Remedial Design/ Remedial Action Plan Addendum

Former Farmland Nitrogen Plant

City of Lawrence

June 09, 2023

→ **The Power of Commitment**

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1. Introduction

On behalf of the City of Lawrence, Kansas (the City), GHD Services Inc. (GHD) prepared this Remedial Design/ Remedial Action Plan Addendum (Addendum) for the Former Farmland Industries Nitrogen Plant (Site). The project has the Kansas Department of Health and Environment (KDHE) Site Identification C4-023-00009. The original Remedial Design/Remedial Action Plan was prepared by the City in 2012 in accordance with Consent Order No. 10-E-94 BER between KDHE and the City. The Consent Order became effective at the time of signing on September 29, 2010. Prior to the signing of the Consent Order, a Remedial Action Plan was completed by Shaw Environmental for the FI Kansas Remediation Trust (SELS Administrative Services, LLC, Trustee) in 2009.

KDHE issued an Explanation of Significant Difference (ESD) for the Site on October 28, 2022. The ESD authorizes changes to the remedies established in the Corrective Action Decision (CAD) issued on March 3, 2010. The changes were proposed in a document prepared by GHD titled *Proposed Changes to Farmland Remedial Alternatives, Former Farmland Nitrogen Plant, Lawrence, Kansas*, dated June 15, 2022.

1.1 Purpose of this Report

The purpose of this Addendum is to provide a basis for design and implementation of modifications to the approved remedies authorized by the ESD and supplements the Remedial Design/Remedial Action Plan prepared by the City in 2012.

1.2 Project Description and Operational History

The Site is a former nitrogen fertilizer manufacturing plant located at 1608 North 1400 Road in Lawrence, Kansas. The location of the Site is shown on Figure 1. Nitrogen fertilizers were manufactured at the Site from 1954 until 2001. Farmland Industries, Inc., the parent company to Farmland Nitrogen, filed for bankruptcy in 2003 and placed funding for future cleanup activities into the FI Kansas Remediation Trust (FI Trust). In 2010, the City acquired the property and the remaining balance of the trust funds, with a long-term interest in commercially re-developing the Site. Farmland Industries, and later FI Trust, KDHE, and the City have performed various environmental investigations, groundwater and stormwater monitoring, and remediation at the Site, including the operation of a groundwater containment system. These activities are documented in various reports that have been submitted to KDHE over the course of the project's history.

The former plant property included approximately 467 acres of the former operating facility and 120 acres of contiguous parcels. More than 200 acres of land in the southern part of the Site have been redeveloped as an industrial park known as the Lawrence VenturePark business park (See Figure 1). The remaining northern portion is generally divided into the following specific topographic areas of interest: Sandstone Hill, Central Ponds, Plant A, Western Ponds, Eastern Ponds, Bag Warehouse, and Site-wide Groundwater. The Site Map of the Site is provided as Figure 2.

1.3 Original Remedy

The remedy addresses nitrogen contaminants in soil, sediment, groundwater, surface water, and stormwater, which are primarily ammonia, nitrate, and nitrite. The City has already addressed areas of chromium and arsenic contamination included in the original remedy and no further action is required in those areas. The current remedy consists of:

- extraction and hydraulic containment of contaminated groundwater and impacted storm water runoff with temporary on-site storage of the extracted groundwater followed by land application for agriculture by local producers (as dictated by demand)
- targeted soil excavations with off-site disposal

– targeted soil and pond sediment excavation with on-site internment beneath an impermeable vegetative cap
– land use restrictions in the form of restrictive covenants and Environmental Use Controls (EUCs). This includes a Soil-Waste Management plan.

In addition, prior to issuance of the 2010 CAD, numerous interim remedial measures took place. Those interim measures are described in detail in Section 4 of the 2012 RD/RA Plan.

The City reports progress towards the corrective actions to the KDHE Bureau of Environmental Remediation (BER) in quarterly Performance Evaluation Reports (PERs).

1.4 Current System Status

The groundwater remediation systems for the former Farmland Nitrogen Plant involves two primary components: (1) recovery of nitrogen-impacted perched groundwater by a series of interception trenches and sumps; and (2) containment/recovery of alluvial groundwater by extraction wells PW-9, PSW-3B3, PSW-6B4, and PSW-7B2.

1.4.1 Interceptor Trenches

The perched groundwater interceptor trenches/sumps consist of a series of trenches installed in the perched groundwater along the north side of the former Farmland facility and another system in the Central Ponds Area as shown on Figure 2. These systems are also referred to as french drain systems. Perched groundwater entering the interceptor trenches and sumps can be pumped to ponds that were formerly used for wastewater treatment when the plant was in operation or to either of the two aboveground storage tanks (ASTs) known as AST #5 and AST #6. The stored nitrogen-impacted groundwater was historically pumped from the ASTs to farm fields located north of the Kansas River through a buried pipeline to be land applied as supplemental fertilizer. There is no longer a demand for this end-use of recovered groundwater. In August 2017, KDHE approved the City's request to suspend operation of the interception trenches because the volume of recovered groundwater exceeded storage capacity and the quantity required for land application. Perched water flowing into the Central Ponds interceptor trench system and stormwater from Sandstone Hill continues to flow by gravity into Overflow Pond.

1.4.2 Extraction Wells

Alluvial groundwater recovered by extraction wells PW-9, PSW-3B3, PSW-6B4, and PSW-7B2 is discharged at NPDES outfall 001A1 at the northern site boundary (see Figure 2) to a drainage channel that flows approximately 3,400 feet to the Kansas River. This discharge includes surface water that flows from the Regional Detention Pond through NPDES Outfall 001B1, intermittent flow from Krehbiel Pond, and clean stormwater from the drainage on west side of the Site.

1.4.3 Interim Measure

The perched water from Central Ponds interceptor trenches and stormwater from Sandstone Hill is intermittently pumped from Overflow Pond to East Lime Pond for additional storage capacity. As an Interim Measure, the City occasionally discharges water from Overflow and East Lime Ponds into a sanitary sewer to be treated at the City's Kansas River Wastewater Treatment Plant (KRWWTP). KDHE Bureau of Water approved the discharge of water to the sanitary sewer in an email dated April 2, 2020 from Tom Stiles (KDHE) to Sarah Graves (City).

1.4.4 Site Monitoring

The City monitors groundwater elevation and nitrogen concentrations in groundwater and sumps through a quarterly sampling and analysis program. The data is reported to KDHE in quarterly Performance Evaluation Reports (PERs). The PERs summarize corrective actions, including volume of groundwater recovered and mass of nitrogen removed, groundwater monitoring data, maintenance and construction activities (if any), land application (discontinued), and proposed activities.

1.5 Modified Remedy

The modified remedy includes upgrades and improvements to the Interim Measure of discharging Farmland water stored in Overflow Pond and East Lime Pond (Farmland Containment Ponds) to an existing sanitary sewer through Pump Station #25 to be treated at the City's KRWWTP. The timing of this change in treatment options is favorable because the City is in 95% design for Biological Nutrient Removal (BNR) upgrades to the KRWWTP with construction starting in 2023 to meet new KDHE state-wide nutrient removal requirements.

In addition, the City's goal is to reduce the discharge of impacted water from the alluvial groundwater extraction wells and Krehbiel Pond to the NPDES outfall over time, based on the KRWWTP load capacity and reduction in nitrogen concentrations anticipated over time. To achieve this goal, the City will modify the management of alluvial groundwater from extraction wells and water in Krehbiel Pond as appropriate. These waters could be pumped to Farmland Containment Ponds and discharged to the sanitary sewer rather than being discharged through NPDES Outfall 001A1. The Remedial Action Plan in Section 3 of this report provides further details.

A secondary remedial action will be phytoremediation involving trees or other deep root vegetation to treat nitrogen in perched groundwater in an isolated area north of the railroad tracks.

In addition to modifications to the groundwater remedy, modifications to the Site soil remedy are necessary to support the City's need to develop part of the Site as a Municipal Services & Operations (MSO) Field Campus. The MSO Field Campus will include buildings, roads and parking lots on Sandstone Hill and the Plant A Area that will function as impermeable caps to prevent infiltration of precipitation into Sandstone Hill, and MSO Field Campus stormwater infrastructure will reduce nitrogen-impacted stormwater run-off. Figure 3 shows a conceptual drawing of the MSO Field Campus. Trees or other deep root vegetation in landscaping will contribute to phytoremediation of soils in these areas.

As with the original remedies, groundwater monitoring and EUCs/Restrictive Covenants will remain in place. The Land Use Restrictions areas and Restrictive Covenants are shown on Figure 4.

The differences in the remedy described in the 2010 CAD and the proposed remedies described in the ESD are summarized in Table 1.

Table 1 Comparison of 2020 Corrective Action Decision and Explanation of Significant Difference

Remedy Components in the 2010 Corrective Action Decision	Change to the Remedy Component
Enhanced groundwater monitoring. Land Application. Contaminated soil excavation. CRS unit monitoring and closure. Stormwater management pursuant to NPDES Permit. Subsurface drains connected to sump pumps into detention basins. Groundwater recovery/extraction wells. Provision of bottled water to impacted community members.	Diversion of impacted groundwater and stormwater recovered in containment ponds to City of Lawrence. WWTP Modification of WWTP for new pollutant loading. Impermeable caps Phytoremediation. Discontinued use of land application, subsurface drainage, and sump pumps.
Land Use Controls	No change.
Contingency	No change.

1.6 Permits

The Kansas Department of Agriculture, Division of Water Resources issued two permits to the City for the remediation of the Site. Groundwater Term Permit 20119061 issued in 2011 (expiring in 2031) allows the withdrawal of "contaminated" groundwater from four extraction wells and six sumps for the purpose of land application as fertilizer.

Groundwater Term Permit 20059013 was issued in 2010 (expired in 2020) to operate the ponds as diversionary surface impoundments of “contaminated” water for the purpose of land application as fertilizer.

KDHE issued NPDES permit I-KS31-PO04 on April 1, 2017, for discharge of water to the Kansas River. The permit has expired, and the City is working with KDHE to renew the permit. The source of the water consists of stormwater originating on and off site and extracted groundwater. Two NPDES outfalls are regulated by the NPDES permit. Outfall 001A1 is the final discharge located just south of 15th Street. This location consists of a concrete weir structure, small concrete block building, and flow measurement equipment. Outfall 001B1 is located at the discharge point for the Regional Detention Pond.

2. Remedial Action Objectives

The RAOs in this Addendum remain unchanged from the 2010 CAD and include:

– Groundwater:
  - Prevent ingestion of on-site or off-site groundwater having nitrate contamination in excess of the federal drinking water standard for public water supplies of 10.0 milligrams per liter (mg/L).
  - Contain nitrate and ammonia-contaminated groundwater on-site to prevent degradation of the downgradient Kansas River alluvial aquifer.

– Soil and Sediment:
  - Prevent inhalation of fugitive vapors from surface and subsurface soil contaminated with ammonia in excess of the Site-specific Preliminary Remediation Goals (PRGs).
  - Prevent ingestion, inhalation, or direct contact with soil contaminated with arsenic in excess of relevant RSK goals.
  - Prevent ingestion, inhalation, or direct contact with sediment contaminated with total chromium in excess of relevant RSK goals.
  - Prevent migration of contaminants that would result in groundwater contamination in excess of 10.0 mg/L nitrate or surface water contamination in excess of background quality for nitrate and ammonia.

– Surface and Storm Water:
  - Prevent ingestion of contaminated surface or storm water contaminated with nitrate in excess of the federal drinking water standard for public water supplies of 10.0 mg/L.
  - Restore surface water and storm water quality to background quality for nitrate and ammonia.

The remedial goals for soil contamination are based on the KDHE Tier 2 Level for Soil-to-Groundwater pathways (nitrogen), RSK levels for the Soil pathway (metals), and EPA’s calculated PRGs for ammonia in soil. Remedial goals for groundwater contamination are based on the EPA’s MCL of 10.0 mg/L nitrate. Remedial goals for surface and storm water leaving the Site are 10.0 mg/L for nitrate and 2.0 mg/L for ammonia.

3. Remedial Action Plan

The modified remedial actions will be implemented in two general phases as described in this section: Phase 1 Remedial Actions and Phase 2 Remedial Actions.

3.1 Phase 1 Remedial Actions

3.1.1 Design Study for Nitrogen Removal for Kansas River Wastewater Treatment Plant

The City engaged a professional engineering firm to develop and evaluate conceptual design alternatives for improvements to the KRWWTP that are required to upgrade the plant to comply with new KDHE state-wide nutrient removal requirements. The engineering firm will also evaluate and short-list options and impacts for treatment of Farmland water at the KRWWTP. This will include evaluation of a maximum of four processes. The initial process alternatives being considered for evaluation are:

- Chemical treatment of nitrogen
- Post aerobic digestion (PAD)
- Deammonification – Anita Mox and Demon Anammox.

In addition, the City anticipates evaluating an option of no additional upgrades to the KRWWTP for Farmland water if the planned BNR upgrades can effectively handle the Farmland load and meet new nutrient removal requirements.

As part of the evaluations, the engineering firm will determine modifications to the plant, capital cost, and operational and chemical costs through process modelling.

The engineering firm will prepare a draft Technical Memorandum (TM) to summarize process alternatives and comparisons. The TM will include an evaluation based on three major categories: (1) Cost Components, (2) Non-Cost Criteria, and (3) Risks criteria, with appropriate weighting factors for each category.

3.1.2 Aboveground Storage Tank Demolition

AST #5 and AST #6 will not be a component of the modified remedial alternatives and will be razed to prepare the Sandstone Hill Area for construction of the MSO Field Campus infrastructure. The condition of AST #5 was inspected in April 2018. The contractor who performed the inspection (Utility Service Company, Inc.) issued their report, which stated the following: "Overall, the interior coating system is in poor condition, with several large areas of flash corrosion on the sidewalls. There are also many areas of pinhole corrosion occurring where previous surface pitting has occurred. The roof coatings appear to be in poor condition with maximum amount corrosion. Corrosion is occurring on approximately 90% of the interior surfaces." A similar visual inspection of Tank #6 could not be performed due to the volume of accumulated bottom sediments.

The demolition of the ASTs will include the removal and disposal of accumulated sediments from Tank #6. The sediment removal and management will be performed in accordance with relevant and applicable local, State, and Federal requirements. The sediments were removed from Tank #5 in 2018.

The demolition will include disposal or salvage of the ASTs, electrical panels, controls, cathodic protection piping, and associated appurtenances.

3.1.3 Abandonment of Interceptor Trenches and Sumps

The perched groundwater interceptor trenches/sumps consist of a series of trenches installed in the perched groundwater along the north side of the former Farmland facility and another system in the Central Ponds Area as shown on Figure 2. The interceptor trenches around the ponds consist of 4" perforated pipe installed to depths roughly equivalent to the bottom of the ponds. The 4" piping drains into five sumps that are equipped with pumps for removing water. The pumps are operated on a float control system that shuts the pumps off when the level is low and turns the pumps on when the water level increases. The pumps are installed in 4" PVC casing with 5-ft PVC screens at the bottom of the casing. The water enters the casing from the sump through the screen.

