simplified Physical Separation Facility (SPSF), the Common Facilities (CF), the Water Treatment Facility (WTF), the Railcar Loading Facility (RLF) and rail spurs were dismantled and disposed of, and contaminated soil was excavated, stockpiled, and shipped for disposal. The support zone was regraded, covered with topsoil, and seeded.

3. Factory Site:

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.

During Phase V, the railspurs were dismantled and the area north of the RLF was regraded, covered with topsoil, and seeded.

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 18.2°F; the warmest month is July, with an average maximum temperature of 84.2°F.

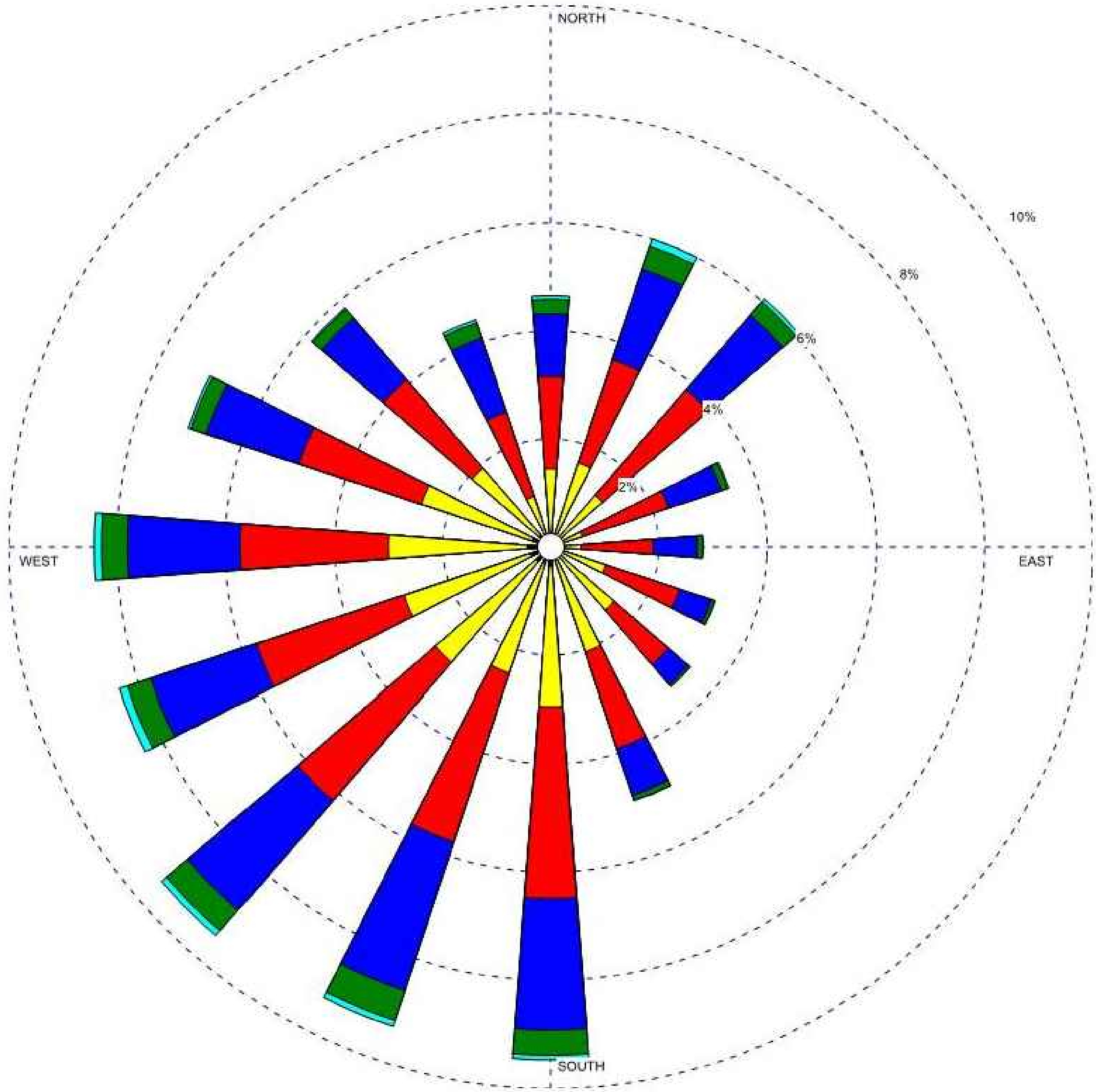
The average wind speed is 10.6 miles per hour. The prevailing wind direction varies from westerly in January to southerly in September and then swings back again to westerly in December. Figure 2.1-1 is a wind rose applicable to the Site. This wind rose was developed using data from the Chicago O'Hare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

The mean monthly precipitation is smallest in February and greatest in May. The average annual precipitation between 1981 and 2010 at the Chicago O’Hare National Weather Service Station was 39.09 inches.

There are numerous thunderstorms near Lake Michigan and West Chicago annually. These thunderstorms occasionally bring hail, damaging wind, and tornadoes. From 1991 through 2010, the annual tornado average incidence rate for the state was 54 (U.S. Dept. Commerce, 2022). More than 65 percent of Illinois tornadoes occur between March and June. The probability of a tornado striking the Facility is 8.54 x 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	COMPANY NAME
> 21		**10/7/2004**	**Illinois State Climatologist Office**
17 - 21	DISPLAY **Wind Speed**	UNIT **Knots**	COMMENTS **1961-1990 Annual Average**
11 - 16	AVG. WIND SPEED **9.25 Knots**	CALM WINDS **3.10%**	
7 - 10			
4 - 6	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **Jan 1 - Dec 31 Midnight - 11 PM**	PROJECT/PLOT NO.
1 - 3			

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

MAY 02, 2022 2:37 PM BRANS00939
I:\93JOBS\93S7001\PHASE VIEA\FIGURES\FIGURE_2.1-1.DWG

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WIND ROSE

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 2.1-1

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 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 2020 United States Census Bureau website indicate that DuPage County's population is 932,877, an increase of 1.7 percent from 2010. From 2000 to 2010, the population increased by 1.4 percent. Population projections made by the DuPage County Department of Economic Development and Planning (DuPage County, 2022) indicate that the DuPage County population will increase to about 1,195,000 by the year 2030. The City of West Chicago's 2020 population is 25,614, a decrease of 5.7 percent from 2010. Approximately 53 percent of West Chicago's population is Hispanic. 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 is 344,314, while that of West Chicago is 7,838. The average household size in DuPage County is 2.7 individuals; in West Chicago the average household size is 3.4 individuals.

The average per capita income in 2020 for West Chicago was $30,245, with a median household income of $77,098. City residents 25 years old and over have the following educational profile: 79 percent are high school graduates and 29 percent have a bachelor’s degree or more. The median age of residents was 34 years in 2019.

Housing for the City of West Chicago has increased 0.5 percent from 2010 to 2020. A total of 7,838 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 ($PM_{2.5}$) (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	17.1							0.093	0.02
Cicero	26.5	0.033	0.027	0.020	0.0762	3.1	1.5	0.080	
Des Plains	30.5							0.079	
Lisle								0.112	
State and Federal Primary Standards	35	0.075	none	0.053	0.1	35	9	0.12	0.15
State and Federal Secondary Standards	35	none	0.5	0.053	none	none	none	0.12	0.15

Notes: (1) Annual means the annual arithmetic mean.
(2) The $PM_{2.5}$, sulfur dioxide (1-hour), nitrogen dioxide (1-hour), carbon monoxide, and ozone concentrations were the highest samples (worst case) for 2019.

Source: Illinois Environmental Protection Agency, Bureau of Air, Springfield, Illinois, "Illinois Annual Air Quality Report 2019".

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 ten largest employers in West Chicago are:

- Jel Sert
- West Chicago Elementary School District 33
- Aspen Marketing Services.
- Ball Horticultural Company
- InNocur Inc.
- Mapei
- Community High School District 94
- OSI Industries
- Sims Recycling Solutions
- New Wincup Holdings

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

- Managerial/Professional 30 %
- Sales/Administrative Support 22 %
- Services 19 %
- Production/Material Moving 22 %
- Construction/Maintenance 7 %

Most West Chicago residents are employed in the manufacturing sector.

2.3.2.2 Property Values

The 2016 - 2020 median housing value for West Chicago was $247,100, in comparison to the median value for DuPage County of $315,600. Surrounding communities of Warrenville, Winfield, and Carol Stream have median home values of $224,500, $319,100, and $257,800, respectively. A total of 2,320 renter-occupied units are in the City of West Chicago with a median monthly rent of $1,130.

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 Metra Union Pacific-West railroad provides both commuter and freight service; the Canadian National Railway and the Union Pacific 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 possibly 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 from 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 occur 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 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.

SERIES	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 Fm Joliet Fm	Upper Bedrock: Mississippi Valley	Silurian dolomite aquifer	0-465	Dolomite, silty at base, locally cherty.
	Alexandrian	Kankakee Ls Edgewood Ls				
Ordovician	Cincinnatian	Maquoketa Shale Group	Upper Bedrock: Midwest Bedrock	Maquoteka confining unit	0-250	Shale, grey or brown; locally dolomitic and/or limestone, argillaceous.
	Mohawkian (Ottawa Ls Megagroup)	Galena Group Decorah Subgroup Platteville Group		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		Ancell aquifer	100-650	Sandstone, fine- and coarse-grained; little dolomite; shale at top. Sandstone, fine- to Sandstone, fine- to medium- grained; locally cherty red shale at base.
	Chazyan	Ancell Gr: St. Peter Ss				
	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. Croixan (Knox Megagroup)	Jordan Ss Eminence Fm Potosi Dolomite		Middle confining unit: Eminence-Potosi		Dolomite, white, fine-grained, geodic quartz, sandy at base.
		Franconia Fm		Middle confining unit: Franconia		Dolomite, sandstone, and shale - glauconitic, green to red, micaceous.
	St. Croixan	Ironton Ss		Ironton-Galesville aquifer	0-270	Sandstone, fine- to medium-grained, well sorted, uppar part dolomitic.
		Galesville Ss				
		Eau Claire Fm	Basal Bedrock	Eau Claire	0-450	Shale and siltstone: dolomitic, glauconitic: sandstone, dolomitic, glauconitic.
		Mt. Simon Fm		Elmhurst-Mt.Simon aquifer	0-2600	Sandstone, coarse-grained, white, red in lower half: lenses of shale and siltstone, red, micaceous.
Precambrian			Crystalline			No aquifers in Illinois

Representative Stratigraphic Column for Northern Illinois (After Visocky et al., 1985)

STRATIGRAPHIC COLUMN FOR NORTHERN ILLINOIS

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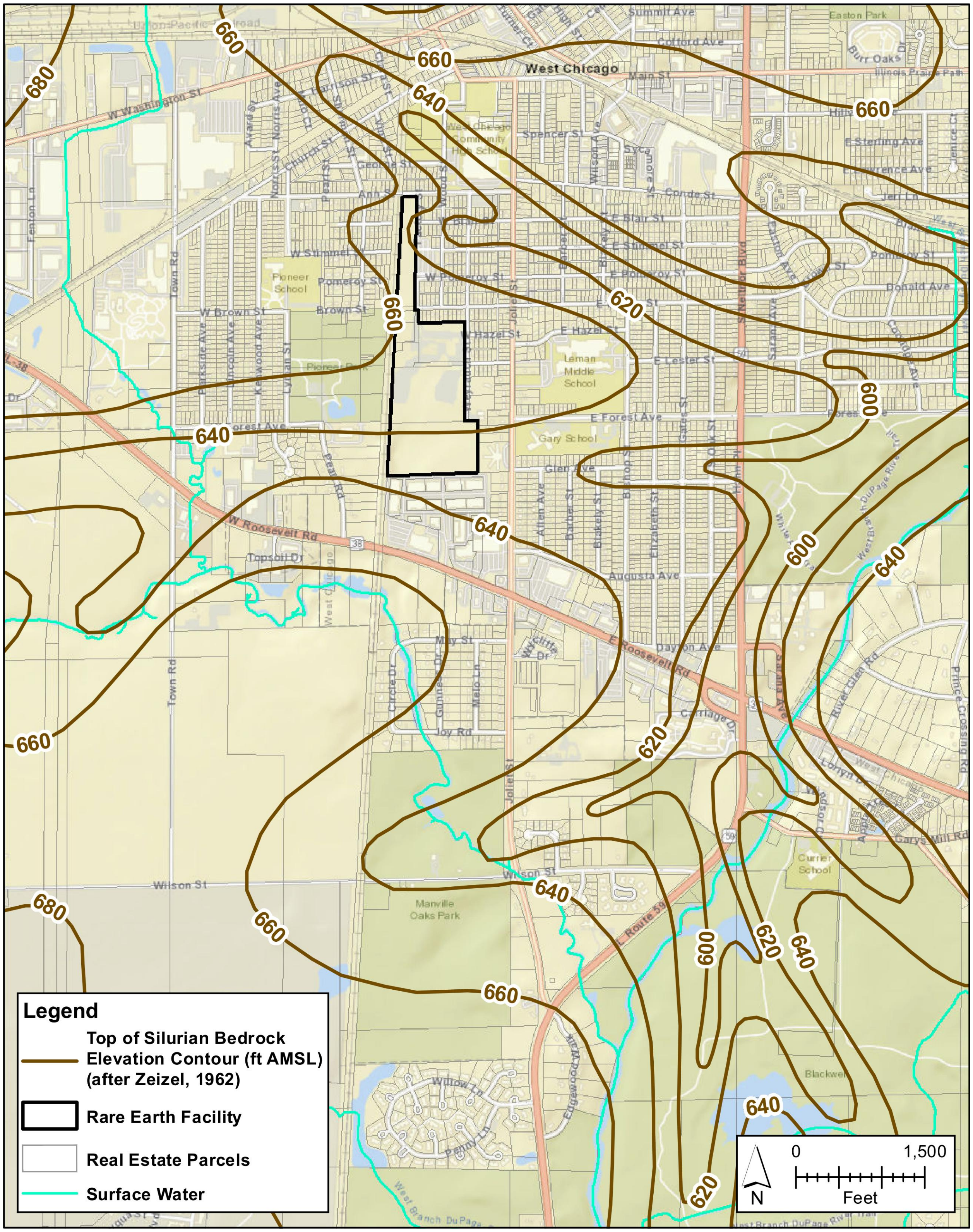
FIGURE 2.6.1-1

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 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.



STRUCTURE CONTOUR MAP
OF THE SILURIAN BEDROCK SURFACE

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PHASE VI
KERR-MCGEE, WEST CHICAGO

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FIGURE 2.6.1-2

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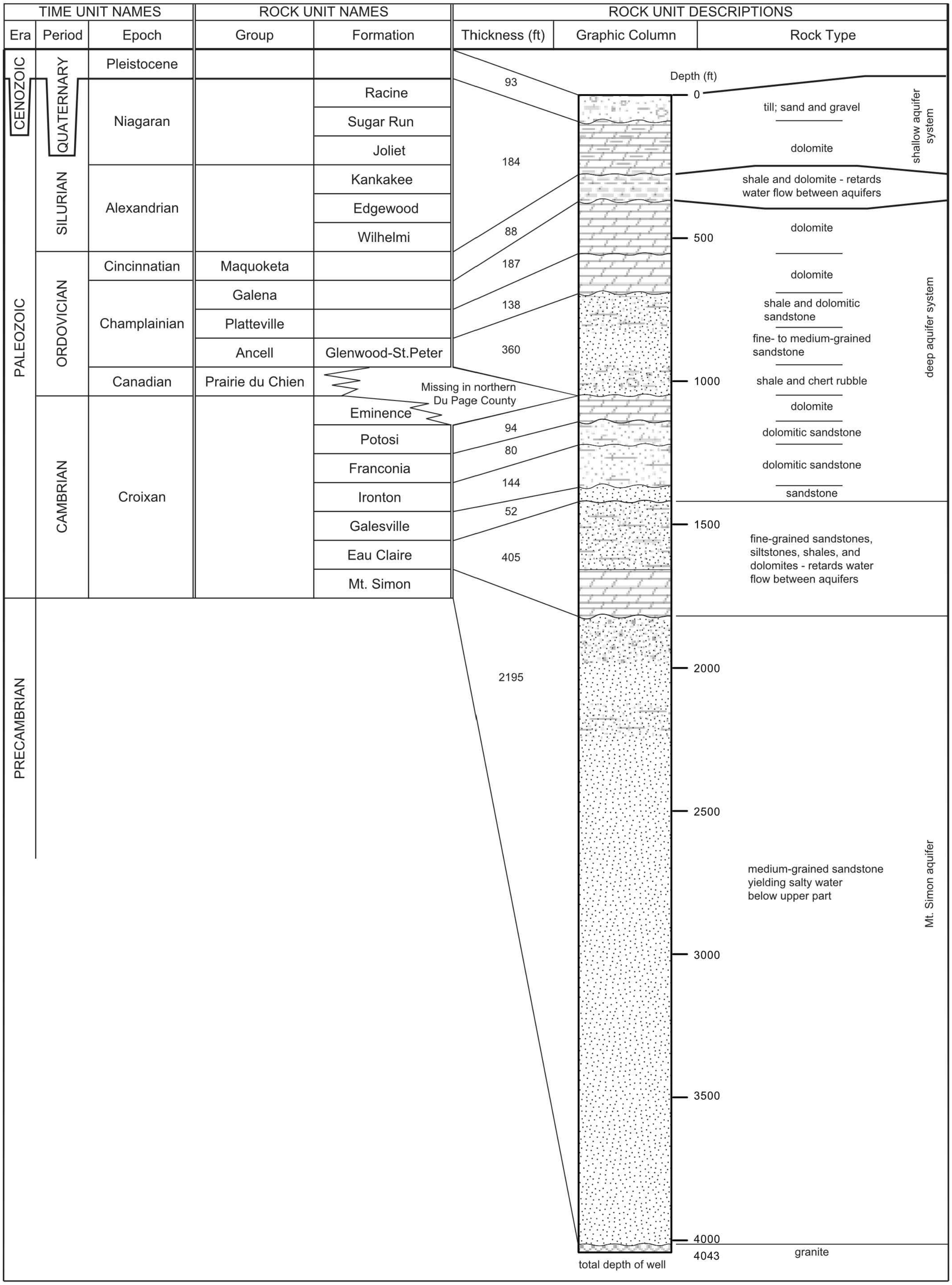
2.6.2 Site Geology

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 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 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



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GEOLOGIC LOG OF DEEP TEST WELL

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

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FIGURE 2.6.2-1

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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 most 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 Testing Company 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 U.S. 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.
- 2014 Weston drilled and completed 6 additional monitoring wells.
- 2016 Weston drilled and completed 8 additional monitoring wells.
- 2017 Four pumping wells and over 30 piezometers were installed as part of the Groundwater Pumping and Infiltration Tests (Weston, 2019). Many of these were installed inside the Pond 1 PSF area, but several were outside the sheet pile walls.
- 2019 As part of the Soil and Groundwater Investigation, 31 delineation borings and 9 exploratory borings were drilled. An additional 32 monitor wells were drilled and completed.

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 184 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 VI 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 strongly influence groundwater flow. The following information regarding the glacial sediment stratigraphic units was taken from Kerr-McGee (1986), Weston (2012a), and Weston (2021b). Thickness estimates for the glacial strata are based site borings used for development of the Site flow and transport model (Weston, 2021c).

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

GENERAL GLACIAL STRATIGRAPHY AT THE SITE

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PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 FIGURE 2.6.2.1-1

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The A-Stratum is a dense, gray to brown, poorly sorted, silty, fine- to coarse-grained sand and gravel outwash deposit. 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, where present under the Site, is in direct contact with the underlying Silurian Racine Formation. The A-Stratum dips to the southeast and is generally less than 5 ft thick, but can be thicker in some locations. 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 till with sand and gravel layers locally intercalated (Weston, 2021b). 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 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 surface has a relatively uniform slope, with an elevation of approximately 710 to 715 ft at the north end of the investigation area to 680 to 690 ft at the south end of the investigation area (Weston, 2021b). The B-Stratum averages about 21 feet in thickness and ranges from about 6 feet to about 38 feet (Weston, 2012a).

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. The C-Stratum is uniformly underlain by the low permeability B-Stratum across the entire investigation area and overlain in most areas by the impermeable D-Stratum. 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. This breach in the D-Stratum extends for some distance east of the Site (Weston, 2022a). Three additional breaches in the D-Stratum to the west and south of the Site were also identified in (Weston, 2022). In these areas, the upper surface of the C-Stratum is in direct contact with the overlying E-Stratum, merging to make one large aquifer unit. The C-Stratum is present either as a single permeable unit, ranging from 5 and 20 ft thick, or as two generally thinner permeable units separated by a clay till (Weston, 2021b).

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 thickness ranges from 5 to 25 ft, with local variation in some areas (Weston, 2021b). Weston (2021b) identified four areas where the D-Stratum is absent or has been breached: 1) beneath the Intermediate Site extending to the east-northeast, 2) west of the north end of the Disposal Site, 3) south of the southwest corner of the REF along a section of Kress Creek, and 4) along the West Branch of the DuPage River southeast of the REF with an area extending northwest generally paralleling Kress Creek. Where the D-Stratum is absent, the C-Stratum and E-Stratum, which are of nearly identical lithologies, are in contact.

The E-Stratum can be characterized at the Site as an orangish-brown coarse-grained sand and gravel unit that occurs above the D-Stratum (Weston, 2021b). Like the A-Stratum and the C-Stratum, 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 material is very coarse grained, with fewer fines and coarser gravel than the C-Stratum. The undisturbed E-Stratum ranges in thickness from about 5 to 25 feet (Weston, 2021b). 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 clayey till, loess deposits, and topsoil. 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 15 feet. The average thickness is less than 3 feet. The F-Stratum also includes fill material used for backfilling on-site excavated areas where it can reach thicknesses of up to approximately 15 ft.

Kerr-McGee (1986) correlated 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 VI 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, 2019). 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 (0.03g).

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 (Zeizel et al., 1962). Because decommissioning activities at the West Chicago Site can only be expected to potentially impact local shallow aquifer units, the discussion of hydrology will focus on the two uppermost aquifer units below the Site, the glacial drift aquifer and the Silurian dolomite aquifer. However, the lower two aquifer units will be discussed briefly for completeness.

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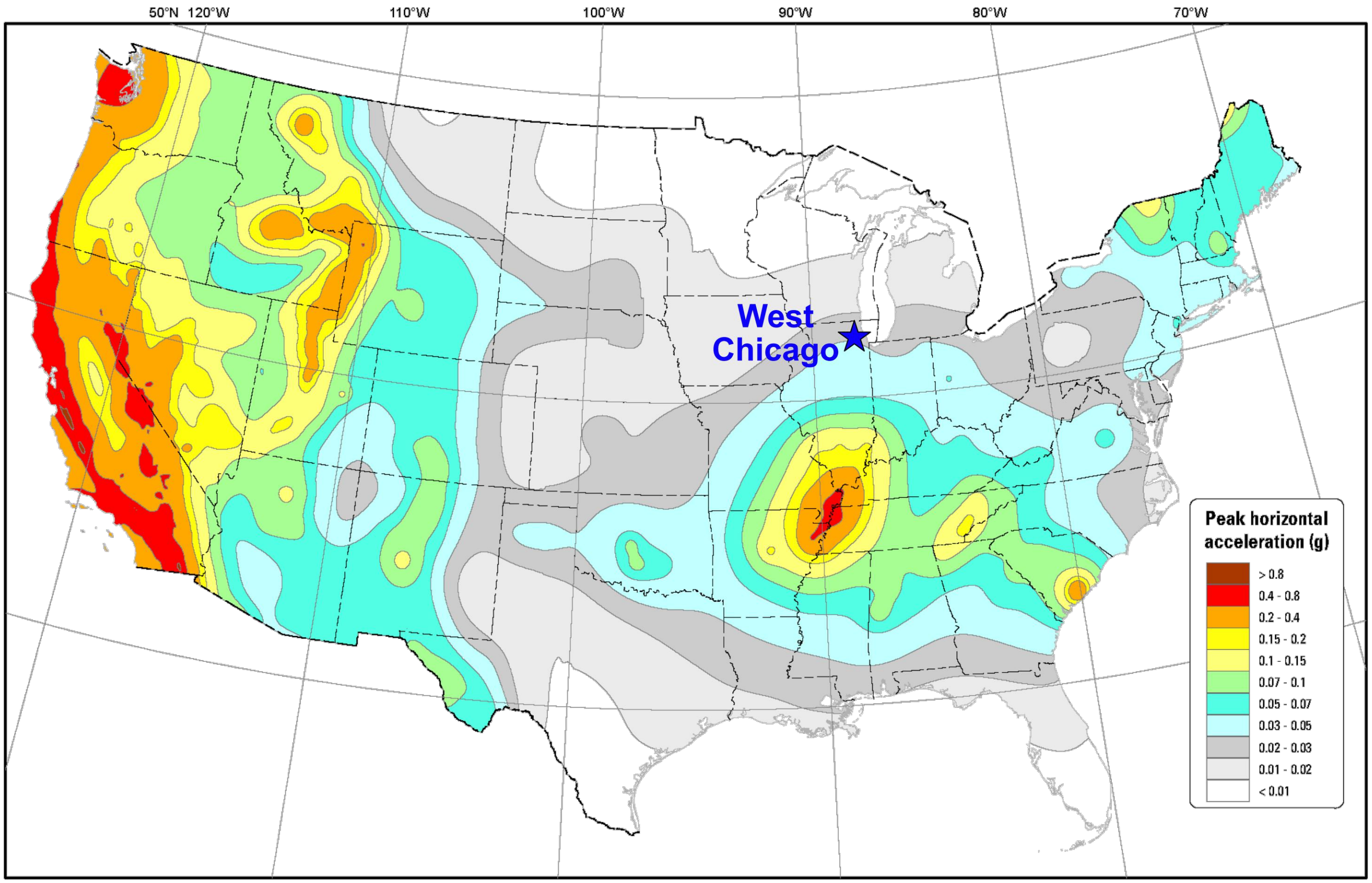


2018 National Seismic Hazard Model for the conterminous United States
Peak horizontal acceleration
with a 10% probability of exceedance in 50 years
NEHRP site class D (V_{s30} = 260 m/s)

HANSON Hanson Professional Services Inc.	PEAK ACCELERATION MAP	
	ENVIRONMENTAL ANALYSIS PHASE VI KERR-MCGEE, WEST CHICAGO	
	JOB NO. 93S7001	FIGURE 2.6.3-1

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 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) provides 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

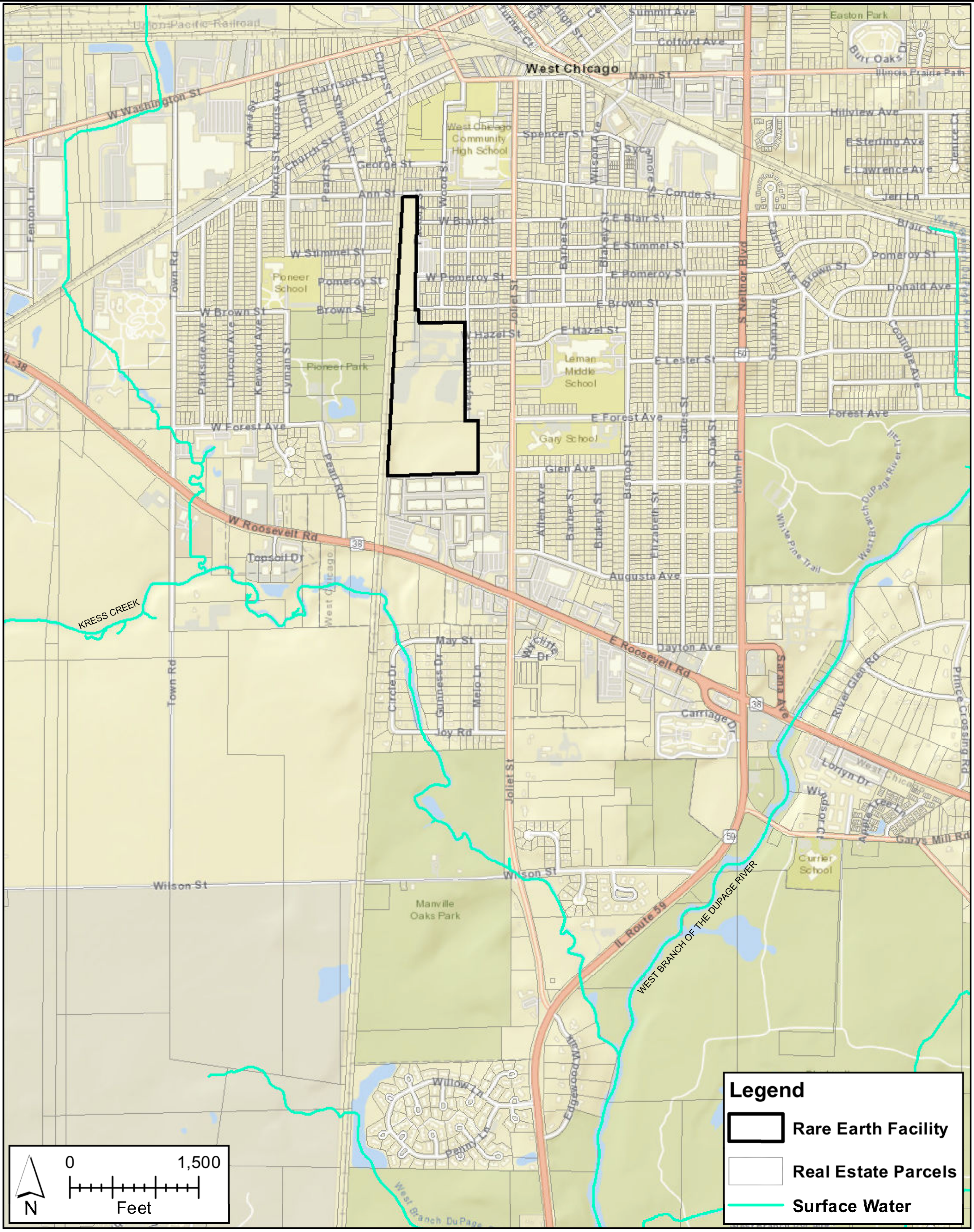
The Facility and the drainage area in the vicinity of the Facility are included on the USGS 7.5-minute quadrangle maps for West Chicago and Naperville, Illinois. The Facility area map (Figure 2.7.2.1-1) shows the location of the Facility with respect to major drainage features.

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 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 storm sewer network collects runoff from the southern area of the Site and off-site residential areas located east, west, and north of the Site. The municipal storm water system in the vicinity of the Site directs water to Kress Creek.

The USGS maintains stream-gaging stations along Kress Creek and the West Branch of the DuPage River. 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 18.2 ft^3/sec over the period of record (USGS, 2022).

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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FACILITY LOCATION MAP

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 2.7.2.1-1

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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. The retention pond has been removed and the Site has been contoured to final grade and grassed for future recreational use. Surface water now drains from the higher areas into low-lying areas on the Site and then enters a storm sewer near the south end of the Site. The parking lot areas also drain into the storm sewer. The storm sewer discharges to Kress Creek (Weston, 2022a).

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, consisting of 90 monitoring locations, is in place at the site. The corrective action monitoring network is being 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 ensure compliance with the groundwater protection standards everywhere on site and in affected off-site areas.

The corrective action monitoring network includes 86 monitoring wells, the three PSF Areas (Pond 1, Pond 2 and the SFE) and one at the location of former Pond 4. Pond 4 is a former waste area pond. Of the 86 monitoring wells, 38 are completed in the E-Stratum, 32 in the C-Stratum, 13 in the upper portion of the Silurian dolomite aquifer, and three (ECI-1, EC-9 and EC-11) are completed across both the E- and C-Strata. Eight of the wells monitor non-PSF sheet pile areas. Pond 1, Pond 2, and the SFE contain PSF fill material. Table 2.7.2.2-1 lists the wells in the corrective action monitoring network. An additional 32 monitoring wells were installed during the 2019-2020 Soil and Groundwater Investigation but are not currently part of the compliance well network. The locations of the compliance monitoring wells are shown in Figure 2.7.2.2-1. Additional monitoring well information can be found in Section 3.3.7.

