January 18, 2019 Reference No. 11152783

Ms. Cathryn Mallonee
Remediation Unit
Bureau of Environmental Remediation
Kansas Department of Health and Environment
1000 SW Jackson Street, Suite 410
Topeka, Kansas 66612-1367

Dear Ms. Cathryn Mallonee:

**Re: Revised 2018 Data Gap Study Work Plan**
**Former Farmland Industries Nitrogen Plant**
**1608 N 1400 Road**
**Lawrence, Kansas 66046**
**KDHE Consent Order No. 10-E-94**
**KDHE Project Code: C4-023-00009**

GHD Services Inc. (GHD) prepared this *2018 Data Gap Study Work Plan (WP)* for the above-referenced Site on behalf of our client the City of Lawrence (the City) and at the request of the Kansas Department of Health and Environment (KDHE) during our meeting on October 15, 2018. The City engaged our services in February 2018 to assist them in reviewing the Site data, updating the conceptual site model (CSM), and developing alternatives to the corrective actions approved by KDHE in the Corrective Action Decision (CAD), dated March 15, 2010. In order to prepare an updated CSM, GHD reviewed the extensive volume of historical data collected by others. During our review, GHD identified several data gaps that require additional or updated information. GHD believes this additional information will help develop and evaluate suitable corrective action alternatives to replace or supplement those already approved.

# 1. Background

GHD prepared a three-dimensional visualization of the Site's lithology to a depth of approximately 60 feet below land surface, identified approximate lateral and vertical extent of nitrate and ammonia (chemicals of concern (COCs)) in soil and groundwater, and highlighted documented and potential COC source areas. The Site layout is shown on Figure 1.

The specific gaps for which data appeared missing or incomplete were highlighted by the updated CSM and a detailed review of recent observed data trends in groundwater data.

The data gaps for which GHD recommends further study and analysis are as follows:

### *Groundwater recovery well PW-9*

1. The hydraulic containment with respect to recovery well PW-9 (located on Figure 2) should be evaluated because the current pumping rate at PW-9 typically operates between 10 and 15 gallons per minute (gpm). This current rate is lower than the design flow rate of approximately 20 gpm

established in the CAD for the alluvial recovery wells (i.e., PSW-3B3, PSW-6B4, and PSW-7B2). The hydraulic capture and containment strategy was designed and has operated based on interpretations of aquifer test data collected in 1994. We have not found more recent hydraulic analysis for PW-9 confirming its hydraulic performance at current pumping rates.

2. The historical reports contain very little or no information pertaining to the performance standards for the entire alluvial aquifer Groundwater Extraction System (GES), such as target capture zone, required groundwater extraction rates, or confirmation of hydraulic capture. The KDHE CAD document anticipates sustained hydraulic capture of alluvial groundwater to prevent off-site migration of nitrate at concentrations greater than 10 mg/L. However, recent groundwater data shows increasing nitrate concentrations at alluvial aquifer wells PSW-5B2, PSW-19B, and PSW-20B, which are located near the Site boundary. The purpose of the Aquifer Hydraulic analysis is to identify the hydraulic parameters of the alluvial aquifer system, such as transmissivity and hydraulic conductivity. GHD will use these hydraulic parameters to estimate individual recovery well pumping rates necessary for hydraulic capture of COCs in groundwater.

3. Laboratory analyses for nitrate and ammonia in recovered groundwater samples from PW-9 indicate the persistent presence of these constituents. The CSM identifies the possibility that the perched groundwater, alluvial aquifer and bedrock aquifer maybe in communication with each other near PW-9.

### *West Extension Pond*

1. GHD primarily relied upon soil ammonia and nitrate data collected in 2005, and reported in the *Site Characterization Report* (Shaw, February 2006) to populate the computer-enhanced three-dimensional analysis. The data revealed elevated nitrate and ammonia concentrations in soil near the West Extension Pond (Figure 3), which represent a potential ongoing source for dissolved nitrate and ammonia in groundwater in that the area. The model implies that COCs may extend across the perched groundwater unit and close to the alluvial aquifer contact in and near the vicinity of the West Extension Pond. However, the historical data are not conclusive with respect to identifying depths of nitrate and ammonia in soil relative to the water table at the time(s) of sample collection. Therefore, GHD is unable to discern whether the COCs data are actually the result of collection and analysis of saturated soils below the water table or a true reflection of nitrate and ammonia in the unsaturated soil above the water table.