The City will contract a Kansas-licensed water well contractor, or other qualified vendor, to plug and abandon the sumps and interceptor trench piping in-place. The contractor will fill the 4" lateral piping and sumps by pumping a KDHE-approved grout into the piping and sumps. The contractor will remove the top three feet of the 24" sumps to the ground surface and bring the annular space to grade with topsoil. The City will notify KDHE at least seven days in advance of plugging operations and submit a plugging report to KDHE within thirty days of completing the plugging operations.

3.1.4 MSO Field Campus Stormwater Infrastructure Improvements Design

The City will design stormwater infrastructure improvements on Sandstone Hill and the Plant A Area to serve the future MSO Field Campus. The project will require cut and fill practices on top of Sandstone Hill to prepare the area for construction of stormwater sewers, water lines, electrical lines, curbing, roads, parking lots and other infrastructure required for the MSO Field Campus. The cut and fill activities will be conducted in established Land Use Restrictions areas and be in accordance with the approved Soil Management Plan.

The stormwater infrastructure for the MSO Field Campus will be designed and built to direct clean stormwater from impermeable surfaces, such as roads and parking areas, to the Regional Detention Pond. Potentially nitrogen-impacted stormwater from green spaces in the MSO Field Campus will be directed to Farmland Containment Ponds to be managed and discharged to the sanitary sewer through Pump Station #25. A conceptual design for the MSO Field Campus is provided as Figure 3.

3.1.5 Convert Recovery Wells to Monitoring Wells

The laboratory analytical data for effluent samples collected from the alluvial groundwater extraction wells PSW-3B3, PSW-6B4, and PSW-7B2 show low to non-detect nitrogen concentrations. This indicates that these wells are providing no apparently useful remedial benefit. The alluvial groundwater concentrations of nitrate within the influence of these three recovery wells is generally below the capture requirement concentration level (10 mg/L) and are recovering clean groundwater. Although the nitrate concentrations in samples from PSW-6B4 fluctuate above the action level.

As such, a goal will be to eventually shut down groundwater extraction wells PSW-3B3, PSW-6B4, and PSW-7B2 and convert them for use as monitoring wells, rather than extraction wells. This goal is contingent upon nitrate concentrations in samples from PSW-6B4.

3.1.6 Design Nitrogen Side Stream Upgrades for Kansas River Wastewater Treatment Plant

The City and its contractors will design the nitrogen side stream upgrades to KRWWTP to treat Farmland water based upon the results and recommendations of the study described in Section 3.1.1. This may require no Farmland updates to KRWWTP if the study concludes that other upgrades designed to meet new KDHE state-wide nutrient requirements can handle the Farmland water.

3.2 Phase 2 Remedial Actions

3.2.1 Build MSO Stormwater Infrastructure Improvements Design

The City will build stormwater infrastructure improvements on Sandstone Hill and the Plant A Area to serve the future MSO Field Campus in accordance with the design completed under Phase 1 Remedial Actions (see Section 3.1.4). This will include cutting and filling soils on top of Sandstone Hill and construction of stormwater sewers, water lines, electrical lines, curbing, roads, parking lots and other infrastructure required for the MSO Field Campus. The cut and fill activities will be conducted in accordance with the approved Soil-Waste Management Plan.

3.2.2 Alluvial and Krehbiel Pond Water Management infrastructure

Currently, alluvial groundwater captured by extraction well PW-9 is discharged to an outfall in a drainage channel in the north part of the Site which flows approximately 3,400 feet to the Kansas River. The City's goal is to reduce the discharge of impacted water to the NPDES outfall over time, based on the KRWWTP load capacity and reduction in nitrogen concentrations anticipated over time. This may include infrastructure (pumps, piping, valves, and meters) to convey the alluvial water extracted by PW-9, water in Krehbiel Pond, and stormwater from green spaces of the MSO Field Campus to the Farmland Containment Ponds. This will alleviate the discharge of nitrogen-impacted groundwater to the drainage channel and Kansas River. Figure 5 shows the proposed water management diagram.

3.2.3 Containment Pond Improvement and Water Management Infrastructure

Currently, nitrogen impacted storm water and water captured by Central Ponds interceptor trenches is stored in the Farmland Containment Ponds and periodically pumped to a sanitary sewer to be treated at the KRWWTP. The City will modify the Farmland Containment Ponds, and stormwater infrastructure to improve on-site management and storage of the Farmland water, if necessary. The improvements will include modifying the capacity and configurations of the ponds and construction of infrastructure to allow the City to pump the water at optimal times to the sanitary sewer through existing Pump Station #25. This will enable the City to manage nitrogen loads to the KRWWTP by allowing the City to minimize discharges to the KRWWTP during peak hydraulic and/or nitrogen loading periods. Design of the pond improvements and water management infrastructure may include pre-treatment options to reduce nitrogen concentrations such as aerators or other low-energy technologies such as engineered wetlands.

3.2.4 Municipal Services & Operations Field Campus

The MSO Field Campus will be designed and built in Phase 2 Remedial Actions. The MSO Field Campus will include a Central Maintenance Garage, MSO Vehicle Conditioned Vehicle Storage building, vehicle fuelling facilities, and office buildings to house various MSO departments. These buildings, roads, and parking lots on Sandstone Hill and the Plant A area will act as impermeable caps to prevent infiltration of precipitation into Sandstone Hill and improved stormwater infrastructure built during Phase 1 Remedial Actions and will reduce nitrogen-impacted stormwater run-off.

The designs for these buildings will consider vapor intrusion. This likely will require vapor intrusion investigations to determine if vapor mitigation systems are needed. Vapor mitigation systems may include passive or active systems. Passive vapor mitigation involves barriers installed in pre-construction phases to prevent the entry of vapors. Active mitigation is the practice of depressurizing the sub-slab to keep chemical vapors from passing through the slab and entering the building. This method involves engineering buildings to prevent vapor intrusion and is considered to be highly effective. Active mitigation is usually more expensive than a passive system due to the high cost of maintenance.

The designs for landscaping for the MSO Field Campus will incorporate trees or other deep root vegetation capable of contributing to phytoremediation of remaining nitrogen-impacted soils in the MSO Field Campus area.

3.2.5 Build Nitrogen Removal Upgrades for Kansas River Wastewater Treatment Plant

The City and its contractors will build the nitrogen removal upgrades at the KRWWTP if additional upgrades beyond the BNR are necessary to treat Farmland water based upon the conclusions of the evaluation discussed in Section 3.1.7.

3.2.6 Phytoremediation

The City will prepare a Phytoremediation Workplan to mitigate the nitrate/nitrite-affected groundwater present below the field north of the BNSF railroad tracks and south of N 1500 Rd (see Figure 6). The affected area includes perched groundwater in the vicinity of MW-23A, MW-24A, and MW-28A. These impacts to groundwater, ranging in depths from approximately 5 feet to 13 feet below ground surface, were identified during a Supplemental Investigation performed in June 2021. A detailed description of the area can be found in *Supplemental Investigation Report* dated October 2017 (GHD 2021). The Phytoremediation Work Plan will be submitted to KDHE BER for review and will include plans for planting of deep-rooted crops or trees to uptake nitrogen impacts from the shallow groundwater. Agricultural testing of the soil will be performed to determine the type and quantities of amendments to support and sustain growth of the desired crop or trees. Additional phytoremediation areas may be considered as the project develops.

3.3 Performance Monitoring

The City will continue Performance Monitoring on a semi-annual basis rather than quarterly. The performance monitoring will include groundwater monitoring and monitoring of nitrogen concentrations in the Farmland Containment Ponds.

The City will monitor groundwater hydraulic gradients and nitrogen concentrations on a semi-annual basis to evaluate the performance of the modified remedial actions. This will include collecting data from the existing monitoring well network, extraction well PW-9, extraction wells PSW-3B3, PSW-6B4, and PSW-7B2, which will be converted to monitoring wells if discontinuation of pumping the wells is supported by monitoring data from PSW-6B4, and an off-site private domestic well known as the Kitsmiller well. The table below summarizes the monitoring well network.

Table 2 Summary of Monitoring Well Network

Designation	Monitoring Wells
Perched Unit	PSW-1A, PSW-2A, PSW-3A, PSW-5A, PSW-6A, PSW-7A, PSW-9A, PSW-13A, PSW-17, PSW-18, PSW-19A, MW-21A, MW-22A, MW-23A, MW-24A, MW-26A, MW-27A, MW-28A, and MW-29A
Alluvial Aquifer	PSW-1B, PSW-2B, PSW-4, PSW-5B2, PSW-9B, PSW-15, PSW-19B, PSW-20B, SW-10, MW-21B, MW-22B, MW-23B, MW-24B, MW-25B, MW-26B, MW-27B, MW-28B, and MW-29B
Alluvial Aquifer (Extraction wells to be converted to Monitoring Wells)	PSW-3B3, PSW-6B4, and PSW-7B2 (if monitoring data supports discontinuation of groundwater extraction).
Alluvial Aquifer Extraction Well	PW-9
Sandstone Hill/Shale Unit	N-1, N-2, CPMW-1S, CPMW-1D, CPMW-2SR, and PSW-13B

Groundwater monitoring will be completed on a semi-annual basis. Before sampling, any site conditions that may affect the quality of the sample will be documented. Weather conditions will be recorded, including temperature, wind direction, and precipitation (type and intensity). The outer protective monument, well casing, and well cap will be inspected for any signs of damage. If there is evidence of damage, or if a lock is missing, this information will be recorded in the field notebook and reported to KDHE.

Prior to commencing well purging and groundwater sampling, the water level in each monitoring well will be measured to the nearest 0.01 foot for hydraulic monitoring and to determine the well volume. Typically, a complete round of water level measurements will be recorded to establish groundwater conditions prior to initiating well purging or groundwater sampling activities. Static water elevation measuring devices will be decontaminated before and after use at each well.

A pre-cleaned submersible pump or peristatic pump will be used to purge three well screen volumes of water prior to sampling. The pump or tubing will be positioned in the well so that the pump intake is set at the midpoint of the well screen. During purging, field parameters consisting of pH, groundwater temperature, and specific conductance will be monitored and recorded.

Once the purging has been completed, groundwater samples will be collected from the monitoring wells directly into laboratory-supplied containers, labelled with a unique sample identification, and placed in a laboratory-supplied cooler with ice to maintain a sample temperature no more than 4°C. The samples will be transported to the City of Lawrence Laboratory - Municipal Services and Operations laboratory, or other KDHE-accredited laboratory, following standard chain-of-custody protocols. The City of Lawrence laboratory holds NELAP Laboratory Accreditation identification E-60665. The project laboratory will analyse the samples for:

– ammonia (as N) by EPA Method 350.1
– nitrate/nitrite by EPA Method 353.2.

Quality Assurance and Control will be in accordance with the Site-specific Quality Assurance Project Plan provided in Appendix A.

The City will monitor the concentration of nitrogen in groundwater samples collected from extraction well PW-9, in water samples collected from monitoring stations to be established in the improved Farmland Containment Ponds, and in effluent water samples collected at a monitoring point to be established in the discharge to Pump Station #25. The City will record the volume of water recovered from extraction well PW-9 and volume of water discharged to the sanitary sewer. This data will be used to calculate and report the mass of nitrogen removed from the Site and discharged to Pump Station #25.

Performance evaluation reports will be prepared and submitted semi-annually to KDHE. At a minimum, the reports will include:

– a narrative description and graphic evaluation of the effectiveness of the remedial action
– laboratory analytical data including summary tables and figures
– static water elevation measurements and top-of-casing elevations
– a figure illustrating the site and associated monitoring wells
– a description of any deviations from the approved sampling procedures
– QA/QC data evaluation
– a contour map of the water level elevation (potentiometric surface map)
– other relevant site data collected during the reporting period
– volumes of water and nitrogen mass extracted from PW-9
– volumes of water and nitrogen mass discharged through Pump Station #25 to a sanitary sewer and treated at KRWWTP
– recommendations for modifications to the remedial actions or performance monitoring, if warranted.

Groundwater monitoring and reporting will be performed on a semi-annual basis for 5 years, then a 5-Year Review will be performed. The purpose of a 5-Year Review is to determine whether the remedy at a site is, or upon completion will be, protective of human health and the environment. The results of the 5-Year Review will be evaluated according to the Performance Evaluation Decision Chart presented as Figure 7.

If further monitoring is determined to be appropriate during the 5-Year Review, The City will work with KHDE to determine an appropriate monitoring and reporting schedule (semi-annual or annual). Monitoring of groundwater and stormwater will continue until one of the following Site conditions is met per KDHE policy # BER-RS-024, Reclassification Plan:

– Chemical of concern (COC) concentrations in groundwater and stormwater are below KDHE Tier 2 RSKs for a non-residential scenario at representative KDHE-approved indicator monitoring locations (e.g., source areas, and down gradient locations) over four semi-annual or annual sampling events.

- The four-point moving average of COC concentrations in groundwater and stormwater is below KDHE Tier 2 RSKs for a non-residential scenario for at least two years and trend analyses (based on a sufficient dataset) indicate stable or decreasing concentration trends.

