REPORT

Assessment of Corrective Measures - Semi-Annual Report

Great River Energy, Stanton Station, Closed Bottom Ash Landfill

Submitted to:

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1.0 INTRODUCTION

WSP USA Inc. (WSP) prepared this semi-annual report for the ongoing evaluation of corrective measures for the Bottom Ash Landfill at Great River Energy's (GRE) Stanton Station in accordance with the United States Environmental Protection Agency (USEPA) Coal Combustion Residuals (CCR) Rules in 40 Code of Federal Regulations (CFR) Part 257 (the Federal rule) and the North Dakota Department of Environmental Quality (NDDEQ) CCR Rule found in North Dakota Administrative Code (NDAC) Title 33.1, Article 20, Chapter 08 (the State rule). This semi-annual report was prepared to document progress towards selection and design of a remedy as part of the groundwater corrective measures addressing the statistically significant level (SSL) of arsenic above the site groundwater protection standards (GWPS) in groundwater at monitoring well MW-103 downgradient of the Bottom Ash Landfill. The GWPS for arsenic at the Bottom Ash Landfill is set at the USEPA maximum contaminant level (MCL) of 0.01 milligrams per liter (mg/L).

The SSL for arsenic at MW-103 was originally identified on March 28, 2022, when assessment monitoring statistics were completed following the fourth quarter (Q4) 2021 sampling and testing event. A notification identifying the SSL for arsenic was posted online and submitted to the NDDEQ on April 27, 2022 (within 30 days of identifying the SSL). The Assessment of Corrective Measures (ACM) was initiated on June 24, 2022, within 90 days of identifying the SSL for arsenic. A 60-day extension approved by the NDDEQ on September 16, 2022 (NDDEQ 2022) altered the deadline for completion of the ACM to November 21, 2022, on which date the ACM was finalized and submitted to the NDDEQ (GAUSA 2022). The NDDEQ approved the ACM on February 21, 2023 (NDDEQ 2023). This semi-annual report covers activities conducted since January 2025, following completion of the 2024 Annual Groundwater Monitoring and Corrective Action Report (WSP 2025a).

In the 2.5 years since completion of the ACM, extensive field, laboratory, and modeling investigations have been conducted in support of final remedy selection. Based on the data evaluated to date, items have been identified that are necessary to resolve prior to remedy selection. Section 3.0 (including Figure 4) describes the efforts taken to date and anticipated work to be completed for final remedy selection based on the requirements of 40 CFR 257.97 and NDAC 33.1-20-08-08(7).

1.1 Purpose

The purpose of the ACM was to identify potential corrective measures to prevent further releases and to remediate any identified releases to groundwater at the Bottom Ash Landfill. Based on the findings of the ACM, further evaluation is being performed, site-specific studies are being completed, and a final long-term corrective action plan is being developed pursuant to 40 CFR 257.97 and -98 and NDAC 33.1-20-08-06(6) and (7). This process is iterative and composed of multiple steps to analyze the effectiveness of corrective measures to address the migration of CCR constituents in groundwater downgradient of the Bottom Ash Landfill.

1.2 Evaluation of Corrective Measures

Pursuant to 40 CFR 257.97 and NDAC 33.1-20-08-06(6), WSP, on behalf of GRE, is further evaluating the potential corrective measures identified in the ACM Report (GAUSA 2022) to identify a remedy or combination of remedies.

1.2.1 Source Control Corrective Measures

Prior to the initiation of assessment monitoring and the ACM, the Bottom Ash Landfill was closed with an engineered final cover placed over CCR left in place. Closure in place was completed in accordance with the closure plan (GAI 2019) and was documented in the Construction Quality Assurance (CQA) Report provided to the NDDEQ (GAUSA 2021). The cover system was designed to minimize infiltration and erosion and to meet or exceed the requirements of 40 CFR 257.102(d)(3) and NDAC 33.1-20-08-07(3)(d)(3). Due to the reduced infiltration through the final cover and the lack of contact between CCR and groundwater, the closure of the Bottom Ash Landfill is anticipated to perform well as a source control measure.

1.2.2 Groundwater Remediation Corrective Measures

In addition to the closure and final cover source control corrective measures, the following groundwater remediation corrective measures were identified in the ACM as potentially feasible for use at the Bottom Ash Landfill:

- Monitored Natural Attenuation (MNA) and Enhanced Monitored Natural Attenuation (Enhanced MNA)
- Hydraulic Containment (Groundwater Pump and Treat)
- Geochemical Approaches (In Situ Injection)
- Permeable Reactive Barriers
- Phytoremediation

As outlined below, certain options are no longer being evaluated for a number of reasons. At present, the following groundwater remediation corrective measures are still being evaluated for implementation at the Bottom Ash Landfill:

- MNA and Enhanced MNA
- In Situ Injection

MNA and Enhanced MNA and in situ injection are continuing to be evaluated based on the findings from the Tier I MNA report (WSP 2023), the Tier II and III MNA report (WSP 2024), and initial bench testing for chemical injection as detailed in the 2024 Annual Report (WSP 2024). The findings from these efforts indicate that MNA is occurring and effective at the site, and preliminary findings that in situ injection may be able to reduce the time necessary to attain the GWPS and could be used to enhance MNA.

The other options originally identified in the ACM report are not currently being evaluated based on site-specific reasons.

- Phytoremediation is not currently being evaluated as a corrective measure for the site due to the groundwater depth in the area of concern being deeper than can typically be affected by phytoremediation. Depending on plant type, many root systems for plants used in traditional phytoremediation approaches focus on the upper 1 to 2 feet from the ground surface (ITRC 2009). Groundwater downgradient of the Bottom Ash Landfill is approximately 20 feet below the ground surface.
- Permeable reactive barriers are not currently being evaluated due to the depth between bedrock versus the uppermost encountered groundwater. Critically, for a permeable reactive barrier to be effective, the barrier should ideally “extend to and be keyed into a competent bedrock layer or aquitard” to prevent circumvention of groundwater around the installed barrier (ITRC 2011). Downgradient of the Bottom Ash Landfill, materials have been mixed through both natural deposition and alteration to the conditions through closure and removal of the industrial site, making identification of a continuous material suitable for keying a barrier difficult.

- Hydraulic containment (groundwater pump and treat) is not currently being evaluated as a stand-alone remedy. Pump and treat extraction technologies tend to be more efficient for constituents that are not readily attenuated by mechanisms such as adsorption. Additional chemical testing, similar to that for in situ injection, is necessary to determine the extraction potential for arsenic with different treatment technologies and can be executed concurrently with testing for other alternatives.

If the currently pursued measures prove not to be adequate, these or other potential corrective measures may be considered in the future.

2.0 SUMMARY OF WORK COMPLETED – JANUARY 2025 TO JULY 2025

The following subsections summarize field activities, desktop analyses, and supplemental data collected between January 2025 and July 2025, following completion of the most recent annual report (WSP 2025a). This work further delineates the nature and extent of the SSL and continues the evaluation of the potential groundwater remediation corrective measures presented in the ACM Report (GAUSA 2022) and subsequent reporting.

The collected data continues to be used to evaluate the feasibility, mechanisms, rates, and stability of identified potential corrective measure alternatives to address the SSL for arsenic in groundwater downgradient of the Bottom Ash Landfill. Evaluations of the data as they relate to remedy selection alternatives are ongoing and will be presented in future report(s).

2.1 Groundwater Monitoring and Analysis Activities

CCR compliance groundwater monitoring related activities have been conducted at the Bottom Ash Landfill since June 2016. An assessment monitoring program was initiated for the Bottom Ash Landfill in the first quarter (Q1) 2021 following the identification of a statistically significant increase (SSI) for boron at MW-103. Following the transition to assessment monitoring, samples have been collected and analyzed for the assessment monitoring and detection monitoring parameter lists.

Since completion of the most recent annual report in January 2025 (WSP 2025a), additional samples have been collected in March 2025 and June 2025 as required by the assessment monitoring program. The March 2025 annual assessment monitoring sample for arsenic at MW-103 was 0.0087 mg/L, below the site GWPS of 0.01 mg/L. However, statistical analysis of the March 2025 sampling results indicated that the SSL for arsenic at MW-103 continues. A notification of the continued SSL was posted to GRE’s publicly-accessible website and provided to the NDDEQ.

The June 2025 assessment monitoring sample for arsenic at MW-103 was 0.0091 mg/L, below the site GWPS of 0.01 mg/L. Data evaluation and statistical analysis has not yet been completed for the June 2025 sample. Results of the statistical analysis for the June 2025 event will be addressed within the required timeframes stipulated by the Federal and State rules, with notifications posted as required and results included in the 2025 Annual Groundwater Monitoring and Corrective Action Report, due in January 2026.

At MW-103, arsenic displays a statistically significant decreasing trend from the beginning of the baseline period in July 2016 through March 2025. However, the arsenic data collected at MW-103 from the beginning of assessment monitoring in March 2021 through March 2025 shows no statistically significant trend. An SSL for arsenic continues to be identified based on the confidence interval approach.

2.1.1 Groundwater Flow Direction and Gradient

Depth to groundwater measured in March 2025 at the site wells was used to estimate groundwater contours around the Bottom Ash Landfill (Figure 1). Depths to groundwater were measured at sampled wells during the March 2025 sampling event prior to purging. Groundwater elevations are shown on Figure 1. Based on the Q1 2025 groundwater elevations, the shallow groundwater at the Bottom Ash Landfill generally flows to the north and northeast towards the Missouri River.

The groundwater flow rate across each facility was estimated with the equation:

$$V_s = k \times {}^{i}/_{n_e}, \qquad \textit{Equation 1}$$

where:

V_s = the groundwater flow rate in feet per day (ft/day)
k = the hydraulic conductivity in ft/day, estimated from slug testing results from system wells
i = the hydraulic gradient in feet per feet (ft/ft), calculated based on groundwater elevations for the presented monitoring events
n_e = the effective porosity, a unitless parameter, estimated to be 0.25 for a silt/sand (Duffield 2007), reflective of site soils

The average gradient used in the velocity calculation and associated calculated range of horizontal groundwater flow velocities estimated for the Bottom Ash Landfill during the Q1 2025 monitoring event are shown below.

- March (Q1) 2025
  - Hydraulic conductivity (k) values: 0.023 ft/day to 21.9 ft/day (site-specific values collected at the site in 2024; WSP 2024)
  - Average gradient = 0.007 ft/ft
  - Range of groundwater flow velocities: 0.0006 ft/day to 0.62 ft/day

2.1.2 Groundwater Sampling

Groundwater was sampled in March 2025 and June 2025 from the monitoring network wells and the nature and extent wells. The March 2025 sample is the annual assessment monitoring sample and was analyzed solely for the assessment monitoring parameter list. The June 2025 sample was collected for the semi-annual detection and assessment monitoring sampling event, with samples analyzed for both the detection monitoring and assessment monitoring parameter lists.

2.2 Continued Nature and Extent Delineation

The locations of the site monitoring wells (both the wells included in the BAL CCR monitoring network and those wells installed in May 2022 and February 2023 for determination of the nature and extent of the arsenic plume downgradient of the BAL), and a potentiometric surface contour map showing the March 2025 groundwater contours are shown in Figure 1. Table 1 provides a summary of the construction details for the site monitoring wells.

2.2.1 Efforts to Address Turbidity and Plume Delineation

As discussed in both the 2024 ACM Semi-Annual Report (WSP 2024) and the 2024 Annual Groundwater Monitoring and Corrective Action Report (WSP 2025a), ongoing issues with high turbidity in several of the nature and extent wells downgradient of the Bottom Ash Landfill have made plume delineation challenging. A subset of the nature and extent wells were identified in the annual report for further review. In June 2025, effort was undertaken to redevelop monitoring wells MW-219, MW-301, and MW-PB1. These locations were discussed within the 2024 Annual Report due to repeated high turbidity measurements and significant differences between measured total arsenic concentrations and dissolved arsenic concentrations (WSP 2025a).

Since Q2 2024, no samples have been able to be collected at MW-PB1 due to insufficient volume at the time of sampling coupled with minimal recharge. During the redevelopment activities, MW-PB1 was initially found to have approximately 0.60 gallons of water within the casing prior to beginning purging. The well was twice purged dry and allowed to recharge. Based on insufficient volume of recharge, redevelopment was unable to be completed, and a sample was unable to be collected from the well during routine sampling later in June. Because samples have not been able to be collected from this well since Q2 2024, a new property boundary well (MW-PB1R) was installed in June 2025 adjacent to MW-PB1. MW-PB1Rwas drilled to approximately 36 feet below ground surface, approximately 11 feet deeper than MW-PB1. This new property boundary well was developed and is anticipated to initially be sampled in Q3 2025. The boring and well completion log for MW-PB1R is still being finalized by the driller and will be included in the 2025 annual report.

Well MW-219 was successfully redeveloped. Over a 3-day period, a total of 39.6 gallons of water were removed from the well prior to stabilization of the field parameters. In comparing the Q1 2025 turbidity measurements to those collected during redevelopment and in the consequent Q2 2025 sampling event, turbidity within the well has improved from the Q1 2025 measurement of 450 Nephelometric Turbidity Units (NTU) to the Q2 2025 measurement of 53 NTU. Observations of the appearance of water purged from the well have also improved, from dark brown and opaque during the purging portion of redevelopment, to consistently clear during both purging and sampling for the Q2 2025 sampling event. Analysis of the associated analytical results for the Q2 2025 sampling event is ongoing.

For well MW-301, preliminary effort to redevelop the well was inconclusive. A total of 16.8 gallons of water were removed from the well, with no visible or measurable improvement towards stabilization of the field parameters. Comparison of the Q1 2025 and Q2 2025 turbidity measurements show no appreciable difference (261 NTU during the Q1 2025 monitoring event and 246 NTU during the Q2 2025 event). Throughout purging for redevelopment, the water was medium to dark brown and opaque, while during both the Q1 2025 and Q2 2025 sampling events the purge and sample water were noted as being semi-turbid. Additional efforts to purge the well are planned for Q3 2025, prior to determining if the well should be abandoned. Analysis of the associated analytical results for the Q2 2025 sampling event is ongoing.

As during prior sampling events throughout 2024 (WSP 2024; WSP 2025a), both dissolved and total analysis was conducted for a subset of parameters during the Q1 2025 and Q2 2025 sampling events. Total analysis captures both the dissolved aqueous concentrations present in samples, as well as the insoluble particulate concentrations. Dissolved concentrations are determined by filtering samples prior to analysis, to remove insoluble particulates greater than 0.45 microns in diameter. During the Q1 2025 sampling event, the parameters that were tested with both dissolved and total analysis included the Appendix IV metals, and aluminum, iron, and manganese (primary components of most soils).

Comparison of dissolved results to total results for aluminum, iron, and manganese, when made in the context of samples with high turbidity, can help to determine if the associated total results are representative of site groundwater, or the results indicate the presence of excessive artificially mobilized particles (i.e., site soil particles that have entered the water column as a result of the sampling methods). Initial analysis of the aluminum, iron, and manganese total and dissolved data for samples with excess turbidity suggest that the total results reflect artificially suspended soil particles and are not representative samples of the groundwater, based on the reported concentrations and the magnitude of the difference between the total and dissolved concentrations.

2.2.2 Comparison of Total and Dissolved Arsenic Data

Review of the total and dissolved arsenic concentrations also suggest that the total concentrations from the Q1 2025 monitoring event may not be representative of the site groundwater based on the presence of excess turbidity, specifically at the wells that were targeted for redevelopment (MW-219 and MW-301). Figure 2 presents the total arsenic concentrations measured during Q1 2025, while Figure 3 presents the dissolved arsenic concentrations measured during the same Q1 2024 event. In both Figure 2 and Figure 3, locations that are color-coded orange had arsenic concentrations that are greater than the GWPS (0.01 mg/L) but less than twice the GWPS (0.02 mg/L), while locations in red had concentrations that are more than twice the GWPS (0.02 mg/L). Color-coding of the figures was used as part of the plume delineation effort to narrow in upon and bound the highest site concentrations.

2.3 Site Conceptual Model

An updated site hydrogeological model has been developed for use in reviewing the site conceptual model. Seequent Limited’s Leapfrog Geo software has been used to compile and analyze site monitoring well and borehole information collected across the site. The intention of the updated hydrogeological model is to provide a three-dimensional visualization of the available site information within a format that will allow for further updates with time.

2.4 Further Evaluation of Geochemical Injection

2.4.1 Geochemical Modeling

Based on the outcomes of the preliminary bench scale testing of potential admixtures on site groundwater discussed in the 2024 Annual Groundwater report (WSP 2025a), the geochemical models that were previously prepared ahead of testing were updated. These updates to the modeling confirmed previous model results and further support the applicability of chemical injections as a viable remedy in the area of MW-103 for arsenic. Additional updates to the model are planned following the outcomes of the next phase of bench scale testing (described in Section

2.4.2 Bench Scale Testing of Potential Admixtures on Site Groundwater and Soils

A second phase of bench scale testing is being conducted to evaluate the effectiveness of injecting ferrous iron material and ferric iron material arsenic in samples of groundwater collected from wells MW-103 and MW-211 and soil collected from near MW-103 and MW-211. MW-103 is the original location of interest downgradient of the Bottom Ash Landfill where arsenic has exceeded the GWPS, while MW-211 represents an additional downgradient location with arsenic concentrations greater than the GWPS.

For the second phase of bench scale testing, WSP contracted Terracon Consultants Inc. to drill exploratory boreholes offset from existing wells MW-103 and MW-211. The boreholes were drilled to similar depths as the existing wells to allow for collection of soil samples representative of the materials within the screened intervals of

MW-103 and MW-211. Borehole BH-103R was offset from MW-103 approximately 10 feet to the east of the well. Borehole BH-211R was offset from MW-211 approximately 10 feet to the west of the well. The intention of offsetting the exploratory boreholes from the wells was to allow for collection of similar materials while minimizing the potential for damage to the wells. Boreholes BH-103R and BH-211R were drilled on June 17, 2025. Final borehole logs are still being prepared by the driller.

At each borehole, four, 1-gallon Ziploc-style bags were prepared with the location name, date and time, name of sampler, and bag number (i.e., 1 of 4, etc.). Materials at similar depths to the screened intervals for existing wells MW-103 and MW-211 were collected within the bags, filling the bags to the extent possible and squeezing out any excess air prior to closing. Sample bags were placed within secondary Ziploc-style bags for prevention of punctures and leakage from the bags during shipping. Following collection of the samples, the closed sample bags were placed within coolers with ice for shipping. Chain-of-custody protocols consistent with the site SAP (Golder 2019) were followed. Chain-of-custody information was included within the sample coolers for shipment. The soil samples were shipped overnight on ice to Terra Systems, Inc. and arrived at the lab on June 18, 2025.

Following the preliminary bench scale testing as discussed in the 2024 Annual Groundwater report (WSP 2025a), a groundwater sampling plan was prepared to outline the methods for collecting samples for the second phase of a bench-scale treatability study (WSP 2025b; Appendix A). To simulate the in-situ redox conditions of the site groundwater during the bench scale testing, the sampling methods include steps to minimize interaction of groundwater with the surface atmosphere. WSP coordinated with MVTL to collect groundwater samples for the second phase of the treatability study on June 23, 2025. Similar to the preliminary phase of testing (WSP 2025a), groundwater was collected from MW-103, as the original location of interest downgradient of the Bottom Ash Landfill, and MW-211, representing an additional downgradient location with arsenic concentrations greater than the site GWPS. Collected groundwater samples were shipped overnight on ice to Terra Systems, Inc., and arrived at the lab on June 24, 2025.

Admixtures for the second phase of treatability testing mirror those used within the first phase of testing and consist of a ferrous iron material and a ferric iron material. The second phase of bench testing began on June 24, 2025 on receipt of the collected groundwater samples at the Terra Systems, Inc., laboratory. Testing is ongoing, with results of the second phase of bench testing expected in September.

3.0 SUMMARY OF REMEDY SELECTION PROCESS ACTIVITIES

3.1 Work Completed to Date

Following the initial identification of the SSL for arsenic at MW-103 in Q1 2022, steps have been taken to delineate the plume and progress towards final remedy selection. These steps include:

- Completion of the Assessment of Corrective Measures report in 2022 (GAUSA 2022).
- Installation, development, and sampling of 15 nature and extent wells and 2 property boundary wells in 2022 and 2023.
- Geochemical and geotechnical testing of aquifer solids collected during drilling in 2022 and 2023.
- In situ hydraulic conductivity testing and analysis in 2023 and 2024.
- Installation of dedicated low-flow pumps in the new wells in 2024.

- Geochemical modeling and evaluation of MNA per the EPA's guidance including Tiers I, II, and III in 2023 and 2024.
- Additional geochemical modeling to supplement chemical injection testing based on site hydrogeological conditions.
- Groundwater sampling and analysis for bench-scale chemical injection testing.
- Initial characterization and bench-scale testing for comparing possible chemical injection additives to site groundwaters.
- Groundwater sampling and analysis from the Bottom Ash Landfill network wells and nature and extent wells to further understand the extent and magnitude of arsenic above the GWPS downgradient of the Bottom Ash Landfill.
- Development of a Leapfrog model to better visualize site hydrogeological information in support of the site conceptual model.
- Soil and groundwater sampling for the second phase of laboratory analysis to evaluate the suitability of chemical injection at the site.

Figure 4 presents a simplified Gantt chart of the work conducted to date and planned activities over the next 6 months (until the next semi-annual report), with the intent of holding the public meeting and selecting a remedy as soon as feasible.

3.2 Remedy Selection

At present, selection of a final remedy is expected to be based on the following information:

- Plume Delineation
  - The arsenic plume downgradient of the Bottom Ash Landfill appears to be small (based on dissolved arsenic, the plume is less than 400 feet wide and not extending downgradient beyond the CCR unit boundary by more than 50 to 100 feet).
- GWPS Attainment
  - Downgradient of the Bottom Ash Landfill, MNA is expected to reduce arsenic sufficiently to attain the GWPS. Expansion of the plume and re-mobilization of arsenic are not expected based on modeling, aquifer solids testing, and monitoring data collected to date. This is supported by the conclusions of the MNA Tier I, II, and III reports (WSP 2023; WSP 2024) developed in alignment with USEPA guidance for MNA (USEPA 2015).
  - The modeled amount of time needed to attain the GWPS at MW-103 at the unit boundary of the Bottom Ash Landfill is significant (WSP 2024). Various conditions not reflected in the modeling may decrease the time to attain the GWPS, as evidenced by recent concentrations below the GWPS that remain considered as SSLs (see Section 2.1). Enhanced MNA utilizing geochemical injection will likely reduce this time frame even further.
  - Initial modeling and initial bench-scale testing suggest chemical injection with iron will speed up attainment of the GWPS at MW-103. Bench scale testing of groundwater and aquifer solids with iron is

ongoing to further evaluate the viability and suitability of chemical injection. Additional injection modeling is needed based on the outcomes of the bench scale testing.

  - Additional modeling was completed in 2025 using the results of bench scale testing and updated groundwater sampling data. These updates to the modeling confirmed previous model results and further support the applicability of chemical injections as a viable remedy in the area of MW-103 for arsenic.

- Holistic Site Approach
  - Based on newly identified SSLs at the Bottom Ash Impoundment, final remedy selection for the Bottom Ash Landfill will be predicated on the potential for interaction with the parameters of interest at the Bottom Ash Impoundment. A selected remedy will ideally be constrained to not create further issues with other parameters, along with obtaining concentrations below the associated GWPS values.

4.0 PLANNED ACTIVITIES

On behalf of GRE, WSP is implementing activities to support the corrective action remedy selection process. In particular, evaluation continues to determine the potential of geochemical injection to achieve the GWPS or to enhance MNA to achieve the GWPS at the site. Groundwater monitoring at the site will continue to be used to track conditions at the site and monitor the impact of continued natural attenuation at the site as evidenced by recent concentrations below the GWPS. An evaluation of geochemical injection is ongoing to ensure that a chosen injectate doesn’t mobilize other parameters, resulting in additional issues downgradient of the Bottom Ash Landfill. Selection and implementation of corrective measures can be iterative, and GRE and WSP will continue data collection efforts, as necessary, to further refine the site conceptual model and evaluate the feasibility of remedies identified in the ACM report (GAUSA 2022) in order to select a final remedy.

Supplementary data collection and evaluation activities proposed to be completed prior to the next annual report in January 2026 include:

- Arsenic Delineation
  - Continue to evaluate wells with high turbidity and significant differences between total and dissolved arsenic concentrations following redevelopment in Q2 2025. Determine whether redevelopment has improved sample quality or if abandonment and replacement of the associated wells is necessary.
- Further Evaluation of Geochemical Injection
  - Finalize bench testing of the site groundwater and aquifer solids with the addition of identified reactants in order to evaluate reaction time, response to varying dosage rates, and comparison to modeled predictions.
  - Update geochemical modeling based on the outcomes of the second phase of bench testing.
  - Begin the development of a transport model in support of injection design.
- Coordination with the NDDEQ
  - Meet with the NDDEQ to discuss remedy options and overall site approach. The EPA has proposed approving NDDEQ’s CCR program which would allow the NDDEQ to review and support remedy selection in a regulatory capacity that meets both state and federal requirements.

- Groundwater Monitoring
  - Collect Q4 2025 semi-annual detection and assessment monitoring samples.

On behalf of GRE, WSP will continue to prepare semi-annual progress reports to document the progress in selecting and designing a groundwater remedy in accordance with 40 CFR 257.97 and -98 and NDAC 33.1-20-08-06(6) and (7) until a final remedy is selected. Prior to the final selection of a corrective measure, a public meeting will be scheduled for a minimum of 30 days before the selection of the remedy to present the results of the corrective measures assessment, including additional information still to be gathered. The next semi-annual report will be included in the 2025 annual groundwater monitoring and corrective action report, due January 31, 2026. On behalf of GRE, WSP will continue to include future semi-annual progress reports with the routine groundwater monitoring and corrective action reports to meet the requirements of 40 CFR 257.105(h)(12), 40 CFR 257.106(h)(9), and 40 CFR 257.107(h)(9), and NDAC 33.1-20-08-08(1)(h)(12), 33.1-20-08-08(2), and 33.1-20-08-08(3).

Upon selection of a remedy, a final report will be prepared describing the selected remedy and how the remedy meets the standards in 40 CFR 257.97 and -98 and NDAC 33.1-20-08-06(6) and (7). The final remedy selection report must be certified by a qualified professional engineer licensed in the state of North Dakota per 40 CFR 257.97(a) and approved by the NDDEQ per NDAC 33.1-20-08-6(7)(a). Once the remedy has been selected and approved by the NDDEQ, the implementation of the remedy will be initiated in accordance with 40 CFR 257.98 and NDAC 33.1-20-08-06(8).