The deepest aquifer of concern at the Site is the Silurian dolomite aquifer. 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. Weston (2021a) reported that the average annual precipitation for West Chicago is 33 inches per year. Therefore, the average recharge to the glacial aquifer in the West Chicago region is between 1.6 and 5.0 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 2.7.2.2-2 shows the location of site monitoring wells completed in the Silurian dolomite. Figure 2.7.2.2-3 illustrates the potentiometric surface in the Silurian dolomite aquifer based on average groundwater elevations measured in 2015 – 2020 (Weston, 2022a). Flow directions within the Silurian dolomite aquifer are variable, generally toward the north-northwest beneath and north of the Site, and southerly south of the Site. Weston (2022a) notes that this localized departure from the regional east-southeast flow in the upper Silurian dolomite is due to groundwater pumping from the City well fields located in the northwest portion of West Chicago. Hydraulic gradients in the dolomite aquifer at the Site are relatively flat south of Pond 1 and steeper north of Pond 1 (0.0092 ft/ft between wells KMB-4R and K-1). 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 aquifer pump testing and 3.6E-3 cm/sec (10.3 ft/day) based on slug testing. Assuming a porosity of 0.12 and 2020 average groundwater elevations, the estimated linear groundwater velocity in the

TABLE 2.7.2.2-1

Site Corrective Action Monitoring Wells

Well	Easting (NAD83)	Northing (NAD83)	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[b]	1017944.06	1897889.33	754.60	754.30	743.0	732.6
E-4[b]	1018045.83	1897894.07	755.65	758.35	742.6	732.6
E-5[b]	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[b]	1017909.12	1897219.33	747.01	749.74	737.9	727.5
E-8[b]	1018006.47	1897316.58	750.73	753.38	740.7	730.7
E-10	1017844.65	1896746.25	745.46	748.07	737.5	727.5
E-12	1018499.31	1896501.04	745.65	745.86	731.7	721.7
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	1017899.71	1894985.18	730.75	730.85	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	741.68	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	731.06	720.8	710.6
EB-9R	1017770.46	1895327.53	730.49	732.38	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
EB-13	1018140.43	1896448.24	745.04	745.03	727.0	717.0
EC-9[bd]	1017890.58	1896948.13	745.95	748.37	726.5	716.1
EC-11[bd]	1017867.97	1896630.32	745.01	747.16	733.4	723.0
ECI-1[c]	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	1017668.85	1896865.23	747.56	748.23	741.3	731.2
EF-13	1018175.48	1896992.64	747.17	746.92	734.2	729.2
EF-14[b]	1018078.84	1897598.71	753.32	756.18	743.3	733.3
EO-2[e]	1018050.12	1898715.54	751.28	752.77	744.7	739.5
TB-1RR	1017966.00	1896348.61	744.15	747.13	732.2	728.2
TB-2	1018759.71	1895228.97	736.47	736.14	728.5	718.5
POND-1[a]	1018549.71	1896144.53	740.50	743.02	735	716.0
POND-2[a]	1018011.90	1895919.02	0.00	739.69	734	722.0
POND-4	1018274.05	1895470.31	0.00	733.74	733	721.5
SFE[a]	1018116.34	1896565.83	745.47	747.20	745.5	745.5
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
C-12	1018499.80	1896507.44	745.77	745.76	714.8	709.8
CB-1	1018897.22	1895015.50	738.41	742.19	700.9	690.9
CB-2	1017891.51	1894989.85	730.81	733.26	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	741.80	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	732.22	709.9	704.9
CB-10	1018761.17	1896523.21	749.26	749.18	717.3	707.3
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-5	1018267.45	1896729.92	752.08	752.15	714.1	704.1
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
CF-14	1018078.58	1897594.01	753.05	756.14	720.0	710.0
CI-1	1018750.87	1896633.07	752.62	755.54	710.9	700.9
CO-2[e]	1018050.12	1898722.27	751.20	753.27	720.8	710.7
Silurian						
K-1	1018112.57	1897923.42	755.24	758.26	674.2	669.2
K-2	1018267.22	1896734.03	751.95	751.85	659.9	654.9
KMB-1R	1018896.53	1895026.40	738.70	742.09	651.4	646.4
KMB-2R	1017896.53	1894998.59	731.34	733.82	658.0	648.0
KMB-4R	1018760.23	1896296.80	746.83	746.55	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	741.44	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
KMF-14	1018078.91	1897589.14	753.04	756.06	673.0	668.0
KMI-1	1018755.12	1896626.60	752.63	754.61	665.3	660.3
KMO-1[e]	1019503.60	1897961.13	749.54	749.29	677.3	672.3

Based on Weston (2022a), Table 3-2

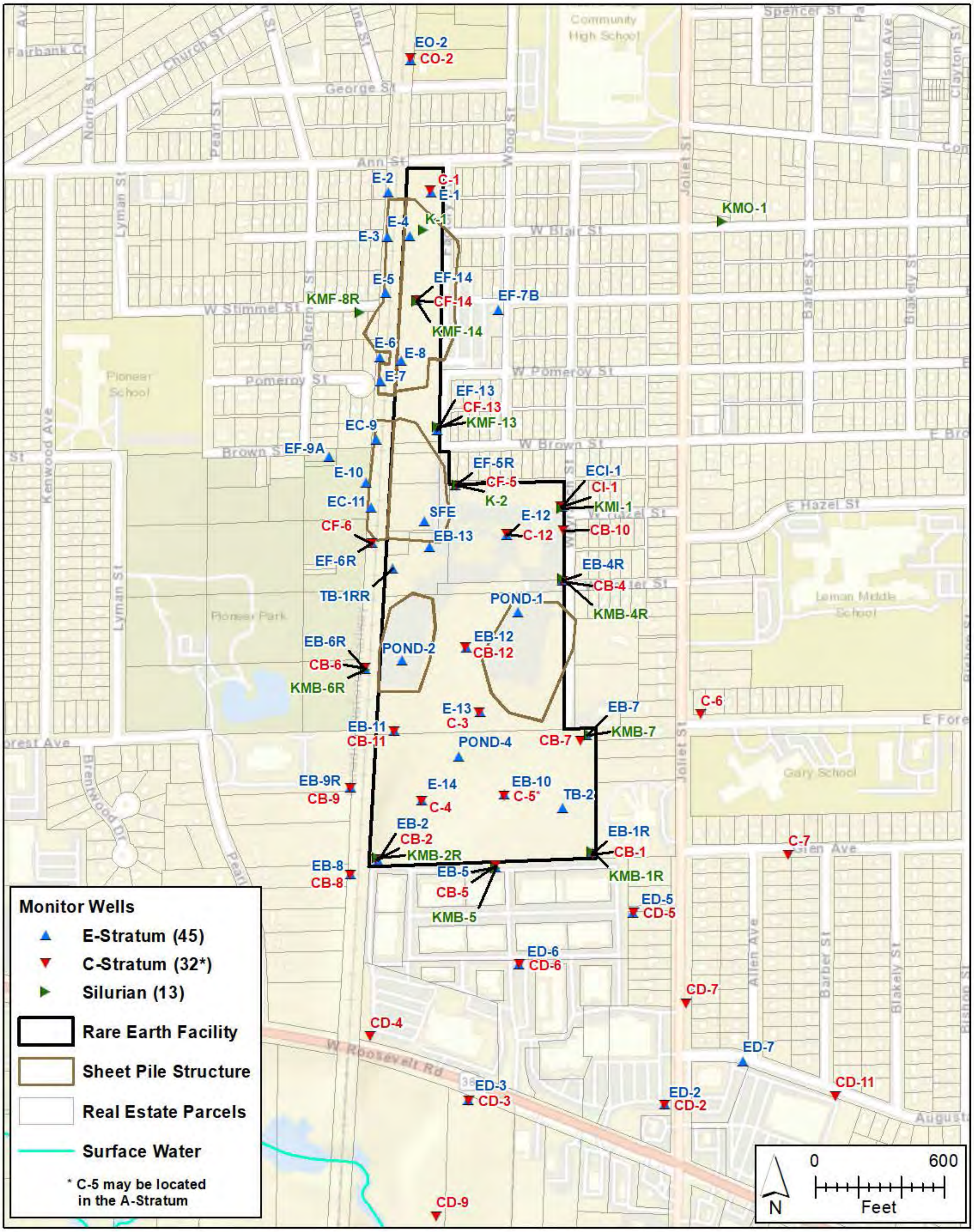
a) Well located inside a PSF area.

b) Well located inside a sheet pile enclosure with no under-drain.

c) Well ECI-1 is completed across both the E- and C-Strata.

d) Wells EC-9 and EC-11 may be completed across both the E- and C-Strata

e) Background well



CORRECTIVE ACTION MONITORING WELL LOCATION MAP

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FIGURE 2.7.2.2.-1

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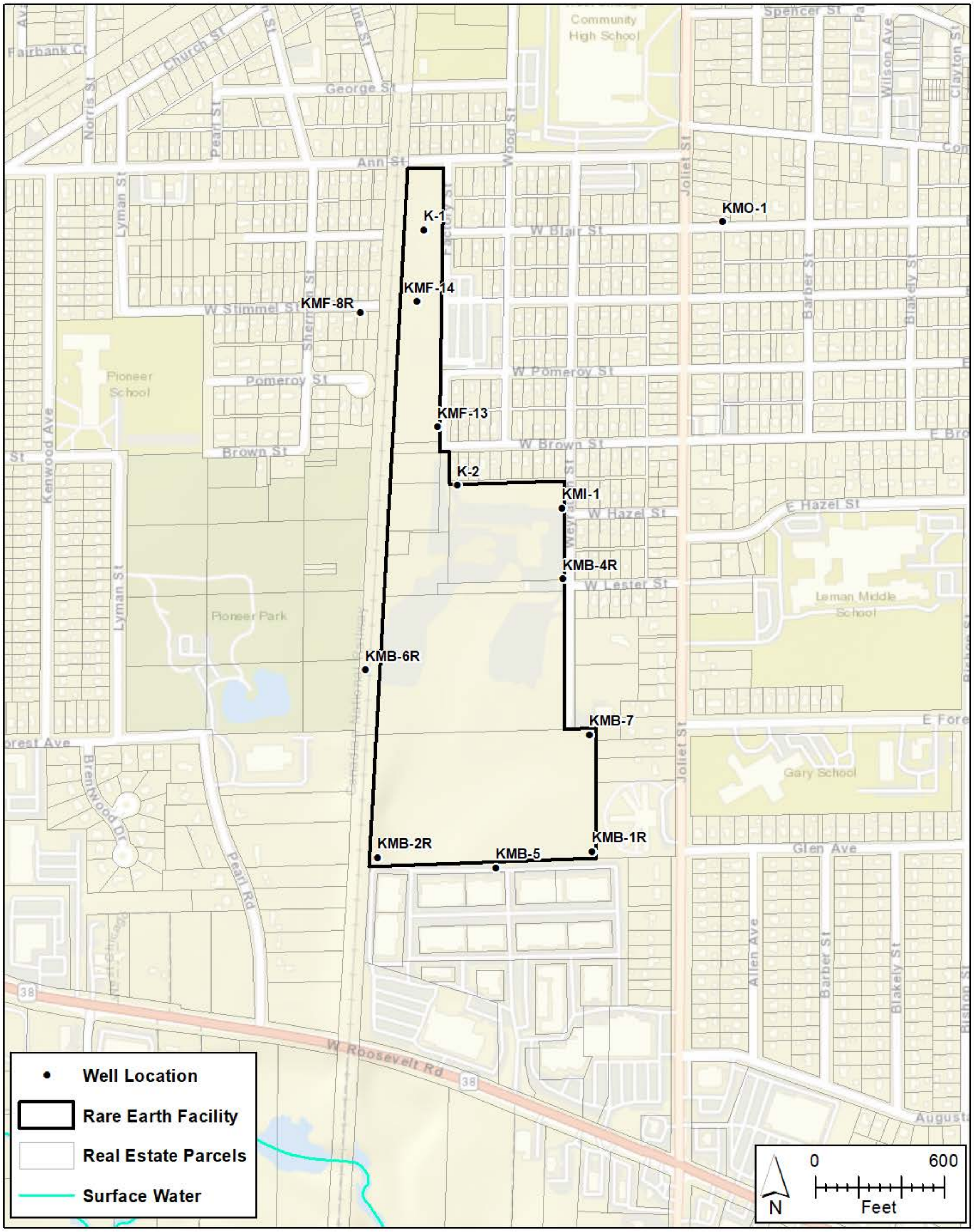

SILURIAN DOLOMITE CORRECTIVE ACTION MONITORING WELLS

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FIGURE 2.7.2.2.-2

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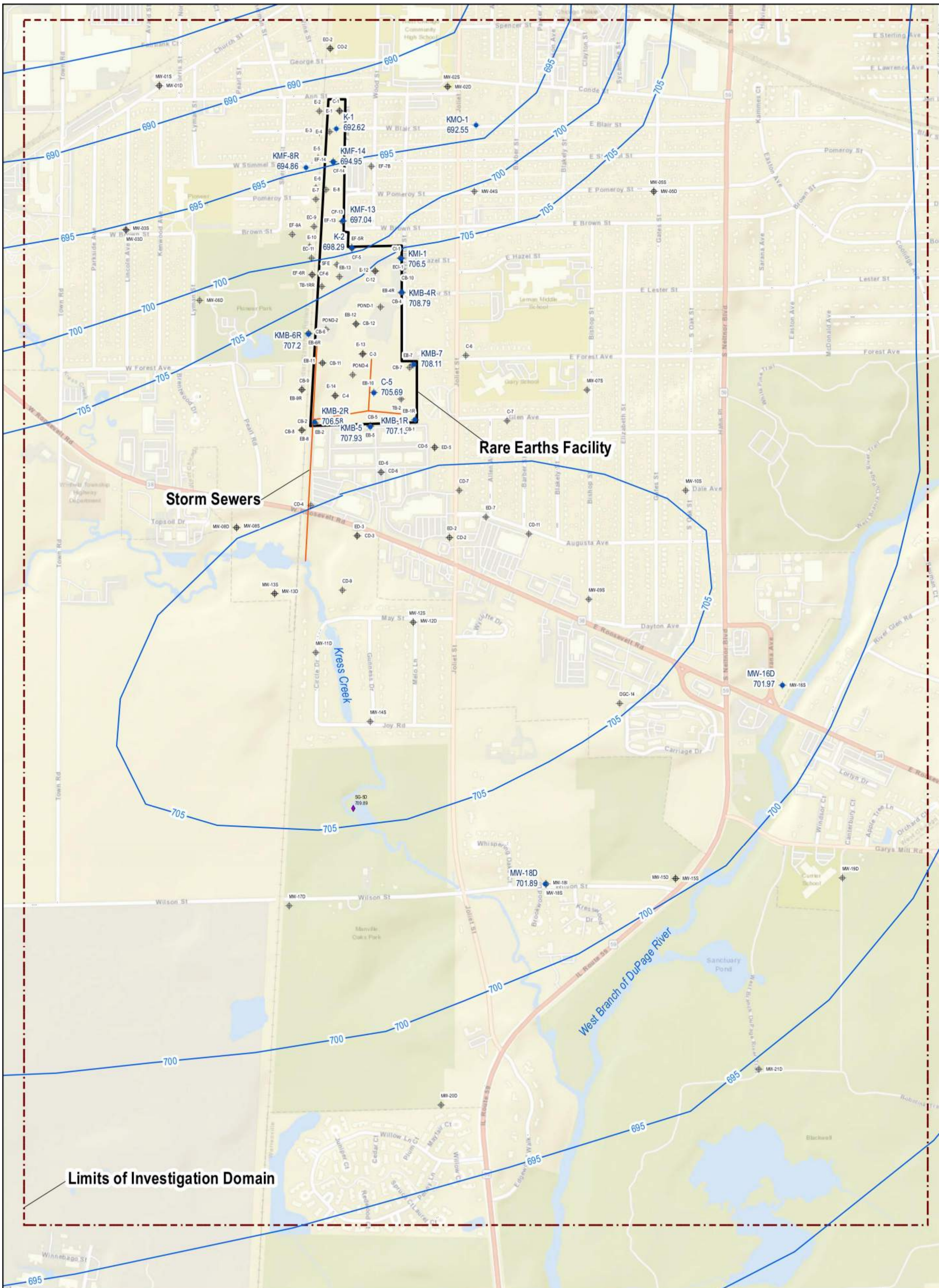

Legend

Groundwater Monitoring Wells

- A-Stratum and Silurian
- Other Strata

Surface Water Locations

- Staff Gage
- Estimated Potentiometric Elevations Contours
- Stormwater Sewer
- Investigation Domain

Notes:

1. Estimated Silurian groundwater elevation contours were interpreted based on the average groundwater elevations measured in 2015 - 2020.

NFE - North Factory East Area
NFW - North Factory West Area
SFE - South Factory East Area
SFW - South Factory West Area

N

Illinois State Plane, NAD83

0 500 1,000 1,500 ft

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AVERAGE POTENTIOMETRIC SURFACE FOR THE SILURIAN DOLOMITE

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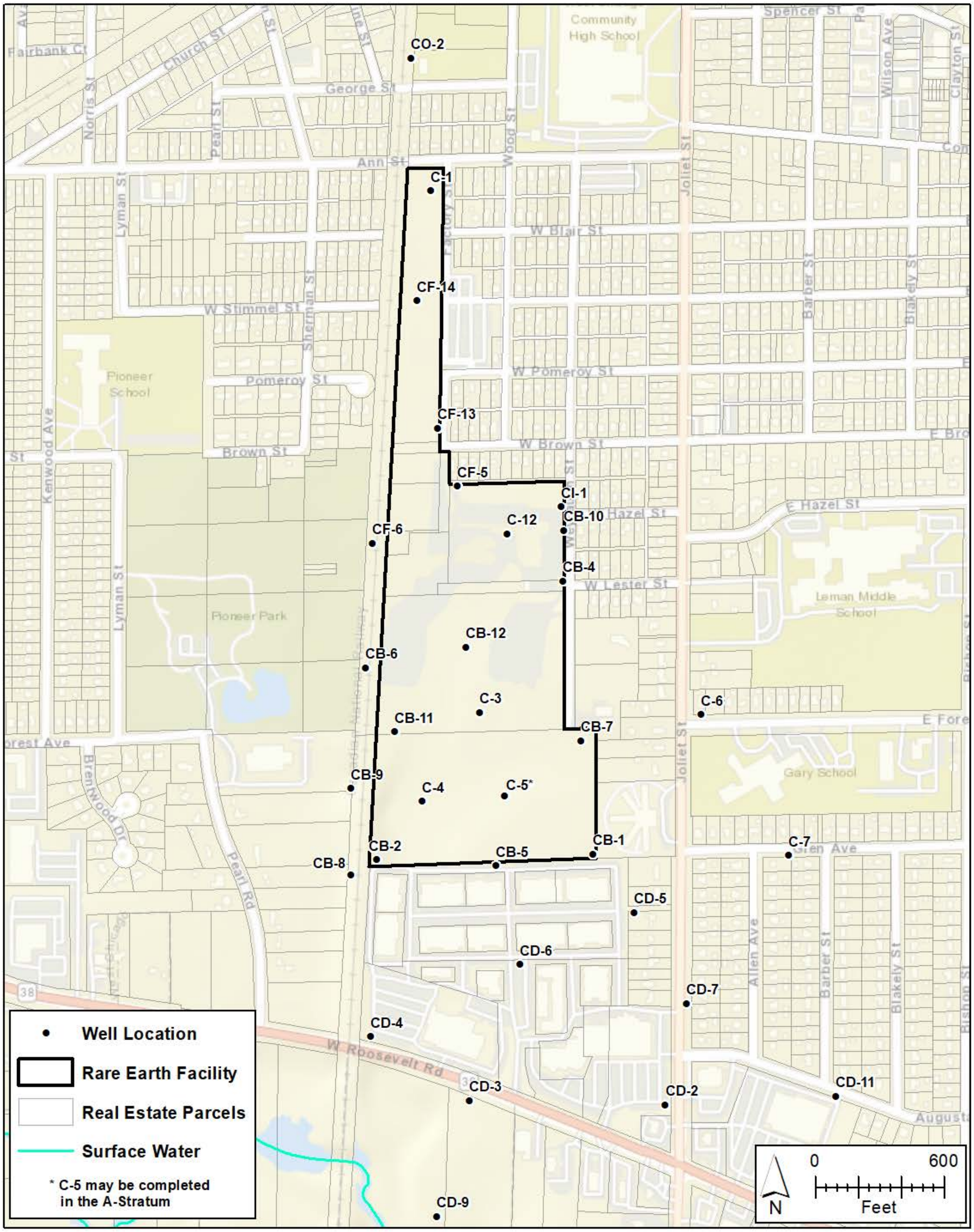
FIGURE 2.7.2.2.-3

dolomite aquifer could range from less than 0.01 ft/day to 1.50 ft/day. Actual linear velocities 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 are 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. This breach in the D-Stratum extends for some distance east of the Site (Weston, 2022a). Three additional breaches in the D-Stratum to the west and south of the Site were also identified in Weston (2022a). In these 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 80 to 120 ft at the Site, based on various subsurface investigations conducted to date (Weston, 2022a).

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.

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 potentiometric surface for the C-Stratum based on average groundwater elevations measured in 2015 – 2020 (Weston, 2022a). The hydraulic gradient within the C-Stratum was generally southerly with lows along Kress Creek and the West Branch of the DuPage River. The average (2015-2020) horizontal hydraulic gradient in the C-Stratum beneath the Site was estimated to be approximately 0.0054 ft/ft (Weston, 2022a), with a steeper gradient southwest of the Site toward Kress Creek and a flatter gradient to the southeast of the Site. Hydraulic conductivity values for the C-Stratum range from 0.51 to 669 ft/day (Weston, 2021c), with an arithmetic average of 173.1 ft/day. Kerr-McGee (1986) reported an average porosity for the C-Stratum of 0.33. Based on the average hydraulic conductivity value, a porosity of 0.33, and



C-STRATUM CORRECTIVE ACTION MONITORING WELLS

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FIGURE 2.7.2.2-4

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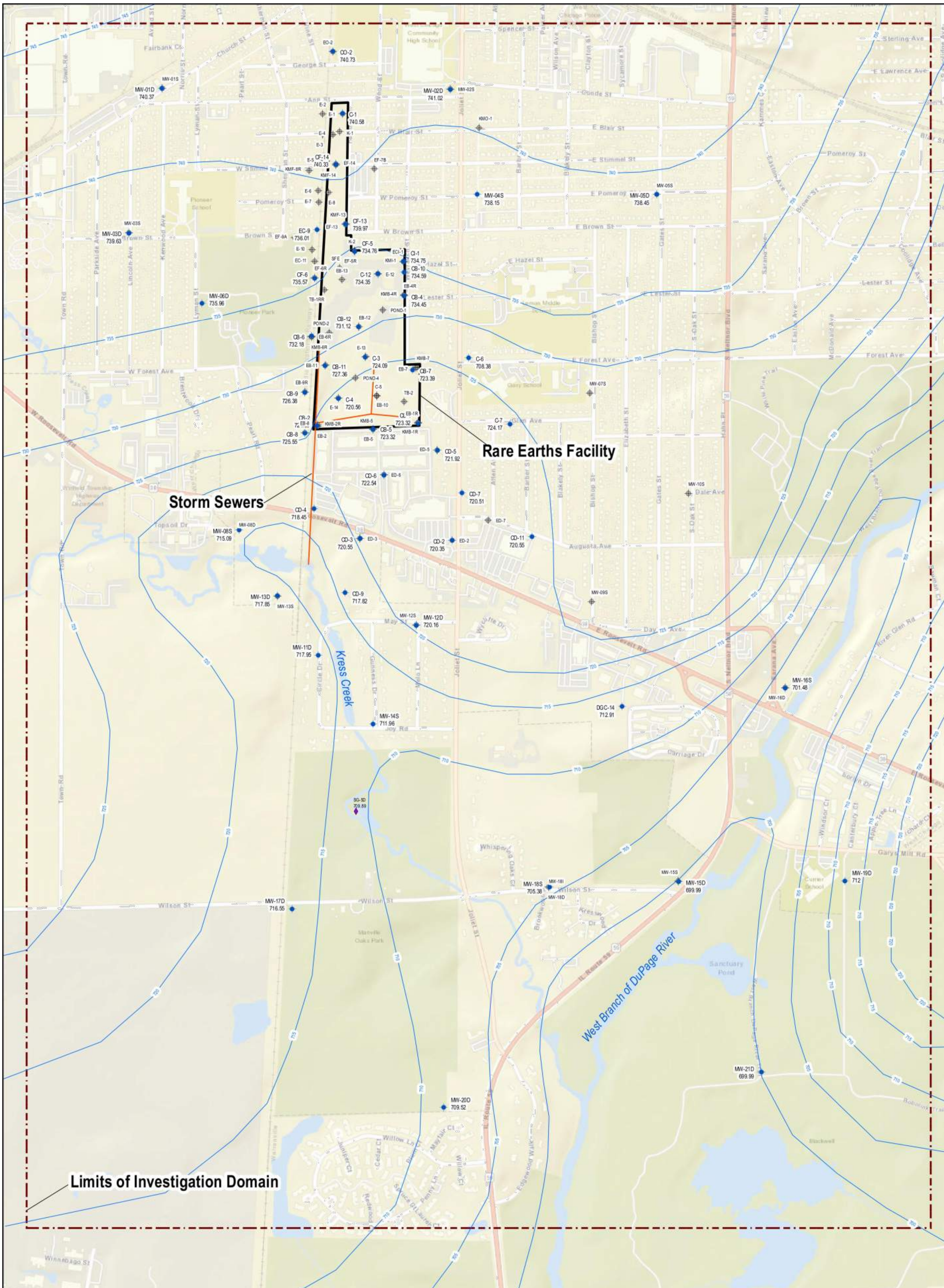

Legend

Groundwater Monitoring Wells

- C-Stratum
- Other Strata

Surface Water Locations

- Staff Gage
- Estimated Groundwater Elevations Contours
- Stormwater Sewer
- Investigation Domain

Notes:

1. Estimated C-Stratum groundwater elevation contours were interpretted based on the average groundwater elevations measured in 2015 - 2020.

NFE - North Factory East Area
NFW - North Factory West Area
SFE - South Factory East Area
SFW - South Factory West Area

N

Illinois State Plane, NAD83

0 500 1,000 1,500 ft

AVERAGE POTENTIOMETRIC SURFACE FOR THE C-STRATUM

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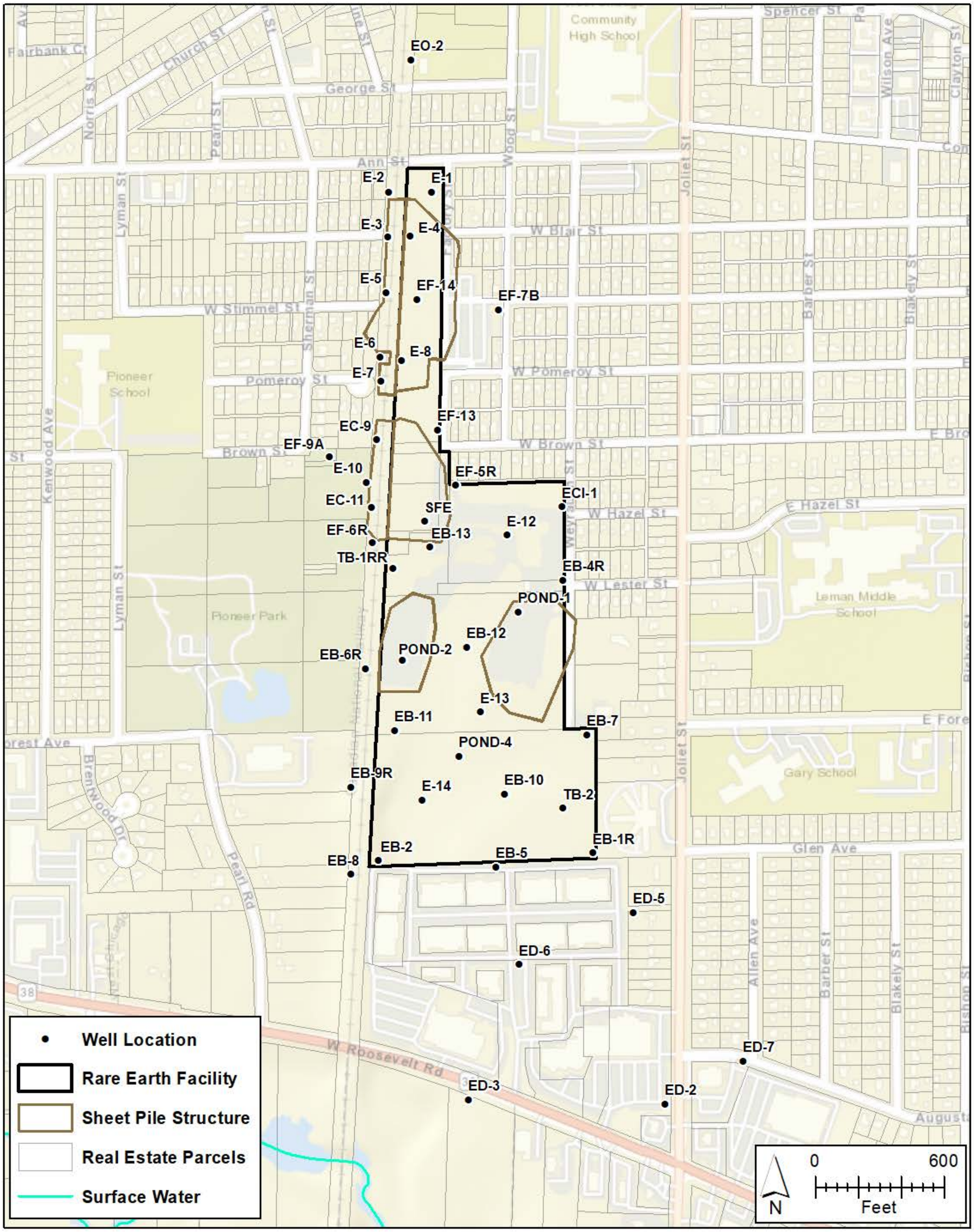
FIGURE 2.7.2.2-5

the hydraulic gradient reported above, the average linear groundwater velocity in the C-Stratum beneath the Site is about 2.8 ft/day.

Figure 2.7.2.2-6 shows the current E-Stratum monitor well array at the Site. Wells ECI-1, EC-9 and EC-11, completed in both the E-Stratum and C-Stratum, are included on this location map. Figure 2.7.2.2-7 plots the potentiometric surface for the E-Stratum based on average groundwater elevations measured in 2015 – 2020 (Weston, 2022a). Groundwater flow in the E-Stratum is generally from north to south at the Site with lows along Kress Creek and the West Branch of the DuPage River. 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 and to the West Branch of the DuPage River southeast of the Site.

The average (2015-2020) horizontal hydraulic gradient in the E-Stratum beneath the Site was estimated to be approximately 0.0052 ft/ft (Weston, 2022a), with a steeper gradient southwest of the Site toward Kress Creek and a flatter gradient to the southeast of the Site. Weston (2021c) 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 1.22 to 570 ft/day, with an arithmetic average of 198.9 ft/day. For the pumping tests, hydraulic conductivity values ranged from 116 to 691 ft/day, with an arithmetic average of 328.2 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 reported above, the average linear groundwater velocity in the E-Stratum beneath the Site ranges from about 4.1 ft/day to about 6.8 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.