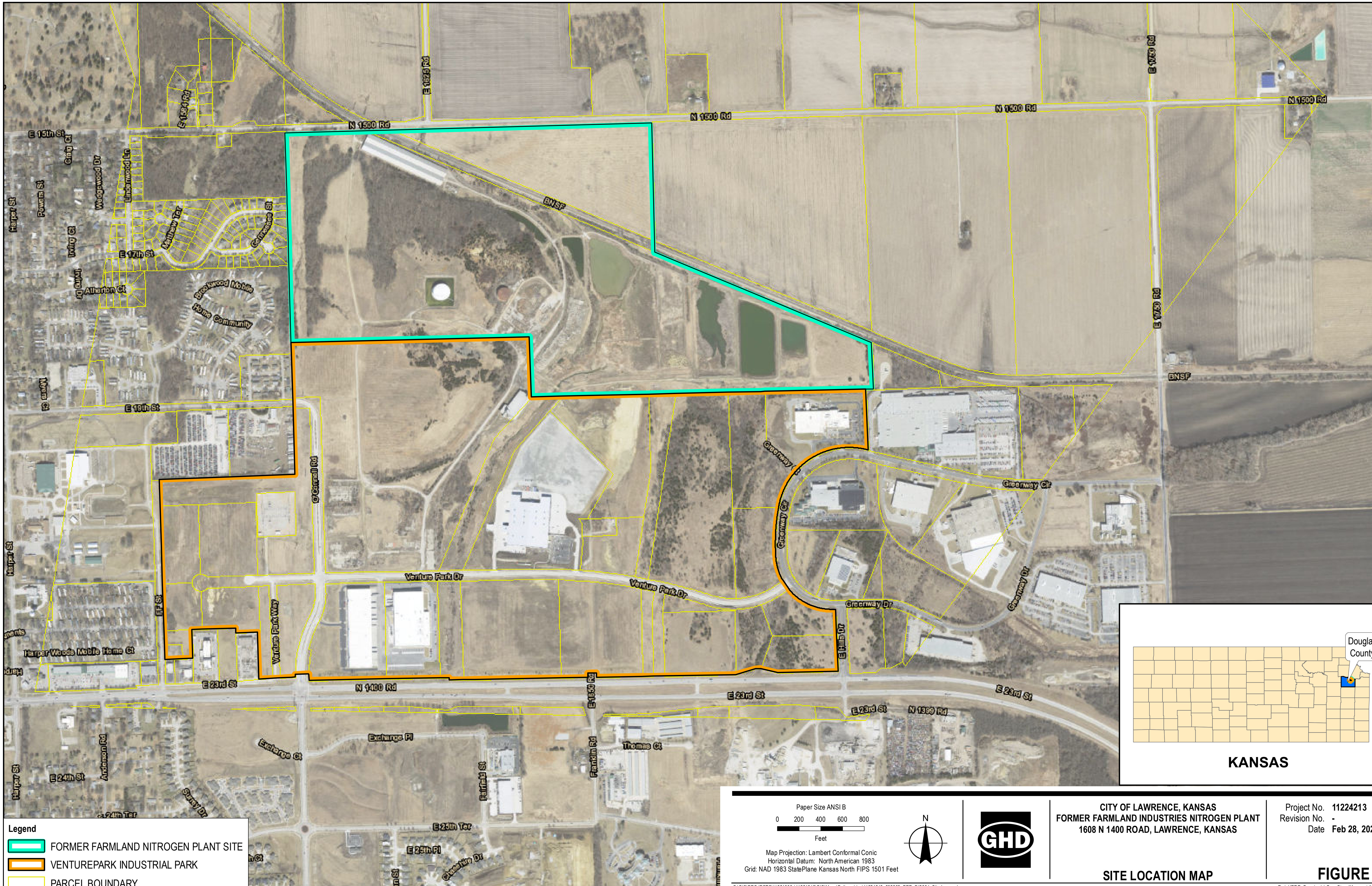
A Final Site Monitoring Evaluation Report will be submitted to KDHE which documents that Site monitoring and/or corrective action implemented at the Site has satisfied the KDHE-established corrective action goals or site monitoring goals. At its discretion, the City may submit a Reclassification Plan (RCP) to KDHE for review and approval to reclassify the site from active to resolved status (see BER Policy # BER-RS-024).

3.4 Contingency Plan

If the Performance Monitoring indicates unstable groundwater plume conditions in the alluvial aquifer, a review of the Site conditions present at that time, as well as historical data, will be performed to determine the most appropriate approach for addressing the plume conditions, including additional investigation, installation of additional alluvial extraction wells, converting monitoring wells PSW-3B3, PSW-6B4, and PSW-7B2 back to extraction wells, and other current or newly available technologies.

3.5 Implementation Schedule

The City has developed a general preliminary implementation timeline for the remedial actions which is provided as Figure 8. Final schedules will be developed during planning, bidding, design work, and contractor selection for the individual components of the remedial actions. The City will provide final schedules to KDHE as they are developed.



Paper Size ANSI B

0 200 400 600 800

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kansas North FIPS 1501 Feet

N

CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS

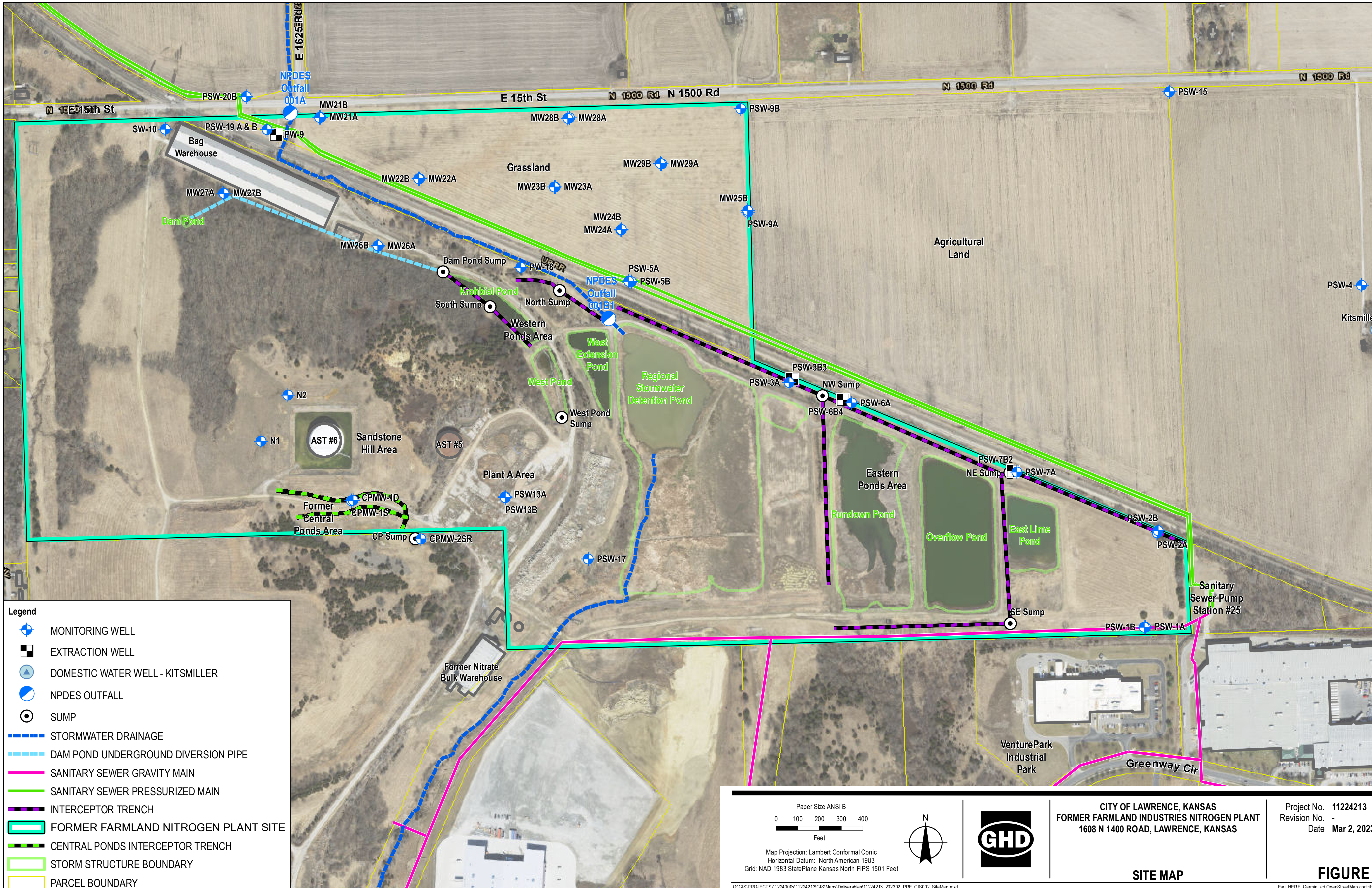
SITE LOCATION MAP

Project No. **11224213**
Revision No. **-**
Date **Feb 28, 2023**

FIGURE 1

Q:\GIS\PROJECTS\11224000s\11224213\GIS\Maps\Deliverables\11224213_202302_PRE_GIS001_Site Loc.mxd

Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, City of Lawrence, Kansas. UAV imagery obtained by GHD February 7, 2023.


E 1625 Rd
NPDES Outfall 001A
PSW-20B
N 15E 15th St
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N 1500 Rd
N 1500 Rd
N 1900 Rd
PSW-15
PSW-9B
MW21B
MW21A
MW28B
MW28A
SW-10
PSW-19 A & B
PW-9
Bag Warehouse
Grassland
MW29B
MW29A
MW22B
MW22A
MW23B
MW23A
MW27A
MW27B
MW25B
PSW-9A
Dam Pond
MW24B
MW24A
Agricultural Land
MW26B
MW26A
Dam Pond Sump
PW-18
UPRR
PSW-5A
PSW-5B
NPDES Outfall 001B1
Krehbiel Pond
North Sump
South Sump
PSW-4
Western Ponds Area
Kitsmiller
West Extension Pond
Regional Stormwater Detention Pond
West Pond
PSW-3B3
PSW-3A
NW Sump
PSW-6A
PSW-6B4
N2
West Pond Sump
AST #6
Sandstone Hill Area
AST #5
N1
Plant A Area
PSW-7B2
NE Sump
PSW-7A
Eastern Ponds Area
PSW13A
PSW13B
CPMW-1D
CPMW-1S
Former Central Ponds Area
Rundown Pond
Overflow Pond
East Lime Pond
PSW-2B
PSW-2A
CP Sump
CPMW-2SR
PSW-17
Sanitary Sewer Pump Station #25
SE Sump
PSW-1B
PSW-1A
Former Nitrate Bulk Warehouse
VenturePark Industrial Park
Greenway Cir
Legend
MONITORING WELL
EXTRACTION WELL
DOMESTIC WATER WELL - KITSMILLER
NPDES OUTFALL
SUMP
STORMWATER DRAINAGE
DAM POND UNDERGROUND DIVERSION PIPE
SANITARY SEWER GRAVITY MAIN
SANITARY SEWER PRESSURIZED MAIN
INTERCEPTOR TRENCH
FORMER FARMLAND NITROGEN PLANT SITE
CENTRAL PONDS INTERCEPTOR TRENCH
STORM STRUCTURE BOUNDARY
PARCEL BOUNDARY
Paper Size ANSI B
0 100 200 300 400
Feet
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kansas North FIPS 1501 Feet
N
GHD
CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS
Project No. 11224213
Revision No. -
Date Mar 2, 2023
SITE MAP
FIGURE 2
Q:\GIS\PROJECTS\11224000s\11224213\GIS\Maps\Deliverables\11224213_202302_PRE_GIS002_SiteMap.mxd
Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, City of Lawrence, Kansas. UAV imagery obtained by GHD February 7, 2023.

Master Plan

1a. Fuel Island

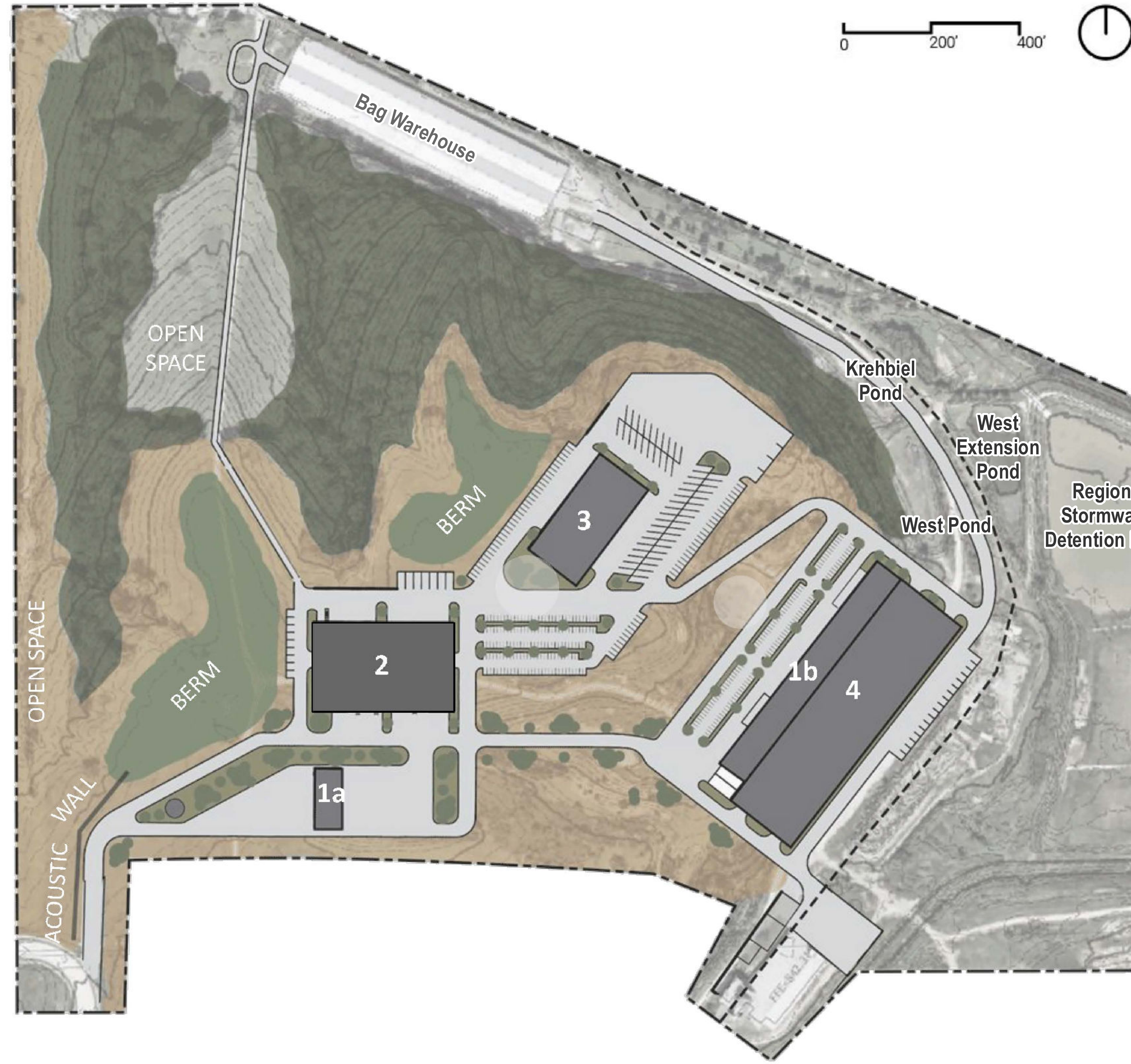
1b. MSO Building*: Streets, Stormwater, Water, Wastewater, Traffic and Inspections Divisions