Signature Page

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https://wsponlinenam.sharepoint.com/sites/gld-170737/project files/5 technical work/2025- stanton gw/acm/jul 25 semi-ann rpt/for admin/_formatted/gl21509219.000-039-rpt-0_jul25_bal_acm_semi-ann-31jul25.docx

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Tables

Table 1: Stanton Station Monitoring Well Summary

Location	Well ID	Date Constructed	TOC Elevation[a]	Ground Surface Elevation[a]	Screen Interval	Top of Screen Elevation	Bottom of Screen Elevation	Sand Pack Interval	Geologic Unit(s) Completed In
			ft AMSL	ft AMSL	ft bgs	ft AMSL	ft AMSL	ft bgs	
Upgradient/Side-gradient	MW-6B	9/8/1992	1,711.5	1,709.4	28.4-38.4	1,681.3	1,671.3	19.0-38.5	Outwash
	MW-7A	8/27/1992	1,713.7	1,711.3	7.0-17.0	1,704.1	1,694.1	5.0-18.0	Silty sand/clay
	MW-7B	9/9/1992	1,712.9	1,711.2	28.1-38.1	1,682.7	1,672.7	23.0-38.5	Silty sand/outwash
	MW-8B	9/3/1992	1,749.8	1,747.6	54.0-64.0	1,694.4	1,684.4	49.0-64.5	Outwash
	MW-105	11/18/2015	1,717.0	1,714.0	9.0-19.0	1,705.0	1,695.0	7.0-19.0	Clay/outwash
Bottom Ash Landfill Downgradient	MW-9N	7/19/2010	*1,703.5*	*1,701.0*	*11.5-21.5*	1,689.5	1,679.5	*9.5-21.5*	Sand, clayey sand, gravel
	MW-102	11/17/2015	1,712.1	1,708.8	14.0-24.0	1,694.8	1,684.8	12.0-24.0	Silty sand/clay
	MW-103	11/17/2015	1,709.5	1,706.2	14.0-24.0	1,692.2	1,682.2	12.0-24.0	Outwash
Bottom Ash Impoundment Downgradient	MW-201	8/10/2020	1,704.9	1,701.9	9.5-19.5	1,692.4	1,682.4	7.0-19.5	Fat clay, sand w/silt
	MW-202	8/10/2020	1,703.7	1,701.6	8.0 - 18.0	1,693.6	1,683.6	6.0-18.0	Fat clay, lean clay w/sand
	MW-203	8/10/2020	1,705.8	1,702.7	6.0 -16.0	1,696.7	1,686.7	5.0-16.0	Sand w/silt, fat clay
Bottom Ash Landfill Nature and Extent Delineation Wells	MW-1R	11/8/1995	*1,706.7*	*1,703.5*	*23.7-32.7*	1,679.8	1,670.8	*21.7-34.7*	Gravel, fat clay
	MW-104	11/17/2015	1,712.0	1,709.0	14.0-24.0	1,695.0	1,685.0	12.0-24.0	Outwash
	MW-210	5/9/2022	1,703.1	1,699.9	12.0 - 22.0	1,687.9	1,677.9	12.0 - 22.0	Sand w/silt
	MW-211	5/10/2022	1,708.7	1,705.4	12.0 - 22.0	1,693.4	1,683.4	10.0 - 22.0	Lean clay, sand w/silt
	MW-212	5/10/2022	1,709.6	1,706.4	13.5 - 23.5	1,692.9	1,682.9	10.0 - 23.5	Fat clay, lean clay silty sand
	MW-213	5/12/2022	1,706.0	1,702.7	19.5 - 29.5	1,683.2	1,673.2	19.5 - 29.5	Fat clay, lean clay silty sand
	MW-214	5/12/2022	1,709.2	1,705.8	5.0 - 15.0	1,700.8	1,690.8	4.0 - 15.0	Fat clay, silty sand
	MW-215	2/7/2023	1,702.0	1,699.0	9.0 - 19.0	1,690.0	1,680.0	6.0 - 19.0	Silty sand with gravel, poorly graded sand with gravel
	MW-216	2/8/2023	1,702.9	1,699.7	10.0 - 20.0	1,689.7	1,679.7	7.0 - 20.0	Silty sand, poorly graded sand with gravel
	MW-217	2/9/2023	1,700.0	1,697.0	9.5 - 19.5	1,687.5	1,677.5	7.0-19.5	Poorly graded sand with silt and gravel
	MW-218	2/9/2023	1,701.1	1,698.1	9.5 - 19.5	1,688.6	1,678.6	7.0 - 19.5	Silty sand, poorly graded gravel with sand
	MW-219	2/6/2023	1,705.1	1,702.2	10.0 - 20.0	1,692.2	1,682.2	8.0 - 20.0	Silty sand, clayey sand
	MW-220	2/8/2023	1,702.4	1,699.7	25.0 - 35.0	1,674.7	1,664.7	22.0 - 35.0	Poorly graded sand, clayey sand
	MW-221	2/10/2023	1,705.0	1,701.8	22.0 - 32.0	1,679.8	1,669.8	18.0 - 32.0	Poorly graded sand with silt and gravel
	MW-222	2/6/2023	1,721.9	1,719.0	26.0 - 36.0	1,693.0	1,683.0	23.0 - 36.0	Lean clay with sand, poorly graded sand with silt and gravel
	MW-300	2/9/2023	1,700.1	1,696.9	9.0 - 19.0	1,687.9	1,677.9	7.0 - 19.0	Silty sand, poorly graded sand with silt and gravel
	MW-301	2/10/2023	1,698.6	1,695.5	20.0 - 35.0	1,675.5	1,660.5	18.0 - 35.0	Lean clay, lean clay with sand, clayey sand
Property Boundary	MW-PB1	8/11/2020	1,698.8	1,695.9	15.0 - 25.0	1,680.9	1,670.9	13.0 - 25.0	Silt w/sand, silty sand
	MW-PB3	2/9/2023	1,701.6	1,698.5	24.0 - 39.0	1,674.5	1,659.5	18.0 - 39.0	Sandy lean clay

a. TOC (top of casing) and ground surface elevations surveyed by Interstate Engineering, Inc. in September 2020, October 2022, and April 2023.

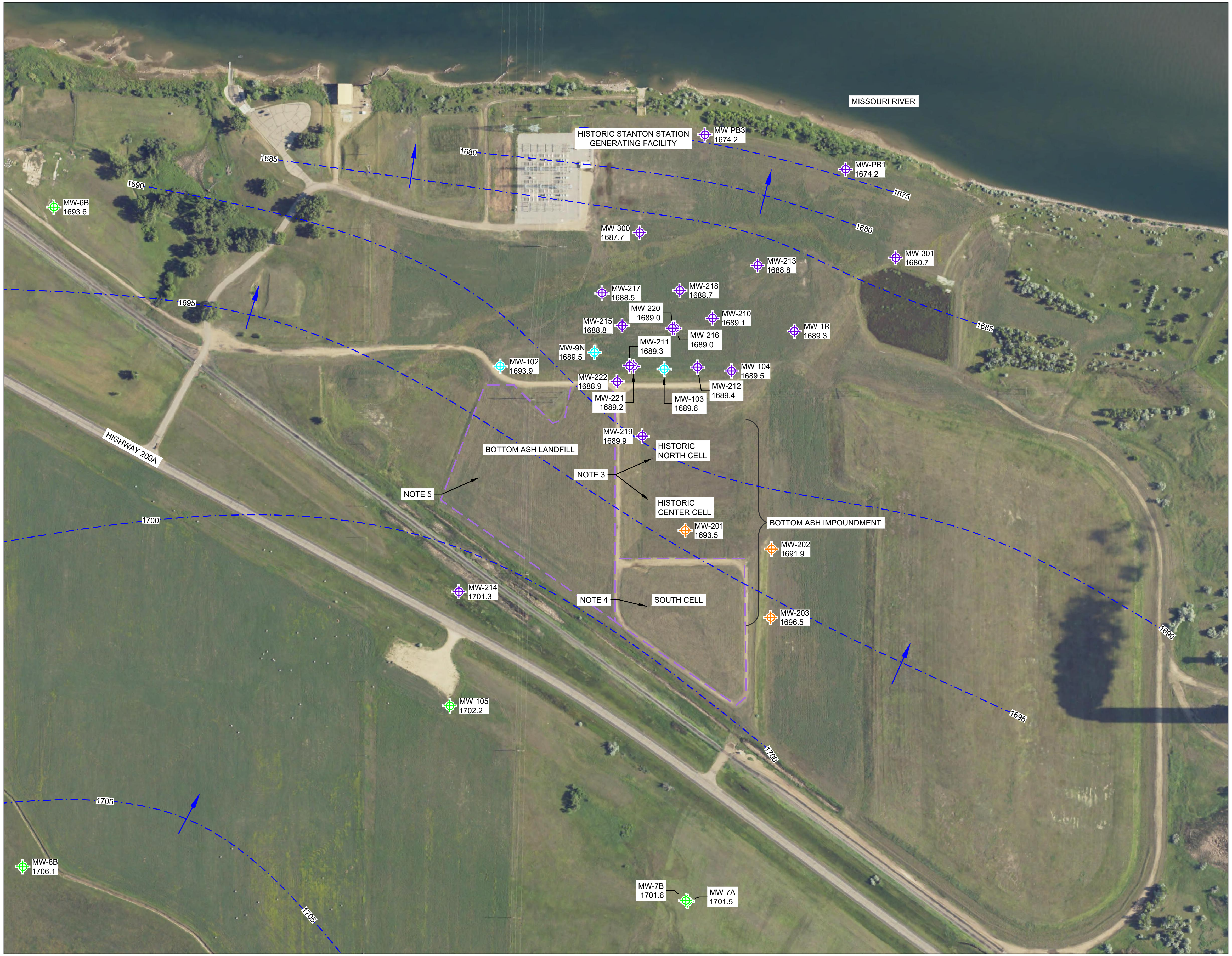
Notes:

Well construction measurements are from the original bore log, well data sheet, or well construction form.

Well construction information for MW-9N and MW-1R shown in italics are estimates based on the original well logs, accounting for the casing reductions completed in June 2020.

ft AMSL: feet above mean sea level; ft bgs = feet below ground surface; GW = groundwater

Figures



LEGEND - Q1 2025 GROUNDWATER CONTOURS

⌖	UPGRADIENT OR SIDEGRADIENT MONITORING WELL
⌖	LANDFILL DOWNGRADIENT MONITORING WELL
⌖	IMPOUNDMENT DOWNGRADIENT MONITORING WELL
⌖	NATURE AND EXTENT WELLS
— —	CLOSED BOTTOM ASH LANDFILL/IMPOUNDMENT FOOTPRINT
→	GENERAL DIRECTION OF GROUNDWATER FLOW
— · —	GROUNDWATER CONTOURS AND ELEVATIONS

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2023.
2. GROUNDWATER CONTOURS ARE BASED ON NOVEMBER 2024 ELEVATION INFORMATION FROM THE SHOWN MONITORING WELLS, AS WELL AS MONITORING WELLS AND PIEZOMETERS NOT SHOWN.
3. THE NORTH AND CENTER CELLS OF THE BOTTOM ASH IMPOUNDMENT WERE CLOSED BY REMOVAL OF WASTE AND LINER.
4. THE SOUTH CELL OF THE BOTTOM ASH IMPOUNDMENT WAS CLOSED WITH A FINAL COVER OVER PLACED WASTE.
5. THE BOTTOM ASH LANDFILL WAS CLOSED BY CONSOLIDATION OF PLACED WASTE INTO A SMALLER FOOTPRINT AND CONSTRUCTION OF A FINAL COVER.

N

0 200 400

1" = 200' FEET

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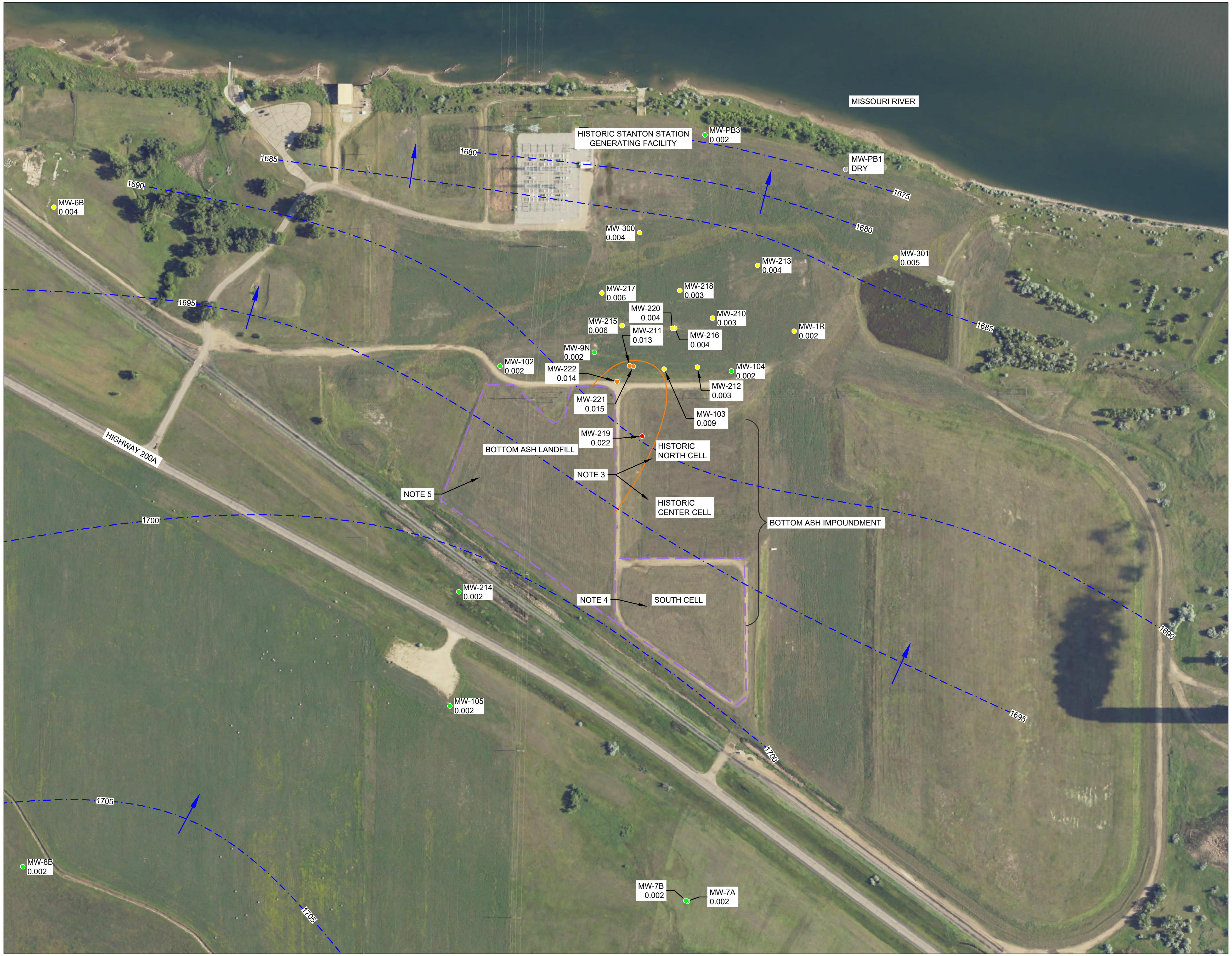
MONITORING WELL LOCATIONS AND
Q1 2025 GROUNDWATER ELEVATIONS AND CONTOURS
GREAT RIVER ENERGY - STANTON STATION

FIGURE 1



LEGEND - Q1 2025 TOTAL ARSENIC

● RESULT ND < 0.002

● RESULT 0.002 TO < 0.01

● RESULT 0.01 TO < 0.02

● RESULT > 0.02

— — CLOSED BOTTOM ASH LANDFILL/IMPOUNDMENT FOOTPRINT

→ GENERAL DIRECTION OF GROUNDWATER FLOW

— · — GROUNDWATER CONTOURS AND ELEVATIONS

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2023.
2. GROUNDWATER CONTOURS ARE BASED ON MARCH 2025 ELEVATION INFORMATION FROM THE SHOWN MONITORING WELLS, AS WELL AS MONITORING WELLS AND PIEZOMETERS NOT SHOWN.
3. THE NORTH AND CENTER CELLS OF THE BOTTOM ASH IMPOUNDMENT WERE CLOSED BY REMOVAL OF WASTE AND LINER.
4. THE SOUTH CELL OF THE BOTTOM ASH IMPOUNDMENT WAS CLOSED WITH A FINAL COVER OVER PLACED WASTE.
5. THE BOTTOM ASH LANDFILL WAS CLOSED BY CONSOLIDATION OF PLACED WASTE INTO A SMALLER FOOTPRINT AND CONSTRUCTION OF A FINAL COVER.
6. TOTAL ARSENIC RESULTS ARE FROM Q1 2025 SAMPLING EVENT.
7. ALL CONCENTRATION AREAS ARE FOR VISUAL PURPOSES. THESE ARE ESTIMATIONS BASED ON THE Q1 2025 SAMPLING EVENT.

wsp

Q1 2025 TOTAL ARSENIC CONCENTRATIONS
GREAT RIVER ENERGY - STANTON STATION

FIGURE 1

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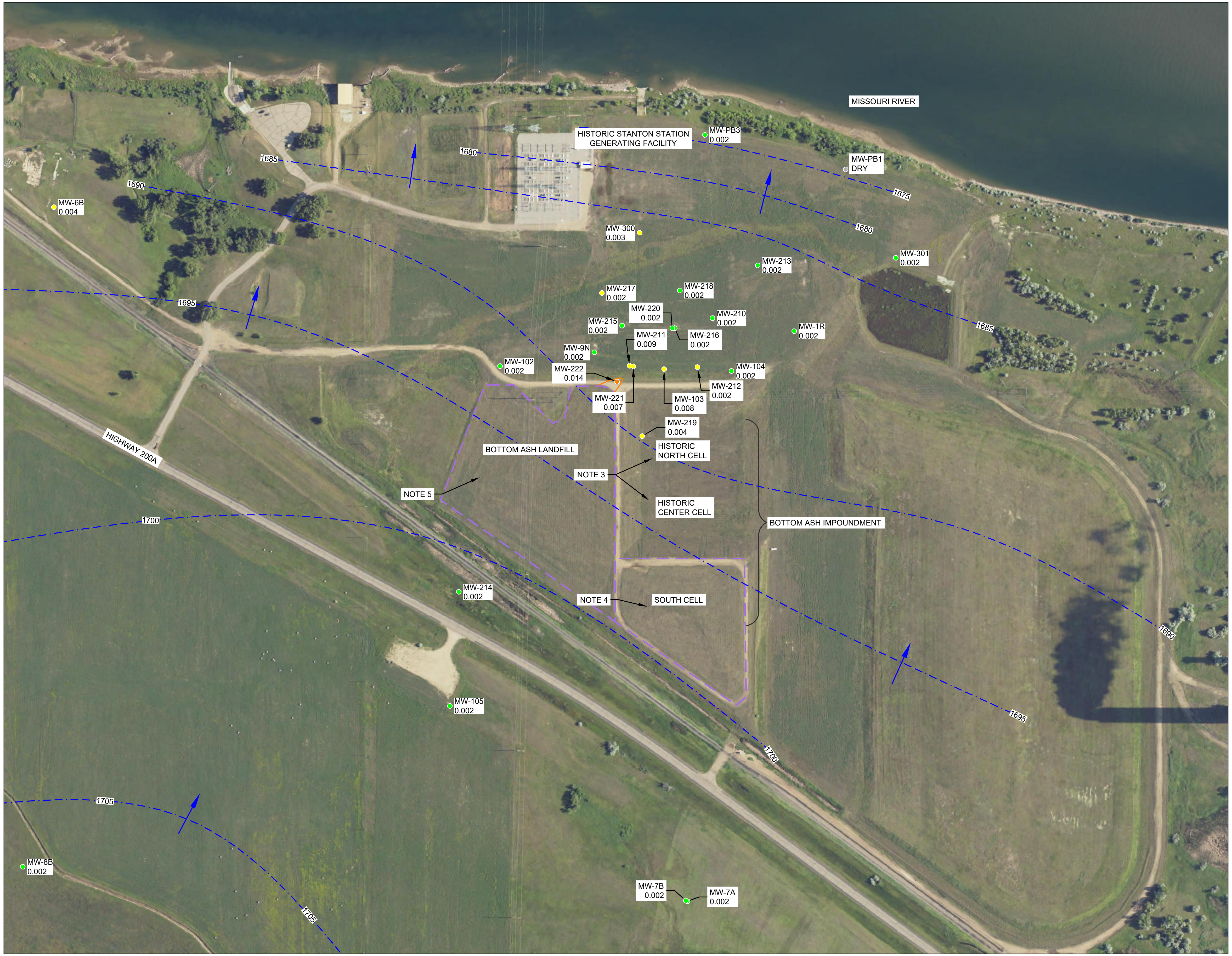
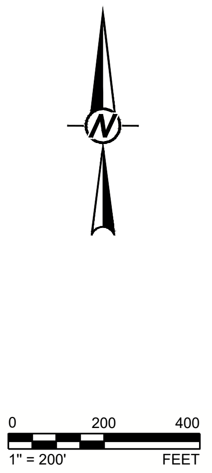


LEGEND - Q1 2025 DISSOLVED ARSENIC

🟢	RESULT ND < 0.002
🟡	RESULT 0.002 TO < 0.01
🟠	RESULT 0.01 TO < 0.02
🔴	RESULT > 0.02
— — —	CLOSED BOTTOM ASH LANDFILL/IMPOUNDMENT FOOTPRINT
→	GENERAL DIRECTION OF GROUNDWATER FLOW
— · —	GROUNDWATER CONTOURS AND ELEVATIONS

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2023.
2. GROUNDWATER CONTOURS ARE BASED ON MARCH 2025 ELEVATION INFORMATION FROM THE SHOWN MONITORING WELLS, AS WELL AS MONITORING WELLS AND PIEZOMETERS NOT SHOWN.
3. THE NORTH AND CENTER CELLS OF THE BOTTOM ASH IMPOUNDMENT WERE CLOSED BY REMOVAL OF WASTE AND LINER.
4. THE SOUTH CELL OF THE BOTTOM ASH IMPOUNDMENT WAS CLOSED WITH A FINAL COVER OVER PLACED WASTE.
5. THE BOTTOM ASH LANDFILL WAS CLOSED BY CONSOLIDATION OF PLACED WASTE INTO A SMALLER FOOTPRINT AND CONSTRUCTION OF A FINAL COVER.
6. DISSOLVED ARSENIC RESULTS ARE FROM Q1 2025 SAMPLING EVENT.
7. ALL CONCENTRATION AREAS ARE FOR VISUAL PURPOSES. THESE ARE ESTIMATIONS BASED ON THE Q1 2025 SAMPLING EVENT.



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Q1 2025 DISSOLVED ARSENIC CONCENTRATIONS
GREAT RIVER ENERGY - STANTON STATION

FIGURE 1

Figure 4 - Great River Energy - Stanton Station - Bottom Ash Landfill - Assessment of Corrective Measures and Remedy Selection Timeline

<table>
<tr><th>Q1 2022</th><th>Q2 2022</th><th>Q3 2022</th><th>Q4 2022</th><th>Q1 2023</th><th>Q2 2023</th><th>Q3 2023</th><th>Q4 2023</th><th>Q1 2024</th><th>Q2 2024</th><th>Q3 2024</th><th>Q4 2024</th><th>Q1 2025</th><th>Q2 2025</th><th>Q3 2025</th><th>Q4 2025</th></tr>
<tr><td colspan="14">Well Sampling and Analysis</td><td colspan="2">Well Sampling & Analysis</td></tr>
<tr><td>SSL</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td colspan="2">Drilling, Well Installation, Well Development - Initial Nature and Extent Wells</td><td></td><td colspan="2">Drilling, Well Installation, Well Development - Additional Nature and Extent Wells</td><td></td><td></td><td></td><td colspan="2">Dedicated Low-Flow Pumps for Nature and Extent Wells</td><td></td><td></td><td colspan="2">Redevelop/Replace Nature & Extent Wells with Turbidity Issues</td><td colspan="2">Redevelop/Replace Nature & Extent Wells with Turbidity Issues</td></tr>
<tr><td></td><td colspan="2">Geochemical and Geotechnical Lab Testing of Soil Samples</td><td></td><td colspan="4">Geochemical and Geotechnical Lab Testing of Soil Samples</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">Measure Total and Dissolved Metals in Groundwater Samples</td><td colspan="2">Measure Total and Dissolved Metals in Groundwater Samples</td></tr>
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</table>

APPENDIX A

Sampling and Analysis Plan- Second Phase, Bench-Scale Treatability Testing

DRAFT

TECHNICAL MEMORANDUM

DATE June 20, 2025

Project No. GL21509219.000

TO Erik Heinen, Great River Energy; Jeremy Meyer, MVTL

CC Todd Stong, Todd Rees, PJ Nolan, Cole Meyer

FROM Erin Hunter

EMAIL erin.hunter@wsp.com

SAMPLING AND ANALYSIS PLAN – SECOND PHASE, BENCH-SCALE TREATABILITY TESTING

This memorandum has been prepared to describe the planned procedures for the acquisition of groundwater samples for use in bench-scale treatability testing evaluations for Great River Energy's Stanton Station. Based on the current site conditions, samples are planned from two locations during the second phase of testing, at wells MW-103 and MW-211 (Figure 1).

Details for collection of samples in this document provide additional information beyond the sampling and analysis procedures within the site Groundwater Monitoring Plan (Golder 2019), included as Attachment A. The following sections within the site Groundwater Monitoring Plan will be referenced and followed as part of the sampling procedures:

- Procedures Prior to Sampling, Section 3.1
- Sample Collection, Section 3.2
  - Decontamination, Section 3.2.1
  - Sampling Equipment and Materials, Section 3.2.2
  - Purging, Section 3.2.3.1
  - Sample Collection, Section 3.2.3.2
  - Sample Preservation, Handling, and Shipment, Section 3.2.3.3
- Chain-of-Custody Controls, Section 3.4
- Field Documentation, Section 3.5

Equipment

The following additional equipment is required for collection for the treatability testing samples beyond the standard sampling equipment detailed in Section 3.2.2 of Attachment A.