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E-STRATUM CORRECTIVE ACTION MONITORING WELLS

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FIGURE 2.7.2.2-6

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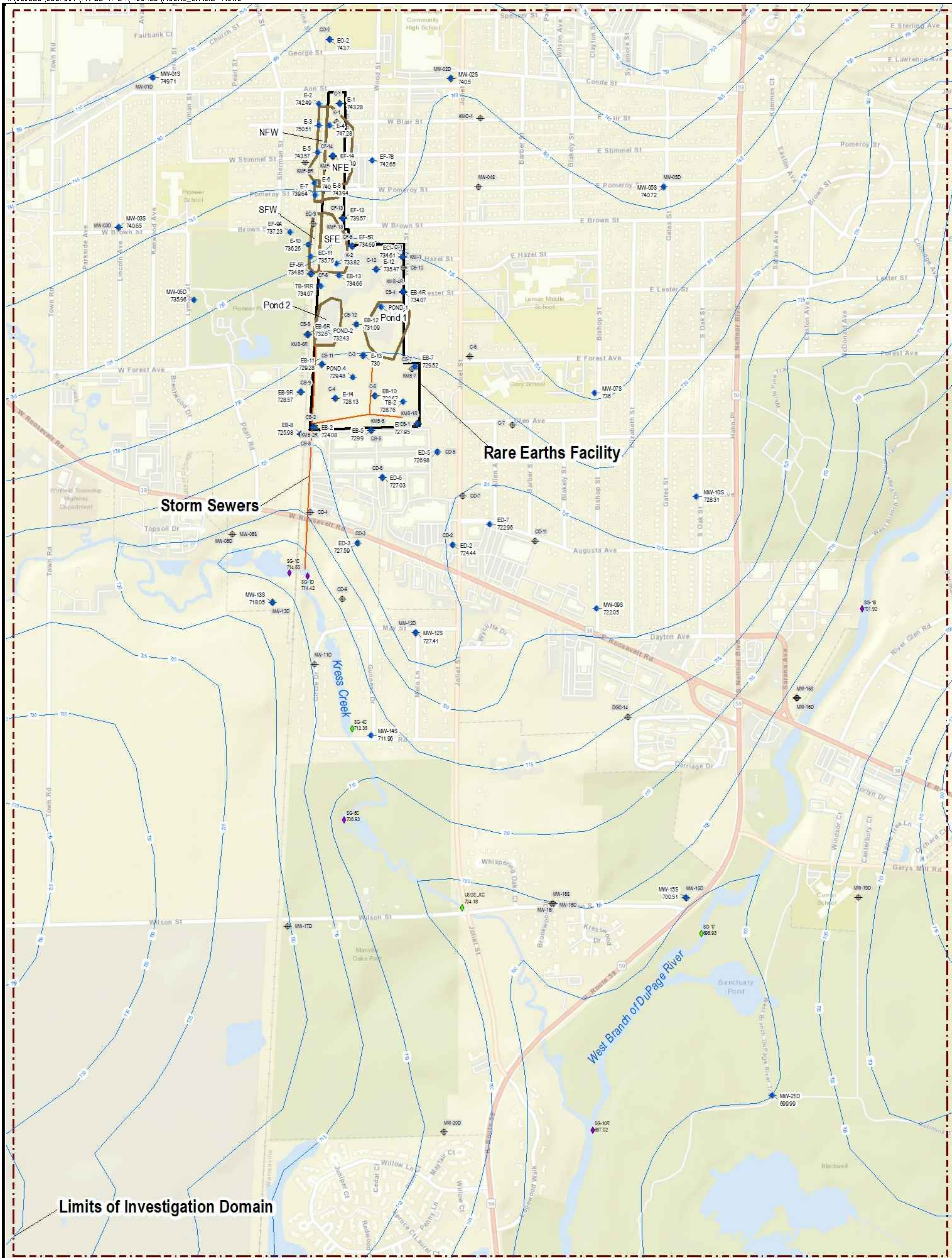

Legend

Groundwater Monitoring Wells
- E-Stratum
- Other Strata

Surface Water Locations
- Staff Gage - Transducer
- Staff Gage - Manual

- Estimated Groundwater Elevations Contours
- Stormwater Sewer
- Investigation Domain
- Sheet Pile Structures

Notes:
1. Estimated E-Stratum groundwater elevation contours were interpretted based on the average groundwater elevations measured in 2015 - 2020.

NFE - North Factory East Area
NFW - North Factory West Area
SFE - South Factory East Area
SFW - South Factory West Area

N

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0 500 1,000 1,500 ft

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AVERAGE POTENTIOMETRIC SURFACE FOR THE E-STRATUM

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PHASE VI
KERR-MCGEE, WEST CHICAGO

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FIGURE 2.7.2.2-7

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.

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 was 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 (Kerr-McGee, 1993d). 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.

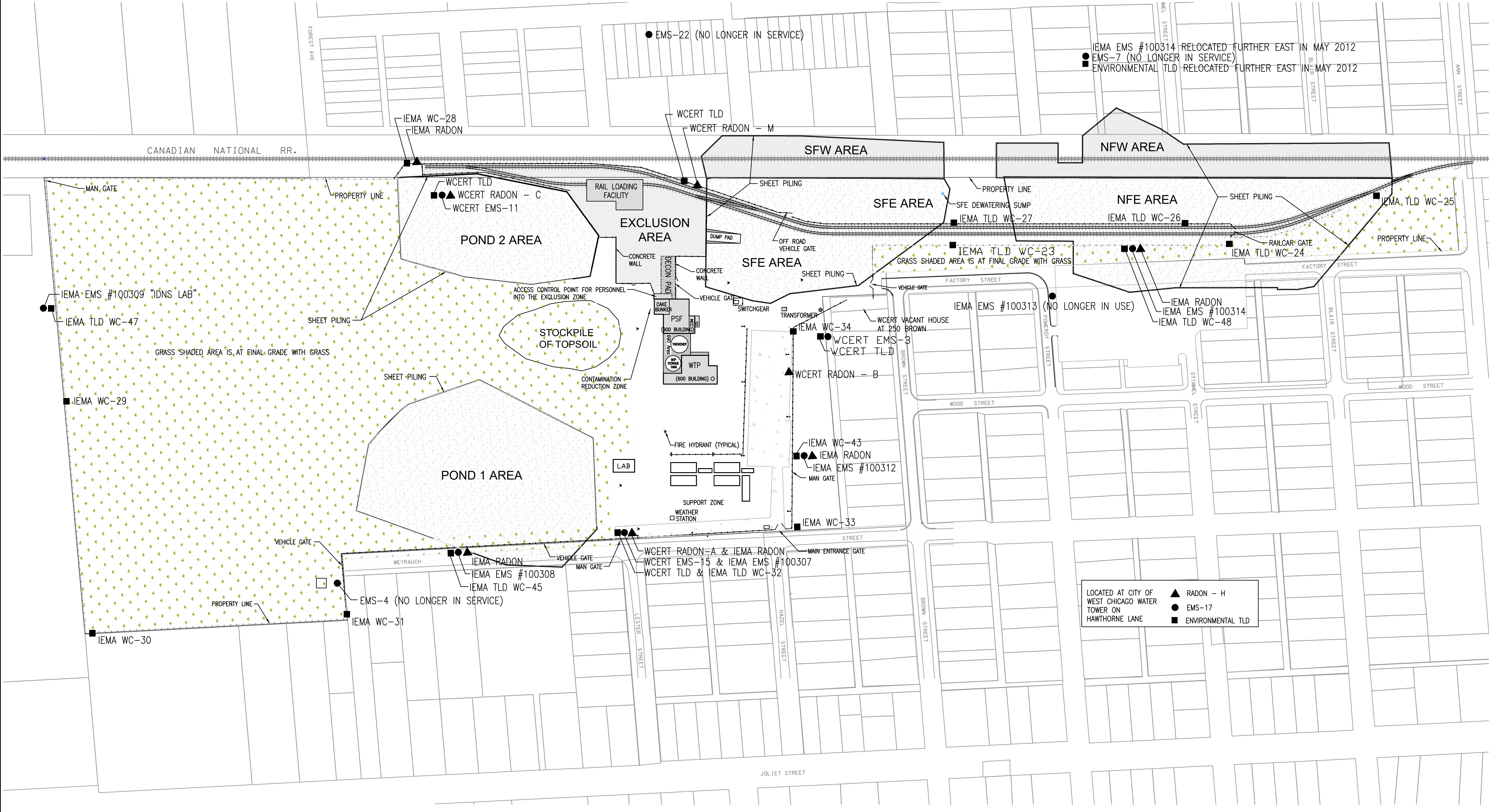
2.9 RADIOLOGICAL AND CHEMICAL CHARACTERISTICS

Environmental monitoring programs for the West Chicago Facility began in the late 1970s under the auspices of the U.S. NRC. Since then, a routine sampling program for defined locations around the licensed area was in operation. However, IEMA granted environmental monitoring for the REF to be suspended, partially or completely, for portions of 2014 and 2015 when decommissioning activities were not being conducted and when site conditions were determined to have no environmental impact. Then, after the soil contamination was remediated to meet the soil clean up objectives for unrestricted use, IEMA removed the requirement of environmental monitoring, except for the Groundwater Monitoring Program, from Weston's radioactive materials license. IEMA will reinstate the requirement for environmental monitoring, as described in Section 4, prior to the start of Phase VI decommissioning activities. The last environmental monitoring data collected is for the last two quarters of 2015. The following sections summarize the 2015 environmental data and show the sampling locations for radiological environmental monitoring at the West Chicago Facility.

2.9.1 Air

The licensee operated 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 2015 are shown in Figure 2.9.1-1 (Weston, 2016a). The particulate samplers measure the concentrations of several different radionuclides that may be released from the Facility. Filters were changed and analyzed weekly for natural thorium (Th-232). The weekly results were 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 were



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

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PHASE V SITE PLAN & MONITORING LOCATIONS

ENVIRONMENTAL ANALYSIS
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KERR-MCGEE, WEST CHICAGO

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FIGURE 2.9.1-1

TABLE 2.9.1-1
2015 AIR PARTICULATE MONITORING DATA

EMS	Isotope	January	February	March	April	May	June	July	August	September	October	November	December	Annual Average
3	Th-alpha	(a)	(a)	(a)	(a)	(a)	(a)	1.15E-15	1.35E-15	1.10E-15	7.98E-16	8.66E-16		1.1E-15
11	Th-alpha	(a)	(a)	(a)	(a)	(a)	(a)	1.15E-15	7.26E-16	1.85E-15	1.51E-15	2.09E-15		1.5E-15
15	Th-alpha	(a)	(a)	(a)	(a)	(a)	(a)	1.3E-15	1.41E-15	1.10E-15	1.23E-15	1.84E-15		1.4E-15
17	Th-alpha	(a)	(a)	(a)	(a)	(a)	(a)	1.09E-15	1.05E-15	9.32E-16	9.15E-16	9.26E-16		9.8E-16

All activities in micro-Ci/ml
(a) Air monitoring was suspended

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 2015 quarterly airborne particulate samples (Weston, 2016a).

In addition to airborne particulates, radon (Rn-222 and Rn-220) were sampled and analyzed on a quarterly basis using co-located Type M and Type F track-etch detectors. The network consisted of five radon detector locations, which can be 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 2015 radon-222 monitoring data for Type M detectors and Table 2.9.1-4 presents the total radon data for Type F detectors (Weston, 2016a). All air monitoring results were within regulatory limits.

2.9.2 Surface Water

The licensee conducted 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 2015. These sampling locations are shown in Figure 2.9.2-1. Surface water samples were collected and analyzed quarterly for gross alpha activity. If the gross alpha measurement exceeds 10 pCi/L, the 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 2013 (Weston, 2016a). All surface water results were within regulatory limits.

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 (U.S. 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,

TABLE 2.9.1-2
2015 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	1.7E-14	3.1E-14	2.7E-14	1.7E-14
Ra-226	6.2E-16	4.7E-15	6.9E-16	8.3E-16
Ra-228	6.6E-17	3.7E-17	4.3E-17	1.2E-16
Th-228 (a)	4.1E-16	5.2E-16	1.2E-15	1.9E-15
Th-232	9.3E-17	5.2E-16	1.5E-16	1.3E-16
U-234	1.4E-16	2.0E-16	4.9E-17	2.4E-17
U-235	1.9E-16	7.2E-16	1.4E-16	1.5E-16
U-238	9.7E-18	1.2E-16	2.9E-17	1.6E-17

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

TABLE 2.9.1-3
2015 RADON MONITORING DATA, TYPE M DETECTORS FOR RN-222

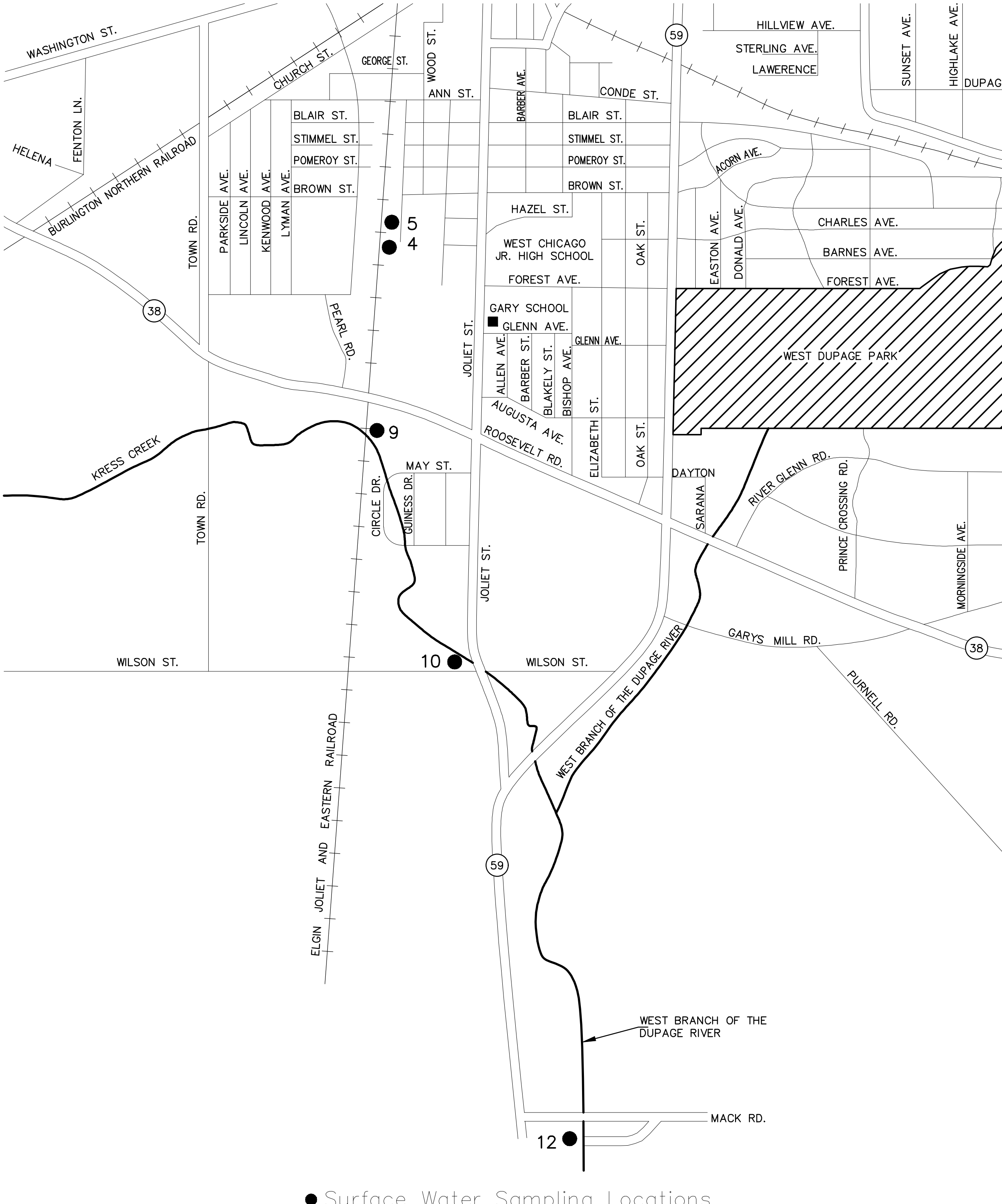
Location	First Quarter pCi/L	Second Quarter pCi/L	Third Quarter pCi/L	Fourth Quarter pCi/L	Annual Average pCi/L
A1	< 0.3	0.4	< 0.3	< 0.4	A 0.3
A2	< 0.3	< 0.3	< 0.3	< 0.4	
B1	< 0.3	< 0.3	< 0.3	< 0.4	B 0.3
B2	< 0.3	0.4	< 0.3	< 0.4	
C1	< 0.3	< 0.3	< 0.3	< 0.4	C 0.3
C2	< 0.3	< 0.3	0.4	< 0.4	
H1	< 0.3	< 0.3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

TABLE 2.9.1-4
2015 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	0.5	0.4	1.0	< 0.4	A
A2	< 0.3	< 0.3	0.5	< 0.4	0.5
B1	< 0.3	< 0.3	0.6	0.6	B
B2	< 0.3	0.4	0.4	0.7	0.5
C1	< 0.3	0.5	< 0.3	< 0.4	C
C2	< 0.3	< 0.3	0.4	< 0.4	0.4
H1	< 0.3	< 0.3	< 0.3	< 0.4	H
H2	< 0.3	0.3	< 0.3	< 0.4	0.3
M1	< 0.3	0.4	< 0.3	0.5	M
M2	< 0.3	< 0.3	0.4	< 0.4	

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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PHASE V SURFACE WATER SAMPLING LOCATIONS

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001 | FIGURE 2.9.2-1

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TABLE 2.9.2-2
2015 ANNUAL AVERAGE SURFACE WATER SAMPLING DATA

	Surface Water Sampling Location				
	4	**5**	**9**	**10**	**12**
Gross alpha (pCi/L)	63.1	54.9	43.2	4.1	< 0.01
Ra-226 (pCi/L)	0.3	0.3	0.3	(a)	(a)
Ra-228 (pCi/L)	0.3	0.4	0.9	(a)	(a)
Th-228 (pCi/L)	0.1	< 0.01	0.9	(a)	(a)
Th-232 (pCi/L)	< 0.01	< 0.01	< 0.01	(a)	(a)
Uranium (pCi/L)	72.1	69.8	53.3	(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 (U.S. 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

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 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, well over 100 monitor wells have been completed in and around the Site. The current corrective action monitoring network includes 90 monitoring locations, 86 monitoring wells, the three PSF Areas, and at the location of the former Pond 4. Historically, N-series wells, completed in the E-Stratum off-site, were used as background wells for compliance purposes. An additional 32 monitoring wells were installed during the 2019-2020 Soil and Groundwater Investigation but are not currently part of the compliance well network. The N-series wells were abandoned, and background concentrations are now monitored at wells, EO-2, CO-2, and KMO-1.

Groundwater protection standards (GWPS) were developed in 1999 for 20 constituents found to be elevated in the groundwater beneath the Site and 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. Based on the 2019-2021 groundwater analytical data, constituents that exceeded the GWPS included adjusted gross alpha, fluoride, manganese, sulfate, TDS, and uranium in the E-Stratum, fluoride, iron, manganese, nickel, radium, sulfate, and TDS in the C-Stratum, and sulfate and TDS in the Silurian dolomite aquifer (Weston, 2022a).

For those groundwater constituents that are above their respective GWPS, Weston has implemented a corrective action program that will serve to return regulated constituent concentrations to the GWPS set by IEMA. The groundwater corrective action program includes: (a) source removal in the PSF Areas, (b) natural attenuation, (c) treatment of groundwater in Pond 1, Pond 2, and the SFE Area, (d) groundwater monitoring, and (e) institutional controls.

Groundwater monitoring is governed by License Condition 6 of the Weston Solutions Inc. Radioactive Material License (STA-583), which requires semi-annual 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 semi-annual sampling events. Additionally, for constituents that have qualified for annual analysis at a well, License Condition 6 allows triennial analysis if the constituent does not exceed the groundwater protection standard for three consecutive 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 semi-annual samples are analyzed for the nine semi-annual constituents.

Currently at the site, there are 42 compliance monitoring locations in the E-Stratum, 32 compliance monitor wells in the C-Stratum, three compliance monitor wells (ECI-1, EC-9 and EC-11) completed across both the E-Stratum and the C-Stratum, and 13 compliance monitor wells completed in the upper portion of the Silurian dolomite aquifer (see Table 2.7.2.2-1). Three of the E-Stratum monitoring locations are in the PSF Areas (Pond-1, Pond-2 and the SFE) and one is at the location of former Pond 4. The remaining 38 E-Stratum compliance monitoring locations are monitor wells. Six of the E-Stratum compliance monitor wells and two of the wells completed across both the E-Stratum and the C-Stratum are inside non-PSF sheet pile areas. The A-Stratum is not monitored separately at the Site but is hydraulically connected to the Silurian aquifer.

Table 2.9.3-2 presents average groundwater concentrations for the nine semi-annual constituents (fluoride, adjusted gross alpha activity, iron, manganese, nickel, combined radium-226 and radium 228, sulfate, total dissolved solids, and total uranium). None of the other eleven constituents except nitrate has exceeded the groundwater protection standard since 2003, and that only in background well EO-2. Since well EO-2 is upgradient of the Site, those nitrate exceedances are not related to past activities at the Site. Values shown in Table 2.9.3-2 are the average of the last three analyses completed through 2020 for each constituent in each well. For these averages, any values less than the method detection limit or minimum detectable concentration were

assumed to be equal to the method detection limit or minimum detectable concentration. Adjusted gross alpha activity was assumed to be zero if uranium activity for a sample exceeded the measured gross alpha activity for the sample.

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 was monitored using thermoluminescent dosimeters (TLD) at three locations on the West Chicago Facility and one offsite uncontaminated location. The five locations 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 were analyzed quarterly to determine the gamma exposure rate. The results of the direct gamma radiation monitoring for 2015 are provided in Table 2.9.6-1 (Weston, 2016a). 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

Average Concentrations for Groundwater Sampling Data (Average of Last Three Analyses)

Well	Fluoride (mg/L)	Adjusted 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)
GWPS	4	15	5	0.61	0.1	5	400	1200	30
E-Stratum									
E-1	3.20	1.23	0.06	0.002	0.005	1.37	101	477	3.23
E-2	4.67	4.84	0.06	0.005	0.003	1.45	98	795	2.02
E-3[b]	8.10	0.00	0.24	0.191	0.004	1.04	196	697	308.39
E-4[b]	5.90	1.01	0.59	4.267	0.025	1.41	2000	3133	18.10
E-5[b]	4.07	5.01	0.06	0.002	0.003	1.08	114	565	68.65
E-6	5.23	5.49	0.06	0.228	0.014	0.98	363	1003	28.75
E-7[b]	1.43	2.57	0.07	0.127	0.010	1.02	320	1267	12.34
E-8[b]	11.00	0.00	0.63	0.550	0.015	1.41	2133	3200	87.95
E-10	3.17	3.42	0.06	0.084	0.004	0.98	103	1033	31.13
E-12	4.07	9.81	3.74	0.613	0.009	1.67	149	1267	0.32
E-13	8.07	7.30	0.06	0.012	0.007	1.19	140	1030	23.85
E-14	8.67	4.19	1.77	0.207	0.012	0.99	244	1067	9.62
EB-1R	8.67	3.03	0.06	0.078	0.010	1.61	122	853	85.46
EB-2	0.35	7.68	3.60	0.093	0.003	1.55	64	625	1.13
EB-4R	1.93	8.77	0.06	0.009	0.003	1.16	73	1307	1.96
EB-5	7.47	6.47	0.06	0.146	0.004	1.69	97	2267	3.12
EB-6R	1.12	1.15	0.06	0.007	0.004	1.70	76	726	7.66
EB-7	3.17	8.64	0.06	0.002	0.005	1.04	96	1067	0.77
EB-8	3.33	6.15	3.06	0.323	0.015	1.51	165	735	0.76
EB-9R	0.19	4.61	1.81	0.517	0.004	1.28	54	732	2.05
EB-10	3.13	5.21	3.14	0.288	0.009	1.38	96	867	12.09
EB-11	11.00	0.00	0.06	0.004	0.009	0.98	210	1037	131.15
EB-12	5.57	6.17	0.06	0.094	0.006	0.99	139	1133	4.08
EB-13	2.27	8.57	2.45	0.380	0.015	1.07	160	1133	11.98
EC-9[bd]	3.57	9.92	0.07	0.033	0.023	1.04	306	1300	23.58
EC-11[bd]	5.20	0.00	0.06	0.007	0.009	0.93	189	1047	51.04
ECI-1[c]	0.39	5.43	0.13	0.293	0.003	2.13	101	1273	7.57
ED-2	0.19	18.23	0.63	0.152	0.004	3.55	114	2000	4.67
ED-3	0.28	7.00	0.08	0.002	0.003	2.20	20	588	0.55
ED-5	6.17	0.00	0.06	0.035	0.009	1.19	116	1000	55.29
ED-6	0.30	13.25	0.12	0.037	0.005	1.91	73	2730	0.98
ED-7	0.19	12.65	4.70	0.460	0.003	2.77	106	1900	3.02
EF-5R	3.00	0.00	0.10	0.050	0.003	0.92	102	1167	49.90
EF-6R	2.47	4.88	0.58	0.321	0.005	0.93	111	1057	6.58
EF-7B	6.93	2.32	0.06	0.002	0.005	1.06	120	480	4.71
EF-9A	0.42	5.80	0.48	0.091	0.004	1.35	84	935	3.72
EF-13	0.35	5.30	1.23	0.327	0.016	1.43	93	921	2.99
EF-14[b]	1.80	2.31	0.97	1.290	0.038	1.56	2567	3700	17.59
EO-2	0.37	3.51	0.06	0.093	0.003	1.67	33	463	4.80
TB-1RR	4.10	1.35	0.09	0.156	0.005	1.32	102	1053	26.43
TB-2	8.20	1.33	0.06	0.003	0.006	1.19	103	812	43.26
Pond-1[a]	10.00	0.79	0.59	0.235	0.006	1.42	113	456	140.95
Pond-2[a]	5.60	4.68	0.10	0.366	0.005	1.14	145	967	61.50
Pond-4	0.40	3.32	0.05	0.035	0.003	1.45	26	222	2.76
SFE[a]	13.33	0.00	0.16	0.349	0.026	1.08	403	1333	142.73
C-Stratum									
C-1	0.27	10.12	1.85	0.132	0.003	2.25	112	1200	0.38
C-3	1.63	7.26	6.90	0.152	0.101	1.76	600	1767	1.05
C-4	0.47	4.82	0.99	0.054	0.006	1.27	51	390	0.80
C-5	0.29	7.45	0.61	0.026	0.005	1.09	2	150	0.69
C-6	0.37	10.92	13.00	0.127	0.117	1.21	1333	2833	0.18
C-7	0.23	8.22	7.47	0.167	0.091	1.06	900	1967	0.30
C-12	1.87	11.87	5.53	0.288	0.065	2.56	747	2133	0.21
CB-1	7.53	9.97	6.37	0.250	0.080	2.12	570	1633	0.20
CB-2	1.23	8.57	3.00	0.131	0.006	1.07	121	673	0.54
CB-4	1.67	9.38	8.60	0.723	0.024	1.41	510	1567	0.16
CB-5	0.43	7.08	1.53	0.012	0.052	1.03	470	1233	0.52
CB-6	1.70	8.50	3.47	0.407	0.007	1.01	154	1093	0.23
CB-7	1.73	9.41	10.67	0.391	0.072	1.72	913	2033	0.26
CB-8	2.67	7.20	3.28	0.097	0.014	1.21	206	805	0.27
CB-9	0.28	7.62	2.99	0.041	0.024	1.08	254	875	0.65
CB-10	1.18	8.97	3.90	0.286	0.050	1.41	507	1700	0.18
CB-11	1.03	6.95	2.85	0.200	0.028	1.12	210	929	0.22
CB-12	1.93	9.96	2.44	0.281	0.026	1.34	271	1110	0.17
CD-2	0.26	7.83	7.23	0.092	0.022	3.43	254	1333	0.16
CD-3	0.27	8.00	2.25	0.020	0.031	1.13	354	1127	0.19
CD-4	0.50	9.94	5.90	0.248	0.004	6.21	105	2200	0.45
CD-5	1.77	9.01	6.60	0.103	0.053	1.27	453	1433	0.17
CD-6	0.44	7.50	4.77	0.068	0.062	1.78	265	930	0.21
CD-7	0.31	8.75	5.80	0.054	0.072	1.63	613	1600	0.19
CD-9	0.25	7.71	2.24	0.034	0.042	1.45	410	1200	0.30
CD-11	0.28	5.79	0.51	0.041	0.003	1.22	94	734	2.65
CF-5	0.35	9.63	3.28	0.241	0.003	1.30	108	1333	0.47
CF-6	1.93	1.83	0.38	0.168	0.010	1.01	162	1210	21.47
CF-13	0.40	8.44	1.19	0.109	0.004	1.33	91	1333	0.59
CF-14	0.48	6.88	2.88	0.109	0.037	1.51	286	1433	0.27
CI-1	0.37	10.17	1.34	0.316	0.003	2.50	96	1293	2.79
CO-2	0.23	6.52	1.95	0.042	0.002	2.46	115	1193	0.45
Silurian									
K-1	1.00	10.39	3.41	0.094	0.053	1.62	937	1900	1.87
K-2	0.40	8.00	0.11	0.082	0.015	1.01	184	1300	0.23
KMB-1R	0.41	9.04	4.26	0.053	0.021	1.96	197	1400	0.16
KMB-2R	0.67	7.22	3.80	0.084	0.011	1.79	174	1195	0.16
KMB-4R	0.34	8.70	0.11	0.092	0.011	1.81	128	1147	0.71
KMB-5	0.39	8.68	3.60	0.066	0.009	1.67	138	1323	0.17
KMB-6R	0.30	8.74	1.85	0.131	0.006	1.40	117	1357	1.42
KMB-7	0.36	9.26	0.06	0.119	0.006	1.42	107	1273	1.35
KMF-8R	0.65	9.26	2.81	0.018	0.021	1.31	1433	2467	0.21
KMF-13	0.63	8.94	3.55	0.040	0.045	1.23	373	1500	0.13
KMF-14	0.62	9.77	3.28	0.061	0.042	1.44	1000	2167	0.45
KMI-1	0.47	8.53	1.67	0.134	0.024	1.19	320	1333	0.82
KMO-1	1.39	4.45	1.22	0.013	0.002	1.46	106	778	1.19

a) Well located inside a PSF area.
b) Well located inside a sheet pile enclosure with no under-drain.
c) Well ECI-1 is completed across both the E- and C-Strata.
d) Wells EC-9 and EC-11 may be completed across both the E- and C-Strata

TABLE 2.9.6-1
2015 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	31.7	8.4	31.2	13.5	34.7	15.8	28.5	12.7	126.1	50.4
EMS-11	27.3	4.1	26.4	8.6	27.1	8.2	24.3	8.5	105.1	29.4
EMS-15	22.8	-0.4	23.2	5.4	24.7	5.9	20.8	5.0	91.5	15.9
Radon Station M	21.4	-1.9	19.2	1.5	20.0	1.2	17.2	1.4	77.8	2.2
EMS-17 (Background)	30.0	6.7	32.3	14.6	29.1	10.3	24.1	8.3	115.5	39.9
Deploy Control	23.3	0.0	17.8	0.0	18.9	0.0	15.8		75.8	0.0

1. Gross – value before deducting the background value
2. Net – value after deducting the background value
3. Deploy Control – quality control TLD provided by the manufacturer for estimating dose during transport and deployment of field TLDs.

3.0 PLANNED CLOSURE ACTIVITIES

3.1 STRATEGY

The licensee's objective is to decommission the Facility so that the property can be closed and released for public use and License STA-583 can be terminated. Decommissioning activities to date consist of eight phases: Phase I, Phase IA, Phase IB, Phase II, Phase IIA, Phase III, Phase IV, and Phase V. Phase VI activities, assessed in this Environmental Analysis Report, are scheduled for 2022 through 2030. Decommissioning of the site is expected to be complete by fall of 2026 with long-term monitoring continuing through 2028 (Weston, 2022b). By that time, all active groundwater remediation will have been completed with long-term monitoring to extend for 15 more years and natural attenuation expected to achieve compliance with Groundwater Protection Standards (GWPS) within 375 years.

Phase I, IA, 1B, II, IIA, III, IV and V Activities (1995 – 2022) will be described below for the purposes of completeness and to provide additional details regarding the Phase I to Phase V activities that have been discussed in earlier sections.

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. *Phase IB Operations 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 1994a) 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 Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson Engineers, July 1994b). 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 rail spur 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 1995i) and the *Site Excavation Plan Amended Documents* (Kerr-McGee, 1996e). These activities are 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). 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 rail spur, 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* (Kerr-McGee, 1997c) describes Phase IV activities. Phase IV decommissioning activities, originally scheduled for 1998 through 2001, are assessed in the *Environmental Analysis Report - Phase IV for the Decommissioning Activities 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.

The Plan and Cost Estimate for REF Completion (Weston, 2012c) describes Phase V activities. Phase V decommissioning activities are assessed in the *Environmental Analysis Report - Phase V for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Hanson, February 2013). The activities assessed were abandonment of the water treatment plant (WTP) water well, 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 (SZ), relocation of rail spurs, excavation, stockpiling, verification and restoration of the ground underlying facilities, railcar loading of material for off-site disposal, groundwater remediation through hot-spot pumping and immobilization and final grading and seeding. All Phase V activities were performed except for groundwater remediation through hot-spot pumping and immobilization.

Several alternative corrective actions were considered in the Revision 5 CAP and addressed in the Phase V EA aimed at remediating areas that may not meet the Groundwater Protection Standards within a reasonable time frame. These possible corrective actions included 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.

In 2013, Weston implemented a phased testing program to assess the feasibility of grouting PSF. Weston concluded that immobilization may restrict the site's "beneficial use" and impose "unknown future risks" (Weston, 2022a). In 2016, Weston prepared and submitted a Technical Memorandum (Memorandum) for Groundwater Corrective Action (Weston, 2016b). An in-depth review of the Memorandum led to the recommendation of evaluating enhanced uranium recovery methods commonly used for in-situ uranium mining, with a focus on testing oxidizing and complexing agents to significantly reduce the time required to lower uranium concentrations to the GWPS.

From 2016 to 2020, Weston successfully implemented the above recommendations by conducting bench- and pilot-scale studies to evaluate the feasibility of in-situ leaching (ISL) of uranium from the PSF material, the latest of which being summarized in Weston (2021b). The feasibility and pilot-scale leaching studies were determined to be effective at removing approximately 50 percent of the adsorbed uranium on PSF material.