2. Central Maintenance Garage

3. Solid Waste Division

4. MSO Conditioned Vehicle Storage

*includes MSO Engineering, GIS and Administrative staff



City of Lawrence

Paper Size ANSI B

0 100 200 300

Feet

N

GHD

CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS

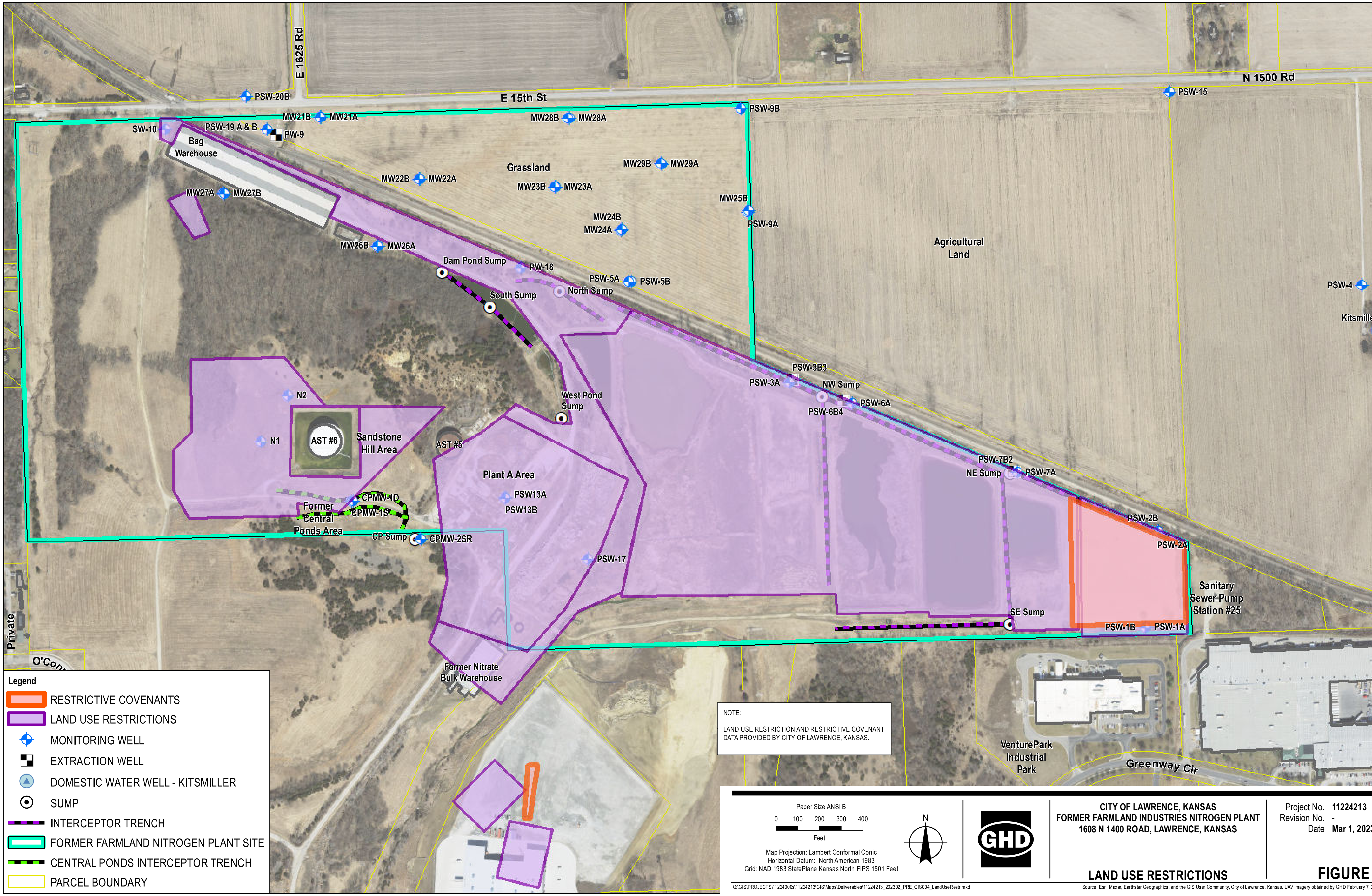
MUNICIPAL SERVICES &
OPERATIONS FIELD CAMPUS

Project No. 11224213
Revision No. -
Date Mar 1, 2023

FIGURE 3

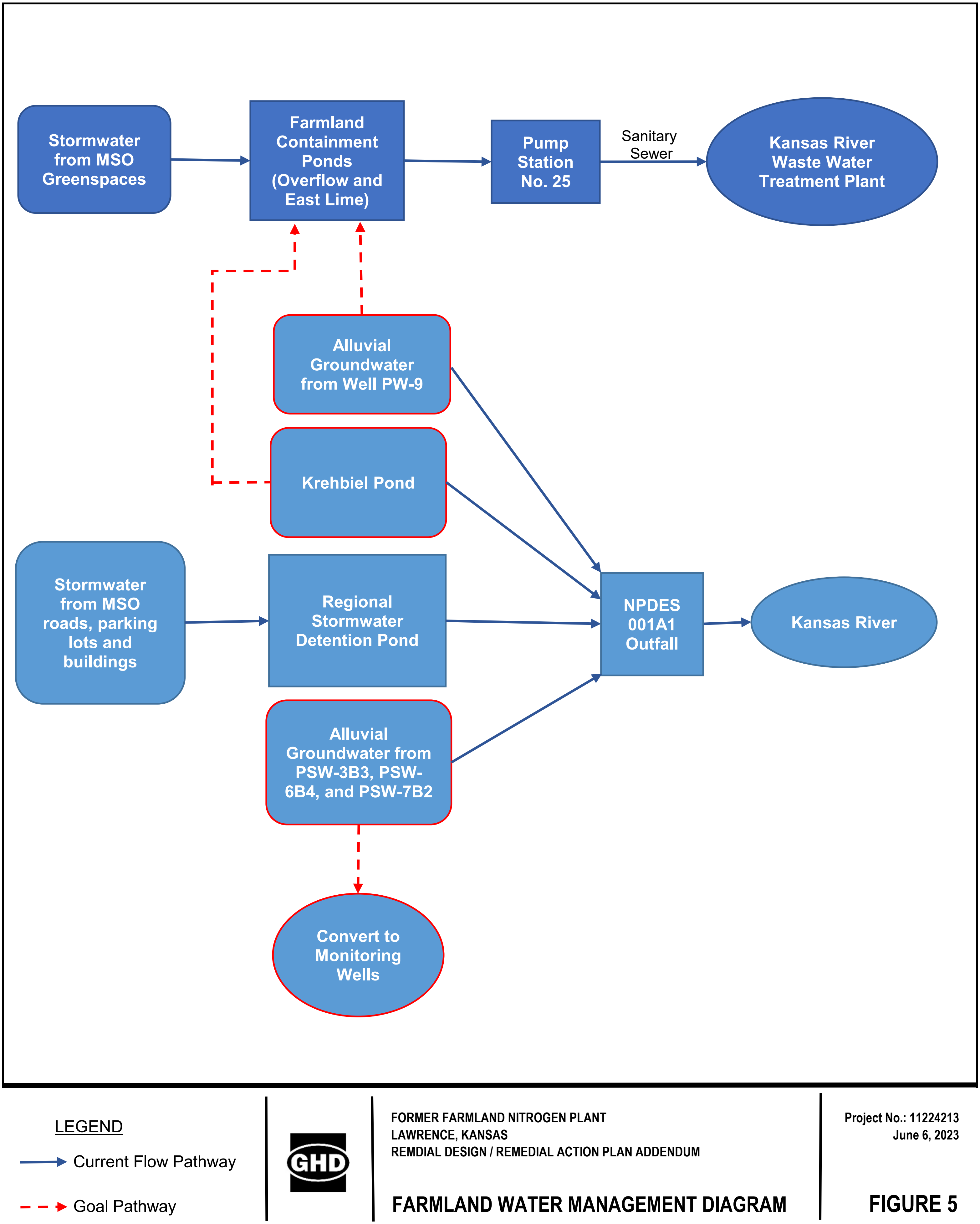
Q:\GIS\PROJECTS\11224000s\11224213\GIS\Maps\Deliverables\11224213_202302_PRE_GIS003_Campus.mxd

Source: City of Lawrence, Kansas



LAND USE RESTRICTIONS

FIGURE 4

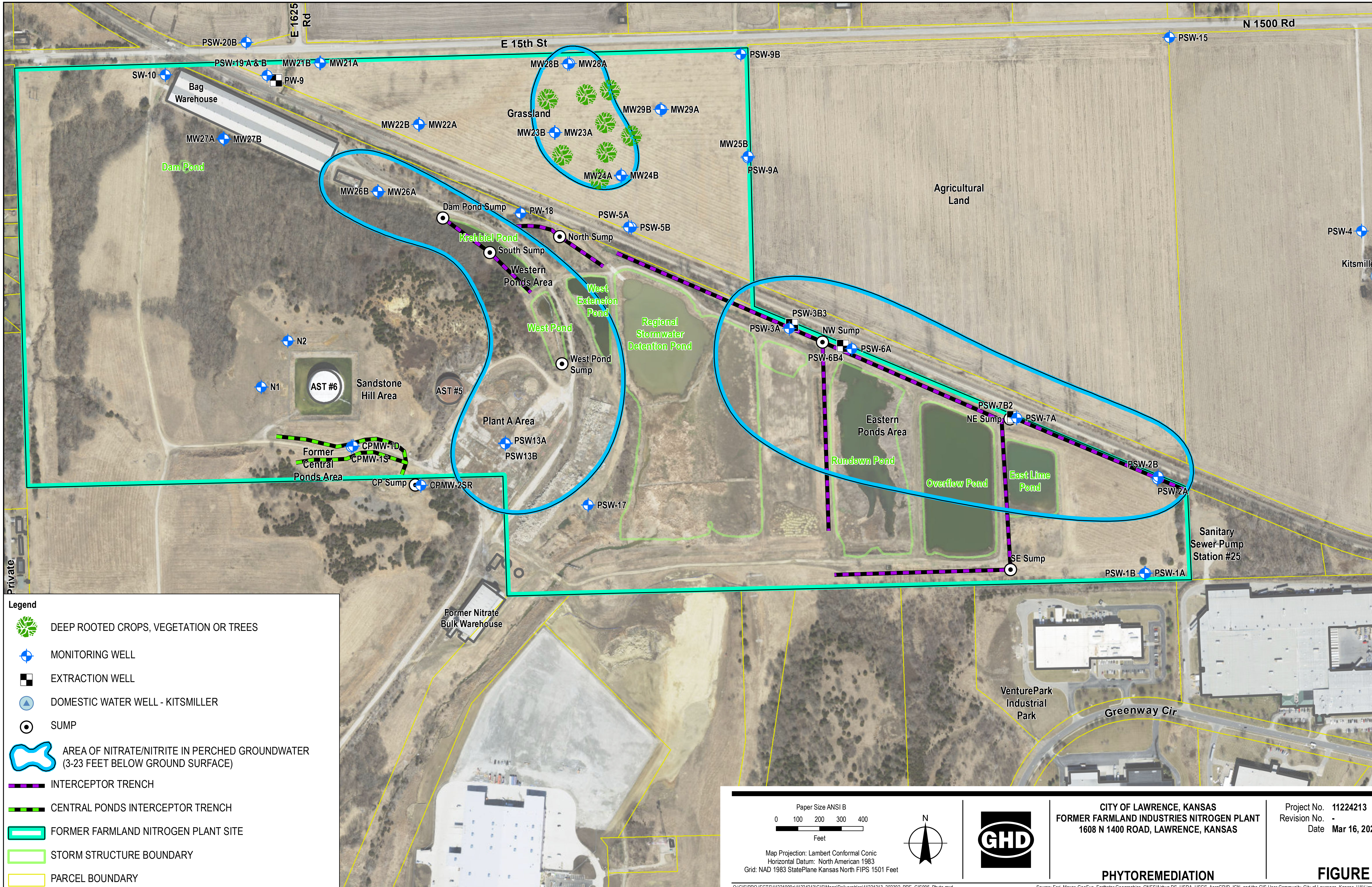


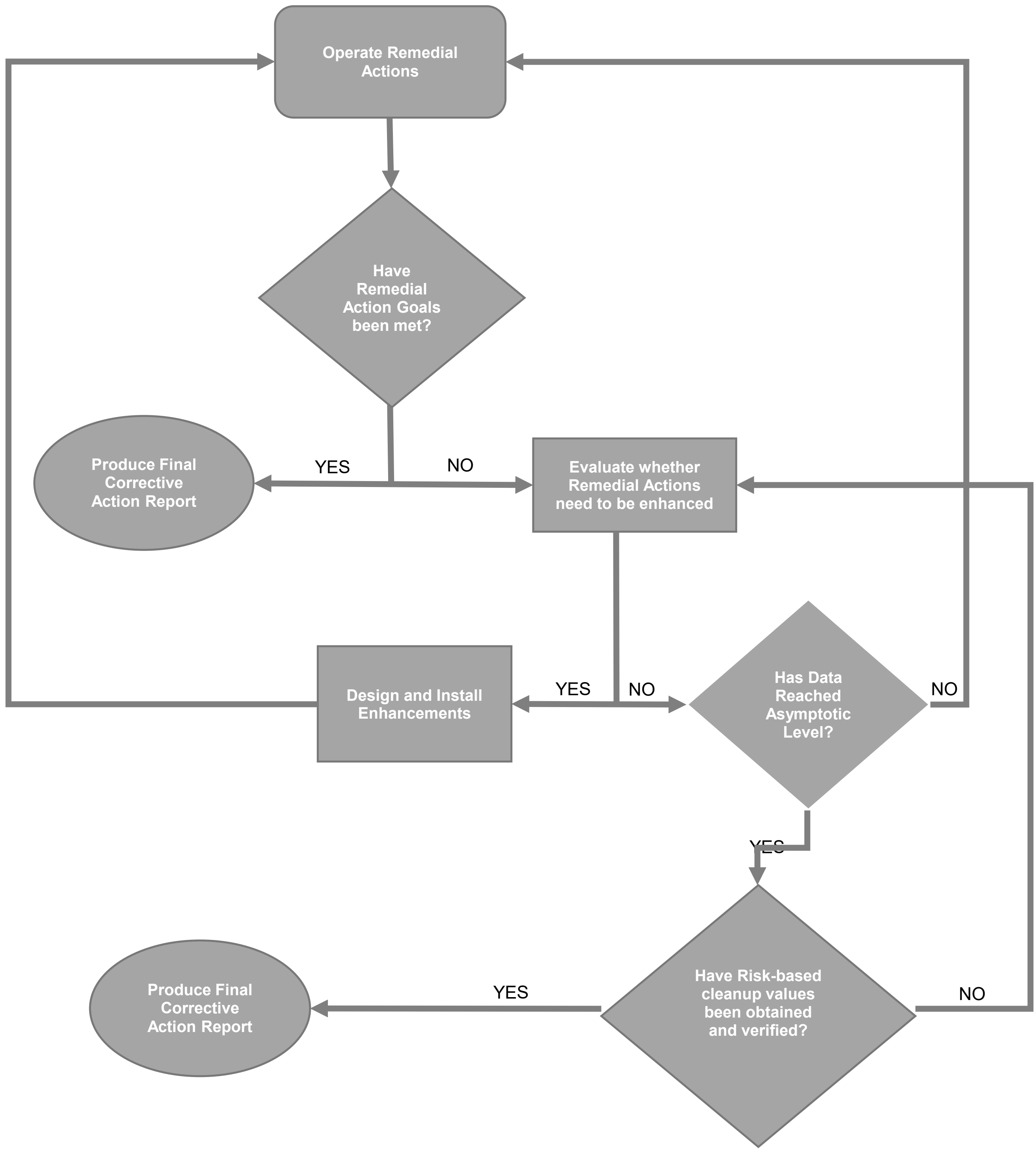
FORMER FARMLAND NITROGEN PLANT
LAWRENCE, KANSAS
REMDIAL DESIGN / REMEDIAL ACTION PLAN ADDENDUM

Project No.: 11224213
June 6, 2023

FARMLAND WATER MANAGEMENT DIAGRAM

FIGURE 5


E 15th St
N 1500 Rd
E 1625 Rd
PSW-20B
PSW-19 A & B
MW21B
MW21A
SW-10
PW-9
Bag Warehouse
MW28B
MW28A
Grassland
MW29B
MW29A
MW22B
MW22A
MW23B
MW23A
MW27A
MW27B
Dam Pond
MW25B
PSW-9A
PSW-9B
PSW-15
MW24A
MW24B
MW26B
MW26A
Agricultural Land
Dam Pond Sump
PW-18
PSW-5A
PSW-5B
North Sump
Krehbiel Pond
South Sump
PSW-4
Kitsmiller
Western Ponds Area
West Extension Pond
Regional Stormwater Detention Pond
West Pond
PSW-3B3
PSW-3A
NW Sump
PSW-6A
PSW-6B4
N2
West Pond Sump
N1
AST #6
Sandstone Hill Area
AST #5
Plant A Area
PSW-7B2
NE Sump
PSW-7A
Eastern Ponds Area
PSW13A
PSW13B
CPMW-1D
CPMW-1S
Former Central Ponds Area
Rundown Pond
Overflow Pond
East Lime Pond
PSW-2B
PSW-2A
CP Sump
CPMW-2SR
PSW-17
Sanitary Sewer Pump Station #25
SE Sump
PSW-1B
PSW-1A
Private
Former Nitrate Bulk Warehouse
VenturePark Industrial Park
Greenway Cir
Legend
DEEP ROOTED CROPS, VEGETATION OR TREES
MONITORING WELL
EXTRACTION WELL
DOMESTIC WATER WELL - KITSMILLER
SUMP
AREA OF NITRATE/NITRITE IN PERCHED GROUNDWATER (3-23 FEET BELOW GROUND SURFACE)
INTERCEPTOR TRENCH
CENTRAL PONDS INTERCEPTOR TRENCH
FORMER FARMLAND NITROGEN PLANT SITE
STORM STRUCTURE BOUNDARY
PARCEL BOUNDARY
Paper Size ANSI B
0 100 200 300 400
Feet
Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kansas North FIPS 1501 Feet
N
GHD
CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS
PHYTOREMEDIATION
Project No. 11224213
Revision No. -
Date Mar 16, 2023
FIGURE 6
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, City of Lawrence, Kansas. UAV imagery obtained by GHD February 7, 2023.