- To be provided by Minnesota Valley Testing Laboratories (MVTL)
  - EZ-Pour F-Style Jugs – 1-gallon (total of 11 for this event – 10 planned 1-gallon samples and 1 spare)

  - Small bottle containers to help top-off the 1-gallon containers
  - Nitrogen gas with gas flow regulator – for maintaining zero-oxygen headspace within the sample collection jugs
    - Gas flow meter (for use with the nitrogen gas if available)
    - Manifold with valves to allow nitrogen gas to go to two containers (container being filled and next container being purged)
    - 1-gallon container lids with two holes (one for nitrogen tubing and one for groundwater tubing)
  - Coupling for connecting to the existing dedicated pump tubing (minimum of one per well)
  - Tubing – New, certified clean tubing will be attached to the end of each monitoring well's dedicated tubing for sampling purposes, and additional tubing for use from the gas flow regulator into the sample jugs
  - Scissors or other equipment for trimming tubing to the required lengths.
  - Coolers for 10, 1-gallon sample jugs (likely can get 5, 1-gallon jugs in a standard sized cooler)
  - Containerized ice for shipping sample coolers
- To be provided by WSP
  - Indelible ink pens
  - Garbage or Ziploc-style bags sized (2-gallon size) for use as secondary containment during shipping for the sample containers
  - Field Datasheets (example included as Attachment B)
  - Chain of Custody forms for Terra Systems (Attachment C), and 1-gallon Ziploc-style bags
  - Bagged ice for keeping samples at temperature while on-site (MVTL to swap this out for containerized ice for shipping)
  - Nitrile gloves
  - Shop towels
  - DI/distilled water for rinsing out gallon containers

Additionally, WSP will coordinate with MVTL, the primary contracted sampler at the site) for access to the well keys and assistance with sampling with the dedicated equipment.

Sampling Procedures

The objective of the sampling is to obtain five (5) gallons of groundwater each from both MW-103 and MW-211.

Figure 1: Typical Sampling Setup

- Prepare sample jug immediately prior to sampling, by writing the required sample identification information directly on the sample jug with an indelible ink pen.
- Prior to sampling, each 1-gallon sample jug will be rinsed with DI water, and the screw-on lid will be reattached.
- Purge dedicated pump and tubing following the procedure outlined in Section 3.2.3.1 of Attachment A, including measurement of field parameters to stability.
- Attach a clean coupling to the existing tubing at the monitoring well and attach the other end of the coupling to at least a 2-ft length of clean tubing.
- Attach a clean length of tubing to the regulator on the nitrogen tank, insert the open end of the tubing into the sample jug, and fill the jug with nitrogen gas at 2,000 milliliters per minute (mL/min) for 2 minutes (or fill with nitrogen at a rate that can feel positive pressure out from the container for 2 minutes). The rate of gas flow will be monitored with a gas flow meter with appropriate range. A spare cap is recommended for providing coverage for the tubing while filling the sample jugs.
- While maintaining a nitrogen gas flow rate of 100 mL/min of nitrogen purge (or positive pressure out from the container), the sampling tubing will be inserted into the bottom of the sample jug.
- While maintaining a groundwater extraction flow rate of 200 mL/min or less, fill the provided sample jug from the bottom up while maintaining the nitrogen purge of the headspace of the sample jug (take care to move nitrogen tubing upward so gas does not flow into groundwater sample creating bubbles). Bottles should be

filled from the bottom up, in order to maintain the nitrogen headspace layer and minimize contact of the groundwater with the natural atmosphere.

- Minimize head space in the sample container as much as possible, filling to the extent possible, and reattach the screw-on lid. If needed, use a small sample bottle to top-off the gallon-sized sample container.
- Place each sample jug in a bag (either resealable or garbage bag) and close, to minimize direct contact between the sample jugs and ice for sample label preservation and secondary containment for shipping.
- Place packaged sample containers in coolers with bagged ice. Back at lab/office, prepare coolers for shipping by replacing bagged ice with containerized ice. Prior to shipping, coolers will be secured with packing tape.
- Chain-of-custody forms (Attachment C) will be filled out at the associated sample collection and handling stages, and will be sent with the samples, taped to the interior of the shipping coolers.
- Samples will be shipped overnight to:

  Terra Systems, Inc.
  ATTN: Michael Lee
  130 Hickman Road, Suite 1
  Claymont, Delaware 19703
- Upon shipment of the samples, a notification including the sample tracking number is to be provided to:

  Erin Hunter
  WSP USA Inc.
  Cell: 814-341-6488
  Email: erin.hunter@wsp.com

WSP USA Inc.

Attachments: Figure 1 – Site Map
Attachment A – 2019 Groundwater Monitoring Plan
Attachment B – Example Field Data Sheet
Attachment C – Chain-of-Custody Forms – Terra Systems Groundwater Samples for Phase 2

https://wsponlinenam.sharepoint.com/sites/gld-170737/project files/5 technical work/2025- stanton gw/acm/chemical injection/phase 2 testing/sap pt. 2/gl21509219.000_tm_isi-sap-round2.docx

FIGURE

Site Map

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LEGEND

⊕	UPGRADIENT OR SIDEGRADIENT MONITORING WELL
⊕	DOWNGRADIENT MONITORING WELL
●	DOWNGRADIENT PROPERTY BOUNDARY MONITORING WELL
△	PIEZOMETER
―	CLOSED BOTTOM ASH LANDFILL/IMPOUNDMENT FOOTPRINT

NOTE(S)

1. SEE TEXT FOR DETAILS OF SAMPLING PROGRAM.
2. CLOSED BOTTOM ASH LANDFILL/IMPOUNDMENT FOOTPRINT IS APPROXIMATE.

REFERENCE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE IMAGERY PROGRAM, 2020.

N

0 300 600

1" = 600' FEET

MONITORING WELL AND PIEZOMETER 2024 SAMPLING LOCATIONS
GREAT RIVER ENERGY - STANTON STATION

FIGURE 1

ATTACHMENT A

2019 Groundwater Monitoring Plan

Groundwater Monitoring Plan

Great River Energy - Stanton Station
Permit Number SP-043

Submitted to:

North Dakota Department of Health
Division of Waste Management
918 East Divide Avenue, 3rd Floor
Bismarck, North Dakota 58501

Submitted by:

Great River Energy
2875 Third Street SW, Underwood, North Dakota 58576

Prepared by:
Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228
+1 303 980-0540

1894121

February 20, 2019

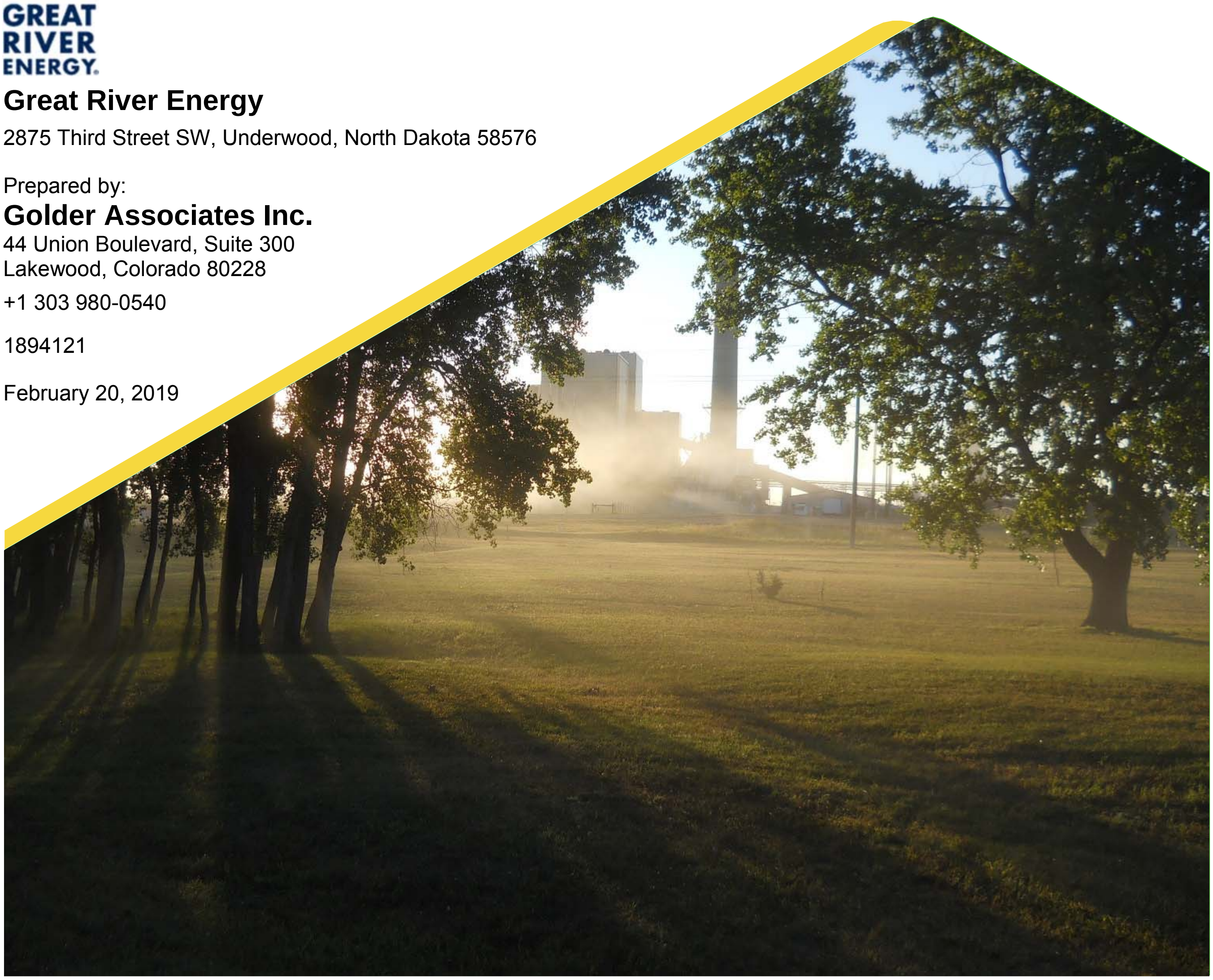

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

This Groundwater Monitoring Plan (GMP) has been prepared by Golder Associates Inc. (Golder) on behalf of Great River Energy (GRE) for the inert waste landfill (Bottom Ash Landfill), Surface Impoundment (Bottom Ash Impoundment), and Closed Special Waste Landfill (Ponds B and C) regulated by the North Dakota Department of Health (NDDH) under Permit Number 0043. Stanton Station is a coal-fired electric generation facility located in Mercer County, North Dakota, approximately 3 miles southeast of the city of Stanton along the Missouri River. Figure 1 shows the location of Stanton Station.

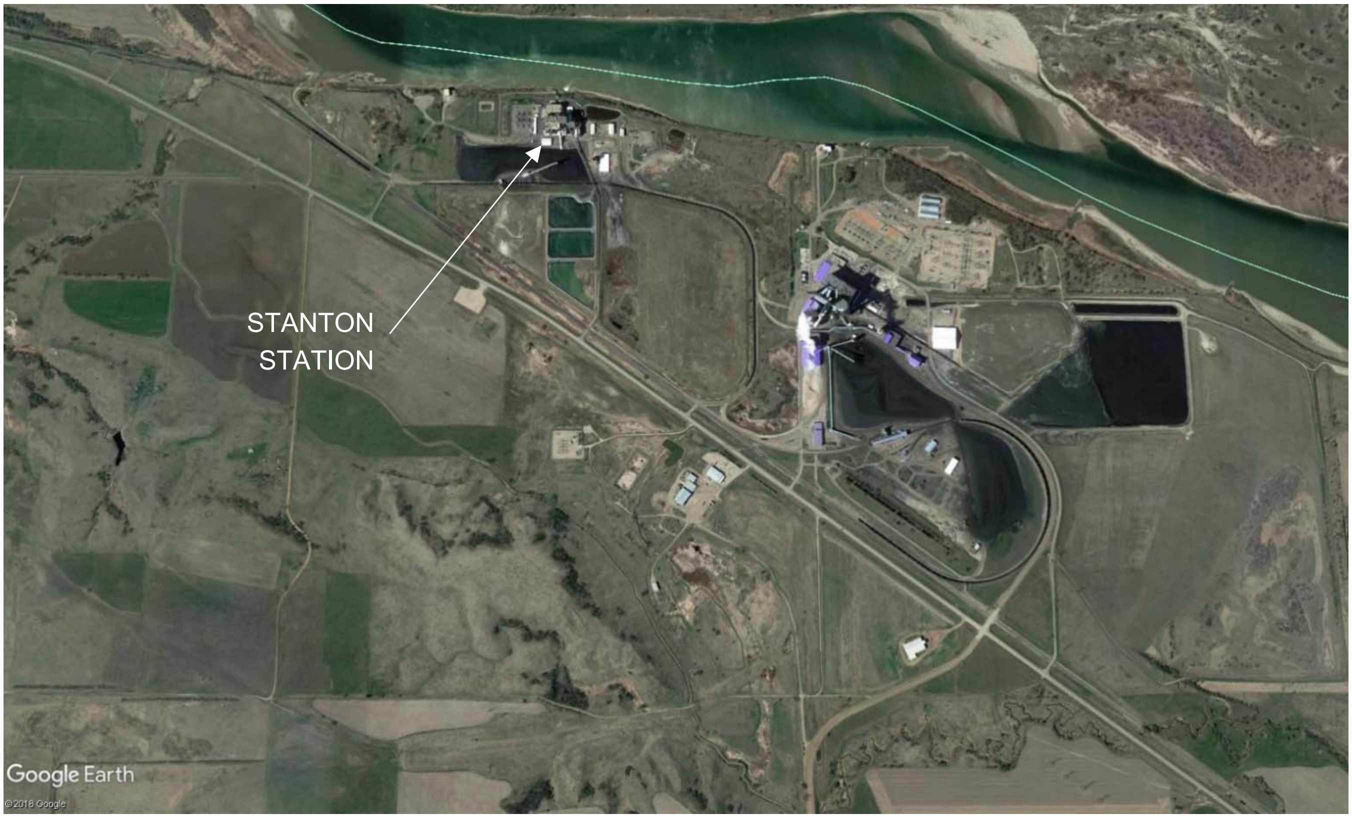

Figure 1: Site Location (Google Earth Pro, July 2016)

This GMP has been developed in accordance with requirements of the NDDH, standards-of-practice, and is designed to be consistent with U.S. Environmental Protection Agency (EPA) accepted procedures such as those described in:

- Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA 2009); and
- Criteria for Municipal Solid Waste Landfills, Code of Federal Regulations Title 40 Part 258 (40 CFR 258);

Per the requirements of North Dakota Administrative Code (NDAC) 33-20-13-02.4, this GMP includes:

- Number and location of wells;
- Procedures for decontamination of sampling equipment;
- Procedures for sample collection;

- Laboratory analytical methods;
- Chain-of-custody (COC) controls;
- Parameters for analysis;
- Quality assurance/quality control (QA/QC) procedures;
- A monitoring schedule;
- Data statistical methods and analysis procedures;
- Data management practices; and
- Reporting procedures.

1.1 Plan Objectives

The purpose of this GMP is to:

1) Provide methods and procedures for collecting and analyzing groundwater data to ensure the results are representative of groundwater conditions at the site.
2) Provide a means to consistently evaluate the data and to establish criteria that will identify statistically significant increases (SSIs).
3) Provide a basis for evaluating site groundwater during the closure and post-closure monitoring period (no active disposal with all areas closed and covered). In particular, evaluate the effects of the following on the groundwater data: ceasing disposal, removing portions of the Bottom Ash Impoundment, constructing final cover, and establishing vegetation.

1.2 Document Organization

This document is intended as a comprehensive guidance for personnel involved with water quality monitoring at Stanton Station. Section 1.0 provides background information, including site geologic and hydrogeologic conditions. Section 2.0 provides an overview of the monitoring well network. Section 3.0 presents the sampling and analysis procedures, detailing methods for sample collection and analytical testing. Section 4.0 describes the monitoring program at Stanton Station. Section 5.0 discusses the statistical analysis plan for the site monitoring program. Section 6.0 provides data management procedures, while Section 7.0 presents annual reporting requirements and procedures. A list of references is provided in Section 8.0.

1.3 Background

GRE's Stanton Station began generating power in 1966 and ceased power production in February 2017. Coal combustion residuals (CCRs) are managed in composite-lined surface water impoundment cells and dry waste facilities regulated and permitted by the NDDH in accordance with NDAC Article 33-20, Solid Waste Management and Land Protection.

At the start of operations, ash was sluiced to an area east of the power station currently referred to in Permit 0043 as the "Historic Ash Disposal Area." Beginning in 1982, ash disposal was directed to three unlined treatment ponds (Ponds A, B, and C) via wet placement. Starting in 1992, Ponds A, B, and C were converted to the composite-lined Bottom Ash Impoundment over the eastern portion of Pond A, the Bottom Ash Landfill over the western portion of

Pond A, and an ash landfill over the eastern portions of Ponds B and C. The ash landfill occupying the prior locations of Ponds B and C was subsequently closed and capped, and is referred to within this document as the Closed Special Waste Landfill. Final cover construction over the Closed Special Waste Landfill was completed in 1997.

In 2017, Stanton Station ceased production of power and began deconstruction of the plant and restoration of the site. As part of the restoration activities, a revised Closure and Post-Closure plan for the Bottom Ash Landfill and Bottom Ash Impoundment was developed and submitted to the NDDH (Golder 2018). Closure of the Bottom Ash Landfill and Bottom Ash Impoundment are anticipated to begin in 2019, as well as site regrading for post-restoration activities.

Consistent monitoring of groundwater at Stanton Station began in 1997. Earlier samples collected at wells across the site are included in the complete groundwater database.

1.4 2019 Changes to Program

Stanton Station is currently monitored under two separate programs – a NDDH program as described in the 2005 Sampling and Analysis Plan (SAP) (McCain 2005), and a separate coal combustion residual (CCR) program administered in conjunction with the EPA’s CCR rule (40 CFR Parts 257 and 261), herein referred to as the CCR program. With closure and post-closure activities occurring at the site, the following changes are proposed to better align the site monitoring programs while meeting the plan objectives.

1) Consolidation of sampling programs.
    a. With closure and post-closure care ongoing at the facility, a consolidation of monitoring programs is proposed. For the Bottom Ash Landfill and Bottom Ash Impoundment, a move to follow the CCR program as outlined within the *Coal Combustion Residuals Groundwater Monitoring System Certification* and the *Coal Combustion Residuals Groundwater Statistical Method Certification* for Stanton Station (Golder 2017a and 2017b) is proposed, while no longer monitoring in accordance with the program as currently defined in the 2005 SAP (McCain 2005). For the Closed Special Waste Landfill, changes and additions to the program to provide consistency with the CCR monitoring program at the remainder of the site are described within this document.
2) Removal of wells MW-4 and MW-8A from the NDDH monitoring program (The proposed monitoring well network is shown in Figure 2).
    a. MW-4 is an upgradient well that the NDDH previously requested to not include with the upgradient monitoring wells for statistics. MW-4 has been monitored at GRE’s discretion, and was not considered part of the monitoring network in the 2005 SAP. GRE is proposing removal of this well from discretionary monitoring since the existing five upgradient/side-gradient monitoring wells in the program provide sufficient upgradient information.
    b. MW-8A is an upgradient well. Only one sample has been collected from this location, at the time of drilling and installation of the well in 1992. The well has historically had insufficient volume for sample collection, as evidenced by the lack of samples collected since the 1992 sample. The well is not anticipated to have enough volume for sample collection at any point, as the measured depth of MW-8A is 27.0 feet below ground surface (ft bgs), while the water level in its nested well, MW-8B, is approximately 40 ft bgs (during the October 2017 monitoring event, 39.2 ft bgs; May 2018, 43.2 ft bgs).

3) Removal of wells due to Facility Closure and Site Re-Grading (The proposed monitoring well network is shown in Figure 2).

   As part of closure of the Bottom Ash Landfill and Bottom Ash Impoundment (consistent with the closure/post-closure care plan submitted to the NDDH in December, Golder 2018) and re-grading of the site for post-restoration activities, several monitoring wells are proposed to be removed. These include MW-3B, MW-1R, and MW-100.

   a. MW-3B is located downgradient of the currently permitted Bottom Ash Landfill footprint. Due to re-grading and closure, the Bottom Ash Landfill will be consolidated into a smaller footprint, and this well will no longer be downgradient of the closed Bottom Ash Landfill. In addition, to accommodate improved site drainage around the Bottom Ash Landfill after closure, the well and berm on which this well is installed will be removed.

   b. MW-1R is located downgradient of the current Bottom Ash Impoundment boundary. The north and center cells of the Bottom Ash Impoundment will be closed by removal of CCR and this well will no longer be located within a reasonable distance of the facility boundary and will not be positioned in a location to adequately monitor for potential impacts from the closed Bottom Ash Impoundment south cell footprint. Additionally, this well may be impacted by the post-restoration site drainage plan.

   c. MW-100 is located between the Bottom Ash Landfill and the Bottom Ash Impoundment (see Section 2.1 for a description of the monitored facilities), at the edge of the Bottom Ash Impoundment center cell. Due to its location, MW-100 was included as part of the monitoring network in the 2005 SAP but was not considered a downgradient compliance monitoring well within the 2005 SAP. This well will be removed as part of the closure plan for removal of the Bottom Ash Impoundment center cell.

4) Addition of wells to the monitoring program (The proposed monitoring well network is shown in Figure 2).

   As a result of the removal of wells described above, and changes to the final closure footprints for the Bottom Ash Landfill and Bottom Ash Impoundment, additional wells have been added or are proposed to be added to the monitoring network.

   a. MW-105 has been added as an additional upgradient well, located south of the facilities across North Dakota Highway 200.

   b. MW-102 and MW-103 have been added downgradient of the Bottom Ash Landfill to work in conjunction with MW-9N to monitor groundwater behavior downgradient of the Bottom Ash Landfill.

   c. To monitor conditions downgradient of the reduced Bottom Ash Impoundment footprint (as only the south cell will be closed with CCR in place) three new monitoring wells are proposed (MW-201, MW-202, and MW-203).

   d. To more comprehensively monitor the Closed Special Waste Landfill during the remainder of the post-closure period, two monitoring wells downgradient of the Closed Special Waste Landfill are proposed (MW-204 and MW-205). Post-closure activities for the Closed Special Waste Landfill are expected to be completed in 2027, following 30 years of post-closure monitoring (closure construction completed Fall of 1997).

5) Alterations to the sampling frequency.

   a. To mirror the CCR detection monitoring program, this plan proposes changing the sampling frequency from quarterly to semi-annually.

6) Alterations to the analyte list.

   a. For the Bottom Ash Landfill and Bottom Ash Impoundment, the CCR Appendix III list will be used during Detection Monitoring, while the CCR Appendix IV list will be used for Assessment Monitoring (as described in Section 5.6). The Appendix III list represents appropriate indicator parameters for monitoring impacts associated with CCRs. In the EPA CCR Rule, it indicates:

      > "In selecting the parameters for detection monitoring, EPA chose constituents that are present in CCR and would rapidly move through the subsurface, and thus provide an early detection of whether contaminants were migrating from the CCR unit." (EPA 2015),

      The Appendix IV list includes parameters closely associated with CCRs that have known impacts to human health and the environment.

   b. For the Closed Special Waste Landfill, changes to the current parameter list are proposed to align with the CCR monitoring program and to better meet the objectives of monitoring potential releases from the Closed Special Waste Landfill. To accomplish this, the CCR Appendix III list is proposed for Detection Monitoring of the Closed Special Waste Landfill, and the CCR Appendix IV list is proposed for Assessment Monitoring of the Closed Special Waste Landfill.

7) Updates and changes to statistical methodology.

   a. Since publication and approval of the 2005 SAP, the EPA published an updated version of the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (EPA 2009), the prevailing guidance for groundwater monitoring and statistical analysis at RCRA facilities. The updates within this plan aim to bring the statistical analysis of site groundwater results in line with the Unified Guidance and state-of-the-practice techniques.

   b. The 2005 SAP cites use of inter-well statistical methodology as the primary means for statistical analysis at the site in an effort to "simplify" the interpretation. However, earlier documentation at the site described in the 2005 SAP as well as the EPA Unified Guidance (EPA 2009) recommend use of intra-well statistical methodology for historically impacted and geologically heterogenous sites, such as those included under Permit 0043 at Stanton Station.

   c. For the Bottom Ash Landfill and Bottom Ash Impoundment, the statistical methodology is detailed in the *Coal* Combustion *Residuals Groundwater Statistical Method Certification* (Golder 2017b). This document in included as APPENDIX A.

   d. For the Closed Special Waste Landfill, similar approaches to those described in APPENDIX A for the CCR program will be followed and are detailed within this document.

1.5 Site Setting

Stanton Station is located along the Missouri River, and the general area is primarily characterized by the presence of glacial deposits, with alluvial deposits dominating near-surface geology adjacent to the Missouri River. The following sections detail regional and site geology and hydrogeology.

1.5.1 Site Geology

Regional geology of the area surrounding Stanton Station is documented in the *Hydrogeologic Assessment Report, Stanton Station Ash Ponds* (Braun 1993). Physiographically, Stanton Station is located in the Missouri Slope District of the Glaciated Missouri Plateau Section of the Great Plains Province. Subsurface and surficial stratigraphy of Mercer County and the adjacent Oliver County were reviewed in depth by C.G. Carlson for the North Dakota Geological Society (Carlson 1973). Primary near-surface stratigraphic units in the area of Stanton Station include the Tongue River Formation and Cannonball Formation, with named lignite beds prominent in the vicinity of the site.

Near-surface geology at Stanton Station consists of two primary geologic units: the upper alluvial terrace deposits of the Missouri River, and underlying sediments and bedrock belonging to the Bullion Creek Formation, each of which have varying extents and thicknesses across the site (Braun 1993). Conceptual geologic cross sections were developed as part of the *Coal Combustion Residuals Groundwater Monitoring System Certification* (Golder 2017a) based on boring and historical site information (APPENDIX B).

1.5.2 Site Hydrogeology

The principal hydrostratigraphic unit and uppermost water-bearing unit in the vicinity of the CCR facilities (Bottom Ash Landfill and Bottom Ash Impoundment) consists of alluvial deposits, which includes two subunits: an upper silty sand and clay, and an underlying outwash sand and gravel. Individually, these subunits are laterally heterogeneous and geologic conditions within these subunits can be characterized by interbedded layers of gravel, sand, silt, clay, and coal.

Due to variations in subunit thickness throughout the site, groundwater in the uppermost water bearing unit is monitored in both the outwash subunit and the silty sand and clay subunit, with flow generally moving from southwest to northeast towards the Missouri River. Depths from the ground surface to the uppermost water-bearing unit range from 5 to 20 feet in the area around Stanton Station. A map showing recent available groundwater elevations is shown in Figure 2.

1.5.3 Release Conceptual Model

At Stanton Station, a hypothetical sub-surface release from the Bottom Ash Landfill, Bottom Ash Impoundment, or the Closed Special Waste Landfill would flow downgradient, to the northeast of the site. The downgradient wells are positioned along the northern edge of the Bottom Ash Landfill and Bottom Ash Impoundment, and along both the northern and eastern edges of the Closed Special Waste Landfill, to monitor for a potential release.