Phase VI activities (scheduled for 2023-2027) assessed in the Environmental Analysis Report, are focused on decommissioning activities meant to remediate groundwater, including excavation and treatment of unsaturated zone PSF material in Pond 1, Pond 2, and the SFE Area. The Weston stated purpose for treatment of the shallow and unsaturated PSF material is to reduce the residual uranium activity of the unsaturated PSF to levels as low as reasonably achievable (ALARA). The motivation for this treatment is to minimize the potential for exposure to the public if this PSF material were excavated and/or moved to another location. The site soils, including the PSF, comply with 332.170(a). The objectives of treatment of the shallow, unsaturated PSF material is to reduce exposure from radionuclides (in this case uranium) to ALARA. The remainder of Phase VI activities relate directly to groundwater corrective action with the objective of achieving cleanup to the Groundwater Protection Standards.

Phase VI activities include:

- Construction of a lined and bermed Treatment Cell in Pond 1, following excavation of the unsaturated PSF
- Stockpiling materials
- Treatment of unsaturated zone PSF material from Pond 1, Pond 2, and the SFE Area
- Removal and treatment of relatively stagnant groundwater inside the sheet piles in Pond 1, Pond 2, and the SFE
- Transfer treated PSF back to Pond 1, Pond 2, and SFE and replace fill and topsoil
- Disposal of treatment solutions and solids
- Assuring perpetual maintenance of groundwater pathway Institutional Controls
- Demolition of treatment facilities and structures
- Removal of existing sheet piles surrounding the PSF areas
- Erosion and surface water control
- Final grading and seeding
- Groundwater monitoring

Semi-annual groundwater monitoring is continuing. The current compliance monitoring network is composed of 90 monitor wells and sampling locations in the glacial drift aquifer and the underlying Silurian Dolomite and located both on and off site. An additional 32 monitoring wells were installed during the 2019-2020 Soil and Groundwater Investigation but are not currently part of the compliance well network. 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. 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. During Phase VI remediation activities, the REF security will be staffed 24 hours per day Monday through Sunday.

The process building will be equipped with a 24-hour video monitoring and alarm system. There will be periods when the treatment operations at the site will be suspended because of weather. During these times, the site and process building will be monitored by a third-party alarm system.

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 VI activities are scheduled to begin upon the issuance of a license amendment by IEMA. Decommissioning of the Site is scheduled to be complete by October 2027.

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
  Dewatering and Groundwater Treatment System Operation
  Leach Solution Injection and Leachate Extraction
  Indoor Maintenance

Leachate Treatment

System Inspections

Radiological Monitoring

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, Backfilling, Compaction, and other Earthwork

  Liner Installation

  Sheet Pile Extraction

  Chemical and Supply Delivery

  Truck and Shipment Loading

  Sampling and Groundwater Monitoring

  Building and Concrete Demolition

  All other activities not specifically listed elsewhere

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

  Leaching Solution Preparation

  Treatment Cell Inspections and Outdoor Maintenance

The following sections detail the various Phase VI 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 Revision 6 of the Corrective Action Program (CAP) (Weston, 2022a). The CAP relies on monitored natural attenuation combined with institutional controls as the primary groundwater corrective action at the Site. 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 depicts current topography at the site as well as shows the location of the sheet pile areas that received PSF backfill

EXISTING SITE LAYOUT

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HANSON NO. 93S7001 FIGURE 3.3.2-1

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material. Areas within the sheet pile enclosures are hydraulically isolated from the local groundwater flow system and, therefore, essentially stagnant. As a result, these enclosed areas experience limited natural attenuation.

The primary corrective action for groundwater at the site is a combination of monitored natural attenuation and Institutional Controls. The Institutional Controls remove the groundwater pathway, reducing exposure and risks to human health and the environment (Weston, 2022a). To expedite groundwater cleanup, Phase VI activities will also remove all or some of the sheet pile to improve groundwater circulation through the sheet-pile areas. After Phase VI activities, groundwater uranium concentrations are expected to meet the Groundwater Protection Standard within 375 years (Weston, 2021c).

3.3.2.1 Institutional Controls

The REF currently has several institutional controls in effect during site decommissioning. Section 18-4(a) of the City of West Chicago's Code of Ordinances mandates city water for potable water purposes eliminating the need for private wells. West Chicago approved Ordinances 3069 and 05-O-0010 prohibit wells within an institutional control area adjacent to the REF that might contain impacted groundwater. DuPage County also has an ordinance that applies to unincorporated areas of DuPage County. Section 18-401.8 of the Ordinance specifies that a permit for a new water well will not be issued when a community water supply becomes reasonably available. Subsection 2, Parts I and II of the ordinance, impose additional restrictions on individual properties near the REF. The restrictions require individual parcels to connect to a public water supply when it becomes available and abandon any existing water wells except for groundwater monitoring or remediation purposes. Finally, railway property from Ann Street to Kress Creek has a private deed restriction that imposes groundwater use restrictions. Figure 3.3.2.1-1 provides the City and County institutional control areas covered by the controls listed above. As groundwater conditions evolve at the site, changes to institutional controls could become necessary to eliminate access to groundwater.

3.3.2.2 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 Protection Standards. These processes include advection, adsorption, dispersion, redox reactions, and dilution by precipitation infiltration. The associated action with natural attenuation is monitoring of groundwater conditions, which will occur throughout the Phase VI activities. The attenuation of groundwater concentrations will be monitored with the groundwater corrective action monitoring network described in Section 3.3.7.

3.3.2.3 Groundwater Removal from Pond 1, Pond 2, and the SFE

The groundwater within the sheet pile in Pond 1, Pond 2, and the SFE is relatively stagnant as compared to groundwater movement outside of the sheet pile areas. As a result, concentrations of uranium and fluoride are significantly elevated in the groundwater. Prior to removal of the sheet piles, groundwater from Pond 1 will be pumped using two 6-inch dewatering/extraction wells installed before the construction of the treatment cell. The existing Pond 2 sump and MW-SFE in the SFE area will be used to pump groundwater from Pond 2 and the SFE area. New wells will be installed if site construction activities impact the existing wells. Each well will be equipped with one pump capable of yielding a flow rate of 30 gallons per minute (gpm).

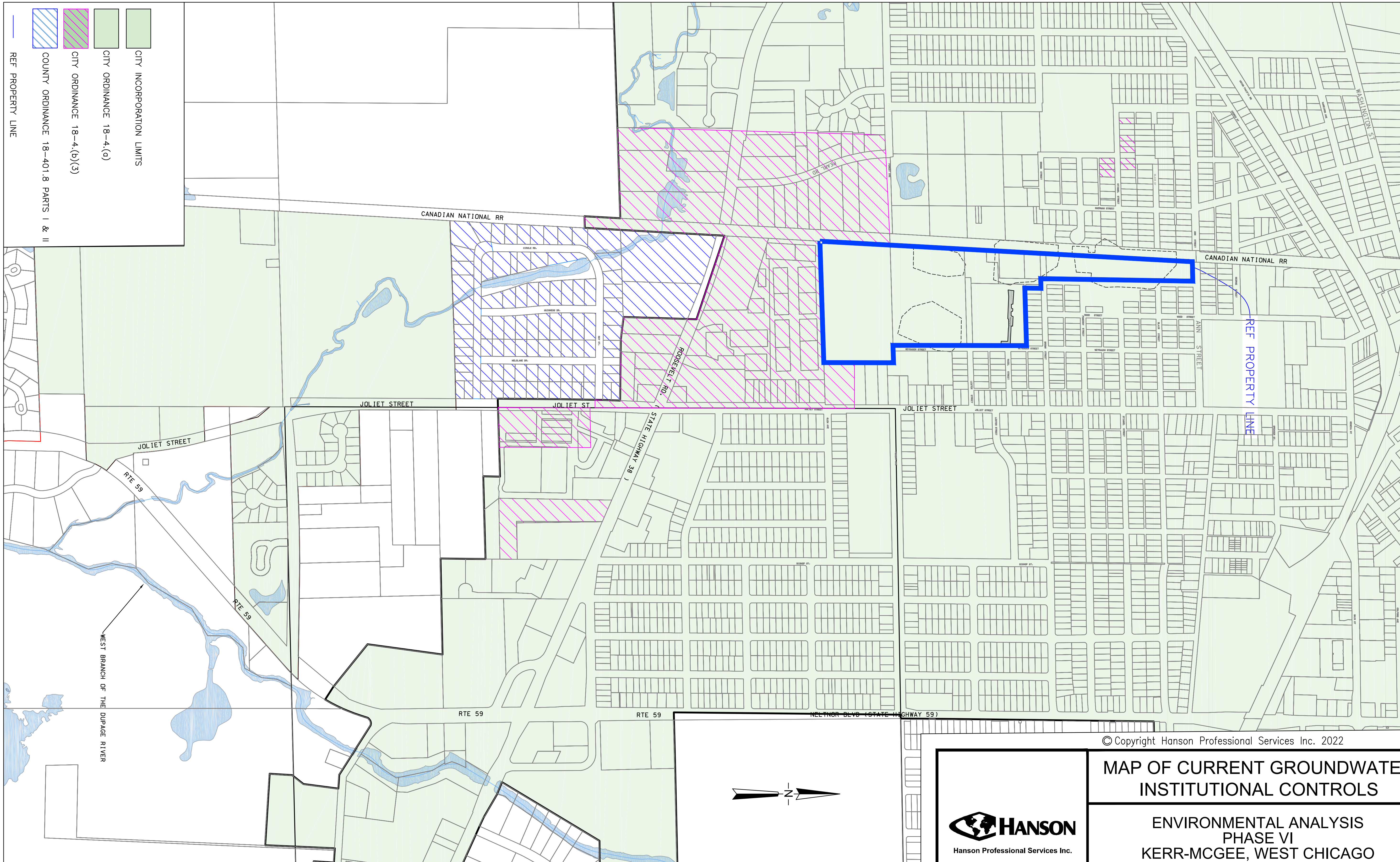
The groundwater treatment will be performed with an ion exchange system that is housed in a temporary heated building consisting of the following elements:

- Two equalization tanks, one each before and after solids removal.
- Two parallel and independent ion exchange treatment trains, each equipped with a 42-inch-diameter treatment vessel.
- Acid dosing system for pH adjustment.
- Treatment media, piping connections, valves, instrumentation, and other ancillary equipment.

The treated groundwater will meet an effluent standard of 300 pCi/L and discharge via a force main to a storm sewer that flows to the West Branch of the DuPage River.

3.3.2.4 Sheet Pile Removal

Currently sheet piles inhibit groundwater flow through the areas within sheet pile and in so doing significantly reduce groundwater velocity. This reduces the pore volumes flushing through these areas significantly lower than what would occur naturally. Because the contact time between groundwater and PSF material within the sheet piles is significantly increased due to slower flushing, and the groundwater velocities across the Site are greatly reduced by the sheet pile interruption of the flow system, the time to reach the uranium Groundwater Protection Standard is greatly impacted.



MAP OF CURRENT GROUNDWATER INSTITUTIONAL CONTROLS

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FIGURE 3.3.2.1-1

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The Site Groundwater Flow and Transport Model (Weston, 2021c) predicts that through the removal of the sheet piles reduction of groundwater concentrations of uranium, fluoride and manganese is much faster, resulting in earlier compliance with the Groundwater Protection Standards. For example, without removal of the sheet piles uranium concentrations above the Groundwater Protection Standard in the E-stratum are predicted to persist for over 2,000 years. With sheet pile removal the time frame reduces to approximately 375 years. Compliance times for sulfate, nickel and iron are minimally affected by sheet pile removal.

With institutional controls in place, the only receptor location for the groundwater pathway is surface water south and southeast of the site. The Site Groundwater Flow and Transport Model (Weston, 2021c) predicts that even with sheet pile removal, no constituent with a defined Groundwater Protection Standard will discharge to either Kress Creek or the West Branch of the DuPage River at concentrations exceeding applicable standards.

3.3.3 Treatment of Unsaturated PSF

Corrective action activities at the site have been structured to minimize residual human-health and environmental risk associated with elevated concentrations exceeding the Groundwater Protection Standards on site and down gradient groundwater. REF on-site soils, including the PSF materials, meet the residential soil clean-up standards for radium and uranium. However, the PSF material remains a groundwater source for uranium and fluoride due to the presence of leachable uranium and fluoride on the surface of the PSF materials.

Weston will treat the near-surface and readily accessible PSF material to leach the more extractable fraction of uranium and fluoride. While the treatment of the unsaturated PSF is beneficial to groundwater remediation, the primary purpose of this active remedial process is to allow for treated, shallow surficial PSF to be excavated and/or relocated off-site without posing risk to human health and the environment. Any excavation and/or relocation activities will be controlled by site closure and license termination with restrictions. Activities associated with the treatment of the unsaturated PSF material include excavation and stockpiling of PSF material, treatment of PSF material, waste stream disposal and closure of the treatment cell.

3.3.3.1 Treatment of PSF Infrastructure

The treatment process requires lixiviant mixing, its application to the PSF material in the Pond 1 Treatment Cell, and the treatment and disposition of the leachate and associated waste streams. The major components of the treatment system are the Pond 1 Treatment Cell (described below in Section 3.3.3.2), the lixiviant mixing and injection system, the leachate extraction and treatment system, and the temporary process building and office trailer. Figure 3.3.3.1-1 provides a plan layout drawing for the process building and the associated infrastructure. The process building will house the equipment for lixiviant preparation and leachate treatment. The building will be about 100 feet by 120 feet, with offices, bathrooms, showers, and lockers for plant operators. The process building will have a secondary containment system to contain, collect, and manage leaks and spills.

The lixiviant mixing and injection system will consist of chemical mixing and lixiviant storage tanks, chemical feed systems, and injection wells. The leachate extraction and treatment system will consist of extraction pumps and wells, leachate and evaporator residue storage and feed tanks, three thermal evaporators, three slurry dryers, and bag loading systems.

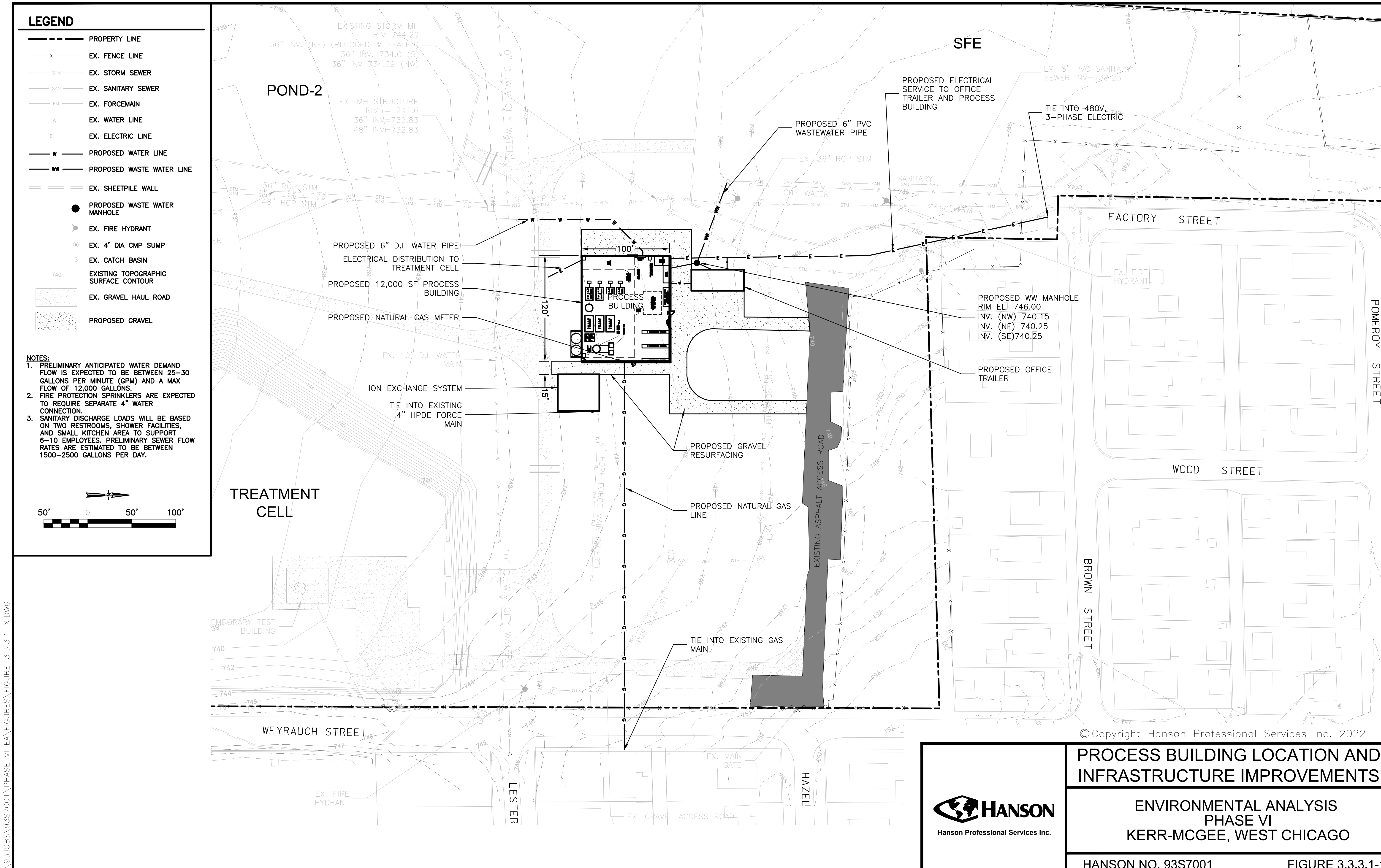
Pregnant lixiviant or leachate from the treatment cell will be pumped using extraction wells and conveyed to the leachate treatment system. The primary leachate treatment system will consist of three thermal evaporators connected to four downstream slurry dryers and necessary ancillary equipment. Each of the three natural gas-fired evaporators will have a capacity to treat 400 gallons of leachate per hour for a combined processing rate of approximately 1,200 gallons per hour. The residue generated by the evaporator will be transferred to a residue storage tank at approximately 180 to 240 gallons per hour before being processed by the slurry dryers.

The slurry dryers will process approximately 200 gallons of evaporator residue per hour, about 50 gallons per hour per slurry dryer. The slurry dryers will yield a solid waste product that will be bagged in 2-ton bulk bags and stored outside on the west side of the treatment plant until they can be disposed of at a permitted offsite disposal facility in Utah.

The leachate will be evaporated with the vapor released on site. The monitoring program for the treatment process is discussed in Section 4.2. Weston (2022) estimates treatment of 7.5 million gallons of leachate from the PSF Treatment Cell, producing approximately 1,850 tons of solids for offsite disposal in Utah. The Treatment Process Flow diagram in included as Figure 3.3.3.1-2.

3.3.3.2 Excavation, Stockpiling and Treatment Cell Construction

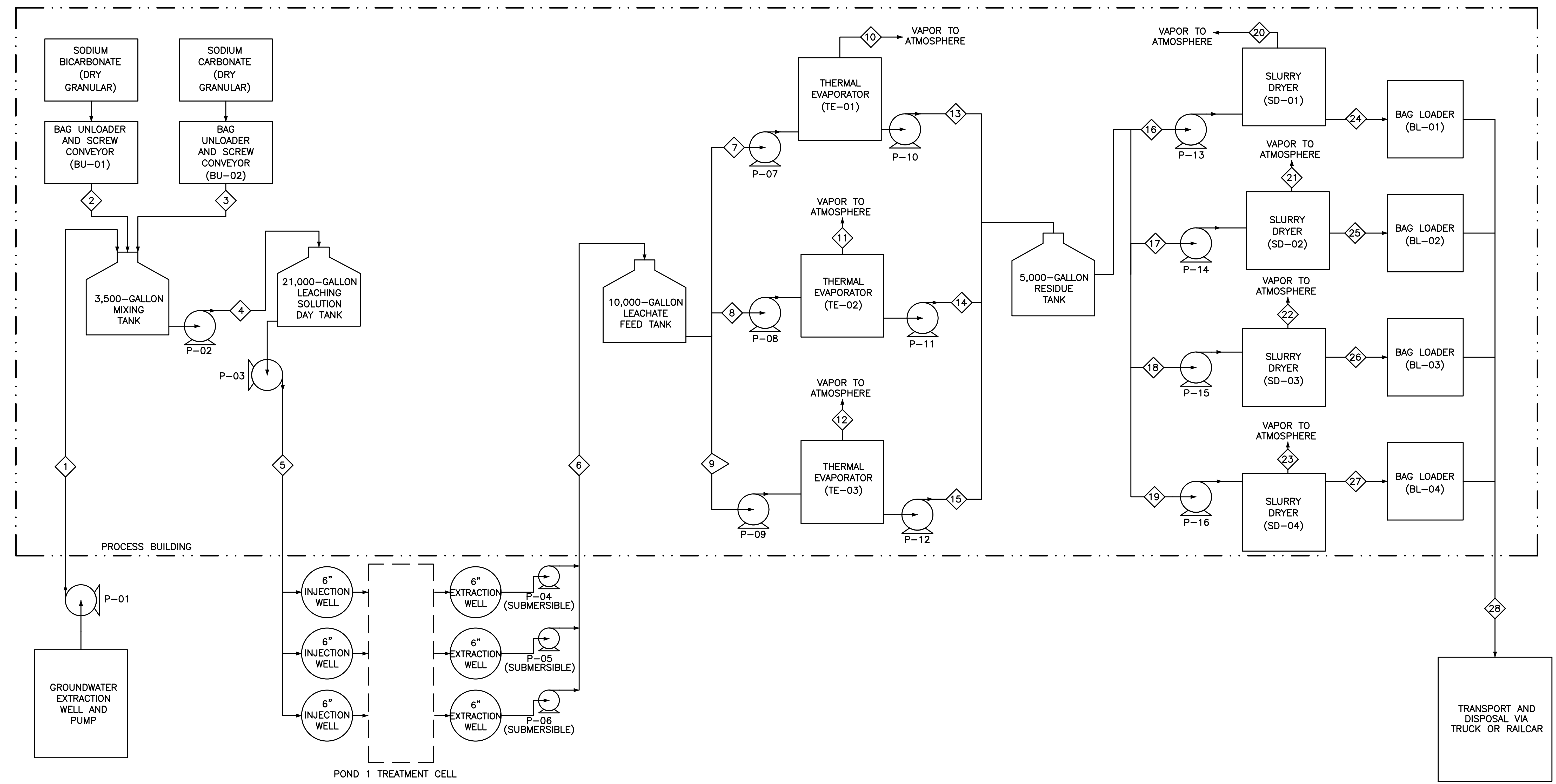
The PSF material that will be treated resides within the sheet pile in Pond 1, Pond 2 and the SFE areas. The treatment cell will treat all the PSF material in one treatment cycle. The treatment cell will be constructed within the footprint of Pond 1. The treatment cell will be developed both below and above grade in Pond 1 so all Pond 1 PSF material that will be treated will require relocation to a temporary stockpile. The surface soils and cover fill material will also



PROCESS BUILDING LOCATION AND INFRASTRUCTURE IMPROVEMENTS

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

HANSON NO. 93S7001 FIGURE 3.3.3.1-1



PROCESS STREAM LEGEND

STREAM NO.	DESCRIPTION
1	GROUND WATER
2	DRY SODIUM BICARBONATE
3	DRY SODIUM CARBONATE
4	LEACHING SOLUTION
5	LEACHING SOLUTION
6	TOTAL LEACHATE
7	TE-01 LEACHATE
8	TE-02 LEACHATE
9	TE-03 LEACHATE
10	TE-01 WATER VAPOR
11	TE-02 WATER VAPOR
12	TE-03 WATER VAPOR
13	TE-01 RESIDUE
14	TE-02 RESIDUE
15	TE-03 RESIDUE
16	SD-01 FILL RESIDUE
17	SD-02 FILL RESIDUE
18	SD-03 FILL RESIDUE
19	SD-04 FILL RESIDUE
20	SD-01 WATER VAPOR
21	SD-02 WATER VAPOR
22	SD-03 WATER VAPOR
23	SD-04 WATER VAPOR
24	SD-01 SOLID WASTE
25	SD-02 SOLID WASTE
26	SD-03 SOLID WASTE
27	SD-04 SOLID WASTE
28	TOTAL SOLID WASTE

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PROCESS FLOW DIAGRAM

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

HANSON NO. 93S7001 FIGURE 3.3.3.1-2

have to be stripped off Ponds 1 and 2 and the SFE and be stored in a temporary stockpile. Figure 3.3.3.2-1 shows the excavation and preparatory grading plan, with a temporary stockpile area south of Pond 2.

The first excavation activity will be to strip the topsoil from Ponds 1 and 2 and the SFE. The cover material for Pond 2 and the SFE will also be re-located to a temporary stockpile. Cover material from Pond 1 will be stripped and used to build a berm surrounding the treatment cell with any surplus being relocated to a temporary stockpile. Because the treatment cell will reside within the footprint of Pond 1, Pond 1 shallow PSF will have to be excavated and stored during treatment cell construction. The Pond 1 PSF material will be temporarily stored within the Pond 2 footprint.

After a berm has been partially constructed and Pond 1 PSF has been stockpiled, any voids in the sheet pile will be sealed using Geofoam Inserts. The treatment cell will be constructed using a double-liner system with a geocomposite material between the two liners (see Figure 3.3.3.2-2 for construction details of the liner system). The treatment system will leach uranium from the PSF material with a treatment solution that will be injected and extracted using well points or pipes. These will be constructed within the treatment cell followed by backfilling with the PSF material to be treated. The Pond 1 PSF material stockpiled within the Pond 2 footprint will be the first material placed in the treatment cell. This will be followed by excavating and placement of Pond 2 PSF in the treatment cell, followed by excavation and placement of SFE PSF material.

Once the PSF material is placed within the treatment cell, the treatment cell cover system will be constructed (see Figure 3.3.3.2-2). The treatment cell cover will have sandbags and additional fill material to serve as ballast. A well access road, and injection and extractor well piping will be constructed as shown on Figure 3.3.3.2-3. During treatment activities open excavations in Pond 2 and the SFE will be secured with temporary safety fencing.

3.3.3.3 Treatment of PSF in Pond 1 Treatment Cell

From 2016 to 2020, Weston successfully conducted bench- and pilot-scale studies to evaluate the feasibility of in-situ leaching (ISL) of uranium from the PSF material, the latest of which was summarized in Weston (2021a). Based on the Phase IIIB Bench-Scale Study (Weston, 2020a) and the Pilot-Scale Study results (Weston, 2020c), the leaching solution would use approximately 0.6 M sodium bicarbonate and 0.23 M sodium carbonate as the leaching agents. The leaching solution will be introduced to the treatment cell through injection wells on the north side of Pond 1 (Figure 3.3.3.3-1). The solution will fully saturate the PSF material's pore space as it flows from the injection wells to the extraction wells on the south side of Pond 1. The estimated injection and extraction rate is approximately 15 gpm which will result in a pore volume displacement time of approximately 10 weeks. Over the treatment period approximately 7.5 million gallons of pregnant lixiviant will be extracted from the extractor wells. The leachate will be pumped to a treatment process building and treated with thermal evaporation, using evaporators and slurry dryers. The disposition of waste from the treatment process is discussed below in Section 3.3.3.4.

3.3.3.4 Waste Stream Disposal

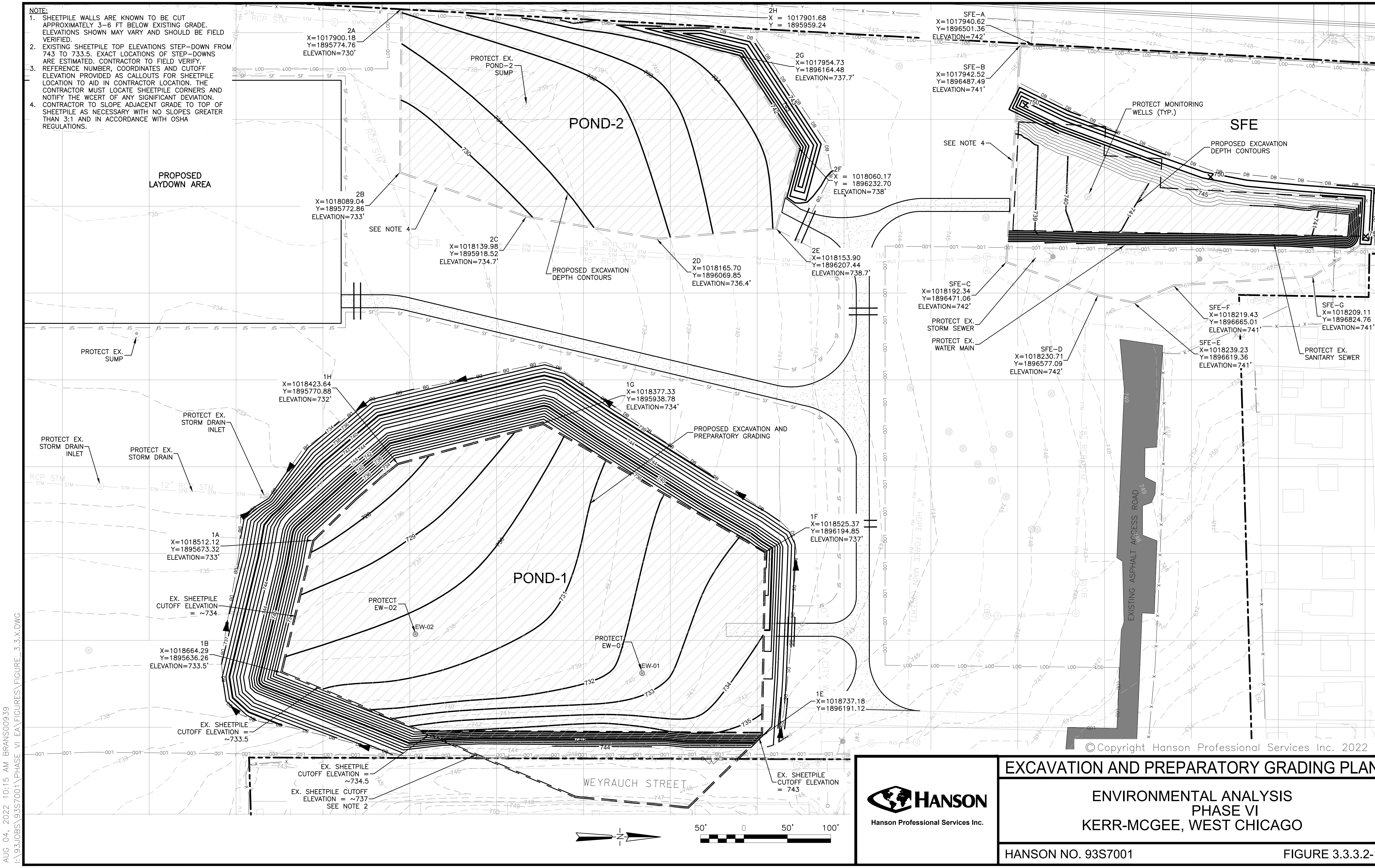
There are two activities that will create a waste stream requiring disposition. The first will be the existing groundwater within PSF material behind the sheet pile. This waste stream will be treated through an ion exchange system. Groundwater will be treated to an effluent discharge standard of 300 pCi/L using an ion exchange system employing uranium-specific media which selectively removes uranium from water. Spent ion exchange media will be sent to a licensed facility for recovering uranium. The treated fluid will be discharged to the storm sewer.

The second activity is the leaching of unsaturated zone PSF material. The solution will be prepared and delivered to the treatment cell, where uranium will be leached from the PSF material. Subsequently, the treated PSF material will be neutralized with hydrochloric acid. The leachate generated during the leaching and neutralization steps will undergo thermal evaporation. Fluid will be evaporated with monitored vapor being released on site. The solids present after the effluent waste stream is run through the evaporators and dryers will be stored on-site in an exclusion zone for two to three months before being shipped in five shipments of approximately 370 tons or 740,000 pounds, to the Energy Solutions licensed radioactive waste disposal site in Clive, Utah.