GHD

FORMER FARMLAND NITROGEN PLANT
LAWRENCE, KANSAS
REMEDIAL DESIGN / REMEDIAL ACTION PLAN ADDENDUM

FARMLAND PERFORMANCE EVALUATION DECISION MATRIX

Project No.: 11224213
March 1, 2023

Figure 7

Figure 8
Tentative Implementation Plan
Former Farmland Nitrogen Plant
Lawrence, Kansas

START DATE

January 01, 2023

PROJECT NAMES + TASK TITLES	START DATE	END DATE	# of Days
Phase 1 Remedial Actions	**01/01/23**	**12/30/27**	**1304**
Bid: AST Demolition	05/01/23	06/06/23	27
AST Demolition	08/01/23	11/01/23	67
Abandon Interceptor Trenches/Sumps	01/01/24	06/01/24	110
Design: MSO Stormwater Infrastructure (Sandstone Hill/Plant A)	01/01/23	06/01/24	370
Study: Farmland Nitrogen Removal Processes for KRWWTP	06/01/23	12/01/23	132
Convert Recovery Wells to Monitoring wells	08/01/24	08/30/24	22
Design: Farmland Nitrogen Removal for KRWWTP	01/01/24	06/01/24	110
Site Performance Monitoring and Reporting	01/01/23	12/30/27	1304
Five Year Remedy Review	12/01/27	12/30/27	22
Phase 2 Remedial Actions	**02/01/24**	**12/30/27**	**1021**
Build: MSO Stormwater Infrastructure (Sandstone Hill / Plant A)	02/01/24	06/01/24	87
Bid: Design for Containment Pond Improvement & Water Mgmt. Infrastructure, including PW-9 and Krehbiel Pond designs	02/01/24	02/21/24	15
Design: Containment Pond Improvement & Water Mgmt. Infrastructure, including PW-9 and Krehbiel Pond designs	03/01/24	07/01/24	87
Build: Containment Pond Improvement & Water Mgmt. Infrastructure, including PW-9 and Krehbiel Pond designs	07/01/24	08/01/25	285
Build: MSO Campus Buildings	01/01/25	12/30/27	782
Build: Farmland Nitrogen Removal at KRWWTP (contingent upon Study)	05/01/25	12/31/25	175
Bid: Phytoremediation Workplan	12/01/26	12/21/26	15
Design: Phytoremediation Workplan	02/01/27	03/01/27	21
Implement Phytoremediation Workplan	04/01/27	07/30/27	87

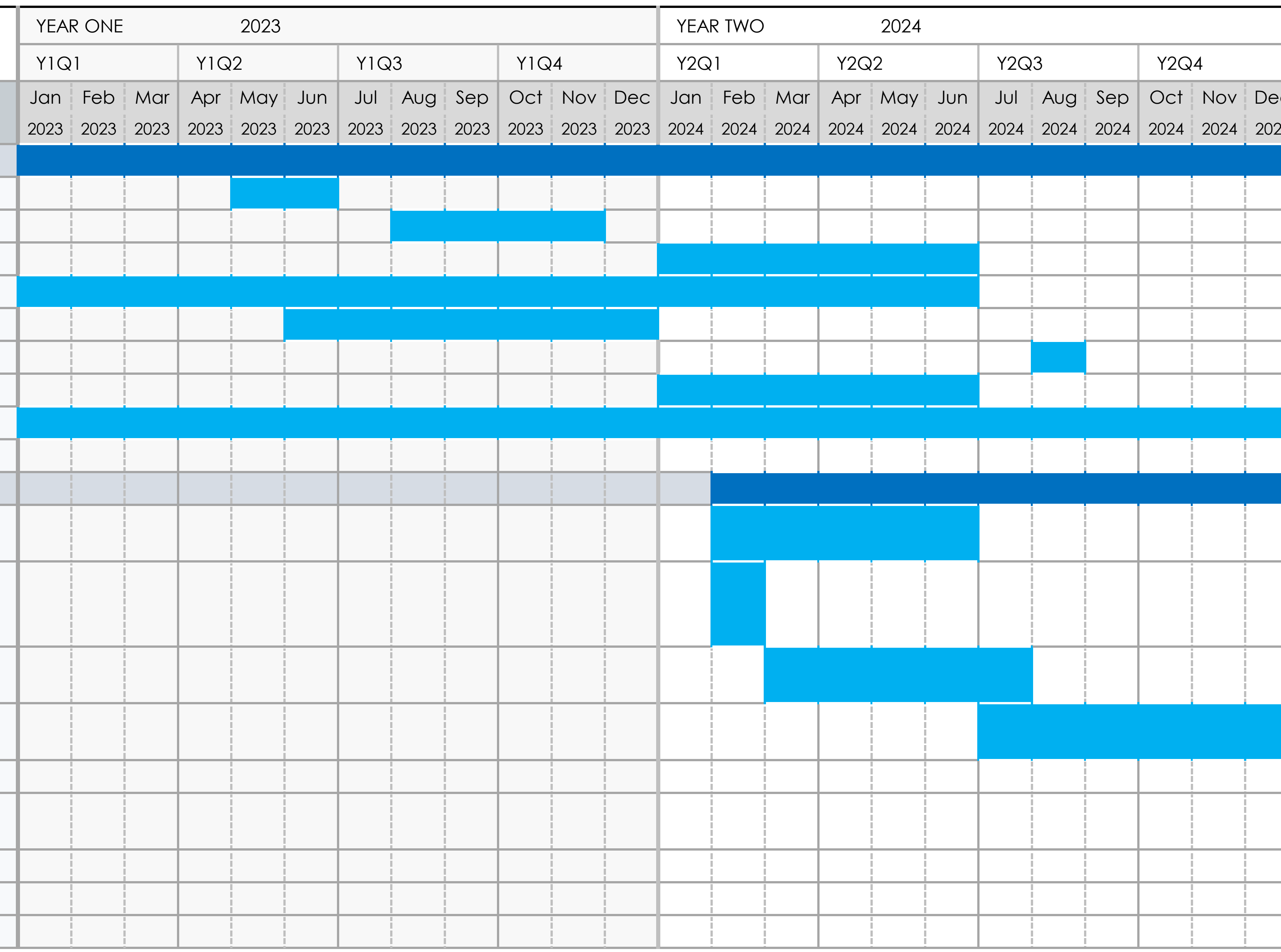


Figure 8
Tentative Implementation Plan
Former Farmland Nitrogen Plant
Lawrence, Kansas

START DATE

January 01, 2023

YEAR THREE 2025: Y3Q1 (Jan 2025, Feb 2025, Mar 2025), Y3Q2 (Apr 2025, May 2025, Jun 2025), Y3Q3 (Jul 2025, Aug 2025, Sep 2025), Y3Q4 (Oct 2025, Nov 2025, Dec 2025)

YEAR FOUR 2026: Y4Q1 (Jan 2026, Feb 2026, Mar 2026), Y4Q2 (Apr 2026, May 2026, Jun 2026), Y4Q3 (Jul 2026, Aug 2026, Sep 2026), Y4Q4 (Oct 2026, Nov 2026, Dec 2026)

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Design: MSO Stormwater Infrastructure (Sandstone Hill/Plant A)	01/01/23	06/01/24	370
Study: Farmland Nitrogen Removal Processes for KRWWTP	06/01/23	12/01/23	132
Convert Recovery Wells to Monitoring wells	08/01/24	08/30/24	22
Design: Farmland Nitrogen Removal for KRWWTP	01/01/24	06/01/24	110
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Phase 2 Remedial Actions	**02/01/24**	**12/30/27**	**1021**
Build: MSO Stormwater Infrastructure (Sandstone Hill / Plant A)	02/01/24	06/01/24	87
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Figure 8
Tentative Implementation Plan
Former Farmland Nitrogen Plant
Lawrence, Kansas

START DATE

January 01, 2023

PROJECT NAMES + TASK TITLES	START DATE	END DATE	# of Days	YEAR FIVE 2027											
				Y5Q1			Y5Q2			Y5Q3			Y5Q4		
				Jan 2027	Feb 2027	Mar 2027	Apr 2027	May 2027	Jun 2027	Jul 2027	Aug 2027	Sep 2027	Oct 2027	Nov 2027	Dec 2027
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Appendices

Appendix A
Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN
for the
CITY OF LAWRENCE
FORMER FARMLAND LAWRENCE NITROGEN
FERTILIZER PLANT
LAWRENCE, KANSAS

Prepared By:
City of Lawrence
Municipal Services & Operations Department
Environment, Health, and Sciences
P.O. Box 708
Lawrence, Kansas 66044

June 9, 2023

QUALITY ASSURANCE PLAN

CITY OF LAWRENCE
FORMER FARMLAND LAWRENCE NITROGEN PLANT
LAWRENCE, KANSAS

TABLE OF CONTENTS

TABLES

FIGURES

1.0 Project Management

This Quality Assurance Project Plan (QAPP) is written to present the standard procedures, policies, field methods, and Quality Assurance/Quality Control (QA/QC) measures intended to achieve the project objectives for monitoring activities at the former Farmland Nitrogen Fertilizer Plant (Site). This QAPP is intended to meet the requirements for conducting the work in accordance with the Corrective Action Decision issued by the Kansas Department of Health and Environment (KDHE) on March 10, 2010 as well as all requirements in the Kansas Water Pollution Control Permit and authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) (Permit No. I-KS31-PO04).

1.1. Project Background

The Site is located in the City of Lawrence, Kansas (City). The Site began manufacturing nitrogen fertilizers in 1954. Products manufactured and distributed at this facility included anhydrous ammonia, granular urea, prilled ammonium nitrate, nitric acid, and urea-ammonium nitrate (UAN). Wastes generated as a result included sludge and wastewater that were released to soil, groundwater and surface water on and near the property.

Farmland discontinued operations in 2002 due to an economic downturn in the global fertilizer market. In 2003, Farmland Industries, Inc., the parent company to Farmland Nitrogen, filed bankruptcy and placed funding for the future cleanup activities into the FI Kansas Remediation Trust (FI Trust). Between 2003 and 2010, the FI Trust, through SELS Administrative Services, LLC as Trustee, performed additional assessments and continued corrective actions as required and approved by the Kansas Department of Health and Environment (KDHE). In 2010, the City acquired the property and entered into a Consent Order (Case No. 10-E-94 BER) with KDHE. The City voluntarily assumed all responsibility for the continued remediation of the site with the goal of redeveloping the site into a future industrial business park. Under this consent order (CO), the City agreed to be responsible for the required remediation and the obligations and requirements of the CO, including the continued operation and maintenance of all active remediation systems, as well as all reporting requirements of the Resource Conservation and Recovery Act (RCRA) and NPDES permits for the Site.

The Facility property includes approximately 467 acres of the former operating facility. More than 200 acres of this land in the southern part of the Site have been redeveloped as an industrial park known as Lawrence VenturePark Business Park. The remaining northern portion is the area currently under remediation.

1.2. Project Organization

The City personnel have the overall responsibility for all phases of the Remedial Design/Remedial Action (RD/RA) implementation. The City will provide management, perform and/or observe all field activities, and prepare and submit project deliverables to the KDHE.

The laboratory analytical work will be conducted by either the City of Lawrence Water Quality Laboratory which is a NELAC certified laboratory for analysis of the compounds of interest or by PACE Analytical Services in Lenexa, KS. Laboratory Quality Assurance/Quality Control documents and certificates for both the City and Pace laboratory are available for inspection at each respective laboratory.

The City will use professional engineering firms for study and design and construction contractors for construction or demolition activities. The City will provide administrative oversight and will issue the project deliverables associated with these tasks.

The responsibilities and experience of City technical personnel and key technical personnel are summarized below.

Project Manager – Environmental Remediation Manager

The Environmental Remediation Manager for the City of Lawrence, KS is the City's approved Project Manager. This position will be responsible for overseeing the implementation of the Consent Order. In addition to the Project manager role, this position will serve as quality assurance officer for the project and on-site project coordinator.

- Project administration
- Supervision of project team
- Primary liaison between KDHE, EPA, and local agencies
- Consent Order compliance
- Coordination, preparation, and approval of all project deliverables
- Project QA/QC direction/coordination and review
- Field activity and field QA/QC management
- Field data preparation
- Data assessment
- Laboratory QA/QC review
- Report preparation and review
- Preparation for and attendance at all project meetings
- Final QA/QC review and approval

Project Hydrogeologist

The City of Lawrence currently contracts a consultant that serves as the project hydrogeologist on the project.