The groundwater flow rate across each facility was estimated with the equation $V_s = k \times i/n_e$, where:

- V_s is the groundwater flow rate, in feet per day (ft/day);
- k is the hydraulic conductivity, estimated from slug testing results from system wells (Braun 1993), in ft/day;
- i is the hydraulic gradient, calculated based on groundwater elevations for each monitoring event, in feet per feet (ft/ft);

- n_e is the effective porosity, estimated to be 0.25 for a silt/sand and is reflective of site soils (Duffield 2007).

The range of groundwater flow velocities calculated for the units during the May 2018 and November 2018 detection monitoring sampling events are shown below. As the Bottom Ash Landfill, Bottom Ash Impoundment, and Closed Ash Landfill are adjacent to one another and intersect similar geologic formations within the uppermost water-bearing zone, the groundwater flow rates are the same during each sampling event and are presented below based on a range of measured hydraulic conductivity (k) values from 1.05 ft/day to 40 ft/day.

- May 2018: 0.03 – 1.20 ft/day
- November 2018: 0.03 – 1.30 ft/day

2.0 MONITORING NETWORK

This GMP includes a monitoring network for each of the facilities at Stanton Station. To support the evaluation and analysis of water quality at the site, both upgradient and downgradient monitoring wells will be sampled.

2.1 Facilities

Stanton Station has three facilities that are monitored for the NDDH program:

- Bottom Ash Landfill – The Bottom Ash Landfill is located south of the plant site and west of the Bottom Ash Impoundment.
- Bottom Ash Impoundment – The Bottom Ash Impoundment is located south of the plant site, east of the Bottom Ash Landfill and west of the Closed Special Waste Landfill and consists of three interconnected cells designated as the north, center, and south cells. Only the south cell is planned to be closed with CCR in-place, while the north and center cells are planned to be closed by removal of CCR consistent with the closure/post-closure plan that was submitted to the NDDH in December 2018 (Golder 2018).
- Closed Special Waste Landfill – The Closed Special Waste Landfill is located to the southeast of the plant site, east of the Bottom Ash Impoundment.

2.2 Monitoring Locations

With the removal of the monitoring wells described in Section 1.4, water quality samples at Stanton Station will be collected from 14 locations. There are five upgradient/side-gradient monitoring wells (MW-6B, MW-7A, MW-7B, MW-8B, and MW-105) and nine downgradient monitoring wells, divided by unit as follows:

- Bottom Ash Landfill: MW-9N, MW-102, and MW-103
- Bottom Ash Impoundment: MW-201, MW-202, and MW-203
- Closed Special Waste Landfill: MW-10, MW-204, and MW-205

Monitoring well locations (both existing and proposed) are shown on Figure 2, construction details are provided in Table 1, and well construction logs are provided in APPENDIX C. Once this GMP and the location of the proposed wells is approved, GRE will submit an installation plan for the proposed wells (MW-201 through MW-205) to the NDDH for approval. The new wells will be installed in accordance with NDAC 33-20-13-04.

3.0 SAMPLING AND ANALYSIS PROCEDURES

The procedures for sampling and analysis provided in this section are intended as a working document that will be adapted as needed to reflect regulatory, technological, or operational changes. The data gathering and evaluation (i.e., sampling and analysis) procedures described herein are designed to:

- Be in accordance with the NDDH Regulations for Solid Waste Management.
- Be consistent with procedures recommended by the EPA.
- Provide monitoring results that represent groundwater quality at the upgradient and downgradient locations.

The following methodology is considered appropriate for sample collection to accurately monitor parameters in groundwater samples collected at the site.

3.1 Procedures Prior to Sampling

Prior to sample collection, the field procedure will begin with the preparation of the field log, verification of the required sample bottles, and organization and inspection of the field instrumentation.

Sample bottles will be provided by the analytical laboratory. Additional bottles for quality assurance/quality control (QA/QC) samples (duplicates, field blanks, and equipment blanks) will be arranged with the laboratory prior to shipment, as necessary. Specifics regarding QA/QC procedures are described in Section 3.3.

The laboratory will provide sample labels, chain-of-custody (COC) forms, and COC seals with delivery of the sample bottles. The containers, preservation techniques, and holding times for each parameter will be consistent with EPA-accepted procedures.

Each monitoring well will be inspected prior to sampling. The condition of the casing, monitoring well pad, reference mark for water level measurements, protective casing, monitoring well identification markings, and security lock will be recorded. Further, a check of the total depth of each well is recommended every four to eight sampling events to confirm well integrity.

Static water levels will be measured in monitoring wells at the facility within 24 hours of each other, prior to purging and groundwater sampling. Water level measurements will be made to the nearest 0.01 foot using a portable electric water level indicator. The depth to water will be measured from a dedicated reference mark on the riser pipe. Occasionally, the dedicated reference mark will be re-surveyed, if needed. A summary of the monitoring well depths is provided in Table 1, and well logs are provided in APPENDIX C.

The water level probe and tape will be decontaminated prior to use and between each location. Refer to Section 3.2.1 for decontamination procedures. A pair of new disposable gloves of appropriate material (e.g., latex or nitrile) will be worn while performing groundwater level measurements. Gloves will be changed between monitoring locations.

3.2 Sample Collection

Samples will be collected from the monitoring wells using low-flow procedures (Puls and Barcelona 1996). Dedicated bladder pumps and/or other reusable or disposable equipment will be used for purging and sample collection. Sample collection procedures are provided below.

3.2.1 Decontamination

All reusable, non-dedicated sampling equipment will be decontaminated prior to sampling and between each sampling location. Decontamination will be performed by washing all equipment with an Alconox® or comparable solution followed by a rinse with distilled or deionized water, followed by a second final rinse with distilled or deionized water. All clean or unused sampling equipment will be handled and maintained by personnel wearing clean, new, disposable gloves constructed of appropriate material (e.g., nitrile or latex). Decontamination times and locations will be recorded in the field log.

3.2.2 Sampling Equipment and Materials

The sampling equipment and materials may include the following:

- Dedicated bladder pump, controlling unit, compressed gas and discharge tubing, or disposable bailers with nylon rope
- Electric water level indicator
- Field water quality meter(s) capable of measuring pH, temperature, turbidity, and specific conductance
- Flow-through cell for the water quality meter(s)
- Water quality meter calibration solutions
- Disposable gloves (latex, nitrile, or other appropriate material)
- Deionized or distilled water
- Phosphate-free environmental detergent such as Alconox®
- Plastic sheeting to limit possible contamination of sampling equipment
- Re-sealable bags for sample storage and shipping
- Graduated container for purge water
- 5-gallon plastic buckets for decontamination
- Sample bottles and sample preservatives (if bottles are not pre-preserved by the laboratory)
- Field record forms, including sampling forms, COC forms, and sample labels
- Coolers and ice
- Paper towels

3.2.3 Procedures

Before the start of purging activities at each monitoring well, the date, time, weather conditions, physical condition of the monitoring well, and other pertinent data will be recorded in the field log. Any non-dedicated purging and sampling equipment will be decontaminated in accordance with the procedures described in Section 3.2.1 prior to use. Field parameter (pH, temperature, turbidity, and specific conductance) meters will be user-calibrated following manufacturer’s recommended procedures prior to the sampling event. Field calibration values will be recorded in the field log or on an Instrument Calibration Form, similar to the example provided in APPENDIX D.

3.2.3.1 Purging

Low-flow sampling methods and procedures will be used to purge the monitoring wells. Low-flow refers to the rate at which water is drawn into the pump, typically 0.1 to 0.5 liters per minute or approximately 0.025 to 0.125 gallons per minute (Puls and Barcelona 1996) and involves purging and sampling across a small portion of the screened interval. During low-flow sampling, the static water level will be monitored with an electric water level indicator. Pumping rates will need to be adjusted to limit drawdown when purging. Manufacturer information for the bladder pumps and associated controlling unit (GeoControl Pro) is included in APPENDIX E.

Additional details for low-flow sampling procedures is provided in the EPA's Region I Standard Operating Procedure (SOP), Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells included as APPENDIX F (EPA 2017).

Prior to sample collection, each well will be purged of stagnant water from the pump and tubing. Once the stagnant water has been purged, field parameters (pH, temperature, turbidity, and specific conductance) will be measured using either a handheld meter or a flow through cell in conjunction with a field meter. The field parameters will be recorded in the field log approximately every three to five minutes. Field parameters will be monitored no fewer than three times before sample collection. Samples will be collected once the stagnant water has been removed and the field parameters have stabilized. Stabilization is considered to have been reached when there is less than ± 3 percent change in at least three consecutive measurements of temperature and specific conductance, and ± 0.1 units change in three consecutive measurements of pH.

A summary of sampling activities for monitoring wells, including the sampling schedule and method, purge rate, and stabilization criteria are included in Table 2. If a monitoring well is pumped dry during purging, it can be assumed that stagnant water has been removed. In this case, the sample may be collected once the well has recharged enough to provide adequate sample volume.

The cumulative volume of water purged will be recorded upon stabilization of the field parameters. Purge water generated during sampling events will be discharged on the ground at or near the monitoring well location.

3.2.3.2 Sample Collection

After purging is completed and before handling the sample containers, sampling personnel will re-glove with new disposable gloves of appropriate material. Sample bottles will be labeled with the monitoring well number, date and time of sample collection, and preservative (if applicable), along with name of collector and parameters requested for analysis if required.

Samples will be collected in plastic or glass containers of appropriate capacity. Pre-cleaned sample containers with appropriate preservatives will be provided by the analytical laboratory. Containers should not be rinsed before filling. Sample containers and preservatives are outlined in Tables 3 and 4 for the various programs. For monitoring wells that are pumped dry, samples will be collected after a sufficient volume is available. Wells proposed for inclusion in the program (Section 2.2) are not anticipated to go dry based on site history and sampling methodology.

During sampling, equipment or fingers will not be allowed to contact the inside of the sample containers or the caps. Aliquots for each groundwater sample will be collected directly from the pump discharge and the pumping will be kept at a low rate. Field filtering of samples will not be performed, and any necessary filtering of samples will be performed by the laboratory.

Following completion of groundwater sampling at each monitoring well, all non-dedicated sample equipment will be decontaminated in accordance with the procedures specified above in Section 3.2.1. Following sample collection at each monitoring well, the monitoring well security cap will be replaced and locked.

3.2.3.3 Sample Preservation, Handling, and Shipment

Samples collected for laboratory analysis require preservation and/or refrigeration. Preservation and refrigeration requirements for detection monitoring events are provided on Table 3, and for assessment monitoring events in Table 4. Preservation of samples ensures sample integrity and prevents or minimizes degradation or transformation of the constituents to be analyzed. Appropriate preservatives will be provided by the laboratory and attached to the sample containers in small vials or added to the empty bottles in the laboratory before they are taken to the field. Samples will be placed in a chilled cooler containing ice (or ice packs) to reduce and maintain sample temperatures at or below 4° Celsius. More ice will be added as needed during sample collection and prior to sample drop-off or shipment to the analytical laboratory.

At the end of each day of sampling, the collected samples will be dropped-off or shipped for overnight delivery to the analytical laboratory. Packing material will be added to each cooler to reduce the risk of sample container breakage, particularly glass containers, during transport. A completed and signed COC form for all samples contained within the cooler will be sealed inside a re-sealable bag and placed in the cooler. The cooler will be sealed with shipping tape wrapped completely around the lid and box and a signed COC seal, provided by the laboratory, will be affixed to the outside of the cooler.

Recommended holding times for each analyte or group of analytes are presented in Tables 3 and 4. Sampling schedules and shipments to the laboratory will be coordinated to meet the recommended holding times (i.e., coordinate ahead of time with the laboratory if a Saturday delivery will occur). Laboratory analyses performed outside the recommended holding times will be flagged or qualified appropriately in the analytical report provided by the laboratory.

3.3 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures will be followed so that laboratory preparation, field sampling, and transport activities do not bias the results of the chemical analysis. QA/QC samples are collected to provide a quantitative basis for evaluating the analytical results. Proposed locations for collecting the QA/QC samples are provided on Table 5 to meet the recommended frequency for QA/QC samples collected for groundwater sampling programs.

The QA/QC samples will be used to validate the data for both downgradient and upgradient samples.

Blind Duplicate Sample – Blind duplicate samples will be collected by the sampling personnel in a manner identical to the primary sample. The duplicate sample will be analyzed by the laboratory just as the primary sample is analyzed and assigned unique sample identification numbers unassociated with the primary sample (i.e., MW-A, MW-1000, Duplicate 1, etc.). The duplicate is submitted to the analytical laboratory to allow for a determination of overall analytical precision. The quantity of duplicate samples should equal 5 to 10 percent of the total primary samples for a sampling event.

Field Blank – A field blank consists of sample bottles filled with deionized or distilled water at the sample site. The field blank will be analyzed by the laboratory as if it was a “real” sample. The blanks will serve as a quality check on container cleanliness, reagent, external contamination, and the analytical method. At least one field blank is typically collected for each day of sampling. The field blank will be labeled as “Field Blank” on the sample bottle and COC, and a field form should be completed.

Equipment Blank – A variation of the field blank is the equipment blank. Equipment blanks will be prepared in a manner identical to field blanks, except that deionized water is poured through clean (field decontaminated) non-dedicated sampling equipment and into the sample bottle. Equipment blank samples are used to assess that the potential for cross-contamination has been minimized by the equipment decontamination procedures. One equipment blank is typically collected for each day of sampling when non-dedicated sampling equipment is used. The equipment blank will be labeled as “Equipment Blank” on the sample bottle and COC. A field form should be completed documenting the piece of equipment associated with the equipment blank. At present, no non-dedicated equipment is used at Stanton Station, so no equipment blanks have been included on Table 5.

Matrix Spike and Matrix Spike Duplicate – Matrix spike (MS) and matrix spike duplicate (MSD) samples are collected by the sampling personnel in a manner identical to the primary sample. Once at the laboratory, the MS/MSD sample will be “spiked” with a known concentration of an analyte and analyzed by the laboratory just as the primary sample is analyzed. The spikes provide a measure of the precision of the analytical method(s) and techniques used by the laboratory. The duplicate is intended to assess that the results from the primary sample are accurate and reproducible. MS/MSDs are usually collected at a frequency of at least one MS/MSD pair per 20 regular samples. The MS/MSD will be labeled as “MS/MSD-1”, “MS/MSD-2”, etc. on the sample bottle and COC. A field form should be completed documenting the sample location associated with the MS/MSD.

3.4 Chain-of-Custody Controls

EPA-accepted COC procedures will be followed to document the integrity of the samples from the time the sample containers leave the laboratory until the issuing of the laboratory results. A written record of sample container possession and transference of samples will be documented on appropriate COC forms. From the time the empty sample containers leave the laboratory until the issuing of the laboratory results, the samples and/or sample containers will be: 1) in sight of the assigned custodian; or 2) locked in a tamper proof location; or 3) sealed with a tamper proof seal. A written record of sample container possession and transference of samples will be documented on appropriate COC forms.

The forms will also be used as a mechanism of communication between the sampling personnel and the analytical laboratory to note any specific details or requirements regarding the requested laboratory analysis. At the completion of the sampling event, a copy of the completed COC form(s) signed by all appropriate entities handling the samples will be retained with the laboratory report for site records.

3.5 Field Documentation

Documentation of observations and data acquired in the field provides information on the acquisition of samples and a permanent record of field activities. Observations and data will be recorded on field forms or in a field log. An example field form is provided in APPENDIX D. The field forms or log will be maintained by field personnel during the sampling and measurement activities. Field logs will be initialed and dated by the person recording the data. The field log entries are to include a full description of each sampling event, which may include the following:

- Monitoring well number
- Date and time the monitoring well was sampled
- Personnel present
- Weather conditions

- Any unusual field conditions or sampling difficulties
- Physical condition of the monitoring well (e.g., evidence of tampering)
- Depth to monitoring well screen and pump intake
- Purging device (pump type)
- Depth to water
- Pump dial setting
- Purge rate and volume purged
- Instrument calibration notes and results
- Stabilization parameter readings
- Color, clarity, and/or other visual characteristics of the water
- Temperature inside of cooler prior to shipping
- Notes to accompany any photos taken during sampling
- Documentation of repairs that may be needed
- Comments and/or other site observations

Additionally, any QA/QC samples collected (e.g., duplicate samples) should be described in the field log and will be assigned an appropriate sample identification number. A discussion of groundwater monitoring QA/QC procedures is presented in Section 3.3.

3.6 Analytical Procedures

Laboratory analytical methods will be performed in accordance with EPA-approved methods by a North Dakota-certified analytical laboratory. Laboratory analytical methods may be modified periodically to reflect the current technical practice. Reporting limits for the parameters analyzed will be the lowest concentrations that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions. Instrument detection limits will be kept at or below the practical quantitation limits (PQLs). Analytical methods and reporting limits are listed in Tables 3 and 4.

QA/QC procedures performed by the certified laboratory can be provided upon request and should be included with analytical reports. Quality control checks by the laboratory may include analyses of MS/MSD samples, laboratory blanks, and laboratory control standards for each parameter in the monitoring program.

3.6.1 Analytical Reports

The contents of the laboratory analytical reports will include:

- The sample identification number;
- Analytical results for both primary and duplicate samples;
- Dates that samples are collected in the field, received by the laboratory, and analyzed by the laboratory;

- Analytical methods;
- Reporting limits;
- MS/MSD results; and
- Other QA/QC results.

3.7 Data Evaluation

Data evaluation should be performed on the analytical data. The data should be reviewed to determine the usability of the data. The data should be reviewed in a timely manner to allow for re-analysis of a sample within holding times, where possible.

Data evaluation will include a review of holding times to assess whether EPA-prescribed holding times were met, and an evaluation of analytical accuracy and precision based on the results of analyses of duplicate samples, MS/MSD samples, and other samples tested for QA/QC purposes. QA/QC data will be compared to the certified laboratory's quality assurance objectives and deviations from these objectives will be investigated. An example laboratory data evaluation checklist, which assists in data evaluation, is included in APPENDIX G. Refer to the following EPA guidance documents for additional information:

- Guidance on Environmental Data Verification and Data Validation (EPA 2002)
- National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA 2017)

4.0 MONITORING PROGRAM

This monitoring program has been developed to support and manage water quality monitoring at Stanton Station, as regulated by the NDDH under Permit Number 0043. The monitoring parameters, frequency of monitoring, and statistical analysis methods for the monitoring program are described in the following sections.

4.1 Parameters

Water quality will be sampled and analyzed at the Bottom Ash Landfill, Bottom Ash Impoundment, and Closed Special Waste Landfill for the parameters provided in Table 3 during detection monitoring and for the parameters provided in Table 4 in the event of assessment monitoring (as described in Section 5.6). Water levels will also be measured at the time of sample collection for all wells. Additionally, the following field parameters will be monitored: pH, specific conductance, temperature, and turbidity. In the future, the analyte list may be revised to account for site-specific conditions, if necessitated and approved by the NDDH.

Parameters reflect the requirements of the EPA's CCR rule, with required parameters for detection monitoring (40 CFR 257.94(a)) listed in Appendix III of the rule and required parameters for assessment monitoring (40 CFR 257.95(b)) listed in Appendix IV of the rule.

4.2 Frequency of Sampling

Samples for the detection monitoring program will be collected semi-annually. In the event of assessment monitoring (as described in Section 5.6), sampling schedules will be modified to reflect the requirements of the assessment monitoring program.

4.3 Statistical Analysis

The purpose of groundwater monitoring at Stanton Station is to determine if on-site disposal has impacted the groundwater quality and to evaluate the effects of recent and ongoing measures during site-closure activities. To determine if an impact has occurred, baseline and more recent groundwater data from each well will undergo statistical analysis. The statistical plan for the groundwater analytical data for the Bottom Ash Impoundment and Bottom Ash Landfill for the CCR program is included as APPENDIX A, while the statistical plan for the Closed Special Waste Landfill is described in detail in Section 5.0.

5.0 STATISTICAL ANALYSIS PLAN

The statistical plan for the groundwater analytical data during detection monitoring for the Closed Special Waste Landfill is described within the following section. The statistical methodology outlined within this document was selected in accordance with the Unified Guidance (EPA 2009).

Statistical analysis will be conducted using Sanitas (Sanitas Technologies 2014) or similar statistical analysis software.

Comparative statistical analysis will be performed semi-annually following each monitoring event to identify whether concentrations are statistically significant in comparison to baseline values, with the results reported annually.

The baseline data for constituents in the monitoring program will be reviewed periodically (approximately every 2 to 3 years based on a semi-annual sampling frequency) to determine if recent results that are not statistically significant in comparison to baseline values can be incorporated into an updated baseline period (specifics of the baseline update procedure are discussed in depth in Section 5.3.7).

5.1 Current Data

At present, the statistics used for analysis of Stanton Station's groundwater conditions utilize all available data points, with exceptions provided for issues identified using professional judgement (i.e., outliers, database errors, detection limit changes). To best identify potential changes to groundwater quality based on current site conditions, truncating or shifting of baseline periods may occur in the future. In many cases this will allow for more conservative limits to be established for parameters where reporting limits have been reduced.

5.2 Intra-Well Methodology

Intra-well (comparing compliance data to baseline data within a single well) statistics were identified as an appropriate method for groundwater monitoring at Stanton Station. This method was selected based on the following factors outlined in the Unified Guidance (EPA 2009).

- Per the Unified Guidance: Intra-well methodology allows establishment of reasonable baseline periods for future tests in historically impacted wells. Additionally, measurements occur solely between the baseline period and compliance period of testing within a single well.
  - Past CCR depositional facilities are known to have impacted the subsurface hydrology. Those facilities have been removed and new facilities with engineered liner systems have been constructed (see Section 1.3). The use of intra-well statistics allows future potential changes in water chemistry to be more readily tracked in relation to current facilities at Stanton Station.
- Per the Unified Guidance: Confounding results stemming from spatial variability can be eliminated.

- Due to the heterogeneity of the glacial geology at Stanton Station (see Section 1.5), spatial variability of the monitored hydrostratigraphic units is encountered throughout the groundwater monitoring network. Use of intra-well statistics allows comparisons to be made on a per well basis, which avoids comparisons being made between differing geologic and geochemical conditions.

5.3 Methodology for Baseline Diagnostic Tests

5.3.1 Collection of Baseline Data

Baseline samples (a minimum of eight) will be collected for new wells added to the program, as well as for wells not historically part of the CCR program (i.e., MW-10). Samples will be analyzed for both the Appendix III and Appendix IV constituent lists (Tables 3 and 4). The following field parameters will also be recorded: pH, specific conductivity, temperature, and turbidity. Following collection of the baseline samples, semi-annual detection monitoring samples will be analyzed for the Appendix III constituent list. In the event of assessment monitoring, samples will be analyzed for the Appendix IV constituent list. During both the baseline period and any future sample collection, metals will be analyzed as total recoverable metals, i.e., samples will not be filtered.

To obtain independent samples, baseline samples will be collected approximately every two months during the baseline period. As a result of site restoration and re-grading activities, new wells will likely not be installed until late 2019/early 2020. Comparative statistics will not be conducted until a complete set of baseline data (i.e., a minimum of eight samples per constituent) has been collected.

The statistical analyses described in the following sections will be performed for each of the Appendix III constituents listed in Table 3 during detection monitoring. With the exception of field pH, statistical analysis will not be conducted on field constituents (specific conductivity, temperature, and turbidity). There is a high potential for false positive results with field measurements due to the potential for sample collection inconsistency (e.g., changes in field conditions and sampling personnel), equipment calibration variability, and other causes of measurement variability.

5.3.2 Initial Data Review and Non-Detect Handling

Initially, data will be plotted on time-series graphs to assess the temporal variability of the data and to visually screen for potential outliers. Temporal variability can be caused by seasonality, changes to the monitored system, changes to the analytical method, recalibration of instruments, and anomalies in the sampling method (EPA 2009).

Non-detect values (ND) are results where the constituent is not detected at a concentration above the PQL. The PQL is the lowest concentration that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions. ND values will be managed within the statistical procedures discussed in this document, following the approach recommended by the Unified Guidance (EPA 2009):

- For sample populations with < 15% ND, direct substitution of the NDs with ½ the PQL.
- For sample populations with 15% < ND ≤ 50%, the Kaplan-Meier approach or other appropriate method will be used to estimate the mean and standard deviation of the population.
- For sample populations with > 50% ND, non-parametric approaches are used to assess the data, with direct substitution of the NDs with the PQL.

5.3.3 Data Distribution

Parametric statistical tests assume that the data are normally-distributed or can be transformed to a normal distribution. The distribution of the data will be tested for normality using the Shapiro-Wilk normality test with a

95 percent confidence level (or the Shapiro-Francia test when there are more than 50 results within the dataset). Each constituent from each well will be analyzed separately. Datasets found to be non-normal will be tested for other distributions using the 'Ladder of Powers' described by the Unified Guidance and transformed accordingly. Following transformation, parametric statistical methods will be performed on the transform-normally distributed data. Non-parametric statistics will be used for datasets that do not show normal or transform-normal distributions.

5.3.4 Outlier Analysis

In accordance with the Unified Guidance, data points will be identified as outliers if the value was an "extreme, unusual-looking measurement" and "inconsistent with the distribution of the remaining measurements." The Unified Guidance recommends testing for outliers within baseline data, but cautions against removal of outliers, unless a likely error or specific discrepancy can be identified, such as recordkeeping errors, unusual sampling and laboratory procedures or conditions, inconsistent sample turbidity, or values significantly outside the range of other results. In accordance with the Unified Guidance, apparent outliers will be periodically revisited even if initially removed, due to the propensity of groundwater chemistry to change over time.

Outliers will be evaluated and identified through visual inspection and the EPA-recommended Dixon's Test for statistical outliers (or Rosner's Test when there are greater than 25 samples). Dixon's and Rosner's Tests assume that all data values, except the suspected outlier, are normally distributed or can be transformed to fit a normal distribution. Consequently, visual inspection of concentrations over time is important in screening for outliers. The effect of removing outliers from the baseline data will usually be to lower the statistical limit (due to a reduction in the standard deviation), resulting in a more conservative statistical limit and improving the odds of detecting increasing concentration levels.

Outliers will be managed as follows:

- Any suspected outlier identified through statistical analysis or visual methods will be reviewed (i.e., through evaluation of the associated analytical report, laboratory narrative, associated laboratory QA/QC information, and/or field notes) before removal from the dataset to determine if any systematic or systemic errors were responsible for the noted anomalous readings. Rejected data points will not be included in the baseline dataset.
- The rationale for the removal of any outliers will be documented. Most outliers will likely be isolated values that can be attributed to inconsistent sampling or analytical chemistry methodology resulting in laboratory contamination or other anomalies.
- If an outlier is removed, the normality test (Section 5.3.3) will be re-run to determine if the dataset is normally-distributed or transform-normal without the outlier.