### *PSW-5B2*

1. GHD noticed an increasing trend in concentrations of nitrate and ammonia in the monthly groundwater samples collected from alluvial monitoring well PSW-5B2 (Figure 4). As reported in the *August 2018 Performance Evaluation Report* (PER-81), prior to August 2017, concentrations of nitrate and ammonia were historically relatively low or less than laboratory method reporting limits. Since PSW-5B2 is completed in the alluvial aquifer (approximately 60 feet deep), and the observed increasing trend began before the northern ponds' French drain recovery sumps were shut off, the trending data

and shutting down the French drain sumps appear to be unrelated. Further, nitrate/ammonia present in the alluvial aquifer at this location does not appear to have a clear, previously investigated source that could be responsible for the presence, let alone an increasing trend, of nitrate and ammonia in groundwater.

2. Due to the lack of transducer response during aquifer testing in October 2018 (indicating no change in water level due to pumping influence), the data indicates that the area near PSW-5B2 of the alluvial aquifer is not currently under the hydraulic influence of any of the four groundwater recovery wells at their current pumping rates.

### *West and East Lime Ponds*

1. Due to the execution of the KDHE-approved interim measures under the CAD, several thousand cubic yards of excavated soil from potential source areas across the Site were relocated and are now stored in the West Lime and East Lime Ponds (Figure 5). Groundwater data from wells in these areas suggests nitrate and ammonia may be leaching into the perched groundwater. The possible impact of these additional soils (i.e., mass loading) to the perched groundwater system has not been evaluated.

## 2. Scope of Work

This WP describes proposed methods to address each data gap in the following paragraphs.

### *Aquifer Testing*

1. The approach is to analyze the PW-9 extraction system separately from the combined extraction system (PSW-3B3, PSW-6B4, and PSW-7B2). These two systems are approximately 2,000 feet apart and act as independent extraction systems. Both tests involve turning off the extraction wells, monitoring recovery for approximately 24 hours and then turning on the extraction well(s) and monitoring drawdown for approximately 24 hours.

2. As approved by KDHE on the September 20, 2018 conference call, GHD performed aquifer tests on the four existing alluvial wells (PW-9, PSW-3B3, PSW-6B4, and PSW-7B2) during the week of October 8, 2018. The results of these tests will be used to estimate the alluvial aquifer properties and the flow rate necessary to establish and sustain hydraulic capture of nitrate and ammonia in the alluvial aquifer at each alluvial recovery well.

3. Data Reduction and Reporting – The transducer data was downloaded and compensated for barometric changes during the test. The data was analyzed using the software AQTESOLV™ (Duffield, 2007) [1] using the appropriate analytical solutions to determine the hydraulic properties of the alluvial aquifer. Based on the data analysis, the current maximum pumping rate of approximately 13

[1] Duffield, G.M., 2007. *AQTESOLV for Windows Version 4.5 User's Guide*, HydroSOLVE, Inc., Reston, VA.

gpm for PW-9 depressed the water table less than one foot and was too low to yield data for a meaningful analysis. Therefore, additional aquifer testing at PW-9 is needed.

a. The second round of aquifer testing will involve installing a pump with significantly higher combination of flow rate capacity and pressure head capability (approximately 50 gpm).

b. A step test will be conducted once the new pump is installed. The step test will determine the appropriate pumping rate for a 24-hour aquifer test. The step test is a series of three 1-hour tests performed at progressively higher pumping rates (e.g., 20 gpm, 30 gpm, and 40 gpm,) to measure the drawdown in the pumping well and determine its hydraulic efficiency. Based on the step test results, a 24-hour pumping test will be conducted at a single pumping rate. Similar to the initial recovery test, GHD will place transducers in surrounding monitoring wells to measure their hydraulic response. After 24 hours of pumping, the pump will be shut off and the recovery rate of groundwater in the well will be measured. The pumping test analysis will provide the aquifer hydraulic parameters and additional proposed direct-push groundwater sample data (see below) will provide an estimate of the width of the affected groundwater. This information will be used to determine the appropriate pumping rate for hydraulic containment.