1.3. Problem Definition / Background

The Site is located east of the City of Lawrence, Douglas County, Kansas. The original Farmland Nitrogen Fertilizer Plant encompassed 467 acres. Since the City of Lawrence took over the property in 2010, 300 acres in the southern half of the Site have been converted into parcels that are set aside for industrial redevelopment. A site characterization performed in 2005 and approved by KDHE recommended no additional remedial action for this area. This area is now known as Lawrence VenturePark Business Park. The parcels in Lawrence VenturePark are subject to the general environmental restrictions and environmental use controls. One storage facility and two industrial manufacturing facilities now reside in Lawrence VenturePark and the remaining parcels are available for redevelopment. The remaining 167 acres, located in the northern half is designated as remediation area. The

Kansas River is approximately 2 miles to the north. The Site is bordered by Highway K-10 on the south, residential areas on the west, 15th Street, the Burlington Northern and Santa Fe Railroad on the north, and undeveloped commercial real estate on the east. The Site location is shown on **Figure 1**.

This QAPP is an integral part of a RD/RA Plan addendum designed to implement a modified remedial approach that will provide direct projection of human health and the environment through the irreversible reduction of nitrates and ammonia in groundwater and the reduction of infiltration of rainfall with contaminated soils and sediments. Data gathered pursuant to this QAPP will be used to measure progress towards the goal of reducing nitrogen concentrations in groundwater, stormwater, soils, and sediments at the Site.

1.4. Project / Task Description

This QAPP is developed to measure the concentration of ammonia-nitrogen and nitrate-nitrogen in groundwater at the Site and water exiting the Site. A network of monitoring wells (**Figure 2**) are used to determine the extent and limits of nitrogen impact to the Perched Zone, Sandstone Unit, and Deep Alluvial Aquifers at the Site and near the Site. Scheduled groundwater elevation and groundwater sampling will be conducted in the network wells and sample analysis for ammonia-nitrogen and nitrate/nitrite-nitrogen will be performed by the City of Lawrence Water Quality Laboratory. The water level in each monitoring well will be measured to determine the well volume prior to sampling. Selected private water wells will be sampled by the City on the same schedule as groundwater sampling.

1.5. Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the outputs of each step of the DQO process. The DQO process is a series of planning steps based on the scientific method that is designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended application.

The seven steps in the DQO process include:

1. Stating the problem
2. Identifying the decision
3. Identifying inputs to the decision
4. Defining the boundaries of the study
5. Developing a decision rule
6. Specifying limits on decision errors
7. Optimizing the design for obtaining data

The DQOs were developed using the objectives from the KDHE Bureau of Environmental Remediation/Remedial Section Guidance Scope of Work (SOW) for Site Monitoring. The resulting statements and DQOs are summarized in the following:

1. Problem – Monitor groundwater, stormwater, and Containment Pond water discharged to the sanitary sewer to evaluate the effectiveness of the selected remedial alternative.
2. Decision – To what extent is nitrogen present in groundwater, stormwater, and Farmland

Containment Pond discharge.

3. Inputs – Data from groundwater samples and hydraulic monitoring.
4. Boundaries – The Site boundaries are described in the Remedial Design/Remedial Action Plan and the Remedial Design/Remedial Action Plan Addendum.
5. Decision Rule – Nitrogen concentrations are compared to EPA drinking water standard of 10 mg/L nitrate as N and distribution of nitrogen in groundwater must remain within Site boundaries.
6. Error Limits - Ability to detect constituents at laboratory method detection limits (MDL) and quantitate constituents at laboratory targeted quantitation limits. Significance levels for statistical evaluation of increases/decreases in concentrations, as appropriate to data set being evaluated.
7. Design – Monitoring and reporting.

The overall quality assurance objective is to ensure that data of known and acceptable quality are provided. Data Quality Objectives for measurement data are precision, accuracy, representativeness, completeness, and comparability.

Precision is the degree of agreement among repeated measurements. Precision will be assessed through the use of replicate samples and the relative percent difference (RPD) will be calculated for duplicate samples. The goal for RPD for this project is 20%.

Accuracy of analytical measurements will be assessed in the laboratory by analysis of laboratory control samples (LCS) or matrix-spiked samples of known concentrations. An LCS will be analyzed at a frequency of one per laboratory batch of 10 or fewer samples of the same matrix. Accuracy relative to the sample matrix will be assessed by determining percent recoveries from the analysis of MS samples. MS/MSD samples will be collected/designated at a frequency of one per 10 or fewer samples of the same matrix.

Representativeness is assured by sampling of the network wells and stormwater collection points which are representative of the system as a whole.

Completeness is a measure of the number of planned samples compared to the number of valid samples. The percent completeness (%C) shall be calculated as the number of planned samples judged to be valid divided by the total number of samples and multiplied by 100. The goal for %C for this project is 85%.

Comparability is the extent to which data from one study can be compared to another. Standardized methods of sample collection and analysis will assure comparability of this study with previous studies.

All measurements will be made so as to yield consistent results representative of the conditions measured and reflective of the project objectives. All data will be calculated and reported in units consistent with industry standards.

Quality assurance objectives for the measurement of data, including parameters, units of measure, methods, and detection limits, are presented in **Table 1**. Quality assurance objectives for precision, accuracy and completeness have also been established for each measurement variable where possible and are represented in **Table 2**.

Table 1
Analytical Methods and Detection Limits

Parameter	EPA Method	MRL
Ammonia as N	**350.1**	**0.30 mg/L**
Nitrate/Nitrite as N	**353.2**	**0.25 mg/L**

Table 2
Quality Assurance Objectives

Parameter	EPA Method	Laboratory Control Sample % Recovery	Matrix Spike % Recovery	Duplicate Relative % Difference
Ammonia as N	**350.1**	**90-110%**	**90-110%**	**≤20%**
Nitrate/Nitrite as N	**353.2**	**90-110%**	**90-110%**	**≤20%**

1.6. Training Requirements

Outside contractors shall be responsible to assure their employees are current in their training requirements. Field sampling team members are required to have successfully completed relevant field training protocols and should be trained by an experienced sampler before initiating any sampling procedures. Employee training documentation is maintained by the City or outside contractor. Field sampling personnel shall be familiar with procedures as described in this QAPP. Laboratory personnel shall receive training as required by the laboratory QAP's.

1.7. Documentation and Records

Groundwater monitoring activities will be recorded using a controlled form located on the City of Lawrence network drive. The form is presented as **Figure 3**. This form is printed and filled out in the field. The information recorded on this form include water level measurements, well purging times and volumes, sample times, and field measurements used for stability determination. A laboratory chain of custody (CoC) will be completed for each sampling event. This form will contain sampling location, date and time of collection, collector's name, method of preservation, and special remarks concerning the sample.

All documentation is scanned to the City's network drive and all hardcopies are placed in project manager's office for record retention. Other field activities related to remediation on the Site will be recorded in an electronic maintenance log located on the City's network drive.

Borehole logs for monitor well installation or construction will be recorded on a Borehole Log/Monitor Well Construction Diagram and will be completed by the well drilling contractor. The well contractor will complete Water Well Form WWC-5 and submit them to the appropriate agencies. Any rehabilitation or abandonment of monitoring wells will follow these same requirements.

All records and information resulting from the monitoring activities, including all records of analyses and calibration and maintenance of instruments and recordings from continuous monitoring instruments, will be retained for a minimum of 3 years. Groundwater monitoring data, including background sample results, are required to be kept for the life of the facility regardless of ownership.

2.0 MEASUREMENT / DATA ACQUISITION

2.1. Sampling Process Design

The groundwater monitoring system consists of a network of monitoring and extraction wells that have been selected to represent groundwater residing in three hydrogeologic zones at or near the Site. This network will provide groundwater samples representative of groundwater flow conditions and water quality in the deep alluvial aquifer (i.e., Kansas River alluvial aquifer), a zone of shallow perched groundwater, and the Sandstone Unit which is an interbedded sandstone that consists of sandstone, shale, and limestone. Selected private water supply wells will be sampled by the City in conjunction with the normal scheduled groundwater sampling events. A listing of the network wells is provided in **Table 3**.

Table 3
Monitoring Well Network

Deep Alluvial Monitoring Wells	Deep Alluvial Extraction Wells	Perched Zone Wells	Sandstone Unit Wells	Private Well
PSW-1B	PSW-3B3	PSW-1A	CPMW-1D	Kitsmiller
PSW-2B	PSW-6B4	PSW-2A	CPMW-1S	
PSW-4	PSW-7B2	PSW-3A	CPMW-2SR	
PSW-5B2	PW-9	PSW-5A	N-1	
PSW-9B		PSW-6A	N-2	
PSW-15		PSW-7A	PSW-13B	
PSW-19B		PSW-9A		
PSW-20B		PSW-13A		
MW-21B		PSW-17		
MW-22B		PSW-18		
MW-23B		PSW-19A		
MW-24B		MW-21A		
MW-25B		MW-22A		
MW-26B		MW-23A		
MW-27B		MW-24A		
MW-28B		MW-26A		
MW-29B		MW-27A		
SW-10		MW-28A		
		MW-29A		

The groundwater sampling of network wells as detailed in this QAPP will be on a semi-annual schedule. Before sampling, any site conditions that may affect the quality of the sample will be documented. Weather conditions will be recorded, including temperature, wind direction, and precipitation (type and intensity). The order in which sampling of groundwater wells occurs should be considered to avoid cross-contamination. Groundwater wells on the site will commonly be sampled from least contaminated to most contaminated across the entire site. Historically, the Sandstone unit and perched zone wells contain higher levels of nitrogen concentrations to that of the deep alluvial wells. Generally each deep alluvial well is paired with a shallow perched zone well. To maximize the sampling effort, neighboring wells may be sampled consecutively under one condition. Deep alluvial wells are to be sampled before the shallow perched zone wells and all decontamination practices outlined later in this document will be followed. The Project Manager is assigned to provide field staff with the most recent analytical data to ensure the correct order of sampling.

The outer protective monument, well casing, and well cap will be inspected for any signs of damage. If there is evidence of damage, or if a lock is missing, this information will be recorded in the Groundwater Sampling Log form (**Figure 3**) and reported to KDHE.

Sampling at each event will include measurement of water levels in the monitoring well network. Prior to sampling, a water level indicator is used to measure the static water level for hydraulic monitoring and for determination of well volume. A pre-cleaned submersible pump will be used to purge a minimum of three well screen volumes of water prior to sampling. The pump or tubing will be positioned in the well so that the pump intake is set at the midpoint of the well screen. During purging, field parameters consisting of pH, temperature, and specific conductance will be monitored and recorded for stability determination. Once purging is complete, groundwater samples will be collected from the groundwater wells directly into laboratory-supplied containers. Purge water will be containerized and discharged at the KRWWTP or into the Farmland Containment Ponds.

2.2. Sampling Methods Requirements

This QAPP will primarily describe methods and procedures for groundwater sampling. The following sections detail requirements for groundwater sampling.

2.3. Types of Samples

Samples collected and submitted for analysis to either the City of Lawrence Water Quality Laboratory or PACE Analytical Services Laboratory will consist of groundwater samples from monitoring wells and Farmland Containment Ponds. The monitoring wells are completed in three distinct zones, the deep alluvial aquifer (Kansas River Alluvium), perched zone, and the Sandstone Unit. During sample collection, field quality control samples consisting of field duplicates will be collected and submitted for analysis.

2.3.1. Groundwater Sampling

The following subsections summarize network monitoring well preparation, groundwater level measurements, purging the well, field parameter measurements, and sample collection.

- **Safety**

Proper safety precautions must be observed before any sampling activities are to begin. Nitrile gloves should be worn during groundwater level measurement, purging the well, field parameter measurements, and sample collection. After completion of each well sampling, nitrile gloves will be disposed of and replaced with new gloves. No eating, smoking, drinking, or any hand to mouth contact should be permitted during sampling activities.

- **Well Preparation**

Each network monitoring well to be sampled will be inspected. The outer protective monument, well casing, and well cap will be inspected for any signs of damage. If there is evidence of damage, or if a lock is missing, this information will be recorded in the Groundwater Sampling Log form and reported to KDHE. The well will be unlocked and the well cap removed to allow the water level in the well to come to equilibrium with the atmosphere.

- **Groundwater Level Measurements**

The static water level in each groundwater well will be measured prior to purging and sampling during each groundwater sampling event. An electronic water level indicator (Solinst Model 101 or equivalent) is recommended to measure the water level. Measurements will be referenced to the survey point (top of well casing and generally on the north rim of the well casing). All water level measurements will be made to the nearest 0.01 foot and after agreement of three measurements. All water level measuring equipment will be thoroughly decontaminated between each network monitoring well. See section **2.4** of this QAPP for decontamination procedure requirements.

- **Well Purging**

Prior to initiating the purge, the amount of water in the well casing should be determined. The volume of standing water in the well and the volume of three water columns may be determined using a casing volume per foot factor for the appropriate diameter well. The static water level is subtracted from the total well depth as indicated on the Groundwater Sample Log form. This length is multiplied by the appropriate factor in **Table 4**, corresponding to either the single well volume or the three well volume, in gallons.

Three well volume (gallons) = [Total Well Depth (ft.) – Static Water Level (ft.)] x Well Casing Diameter Volume Factor

Table 4
Well Casing Diameter Volume Factors

Casing Diameter (inches)	Gallons/ft. One Water Column	Gallons/ft. Three Water Columns
1	0.04	0.12
2	0.16	0.48
3	0.37	1.11
4	0.65	1.98
5	1.02	3.06
6	1.47	4.41
7	1.99	5.97
8	2.61	7.83
9	3.30	9.90
10	4.08	12.24
11	4.93	14.79
12	5.87	17.61

*SESD Operating Procedure Groundwater Sampling, Environmental Protection Agency, SESDPROC-301-R3, March 6, 2013

A pre-cleaned submersible pump will be used to purge a minimum of three well screen volumes of groundwater prior to sampling. Each monitoring well shall have dedicated ½ in. HDPE tubing used for purging and sampling purposes. The pump or tubing will be positioned in the well so that the pump intake is set at the midpoint of the well screen. This is done so that the purging will pull water from the formation into the screened area of the well and up through the casing to ensure all static volume can be removed. If a pump is placed too deep into the water column, the water above the pump may not be removed and sample collections may not be representative of the aquifer conditions. If the pump rate exceeds the recovery rate of the groundwater, the pump will have to be lowered as needed, but ensuring that no entrainment of sediment from the bottom of the well occurs.

One exception to the above purging criteria is sampling of extraction wells. Extraction wells pump continuously, so no purging of groundwater is required prior to sampling. The valve should be opened and water allowed to flush for a short time before sampling may occur.

The submersible pump is used for all groundwater sampling and should be thoroughly decontaminated between each network monitoring well. See section **2.4** of this QAPP for decontamination procedure requirements.

- **Field Parameter Measurements**

Adequate purge is achieved when pH, temperature, and specific conductance of the groundwater have stabilized. Stabilization occurs when, at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU) and specific conductance and temperature varies no more than approximately 5 percent. There are no set of criteria for establishing how many total sets of measurements are adequate to document stability of parameters. If the purge volume is small, the measurements should be taken frequently. If the purge volume is large, measurements taken every 15 minutes, for example, may be sufficient.

If after three well volumes have been removed and field parameter measurements have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the field parameters have not stabilized after five well volumes, it is at the discretion of the sampler whether or not to collect a sample or to continue purging. These conditions of sampling should be recorded in the Groundwater Field Log form.