5.3.5 Trend Analysis

Most statistical tests assume concentrations do not demonstrate temporal correlation. The Sen's Slope methodology is an intra-well non-parametric statistical analysis for increases or decreases in measured concentrations over time, measured by calculating the slope of the linear relationship of concentration levels and time. Sen's Slope Methodology is paired with the Mann-Kendall test to determine the statistical significance of the calculated Sen's Slope. The methodology involves examining all possible pairs of measurements in the dataset and scoring each pair to determine if a trend exists. The test will be conducted using a confidence level of 99 percent.

If temporal trends are identified within the dataset, the data will be adjusted to account for the trends, the time period used for the baseline statistics will be reassessed, and/or an alternative statistical method will be used to assess for statistically significant increases above background. In the case of downward trends (other than pH), no adjustments may be considered appropriate and a constituent may not be considered for statistical analysis until further data is collected.

5.3.6 Seasonality

Seasonal temporal variability can mask changes in groundwater chemistry. Time-series plots will be observed for visual signs of seasonality, and once enough data has been collected within the program, the data will be evaluated for seasonal variations using the Kruskal-Wallis test. The Kruskal-Wallis test will be performed individually for each constituent at each well and requires at least 3 occurrences of each prospective season with results to calculate the statistic. Datasets that are found to have seasonality will be de-seasonalized for subsequent statistical analysis.

5.3.7 Updating the Baseline Period

The Unified Guidance recommends updating the baseline period every two to three years when the sampling frequency is semi-annual, or when four to eight samples have been collected. A baseline update will include a review of any revisions to federal and state regulations and EPA statistical guidance documents that may have been promulgated since the previous baseline statistical analysis. The baseline period for a specific constituent will not be updated if verified SSIs have been identified for that constituent, unless a demonstration has been made that the SSI is not related to a release from the facility.

Prior to inclusion of more recent data in an updated baseline period, a Wilcoxon Rank-Sum test will be conducted. The Wilcoxon Rank-Sum test, also referred to as the Mann-Whitney test, determines if measurements from one population are statistically significantly higher or lower than another population. The test is non-parametric, namely the data being tested is not assumed to fit a specific distribution, such as a normal distribution. When the baseline period is updated, the Wilcoxon Rank-Sum test will be used to compare data from the current baseline period with the more recent data that are intended to be reclassified and included in the updated baseline period. The test will be conducted at a 95 percent confidence level. If the two datasets are drawn from the same population, then the results of the test support updating the prior baseline dataset with the recent data. After the new data are incorporated into the dataset, the baseline diagnostic tests outlined in Section 5.3 will be conducted.

If the Wilcoxon Rank-Sum test detects a significant difference between two sample populations, additional data review will be necessary. The data will be reviewed to determine whether a gradual trend or other change not stemming from a release from the facility has occurred that was not detected during comparative statistical analysis. At the time of the baseline update, some earlier baseline data might need to be removed from the updated baseline period. Removal of earlier baseline data ensures that future statistical analysis is based on current groundwater conditions, rather than on outdated measurements of groundwater chemistry. Alternatively, outliers identified in the previous baseline period (as described in Section 5.3.4) will be re-incorporated into the dataset and re-evaluated as potential outliers during the baseline update, unless the outlier(s) were removed due to sampling, laboratory, or other determinant error.

5.4 Statistical Limits

Either a parametric or non-parametric method will be used to generate the baseline statistical limit for each constituent. The statistical method will vary between constituents and will be selected based on the percent of ND values in the baseline period and the baseline data distribution for each constituent at each well, in accordance with the Unified Guidance (EPA 2009).

For those constituent-well pairs where concentrations of a given analyte are normally or transform-normally distributed and have equal to or greater than 50% detections, Shewhart-CUSUM control charts will be used. The Unified Guidance notes that Shewhart-CUSUM control charts use two separate evaluation procedures. First, compliance measurements are compared to the Shewhart Control Limit (SCL). Second, the cumulative summation (CUSUM) of the standardized means is compared to the “internal decision value” (h_i). The Unified Guidance recommends one standardized control limit (h_c) for both the SCL and h_i. The mean $(\bar{x})$ and standard deviation (s) of the baseline data set are used to calculate the control limit, by the following equation:

$$h_c = \bar{x}_{BG} + hs_{BG}$$

Per the Unified Guidance, h is the standardized control limit and will be set at 4.5.

Where the concentrations of a given constituent-well pair are not normally or transform-normally distributed, or has less than or equal to 50 percent detections, a non-parametric prediction limit will be used. The non-parametric limit will be assigned as the highest detected value (excluding outliers) or the highest PQL, whichever is greater.

In the case of increasing trends within the baseline period, the data will be adjusted to account for the trends where a source other than the facility can be identified and/or an alternative statistical method will be used to assess for statistically significant increases above background. In the case of downward trends (other than pH), no adjustments may be considered appropriate and a constituent may not be considered for statistical analysis until further data is collected; therefore, the trend test will serve as the alternative method for constituents with decreasing trends.

5.5 Comparative Statistical Analysis

Comparative statistical analysis will be conducted following each monitoring event. For both Shewhart-CUSUM limits and non-parametric prediction limits, the comparative statistical analysis will consist of a comparison of monitoring results (the recent analytical results for each monitoring event performed after the baseline period) to the statistical limit calculated from the baseline data.

The following definitions will be used in discussion of the comparative statistical analysis:

- Elevated CUSUM – an elevated CUSUM occurs when the CUSUM is greater than the Shewhart-CUSUM limit established by the baseline statistical analysis, but the analytical result does not exceed the Shewhart-CUSUM limit. An elevated CUSUM is an indication that concentrations are gradually increasing and that analytical results may exceed the Shewhart-CUSUM limit in the future.
- Potential Exceedance – is defined as an initial elevated CUSUM or an initial analytical result that exceeds the Shewhart-CUSUM limit or non-parametric statistical limit established by the baseline statistical analysis. Confirmatory resampling will determine if the potential exceedance is a false-positive or a verified statistically significant increase (SSI). Non-detect results that exceed either the Shewhart-CUSUM limit or the non-parametric statistical limit are not considered potential exceedances.
- False-positive – is defined as an analytical result that exceeds the statistical limit that can clearly be attributed to laboratory error, changes in analytical precision, or is invalidated through confirmatory re-sampling. False-positives are not used in calculation of subsequent CUSUMs.
- Confirmatory re-sampling – is designated as the next scheduled sampling event.

- Verified SSI – is interpreted as two consecutive SSIs (the original sample and the confirmatory re-sample for analytical results, or two consecutive elevated CUSUMs) for analytical results, or two consecutive elevated CUSUMs for the same constituent at the same well.

The monitoring program has been developed to identify potential exceedances over baseline values. A potential exceedance will not be considered a verified SSI until confirmatory re-sampling is performed. Confirmatory re-sampling will occur during the next regularly scheduled sampling event.

5.6 Reporting and Actions for Verified SSIs

5.6.1 Bottom Ash Landfill and Bottom Ash Impoundment

For the Bottom Ash Landfill and Bottom Ash Impoundment, a description of the course of action for a detection monitoring verified SSI is detailed in Section 3.3 of APPENDIX A, including transitioning to assessment monitoring. Section 3.3 of APPENDIX A describes actions required in the event of an assessment monitoring verified SSI.

If a verified SSI is identified in a downgradient well for an Appendix III constituent as part of the detection monitoring program, GRE will establish an assessment monitoring program meeting the requirements of 40 CFR 257.95 of the CCR rule. Alternatively, GRE may demonstrate that a source other than the regulated CCR facilities caused the SSI, or that the SSI was a result of an error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality that failed to be captured during baseline data collection (40 CFR 257.94(e)(2)). A report documenting the alternative source demonstration (ASD) will be certified by a Professional Engineer registered in the state of North Dakota and placed in the Site’s Operating Record within 90 days of the SSI determination. If a successful demonstration is made and documented, GRE will continue with the detection monitoring program. If, after 90 days, a successful demonstration is not made, GRE will initiate an assessment monitoring program.

5.6.2 Closed Special Waste Landfill

If a detection monitoring verified SSI is identified for the downgradient wells monitoring the Closed Special Waste Landfill, GRE will notify the NDDH within 90 days of completing the comparative statistics. Following identification of a verified SSI, GRE may do one of the following:

- Demonstrate that a source other than the Closed Special Waste Landfill caused the SSI, or that the SSI was a result of an error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality that failed to be captured during baseline data collection. A report documenting the alternative source demonstration (ASD) will be prepared and included with the annual report. If a successful demonstration is made and documented, monitoring will continue as outlined within this document.

- Continue monitoring the Closed Special Waste Landfill as outlined within this document during the remainder of the post-closure period or an agreed upon length of time with the NDDH to assess the effectiveness of recent and ongoing site source control measures.

- In the event a successful ASD cannot be made, or GRE and the NDDH agree that site source control measures are ineffective, GRE will initiate an assessment monitoring program. The assessment monitoring program will be approved by the NDDH and will generally follow the assessment monitoring program outlined in the EPA’s CCR Rule.

6.0 DATA MANAGEMENT

The water quality database for Stanton Station is maintained electronically using Earthsoft's EQuIS™ data management software. Upon completion of each monitoring event and subsequent laboratory analysis, analytical results are received from the laboratory in hard-copy report formats and as electronic data deliverable (EDD) files. After the results have been verified and reviewed (Section 3.7), the EDDs will be appended to the existing database. These data management procedures support the QA/QC procedures discussed in Section 3.3.

7.0 REPORTING

An annual monitoring report will be submitted to the NDDH in the year following the monitoring year. The report will summarize the results of the year's groundwater monitoring, describe any changes or modifications at the site that may affect the monitoring network, and propose changes to the monitoring network, parameters, or frequency based on evaluation of the annual data. The report will also note the occurrence of any verified SSIs and proposed actions to resolve the verified SSI.

Revisions to this GMP, including statistical methods, will be submitted to the NDDH for approval along with the rationale for the proposed change.

8.0 REFERENCES

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Tables

Table 1: Monitoring Well Summary

Location	Well ID	Date Constructed	TOC Elevation	Ground Surface Elevation	Screen Interval	Top of Screen Elevation	Bottom of Screen Elevation	Sand Pack Interval	Geologic Unit(s) Completed In
			ft amsl	ft amsl	ft bgs	ft amsl	ft amsl	ft bgs	
Upgradient/Side-gradient	MW-6B	9/8/1992	1711.2	1709.3	28.4-38.4	1681	1671	19.0-38.5	Outwash
	MW-7A	8/27/1992	1713.4	1711.0	7.0-17.0	1704	1694	5.0-18.0	Silty Sand/Clay
	MW-7B	9/9/1992	1712.7	1710.9	28.1-38.1	1682	1672	23.0-38.5	Silty Sand/Outwash
	MW-8B	9/3/1992	1749.7	1747.2	54.0-64.0	1694	1684	49.0-64.5	Outwash
	MW-105	11/18/2015	1716.6	1713.5	9.0-19.0	1704	1694	7.0-19.0	Clay/Outwash
Bottom Ash Landfill Downgradient	MW-9N	7/19/2010	1708.1	1705.5	16.0-26.0	1689	1679	14.0 - 26.0	Outwash
	MW-102	11/17/2015	1711.7	1708.5	14.0-24.0	1694	1684	12.0-24.0	Silty Sand/Clay
	MW-103	11/17/2015	1709.1	1705.6	14.0-24.0	1692	1682	12.0-24.0	Outwash
Bottom Ash ImpoundmentDowngradient	MW-201 *								
	MW-202 *								
	MW-203 *								
Closed Ash Landfill	MW-10	7/19/2010	1707.7	1705.1	15.0-25.0	1690	1680	13.0-25.0	Sand/Silty Sand/Clay
	MW-204 *								
	MW-205 *								

Notes:

TOC: top of casing

ft amsl: feet above mean sea level

ft bgs: feet below ground surface

TOC and ground surface elevations surveyed by Interstate Engineering, Inc. in December 2015.

Well construction measurements are from the original bore log, well data sheet or well construction form.

* MW-201, MW-202, MW-203, MW-204, and MW-205 are proposed well locations. Once approved, these wells will be constructed in accordance with NDAC 33-20-13-07 and the installation information will be provided to the NDDH.

Table 2: Sampling Methods

Location	Sampling Schedule	Sampling Method	Purge Rate (mL/min)	Determination of Steady-State Conditions			Time Interval Goal for Steady-State
				Temperature	**pH**	**Specific Conductance**	
Monitoring Wells	Semiannual	Low-Flow	100 - 500	Less than +/- 3% change in three consecutive readings	Three consecutive readings within +/- 0.1 pH units	Less than +/- 3% change in three consecutive readings	3-5 minutes between readings

Table 3. Parameter and Analysis Summary - Detection Monitoring

Parameter [1]	Method Reference [2]	Target Reporting Limit	Container [3]	Preservation [4]	Max. Holding Time from Sampling [5]
Field Parameters					
pH	SESDPROC-100-R3	0.1 units	--	--	Immediately or within 15 minutes
Specific Conductance*	SESDPROC-101-R1	1.00 umhos/cm	--	--	Immediately or within 15 minutes
Temperature*	SESDPROC-102-R4	--	--	--	Immediately or within 15 minutes
Turbidity*	SESDPROC-103-R3	--	--	--	Immediately or within 15 minutes
General Chemistry					
Chloride	SM 4500 Cl E/00	1.0 mg/L	Plastic	4° ± 2°C	28 days
Fluoride	EPA 9214	TBD		4° ± 2°C	28 days
pH (lab)*	SM 4500 H+ B/00	0.1 units		4° ± 2°C	Immediately or within 15 minutes
Sulfate	SM 4500 SO4	5.0 mg/L		4° ± 2°C	28 days
Total Dissolved Solids	I1750-85	5.0 mg/L		4° ± 2°C	7 days
Metals (total)					
Boron	EPA 6010	0.1	Plastic	HNO_3 to pH<2	6 months
Calcium		1.0			

Notes:

1. Boron, calcium, chloride, fluoride, sulfate, and total dissolved solids are tested in the laboratory. Temperature, turbidity, and specific conductance are tested in the field and pH is tested in the field and in the laboratory.
2. Or equivalent method.
3. Containers and volumes will be specified by the lab.
4. Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the temperature maximum has not been exceeded.
5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

* Additional parameters that are not part of the Appendix III Detection Monitoring list and are collected for informational purposes only.

Table 4. Parameter and Analysis Summary - Assessment Monitoring

Parameter [1]	Method Reference [2]	Target Reporting Limit [3]	Container [4]	Preservation [5]	Max. Holding Time from Sampling [6]
Field Parameters					
pH	SESDPROC-100-R3	0.1 units	--	--	Immediately or within 15 minutes
Specific Conductance*	SESDPROC-101-R1	1.00 umhos/cm	--	--	Immediately or within 15 minutes
Temperature*	SESDPROC-102-R4	--	--	--	Immediately or within 15 minutes
Turbidity*	SESDPROC-103-R3	--	--	--	Immediately or within 15 minutes
General Chemistry					
Fluoride	EPA 9214	TBD	Plastic	4° ± 2°C	28 days
pH (lab)*	SM 4500 H+ B/00	0.1 units		4° ± 2°C	Immediately or within 15 minutes
Metals (total)					
Antimony	EPA 6010	0.001 mg/L	Plastic	HNO_3 to pH<2	6 months
Arsenic		0.002			
Barium		0.002			
Beryllium		0.0005			
Cadmium		0.0005			
Chromium		0.002			
Cobalt		0.002			
Lead		0.0005			
Lithium		0.1			
Molybdenum		0.002			
Selenium		0.002			
Thallium		0.0005			
Mercury	EPA 7470A	0.2	Plastic	HNO_3 to pH<2	28 days
Radium-226 and 228 combined	EPA 9315 and EPA 9320	1.0 and 2.0 pCi/L	Plastic	HNO_3	6 months

Notes:

1. Fluoride and all metals are tested in the laboratory. Temperature, turbidity, and specific conductance are tested in the field and pH is tested in the field and in the laboratory.
2. Or equivalent method.
3. Listed reporting limits are the maximum allowable reporting limits.
4. Containers and volumes will be specified by the lab.
5. Sufficient ice should be placed with the samples in the shipping container to ensure that ice is still present when the samples arrive at the laboratory. However, even if ice is present when the samples arrive, it is necessary to immediately measure the temperature of the samples and confirm that the temperature maximum has not been exceeded.
6. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid.

* Additional parameters that are not part of the Appendix IV Assessment Monitoring list and are collected for informational purposes only.

Table 5: Proposed Quality Assurance/Quality Control Sample Collection Locations

Location	Well ID	Detection Monitoring Event	Assessment Monitoring Event
Upgradient/Side-gradient	MW-6B		Duplicate
	MW-7A		
	MW-7B	Duplicate	
	MW-8B		Field Blank
	MW-105		
Bottom Ash Landfill	MW-9N		
	MW-102	Duplicate	
	MW-103		MS/MSD
Bottom Ash Impoundment	MW-201		
	MW-202	Field Blank	
	MW-203		Duplicate
Closed Ash Landfill	MW-10		Field Blank
	MW-204		
	MW-205	MS/MSD	

Notes:
Locations to collect samples are suggestions only to help with the distribution of QA/QC samples across the site and between facilities.

Figures

LEGEND

—3600—	EXISTING GROUND TOPOGRAPHY (REFERENCES 3 AND 4)
—3600—	CONCEPTUAL FINAL GRADES (REFERENCES 3 AND 4)
◑	EXISTING PROGRAM MONITORING WELLS
⊕	NEW PROGRAM MONITORING WELLS
⊗	PROPOSED MONITORING WELLS TO REMOVE
●	PROPOSED NEW MONITORING WELLS (LOCATIONS APPROXIMATE, FOR DISCUSSION ONLY)
(1688)	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL) (NOTE 1)
→	GENERAL DIRECTION OF GROUNDWATER FLOW
—	POTENTIOMETRIC SURFACE CONTOUR (NOTE 3)

NOTE(S)

1. GROUNDWATER ELEVATIONS WERE MEASURED NOVEMBER 2018.
2. MW-8A IS PROPOSED FOR REMOVAL. MW-8B WILL REMAIN A PART OF THE MONITORING PROGRAM.
3. GROUNDWATER SITE INFORMATION WAS USED IN THE CREATION OF POTENTIOMETRIC SURFACE CONTOURS. CONTOUR INTERVAL IS FIVE (5) FEET.
4. GROUNDWATER ELEVATION MEASUREMENTS FOR MW-1R DID NOT OCCUR DURING NOVEMBER 2018 AS THE MONITORING WELL WAS INACCESSIBLE DURING PLANT DECONSTRUCTION.

REFERENCE(S)

1. T144N, R84W, MERCER COUNTY, NORTH DAKOTA.
2. AERIAL IMAGE IS A COMBINATION OF IMAGERY OBTAINED FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE NATIONAL AERIAL IMAGE PROGRAM, ACQUIRED IN 2018, AND IMAGERY PROVIDED BY GRE, ACQUIRED IN JUNE 2018.
3. EXISTING GROUND TOPOGRAPHY IS FROM AN AERIAL SURVEY PERFORMED BY KBM, INC. ON APRIL 27, 2001 (SITE WIDE), A GROUND SURVEY PERFORMED BY INTERSTATE ENGINEERING IN 2014 (BOTTOM ASH IMPOUNDMENT AND LANDFILL AREA), A GROUND SURVEY PERFORMED BY INTERSTATE ENGINEERING IN 2017 (COAL PILE AREA), AND A GROUND SURVEY PERFORMED BY INTERSTATE ENGINEERING IN 2018.
4. EXISTING GROUND CONTOURS ARE TWO (2) FEET AND CONCEPTUAL FINAL GRADE CONTOURS ARE ONE (1) FOOT.

GOLDER

PROPOSED MONITORING WELL NETWORK

GREAT RIVER ENERGY – STANTON STATION

FIGURE 2

Path: \\den1-v-fs1\acad\GREAT RIVER ENERGY\STANTON\99_PROJECTS\1894194\Site Restoration\Conceptual Figures\ | File Name: 1894194A005.dwg

APPENDIX A

Coal Combustion Residuals Groundwater Statistical Method Certification, Great River Energy - Stanton Station

CCR GROUNDWATER STATISTICAL METHOD CERTIFICATION

COAL COMBUSTION RESIDUALS GROUNDWATER STATISTICAL METHOD CERTIFICATION

Great River Energy – Stanton Station

Submitted To: Great River Energy
Stanton Station
4001 Highway 200A
Stanton, North Dakota 58571

Submitted By: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228

October 12, 2017 **177255**

Table of Contents

List of Tables

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this Coal Combustion Residuals (CCR) Statistics Groundwater Statistical Method Certification Report on behalf of Great River Energy (GRE) to certify that the statistical methodology to be employed at GRE's Stanton Station (SS) is appropriate and meets the requirements of 40 CFR 257.93.

1.1 Purpose

The CCR rule establishes specific requirements for statistical analysis of groundwater monitoring networks in 40 CFR 257.93 (Groundwater sampling and analysis requirements). Per part (f) of § 257.93, owners or operators of CCR units must select a statistical method to evaluate groundwater monitoring data for the constituents specified in Appendix III and Appendix IV of the rule. This report serves as the documentation of the required certification of the selected statistical methodology, in accordance with 40 CFR 257.93(f)(6).

This document may be periodically revised based on a review of changes to guidance documents provided by the United States Environmental Protection Agency (EPA) or other governing entities, as well as revisions to the language of the rule itself.

1.2 Site Background

Stanton Station is a coal-fired electric generation facility located in Mercer County, North Dakota, approximately 3 miles southeast of the city of Stanton along the Missouri River. SS has two CCR facilities regulated under the CCR rule. The CCR units include the following:

- Bottom Ash CCR Landfill (Bottom Ash Landfill)
- Bottom Ash CCR Surface Impoundment (Bottom Ash Impoundment)

1.3 Constituents

Baseline samples (a minimum of eight) were collected between June 2016 and April 2017 and were analyzed for both the Appendix III and Appendix IV constituent lists associated with the CCR rule (Table 1). Additionally, the following field parameters were recorded: pH, specific conductivity, temperature, and turbidity. Following collection of the baseline samples, semi-annual detection monitoring samples will be analyzed for the Appendix III constituent list. If assessment monitoring is required, samples will also be analyzed for the Appendix IV constituent list in accordance with CCR rule requirements. During both the baseline period and any future sample collection, metals will be analyzed as total recoverable metals, i.e. the samples will not be filtered.

The statistical analyses described in the following sections will be performed for each of the Appendix III constituents listed in Table 1 during detection monitoring, and for the Appendix IV constituents in the event of assessment monitoring. With the exception of field pH, statistical analysis will not be conducted on field constituents (specific conductivity, temperature, and turbidity). There is a high potential for false positive results with field measurements because of sample collection inconsistency (e.g., changes in field conditions and sampling personnel), equipment calibration variability, and other causes of measurement variability.

Table 1. CCR Constituent Lists

Appendix III Constituents		Appendix IV Constituents
Boron		Antimony
Calcium		Arsenic
Chloride		Barium
Fluoride		Beryllium
pH		Cadmium
Sulfate		Chromium
Total Dissolved Solids (TDS)		Cobalt
		Fluoride
		Lead
		Lithium
		Molybdenum
		Mercury
		Radium-226 and -228 combined
		Selenium
		Thallium

2.0 STATISTICAL METHODOLOGY

The purpose of groundwater monitoring in conjunction with the CCR rule is to determine if the regulated CCR Units are impacting groundwater. To determine if an impact has occurred, recent groundwater data from each well will undergo statistical analysis. The statistical methodology outlined within this document was selected in accordance with 40 CFR 257.93 of the CCR rule and the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (Unified Guidance, EPA 2009). Additional consideration was given to recommendations prepared by the Electric Power Research Institute (EPRI, 2015).

Baseline diagnostic tests will be conducted using the baseline samples that were collected at each well between June 2016 and April 2017. Statistical analysis will be conducted using Sanitas (Sanitas Technologies 2014) or similar statistical analysis software.

During detection monitoring, comparative statistical analysis will be performed after each monitoring event to identify whether concentrations are potentially statistically significant in comparison to baseline values, with the results reported annually. If assessment monitoring is conducted, comparative statistical analysis will be conducted following the collection of the specified number of confirmation samples.

The baseline data for all constituents, as determined by the monitoring program, will be reviewed periodically (approximately every 2 to 3 years based on a semi-annual sampling frequency) to determine if recent results that are not statistically significant in comparison to baseline values can be incorporated into an updated baseline period (specifics of the baseline update procedure are discussed in depth in Section 2.2.6).

2.1 Intra-Well Methodology

Intra-well (comparing compliance data to baseline data within a single well) statistics were identified as an appropriate method for groundwater monitoring at SS. This method was based on the following factors outlined in the Unified Guidance (EPA 2009).

- Per the Unified Guidance: “Intra-well methodology allows establishment of reasonable baseline periods for future tests in historically impacted wells. Additionally, measurements occur solely between the baseline period and compliance period of testing within a single well.”
    - Past CCR depositional facilities are known to have impacted the subsurface hydrology. Those facilities have been removed and new facilities with engineered lining systems constructed. The use of intra-well statistics allows future potential changes in water chemistry to be more readily tracked in relation to current CCR facilities at SS.
- Per the Unified Guidance: “Confounding results stemming from spatial variability can be eliminated.”

- Due to the heterogeneity of the glacial geology at SS, spatial variability is displayed throughout the groundwater monitoring network. Use of intra-well statistics allows comparisons to be made on a per well basis, which avoids comparisons being made in differing geologic/geochemical conditions.

2.2 Methodology for Baseline Diagnostic Tests

2.2.1 Initial Data Review and Non-detect Handling

Initially, data will be plotted on time-series graphs to assess the temporal variability of the data and to visually screen for potential outliers. Temporal variability can be caused by seasonality, changes to the monitored system, changes to the analytical method, recalibration of instruments, and anomalies in the sampling method (EPA 2009).

Non-detect values (ND) are results where the constituent is not detected at a concentration above the Practical Quantitation Limit (PQL). The PQL is the lowest concentration that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions. ND values will be managed within the other statistical procedures discussed in this document, following the approach recommended by the Unified Guidance (EPA 2009):

- For sample populations with < 15% ND, direct substitution of the NDs with ½ the PQL.
- For sample populations with 15% < ND ≤ 50%, the Kaplan-Meier approach will be used to estimate the mean and standard deviation of the population.
- For sample populations with > 50% ND, non-parametric approaches are used to assess the data, with direct substitution of the NDs with the PQL

2.2.2 Data Distribution

Parametric statistical tests are based on the assumption that the data are normally-distributed or can be transformed to a normal distribution. The distribution of the data will be tested for normality using the Shapiro-Wilk normality test with a 95 percent confidence level (or the Shapiro-Francia test when there are more than 50 results within the dataset). Each constituent from each well will be analyzed separately. Datasets found to be non-normal will be tested for other distributions using the 'Ladder of Powers' described by the Unified Guidance and transformed accordingly. Following transformation, parametric statistical methods will be performed on the normally or transform-normally distributed data. Non-parametric statistics will be used for datasets that do not show normal or transform-normal distributions.