### *Potential Source Characterization: PW-9, West Extension Pond, PSW-5B2, West Lime Pond, and East Lime Pond*

1. Groundwater assessment and monitoring data in the perched groundwater and alluvial aquifer are missing or incomplete in the following areas: around PW-9, including the Bag Warehouse, (Figure 2), around the West Extension Pond (Figure 3), and around PSW-5B2 (Figure 4). Additionally, GHD recommends vertical aquifer profiling around the perimeter and immediately downgradient from the West Extension Pond to better understand if (and to what degree) there is hydraulic communication between the perched and alluvial hydraulic units in this area.

2. GHD recommends performing targeted direct-push soil and groundwater sampling in the PW-9 and West Extension Pond to confirm that potentially identified source areas have been characterized. Proposed boring locations are shown on Figure 2 for PW-9 and Figure 3 for the West Extension Pond. Direct-push borings will be advanced to a maximum depth of approximately 70 feet below ground surface (bgs), unless competent bedrock refusal is met. The actual depth will be guided by field screening nitrate results.

   a. Soil sampling will be performed continuously in five-foot increments for lithologic logging purposes. Unsaturated soil samples will be collected at 5-foot intervals starting from 5 feet bgs to bedrock refusal or until the perched groundwater is encountered, whichever occurs first. Soil samples will be submitted for laboratory analyses of nitrate and ammonia content

   b. Groundwater samples will be collected from within the direct push drilling equipment. Samples will be collected using dedicated polyethylene tubing with a foot valve or with a peristaltic pump. Concurrent with sample collection, the groundwater will be measured for pH, temperature, and conductivity. Up to four groundwater samples will be collected from each boring starting with the perched groundwater (if possible), the upper alluvial aquifer (approximately 30-35 feet bgs), the middle alluvial aquifer (approximately 40-45 feet bgs), and at the bottom of each boring (approximately 65-70 feet bgs). Groundwater samples will be submitted to the laboratory for analyses of nitrate and ammonia content.

c. The City, as is customary for this project, will perform all water analyses. All soil samples and duplicate quality control groundwater samples (at the rate of approximately 2 in 10) will be analyzed by Pace Analytical Laboratories in Lenexa, Kansas.

d. Additional field screening using commercially available and KDHE-approved test kits may also be used to adjust sampling location, depth and frequency. Any samples analyzed by a field test kit will also be confirmed by analysis in one of the fixed laboratories.

e. All downhole equipment will be field cleaned before the work and between each new boring.

f. As is currently the sampling protocol for the Site, all purged groundwater (not otherwise submitted for analysis) will be containerized and disposed of at the City's waste water treatment plant as previously approved by KDHE.

g. All soil cuttings from direct-push activities will be stored on-site with other nitrate/ammonia affected soil and kept covered, until a future date when corrective action alternatives approved for the Site are implemented

3. For PSW-5B2 (Figure 4), the objective is to confirm the nature and extent of nitrate and ammonia in regional alluvial aquifer. One direct-push borehole will be drilled adjacent to PSW-5B2 to define the stratigraphy and confirm sample depths. Additional direct-push borings will be advanced laterally and downgradient from PSW-5B2 at 25 ft, 75ft, and 150 ft (maximum) intervals. Groundwater samples will be collected from the upper (35-40 ft bgs), middle (50-55 ft bgs) and lower (65-70 ft bgs) alluvial aquifer for chemical analysis. Groundwater samples will be analyzed in the field for nitrates using a Hach Test kit (or approved equal) for nitrates and laboratory analysis for nitrates and ammonia. Direct-push borings will extend away from PSW-5B2 until the field tests show nitrates values at 10 mg/L or less. If only one sample in a borehole shows a concentration above 10 mg/L, then the next step-out borehole may only be sampled from that same interval.

4. GHD recommends collecting soil and groundwater samples within the boundaries of the West and East Lime Ponds (Figure 5) to characterize the lateral and vertical extent of nitrate and ammonia in soil and the perched groundwater. Soil samples will be collected within the relocated soil, in the former pond sediment, and from the underlying native soil for analysis of nitrate and ammonia content and geotechnical analysis to estimate permeability. If possible, a perched groundwater will be collected for chemical analysis. Otherwise a saturated soil sample will be collected. GHD notes that the groundwater database does not show impacts to the alluvial aquifer in these areas. Hence, no alluvial groundwater samples are proposed to be collected at this time.