3.3.3.5 Demolition of the Treatment Cell and Treatment Plant

After the active remediation period, the treatment cell and the treatment facility and associated equipment will have to be decommissioned and decontaminated. Following remedial activities, all equipment, utilities, and building materials will be decontaminated, demolished, and removed to restore the site. The major elements of demolition include:

- Treatment Building Demolition
- Treatment System Decontamination and Removal
- Radiological Survey of all treatment equipment, building material, tools, and office material


NOTE:
1. SHEETPILE WALLS ARE KNOWN TO BE CUT APPROXIMATELY 3-6 FT BELOW EXISTING GRADE. ELEVATIONS SHOWN MAY VARY AND SHOULD BE FIELD VERIFIED.
2. EXISTING SHEETPILE TOP ELEVATIONS STEP-DOWN FROM 743 TO 733.5. EXACT LOCATIONS OF STEP-DOWNS ARE ESTIMATED. CONTRACTOR TO FIELD VERIFY.
3. REFERENCE NUMBER, COORDINATES AND CUTOFF ELEVATION PROVIDED AS CALLOUTS FOR SHEETPILE LOCATION TO AID IN CONTRACTOR LOCATION. THE CONTRACTOR MUST LOCATE SHEETPILE CORNERS AND NOTIFY THE WCERT OF ANY SIGNIFICANT DEVIATION.
4. CONTRACTOR TO SLOPE ADJACENT GRADE TO TOP OF SHEETPILE AS NECESSARY WITH NO SLOPES GREATER THAN 3:1 AND IN ACCORDANCE WITH OSHA REGULATIONS.
PROPOSED LAYDOWN AREA
2A X=1017900.18 Y=1895774.76 ELEVATION=730'
PROTECT EX. POND-2 SUMP
POND-2
2H X = 1017901.68 Y = 1895959.24
2G X=1017954.73 Y=1896164.48 ELEVATION=737.7'
2F X = 1018060.17 Y = 1896232.70 ELEVATION=738'
2B X=1018089.04 Y=1895772.86 ELEVATION=733'
SEE NOTE 4
2C X=1018139.98 Y=1895918.52 ELEVATION=734.7'
PROPOSED EXCAVATION DEPTH CONTOURS
2D X=1018165.70 Y=1896069.85 ELEVATION=736.4'
2E X=1018153.90 Y=1896207.44 ELEVATION=738.7'
SFE-A X=1017940.62 Y=1896501.36 ELEVATION=742'
SFE-B X=1017942.52 Y=1896487.49 ELEVATION=741'
PROTECT MONITORING WELLS (TYP.)
SFE
SEE NOTE 4
PROPOSED EXCAVATION DEPTH CONTOURS
SFE-C X=1018192.34 Y=1896471.06 ELEVATION=742'
PROTECT EX. STORM SEWER
PROTECT EX. WATER MAIN
SFE-D X=1018230.71 Y=1896577.09 ELEVATION=742'
SFE-F X=1018219.43 Y=1896665.01 ELEVATION=741'
SFE-E X=1018239.23 Y=1896619.36 ELEVATION=741'
SFE-G X=1018209.11 Y=1896824.76 ELEVATION=741'
PROTECT EX. SANITARY SEWER
PROTECT EX. SUMP
1H X=1018423.64 Y=1895770.88 ELEVATION=732'
1G X=1018377.33 Y=1895938.78 ELEVATION=734'
PROPOSED EXCAVATION AND PREPARATORY GRADING
PROTECT EX. STORM DRAIN INLET
PROTECT EX. STORM DRAIN INLET
PROTECT EX. STORM DRAIN
1A X=1018512.12 Y=1895673.32 ELEVATION=733'
1F X=1018525.37 Y=1896194.85 ELEVATION=737'
POND-1
EX. SHEETPILE CUTOFF ELEVATION = ~734
PROTECT EW-02
EW-02
PROTECT EW-01
EW-01
1B X=1018664.29 Y=1895636.26 ELEVATION=733.5'
1E X=1018737.18 Y=1896191.12
EX. SHEETPILE CUTOFF ELEVATION = ~733.5
EX. SHEETPILE CUTOFF ELEVATION = ~734.5
EX. SHEETPILE CUTOFF ELEVATION = ~737 SEE NOTE 2
EX. SHEETPILE CUTOFF ELEVATION = 743
WEYRAUCH STREET
EXISTING ASPHALT ACCESS ROAD
4" HDPE FORCE MAIN
36" RCP STM
48" RCP STM
12" RCP STM
50' 0 50' 100'
N
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EXCAVATION AND PREPARATORY GRADING PLAN
ENVIRONMENTAL ANALYSIS PHASE VI KERR-MCGEE, WEST CHICAGO
HANSON NO. 93S7001
FIGURE 3.3.3.2-1
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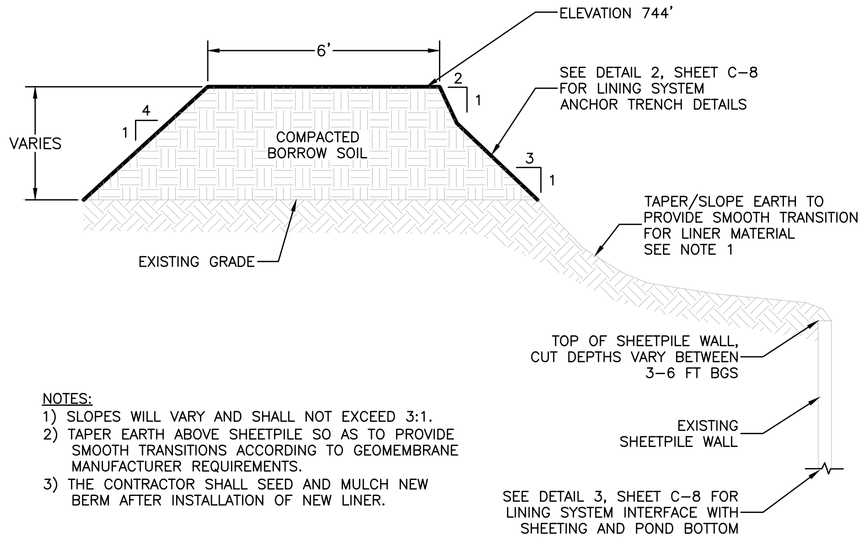
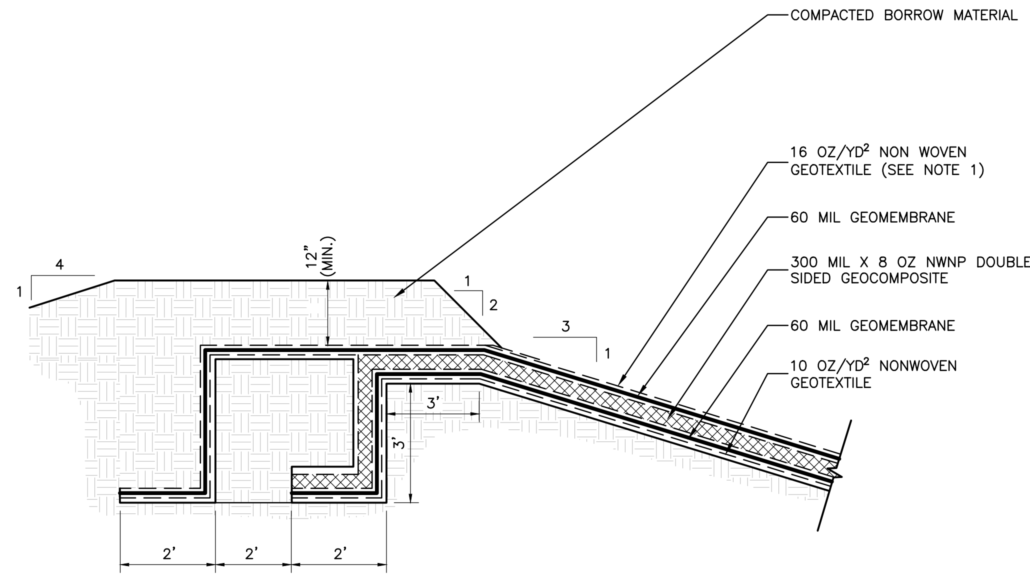


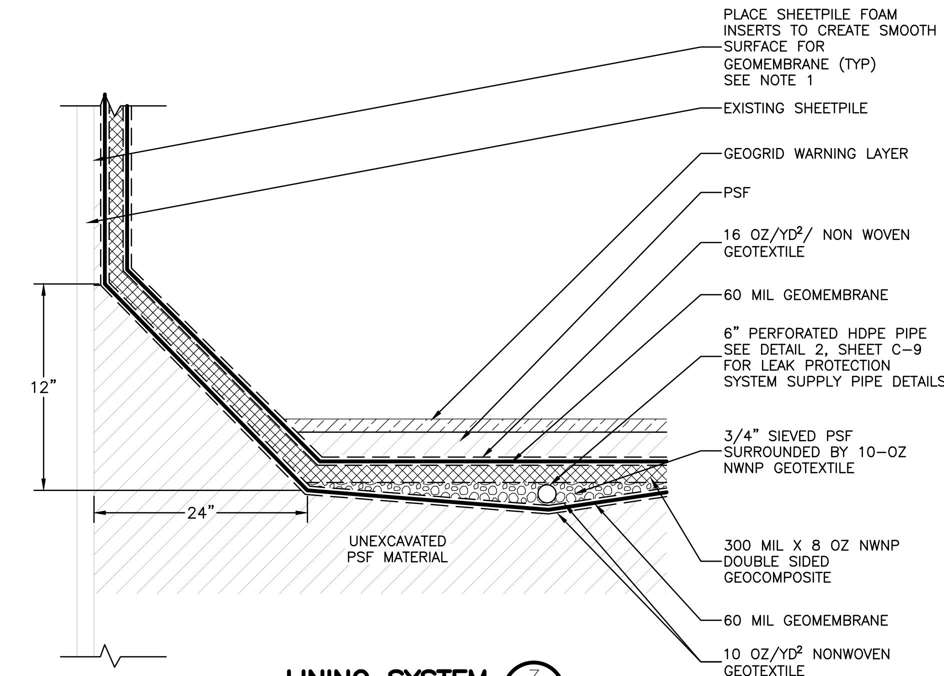
NOTES:
1) SLOPES WILL VARY AND SHALL NOT EXCEED 3:1.
2) TAPER EARTH ABOVE SHEETPILE SO AS TO PROVIDE SMOOTH TRANSITIONS ACCORDING TO GEOMEMBRANE MANUFACTURER REQUIREMENTS.
3) THE CONTRACTOR SHALL SEED AND MULCH NEW BERM AFTER INSTALLATION OF NEW LINER.

POND PERIMETER BERM 1 / C-3
N.T.S.



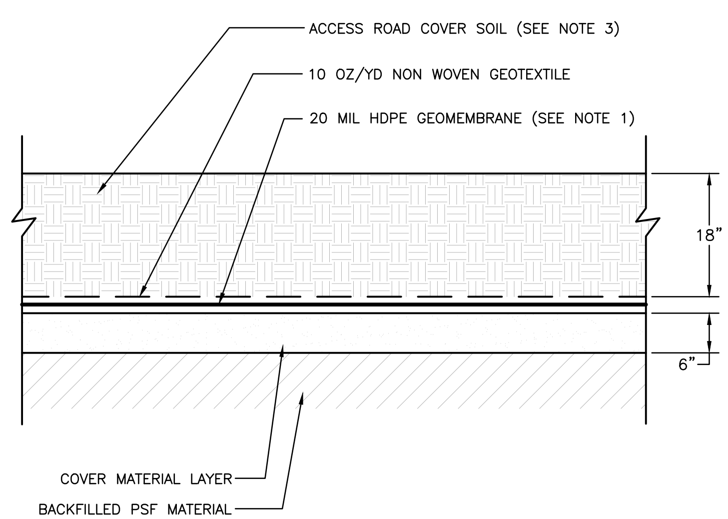
NOTES:
OVERLAP AND SEAL GEOTEXTILE TO BE CUT AFTER PSF PLACEMENT SEE DETAIL 4, C-8.

GEOSYNTHETICS ANCHOR TRENCH 2 / C-3
N.T.S.



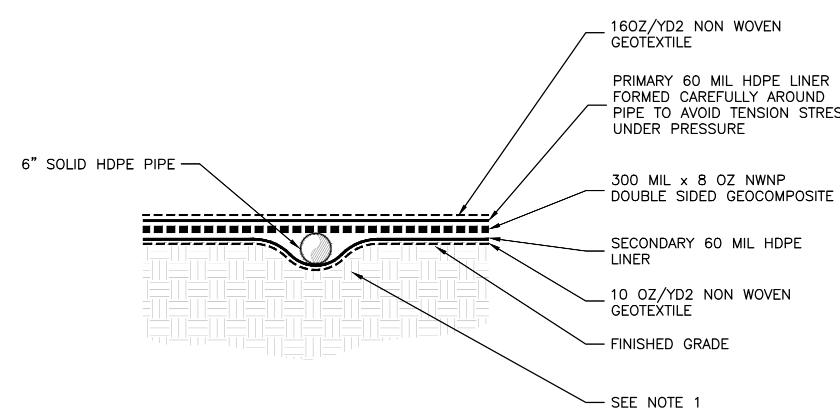
LINING SYSTEM 3 / C-3
N.T.S.

NOTE:
1) FOAM INSERTS ARE TO BE SECURED BY GLUING OR STRAPPING TO THE SHEETPILE SURFACE. METHOD OF SECURING TO BE APPROVED BY WCERT.



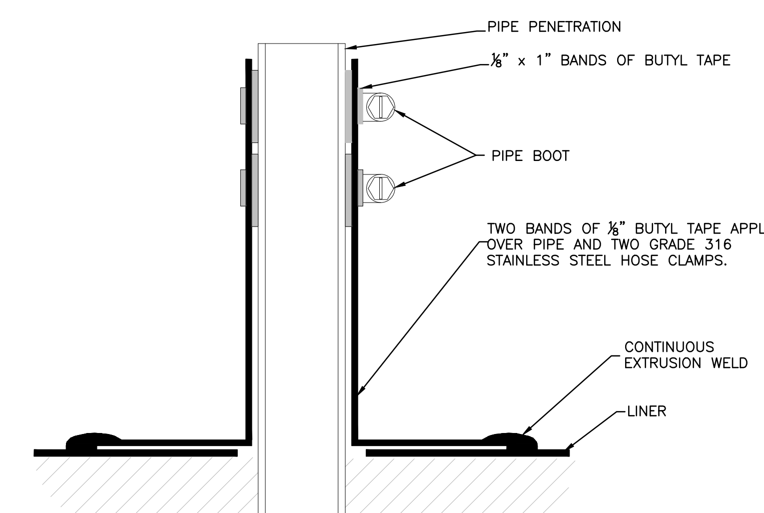
FINAL COVER SYSTEM CROSS SECTION FOR CONSOLIDATION AREA TOP AREA 4 / C-4
N.T.S.

NOTES:
1) AFTER PLACEMENT OF PSF, CUT AND FOLD BACK TOP LAYER OF 16OZ/YD GEOTEXTILE LEAVING PRIMARY GEOMEMBRANE EXPOSED FOR WELDING.
2) EXTRUSION WELD COVER GEOMEMBRANE IN FIELD AREAS AND WELD TO EXPOSED PRIMARY GEOMEBRANE AT ELEVATION 743 ON BERM. LEAVE 12-INCH GAPS EVERY 20-FEET FOR VENTING.
3) PLACE 6" THK. PROTECTIVE COVER MATERIAL FOR ENTIRE POND AREA AND 18" THK COVER MATERIAL FOR POND ACCESS ROADS AS INDICATED ON SHEET C-4. ADD ADDITIONAL BALLAST MATERIAL (SANDBAGS OR ADDITIONAL COVER MATERIAL) AS NECESSARY TO KEEP THE COVER IN PLACE.



LEAK PROTECTION PIPE ON SLOPE DETAIL 5 / C-3
N.T.S.

NOTES:
1) FORM SMOOTH TRANSITION AROUND PIPE IN EXISTING GRADE, COMPACTED BORROW, OR FOAM BOARD TO PROTECT BOTTOM LINER AND MAINTAIN FLAT PRIMARY LINER.
2) REFER TO DETAIL 2, C-8 FOR LINER SYSTEM DETAILS.



TYPICAL PIPE PENETRATION DETAIL 6 / C-3,4
N.T.S.

NOTES:
1) REPEAT CONTINUOUS EXTRUSION WELD AND BAND CONSTRUCTION ON SECONDARY LINER PENETRATION.
2) CUT GEOTEXTILE AND GEOCOMPOSITE AROUND PENETRATION.
3) ALL PIPE PENETRATIONS TO BE LEAK PROOF.

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CONSTRUCTION DETAILS AND NOTES (SHEET 1 OF 2)

ENVIRONMENTAL ANALYSIS
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HANSON NO. 93S7001 FIGURE 3.3.3.2-2

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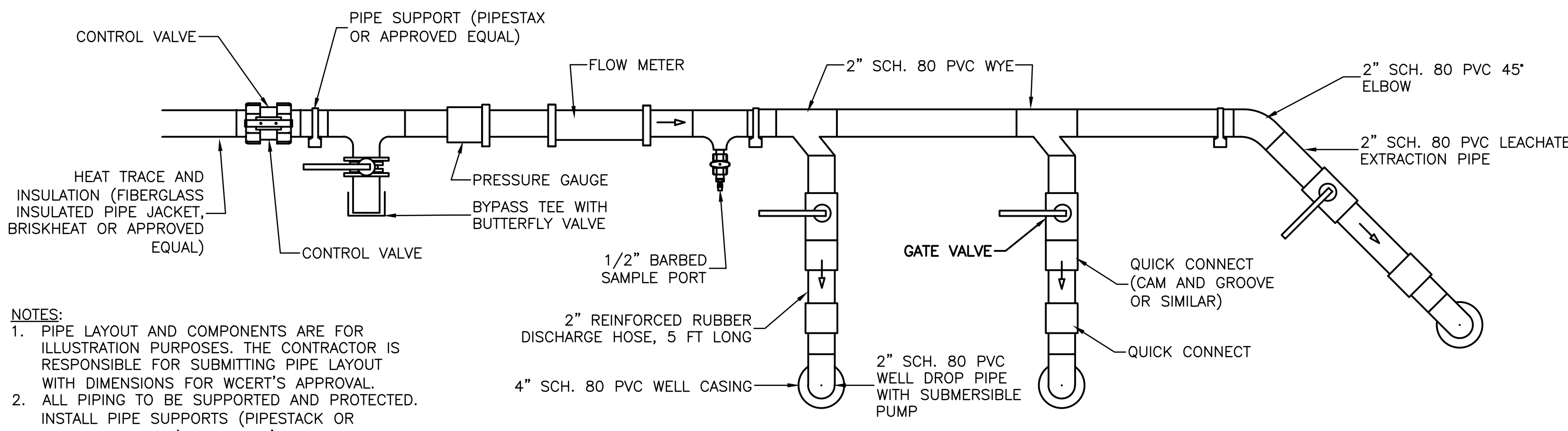
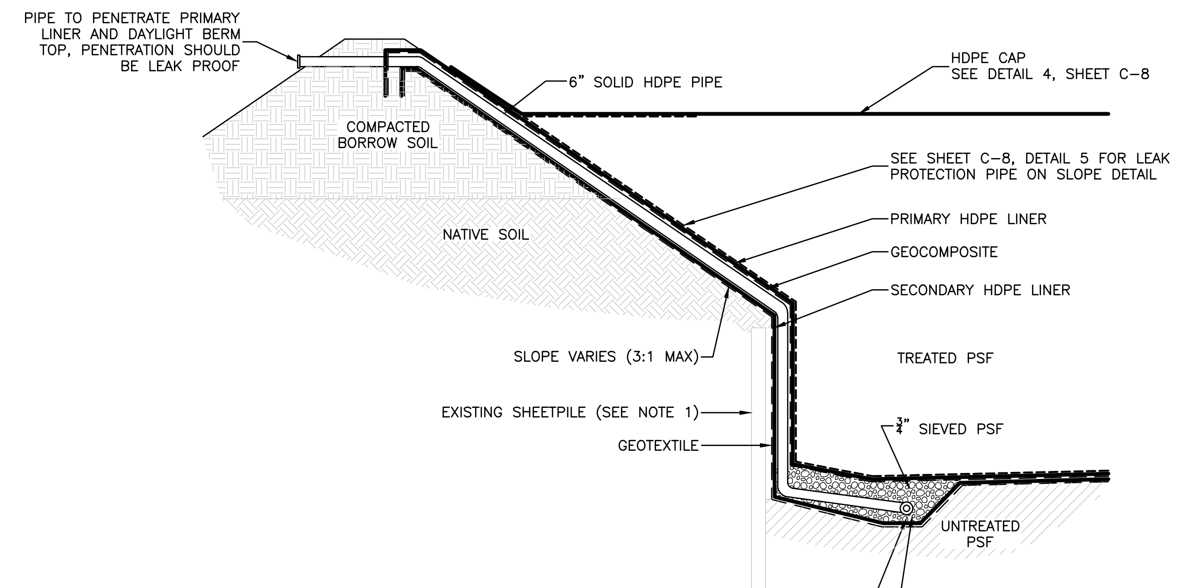


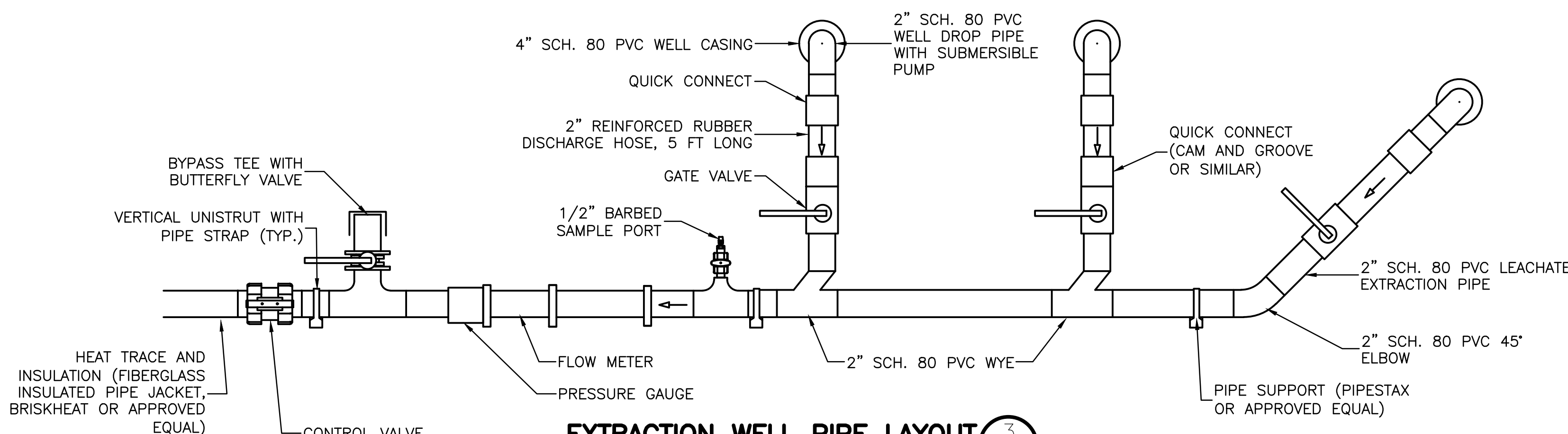
NOTES:
1. PIPE LAYOUT AND COMPONENTS ARE FOR ILLUSTRATION PURPOSES. THE CONTRACTOR IS RESPONSIBLE FOR SUBMITTING PIPE LAYOUT WITH DIMENSIONS FOR WCERT'S APPROVAL.
2. ALL PIPING TO BE SUPPORTED AND PROTECTED. INSTALL PIPE SUPPORTS (PIPESTACK OR APPROVED EQUAL) SPACED 5' FOR ENTIRE LENGTH OF PIPE.

INJECTION WELL PIPE LAYOUT (1 / C-4)
N.T.S



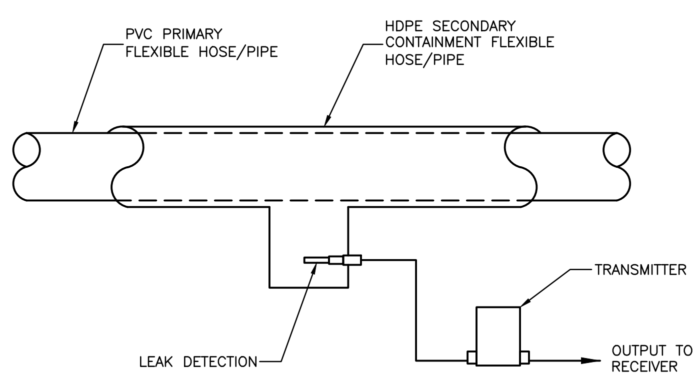
NOTES:
1. POSITION PIPE IN RECESSED FLANGE OF EXISTING SHEETPILE AND CUT/FORM FOAM INSERT TO CRADLE PIPE AND SMOOTH PRIMARY LINER.
2. SEE PIPE PENETRATION DETAIL 6, SHEET C-8
3. SEE SHEET C-3 FOR PIPE DIMENSIONS.

LEAK PROTECTION SYSTEM SUPPLY PIPING (2 / C-3)
N.T.S

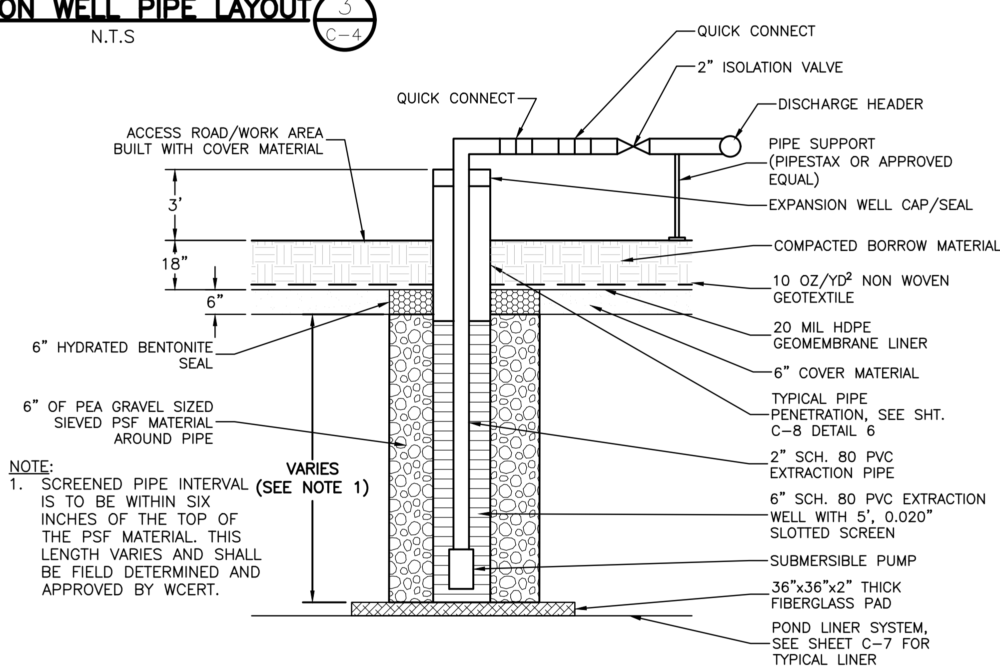


EXTRACTION WELL PIPE LAYOUT (3 / C-4)
N.T.S

NOTES:
1. PIPE LAYOUT AND COMPONENTS ARE FOR ILLUSTRATION PURPOSES. THE CONTRACTOR IS RESPONSIBLE FOR SUBMITTING PIPE LAYOUT WITH DIMENSIONS FOR WCERT'S APPROVAL.
2. ALL PIPING TO BE SUPPORTED AND PROTECTED. INSTALL PIPE SUPPORTS SPACED 5' FOR ENTIRE LENGTH OF PIPE.

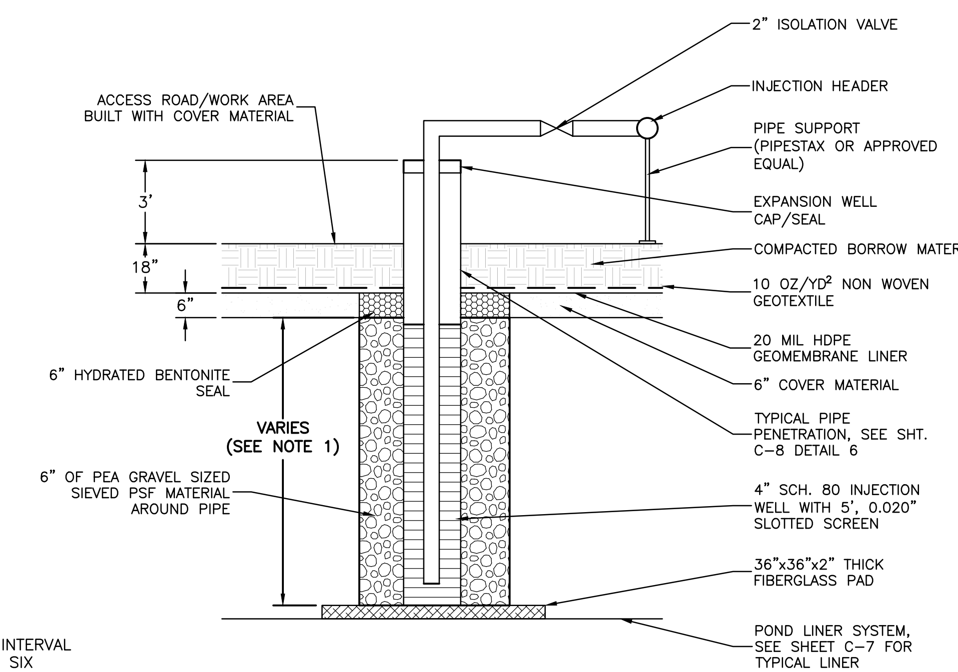


LEAK DETECTION CONTAINMENT DETAIL (4 / C-4)
N.T.S



NOTE:
1. SCREENED PIPE INTERVAL IS TO BE WITHIN SIX INCHES OF THE TOP OF THE PSF MATERIAL. THIS LENGTH VARIES AND SHALL BE FIELD DETERMINED AND APPROVED BY WCERT.

EXTRACTION WELL PUMP AND PIPING DETAIL (5 / C-4)
N.T.S



NOTE:
1. SCREENED PIPE INTERVAL IS TO BE WITHIN SIX INCHES OF THE TOP OF THE PSF MATERIAL. THIS LENGTH VARIES AND SHALL BE FIELD DETERMINED AND APPROVED BY WCERT.

INJECTION WELL AND PIPING DETAIL (6 / C-4)
N.T.S

HANSON Hanson Professional Services Inc.	CONSTRUCTION DETAILS AND NOTES (SHEET 2 OF 2)
	ENVIRONMENTAL ANALYSIS PHASE VI KERR-MCGEE, WEST CHICAGO
	HANSON NO. 93S7001 — FIGURE 3.3.3.2-3

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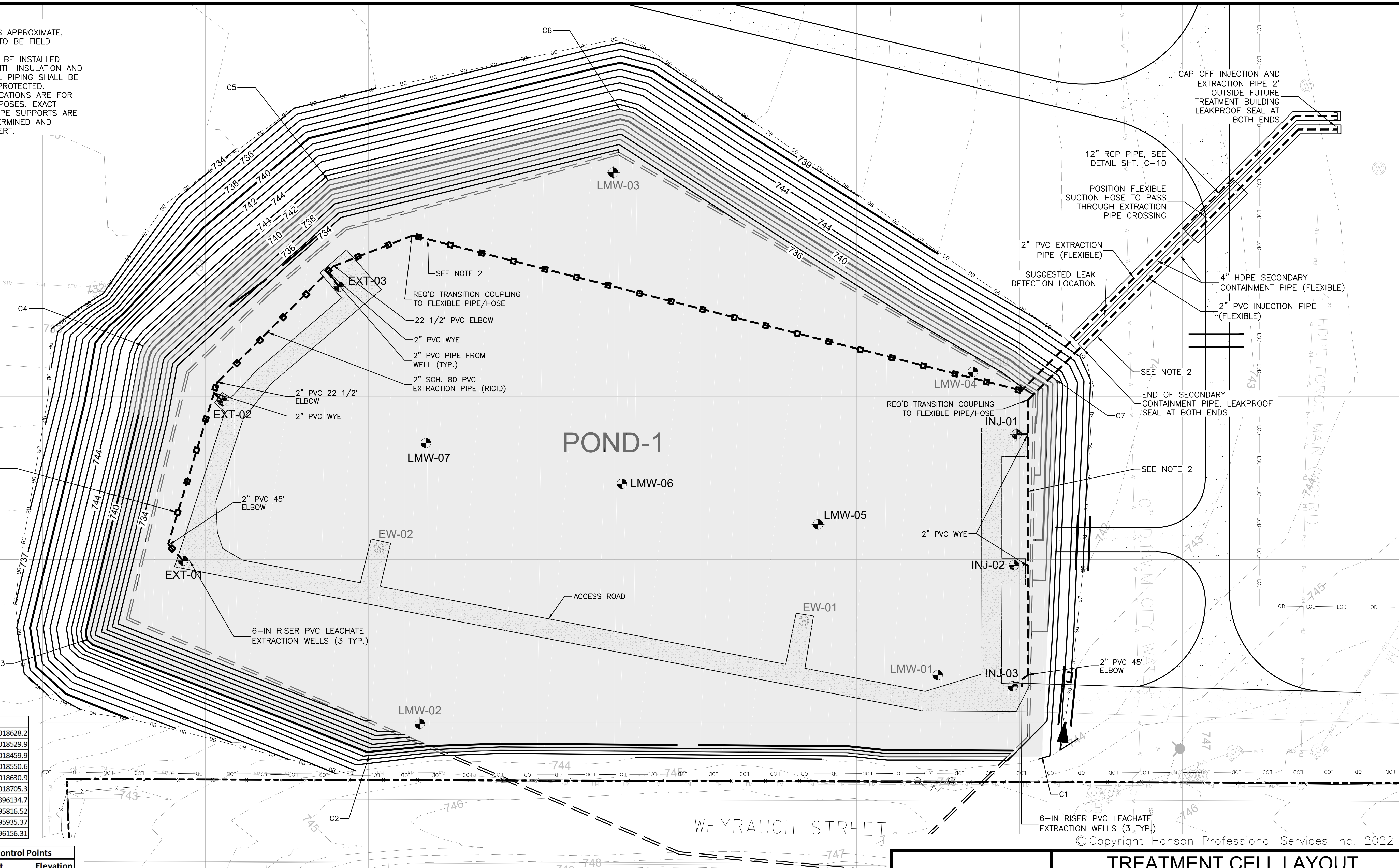
I:\93JOBS\93S7001\PHASE VI EA\FIGURES\FIGURE_3.3.3.X.DWG

NOTES:

1. PIPE ALIGNMENT IS APPROXIMATE, FINAL ALIGNMENT TO BE FIELD DETERMINED.
2. ALL PIPING SHALL BE INSTALLED ABOVE GROUND WITH INSULATION AND HEAT TRACING. ALL PIPING SHALL BE SUPPORTED AND PROTECTED.
3. PIPE SUPPORT LOCATIONS ARE FOR ILLUSTRATION PURPOSES. EXACT LOCATIONS FOR PIPE SUPPORTS ARE TO BE FIELD DETERMINED AND APPROVED BY WCERT.