2.2.3 Outlier Analysis

In accordance with the Unified Guidance, data points will be identified as outliers if the value was an "extreme, unusual-looking measurement" and "inconsistent with the distribution of the remaining measurements." The Unified Guidance recommends testing for outliers within baseline data, but cautions against removal of outliers, unless a likely error or specific discrepancy can be identified, such as recordkeeping errors, unusual sampling and laboratory procedures or conditions, inconsistent sample turbidity, and values significantly outside the range of other results. In accordance with the Unified Guidance, apparent outliers will be periodically revisited even if initially removed, due to the propensity of groundwater chemistry to change over time.

Outliers will be evaluated and identified through visual inspection and the EPA-recommended Dixon's Test for statistical outliers (or Rosner's Test when there are greater than 25 samples). Dixon's and Rosner's Tests assume that all data values, except the suspected outlier, are normally distributed or can be transformed to fit a normal distribution. Consequently, visual inspection of concentrations over time is important in screening for outliers. The effect of removing outliers from the baseline data will usually be to lower the statistical limit (due to a reduction in the standard deviation), resulting in a more conservative statistical limit and improving the odds of detecting increasing concentration levels.

Outliers will be managed as follows:

- Any suspected outlier identified through statistical analysis or visual methods will be reviewed (i.e., through evaluation of the associated analytical report, laboratory narrative, associated laboratory quality assurance/quality control information, and/or field notes) before removal from the dataset to determine if any systematic or systemic errors were responsible for the noted anomalous readings. Rejected data points will not be included in the baseline dataset.
- The rationale for the removal of any outliers will be documented. The majority of the outliers will likely be isolated values that can be attributed to inconsistent sampling or analytical chemistry methodology resulting in laboratory contamination or other anomalies.
- If an outlier is removed, the normality test (Section 2.2.2) will be re-run to determine if the dataset is normally-distributed or transform-normal without the outlier.

2.2.4 Trend Analysis

Most statistical tests assume concentrations do not demonstrate temporal correlation. The Sen's Slope methodology is an intra-well statistical analysis of increases or decreases in measured concentrations over time measured by calculating the slope of the linear relationship of concentration levels and time. Sen's Slope Methodology is paired with the Mann-Kendall test to determine the statistical significance of the calculated Sen's Slope. The methodology involves examining all possible pairs of measurements in the dataset and scoring each pair to determine if a trend exists. The test will be conducted using a target confidence level of 99 percent.

If temporal trends are identified within the dataset, the data will be adjusted to account for the trends, the time period used for the baseline statistics will be reassessed, and/or an alternative statistical method will be used to establish a limit. In the case of downward trends, no adjustments may be considered appropriate and a particular constituent may not be considered for statistical analysis until further data is collected.

2.2.5 Seasonality

Seasonal temporal variability can mask changes in groundwater chemistry. Time-series plots will be observed for visual signs of seasonality, and once enough data has been collected within the program, the data will be evaluated for seasonal variations using the seasonal Mann-Kendall trend test. The Mann-Kendall test is an intra-well evaluation performed individually for each constituent at each well and requires at least 3 occurrences of each prospective season with results to calculate the statistic. Datasets that are found to be have seasonality will be de-seasonalized for subsequent statistical analysis.

2.2.6 Updating the Baseline Period

The Unified Guidance recommends updating the baseline period every two to three years when the sampling frequency is semi-annual, or four to eight samples. A baseline update will include a review of any revisions to federal and state regulations and EPA statistical guidance documents that may have been promulgated since the previous baseline statistical analysis. The baseline period for a specific constituent will not be updated if verified statistically significant increases (SSIs) have been identified for that constituent, unless a demonstration has been made that the SSI is not related to a release from the facility.

Prior to inclusion of more recent data in an updated baseline period, a Wilcoxon Rank-Sum test will be conducted. The Wilcoxon Rank-Sum test, also referred to as the Mann-Whitney test, determines if measurements from one population are statistically significantly higher or lower than another population. The test is non-parametric, namely the data being tested is not assumed to fit a specific distribution, such as a normal distribution. When the baseline period is updated in the future, the Wilcoxon Rank-Sum test will be used to compare data from the current baseline period with the more recent data that are intended to be reclassified and included in the updated baseline period. The test will be conducted at a 95 percent confidence level. If the two datasets are drawn from the same population, then the results of the test support updating the prior baseline dataset with the recent data. After the new data are incorporated into the dataset, the baseline diagnostic tests outlined in Section 2.2 will be conducted.

If the Wilcoxon Rank-Sum test detects a significant difference between two sample populations, additional data review will be necessary. The data will be reviewed to determine whether a gradual trend or other change not stemming from a release from the facility has occurred that was not detected during comparative statistical analysis. At the time of the baseline update, some earlier baseline data might need to be removed from the updated baseline period. Removal of earlier baseline data ensures that future statistical analysis is based on current groundwater conditions, rather than on outdated measurements of groundwater chemistry. Alternatively, outliers identified in the previous baseline period (as described in Section 2.2.3) will be re-incorporated into the dataset and reevaluated as potential outliers during the baseline update, unless the outlier(s) were removed due to sampling, laboratory, or other determinant error.

3.0 DETECTION MONITORING

3.1 Statistical Limits

Either a parametric or non-parametric method will be used to generate the baseline statistical limit for each constituent. The statistical method will vary between constituents and will be selected based on the percent of ND values in the baseline period and the baseline data distribution for each constituent at each well, in accordance with the Unified Guidance (EPA 2009).

For those constituent-well pairs where concentrations of a given analyte are normally or transform-normally distributed and have equal to or greater than 50% detections, Shewhart-CUSUM control charts will be used. The Unified Guidance notes that Shewhart-CUSUM control charts use two separate evaluation procedures. The Shewhart portion is similar to a prediction limit, comparing compliance measurements to a baseline limit. The CUSUM (cumulative summation) portion analyzes new measurements against prior compliance measurements. The mean ($\bar{x}$) and standard deviation (s) of the baseline data set are used to calculate the limit, by the following equation:

$$\bar{x}_{BG} + hs_{BG}$$

Per the Unified Guidance, h is the standardized control limit and will be set at 4.5.

Where the concentrations of a given constituent-well pairs are not normally or transform-normally distributed, or has less than or equal to 50 percent detections, a non-parametric prediction limit will be used. The non-parametric limit will be assigned as the highest detected value (excluding outliers) or the highest PQL, whichever is greater.

In the case of increasing trends within the baseline period, the data will be adjusted to account for the trends where a source other than the facility can be identified and/or an alternative statistical method will be used to establish a limit. In the case of downward trends, no adjustments may be considered appropriate and a particular constituent may not be considered for statistical analysis until further data is collected; therefore, the trend test will serve as the alternative method for constituents with decreasing trends.

3.2 Comparative Statistical Analysis

Comparative statistical analysis will be conducted following each detection monitoring event. For both Shewhart-CUSUM limits and non-parametric prediction limits, the comparative statistical analysis will consist of a comparison of detection monitoring results (the recent analytical results for each monitoring event performed after the baseline data period) to the statistical limit calculated from the baseline data.

The following definitions will be used in discussion of the comparative statistical analysis:

- Elevated CUSUM – an elevated CUSUM occurs when the CUSUM is greater than the Shewhart-CUSUM limit established by the baseline statistical analysis, but the analytical result does not exceed the Shewhart-CUSUM limit. An elevated CUSUM is an indication that concentrations are gradually increasing and that analytical results may exceed the Shewhart-CUSUM limit in the future.
- SSI – is a statistically significant increase (SSI) and is defined as an elevated CUSUM or an analytical result that exceeds the Shewhart-CUSUM limit or non-parametric statistical limit established by the baseline statistical analysis.
- False-positive SSI – is defined as an analytical result that exceeds the statistical limit that can clearly be attributed to laboratory error, changes in analytical precision, or is invalidated through confirmatory re-sampling. False-positive SSIs are not used in calculation of any subsequent CUSUMs.
- Confirmatory re-sampling – is designated as the next scheduled sampling event.
- Verified SSI – is interpreted as two consecutive SSIs (the original sample and the confirmatory re-sample for analytical results, or two consecutive elevated CUSUMs) for the same constituent at the same well.

The detection monitoring program has been developed to identify potential SSIs over baseline values for the Appendix III constituents. This determination will be made within 90 days of receiving the finalized laboratory analytical report(s) for each sampling event and completion of data quality review as necessary to address questions concerning the validity of sampling methods or laboratory analyses. A potential SSI will not be considered a verified SSI until confirmatory re-sampling is performed. Confirmatory re-sampling will occur during the next regularly scheduled sampling event.

3.3 Alternative Source Demonstrations and Assessment Monitoring

If a verified SSI is identified in a downgradient well for an Appendix III constituent as part of the detection monitoring program, GRE will establish an assessment monitoring program meeting the requirements of 40 CFR 257.95 of the CCR rule. Alternatively, GRE may demonstrate that a source other than the regulated CCR facilities caused the SSI, or that the SSI was a result of an error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality that failed to be captured during baseline data collection (40 CFR 257.94(e)(2)). A report documenting the alternative source demonstration (ASD) will be certified by a Professional Engineer registered in the state of North Dakota and placed in the Site's Operating Record within 90 days of the SSI determination. If a successful demonstration is made and documented, GRE will continue with the detection monitoring program. If, after 90 days, a successful demonstration is not made, GRE will initiate an assessment monitoring program as described in Section 4.0.

4.0 ASSESSMENT MONITORING

An assessment monitoring program will be initiated in the event of a verified SSI of an Appendix III constituent in a downgradient well, unless a successful demonstration is made that an alternative source affected the groundwater chemistry, or that the SSI was a result of an error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality that was not captured during the baseline data collection period.

Many of the statistical comparisons used in assessment monitoring require baseline analyses to be completed prior to comparative statistics. Baseline statistics for assessment monitoring mirror those for detection monitoring, and are discussed in further detail in section 2.2.

4.1 Establishment of Groundwater Protection Standards

In general, the assessment monitoring program will comply with 40 CFR 257.95. Within 90 days of triggering the assessment monitoring program, GRE will sample and analyze each well for the Appendix IV constituents listed in Table 1. Groundwater protection standards (GWPS) will be established for each Appendix IV constituent. Per the CCR rule (40CFR 257.95(h)), the GWPS must fall within one of the following categories:

- For constituents for which a maximum contaminant level (MCL) has been established by the EPA (40 CFR 141), the MCL for that constituent will be the GWPS.
- For constituents for which an MCL has not been established, the statistical baseline concentration for the constituent at the well will be the GWPS.
- For constituents where the statistical baseline level is higher than the MCL, the statistical baseline concentration will be the GWPS.

For those constituents without MCLs or where the statistical baseline level is higher than the MCL, the GWPS will be determined through statistical methods. For those constituents with a normal or transform-normal distribution, prediction limits for future means will be developed. For constituents that are non-normal or have a high percentage of non-detects, prediction limits for future medians will be developed. For both types, the GWPS is considered a one-sided upper prediction interval calculated from the background data for a specified number of future comparisons.

4.2 Comparative Statistics

To determine if Appendix IV constituents have statistically exceeded the associated GWPS, the approaches discussed in the following sections will be used.

4.2.1 Maximum Contaminant Level (MCL) Based GWPS

For those constituents with MCLs as the GWPS, a confidence interval approach will be used. Per recommendations provided by the Unified Guidance and detailed by EPRI (2015), a confidence interval statistically defines the upper and lower bound (the upper and lower confidence limit) of the true mean associated with a groundwater population. The Unified Guidance recommends confidence intervals for assessment monitoring. Confidence intervals identify SSIs through comparison against a fixed standard, namely the MCL-based GWPS.

To calculate a confidence interval, at least 4 samples (the initial sample and 3 resamples) are required. A confidence interval will only be considered statistically above the associated GWPS if *both* the upper and lower confidence limits exceed the GWPS.

4.2.2 Baseline Based GWPS

For those constituents with a GWPS based on baseline concentrations, a prediction interval approach will be used. The Unified Guidance recommends prediction intervals for a future mean for data that follow a normal or transform-normal distribution, and prediction intervals for a future median for data with high percentages of non-detects or non-normally distributed data.

When using prediction intervals for a GWPS, a one-sided prediction interval is calculated using baseline datasets based on a specified number of future comparisons. For parametric comparisons, four measurements are averaged to compare to the GWPS, with statistical significance occurring when the mean is greater than the GWPS. For non-parametric comparisons, the median of three measurements is compared to the GWPS, with statistical significance occurring when the calculated comparative median is greater than the GWPS.

4.3 Returning to Detection Monitoring, ASD, and ACM

If the concentrations of constituents listed in Appendix III and Appendix IV of the rule are shown to be at or below baseline values for two consecutive sampling events, GRE will return to detection monitoring. If the concentrations of any of the Appendix III and Appendix IV constituents are above baseline values, but the Appendix IV constituents are below the established GWPS, GRE will continue with assessment monitoring. If one or more Appendix IV constituents are detected at statistically significant levels above the established GWPS, GRE will place a notification of the exceedance in the Site Operating Record and follow the course of action outlined in 40 CFR 257.95(g) of the CCR rule and as determined by GRE.

If, within 90 days of detecting an Appendix IV constituent at statistically significant levels above the GWPS, a successful alternative source demonstration (ASD) has not been made to indicate an alternative source or that the SSI was a result of an error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality that was not captured during the baseline data collection period, GRE will initiate an assessment of corrective measures (ACM) in accordance with 40 CFR 257.95(g). The ACM will be completed within 90 days, unless a demonstration is made for additional time to complete the assessment.

5.0 CERTIFICATION

Based upon the review described in this report, the undersigned Professional Engineer registered in the state of North Dakota certifies that the statistical methodology presented herein is appropriate for evaluating groundwater monitoring data associated with the regulated CCR facilities at SS, and meets the requirements of 40 CFR 257.93.

GOLDER ASSOCIATES INC.

Craig

Craig Schuettpelz, P.E.
Senior Project Engineer

Erin L. Hunter, PhD.
Project Engineer

ELH/dls

CRAIG C.
SCHUETTPELZ
PE-9220
DATE 10/12/17

6.0 REFERENCES

Electric Power Research Institute (EPRI), 2015. Groundwater Monitoring Guidance for the Coal Combustion Residuals Rule – 2015 Technical Report. November 2015.

Sanitas Technologies, 2014. Sanitas User Guide, Version 9.5.

United States Environmental Protection Agency (EPA), 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*, Office of Resource Conservation and Recovery, EPA-R-09-007, March 2009.

United States Environmental Protection Agency (EPA), 2015. Code of Federal Regulations Title 40 Part 257: Hazardous and Solid Waste Management System; *Disposal of Coal Combustion Residuals from Electric Utilities*. April 17, 2015.

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity

APPENDIX B

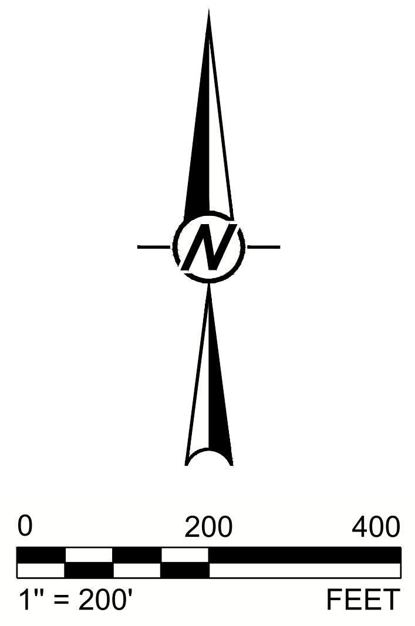
Geologic Cross Sections

LEGEND

✦	UPGRADIENT MONITORING WELLS
✦	DOWNGRADIENT MONITORING WELLS - BOTTOM ASH LANDFILL
✦	DOWNGRADIENT MONITORING WELLS - BOTTOM ASH IMPOUNDMENT
▲	HISTORIC BOREHOLE
→	GENERAL DIRECTION OF GROUNDWATER FLOW
A 3 — A' 3	SECTION MARKER WITH FIGURE NUMBER

NOTE(S)

1. AERIAL IMAGERY OBTAINED FROM UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AERIAL IMAGERY PROGRAM, 2016.
2. GROUNDWATER ELEVATIONS WERE MEASURED APRIL 2017.



Golder Associates

CROSS SECTION LOCATIONS

FIGURE 1

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UNIFIED SOIL CLASSIFICATION SYSTEM

▨ CH - HIGH PLASTICITY CLAY

▨ CL - LOW PLASTICITY CLAY

▨ SP - POORLY GRADED SAND

▨ SC - CLAYEY SAND

▨ COAL

▨ SM - SILTY SAND

▨ SW - WELL GRADED SAND

▨ GP - POORLY GRADED GRAVEL

▨ ML-CL/CL-ML - SILTY LEAN CLAY/LEAN CLAY WITH SILT

▨ GW- WELL GRADED GRAVEL

▨ OL- ORGANIC TOPSOIL

▨ SP-SM - POORLY GRADED SAND WITH SILTY SAND

▨ CL-CH - LEAN-FAT CLAY

▨ ML - SANDY SILT

▨ SP-SC - POORLY GRADED SAND WITH CLAYEY SAND

▨ SM-SC/SC-SM - SILTY SAND WITH CLAYEY SAND

▨ ASH

GEOLOGIC CLASSIFICATION

▨ OUTWASH - PRIMARILY SANDS AND GRAVELS

▨ CONFINING UNIT - PRIMARILY SILTS AND CLAYS

▨ TOPSOIL AND DISTURBED MATERIAL

▨ COAL COMBUSTION RESIDUALS

LINETYPES

━━━━ EXISTING GRADES

━ ━ ━ ━ APPROXIMATED GRADES

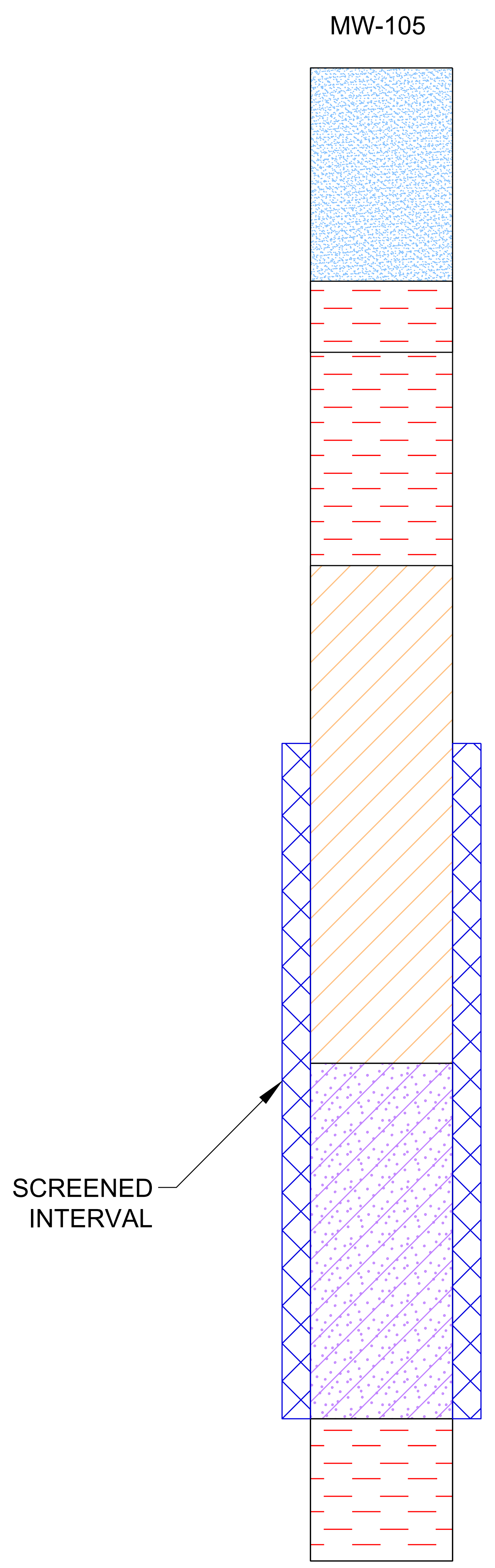
──── TOP OF LINER

──── ASSUMED MATERIAL BOUNDARY

〰 INFERRED MATERIAL BOUNDARY

▽ GROUNDWATER LEVELS (APRIL 2017)

TYPICAL WELL



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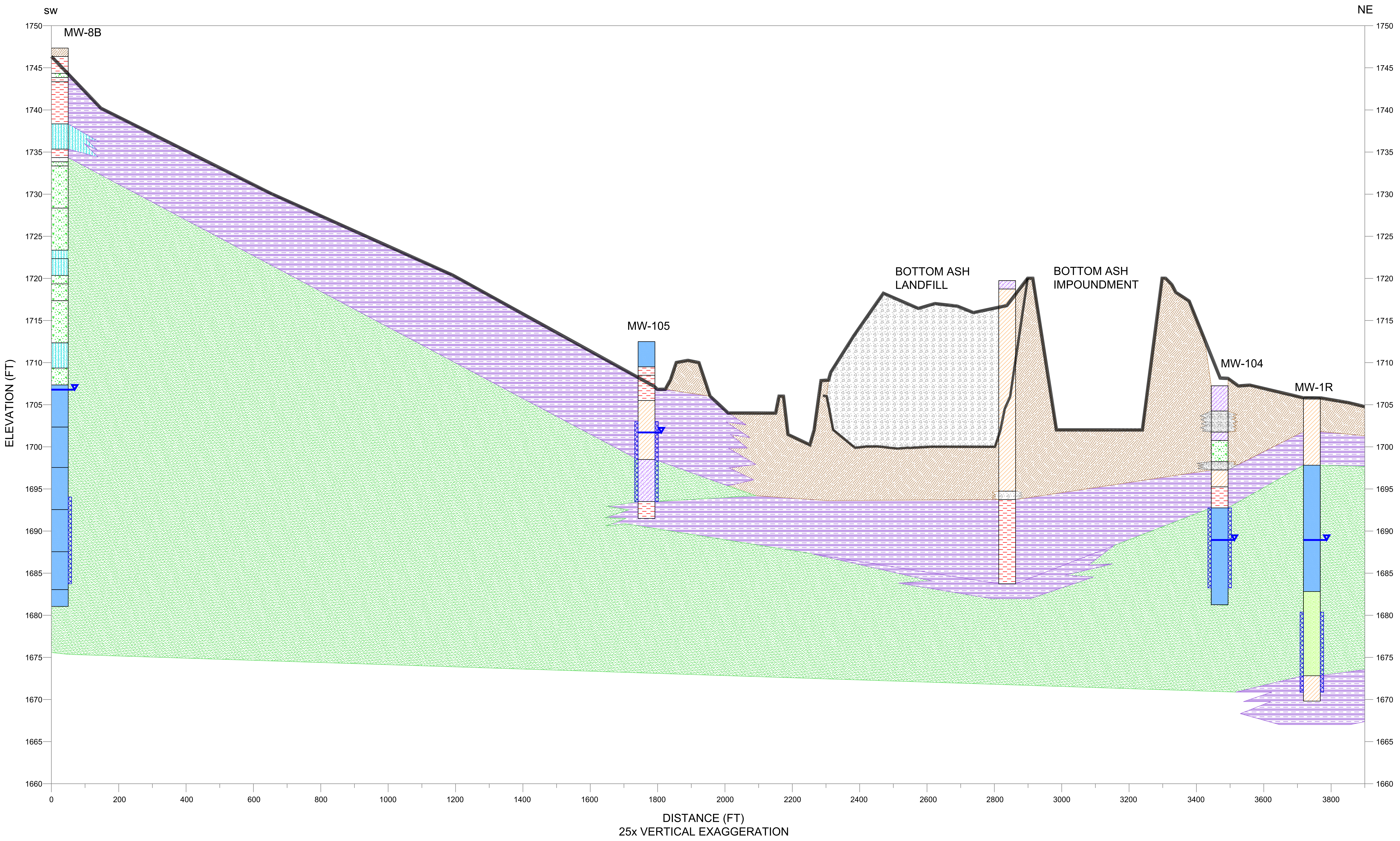
LEGEND FOR CROSS SECTIONS

FIGURE 2



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CROSS SECTION A-A'

FIGURE 3

CROSS SECTION B-B'

FIGURE 4

Golder Associates

Path: \\Denver.golder.gds\projects\17JOBS\1772461 GRE SS\Water Quality\CCR Network Certification\Figures\ | File Name: 1772461_Cross-Sections.dwg

APPENDIX C

Monitoring Well Construction Logs

LOG OF BORING

PROJECT: CFEX-92-0094 ASH PONDS HYDROGEOLOGIC STUDY United Power Association Stanton Station Stanton, North Dakota	BORING: **SB-2** / MW-6A & MW-6
	LOCATION: N91757.00 E91222.15
	DATE: 8/27/92
	SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev. 100.0	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
96.0	4.0		TOPSOIL: Sandy Lean Clay, 0 to 1 foot, black, Silty Sand, medium-grained, reacts with HCL, light brown, roots, dry, loose. 1 to 4 feet, Silty Sand, medium-grained, reacts with HCL, light yellowish brown (2.5Y6/4), dry, trace of roots, loose.			
91.0	9.0	SM	FILL: SILTY SAND, medium-grained grading to a medium-grained Poorly Graded Sand with Silt at 7 to 9 feet, damp, light yellowish brown (2.5Y5/6).			
89.0	11.0	SP SM	FILL: Silty Sand, medium-grained grading to a medium-grained Poorly Graded Sand with Silt, damp, light yellowish brown (2.5Y5/6), natural bedding observed.			
88.0	12.0	CL	LEAN CLAY with SILT, moist, olive brown (2.5Y4/3).			
86.0	14.0	ML SP SM	POORLY GRADED SAND with SILTY SAND, medium-grained, light olive brown (2.5Y5/6), moist to wet at 14 feet.		∇	
80.5	19.5	SP SM	POORLY GRADED SAND with SILTY SAND, fine-grained, waterbearing, light olive brown (2.5Y5/6).			
76.5	23.5	SM	SILTY SAND, grayish brown (2.5Y5/2), waterbearing, cemented sand nodules, slight reaction to HCL.			Having to jet sand out of auger from 20-24 ft; sand blew up intowell at 19.5 ft.
76.0	24.0	SP	POORLY GRADED SAND, yellowish brown (10YR5/8), fine- to medium-grained, waterbearing, cemented sand nodules, slight reaction with HCL.			
75.5	24.5	CH				
75.0	25.0	CH				
74.5	25.5	CL				
		CL	FAT CLAY, carbonaceous, trace of shell fragments, moist, medium dense, reacts with HCL, black (2.5Y2/0), some Silt and fine-grained Sand.			
70.5	29.5					
		SC	FAT CLAY, carbonaceous, trace of shell fragments, moist, medium dense, reacts with HCL, black (2.5Y2/0) at 24 3/4 feet, 2 inch layer of Silty Sand, olive (5Y5/4).			