### *Potential to Recommend Additional Groundwater Monitoring Wells*

1. GHD anticipates that the PW-9 data gap assessment by direct-push may result in the need to further confirm groundwater quality data in the bedrock aquifer as a possible source of COCs from the UAN area to the alluvial aquifer near PW-9. Direct push methods cannot be performed in bedrock. The need to install two bedrock monitoring wells will be partially determined by the direct push work south of the Bag Warehouse. While the specific locations are not known at this time, the bedrock wells may require vertical aquifer profiling to properly assess the potential nitrate contribution from the bedrock. We recommend that a *2018 Data Gap Study Report* be prepared for KDHE’s review and schedule a meeting to discuss whether bedrock monitoring wells are appropriate.

## 3. Schedule

As previously stated, GHD commenced aquifer testing as described herein during the week of October 8, 2018. GHD will schedule the direct-push investigation (subject to weather and subcontractor availability) within 2 weeks of KDHE’s approval of this WP. Depending on weather and Site accessibility, GHD anticipates completing the field work within 30 days of approval. Laboratory analyses should be turned around within 2 weeks from sample collection.

Upon receipt of all the data from this effort, GHD anticipates providing the *2018 Data Gap Study Report* within 60 days after completion of the field program.

Please feel free to contact me (david.hempleman@ghd.com) or Travis Kogl (travis.kogl@ghd.com) at your convenience if you have any questions or wish to discuss this WP.

Sincerely,

GHD

David Hempleman, P.E. (KS PE # 14215)
Senior Environmental Engineer

DH/mk/01

Encl.

cc: Sarah Graves, City of Lawrence
Travis Kogl, GHD
Brian Sandberg, GHD

# Figures


Source: CITY OF LAWRENCE, KANSAS AERIAL IMAGE DATED 2018 AERIAL IMAGE DATED 2018

0 200 400ft

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FORMER FARMLAND INDUSTRIES NITROGEN PLANT
CORRECTIVE ACTION SYSTEM LOCATION MAP
1608 N 1400 ROAD, LAWRENCE, KANSAS

SITE LAYOUT,
2018 DATA GAP STUDY

11152783-02
Jan 18, 2019

FIGURE 1

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Source: CITY OF LAWRENCE, KANSAS AERIAL IMAGE DATED 2018

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FORMER FARMLAND INDUSTRIES NITROGEN PLANT
CORRECTIVE ACTION SYSTEM LOCATION MAP
1608 N 1400 ROAD, LAWRENCE, KANSAS

PW-9 AND BAG WAREHOUSE,
2018 DATA GAP STUDY BORING LOCATIONS

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Jan 18, 2019

FIGURE 2

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Source: CITY OF LAWRENCE, KANSAS AERIAL IMAGE DATED 2018

FORMER FARMLAND INDUSTRIES NITROGEN PLANT
CORRECTIVE ACTION SYSTEM LOCATION MAP
1608 N 1400 ROAD, LAWRENCE, KANSAS

PSW-5B2,
2018 DATA GAP STUDY BORING LOCATIONS

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FIGURE 3

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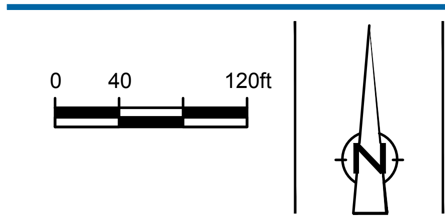


FORMER FARMLAND INDUSTRIES NITROGEN PLANT
CORRECTIVE ACTION SYSTEM LOCATION MAP
1608 N 1400 ROAD, LAWRENCE, KANSAS

Former West Extension Pond,
2018 DATA GAP STUDY BORING LOCATIONS

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FIGURE 4

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Source: CITY OF LAWRENCE, KANSAS AERIAL IMAGE DATED 2018

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FORMER FARMLAND INDUSTRIES NITROGEN PLANT
CORRECTIVE ACTION SYSTEM LOCATION MAP
1608 N 1400 ROAD, LAWRENCE, KANSAS

EAST AND WEST LIME PONDS,
2018 DATA GAP STUDY BORING LOCATIONS

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FIGURE 5

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