In some instances, a well may be pumped dry. In this situation, this constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). For wells with slow recovery rates, purge rates should be slowed to avoid pumping well to dryness. These conditions should be recorded in the Groundwater Field Log form.

- **Sample Collection**

After obtaining three consistent sets of field parameter measurements, the well will be sampled for the parameters of interest, ammonia-nitrogen and nitrate-nitrogen. The samples will be collected from the flow tubing of the pump.

Sample bottles will be certified clean and provided by the selected laboratory and filled according to laboratory specifications. When bottle filling is complete, each sample container will be identified with an appropriate label.

2.4. Sampling Equipment Cleaning Procedures

All sampling equipment cleaning procedures (pre- and post-sampling) in the field will be conducted in accordance with standard protocols. These cleaning methods will be used by all sampling personnel to clean sampling equipment and other field equipment. All sampling equipment will be cleaned prior to and after sampling. Specific cleaning procedures are presented in the following sections for equipment decontamination in the field. It is important that all equipment used to sample multiple wells be decontaminated before and after sample collection in the manner discussed below.

- **Safety**

Proper safety precautions must be observed when field cleaning or decontaminating dirty sampling equipment. When conducting field or decontamination using laboratory detergents, safety glasses and nitrile gloves will be worn. No eating, smoking, drinking, or any hand to mouth contact should be permitted during cleaning operations.

- **Laboratory Detergent**

The laboratory detergent will be a standard brand of phosphate-free detergent such as Alconox 1M or another industry equivalent. Detergent must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

The use of any other type of detergent will be documented in the Groundwater Sampling Log Form.

- **Cleaning Water**

Distilled or deionized water, free of organics, inorganics, metals, and nitrates, will be used. This water must be stored in clean, glass or plastic containers that be closed prior to use. Tap water from municipal water systems may be used for gross cleaning if it is free of the above compounds. However, before use of equipment, it must be triple rinsed with distilled or deionized water.

- **Equipment Decontamination**

Staff will use one dedicated water level indicator and one pump to conduct purging and sampling during groundwater sampling events. It is important that all equipment that comes in contact with groundwater be properly decontaminated between wells to avoid cross-contamination. Cleaning procedures for sampling equipment used for the collection of samples follows:

1. Wash all wetted portions of equipment thoroughly with laboratory detergent and water, and if necessary use a brush to remove any particulate matter or surface film.
2. Rinse wetted portions of equipment with distilled or deionized water to remove laboratory detergent before proceeding to next sampling site.

- **Equipment Storage**

All clean sampling equipment will be stored in a clean location. Cleaning procedures for sampling equipment used for the collection of samples follows:

1. Wash equipment thoroughly with laboratory detergent and water, using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with distilled or tap water.
3. Triple rinse equipment with distilled or deionized water. Air dry in clean area.
4. Store equipment to prevent contamination during transportation to the field.
5. Repeat Steps 1 through 3 after completion of sampling, and then store equipment in a clean location.

2.5. Sample Handling and Custody

Sample custody is an important aspect for sampling programs. The samples must be traceable from the time of sample collection until the data is included in progress reports.

Samples will be labeled as they are collected. All recorded entries will be made with indelible ink. If an error is made, correction will be done by drawing a line through the error, initialing the error, and starting a new entry on the next line or where appropriate. Samples will be transferred to the sample storage area and stored at four degrees Celsius (4°C) as soon as possible.

Sampling activities will be documented on the Groundwater Sampling Log Form. Replicate information and other pertinent data will be recorded by sampling personnel. All entries with errors will be corrected by drawing a line through the error, initializing the error, and starting a new entry on the next line or where appropriate.

2.6. Sample Label

The sample containers will be labeled at the time of sampling with the following information: sampling date and time, sample identification, analytes, preservative (if any), and name of the sampler. The label will be securely attached to the sample container.

2.7. Sample Container Custody

All sample containers will be certified clean and shipped/delivered to the designated location from the contract laboratory or bottle supplier. The containers will remain in the custody of the laboratory until received by the sample custodian or a designated member of the sampling team.

2.8. Sample Custody, Shipment, and Laboratory Receipt

Chain of custody procedures will be implemented for samples shipped to the contract laboratory or delivered to the City laboratory, if someone other than the field sampling personnel will be conducting the analyses. All samples will be maintained in the custody of field sampling personnel until released to laboratory personnel. Prior to sample delivery, chain of custody forms will be filled out by the sampling personnel/sample custodian. All information on the chain of custody form will be checked against the field sampling logs for any discrepancies. Any other persons having custody of the samples prior to laboratory receipt will also be required to sign the chain of custody form, and indicate the time and date of custody received and relinquished. The selected contract laboratory is a local business, so it is anticipated that sample delivery will be performed by the sampling personnel. The chain of custody form will be placed inside the cooler in plastic prior to sealing the cooler. All chain of custody forms received at the contract or City laboratory must be signed and dated by the laboratory sample custodian.

The custodian at the contract laboratory will note the condition of each sample received, as well as questions or observations concerning sample integrity. The sample custodian will also maintain a sample tracking record that will follow the sample through all stages of laboratory processing. The sample tracking record must show the date of sample extraction or preparation, and sample analysis. These records will be used to determine the holding time limit of compliance during laboratory audits and data validation. The signed copy of the chain of custody form (or a copy) will be returned to the site sampling personnel to verify proper receipt of the samples at the laboratory and inclusion in the project file.

2.9. Analytical Methods Requirements

The analytical methods to be used throughout this project are standard EPA methods (or equivalent standard methods). The selected methods for analyzing groundwater and Farmland Containment Pond water are as follows: Ammonia-Nitrogen – EPA Method 350.1; Nitrate/Nitrite-Nitrogen - EPA Method 353.2.

2.9.1. Method Quantitation Limit Requirements for Chemical Analyses

Analytical data obtained during the monitoring will have quantitation limits consistent with the objectives of the investigation and the intended use of the data. The Laboratory Standard Operating Procedures (SOPs) specify method performance criteria and test method procedures in support of achieving the stated quantitation limits. Quantitation limits for all target analytes are summarized in **Table 1**. The listed limits for these target analytes are consistent with analysis for low concentration samples. High concentration samples may require dilution as necessary to achieve on-scale response.

Quantitation limits for target analytes quantified by analytical methods may be sample specific for those samples having complex sample matrices (for example, samples containing numerous analytes at widely different concentration limits). In this case, detection limits for certain samples will be increased when a sample has to be diluted to provide on-scale response for high concentration analytes. Samples requiring higher detection limits will be identified prior to analysis, if possible, and the laboratory notified in this event.

2.10. Quality Control Requirements

Quality control is an overall system of technical activities that measures the attributes and performance of a process against defined standards to see if project requirements are satisfied. The section below describes the quality control elements associated with field activities. Quality control of laboratory processes are addressed in the QAP's of each laboratory and are available upon request. **Table 2** tabulates the project requirements for precision and accuracy as expressed in laboratory control samples and matrix spike samples.

2.10.1. Field Duplicate Samples

Field duplicate samples will be collected at a frequency of one per 20 or fewer monitoring samples or at a minimum of one per day. Field duplicate samples will be submitted to the City's laboratory along with the parent sample. Relative percent differences (RPD) will be calculated from these duplicates.

2.10.2. Field Split Samples

At the project manager's discretion, additional QC samples may include field split samples randomly selected from all monitoring wells (Figure 2) during each sampling event. These samples will be analyzed for the same parameters at the City's laboratory and the contract laboratory. The data will be used to investigate comparability of analyses from the separate laboratories.

2.10.3. Equipment Rinsate Samples

This section discusses guidelines to determine the quality control of equipment cleaning procedures. Decontamination procedures will be recorded in the Groundwater Sampling Log Form. When appropriate, as determined by the Project Manager, the effectiveness of field cleaning procedures will be monitored by rinsing field cleaned equipment with distilled or deionized water and submitting the rinsate (in appropriate sample containers) to the City laboratory for analysis.

2.10.4. Laboratory Quality Control Checks

Laboratory quality control checks are accomplished through the use of system checks and QA/QC samples that are introduced into the sample analysis stream. Laboratory system checks and QA/QC samples for inorganic analysis are listed and defined below:

- **Calibration**

Calibration is the establishment of an analytical curve based on absorbance, emission intensity or other measured characteristic of known standards. The calibration standards must be prepared using the same type of acid or concentration of acids as used in the sample preservation and preparation.

- **Calibration Blank**

Equipment zero will be calibrated by distilled or deionized water that has been acidified to match the concentration of acid used in the samples.

- **Laboratory Control Standard / Continuing Calibration Verification**

An analytical standard used to verify the analysis is within control limits. One analytical standard will be run every 10 analytical samples to verify the calibration of the analytical system.

- **Preparation Blank (reagent blank, method blank)**

An analytical control contains distilled, deionized water and reagents, which is carried through the entire analytical procedure (digested and analyzed). An aqueous method blank is treated with the same reagents as a sample with a water matrix. A solid method blank is treated with the same reagents as a soil sample.

- **Duplicate**

A second aliquot of a sample that is treated the same as the original sample in order to determine the precision of the method.

- **Matrix Spike**

An aliquot of a sample fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

- **Method Detection Limit**

The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from the method blank results.

2.11. Instrument Testing and Maintenance Requirements

Laboratory equipment testing and maintenance are discussed in the laboratory Quality Assurance Plans for The City's Water Quality Laboratory and the contract laboratory. Field Instrument Testing and Maintenance requirements are discussed in the following sections.

2.11.1. Water Level Meter

The field equipment involved in this project require little testing or maintenance. The water level meter (Solinst Model 101 or equivalent) to be used is factory calibrated. Field testing requires only confirmation that the light will light and the instrument will sound when the probe is inserted into water. The quality of the audible signal and light dictate when battery replacement is required. If the signal is weak or the light will not light, Site personnel will replace the battery in the reel with an appropriate replacement battery. Inspection of the meter prior to field mobilization will ensure that a spare battery is available and that the meter is clean.

2.11.2. Conductivity, Temperature, pH Meter

The Conductivity/Temperature/pH meters to be used for field measurements are common and relatively simple devices to operate. Operation and maintenance protocols for any meter selected will be in accordance with the manufacturer's specifications. Inspection prior to use in the field will include checking the batteries, inspecting the electrodes and confirming that the unit has been properly cleaned and calibrated.

2.12. Instrument Calibration

Laboratory equipment will be calibrated in the manner and frequency described in the laboratory QAPs for the City and contract laboratories in accordance with EPA protocols and manufacturer's specifications.

2.12.1. Conductivity, Temperature, pH Meter

The only field equipment to be used that requires calibration is the meter used to measure field parameters for groundwater sampling. Calibration protocol for any meter selected will be in accordance with the manufacturer's specifications and at a minimum once per day during sampling events.

2.13. Inspection Requirements for Supplies

Sample containers will be certified clean by the City Laboratory or contract laboratory (or its supplier) and supplied to the site in sealed cartons. The sample bottles must be stored temporarily in a clean area prior to use.

Supplies and consumables for field measurements and sampling will be obtained from various vendors and include standards for pH and conductivity meter calibration, sample containers, preservatives, detergent, and water for equipment decontamination. Field calibration standards must be traceable to National Institute of Standards and Technology standards.

Materials for monitoring well installation including pipes, fabric, screens, well casing, sand pack, grout and seal materials must be received in undamaged factory containers. Well casing and screens will remain in factory-sealed plastic bags until use. Storage on-site for these materials will be on plastic in a covered warehouse on-site until used.

2.14. Data Acquisition Requirements

Data generated during the monitoring events are verified and validated. These data then will be submitted in the required reports to KDHE. New monitoring well elevations will be determined in the field by a surveyor licensed in the State of Kansas. The well monitoring network top of casing (TOC) elevations will be reevaluated every five years by a surveyor licensed in the State of Kansas.

2.15. Data Management

The field sampling leader will inspect the sample labels and chain-of-custody forms at the end of each field day for completeness and accuracy. Any discrepancies noted will be immediately corrected and initialed. Originals will be transmitted to the Project Manager for review and will be scanned to the City's network drive and retained by the Project Manager.

The lab sample receiving technician will examine the sample labels, chain-of-custody, and containers for completeness and any breakage or loss. Any discrepancies will be communicated within 24 hours to the Project Manager.

Groundwater level measurements will be recorded in the field and transformed by subtracting field measurements from the measured top of casing elevations (as surveyed) into groundwater elevations. These elevations will be plotted onto to Site base maps by zones (i.e., deep alluvial or perched zone) and contoured to create groundwater elevation maps in the perched zone and the deep alluvial aquifer.

Laboratory analyses will be tabulated and stored electronically in spreadsheet format as they are received. Annually, all analyses will be transferred to a spreadsheet that represents all analyses within the previous year for inclusion in a semi-annual report to the KDHE.

3.0 ASSESSMENT and OVERSIGHT

This portion of the QAPP addresses the assessment activities to be performed throughout the conduct of this project to assure that the data collected is adequate for the intended purpose.

3.1. Assessment and Response Actions

Data validation will be performed by the City personnel on each data package delivered from the City and contract laboratories. Unfavorable results of this informal review, if any, will be discussed with the originating laboratory and corrective action will be implemented immediately, if possible. If immediate corrective action is not possible, a written response from the Quality Assurance Officer or contract laboratory liaison directed to the Project Manager will be required to explain the discrepancy and suggest corrective action to resolve the stated problem.

3.1.1. Technical System Audit

The Project Manager or his/her designee may make periodic non-scheduled visits to the project site to evaluate the performance of field personnel and general field operations in progress. Field operations will be observed and discrepancies from the QAPP will be addressed immediately with field sampling personnel.

Performance of the field activities described for this project will be assessed to ensure that the activities are in accordance with the QAPP. A Technical System Audit (TSA) may be performed by the Project Manager on-site during a groundwater sampling event. This TSA will examine sample collection procedures, equipment, personnel, training, and record-keeping to assure that these items are in conformance with the approved QAPP. Additional audits will be performed, at minimum, once during the first five years of the project to assure continued performance. If responsible personnel changes occur, or corrective action is indicated for field operations, a TSA will be conducted. Discrepancies or variances from the QAPP noted in the TSA(s) will be immediately discussed verbally with the Project Manager and Quality Assurance Officer. A written report of the TSA findings and corrective action suggested and enacted will be prepared and filed with project files at the Site offices. Corrective action will be performed immediately, if possible. If a change is suggested for the QAPP, they will be reduced to writing in a proposed revised QAPP, which will be circulated to reviewing authority for approval prior to enactment.

3.1.2. Laboratory System Audit

A laboratory systems audit may be conducted by the Project Manager or his representative. This audit is designed to ensure that the systems and operational capabilities are maintained and test methodology and quality control measures for the project are being followed as specified by the QAPP.

3.1.3. Performance Evaluation Audits

A performance evaluation audit is an audit performed to evaluate a laboratory's ability to obtain an accurate and precise answer in the analysis of a blind check sample by a specific analytical method. This audit may be conducted if it is determined that the quality assurance data provided in the analytical data package are outside acceptance criteria control limits. These performance evaluation audits may include a review of all raw data developed by the laboratory and not reported and the submission of blind spiked check samples for the analysis of the parameters in question. These check samples may be submitted disguised as field samples, in which case the laboratory will not know the purpose of the samples or the samples may be obvious (known) check samples (EPA or National Bureau of Standards traceable).