Well	North	East
EXT-01	1895671.2	1018628.2
EXT-02	1895695.3	1018529.9
EXT-03	1895767	1018459.9
INJ-01	1896183.2	1018550.6
INJ-02	1896181.6	1018630.9
INJ-03	1896180.8	1018705.3
LPZ-01	1018698.43	1896134.7
LPZ-02	1018728.34	1895816.52
LPZ-03	1018389.82	1895935.37
LPZ-04	1018512.21	1896156.31

Table 2: Cap Installation Control Points

Point	North	East	Elevation
C1	1896198.86	1018748.45	742
C2	1895785.46	1018747.61	742
C3	1895613.12	1018676.33	742
C4	1895646.68	1018496.28	742
C5	1895760.40	1018394.60	742
C6	1895939.48	1018351.01	742
C7	1896207.13	1018516.94	742

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TREATMENT CELL LAYOUT

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

HANSON NO. 93S7001

FIGURE 3.3.3.3-1

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- Perforation of the Pond Primary and Secondary Liners
- Removal of Pump and Pond Monitoring Equipment
- Utility Demolition and Removal.

All rinse liquid generated during decontamination will be processed through either the thermal evaporation systems or the ion exchange system. Radiological surveys for potentially contaminated items will be performed according to WCP-345 requirements to determine their suitability for unrestricted release according to the criteria outlined in Appendix A of 32 IAC §340. Materials and equipment that exceed the unrestricted release criteria will be decontaminated and resurveyed using pressure washing, sandblasting, or similar processes. After one round of decontamination, materials and equipment that do not meet the unrestricted release criteria will be disposed at a permitted off-site landfill.

Treated PSF material volume originating from Pond 2 and the SFE area will be transferred back to those areas. The existing 18-inch fill and 6-inch topsoil engineering barrier will be replaced above the treated PSF material in Pond 1, Pond 2, and the SFE using the previously stockpiled and sorted material. Imported fill and topsoil will be used as required and will meet the site's specified requirements. Temporary haul roads will be removed, and all disturbed areas will be graded, seeded, and fertilized to restore to existing site condition (Figure 3.3.3.5-1).

3.3.4 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

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).

Figure 3.3.4-1 shows the site erosion and sediment control plan for the site during the Phase VI active remediation period.

3.3.5 Stockpiles

Excavated PSF material will require stockpiling during Treatment Cell construction. The PSF material is currently in compliance with IEMA residential radiation standards so the potential for harmful exposure is remote. However, silt fencing will be constructed around Pond 1, Pond 2, SFE, temporary stockpiles and any other work areas. Berms will also be constructed around stockpiles to prevent fine particles in storm water runoff from migrating into clean areas. The stockpiles will be covered when not in use to minimize the volume of runoff from construction areas.

3.3.6 Final Grading and Seeding

Final grading and site disposition will require demolition and disposition of the haul roads and final grading of impacted areas. Final grading of Pond 1, Pond 2, and SFE will cover approximately 25 acres of the site. Weston (2022b) estimates that minor grading will be required for an additional 10 acres of the site associated with excavation activities as well as the building footprint. Stockpiled topsoil will be spread over Pond 1, Pond 2, and SFE. Next the Pond 1, Pond 2, SFE, and building footprint areas will be reseeded. Final backfill grades are shown on Figure 3.3.3.5-1. The final grade is designed to direct surface water toward onsite storm drains.

3.3.7 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 monitoring network includes 122 monitoring and sampling locations consisting of 118 monitoring wells, three PSF areas (Pond 1, Pond2, and the SFE) and Pond 4. Ninety (90) of the monitoring and sampling locations are in the current compliance monitoring network (see Table 2.7.2.2-1). The compliance monitoring network includes 45 monitor wells/points completed in the E-Stratum, 32 monitor wells completed in the C-Stratum, and 13 monitor wells completed in the upper portion of the Silurian dolomite aquifer. In 2019 and 2020 Weston conducted a detailed soil and groundwater characterization study (Weston, 2021b) to better define aquifer hydrogeology, hydraulic connection to Kress Creek and the West Branch of the DuPage River and to further delineate constituent plumes in excess of their Groundwater Protection Standards. Weston installed an additional 32 monitoring wells (9 completed in the E-stratum, 17 completed in the C-stratum, 2 completed in the merged E/C stratum and 2 in the B- and A-strata). These wells are not currently part of the semi-annual compliance monitoring program.

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FINAL GRADING PLAN

Hanson Professional Services Inc.

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

HANSON NO. 93S7001

FIGURE 3.3.3.5-1

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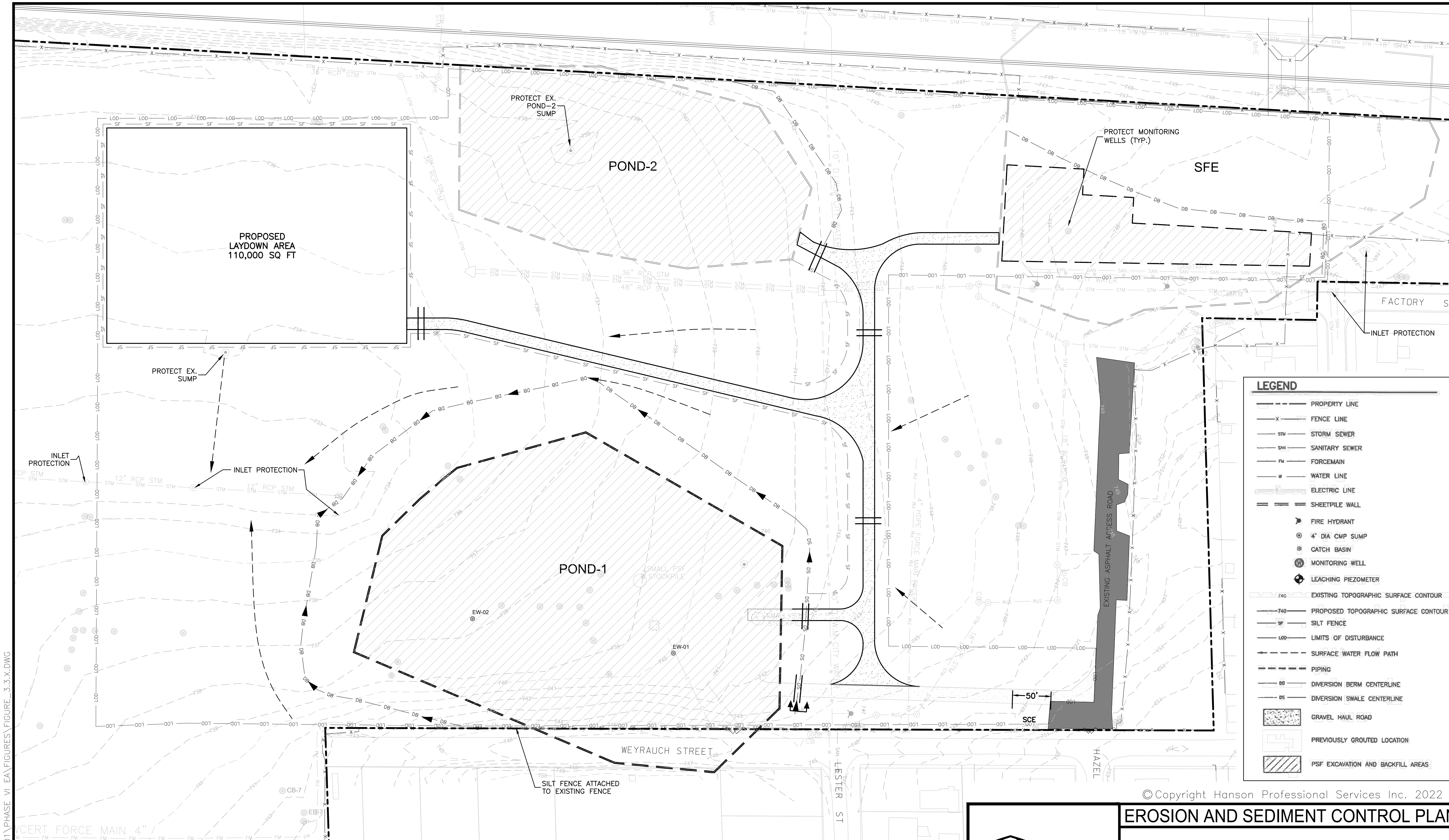

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EROSION AND SEDIMENT CONTROL PLAN

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

HANSON NO. 93S7001 FIGURE 3.3.4-1

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Three of the 90 compliance monitoring locations (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, respectively. These wells allow for groundwater sampling either upgradient (EO-2 and CO-2) or side gradient (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 semi-annual 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 semi-annual 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.

The monitoring program described above will remain in place though the completion of Phase VI activities. Weston has proposed an alternate monitoring plan for a minimum five-year period after Phase VI activities have been completed. The alternate plan is based upon a review of 2019-2021 monitoring data in combination with the results from the 2020 version of the site flow and transport model (Weston, 2021c). The alternate network would include 38 monitoring wells that Weston considers sufficient to characterize flow and contaminant transport after Phase VI activities. This monitoring plan is currently under review by IEMA.

4.0 CLOSURE MONITORING

4.1 LICENSEE'S ENVIRONMENTAL MONITORING PROGRAM

During Phase VI 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, and direct gamma radiation. Weston's proposed 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 will be sampled and analyzed on a weekly basis, radon and thoron gas and direct radiation will be analyzed on a quarterly basis, and groundwater will be analyzed on a semi-annual basis. Additionally, groundwater is analyzed for various non-radiological constituents.

Air sampling will be conducted for suspended particulates using six Environmental Monitoring Stations (EMS) as shown in Figure 4.1-1. EMS-31 is a background station and will be located adjacent to Factory Street. For Phase VI activities, air particulate sampling will be conducted weekly at each location. Samples will be analyzed weekly and quarterly composites 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 all six EMS locations during Phase VI activities, including a background radon station at EMS-31. Each sampling location will have 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.

Weston maintains a comprehensive groundwater monitoring program at the Site, which currently includes 122 monitoring and sampling locations consisting of 118 monitoring wells, three PSF Areas (Pond 1, Pond 2, and the SFE), and the former location of Pond 4. Groundwater samples are collected semi-annually from these monitoring locations. The semi-annual 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 semi-annually. Any constituent that remains below the GWPS for three consecutive semi-annual sampling events may subsequently be analyzed annually. Additionally, if any constituent that has qualified for annual analysis at a well does not exceed the groundwater protection standard for

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	6	EMS-31, 32, 33, 34, 35, and 36 See Figure 4.1-1	Continuous	Weekly	Weekly and Quarterly composite	Weekly: Th-nat Quarterly: U-nat, Th-nat, Ra-228, Ra-226, and Pb-210
Radon and Thoron Gas	6	EMS-31, 32, 33, 34, 35, and 36 See Figure 4.1-1	Continuous	Quarterly	Quarterly	Rn-222 and Rn-220
Groundwater	122	See Table 3.3.8-1 and Figure 3.3.8-1	Grab	Semi-annual	Semi-annual	Th-230 and adjusted gross alpha.
Direct Radiation	6	EMS-31, 32, 33, 34, 35, and 36 See Figure 4.1-1	Continuous passive integrating device	Quarterly	Quarterly	Gamma exposure rate

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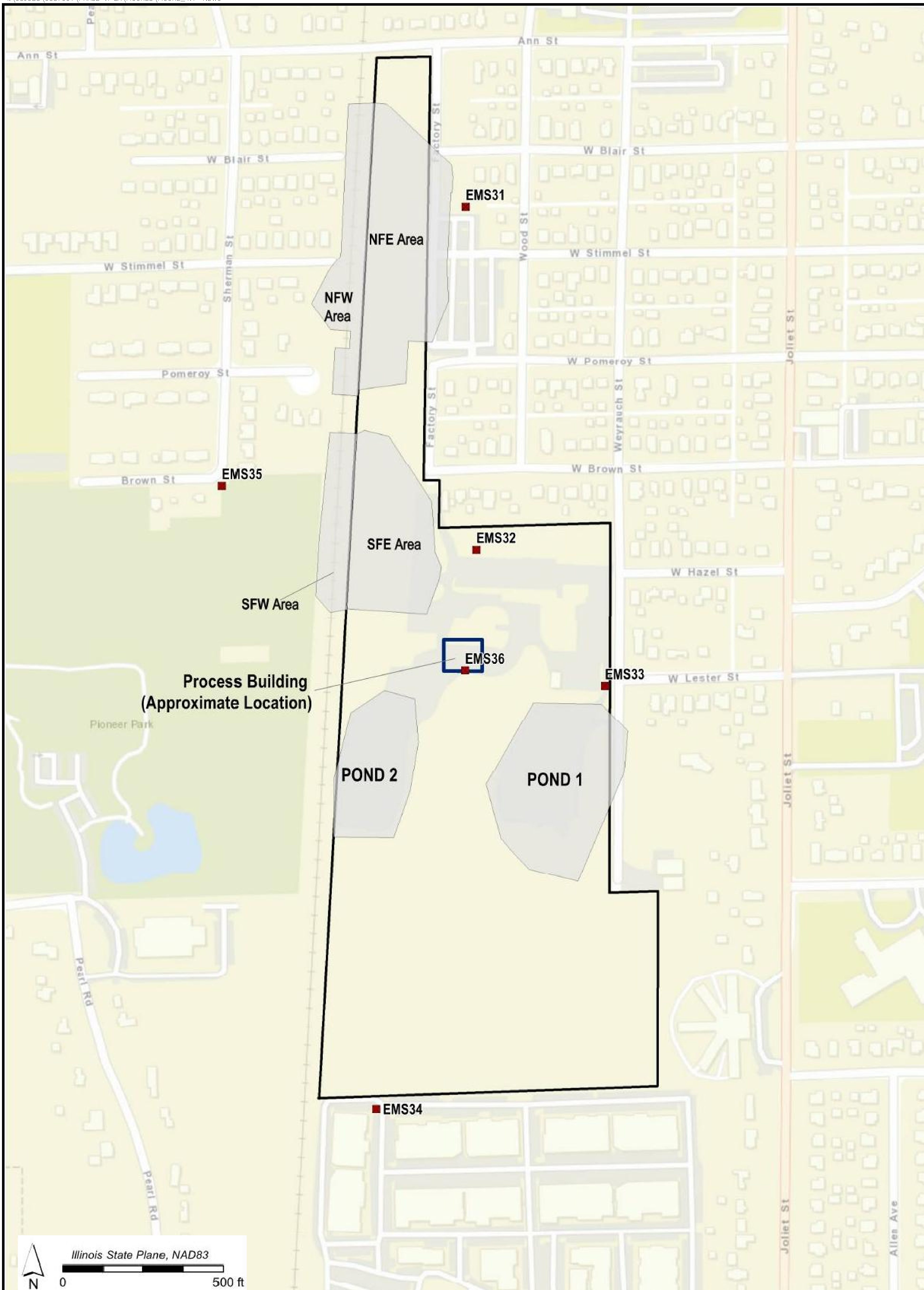

Legend

- Environmental Monitoring Stations
- Approximate Process Building
- Sheet Pile Structure
- Rare Earths Facility

Note:
NFE - North Factory East
NFW - North Factory West
SFE - South Factory East
SFW - South Factory West

PREPARED BY WEST CHICAGO ENVIRONMENTAL RESPONSE TRUST

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PROPOSED MONITORING LOCATIONS

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 4.1-1

three consecutive annual sampling events, that well/constituent may subsequently be analyzed on a triennial basis.

Direct external radiation will be monitored at the six EMS locations. External gamma radiation is measured by thermoluminescence detectors 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 EFFLUENT MONITORING PROGRAM

4.2.1 Emissions Testing Program

Weston will implement a comprehensive source emissions testing program for the full-scale evaporator and slurry dryer system. The testing will evaluate concentrations of potential pollutants in the air emissions exhausted from the evaporators and slurry dryers.

Proposed testing procedures, sample recovery techniques, and laboratory analytical efforts will conform to the requirements of the U.S. Environmental Protection Agency (EPA). Preliminarily, two emissions sampling events will be conducted during the course of the thermal treatment operations. Each sampling event will consist of three test run repetitions, approximately 180 minutes in duration per test run, following 40 CFR 60 Appendix A reference methods. Metals will be measured in accordance with EPA Method 29 (EPA 29). Radionuclides will be measured utilizing a modified EPA Method 5 (EPA MM5) sampling train. The MM5 sampling system will be modified by charging the impinger train with a mixture of 5% HNO3 and 10% H2O2 instead of DI water. Hydrogen chloride (HCl), hydrogen fluoride (HF), ammonia (NH_3), nitrogen oxides (NOx), and sulfur dioxide (SO_2) will be measured utilizing Fourier transform infrared spectroscopy (FTIR) based on EPA Method 320. The volumetric flow rate of the exhaust gas will be measured during each test in accordance with EPA Methods 1, 2, 3/3A, and 4. Table 4.2.1-1 below presents the summary of the preliminary emissions testing program.

4.2.2 Compliance with Air Quality Regulations

As presented in LKI – 1077 (Weston, 2022b), the thermal treatment process for treating the ISL leachate will include three evaporators and four slurry driers. All the evaporation and drying units would be fired by natural gas, resulting in air emissions due to natural gas combustion. The units will likely utilize low-NOx burner technology to minimize emissions and impacts on local air quality. These emissions will be subject to the air permitting requirements of 35 IAC Part 201. Weston with comply with the requirements of 35 IAC 201.175, which includes provisions for the Registration of Smaller Sources (ROSS) Program. Facilities are eligible to operate under

TABLE 4.2.1-1

EMISSIONS TESTING PARAMETERS AND METHODS

Unit	Parameters	Test Method	Number of Test Runs	Test Run Duration	Reporting Units
Evaporator	Metals[1]	EPA 29	3	180 min	ppmvd, lb/hr
	Radionuclides[2]	EPA MM5	3	180 min	ppmvd, lb/hr, μCi/ml
	HCl, HF, NH_3, SO_2, NOx	EPA 320 (FTIR)	3	180 min	ppmvd, lb/hr
Drum Dryer	Metals[1]	EPA 29	3	180 min	ppmvd, lb/hr
	Radionuclides[2]	EPA MM5	3	180 min	ppmvd, lb/hr, μCi/ml
	HCl, HF, NH_3, SO_2, NOx	EPA 320 (FTIR)	3	180 min	ppmvd, lb/hr

[1] Metals include: As, Ba, Bo, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Hg, Mo, Ni, P, Se, Si, Ag, Na, Zn, Total Uranium, Total Thorium

[2] Radionuclides include: Pb-210, U-234, U-235, U-238; Th-228, Th-230, Th-232; Ra-222, Ra-228

the ROSS Program if the actual combined emission rate from particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and volatile organic material is less than 5.0 tons per year.

The combined emission rates from ISL operations are projected to be less than 5.0 tons per year. Thus, the operations will comply with Part 201 requirements by operating under the ROSS Program. Natural gas usage rates will be monitored to calculate annual emission rates to verify that the operations maintain eligibility to operate under the ROSS Program.

The provisions of 35 IAC 212.301 do not allow fugitive particulate matter emissions from any process, including any material handling or storage activity that is visible beyond the facility's property line. Weston will prepare a fugitive dust plan to ensure regulatory compliance. The Plan will include measures to prevent fugitive dust emissions from handling material during and after the ISL treatment operations and identify measures to control fugitive dust from vehicular traffic entering and leaving the facility.

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 Phase VI activities. During Phase VI, radioactive waste (11(e)2 byproduct material) will be generated as a result of thermal evaporation using evaporators and slurry dryers for the leachate solution and by treating groundwater with an ion exchange system. According to the Corrective Measures Implementation Work Plan, (Weston, 2022b), no greater than 370 tons (740,000 pounds) of waste will be generated from the drying process and stored onsite at any point in time until it can be shipped for disposal. The evaporator and dryer waste will be shipped by truck (multiple truck shipments) to a regional rail facility where it will be loaded into approximately four to five railcars and shipped to Energy Solutions near Clive, Utah for permanent disposal. The ion exchange media will be shipped directly from the REF to a uranium recovery facility by truck.

Based on operational plans, two potential accident scenarios were postulated for the Phase VI decommissioning activities. The scenarios were chosen over other postulated accident events, such as a breach of the Pond 1 berm, because they are believed to represent the greatest potential for dose to public. These accident scenarios include a fire which would engulf all of the radioactive waste stored onsite for 2 hours and a fire which would engulf a truck shipment of radioactive waste and burn for 2 hours. 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

In 2019 and 2020, Weston conducted a pilot scale study to assess scalability and the effectiveness of conducting a large scale in-situ leachate process (Weston, 2020c). Waste generated during this study was temporarily stored onsite and then shipped to Energy Solutions in Utah by truck for disposal. As described in LKI-1076 (Weston, 2022a), the leachate solutions to be used during Phase VI groundwater remediation will be the same as those determined in the pilot scale study which generated 11,344 pounds of dryer waste with the following radionuclides and activities: uranium-238 (4.9287E-01 millicurie), uranium-234 (4.7227E-01 millicurie), uranium-235 (2.8532E-02 millicurie), thorium-230 (2.1476E-03 millicurie), natural thorium (2.5751E-02 millicurie), and radium-226 (2.6214E-03 millicurie). Total activity of the waste was 1.0242E+00 millicurie.

Using Radiological Assessment System for Consequence Analyses, Version 4.3.4, computer code for dose assessment, commonly referred to as RASCAL (U.S. NRC, 2015), an accident scenario for the REF was modeled to determine the radiological dose impacts to the nearby population. The accident modeled was a fire which would engulf all the radioactive waste stored onsite for 2 hours. Since the proposed full-scale operations for uranium leaching will create larger volumes of waste than was generated during the pilot scale study with increased radioactivity, the radioactivity for the waste volume described in LKI-1077 (Weston, 2022b) was extrapolated to create a projected baseline source term activity. Those baseline source term activities are as follows: uranium-238 (3.215E+01 millicurie), uranium-234 (3.081E+01 millicurie), uranium-235 (1.861E+00 millicurie), thorium-230 (1.4E-01 millicurie), natural thorium (1.68E+00 millicurie), and radium-226 (1.71E-01 millicurie). Total extrapolated baseline activity of the waste is 6.681E+01 millicurie.

A series of four RASCAL models were created using uniform input parameters while increasing the baseline source term activities of the radionuclides in the waste profile for each separate model by factors of 5, 10, and 20 to determine the potential dose consequence as a result of varying source term activities of waste (see results in Table 5.2-1). Because source terms activities used in the model, other than the baseline source term, are not expected to be encountered during Phase VI, they lead to conservatively high dose estimates and are considered bounding factors.

Accompanied with an airborne release of 2 hours, this accident scenario assumed an atmospheric Class D stability category with an average wind speed of 4.0 miles per hour from a direction of 270 degrees. Other meteorological parameters included an air temperature of 70 degrees Fahrenheit, 50 percent relative humidity, and no precipitation. An airborne release factor of 1.0E-03 and an inhalation factor of 1.0E+00 were used for the entire source term. According to the RASCAL 3.0.5 Workbook, the release fraction assumes the material is on a completely combustible surface (U.S. NRC, 2007) as opposed to the waste generated in Phase VI being a in solid not readily dispersible form. Therefore, using these two default values adds a greater degree of conservatism into the model.

Figure 2-3 in LKI-1077 (Weston, 2022b) illustrates the location of the future Process Building used to treat leachate during Phase VI. Assuming the waste storage area is in the approximate vicinity of the Process Building, the 0.1 miles (528 feet) receptor can be considered

Table 5.2-1

Summary of Dose Estimates for a 2-Hour Fire for All Onsite Radioactive Waste

Source Term Activity	Onsite Fire Total Effective Dose Equivalent in millirem at Distances				
	0.1 Miles	0.2 Miles	0.3 Miles	0.4 Miles	0.5 Miles
BLA	<1	<1	<1	<1	<1
BLA X 5	1.8	<1	<1	<1	<1
BLA x 10	3.6	1.1	<1	<1	<1
BLA x 20	7.2	2.3	1.2	<1	<1

BLA = Baseline Source Term Activity

the fence line observer and the nearest resident for purposes of dose analysis since both locations are relatively close to one another. The maximum projected total effective dose equivalent (TEDE) to a member of the public located 0.1 miles downwind from a fire containing 20 times the baseline source term activity in the postulated fire accident scenario at this location would receive a dose of 7.2 millirem (mrem). Whereas the nearest receptor would receive a dose of less than 1 mrem TEDE from a fire containing the baseline source term activity. This equates to 7.2% and <1.0% of the of the allowable annual dose to a member of the public, as prescribed in 32 IAC 340.310(a)(3), of 100 mrem in any year.

5.3 TRUCK ACCIDENT

The second accident scenario analysis assessed the potential radiological impacts of a truck accident while transporting waste from the West Chicago Facility. The accident scenario assumed the truck catches fire and is engulfed by fire. This accident scenario may result in the release of contaminated material into the air, with subsequent dispersal downwind of the accident site.

Using the RASCAL, Version 4.3.4 (U.S. NRC, 2015), an accident scenario for the truck accident was modeled to determine the radiological dose impacts to the nearby population. The accident modeled was a fire which would engulf all the radioactive waste contained on the truck for 2 hours. Federal law limits the maximum gross weight of a vehicle to 80,000 pounds. For conservatism of this analysis, projected baseline source term activities were calculated assuming the total weight of the waste on the loaded truck to be 80,000 pounds and ignores the tare weight of the truck prior to being loaded. The baseline source term activities of waste for this scenario are as follows: uranium-238 (3.48E+00 millicurie), uranium-234 (3.331E+00 millicurie), uranium-235 (2.01E-01 millicurie), thorium-230 (1.5E-02 millicurie), natural thorium (1.82E-01 millicurie), and radium-226 (1.84E-02 millicurie). Total extrapolated baseline activity of the waste is 7.22E+00 millicurie.

A series of four RASCAL models were created using uniform input parameters while increasing the baseline source term activities of the radionuclides in the waste profile for each separate model by factors of 5, 10, and 20 to determine the potential dose consequence as a result of varying source term activities of waste (see Table 5.3-1). Because source terms activities used in the model, other than the baseline source term, are not expected to be encountered during Phase VI, they lead to conservatively high dose estimates and are considered bounding factors.

Accompanied with an airborne release of 2 hours, this accident scenario assumed an atmospheric Class D stability category with an average wind speed 4.0 miles per hour from a

Table 5.3-1

Summary of Dose Estimates for a 2-Hour Fire for a Radioactive Waste Transport Truck

Source Term Activity	Truck Fire Total Effective Dose Equivalent in millirem at Distances				
	0.1 Miles	0.2 Miles	0.3 Miles	0.4 Miles	0.5 Miles
BLA	<1	<1	<1	<1	<1
BLA X 5	<1	<1	<1	<1	<1
BLA x 10	<1	<1	<1	<1	-<1
BLA x 20	<1	<1	<1	<1	<1

BLA = Baseline Source Term Activity

direction of 270 degrees. Other meteorological parameters include an air temperature of 70 degrees Fahrenheit, 50 percent relative humidity, and no precipitation. An airborne release factor of 1.0E-03 and an inhalation factor of 1.0E+00 were used for the entire source term. According to the RASCAL 3.0.5 Workbook, the release fraction assumes the material is on a completely combustible surface (U.S. NRC, 2007) as opposed to the waste generated in Phase VI being in a solid form that is not readily dispersible. Therefore, using these two default values adds a greater degree of conservatism into the model.

The maximum projected TEDE to a member of the public located 0.1 miles downwind from a truck fire for containing 20 times the baseline source term activity in the postulated fire accident scenario at this location would receive a dose of <1 mrem. This equates to <1.0% of the allowable annual dose to a member of the public, as prescribed in 32 IAC 340.310(a)(3), of 100 mrem in any year.

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 VI 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 excavation and stockpiling of uncontaminated and contaminated materials, backfilling of excavations, sheet pile removal, 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 uncontaminated soils exposed during Phase VI 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 VI 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. Stockpiles will be covered with geomembrane covers to minimize dust generation. Water trucks and hoses will be available for use on-site during handling of soils and sediments. 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 VI decommissioning activities.

Mitigative Measures: All work at the site will be conducted in accordance with City of West Chicago Ordinance 21-0-0015 (West Chicago, 2021).

6.2 REGIONAL DEMOGRAPHY, SOCIOECONOMICS, AND TRANSPORTATION

6.2.1 Demography

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

Mitigative Measures: Since impacts from Phase VI 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 VI 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, 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 VI 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 VI activities. Contaminated materials generated by PSF treatment will be shipped from the site by truck during Phase VI. Section 5.3 addresses potential off-site impacts from a transportation accident during shipment and concludes that impacts would be negligible. Section 5.3 addresses off-site impacts from the transport of contaminated material from West Chicago to Utah. It is concluded that impacts would be minimal.

A negligible increase in traffic on Joliet, Factory, Brown, and Weyrauch Streets is expected.

Mitigative Measures: Off-site transportation impacts are minimal.

6.3 LAND USE

Groundwater remediation activities will continue after Phase VI 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 VI 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 VI decommissioning activities, the site topography will be changed by excavation and stockpiling of uncontaminated materials. Stockpiles will be covered after work 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 VI were introduced during Phase I activities. During Phase VI, stormwater management will include installation of silt fence around the temporary stockpile area and the temporary roads, as well as stormwater inlet protection. A berm will be constructed around the treatment cell.

Erosion and surface runoff will be controlled using silt fences and berms. All temporary stockpiles will be covered during non-working hours and during inclement weather. The site drainage around excavations will be directed to protected storm water inlets.

6.6 SURFACE WATER

Surface water will be controlled through use of surface control berms, ditches, and pipes.

Mitigative Measures: Since all radiologically contaminated soil has been removed from the site, collected stormwater may be used for on-site dust suppression.

6.7 GROUNDWATER

This section reviews the Phase VI groundwater remediation 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 VI activities can be found in Section 3.0 of this report. Phase VI activities with potential to impact groundwater at the Site include:

- Groundwater Removal from Pond 1, Pond 2 and the SFE Area
- Sheet Pile Removal from Pond 1, Pond 2 and the SFE Area
- Excavation of Unsaturated PSF
- Treatment Cell Construction
- Treatment of PSF in Pond 1 Treatment Cell
- Waste Stream Disposal
- Institutional Controls and Groundwater Monitoring

6.7.1 Groundwater Removal from Pond 1, Pond 2, and the SFE Area

Prior to sheet pile removal, Weston will pump the groundwater from Pond 1, Pond 2, and the SFE area. Because the sheet pile is relatively impermeable as compared to the glacial sediments, the groundwater within the sheet pile has long contact time with the PSF which results in higher concentrations of uranium and fluoride in groundwater within the sheet pile enclosures. One of the Phase VI activities will be to remove the sheet pile walls surrounding these areas to enhance groundwater circulation resulting in earlier attenuation of uranium and fluoride concentrations in groundwater. Prior to removal of the sheet pile walls, the stagnant groundwater in the PSF areas will be pumped from the areas and treated with an ion exchange system. This will reduce the potential for higher concentrations of uranium and fluoride moving downgradient of the sheet pile areas when the sheet pile walls are removed.

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.