LOG OF BORING

PROJECT: CFEX-92-0094
ASH PONDS HYDROGEOLOGIC STUDY
United Power Association
Stanton Station
Stanton, North Dakota

BORING: **SB-2 (cont.)**

LOCATION:
N91757.00 E91222.15

DATE: 8/27/92

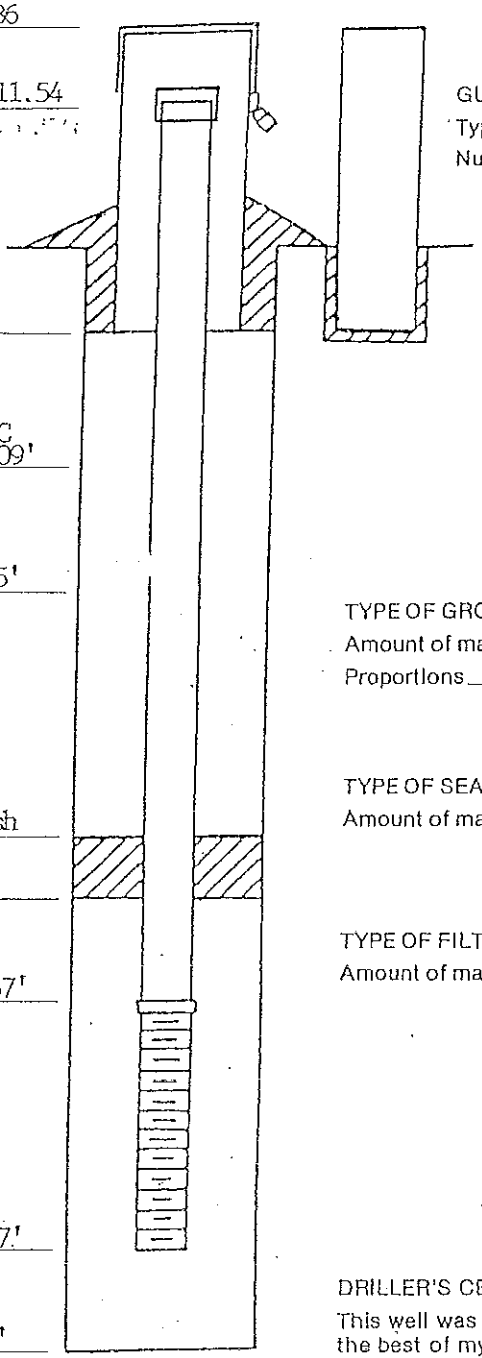
SCALE: 1" = 4'

Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
			SANDY LEAN CLAY, fine, gray (2.5Y6/0), trace of shell fragments.			
65.5	34.5	SC	LEAN CLAY with GRAVEL, trace of shell fragments, lignite fragments, Clayey Sand gray to blue, blue to gray poorly graded, medium-grained Sand with trace of Clay, dense, bluish gray (5B5/1), homogeneous.			
			CLAYEY SAND, medium- to coarse-grained, bluish gray (5B5/1), homogeneous, subangular to subrounded.			
60.5	39.5	SC	CLAYEY SAND, interbedded with medium- to fine-grained poorly graded sand.			Bedrock-Sandstone
			CLAYEY SAND, at 40 feet a 1 inch seam of sand with lignite particles also at 43 feet the same, at 42 to 43 feet a zone of very dense sand interbedded with silts.			Sandstone
55.5	44.5	SP SM	POORLY GRADED SAND with SILT, olive gray (5Y5/2) with lignite laminations, medium dense.			Sandstone
50.5	49.5	SP SM	POORLY GRADED SAND to SILTY SAND with CLAY, bluish gray (5B5/1), medium dense.			Sandstone
45.5	54.5	SM SC	SILTY SAND with CLAY to CLAYEY SAND, interbedded with lignite laminations, bluish gray (5B5/1), medium dense.			Sandstone
40.5	59.5		END OF BORING.			

(See Report and Standard Plates for evaluation and descriptive terminology.)

MONITORING WELL FIELD DATA SHEET

Client United Power Association
Proj. No. CFEX-92-0094
Location UPA Station, Stanton, ND
Well Number MW-6B
Well Location SW¼, SW¼, Sec16, T144N, R84W
Date of Installation 09/08/92
Date of Revision
Crew KD, TC, LL
B.M. Location & Elev. (± 0.01)



Stick up above ground (to 0.1') 1.86
Top of riser pipe (w/o cap) Elev. (± 0.01') 1711.54
Ground surface Elev. (± 0.1')
Depth to bottom of surface seal 1'
Approximate water level before installation TPVC 15.09'
Approximate depth of first water encountered in drilling 13.5'
Depth to top of seal Flush
Depth to bottom of seal 19'
Depth to top of screen 28.37'
Depth to bottom of screen 38.37'
Depth to bottom of boring 38.5'

Protective Cover:
Type Pro-Top
Length 5'
Lock # 2106

GUARD POST:
Type T-Posts
Number 3

Type of sealing material Concrete

RISER PIPE:
Type PVC
Diameter 2"
Total Length 30'
Sections Used 3'
Couplings No
Cap Yes X No

TYPE OF GROUT ABOVE SEAL: Bentonite - Portland Cement Grout
Amount of material used 25 lbs Bentonite, 864 lbs Portland Cement
Proportions 40 gallons of water

TYPE OF SEALING MATERIAL: Same as above
Amount of material used

TYPE OF FILTER MATERIAL: 12 - 30 Silica Sand
Amount of material used 300 lbs

SCREEN: Timco
Type PVC
Slot Size 0.010
Length 10'
Diameter 2"
Plug/Point Male Plug

Note: Depths relative to ground surface.

Method of advance:
HSA X I.D. 3 3/4"
Casing I.D.
Dicone O.D.

DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction, and this report is true to the best of my knowledge.

Braun Intertec Environmental, Inc. 420
Driller's or Firm's Name Certificate No.

913 S. 18th St., P.O. Box 2379, Bismarck, ND 58502-2379
Address

11-23-92
Signed by Date

Method of development:
Air
Jet Surge X Bail

BRAUN

LOG OF BORING

PROJECT: CFEX-92-0094 ASH PONDS HYDROGEOLOGIC STUDY United Power Association Stanton Station Stanton, North Dakota	BORING: SB-3 / MW-7A & MW-7
	LOCATION: N88990.05 E93743.52
	DATE: 8/27/92 SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev. 100.0	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
			TOPSOIL: Dark brown to light brownish gray, silty clay, friable, roots, dry, strong reaction to HCL.			
97.0	3.0					
		SM	SILTY SAND, dry, olive yellow (2.5Y6/6).			
96.0	4.0					
		CL CH	LEAN-FAT CLAY, stiff, moist. From 5 to 7 feet, a vertical sand stringer through half of core (dry), olive brown (2.5Y4/4), mottled, stiff, inclusions of calcite, reacts with HCL.			
90.0	10.0					
89.5	10.5	SM	SILTY SAND, wet, light olive brown (2.5Y5/4).			
88.5	11.5	CL				
88.0	12.0	CH	LEAN-FAT CLAY, soft, light olive brown (2.5Y5/4)			
87.0	13.0	SM				
86.5	13.5	ML	SILTY SAND, waterbearing, light olive brown (2.5Y5/4).			
86.0	14.0	CL				
		CL	SILTY LEAN CLAY, wet, soft, light olive brown (2.5Y5/4).			
		CH				
		SM	LEAN-FAT CLAY, wet, stiff, light olive brown (2.5Y5/4).			
		CL				
		CH	SILTY SAND, waterbearing, light olive brown (2.5Y5/4).			
82.0	18.0					
		CH	LEAN-FAT CLAY, stiff, varying fine-grained sand content throughout, light olive brown (2.5Y5/4).			
			FAT CLAY, moist, olive gray (5Y4/2), mild reaction to HCL, very dense, slightly sticky, plastic, very small shell fragments, fine roots noted at about 23 feet, starting at about 23 feet were small distinct, dark yellow brown (10YR3/4) mottles.			
74.5	25.5					
73.5	26.5	CL	LEAN CLAY with SAND, moist to waterbearing, dark grayish brown (2.5Y4/2), mild reaction to HCL, firm, slightly sticky, slightly plastic.			
		CH	FAT CLAY, moist, dry, color was light olive gray (5Y6/2), moist color was olive gray (5Y4/2), moist color grades to dark gray (2.5YN4/0) at about 30.5 feet. Strong reaction to HCL to 31 feet. Soil was hard,			
69.0	31.0					
		CL				

LOG OF BORING

PROJECT: CFEX-92-0094
ASH PONDS HYDROGEOLOGIC STUDY
United Power Association
Stanton Station
Stanton, North Dakota

BORING: **SB-3 (cont.)**

LOCATION:
N88990.05 E93743.52

DATE: 8/27/92

SCALE: 1" = 4'

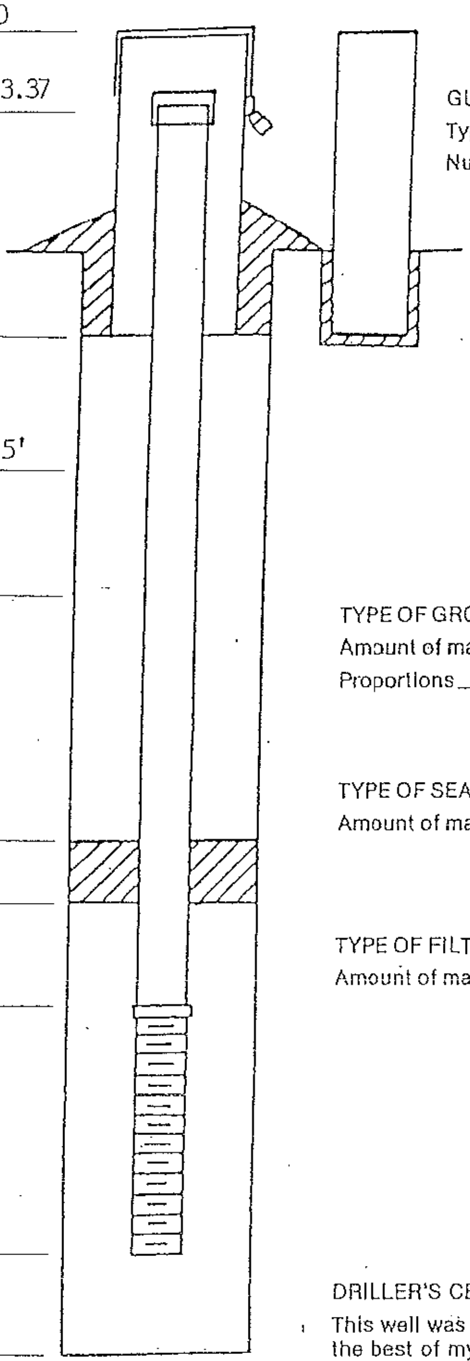
(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
67.0	33.0		friable with subangular blocky structure and slightly sticky to 30.5 feet. From 30.5 feet to 31 feet soil was dense, hard, slightly sticky and plastic. Calcareous nodules from 28.5 feet to 29.5 feet, light gray (5Y7/2) in color. One root channel noted, some small detridal coal, stringers of medium sand noted, a 3 inch layer of dark yellowish brown (10YR4/6), lean clay at about 30.5 feet noted. Many small snail shells from 30.5 feet to 31 feet.			Boring jetted following drilling. Many coal pieces washed out in jetting. Note that no coal pieces were found in barrel sampler in final formation. Coal pieces must be from lower in formation.
		SP	LEAN CLAY, moist, olive brown (2.5Y4/3) grading to very dark gray (5Y3/1). Strong reaction to HCL, slightly sticky, slightly plastic, hard, some detridal coal, some sand, some wood fragments, some roots, many small snail shells and fragments.			
62.0	38.0		POORLY GRADED SAND with some CLAY, medium textured sand, waterbearing, black (5Y2.5/1), slight reaction to HCL, massive structure, soft, nonplastic. Lean Clay seam with cobbles from 37.2 feet to 37.3 feet. Medium sand from 37.3 to 37.5 feet. Coarse sand from 37.5 feet to 37.6 feet, dark olive gray (5Y3/2). Silty clay with sand from 37.6 feet to end of boring. Laminae visible. Sand of fine texture. Very dark gray (5Y3/1) with a slight reaction to HCL.			
			END OF BORING.			

MONITORING WELL FIELD DATA SHEET

Client United Power Association
Proj. No. CFEX-92-0094
Location UPS Station, Stanton, ND
Well Number MW-7A
Well Location SW¼,NE¼,Sec21,T144N,R84W
Date of installation 08/27/92
Date of Revision
Crew KD, TC, IM
B.M. Location & Elev. (± 0.01)

Stick up above ground (to 0.1') 2.20
Top of riser pipe (w/o cap) Elev. (± 0.01') 1713.37
Ground surface Elev. (± 0.1')
Depth to bottom of surface seal 3'
Approximate water level before installation 17.5'
Approximate depth of first water encountered in drilling 12'
Depth to top of seal 3'
Depth to bottom of seal 5'
Depth to top of screen 7'
Depth to bottom of screen 17'
Depth to bottom of boring 18'



Note: Depths relative to ground surface.

Method of advance:
HSA X I.D. 3 1/4"
Casing I.D.
Cone O.D.

GUARD POST:
Type T-Posts
Number 3

Protective Cover:
Type Pro-Top
Length 5'
Lock # 2106

Type of sealing material Concrete

RISER PIPE:
Type PVC
Diameter 2"
Total Length 7'
Sections Used 1'
Couplings No
Cap Yes X No

TYPE OF GROUT ABOVE SEAL: Concrete
Amount of material used
Proportions

TYPE OF SEALING MATERIAL: 1/4" Bentonite Pellet
Amount of material used 25 lbs.

TYPE OF FILTER MATERIAL: 12 - 30 Silica Sand
Amount of material used 240 lbs.

SCREEN:
Type PVC
Slot Size 0.010
Length 10'
Diameter 2"
Plug/Point Male Plug

DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction, and this report is true to the best of my knowledge.

Braun Intertec Environmental, Inc. 421
Driller's or Firm's Name Certificate No.

913 S. 18th St., P.O. Box 2379, Bismarck, ND 58502-2379
Address

Signed by 11-23-92
Date

Method of development:
Air
Jet Surge X Ball

BRAUN

MONITORING WELL FIELD DATA SHEET

Client United Power Association Proj. No. CFEX-92-0094 Location UPA Station, Stanton, ND

Well Number MW-7B Well Location SW¼,NE¼,Sec21,T144N,R84W Date of Installation 09/09/92

Date of Revision ______ Crew KD, TC, LL B.M. Location & Elev. (± 0.01) ______

Stick up above ground (to 0.1') 1.53

Top of riser pipe (w/o cap) Elev. (± 0.01') 1712.55

Ground surface Elev. (± 0.1') ______

Depth to bottom of surface seal 1'

Approximate water level before installation TPVC 15.05'

Approximate depth of first water encountered in drilling 12'

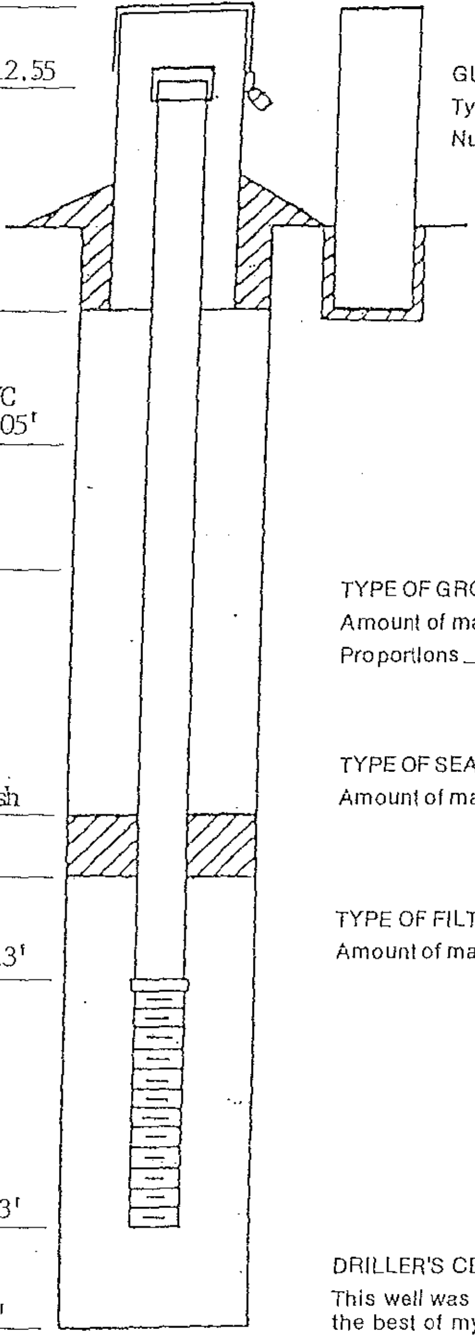
Depth to top of seal Flush

Depth to bottom of seal 23'

Depth to top of screen 28.13'

Depth to bottom of screen 38.13'

Depth to bottom of boring 38.5'



Protective Cover:
Type Pro-Top
Length 5'
Lock # 2106

GUARD POST:
Type T-Posts
Number 3

Type of sealing material Concrete

RISER PIPE:
Type PVC
Diameter 2"
Total Length 30'
Sections Used 3
Couplings Flush-Thread
Cap Yes X No ____

TYPE OF GROUT ABOVE SEAL: Bentonite - Portland Cement Grout
Amount of material used 15 lbs. Bentonite, 480 lbs Portland Cement
Proportions 15 gallons of water.

TYPE OF SEALING MATERIAL: Bentonite - Portland Cement Grout
Amount of material used 15 lbs. Bentonite, 480 lbs. Portland Cement
15 gallons of water.

TYPE OF FILTER MATERIAL: 12 - 30 Silica Sand
Amount of material used 350 lbs.

SCREEN: PVC
Type Timco
Slot Size 0.010
Length 10'
Diameter 2"
Plug/Point Male Plug

Note: Depths relative to ground surface.

Method of advance:
HSA X I.D. 3 3/4"
Casing ____ I.D. ____
cone ____ O.D. ____

DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction, and this report is true to the best of my knowledge.

Braun Intertec Environmental, Inc. 420
Driller's or Firm's Name Certificate No.

913 S. 18th St., P.O. Box 2379, Bismarck, ND 58502-2379
Address

Signed by 11-23-92
Date

BRAUN

Method of development:
Air ____
et ____ Surge Bail

LOG OF BORING

PROJECT: CFEX-92-0094 ASH PONDS HYDROGEOLOGIC STUDY **United Power Association** **Stanton Station** **Stanton, North Dakota**	BORING: **SB-9 / MW-8A & MW-8** LOCATION: **N89124.66 E91102.89** DATE: 9/1/92 SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev. 100.0	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
99.0	1.0		TOPSOIL: Grayish brown, many roots, silt, dry.			
97.0	3.0	CL	LEAN CLAY, roots, blochy structures, calcite rich, strong reaction to HCL, dry, light brown to gray.			
96.5	3.5	SM	SILTY SAND, loose, dry.			
96.0	4.0	CL	SANDY LEAN CLAY, dry, dense, strong reaction to HCL, trace of roots.			
91.0	9.0	CL	SANDY LEAN CLAY, dry, reacts strongly with HCL, dry, light olive brown (2.5Y5/4).			
88.0	12.0	SP SM	SILTY SAND, interbedded with silts and lean clay, damp, trace of lignite and calcite inclusions, light olive brown (2.5Y5/4).			
87.0	13.0	CL	SANDY LEAN CLAY, fine, moist, calcite stringers, trace of lignite, light olive brown (2.5Y5/4).			
86.5	13.5	SP	POORLY GRADED SAND, fine- to medium-grained sand, moist.			
86.0	14.0	SM	SILTY SAND with trace of CLAY, moist, light olive brown (2.5Y5/4).			
81.0	19.0	SM	SILTY SAND, damp, grayish brown (2.5Y5/2). At approximately 18 feet, a 4 inch layer of sandy lean clay, moist, trace of lignite, light olive brown (2.5Y5/2).			
76.0	24.0	SM	SILTY SAND with CLAY, waterbearing, few lignite laminae, from 22 to 24 feet, interbedded medium to coarse laminations of poorly graded sand, olive brown (2.5Y4/3).		▽	
73.0	27.0	SP SM	SILTY SAND, waterbearing, olive brown (2.5Y4/3).			
70.0	30.0	SM	SILTY SAND, waterbearing. At 29.5 feet, a 4 inch layer of the same with clay, olive (5Y5/4), few lignite particles, subrounded.			
		SM	SAND to SILTY SAND, assumed saturated.			No recovery-no sample

LOG OF BORING

PROJECT: CFEX-92-0094
ASH PONDS HYDROGEOLOGIC STUDY
United Power Association
Stanton Station
Stanton, North Dakota

BORING: **SB-9 (cont.)**

LOCATION:
N89124.66 E91102.89

DATE: 9/1/92

SCALE: 1" = 4'

Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
65.0	35.0					
62.0	38.0	SP SM	POORLY GRADED SAND, waterbearing, trace of gravel, coarse grained.			
60.0	40.0	SM	SILTY SAND, trace of Gravel (shale), trace of coarse sand, olive (5Y4/3).			
55.0	45.0	SP	POORLY GRADED SAND, fine- to medium-grained, waterbearing, trace of gravel, few coarse sand stringers (vertical), trace of lignite, iron oxide nodules, olive (5Y4/3).			
50.2	49.8	SP	POORLY GRADED SAND, less gravel and iron oxide nodules. At 49.5 feet, a 3 inch layer of sandy lean clay. Sampler sent back down to the 45 to 50 foot depth. Upon retrieval of sampler, poorly graded fine- to medium-grained sand with cemented silica nodules (resembling a coral structure), mild to reacts strongly with HCL, olive (5Y4/3).			Sand forced up in auger approx. 8 ft. Problems getting hexrod and sampler down to starting depth to advance.
45.2	54.8	SP	No recovery, assume fine- to medium-grained sand.			Having to wash bore hole. Still blowing up 6 to 8 ft in auger.
40.2	59.8	SP	No recovery.			
		SP	Same as 45 to 50 feet with cemented silica nodules.			

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING

PROJECT: CFEX-92-0094 ASH PONDS HYDROGEOLOGIC STUDY United Power Association Stanton Station Stanton, North Dakota	BORING: **SB-9 (cont.)** LOCATION: N89124.66 E91102.89 DATE: 9/1/92 SCALE: 1" = 4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

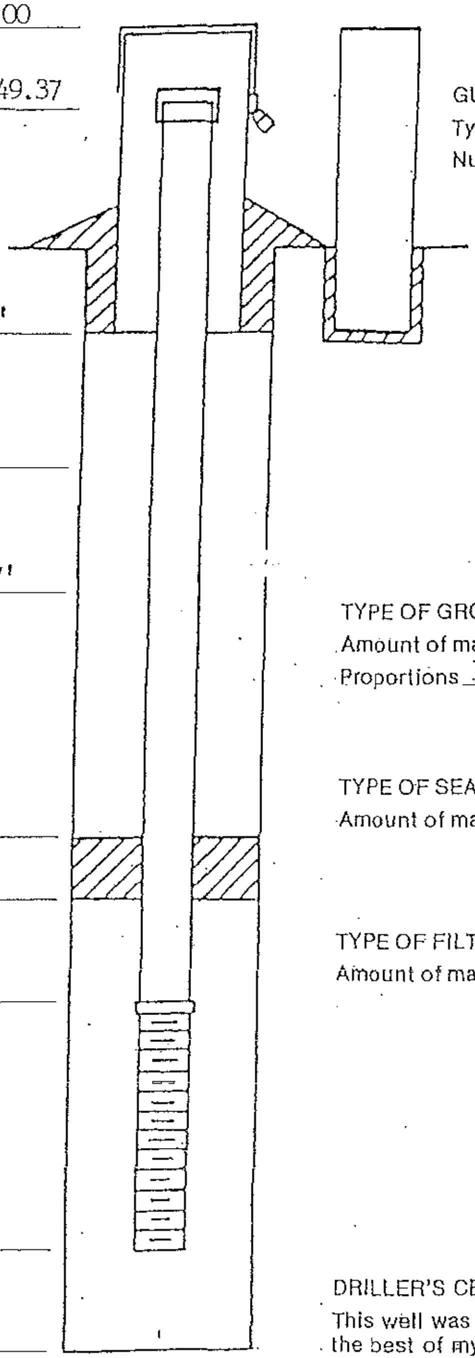
Elev.	Depth	ASTM Symbol		Description of Materials (ASTM D 2488)	BPF	WL	Tests or Notes
35.7	64.3						
		SP	▨	POORLY GRADED SAND, coarse grained with Gravel, waterbearing.			Switched to split spoon.
33.7	66.3						
				END OF BORING.			

MONITORING WELL FIELD DATA SHEET

Client United Power Association Proj. No. CFEX-92-0094 Location UPA Station, Stanton, ND

Well Number MW-8B Well Location SW¼, NW¼, Sec21, T144N, R84W Date of Installation 09/03/92

Date of Revision ______ Crew KD, TC, LM B.M. Location & Elev. (± 0.01) ______



Stick up above ground (to 0.1') 3.00

Top of riser pipe (w/o cap) Elev. (± 0.01') 1749.37

Ground surface Elev. (± 0.1') ______

Depth to bottom of surface seal 1.5'

Approximate water level before installation 22'

Approximate depth of first water encountered in drilling 22.7'

Depth to top of seal 1.5'

Depth to bottom of seal 49'

Depth to top of screen 54'

Depth to bottom of screen 64'

Depth to bottom of boring 64.5'

Note: Depths relative to ground surface.

GUARD POST:
Type T-Posts
Number 3

Protective Cover:
Type Pro-Top
Length 5'
Lock # 2106

Type of sealing material Concrete

RISER PIPE:
Type PVC
Diameter 2"
Total Length 60'
Sections Used 6'
Couplings No
Cap Yes X No ______

TYPE OF GROUT ABOVE SEAL: Neat Cement Grout
Amount of material used ______
Proportions 11 bags Portland (1034#), 35 lbs. Bentonite, 60 gal wate

TYPE OF SEALING MATERIAL: Neat Cement Grout
Amount of material used See grout above

TYPE OF FILTER MATERIAL: 12 - 30 Silica Sand and Natural
Amount of material used 100 lbs. and Natural

SCREEN:
Type PVC
Slot Size 0.010
Length 10'
Diameter 2"
Plug/Point Male Plug

Method of advance:
HSA X I.D. 3 3/4"
Casing ______ I.D. ______
cone ______ O.D. ______

Method of development:
Air ______
Jet ______ Surge X Bail

DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction, and this report is true to the best of my knowledge.