3.2. Reports

The City will prepare progress reports on a semi-annual basis in the form of Performance Evaluation Reports. The progress reports summarize the progress of planned field activities in the reporting period, acquisition and delivery of data, and activities planned for the next period. Data analytical packages will be transmitted to the KDHE through the Kansas Environmental Information Management System (KEIMS) and hard copies if required by KDHE.

4.0 DATA VALIDATION and USABILITY

4.1. Data Review, Validation and Verification Requirements

Laboratory procedures for data reduction, validation, and reporting will be in accordance with the laboratories approved QAP's. Therefore, for each sampling program, the laboratory will be required to submit lab reports that are supported by sufficient quality assurance backup information and data to enable reviewers to be able to evaluate the quality of the data.

Data validation procedures will include an evaluation of the analytical data package. Data validation checklists presented in this section will serve as examples in evaluating sample collection, field records, and analytical performance.

4.2. Validation and Verification Methods

4.2.1. Validation of Field Data

Field data will be reviewed for completeness and accuracy. Field data includes all of the field records and measurements developed by the field sampling team. The field data validation procedures will include:

- A review of field records contained in the field sampling logs for completeness.

- Verify that replicates were properly prepared, identified, and analyzed.

- Review chain of custody forms for proper completion, signatures of laboratory custodians and site sample custodian, and dates.

4.2.2. Validation of the Analytical Data Package

After validation of the field data, validation of the analytical data package will be performed. The analytical data package procedures may include a review of the following:

- A comparison of the data package to the reporting level requirements to ensure completeness in the analytical data package and compliance with the contract.

- A check for holding time violations by comparing the sampling dates, and analysis dates to see if the samples were extracted and/or analyzed within the specified holding times.

- A review of analytical methods and required detection limits to verify that they agree with the QAPP and the laboratory contract.
- A review of laboratory blanks to check the precision of chemical analyses and field collection techniques.

- A review to check if spikes are within allowable control limits specified for the method.

- Matrix spike recoveries for inorganic parameters will be used to evaluate matrix interference that may be affecting the recovery of an analyte with the accuracy of the method.

- Laboratory control samples and/or blank spikes of compounds of interest will be analyzed to evaluate the accuracy of the method.

4.3. Reconciliation with Data Quality Objectives

As soon as possible following each groundwater sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented, if required. If the results are not within the data quality indicators as shown on **Table 2,** data may be qualified. Any limitations on the use of the data will be detailed in the periodic and annual progress reports.

The cause of failure to achieve project data quality objectives will be examined and evaluated. If the cause is found to be equipment failure, calibration and maintenance techniques will be reassessed and improved. If the problem is found to be errors in field sampling techniques, these will be corrected. If the failure to meet data quality objectives is found to be unrelated to equipment, methods, or sample error, specifications in the QAPP may be proposed to the reviewing authority for possible revision.

These data validation procedures will be used by the Quality Assurance Officer or his designated representative for statistically evaluating results of laboratory system checks and project laboratory quality control samples that are submitted to the analytical laboratory from the field or generated internally by the laboratory in accordance with this QAPP. The purpose of implementing these procedures is to verify that the chemical data generated during the investigation are accurate, precise, and complete and are therefore representative of facility conditions.

4.3.1. Accuracy and Precision

Accuracy and precision for sample data will be calculated in the Corrective Action Report by evaluating data from blank, duplicate, and spike QA/QC samples. Procedures for evaluating accuracy and precision are described below for each QA/QC sample type.

- **Blanks**

The evaluation procedure for blanks is a qualitative review of the chemical analysis data reported by the laboratory. The procedure for assessing blank samples will be as follows:

- Identification of any blank samples exhibiting detectable concentrations of target analytes in the sample

- If no target analytes are detected in any blank samples, the tables are ready for entry into the appropriate report

- If any target analytes are found in blank samples, the compound(s) and concentration(s) will be reported and the field data for that period of time will be assessed for potential problems with data interpretation. No data will be removed from the database on the basis of target analytes being detected in blank samples. Appropriate notations, however, will be made in the database reports.

- **Spikes**

The procedure for assessing spike samples will be as follows:

Tabulate spike sample data and calculate the Spiked Sample Recovery (SSR) percent as shown below for each sample:

$$SSR(\%) = \frac{(T - X) \times 100}{A}$$

where: T = total concentration found in spiked sample
X = original concentration in sample prior to spiking
A = actual spike concentration added to sample

- **Duplicates**

The procedure for assessing duplicate samples will be as follows:

For duplicate data calculate the Relative Percent Difference (RPD) as shown below for each duplicate pair:

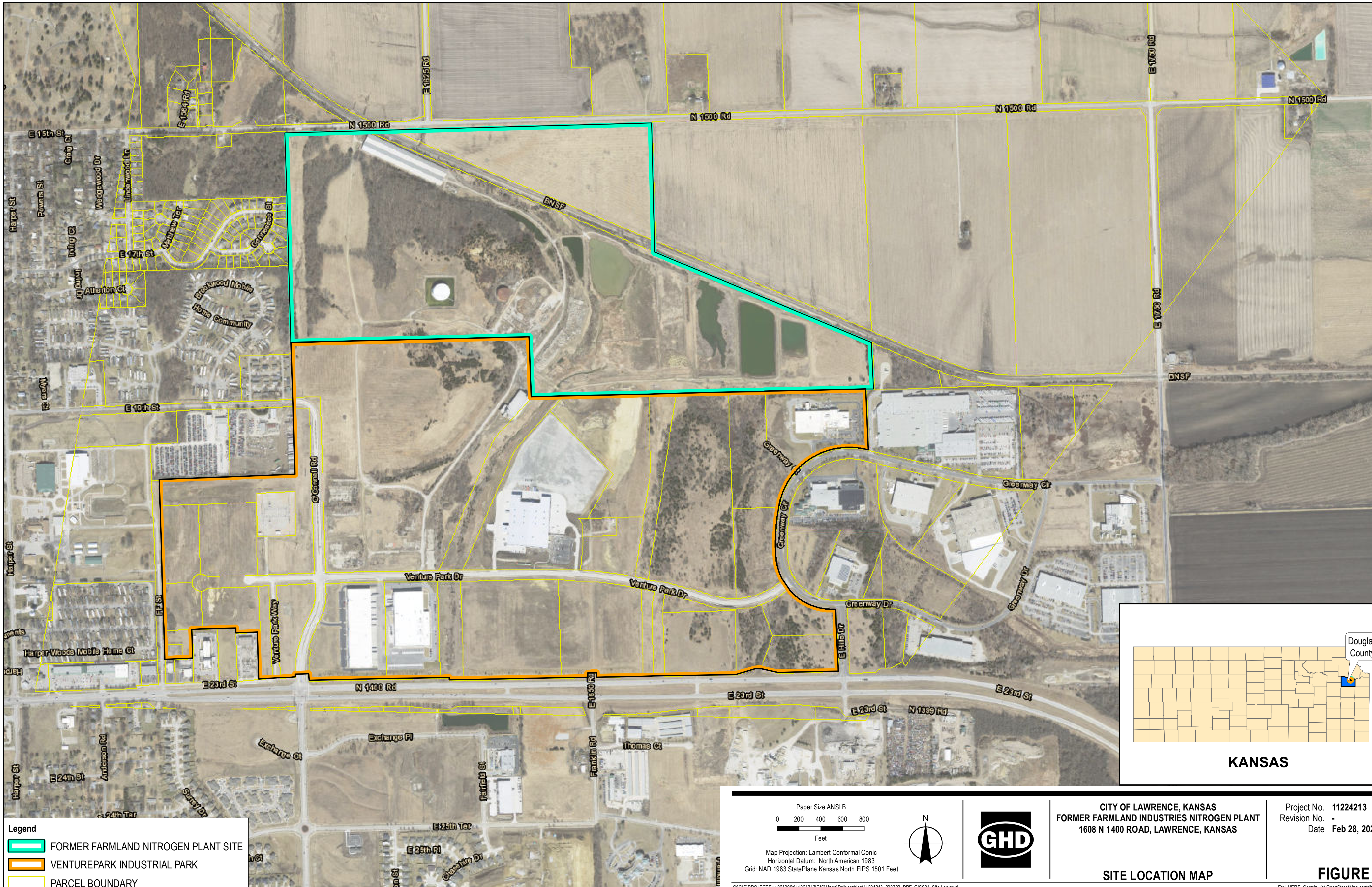
$$RPD (\%) = [| X1 – X2 |] / [(X2 + X1) / 2] * 100$$

where: X1 = concentration for sample 1
X2 = concentration for sample 2

4.3.2. Completeness

To be considered complete, the data set must contain all quality control check analyses, verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals in order to determine if the database is sufficient. When possible, the percent completeness for each set of samples is calculated as follows:

Completeness = valid data obtained/ Number of data planned X 100% total data planned



Paper Size ANSI B

0 200 400 600 800

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kansas North FIPS 1501 Feet

N

GHD

CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS

SITE LOCATION MAP

Project No. 11224213
Revision No. -
Date Feb 28, 2023

FIGURE 1

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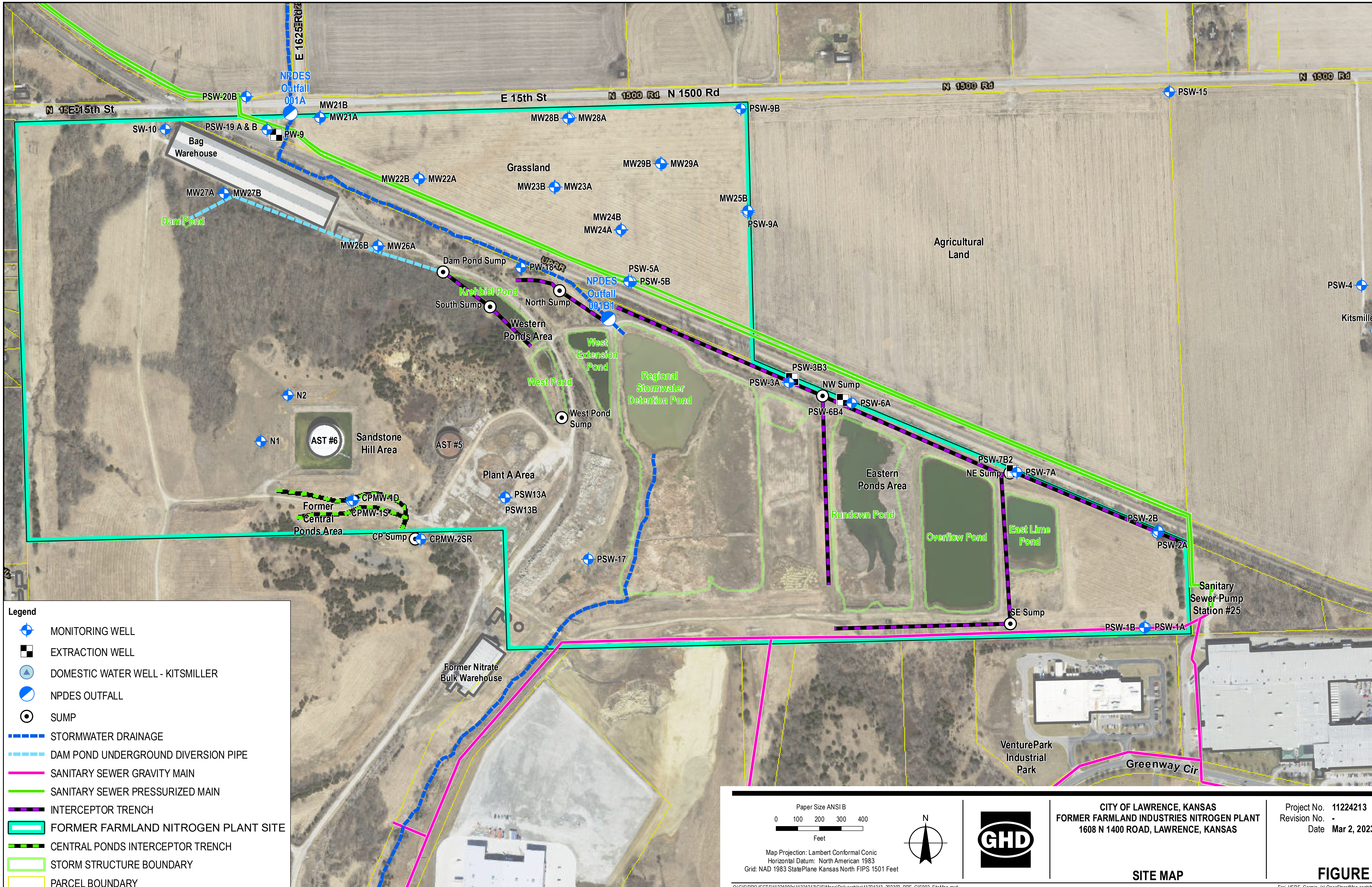
Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, City of Lawrence, Kansas. UAV imagery obtained by GHD February 7, 2023.



Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Kansas North FIPS 1501 Feet

GHD

CITY OF LAWRENCE, KANSAS
FORMER FARMLAND INDUSTRIES NITROGEN PLANT
1608 N 1400 ROAD, LAWRENCE, KANSAS

SITE MAP

Project No. 11224213
Revision No. -
Date Mar 2, 2023

FIGURE 2

Q:\GIS\PROJECTS\11224000s\11224213\GIS\Maps\Deliverables\11224213_202302_PRE_GIS002_SiteMap.mxd

Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community, City of Lawrence, Kansas. UAV imagery obtained by GHD February 7, 2023.

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GROUNDWATER SAMPLING LOG FORM

Date ____________________

Project Name: Lawrence CAP Personnel: ____________________

Weather: ____________________ Comments: ____________________

Days since last precipitation: ____________________

WELL ID						
Condition of Well						
Date/Time of Water Level						
Water Level (ft)						
Total Depth (ft)						
Well Casing I.D.						
Calculated Purge Volume (gal)						
Time of Purging						
Method of Purging						
Time of Field Measurements						
Field Equipment	Hach	Hach	Hach	Hach	Hach	Hach
Temperature						
(3 within 10%)						
(º C)						
Sp. Conductivity						
(3 within 10%)						
(uS/cm)						
pH						
(3 within 10%)						
(S.U.)						
Volume Purged (gal)						
Time of Sampling						
Sampling Method	Grab	Grab	Grab	Grab	Grab	Grab
Parameters Sampled	NH3 NO3	NH3 NO3	NH3 NO3	NH3 NO3	NH3 NO3	NH3 NO3
Containers	250 ml pres. H2SO4	250 ml pres. H2SO4	250 ml pres. H2SO4	250 ml pres. H2SO4	250 ml pres. H2SO4	250 ml pres. H2SO4
Sampling Sequence						
pH Check?						
Field						
Observations						

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