Mitigative Measures: Extracted groundwater will be treated with an ion exchange system and will then be discharged under the existing NPDES permit.

6.7.2 Sheet Pile Removal

The existing sheet piles enclosing PSF areas Pond 1, Pond 2, and the SFE area will be removed to facilitate faster natural attenuation of constituents with elevated concentrations that exceed the groundwater protection standards. Weston will also look at the technical feasibility of removing sheet pile around the non-PSF areas NFE, NFW, and SFW.

Weston determined that the removal of existing sheet piles surrounding the PSF and other areas will promote natural attenuation of residual fluoride and uranium in the groundwater due to increased groundwater flow rates through these areas of the site. Model prediction using the 2020 Groundwater Flow and Transport Model (Weston, 2021) indicates that cleanup times are improved for uranium, decreasing by approximately a factor of five or greater in the E-stratum, and that cleanup times for other elevated constituents are also reduced. The model predicts that enhanced groundwater flow rates resulting from sheet pile removal will reduce uranium activities to less than 30 picocuries per liter (pCi/L) in the glacial drift aquifer beneath and downgradient of the REF in approximately 375 years in the E-Stratum and approximately 150 years in the C-Stratum.

Mitigative Measures: The sheet pile will be removed using a vibratory hammer or similar equipment. Weston will locate removed sheet pile into a designated area where they will undergo radiological surveys and proper disposal. Even with the extraction of stagnant groundwater from within the sheet pile areas, there is potential for temporary increases in select constituents. The groundwater corrective action monitoring program will provide the data needed to monitor potential impacts to groundwater after removal of sheet pile. The primary mitigative measures for groundwater are the institutional controls implemented to cut off the groundwater pathway in areas which could experience concentrations greater than the groundwater protection standards. These are discussed in detail in Section 3.3.2.1 and the Corrective Action Plan (Weston, 2022a) and are shown in relation to the site in Figure 3.3.2.1-1.

6.7.3 Excavation of Unsaturated PSF Material

In Ponds 1 and 2 and the SFE area, the first seven feet of topsoil, fill and PSF will be excavated. Each of these areas has 6 inches of topsoil at surface sitting on 18 inches of fill material that sits on top of the PSF. Pond 1 will be the first excavated to make room for the treatment cell construction in Pond 1. The topsoil will be removed and stockpiled in a laydown area (see Figure 3.3.3.2-1) for later use. The fill material will also be stockpiled in in the laydown area for later use and some or all of it will be used in the construction of the Pond 1 Treatment Cell berm. All stockpiles will remain covered when not in use to prevent erosion and runoff and wind transport.

Once the topsoil and fill are removed, the PSF material will be excavated to a depth of approximately 7 feet for treatment. Because the Treatment Cell will be constructed within Pond 1, the 22,000 CY of PSF excavated will also be relocated to the stockpile area.

After the Treatment Cell Liner has been installed in Pond 1, the stockpiled Pond 1 PSF material will be backfilled into the Treatment Cell. Next Pond 2 PSF material will be excavated and backfilled into the Treatment Cell followed by the SFE PSF. It is estimated that 19,000 CY and 3,700 CY of PSF will be excavated from Pond 2 and the SFE, respectively.

Mitigative Measures: Because the excavations are occurring in the vadose zone, there is minimal possibility of impacting groundwater quality from the excavation. The stockpile area and haul roads will have silt fences to prevent runoff. Stockpiles will be covered when not in use to prevent wind transport.

6.7.4 Treatment Cell Construction

As discussed in the previous section, the PSF Treatment Cell will be constructed in Pond 1 requiring removal of the Pond 1 topsoil, fill and PSF and relocation to the temporary laydown area to be stockpiled. The next step will be construction of the perimeter berm around the treatment cell in Pond 1. The berm will be constructed with 9,000 CY of previously excavated fill material from Pond 1. The berm will increase the containment volume of the cell within Pond 1 above the saturated zone. The treatment cell will be constructed to treat Pond 1, Pond 2 and SFE PSF material (44,700 CY) in one emplacement volume. After the berm is constructed, the double liner system will be installed in the base of the treatment cell excavation.

The lixiviant will be injected into and extracted from the treatment cell using wells. This includes three injection wells, three extraction wells and seven cell monitoring wells to monitor water quality within the cell during treatment. The injection wells will be constructed of 4-inch Schedule 80 polyvinyl chloride (PVC) and the extraction wells will be constructed of 6-inch Schedule 80 PVC. The leachate monitoring wells will be constructed of 2-inch Schedule 80 PVC. A three-layer final cover system will be placed over the 44,700 CY of PSF material that will undergo leaching.

Mitigative Measures: The construction of the Treatment Cell does not offer a direct risk to groundwater because the construction occurs above the water table. To mitigate risks, the Pond

1 Treatment Cell and haul roads and any construction areas will have silt fences. There will be a diversion berm encircling the treatment cell that will divert surface runoff away from the cell and into the storm sewer.

6.7.5 Treatment of PSF in Pond 1 Treatment Cell

The CAP (Weston, 2022a) selected excavation and treatment of unsaturated PSF material as the preferred method to address the potential for continued leaching of uranium from the unsaturated PSF material. This material already complies with IEMA residential soil standards. However, Weston proposes that the treatment of unsaturated PSF will enhance the public benefit of the site such as the potential redevelopment of the site for residential or commercial development in addition to the planned recreational use as a city park.

Unsaturated PSF material from Pond 1, Pond 2, and the SFE area will be excavated and treated with a leaching solution in a lined treatment cell constructed in the footprint of Pond 1, as previously discussed. The resulting leachate or pregnant lixiviant will be extracted and thermally evaporated using evaporators and slurry dryers, connected in series. The leachate treatment system will be housed in a temporary process building.

Mitigative Measures: The treatment of PSF will be performed in a treatment cell that has a liner system installed in the base of the treatment cell excavation. The liner system is a double-liner system with a geocomposite leak detection layer between two 60 mm high-density polyethylene (HDPE) geomembrane liners above and below. Nonwoven textile layers will be above and below the two geomembrane liners to prevent tears and punctures. The leak detection layer will have water within it pressurized above the head in the treatment cell. The leak detection layer will also contain pressure transducers and pH monitors to monitor for pressure loss or pH changes indicative of a leak.

The treatment cell is surrounded by a berm system that extends the treatment cell system vertically above local grade. A three-layer final cover system will be placed over the 44,700 CY of PSF material that will undergo leaching. The cover system will include, from bottom to top, a six-inch cushion layer comprised of fill layer material, a nonwoven geotextile fabric layer, and a 20 mil HDPE geosynthetic liner. The cover is intended to provide a drivable surface for system operations and maintenance while preventing precipitation and surface water runoff from entering the treatment cell footprint and diluting the leaching solution. An 18-inch thick and 2,200-foot-long access road will be constructed over the surface of the final cover system to provide access to monitoring, dewatering, injection, and extraction wells. The access road will be constructed using the fill layer material.

Surrounding the treatment cell is a berm which diverts any runoff from the treatment cell area to a 12-inch storm sewer line. The injection and extraction lines to and from the extraction cell will be enclosed within a HDPE secondary containment pipe which will have a leak detection system. These transport pipes and the secondary containment pipe will have leakproof seals on both ends.

6.7.6 Waste Stream Disposal from Treatment Facility

The treatment of the unsaturated PSF material will produce approximately 7.5 million gallons of leachate with elevated concentrations of uranium, fluoride and likely several metals. The leachate will be pumped to the treatment facility and will first undergo thermal evaporation, using evaporators and slurry dryers. The leachate fluid will be evaporated. There will be vapor from the evaporative process released through a monitored and regulated stack system. The solids present after the effluent waste stream is run through the evaporators will be stored on-site in an exclusion zone prior to shipment to Energy Solutions licensed radioactive waste disposal site in Clive, Utah.

Mitigative Measures: The treatment facility poses minimal risk to groundwater contamination. The primary concern for groundwater would be spills within the treatment facility that could infiltrate into site groundwater. To mitigate this risk, the treatment facility building will be equipped with a secondary containment system to contain, collect, and manage leaks and spills. All leachate treatment and leaching solution preparation system equipment will be housed in the building's secondary containment area which will be equipped with a 6-inch curb and floor sumps. The containment system is designed to hold 10-percent (%) of the total volume of all containers, or the volume of the largest container, whichever is greater. The sump system will include a sump pump which will have the necessary piping to route any spilled fluids to the leachate feed tank where it can be treated by the evaporators and slurry dryers. Process waters will not enter storm or sanitary sewers.

6.7.7 Institutional Controls and Groundwater Monitoring Program

Throughout the corrective action period the groundwater pathway will be cut off to groundwater use through the continued implementation of institutional controls. In addition, the groundwater will be monitored under the IEMA approved groundwater monitoring program (described in Section 3.3.7). The institutional controls are described in Section 3.3.2.1 and shown on Figure 3.3.2.1-1. The monitoring well network will provide groundwater data to assess the impact of Phase VI activities on groundwater beneath and downgradient from the Site.

6.7.8 Summary of Potential Impacts to Groundwater from Closure Operations

The net result from all the mitigative measures listed above is that Phase VI decommissioning activities should have a minimal negative impact on groundwater beneath the Site. It is expected that the disturbance from pulling the sheet piles may locally change groundwater conditions on the site. However, modeling predicts that the long-term groundwater concentrations for elevated constituents will attenuate and comply with standards earlier with sheet pile removal. With the implementation of institutional controls, any transient groundwater increases will pose minimal risk to the public. If monitoring shows that groundwater has the potential to migrate at concentrations in excess of groundwater protection standards to areas not covered by institutional controls, Weston must be prepared to implement measures to mitigate those unforeseen risks.

6.8 ECOLOGY

6.8.1 Biota

Phase VI decommissioning activities are unlikely to impact ecological communities and individual inhabitants at the Facility. There should be no significant impact to species populations as a whole. There are no unique or threatened animal species at the Facility, so Phase VI activities a 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 VI decommissioning activities at the Site. Increased traffic 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 VI 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 VI 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 ASSESSMENT

Phase V activities resulted in the decommissioning and remediation of on-site support structures e.g., the Physical Separation Facility and the remediation of the remaining on-site contaminated soil. Specific standards for residual radium and uranium in on-site soils were required to be remediated to a maximum total radium concentration of 5 picocuries per gram (5 pCi/g) above background as specified in 32 IAC 340 Appendix A. The standard for total residual uranium is 20 pCi/g above background which is based on analyses of potential health risks resulting from unrestricted use of the site. The remedial cleanup standards for both total radium and uranium were effectuated by both regulation and specific conditions within Weston's radioactive material license (License Condition 33 A and B). Free release of structure and equipment were also required to meet 32 IAC 340 Appendix A values.

<u>Section 340 Appendix A Decontamination Guidelines</u>

a) Surface Contamination Guide

Alpha Emitters:

Removable	33 dpm per 100 cm2 average over any one surface
	100 dpm per 100 cm2 maximum
Total Fixed	1,000 dpm per 100 cm2 average over any one surface
	5,000 dpm per 100 cm2 maximum

Beta-Gamma Emitters:

Removable (all beta-gamma emitters except H-3)

222 dpm per 100 cm2 average over any one surface

1,110 dpm per 100 cm2 maximum

Removable (H-3)

2,220 dpm per 100 cm2 average over any one surface

11,100 dpm per 100 cm2 maximum

Total Fixed 2.5 microSv (250 microrem) per hour at 1 cm from surface

b) Concentration in air and water: Appendix B, Table I and II of 10 CFR 20.

c) Concentrations in soil and other materials except water:

1) Radioactive material except source material and radium: Column II of 32 IAC 330.Appendix A.

2) Source material and radium: Concentration of radionuclides above background concentrations for total radium, averaged over areas of 100 square meters, shall not exceed:

A) 5 pCi per gram of dry soil, averaged over the first 15 centimeters below the surface; and

B) 5 pCi per gram of dry soil, averaged over layers of 15 centimeters thickness more than 15 centimeters below the surface.

d) The level of gamma radiation measured at a distance of 100 centimeters from the surface shall not exceed background.

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 as part of the Phase V Environmental Analysis. The assessment evaluated the below activities that could have potentially caused radiological impacts to off-site individuals and populations.

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

Site conditions and the proposed scope of work as described by Weston in the Phase V Plan and Cost Estimate (Weston, 2012c) were used as the basis for the radiological analyses. The radiological assessment evaluated three primary exposure pathways: inhalation of contaminated dust, inhalation of radon and thoron gas, and direct exposure to gamma radiation and yielded the projected doses illustrated in Table 6.9-1 which were in compliance with Sections 332.170(a)(1) and 340.310(a)(3) of 32 IAC.

6.9.1 Radiological Site Assessment of Current Conditions and Phase VI Activities

Since the site meets the requirements for free release, except for the groundwater protection standards, a radiological dose assessment of the REF for current site conditions was conducted using a U.S. Nuclear Regulatory Commission (U.S. NRC) approved modeling tool known as RESRAD. Developed by Argonne National Laboratory and the United States Department of Energy, RESRAD (U.S. NRC, 2020) is a highly complex and sophisticated computer software code that uses site specific radiological data with environmental parameters and exposure pathways to calculate a radiation dose to the critical group. A schematic of a radiation source term through various pathways to the dose receptor is provided in Figure 6.9.1-1 to illustrate the modeling parameters (ANL, 2001).

LKI-1076 (Weston, 2022a) provided a radiation dose assessment for the residual radiological constituents of interest, including uranium-238, thorium-232, and radium-226, at the REF using RESRAD OFFSITE (RESRAD) (U.S. NRC, 2020). This conceptual site dose model uses conservative input parameters to describe site conditions and likely environmental pathways which would lead to a potential radiation dose for a member of the general public. IEMA agreed with the model's final input parameters (IEMA, 2022) and conducted its own RESRAD modeling in order to validate the results provided in LKI-1076 (Weston, 2022a) utilizing the radionuclides of concern and their daughter products as shown in Table 6.9.1-1. RESRAD evaluated the following exposure categories.

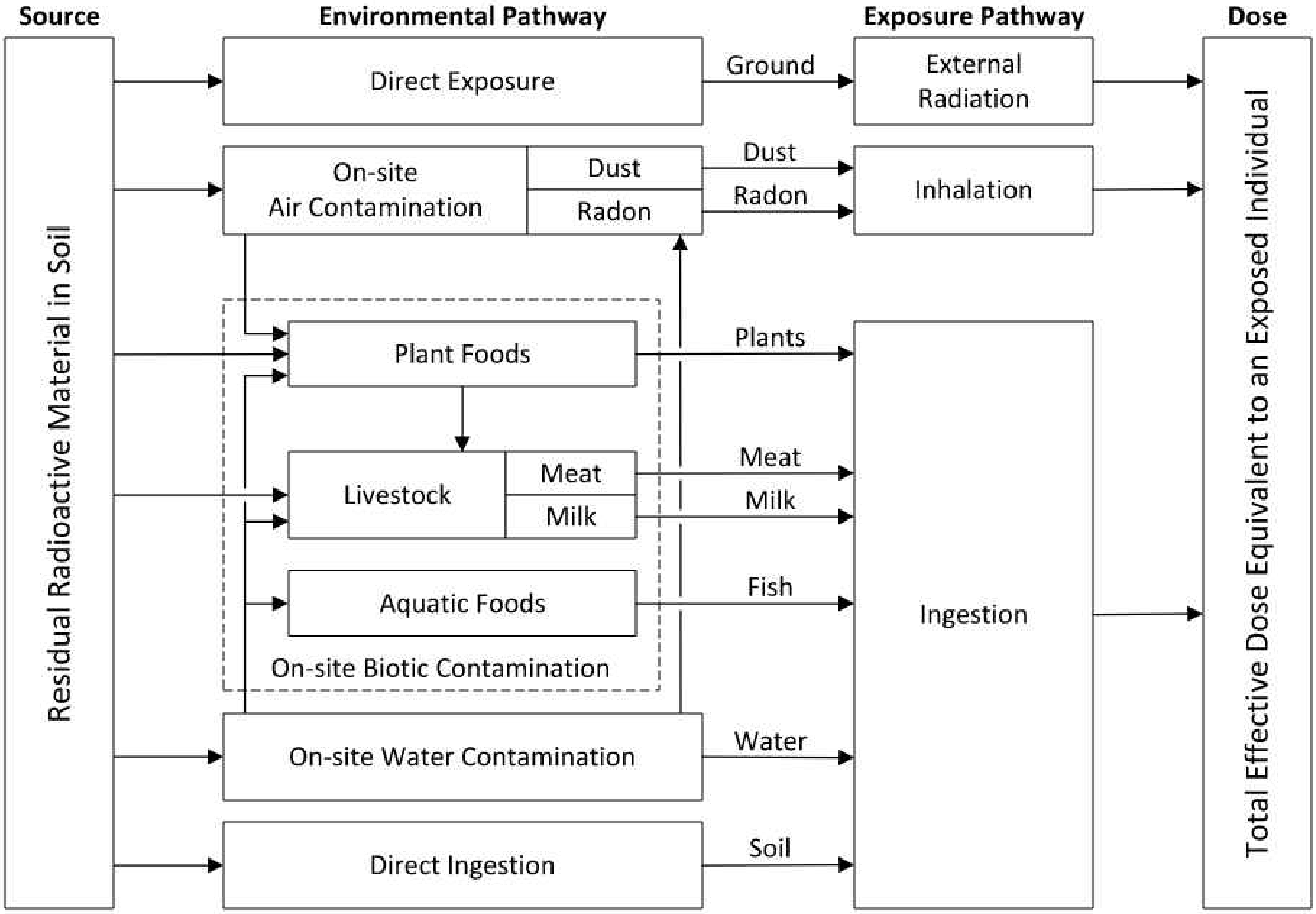
- Direct exposure to residual radioactivity contained in soil
- Internal doses from inhalation of airborne radioactive material with the exception of radon
- Internal doses from ingestion of garden food, well water, aquatic food, and soil

The RESRAD code allows for modeling scenarios to be predicated upon the intended land use for the location being modeled. According to the West Chicago Trust Agreement (West Chicago, 2011), the City of West Chicago agreed to develop the REF into a park after decommissioning is completed. For this proposed land use, the Recreational Scenario could be evaluated to determine a probabilistic dose using RESRAD. Under this scenario, the dose receptor would spend limited periods of time in the modeled area and would not be introduced to other environmental pathways such as plant food and drinking water as opposed to a Residential Scenario which might include all pathways. However, using the Residential Scenario will

TABLE 6.9-1

RADIOLOGICAL ASSESSMENT OF PHASE VI ACTIVITIES

	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



HANSON
Hanson Professional Services Inc.

PATHWAY SCHEMATIC
OF A RADIATION SOURCE TERM

ENVIRONMENTAL ANALYSIS
PHASE VI
KERR-MCGEE, WEST CHICAGO

JOB NO. 93S7001

FIGURE 6.9.1-1

JUL 19, 2022 12:31 PM BRANS00939
I:\93JOBS\93S7001\PHASE VI EA\FIGURES\FIGURE_6.9.1-1.DWG

TABLE 6.9.1-1

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		

conservatively overestimate the potential dose to the receptor for the proposed land use, therefore, it can be considered as the upper bounding factor.

Under the Residential Scenario, it is postulated that the receptor would reside on the REF and use the neighboring land for critical food resources. In doing so, the receptor would be exposed to residual radioactivity in the soil, radioactive material at or below the established soil remediation standards, and receive internal doses from airborne resuspension of the residual material with the exception of radon. The receptor would ingest plant food produce, including fruits, leafy and non-leafy vegetables for a suburban resident and well water would be obtained from the shallow glacial drift present at the REF as the primary drinking water resource. Further, aquatic food would be consumed from Kress Creek, the nearest surface body of water, assumed to contain residual radioactivity.

Over 200 input parameters, represented in Table 6-1 of LKI-1076 (Weston, 2022a), were used in the Residential Scenario to model a dose to the receptor whose residence was on the REF with an evaluation period of 1,000 years. Since the water dependent pathways are considered the critical dose pathways, two variations for this scenario were conducted, one with the water pathways in place and one without the water pathways. This was done to demonstrate the magnitude of the water pathway and the need for continued institutional controls.

The maximal TEDE to the receptor under the Residential Scenario with the water pathways not activated in the model is approximately 0.1 mrem at Year 0 and is attributed to direct radiation from the soil. Doses to the receptor gradually decline, with minor fluctuations, over the following 1,000 years. The TEDE when the receptor is not introduced to the water pathway complies with 32 IAC 332.170(a)(1) and all applicable parts of 330.325. With the water pathway activated, the maximal dose increases to 68.3 mrem at Year 340 and then declines over the next 660 years. This resultant TEDE is not in compliance with 32 IAC 332.170(a)(1) and illustrates the need for institutional controls to remain in place.

6.9.2 Radon Flux Assessment

Using RESRAD (U.S. NRC, 2020), a radon flux evaluation for the REF was conducted using the same soil concentrations for the residual radiological constituents (uranium-238, thorium-232, and radium-226) modeled to determine dose compliance. The maximum radon flux was 0.34 pCi/(m2.s) for the entire REF and occurs at Year 0 with a gradual decline over the next 1000 years. Using the methodologies described in the International Commission on Radiological Protection Publication 126: Radiological Protection Against Radon Exposure (ICRP, 2014), the resultant radon flux was converted to a predicted dose for a receptor who lives on the REF and is indoors for 2,000 hours a year. Radon progeny were assumed to be at 40 percent equilibrium. The resultant annual dose was calculated to be 12.9 mrem.

An outdoor dose of the maximum radon flux was calculated for a receptor standing in the flux for 2 hours i.e., a fence line observer. The resultant dose was calculated to be 0.0019 mrem. This equates to an annual dose of 0.6935 mrem.

6.9.3 Radiation Exposure to Groundwater Assessment

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. 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.

6.9.4 External Gamma Radiation Doses

Because the radiation source term at the REF is limited to the groundwater pathway, external gamma doses will be limited to radioactive waste storage after the leachate treatment process. According to the Corrective Measures Implementation Work Plan (Weston, 2022b), no greater than approximately 370 tons (740,000 pounds) of waste will be generated from the drying process and stored onsite at any point in time until it can be shipped for disposal. The waste will be stored near the Process Building which will provide ample distance to ensure doses to the public are protective. Further, anticipated waste activities will be relatively low and consist mainly of uranium-238 and uranium-234 which are weak gamma emitters having gamma constants of 0.065231 and 0.077589 Rem per hour per curie respectively. This conservatively equates to an approximate annual dose at the fence line of 0.486 mrem, which is indistinguishable from natural background radiation doses. Therefore, external gamma doses from Phase VI activities will be well below the public dose limit of 25 mrem annually as stipulated in 32 IAC 332.170(a)(1).

Waste generated during Phase VI operation will be shipped by truck to a regional rail loadout facility where it will be transloaded onto railcars and shipped to the Energy Solutions disposal site. It is estimated that approximately 20-25 truck shipments will be required to transport the 740,000 pounds of waste from the REF to the rail facility. The general population living along the truck shipping corridor may be exposed to gamma radiation from the passing loaded trucks. For conservatism of this analysis, baseline source term activities were calculated assuming the total weight of the waste on the loaded on the truck is 80,000 pounds and ignores the tare weight of the truck prior to being loaded. The baseline source term activities of waste for this scenario are as follows: uranium-238 (3.46E+00 millicurie), uranium-234 (3.331E+00 millicurie), uranium-235 (2.01E-01 millicurie), thorium-230 (1.5E-02 millicurie), natural thorium (1.82E-01 millicurie), and radium-226 (1.84E-02 millicurie). Total extrapolated baseline activity of the waste is 7.22E+00 millicurie. In calculating the upper-bound population doses, the activity of the waste was assumed to be 20 times higher than the anticipated baseline activities.

Using U.S. NRC-RADTRAN, Version 6, (Sandia, 2013) computer code, a model was created to calculate doses from gamma radiation to individuals along the shipping corridor as a result of Phase VI operations. In the model, the 80,000 pounds of waste, having 20 times the baseline activity, was assumed to have a dose rate of 15 mrem per hour at 1 meter from the truck. This dose rate is highly conservative and does not account for any shielding or self-attenuation. The distance from the REF to the transload facility was estimated at 45 miles with a transit time of 1 hour equating to an average speed of 45 miles per hour. A uniform population density of 500 persons per square kilometer was assumed to calculate total population doses from direct radiation from the passing trucks. The population density used is expected to overestimate exposures for the trip from West Chicago to the transload facility. Under these parameters, RADTRAN calculated the maximum dose to an individual in-transit to be 0.0521 millirem. The maximal calculated in-transit dose to the population for the route is approximately 0.1 person-rem.

6.9.5 Air Dispersion Modeling of Radionuclides

Weston conducted a Thermal Treatment Pilot-Scale Study (Weston, 2022c) to evaluate the efficiency, feasibility, safety, and cost of evaporating the ISL leachate and producing a dry solid as an end product and further support the ISL process as a potential treatment for removing uranium from unsaturated PSF material. After table-top evaluation of other technologies, Weston determined that thermal evaporation and drying is the most promising treatment for the leachate resulting from ISL due to the leachate's very high total dissolved solids (TDS) content.

During the Thermal Treatment Pilot-Scale Study, Weston conducted comprehensive in-stack emissions testing to determine potential emissions of radionuclides and other constituents during thermal treatment of the ISL leachate. Sampling was completed utilizing testing procedures, sample recovery techniques, and laboratory analytical efforts that conform with the widely accepted reference methodologies. The emissions results indicated low-level emissions of radionuclides and other constituents, which were well below applicable regulatory limits.

Emissions levels below regulatory limits notwithstanding and as a conservative measure, Weston simulated the potential exposure of airborne radionuclides to a human receptor at the REF property line during proposed full-scale operations of the evaporation and drying system. For the simulations, Weston used the Clean Air Act Assessment Package – 1988 (CAP-88) computer model, a set of computer programs, databases, and associated utility programs for estimating dose and risk from radionuclide emissions into the air. CAP-88 is a regulatory compliance tool under the National Emissions Standard for Hazardous Air Pollutants.

Weston set up the CAP-88 Model to simulate radionuclides' emission, dispersion, and exposure expected under a full-scale operations scenario that would conservatively produce high emissions rates. The input stack air emissions rate was estimated using radionuclide air concentrations measured during the Thermal Treatment Pilot Study and the anticipated air flow rate for the full-scale system.

The CAP-88 Model estimated the air concentrations and associated potential radiation dose of Ra-226, Ra-228, U-234, U-235, and U-238 at potential exposure points. The modeled results indicate that simulated radionuclide concentrations at the nearest and most conservative exposure point are all below the effluent concentration criteria set by regulation. The total effective dose equivalent (TEDE) of a typical receptor at the exposure point was estimated to be 6.55 mrem per year, well below the 50 mrem per year limit for the public per the requirements listed in 10 CFR

Part 20 Appendix B and below the dose standard established in 32 IAC 330.110(d). Weston will refine the model upon the final design to reflect the most probable system operational conditions.

6.9.6 Regulatory Compliance

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 VI activities.

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 VI activities. Doses to a member of the general public during Phase VI 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," requires:

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 does not exceed 1 mSv (0.1 rem) in any year, exclusive of the dose contribution from:

A. Background radiation;

B. Any medical administration the individual has received;

C. Exposure to individuals administered radioactive material and released in accordance with 32 IAC 335;

D. Voluntary participation in medical research programs; and

E. A licensee's disposal of radioactive material into sanitary sewerage in accordance with Section 340.1030 of this Part.

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)(3)(E), which excludes any dose from the "... disposal of radioactive material into sanitary sewerage ...." The second exclusion is found in Section 340.310(a)(3)(A), which states, "... exclusive of the dose contribution from 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.

6.9.7 Regional Radiological Impacts

Analyses conducted to assess the radiological impacts of Phase VI 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 VI activities. These radiological analyses showed with reasonable assurance that there will be no adverse regional radiological impacts from the proposed Phase VI 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 stockpiling activities associated with construction of a lined and bermed Treatment Cell in Pond 1; excavation and stockpiling activities associated with Pond 2 and SFE PSF material treatment; demolition of the treatment facilities and structures; and removal of existing sheet piles surrounding the PSF areas will be performed during Phase VI 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 VI 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 VI decommissioning activities.

7.4 BIOTA

Vegetation will be eliminated, and animal habitat will be compromised in areas being remediated during Phase VI decommissioning activities. Areas will be revegetated after decommissioning activities are completed.

7.5 MATERIALS AND ENERGY

During the Phase VI 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 natural gas, electricity, and water.

8.0 ALTERNATIVES

8.1 BACKGROUND AND PREVIOUS CONSIDERATIONS

In 1979, Kerr-McGee submitted a stabilization plan to U.S. 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 U.S. NRC in May 1983 (U.S. NRC, 1983). This document discusses alternatives for decommissioning in detail. Eight alternatives are identified, and a preferred alternative was selected by U.S. 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 U.S. 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 U.S. NRC in April 1989 (U.S. 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 U.S. 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 U.S. 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 U.S. NRC staff to license on-site disposal (U.S. NRC, 1990). The ASLB's decision was appealed to the U.S. NRC's Atomic Safety and Licensing Appeal Board (Appeal Board). In March of 1991, the Appeal Board reversed the decision of the ASLB (U.S. NRC, 1991). Following the Appeal Board's decision, the U.S. 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 U.S. 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 U.S. 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, U.S. 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 U.S. 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, April 1998, and February 2014 authorizing Phase I, Phase IA, Phase IB, Phase II, Phase IIA, Phase III, Phase IV, and Phase V activities, respectively.

A complete discussion of decommissioning alternatives and the phased approach is contained in the *Environmental Analysis Report - Phase IB for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility* (Phase IB EA) (Hanson Engineers, July

1994b). Considerations consistent with that report are 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 U.S. 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 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.

8.4 PSF ALTERNATIVES

The Physical Separation Facility (PSF) material is the byproduct of source removal activities at the site between 1997 and 2005. To remediate site soils, approximately 1.1 million tons of contaminated soil and debris were excavated and shipped to a licensed landfill. Approximately 250,000 CY of contaminated material were excavated and underwent soil washing treatment through the PSF. Of that material, approximately 185,000 CY of treated contaminated material met the soil clean-up objectives and was used as a backfill for Pond 1, Pond 2, and the SFE area. The site was regraded in 2016, covered with topsoil, and vegetated. The on-site soils, including the PSF materials, meet the applicable residential use-based soil clean-up standards for both radium and uranium, and residual concentrations of non-radiological COCs meet residential and construction worker soil ingestion remediation objectives.

Since the PSF material has been backfilled within the sheet pile enclosures, groundwater concentrations in Pond 1, Pond 2 and the SFE have exceeded the uranium and fluoride groundwater protection standards. Because the sheet pile walls effectively cut off the groundwater within the sheet pile from the active flow system outside the sheet pile, contact times between the groundwater and the PSF material are significant, resulting in desorption of uranium and fluoride from the PSF material.

Earlier CAPs have looked at potential remedial alternatives for lowering the concentrations of uranium and fluoride in the PSF material emplaced inside the sheet pile enclosures. The

Revision 5 CAP proposed grouting the PSF material as an alternative. Grouting was proposed to immobilize constituents, such as fluoride and uranium, present on the PSF material. In 2013, Weston implemented a phased testing program to assess the feasibility of grouting PSF material. The first phase consisted of laboratory-based bench-scale tests. The tests evaluated several grout types including hydrated-bentonite grouts, cement-based grouts, and chemical grouts. Grouting was determined feasible for reducing the mobility of elevated constituents but concerns regarding degradation of the grouts, relocation of grout to uncontrolled areas off site, and restriction on the site's beneficial use removed the alternative from consideration.

In 2016, Weston prepared and submitted a Technical Memorandum for Groundwater Corrective Action (Weston, 2016b). The memorandum included a formal analysis of groundwater treatment alternatives. The decisions made at that time favored enhanced uranium recovery methods commercially employed in uranium mining over in-situ grouting. Uranium recovery employs in-situ leaching (ISL) using a reactive solution (typically referred to as a lixiviant) to extract uranium. From 2016 to 2020, Weston successfully implemented bench scale and pilot-scale studies to evaluate the feasibility of ISL to remove uranium from the PSF material. A detailed review of the in-situ enhanced recovery treatability and pilot tests performed by Weston can be found in Revision 6 of the CAP (Weston, 2022a).

Results from the tests optimized the leaching solution. The pilot-scale study found that the method was effective at treating the PSF material and lowering uranium concentrations below the groundwater protection standard. One conclusion from the pilot-scale test was that full-scale implementation would require implementation of hydraulic barriers (sheet pile or grouting) within the treatment cells to mitigate uncontrolled migration of the treatment solution. Weston suggested that the treatment may best be suited for ex-situ leaching options. This is one of the reasons in-situ treatment was abandoned as an alternative for PSF material.

In further development and refinement of alternatives for the PSF and groundwater corrective action at the site in general, Weston used the site groundwater flow and transport model (Weston, 2021c). The model was used to investigate the efficacy of removal of the sheet pile surrounding the PSF for the improving time to cleanup for uranium and fluoride. The modeling results found that removal of the sheet pile lowered the uranium time to cleanup greater than a factor of five as compared to leaving the sheet pile in place.

Revision 6 of the CAP (Weston, 2022a) integrates knowledge developed from years of field studies and bench- and pilot-scale studies to develop the groundwater corrective action plan.

The Revision 6 CAP incorporates sheet pile removal as part of the proposed corrective action for groundwater in contact with the PSF. The CAP also proposed that the unsaturated PSF material in Pond 1, Pond 2 and the SFE be treated with a leaching solution ex-situ in a treatment cell constructed within the footprint of Pond 1. During the corrective action period current institutional controls will be maintained to effectively remove the groundwater pathway on and off site. These proposed alternatives will be discussed below.

8.4.1 Unsaturated PSF Material Alternative

Although the PSF material complies with all applicable standards at the site, the Revision 6 CAP (Weston, 2022a) proposed the further treatment of the unsaturated PSF material to allow it to be managed and relocated without future concern of additional exposure risks. A range of treatment methods for PSF material have been extensively studied by Weston. The proposed alternative for unsaturated PSF in Pond 1, Pond 2 and the SFE is to treat the PSF in a treatment cell located in Pond 1 with a lixiviant capable of removing uranium and lowering future leaching potential for the unsaturated PSF.

The objective of this treatment of the unsaturated PSF material is to remove the more soluble fraction of uranium present on the near-surface and readily accessible unsaturated PSF material. This alternative results in more desirable land reuse potential for the REF and is consistent with the as low as reasonably achievable (ALARA) requirements of 32 IAC §330.325. Likewise, this alternative mitigates exposure potential that could occur in the future if the easily accessible shallow PSF material were relocated during site development activities. The shallow PSF material could be moved to other locations, including off-site locations, where its use would be unknown and unrestricted.

8.5 GROUNDWATER REMEDIATION ALTERNATIVES

Various remedial alternatives have been considered for groundwater through the project timeline. The Revision 6 CAP (Weston, 2022a) proposes the following corrective action alternatives for groundwater:

- Excavation of Unsaturated PSF from Pond 1, Pond 2 and the SFE Area
- Treatment Cell Construction inside the Pond 1 sheet pile
- Treatment of Unsaturated PSF in the Pond 1 Treatment Cell
- Placement of the Treated PSF Material back in Pond 1, Pond 2 and the SFE Area
- Groundwater Removal from Pond 1, Pond 2 and the SFE Area

- Sheet Pile Removal from Pond 1, Pond 2 and the SFE Area
- Institutional Controls and Natural Attenuation

The alternatives described above will be discussed in the context of discernable areas of the site, or adjacent offsite, that have groundwater concentrations exceeding their respective groundwater protection standards. These areas or specific media are: 1) Sheet pile areas that include PSF backfill, 2) 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. The CAP relies upon natural attenuation to lower groundwater concentrations to below regulatory limits. Natural attenuation requires institutional controls. If the proposed corrective action alternatives fail to reduce concentrations of regulated constituents to below standards, Weston will consider seeking Alternative Concentration Limits for persistent constituents. The proposed groundwater corrective action alternatives will be discussed in the following sections.

8.5.1 PSF Area Alternatives

Due to past remediation efforts, all on-site soil, including the PSF materials, meet the residential soil clean-up standards for radium and uranium, per License Condition No. 33. Compliance with the clean-up standards notwithstanding, the PSF material remains a source of uranium and fluoride due to the presence of leachable uranium and fluoride on the surface of PSF materials and significantly decreased groundwater flux within the sheet pile. 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 from groundwater advection and dispersion. As discussed in Section 3.3.2, three alternatives have been considered 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 period, Weston concluded that a pump and treat option might not be the best alternative for remediating the PSF areas (Weston, 2012a). Weston proposed the alternative of immobilization of constituents by grouting the PSF material in the Revision 5 CAP (Weston, 2013: LKI 958). Testing of grouting was performed and documented (Hayward Baker, 2014). Studies concluded that grouting was feasible for reducing the mobility of COCs adsorbed on the PSF material but that the volume and toxicity of select constituents would persist on-site in perpetuity with the risk of degradation and/or relocation offsite.

Based upon simulations using the latest version of the site groundwater flow and transport model (Weston, 2021c), Weston predicts that through the removal of the sheet pile surrounding the PSF the cleanup times for uranium and fluoride will be significantly reduced. The removal of sheet pile allows natural advection, dispersion, and infiltration processes to reduce concentrations of these constituents. The Revision 6 CAP (Weston, 2022a) selects sheet pile removal and the resulting natural attenuation as the alternative of choice for saturated PSF within the sheet pile areas. The modeling results found that removal of the sheet pile lowered uranium time to cleanup greater than a factor of five as compared to leaving the sheet pile in place. Prior to sheet pile removal the groundwater within Pond 1, Pond 2 and the SFE will be pumped out and treated to mitigate the release of high concentrations of uranium and fluoride.

8.5.2 Non-PSF Sheet Pile Area Alternatives

The Revision 5 CAP (Weston, 2012a) considered four potential alternatives 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 can 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.

Like the PSF material within sheet pile, groundwater in non-PSF sheet pile regions of the site is stagnant with long residence times which significantly extend any natural attenuation of groundwater concentrations. As a result, with sheet piles in place remediation through natural attenuation within these areas is not likely to reduce concentrations to the groundwater protection standards within a reasonable time frame.

The Revision 6 CAP (Weston, 2022a) proposes sheet pile removal and the resulting natural attenuation as the alternative of choice for saturated, non-PSF material within the sheet pile areas. Again, this option is natural attenuation in conjunction with institutional controls.

8.5.3 Glacial Aquifer Outside Sheet Pile Alternatives

In the Revision 5 CAP (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. The Revision 6 CAP (Weston, 2022a) indicates that monitored natural attenuation is the preferred alternative for groundwater remediation outside the sheet pile areas. If the proposed corrective action alternative fails to reduce concentrations of regulated constituents to below standards, Weston will consider seeking Alternative Concentration Limits for persistent constituents.

8.5.4 Silurian Aquifer Alternatives

The Silurian Aquifer exceeds groundwater protection standards for TDS and sulfate in three site monitoring wells and trends in sulfate have been steady over many years with little improvement. The Revision 5 CAP (Weston, 2012a) listed three options for addressing groundwater contamination in the Silurian dolomite: 1) monitored natural attenuation, 2) pump and treat, and 3) ACLs. The Revision 6 CAP (Weston, 2022a) indicates that monitored natural attenuation is the preferred alternative for Silurian groundwater with the option of seeking Alternative Concentration Limits in the future if required.

8.5.5 Institutional Controls

The previous sections identify natural attenuation as a central element to the groundwater corrective action plan. Because select constituents exceed groundwater protection standards both onsite and offsite, institutional controls are required to remove the groundwater pathway allowing time for natural attenuation to occur over the corrective action period. There are no practical alternatives to institutional controls during the corrective action period. Section 3.3.2.1 as well as Weston (2022a) describes the ordinances and deed restrictions which define the institutional controls in place at the site.

8.6 WATER TREATMENT

The original Water Treatment Plant used in Phases II through V of decommissioning has been demolished from the site at the end of soils cleanup using the Physical Separation Facility. Phase VI activities will again require treatment for both groundwater pumped from Pond 1, Pond 2, and the SFE and leachate that is produced from the Pond 1 treatment cell.

To treat the contaminated groundwater pumped from Pond 1, Pond 2, and the SFE, Weston will develop an ion exchange system to treat stagnant groundwater within the sheet pile. Ion exchange is a treatment alternative for groundwater with elevated constituents such as uranium and fluoride.

The treatment system for the leachate coming from the Pond 1 PSF treatment cell will consist of three thermal evaporators connected to four downstream slurry dryers and ancillary equipment. The leachate treatment equipment and layout may change based on field conditions and other constraints and with IEMA approval.

Weston performed several phases of bench-scale studies and determined that the most promising treatment train capable of dealing with very high total dissolved solids (TDS) content and the constituents expected from the leachate were thermal evaporation and drying.

9.0 REFERENCES

Allison, J.D., D.S. Brown, and K.J. Nove-Gradac, 1991. *MINTEQA2/PRODEFA2, A Geochemical Assessment Model for Environmental Systems: Version 3.0 User's Manual*. Environmental Research Laboratory, Office of Research and Development, U.S. EPA, Athens, GA, 30613, EPA/600/3-91/021.

Algermissen and Perkins, 1976. *Probabilistic Estimate of Maximum Acceleration of Rock in the Contiguous United States.* U.S. Geological Survey, Open File Report No. 76-416, 45 p.

ANSI/ASCE 7-88, 1988. *Minimum Design Loads for Buildings and Other Structures.* American National Standards Institute and American Society of Civil Engineers.

Argonne National Laboratory, 2001. User’s Manual for RESRAD Version 6. Argonne National Laboratory. 2001.

Buffle, J., 1988. Complexation Reactions in Aquatic Systems: An Analytical Approach. Ellis Horwood Limited, Chichester.

City of West Chicago. Website. Available: http://www.westchicago.org. Date accessed: July 6 and 27, 2012.

City of West Chicago, 2011. Environmental Response Trust Agreement (West Chicago), February 2011.

City of West Chicago, 2021. Ordinance No. 21-O-0015, An Ordinance Amending Chapter 10, Article V, Noise Control Regulation of the West Chicago Code of Ordinances, Adopted by the City Council of the City of West Chicago, June 7, 2021.

Davis, J.A. and D.B. Kent, 1990. *Surface Complexation Modeling in Aqueous Geochemistry*. In: Reviews in Mineralogy, Vol. 23, Mineral-Water Interface Geochemistry, Michael F. Hochella, Jr. and Art F. White, editors. Mineralogical Society of America, Washington, D.C.

Dearlove, J.P.L., G. Longworth, M. Ivanovich, J.I. Kim, B. Delakowitz, and P. Zeh, 1991. *A study of groundwater-colloids and their geochemical interactions with natural radionuclides in Gorleben aquifer systems*. Radiochimica Acta, Vol. 52/53, pp. 83-80.

Drever, J.I., 1988. *The Geochemistry of Natural Waters.* Prentice Hall, Englewood Cliffs, NJ, 437 pp.

DuPage County, 2011. 2011 *DuPage County Statistical Profile.* Prepared by the DuPage County Department of Economic Development and Planning.

DuPage County Economic Development and Planning Department, Technical Report Compendium, Section I. Online. Available: https://www.dupagecounty.gov/EDP/Docs/18333. Date accessed: July 16, 2022.

Dzombak, D.A., and F.M.M. Morel, 1990. *Surface Complexation Modeling.* John Wiley & Sons, New York, 393 pp.

Federal Emergency Management Agency, 1991. National Earthquake Hazards Reduction Program (NEHRP), NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings, Part 1 - Provisions, Part 2 - Commentary. Federal Emergency Management Agency (FEMA).

Fetter, C.W., 1993. *Contaminant Hydrogeology*. Macmillan Publishing Company, New York, New York.

Freeze, R.A. and J.A. Cherry. *Groundwater*. Prentice-Hall, Inc., Englewood Cliffs, N.J. 604 p.

Garrels, R.M., and F.T. Mackenzie, 1967. *Origin of the chemical compositions of some springs and lakes*. In: Equilibrium Concepts in Natural Water Systems. Am. Chem. Soc. Adv. Chem. Ser. 67, pp. 222-242.

Grant Environmental, 1994. *Work Plan for Off-Site Groundwater Monitoring Program*. Former Rare Earths Facility, West Chicago, Illinois. September 1994.

Grant Environmental, 1995a. *Environmental Data System* [Computer Program]. Available Distributor: Grant Environmental. April 28, 1995 (LKI-137).

Grant Environmental, 1995b. *Overview of Excavation Delineation West Chicago Rare Earths Facility, West Chicago, Illinois*. Prepared for Kerr-McGee Chemical Corporation. May 15, 1995.

Grant Environmental, 1995c. *Summary of Groundwater Compliance Program former Rare Earth Facility, West Chicago, Illinois*. Prepared for Kerr-McGee Chemical Corporation. October 3, 1995.

Grant Environmental, 1996. *West Chicago Soil Database*. September 26, 1996.

Grant Environmental, 1997. *Revised Excavation Dewatering System Construction and Operations Package*. April 1997 for the Kerr-McGee Chemical Corporation (LKI-326).

Grove Software, Inc., 2011, *MicroShield User's Manual*, copyright 1992-2011.

Hanson Engineers, April 1994. *Environmental Assessment - Phase I for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility*. Hanson Engineers Incorporated. April 1994 for the Illinois Department of Nuclear Safety.

Hanson Engineers, July 1994a. *Addendum to the Environmental Assessment - Phase I for the Phase IA Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility,* Hanson Engineers Incorporated. June 1994 for the Illinois Department of Nuclear Safety.

Hanson Engineers, July 1994b. *Environmental Analysis Report - Phase IB for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility*. Hanson Engineers Incorporated. July 1994 for the Illinois Department of Nuclear Safety.

Hanson Engineers, February 1995. *Environmental Analysis Report - Phase II for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility.* Hanson Engineers Incorporated. February 1995 for the Illinois Department of Nuclear Safety.

Hanson Engineers, June 1995*. 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 Incorporated. June 1995 for the Illinois Department of Nuclear Safety.

Hanson Engineers, April 1996. *Environmental Analysis Report - Phase III for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility.* Hanson Engineers Incorporated. April 1996 for the Illinois Department of Nuclear Safety.

Hanson Engineers, January 1998. *Environmental Analysis Report – Phase IV for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility.* Hanson Engineers Incorporated. January 1998 for the Illinois Department of Nuclear Safety.

Hanson, February 2013. *Environmental Analysis Report – Phase V for the Decommissioning Activities of the Kerr-McGee, West Chicago Rare Earths Facility.* Hanson Professional Services Inc. February 2013 for the Illinois Emergency Management Agency.

Hayward Baker, Inc., 2014, *West Chicago PSF Grouting Pilot Program, Final Report*, January 15, 2014.

Hillel, D., 1980. *Fundamentals of Soil Physics.* Academic Press, New York, 413 pp.

Illinois Department of Nuclear Safety, 1994. Thermoluminescent Dosimetry Data for 1993 for the Kerr-McGee West Chicago Facility, FAX transmittal, March 29, 1994.

Illinois Emergency Management Agency, 2022. *Response to Corrective Action Program, Rev 06 Version 1 (LKI-1076) and Associated Response to Comments (LKI-1075), Former Rare Earths Facility, West Chicago, Illinois.* Illinois Emergency Management Agency. June 10, 2022.

Illinois Environmental Protection Agency, Bureau of Air, Springfield, Illinois. *Illinois Annual Air Quality Report 2019.*

Illinois State Water Survey, Illinois State Climatologist Office. *Wind Roses and Wind Frequency Tables for Illinois*. Online. Available: http://www.isws.illinois.edu/atmos/statecli/roses/wind_climatology.htm. Date accessed: June 26, 2012.

International Commission on Radiological Protection, 2014. Publication 126: Radiological Protection against Radon Exposure, 2014.

Kerr-McGee, 1986. *West Chicago Project Engineering Report, License STA-583, West Chicago Illinois.* Information transmittal to the U.S. Nuclear Regulatory Commission April, 1986, Volumes I - VIII.

Kerr-McGee, 1993. *Closure Plan for the Decommissioning of the Kerr-McGee, West Chicago Rare Earths Facility.* Prepared for the Illinois Department of Nuclear Safety. September 6, 1993.

Kerr-McGee, 1993a. *Initial Interrogatory Responses* from Kerr-McGee to Illinois Department of Nuclear Safety, December 22, 1993.

Kerr-McGee, 1993b. *Environmental Status Reports* from Kerr-McGee to Illinois Department of Nuclear Safety, May 28, 1993, August 31, 1993, November 30, 1993 and March 1, 1994.

Kerr-McGee, 1993c. *Environmental Analysis of the Closure Plan for the Decommissioning of the West Chicago Rare Earths Facility*. Submitted to the Illinois Department of Nuclear Safety. September 6, 1993.

Kerr-McGee, 1993d. *Wetlands Jurisdiction/Section 404 Permit Application* from Kerr-McGee to U.S. Army Corps of Engineers, Illinois Department of Transportation, and Illinois Environmental Protection Agency, December 22, 1993.

Kerr-McGee, 1994. *Response for Phase I Approval*, Letter from Kerr-McGee to Illinois Department of Nuclear Safety, March 14, 1994.

Kerr-McGee, 1994a. *Phase I Remediation West Chicago Rare Earths Facility*. March 1994.

Kerr-McGee, 1994b. *Phase IB Operations Facilities Construction*. May 25, 1994.

Kerr-McGee, 1994c. *West Chicago Rare Earths Facility Program for 1994/1995, Phase II*. May 23, 1994.

Kerr-McGee, 1994d. *Site Excavation Plan for the Kerr-McGee West Chicago Rare Earths Facility*. September 30, 1994.

Kerr-McGee, 1994e. *Letter from R.A. Thompson to Joseph G. Klinger*. November 4, 1994 (LKI-073).

Kerr-McGee, 1995a. *Batch Water Treatment Plant Wastewater Discharge Application*. January 25, 1995 (LKI-099).

Kerr-McGee, 1995b. *Wastewater Pretreatment Plant Preliminary Design*. February 15, 1995 (LKI-105).

Kerr-McGee, 1995c. *Selected Round 5 Interragatory Responses - Wastewater Pre-Treatment Plant Preliminary Design*. April 7, 1995 (LKI-123).

Kerr-McGee, 1995d. *Letter from R. A. Thompson to Joseph G. Klinger*. April 11, 1995 (LKI-126).

Kerr-McGee, 1995e. *West Chicago Rare Earths Facility Kerr-McGee Chemical Corporation Phase II Activities*. June 1995 (LKI-155).

Kerr-McGee, 1995f. *Utility Permit Application to the City of West Chicago*. August 3, 1995 (LKI-178).

Kerr-McGee, 1995g. *West Chicago Physical Separation Testing at Hazen Research May-August, 1995*. September 25, 1995 (LKI-194).

Kerr-McGee, 1995h. *Summary of Ground-Water Compliance Program Former Rare Earths Facility, West Chicago, Illinois*. October 3, 1995 (LKI-191).

Kerr-McGee, 1995i. *Site Excavation Plan for the Kerr-McGee West Chicago Rare Earths Facility*. December 8, 1995 (LKI-209).

Kerr-McGee, 1996a. *WTP Construction Permit Application*. March 22, 1996 (LKI-236).

Kerr-McGee, 1996b. *Common Facilities - Area 690 Engineering Design*. June 26, 1996 (LKI-261).

Kerr-McGee, 1996c. *Water Treatment Plant - Area 600 Engineering Design*. June 26, 1996 (LKI-261).

Kerr-McGee, 1996d. *Simplified Physical Separation Facility - Area 900 Engineering Design*. June 29, 1996 (LKI-263).

Kerr-McGee, 1996e. *Site Excavation Plan Amended Documents*. April 11, 1996 (LKI-243).

Kerr-McGee, 1997a. *Partition Coefficient Studies Report for the Soils at the West Chicago Rare Earths Facility*. February 17, 1997 (LKI-304).

Kerr-McGee, 1997b. *Semi-Annual Report of Radiological Conditions at the Kerr-McGee West Chicago Project.* February 25, 1997 (LKI-310).

Kerr-McGee, 1997c. *Site Excavation Plan for the Kerr-McGee West Chicago Rare Earths Facility*. June 20, 1997 (LKI-339).

Kerr-McGee, 1997d. *Letter from R.A. Thompson to Joseph G. Klinger*. July 24, 1997 (LKI-347).

Kerr-McGee, 1997e. *Letter from R.A. Thompson to Joseph G. Klinger*. October 17, 1997 (LKI-375).

Kerr-McGee, 1997f. Closure Plan for West Chicago Rare Earth Facility, Concrete Demolition and Decontamination. November 5, 1997 (LKI-380).

Kerr-McGee, 2003. First Quarter 2003 Quarterly Report of Water Quality Conditions at the Kerr-McGee West Chicago Project, LKI-723, May 23, 2003.

Kerr-McGee, 2003a. Second Quarter 2003 Quarterly Report of Water Quality Conditions at the Kerr-McGee West Chicago Project, LKI-729, August 11, 2003.

Kerr-McGee, 2003b. Third Quarter 2003 Quarterly Report of Water Quality Conditions at the Kerr-McGee West Chicago Project, LKI-743, November 17, 2003.

Kerr-McGee. 2004. *Response to IEMA Phase V Information Request.* February 23, 2004 (LKI-755).

Kerr-McGee, 2004a. 2003 Annual Report of Radiological Conditions at the Kerr-McGee West Chicago Project, LKI-752, February 12, 2004.

Kerr-McGee, 2004b. Fourth Quarter 2003 Quarterly Report of Water Quality Conditions at the Kerr-McGee West Chicago Project, LKI-754, February 20, 2004.

Kohler, M., E. Wieland, and J.O. Leckie, 1992. *Metal-ligand-surface interactions during sorption of uranyl and neptunyl on oxides and silicates*. In: Water-Rock Interaction, Kharaka & Maest (eds.), Rotterdam.

Langmuir, D., and A.C. Riese, 1985. *The thermodynamic properties of radium*. Geochimica et Cosmochimica Acta, Vol. 49, pp. 1593-1601.

Law Engineering Testing Company, 1981a. *Interim Report - Hydrological Studies, West Chicago Thorium Plant, Kerr-McGee Chemical Corporation,* LAW Project No. 710022. February 16, 1981.

Law Engineering Testing Company, 1981b. *Hydrological Studies, West Chicago Thorium Plant, Kerr-McGee Chemical Corporation,* LAW Project No. 710022. August 24, 1981.

Lemire, R.J. and F. Garisto, 1989. *The solubility of U, Np, Pu, Th, and Tc in a geological disposal vault for used nuclear fuel*. Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, ROE 1LO, AECL-10009.

McCarthy, J.F., and J.M. Zachara, 1989. *Subsurface transport of contaminants*. Environ. Sci. Technol., Vol. 23, No. 5, pp. 496-502.

McKinley, I.G. and A. Scholtis, 1993. A comparison of radionuclide sorption data bases used in recent performance assessments. J. Contam. Hydrology, 13:347-363.

National Council on Radiation Protection and Measurements, 1987. NCRP Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation,* December 30, 1987.

Ortciger, Thomas, Director Illinois Department of Nuclear Safety Letter February 17, 1994 To: R.A. Thompson, Kerr-McGee Re: *Exemption to 321AC332.100 under 321AC,310.306 (A) to allow for Phase I decommissioning activities*.

Sandia, 2013. *RADTRAN 6/RADCAT 6 User Guide.* Sandia National Laboratories. 2013.

Sasman, R.T., R.J. Schicht, J.P. Gibb, M. O'Hearn, C.R. Benson, and R.S. Ludwigs, 1981. *Verification of the Potential Yield and Chemical Quality of the Shallow Dolomite Aquifer in DuPage County, Illinois*, Illinois State Water Survey Circular 149.

Tronox, 2009. *Request to Adjust 2009 WTP Operations (LKI-880).* March 12, 2009.

U.S. Atomic Energy Commission, 1974. *Technical Basis for Interim Regional Tornado Criteria.* Office of Regulation. May 1974.

U.S Census Bureau. *Census 2010 Quickfacts*. Online. Available: http://quickfacts.census.gov/qfd/index.html. Date accessed: July 6 and 27, 2012.

U.S Census Bureau. *Census 2020 Quickfacts*. Online. Available: http://quickfacts.census.gov/quickfacts. Accessed for information on DuPage County, West Chicago, Warrenville, Winfield, and Carol Stream. Date accessed: April 29, 2022.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Online. Available: https://weather.com/safety/tornado/news/2020-03-26-average-number-of-tornados-by-state-each-united.states. Date accessed: July 16, 2022.

U.S. Department of Energy, 1984. Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah, 2 volumes, DOE/EIS-0099-F. July 1984.

U.S. Department of Transportation, 1992. *Accident/Incident Bulletin*, No. 160, Calendar Year 1991, July 1992.

U.S. Environmental Protection Agency, 1983. *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, Title 40, Code of Federal Regulations, Part 192, U.S. Environmental Protection Agency, 1983.

U.S. Environmental Protection Agency, 1987. "PRESTO-EPA-POP: A Low-Level Radioactive Waste Environmental Transport and Risk Assessment Code - Volume 1, Methodology Manual," EPA 520/1-87-024-1, Washington, D.C., December 1987.

U.S. Environmental Protection Agency, 1987a. *PATHRAE-EPA -- Methodology and Users Manual*. U.S. Environmental Protection Agency, Office of Radiation Programs, EPA 520/1-87-028, December 1987.

U.S. Environmental Protection Agency, 1988. "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors For Inhalation, Submersion, and Ingestion", Federal Guidance Report No. 11, EPA-520/1-88-020, 1988.

U.S. Environmental Protection Agency, 1990. Title 40, Code of Federal Regulations, Part 50.6.

U.S. Environmental Protection Agency, 1992. *Technical Support Documentation for the 1992 Citizen's Guide to Radon*, Washington, D.C.: U.S. Environmental Protection Agency report EPA-400-R-92-011, May 1992.

U.S. Geological Survey, 2011. *Seismic-Hazard Maps for the Conterminous United States*. U. S. Geological Survey Scientific Investigations Map 3195, http://pubs.usgs.gov/sim/3195.

U.S. Geological Survey, 2019. *Seismic-Hazard Maps for the Conterminous United States*. Online. Available: https://www.sciencebase.gov/catalog/item/5d5597d0e4b01d82ce8e3ff1

U.S. Geological Survey, 2022. *USGS Current Water Data for Illinois*. Online. Available: https://waterdata.usgs.gov/il/nwis/rt

U.S. Geological Survey, Central Region, Geologic Hazards Team, 1996. *Peak Acceleration (%)g with (5%) Probability of Exceedance in 50 Years (Site: NEHRP B-C Boundary)*, National Seismic Hazard Mapping Project. Revised June 15, 1996.

U.S. Nuclear Regulatory Commission, 1980. Regulatory Guide 4.14, Revision 1, *"Radiological Effluent and Environmental Monitoring at Uranium Mills."* April 25, 1980.

U.S. Nuclear Regulatory Commission, 1983. Final Environmental Statement Related to the Decommissioning of the Rare Earths Facility, West Chicago, Illinois. NRC Docket 40-2061, NUREG-0904, May 1983.

U.S. Nuclear Regulatory Commission, 1984. *Radon Attenuation Handbook for the Uranium Mill Tailings Cover Design*, NUREG/CR-3533, PNL-4878, RAE-18-5, April 1984.

U.S. Nuclear Regulatory Commission, 1984a. *DeMinimis Waste Impacts Analysis Methodology*, NUREG/CR-3585, February 1984.

U.S. Nuclear Regulatory Commission, 1987. "Methods For Estimating Radioactive and Toxic Airborne Source Terms For Uranium Milling Operations," Regulatory Guide 3.59, March 1987.

U.S. Nuclear Regulatory Commission, 1989. *Supplement to the Final Environmental Statement.* NUREG-0904, 2 Volumes, April 1989.

U.S. Nuclear Regulatory Commission, 1990. *In the Matter of KERR-McGEE CHEMICAL CORPORATION* (West Chicago Rare Earths Facility). Docket No. 40-2061-ML. Atomic Safety and Licensing Board, LBP-90-9.

U.S. Nuclear Regulatory Commission, 1991. *In the Matter of KERR-McGEE CHEMICAL CORPORATION* (West Chicago Rare Earths Facility). Docket No. 40-2061-ML. Atomic Safety and Licensing Appeal Board, ALAB-944.

U.S. Nuclear Regulatory Commission, 1992. *A Summary of NRC's Interim Radiological Cleanup Criteria and Current Dose Bases.* Decommissioning and Regulatory Issues Branch U.S. NRC. November 1992.

U.S. Nuclear Regulatory Commission, 2007. *RASCAL 3.0.5 Workbook.* September 2007.

U.S. Nuclear Regulatory Commission, 2015. *RASCAL 4.3: Description of Models and Methods.* May 2015.

U.S. Nuclear Regulatory Commission, 2020. *RESRAD 4: User's Manual for RESRAD-Offsite Code, Volumes 1 and 2.* February 2020.

Visocky, A.P., M.G. Sherrill, and K. Cartwright, 1985. *Geology, Hydrology, and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois,* Illinois State Geological Survey and Illinois State Water Survey Cooperative Groundwater report 10, 136 pp.

Weston, 2003. *Silurian Investigation Report, Former Rare Earths Facility, West Chicago, Illinois (LKI-732).* Prepared for Kerr-McGee Environmental Management Corporation by Weston Solutions, Inc., May 9, 2003.

Weston, 2011. *Draft CAP Revision 5, CD's for Review (LKI-937),* West Chicago Environmental Response Trust, November 3, 2011.

Weston, 2012a. *Corrective Action Program Revision 5, Former Rare Earths Facility, West Chicago, Illinois (LKI-943).* Weston Solutions, Inc., March 2012.

Weston, 2012b. *2011 Annual Report of Radiological Conditions (LKI-946).* Weston Solutions, Inc. July 10, 2012.

Weston, 2012c. *License Condition 63, Plan and Cost Estimate for REF Completion (LKI-947).* Weston Solutions, Inc., July 25, 2012.

Weston, 2012d. *Response to Hanson RFI dated August 27, 2012 (LKI-953).* Weston Solutions, Inc., September 28, 2012.

Weston, 2013. *License STA-583, Amendment 77, Request to Renew and Amend License (LKI-958),* West Chicago Environmental Response Trust, January 30, 2013.

Weston, 2016a. *2015 Annual Report of Radiological Conditions, Former Rare Earths Facility, West Chicago, Illinois (LKI-1009),* West Chicago Environmental Response Trust, March 11, 2016.

Weston, 2016b. *Assignment of a LKI to the Technical Memorandum, Groundwater Corrective Action, Former Rare Earths Facility, West Chicago, Illinois (LKI-1010),* West Chicago Environmental Response Trust, April 5, 2016.

Weston, 2019. *Groundwater Pumping and Infiltration Test Report, Revision 01, Former Rare Earths Facility, West Chicago, Illinois (LKI-1049),* West Chicago Environmental Response Trust, May 2019.

Weston, 2020a. *Phase IIIA and Phase IIIB Bench-Scale Treatability Study Report, Rev 01, In-Situ Leaching of Uranium from PSF Materials, Former Rare Earths Facility, West Chicago, Illinois (LKI-1055),* West Chicago Environmental Response Trust, April 2020.

Weston, 2020b. *2018 Groundwater Flow and Transport Model Report, Revision 01, Former Rare Earths Facility, West Chicago, Illinois, (LKI-1057),* West Chicago Environmental Response Trust, April 2020.

Weston, 2020c. Pilot-Scale Study Report, *In-Situ Leaching of Uranium From PSF Material, Former Rare Earths Facility, West Chicago, Illinois (LKI-1058),* West Chicago Environmental Response Trust, June 2020.

Weston, 2021. *2020 Groundwater Flow and Transport Model, Revision 00, Former Rare Earths Facility, West Chicago, Illinois (LKI-1065),* West Chicago Environmental Response Trust, January 2021.

Weston, 2021a. *Corrective Action Program, Revision 06, Former Rare Earths Facility, West Chicago, Illinois (LKI-1067),* West Chicago Environmental Response Trust, March 2021.

Weston, 2021b. *Soil and Groundwater Investigation Report, Revision 02, Former Rare Earths Facility, West Chicago, Illinois (LKI-1070),* West Chicago Environmental Response Trust, May 2021.

Weston, 2021c. *2020 Groundwater Flow and Transport Model, Revision 01, Former Rare Earths Facility, West Chicago, Illinois (LKI-1072),* West Chicago Environmental Response Trust, June 2021.

Weston, 2022a. *Corrective Action Program, Revision 06, Version 01, Former Rare Earths Facility, West Chicago, Illinois (LKI-1076),* West Chicago Environmental Response Trust, February 2022.

Weston, 2022b. *Corrective Measures Implementation Work Plan, Former Rare Earths Facility, West Chicago, Illinois (LKI-1077),* West Chicago Environmental Response Trust, March 2022.

Weston, 2022c. *Thermal Treatment Pilot-Scale Study, Former Rare Earths Facility, West Chicago, Illinois (LKI-1080).* Weston Solutions, Inc., May 2022.

Willman, H.B. and J.C. Frye, 1970. *Pleistocene Stratigraphy of Illinois:* Illinois State Geological Survey Bulletin 94, 204 pp.

Zeizel, A.J., W.C. Walton, R.T. Sasman, and T.A. Prickett, 1962. *Groundwater Resources of DuPage County,* Illinois State Geological Survey and Illinois State Water Survey Cooperative Groundwater Report 2, 103 pp.