Braun Intertec Environmental, Inc. 421
Driller's or Firm's Name Certificate No.

913 S. 18th St., P.O. Box 2379, Bismarck, ND 58502-2379
Address

11-23-92
Signed by Date

BRAUN

BARR

Barr Engineering Company

MW9N

LOG OF PIEZOMETER

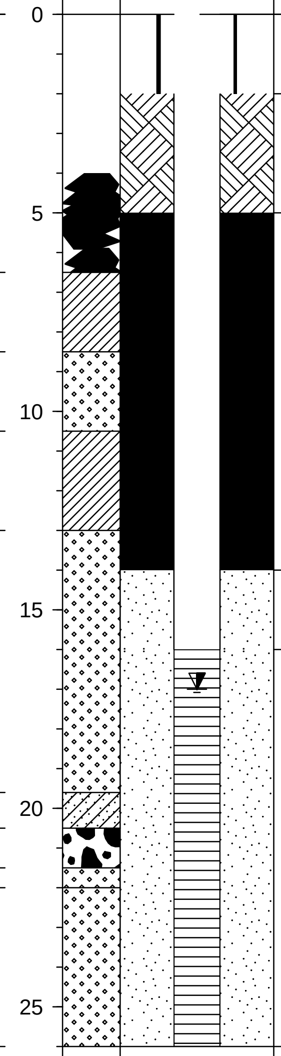
(Reference Boring No. MW9)

Sheet 1 of 1

	Location: Stanton Station	Client: Great River Energy
Barr Project Number: 34291006	Surface Elevation: 1705.52	Top of Casing Elevation: 1708.18

STRATA

DESCRIPTION
COAL: black, dry.
SANDY LEAN CLAY (CL): brown, dry, interbedded with coal.
WELL GRADED SAND (SW): fine to medium grained, brown, dry.
LEAN CLAY (CL): brown, moist, interbedded with medium sand, high plasticity.
WELL GRADED SAND (SW): fine to medium grained, brown, moist, trace clay.
CLAYEY SAND (SC): medium grained, brown, wet.
WELL GRADED GRAVEL (GW): brown, wet, some clay.
WELL GRADED SAND (SW): medium grained, brown, wet.
WELL GRADED SAND (SW): medium grained, dark brown, wet, some gravel.



DEPTH (ft.)		ELEVATION (ft.)
0.0	GS	**1705.52**
2.0		1703.52
5.0		1700.52
14.0		1691.52
16.0		1689.52
26.0		1679.52

Completion Depth: 26.0
Date Started: 7/19/10
Date Completed: 7/19/10
Logged By: JLS4
Drilling Contractor: BRAUN
Drilling Method: HSA
Coordinates
North:
East:

LEGEND

- ⬚ FILTER PACK
- ■ BENTONITE
- ▨ CEMENT GROUT
- ▩ CUTTINGS / BACKFILL

WATER LEVELS

WATER LEVEL: ▼ 17.0 ft
DATE: 07-19-2010
TIME: 11:30 am
0

The stratification lines represent approximate boundaries. The transition may be gradual.

Barr Engineering Company

LOG OF PIEZOMETER

(Reference Boring No. MW10)

Sheet 1 of 1

Location: Stanton Station

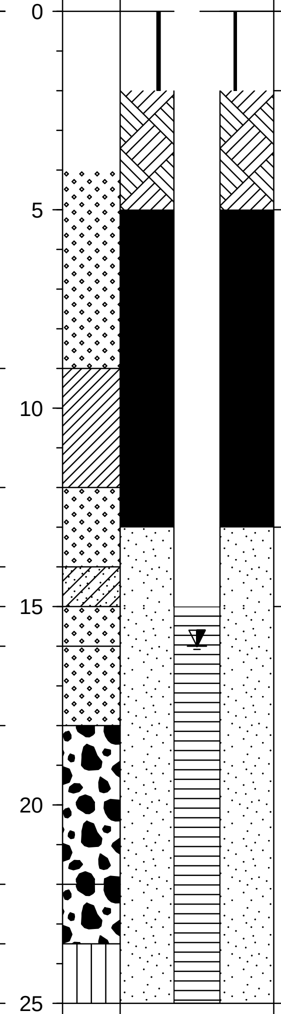
Client: Great River Energy

Barr Project Number: 34291006

Surface Elevation: 1705.20

Top of Casing Elevation: 1707.88

STRATA	
DESCRIPTION	DEPTH (ft.)
WELL GRADED SAND (SW): medium grained, brown, moist.	0 – 9
SANDY LEAN CLAY (CL): brown, moist.	9 – 12
WELL GRADED SAND (SW): medium grained, brown, moist.	12 – 14
SANDY LEAN CLAY (SC): brown, moist.	14 – 15
WELL GRADED SAND (SW): medium grained, brown, moist, some rounded fine gravel.	15 – 16
WELL GRADED SAND (SW): medium to coarse grained, brown, wet, some rounded fine gravel.	16 – 18
WELL GRADED GRAVEL WITH SAND (GW): fine grained, brown, wet, coarse sand.	18 – 22
WELL GRADED GRAVEL WITH SAND (GW): fine grained, brown, wet, coarse sand, some rounded cobbles.	22 – 23.5
SANDY SILT (ML): gray, wet.	23.5 – 25



DEPTH (ft.)		ELEVATION (ft.)
0.0	GS	**1705.20**
2.0		1703.20
5.0		1700.20
13.0		1692.20
15.0		1690.20
25.0		1680.20

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Completion Depth:	25.0
Date Started:	7/19/10
Date Completed:	7/19/10
Logged By:	JLS4
Drilling Contractor:	BRAUN
Drilling Method:	HSA
Coordinates	
North:	
East:	

LEGEND

- ░ FILTER PACK
- ■ BENTONITE
- ▨ CEMENT GROUT
- ▩ CUTTINGS / BACKFILL

WATER LEVELS

WATER LEVEL: ▽ 16.0 ft
DATE: 07-19-2010
TIME: 10:00 am
0

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING LOG NO. B-102

Page 1 of 1

PROJECT: Monitoring Well Installations

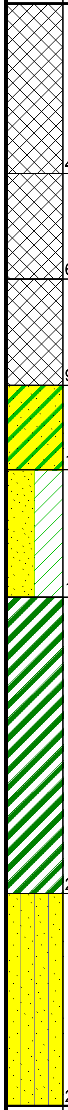
CLIENT: Golder Associates, Inc.
Lakewood, Colorado

SITE: GRE - Stanton Station
Mercer County, North Dakota

LOCATION: See Exhibit A-2

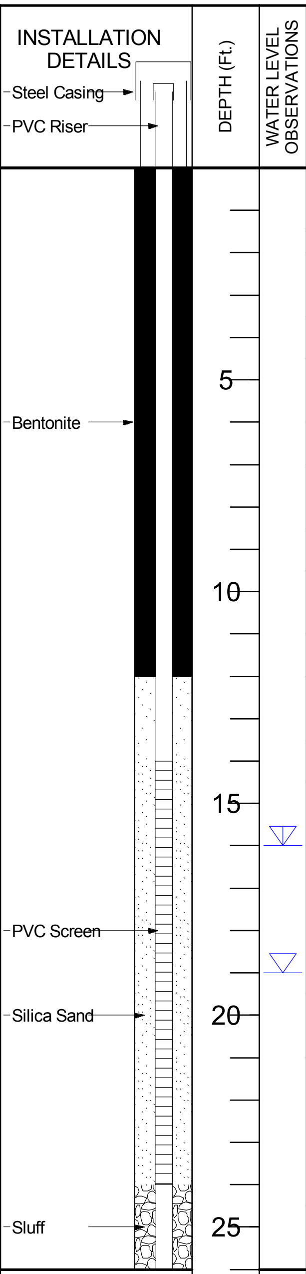
Latitude: 47.28453° Longitude: -101.33443°

Surface Elev.: 1706 (Ft.)



DEPTH		ELEVATION (Ft.)
4.0	**FILL - CLAYEY SAND**, dark brown, very loose to loose, fine to medium-grained, coal inclusions	1702
6.5	**FILL - SILTY SAND**, dark brown, medium dense, fine to coarse-grained, coal inclusions	1699.5
9.0	**FILL - FAT CLAY**, brown, very stiff, boulder around 8 feet	1697
11.0	**CLAYEY SAND (SC)**, brown, medium dense, fine-grained	1695
14.0	**POORLY GRADED SAND WITH CLAY (SP-SC)**, brown, medium dense, fine-grained, sand lenses	1692
21.0	**FAT CLAY (CH)**, grayish-brown, very stiff to stiff waterbearing sand seam at 19 feet	1685
26.0	**SILTY SAND (SM)**, grayish-brown, dense, fine-grained, waterbearing	1680

Boring Terminated at 26 Feet



SAMPLE TYPE	FIELD TEST RESULTS
☒	1-1-1 N=2
☒	2-3-3 N=6
☒	3-5-11 N=16
☒	9-15-15 N=30
☒	6-7-6 N=13
☒	2-5-5 N=10
☒	5-8-10 N=18
☒	3-3-6 N=9
☒	9-15-16 N=31

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3¼" ID HSA 0-24½'

Abandonment Method:
Boring converted to monitoring well installation.

See Exhibit A-3 for description of field procedures.

See Appendix B for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *On 11/20/2015*

Terracon
1805 Hancock Drive
Bismarck, North Dakota

Boring Started: 11/17/2015	Boring Completed: 11/17/2015
Drill Rig: D-90	Driller: MR
Project No.: M2155089	Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-WELL M2155089.GPJ TERRACON2012.GDT 12/2/15

BORING LOG NO. B-103

Page 1 of 1

PROJECT: Monitoring Well Installations

CLIENT: Golder Associates, Inc.
Lakewood, Colorado

SITE: GRE - Stanton Station
Mercer County, North Dakota

LOCATION: See Exhibit A-2

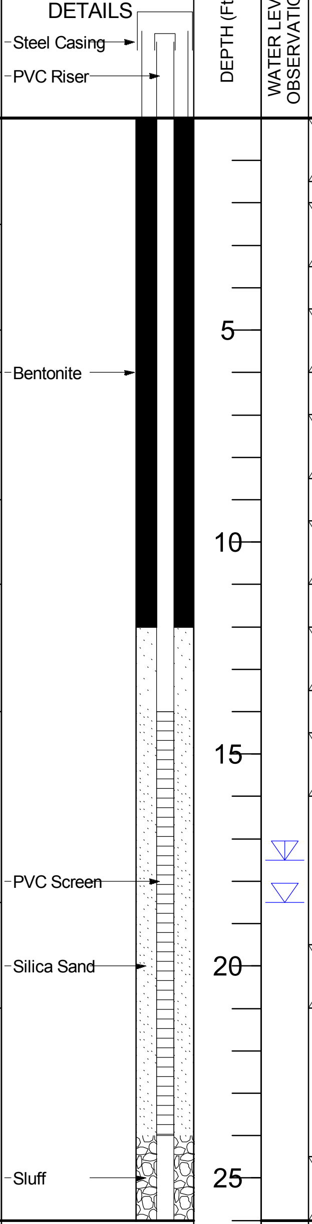
Latitude: 47.2845° Longitude: -101.33185°

Surface Elev.: 1707 (Ft.)

DEPTH		ELEVATION (Ft.)
	FILL - CLAYEY SAND, dark brown, medium dense to loose, fine-grained, coal inclusions	
2.5		1704.5
	FILL - COAL	
5.0		1702
	SILTY SAND (SM), brown, medium dense, fine-grained	
6.0		1701
	POORLY GRADED SAND (SP), light brown, medium dense, fine-grained	
9.0		1698
	POORLY GRADED SAND WITH CLAY (SP-SC), brown, loose, fine-grained	
11.0		1696
	FAT CLAY (CH), brown, stiff, sand lenses	
14.0		1693
	POORLY GRADED SAND WITH CLAY (SP-SC), brown, medium dense, fine-grained	
18.5		1688.5
	POORLY GRADED SAND (SP), brown, loose, fine to coarse-grained, waterbearing	
21.0		1686
	POORLY GRADED SAND WITH SILT AND GRAVEL (SP), grayish-brown, medium dense, fine to coarse-grained, waterbearing	
26.0		1681

Boring Terminated at 26 Feet

INSTALLATION DETAILS



DEPTH (Ft.)	FIELD TEST RESULTS
	3-5-11 N=16
	6-4-5 N=9
5	5-11-13 N=24
	5-6-5 N=11
10	3-3-6 N=9
	4-6-5 N=11
15	5-9-9 N=18
20	3-2-2 N=4
25	5-7-9 N=16

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3¼" ID HSA 0-24½'

Abandonment Method:
Boring converted to monitoring well installation.

See Exhibit A-3 for description of field procedures.

See Appendix B for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *On 11/20/2015*

Terracon
1805 Hancock Drive
Bismarck, North Dakota

Boring Started: 11/17/2015	Boring Completed: 11/17/2015
Drill Rig: D-90	Driller: MR
Project No.: M2155089	Exhibit: A-6

BORING LOG NO. B-105

Page 1 of 1

PROJECT: Monitoring Well Installations

CLIENT: Golder Associates, Inc.
Lakewood, Colorado

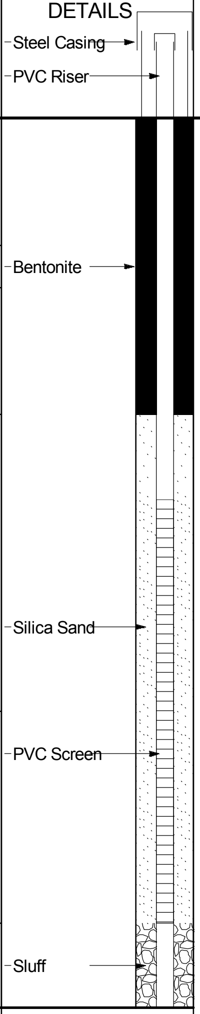
SITE: GRE - Stanton Station
Mercer County, North Dakota

LOCATION: See Exhibit A-2

Latitude: 47.28083° Longitude: -101.33521°

Surface Elev.: 1708 (Ft.)

GRAPHIC LOG	DEPTH		ELEVATION (Ft.)
▨	3.0	**FILL - POORLY GRADED SAND**, light brown, medium dense, fine-grained	1705
▨	4.0	**FILL - SANDY LEAN CLAY**, brown, medium stiff	1704
▧	7.0	**LEAN CLAY (CL)**, brownish-gray, medium stiff, silt laminations	1701
▧	14.0	**FAT CLAY (CH)**, brown, medium stiff, sand lenses and silt laminations waterbearing sand seam at 12.5 feet	1694
▧	19.0	**CLAYEY SAND (SC)**, brown, loose, fine to medium-grained	1689
▧	21.0	**SANDY LEAN CLAY (CL)**, brown, stiff, silt laminations	1687
		Boring Terminated at 21 Feet	



DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
		☒	3-4-6 N=10
		☒	3-2-3 N=5
5		☒	3-2-3 N=5
		☒	3-3-5 N=8
10		☒	3-3-3 N=6
	▽ ▽	☒	3-3-1 N=4
15		☒	2-2-2 N=4
20		☒	2-4-4 N=8

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3¼" ID HSA 0-19½'

Abandonment Method:
Boring converted to monitoring well installation.

See Exhibit A-3 for description of field procedures.

See Appendix B for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*
▽ *On 11/20/2015*

Terracon
1805 Hancock Drive
Bismarck, North Dakota

Boring Started:
Boring Completed: 11/18/2015
Drill Rig: D-90
Driller: MR
Project No.: M2155089
Exhibit: A-8

APPENDIX D

Example Field Forms

Stanton Station

INSTRUMENT CALIBRATION FORM

Project Name: ______________________________ **Project No:** ________________________

Calibration By: ____

Instrument Details

Instrument Name: ____

Serial No.: ____

Model No.: ____

Calibration Details

Calibration Standard: ____

____

Calibration Standard(s) Expiration Date: ____________________________________

Calibration:

Date	Time	**Calibration Standard** Units: ___________	**Instrument Reading** Units: _________

Comments:

Field Datasheet - Groundwater Assessment

Weather:	Temperature: °F / °C	Wind:	Precipitation:	Sunny / Partly Cloudy / Cloudy (circle one)

General Information

Sampling Personnel:
Program Name:
Sampling Event:
Location/Sample ID:

Well Information

Well Locked?	Yes	No
Well Labeled?	Yes	No
Casing Straight?	Yes	No
Grout Seal Intact?	Yes	No
Necessary Repairs:		
Casing Diameter:		

Purging and Sampling Information

Purge Date:		**Time Purging Began:**	
Well Purged Dry?	Yes / No	Time Purged Dry:	
Sample Date:		**Time of Sampling:**	
Bottle List:			
Purging Method:		Control Settings	
Sampling Method:		Purge:	sec
Dedicated Equipment?	Yes / No	Recover:	sec.
QC Sample?	Yes / No	PSI:	
QC Sample ID:		Pumping Rate:	mL/min

Notes:

Water and Free Product Levels

Static Water Level Before Purge:		(±0.01 ft)
Depth to Top of Pump:		(±0.01 ft)
Depth to Bottom of Well:		(±0.01 ft)
Water Level After Sampling:		(±0.01 ft)

Free Product Detected?	Yes	No
Product Level Before Purge:		(±0.01 ft)
Product Level After Purge:		(±0.01 ft)

Notes:

Field Measurements and Purge Parameters

Stabilization (3 consecutive)		**Water Temp (°C)**	**Spec. Cond. (_S/cm)**	**pH (S.U.)**	**Turbidity (NTU)**	**Water Level (ft)**	**Volume Purged (mL)**	**Description:** Clarity, Color, Odor, Etc.
Reading #	**Time**	±3%	±3%	±0.1				Clear, Slightly Turbid, Turbid

Stabilized: Yes No (circle one)

Total Volume Removed: ____________ mL

Minimum volume of stagnant water to purge prior to collection of field parameters: 500 mL

Measurements should be recorded with precision of ±0.5° (temp), ±5% (SC), and ±0.1 S.U. (pH)

Comments:

GREAT RIVER ENERGY

Field Datasheet - Stanton Station Groundwater Levels

Location [1]	**Well ID**	**Date**	**Time**	**Depth to Water**	**Comments**
Upgradient/Side-gradient	MW-6B				
	MW-7A				
	MW-7B				
	MW-8B				
	MW-105				
Bottom Ash Landfill Downgradient	MW-3B				
	MW-9N				
	MW-101				
	MW-102				
Bottom Ash Impoundment Downgradient	MW-1R				
	MW-103				
	MW-104				
Closed Ash Landfill	MW-10				
	MW-X				
	MW-XX				

Notes:
1. Sample upgradient sites first, followed by the downgradient sites.

APPENDIX E

Manufacturer's User Guides for Low Flow Pumps and Controller

Geotech
Bladder Pumps

Installation and Operation Manual

Rev 1/22/2018 Part # 21150035

Table of Contents

DOCUMENTATION CONVENTIONS

This document uses the following conventions to present information:

WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.

CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

Section 1: System Description

Function and Theory

Geotech’s pneumatic Bladder Pumps operate with a unique air-driven action, ideal for both gentle low-flow sampling and high-flow rate purging. Timed ON/OFF cycles of compressed air alternately squeeze the flexible bladder to displace water out of the pump to the surface then exhaust the air allowing the pump to refill.

Fluid enters and fills the pump through the fluid inlet check valve at the bottom of the pump body via hydrostatic pressure. Once filled with fluid, compressed air enters the space between the bladder and the interior of the pump housing, squeezes the bladder, and pushes the fluid to the surface (see Figure 1-1). Operated by the BP Controller or Geocontrol PRO, this logic automatically repeats.
Air does not contact the sample. The bladder prevents contact between the pump driven air and the sample. All wetted pump parts are 316 Grade stainless steel to ensure the purity of the sample is maintained.

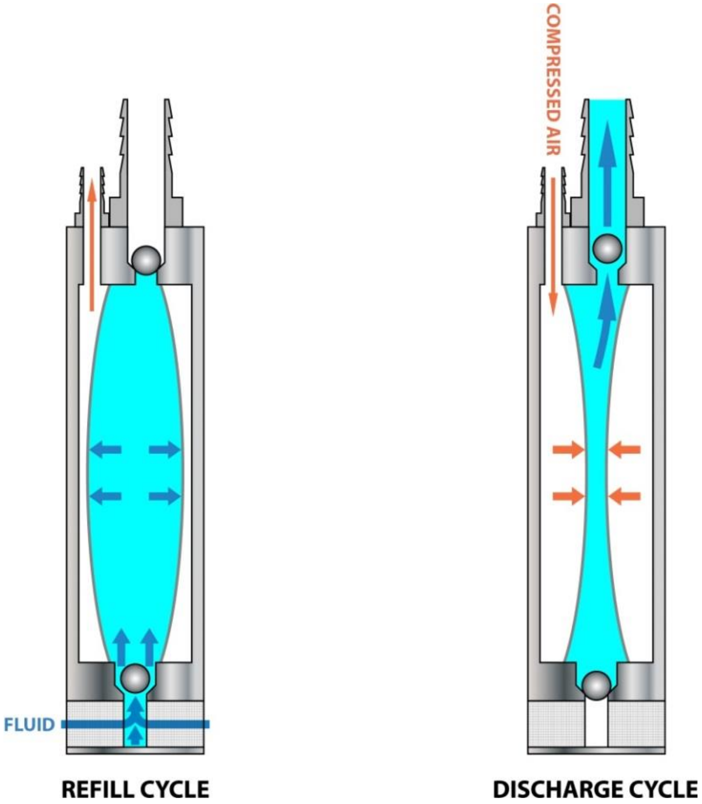


Figure 1-1: Bladder Pump Operation
Not to scale

Be sure to read and understand your portable generator and/or portable air compressor user manual for proper installation, operation, and Earth grounding instructions. If using portable compressed gas tanks, exercise caution, use safety protection devices as outlined by the supplier, and observe any additional safety requirements mandated by local jurisdiction.

System Components

The Geotech Bladder Pump features four accessible parts (see Figure 1-2):

- Intake Screen
- Pump Housing
- Air and Sample Line Connections
- Bladder Assembly

*Optional: Drop Tube Intake Assembly

Intake Screen

The intake filter screen is constructed of 316 Stainless Steel and is easily removed and disassembled for field maintenance. The intake filter screen is intended to protect and extend the life of the bladder material (see *The Warranty*).

Pump Housing

The Geotech Bladder Pump housing is constructed of electropolished 316 Stainless Steel. Viton O-rings provide the high-pressure seals between the end caps and the housing walls. Always lubricate the O-rings with deionized water before installing the housing and intake screen.

Air and Sample Line Connections

The 1.66” Bladder Pump is provided in both low and high-pressure configurations. The low-pressure model is equipped with hose barbs for air and sample line connections, whereas the high-pressure model is equipped with heavy-duty compression fittings. The .850” and .675” models are both considered low pressure. See *Section 6: System Specifications* for operating depths and pressures.

Bladder assembly

The bladders are extruded Polytetrafluoroethylene (PTFE) to provide a long life and to ensure undisturbed samples. The internal bladders are easily replaceable, see *Section 4: System Maintenance*.

Drop Tube Intake Assembly (Optional)

An optional drop tube can be used to sample from depths below the specified maximum sampling depth. The drop tube assembly connects a remote intake feature to the pump through a tube connected to the pump inlet. The intake depth can be any custom length of tubing. The pump assembly itself must still be submerged below the water level. This means the depth to water cannot exceed the maximum pumping depth of the pump.

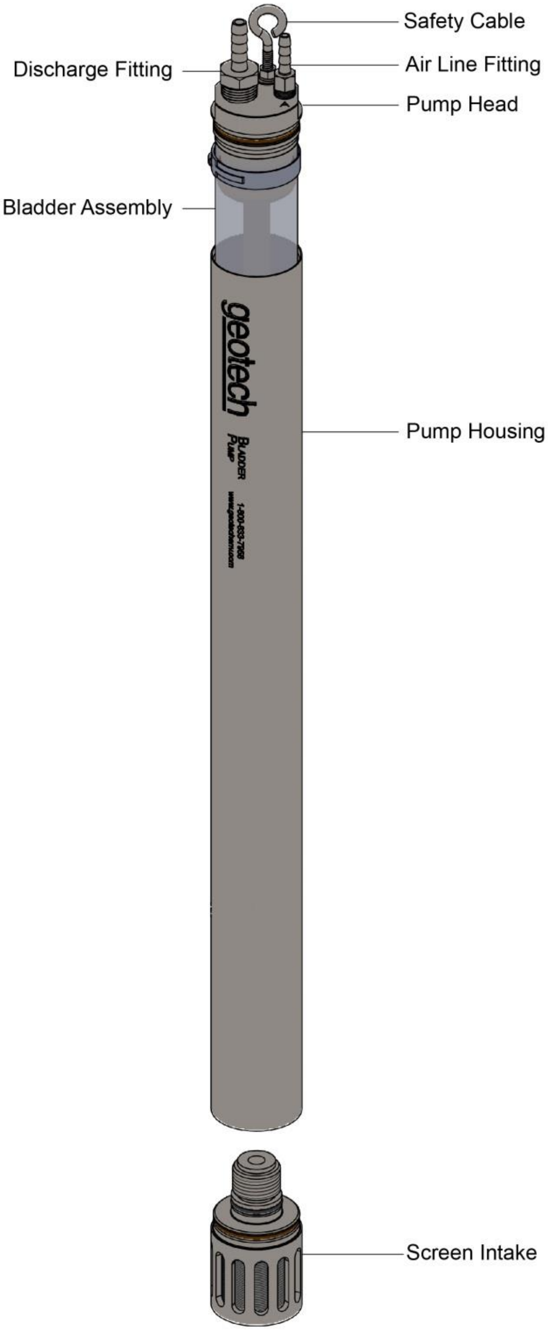


Figure 1-2: Basic* Bladder Pump Assembly

**Example above is based on 1.66" Low Pressure configuration*

Section 2: System Installation

Determine site-specific parameters such as water level, recharge rate and adherence to low flow purging guidelines. Speak with your Geotech Customer Service Representative to ensure the right equipment is being used.

Pump Controller

Geotech Bladder Pumps can be operated using a variety of controllers. Site requirements will determine the optimal control unit. Use the table below as a guide:

Controller	Air Source	Max Operating Depth
Geocontrol Pro	Internal compressor	180’ (55m)
BP Controller 300 PSI	Externally supplied	690’ (210m)
BP Controller 500 PSI	Externally supplied	1000’ (305m)

Pump Tubing Lines

Geotech’s Bladder Pumps are engineered for easy installation and use. Dedicated Bladder Pump systems are available with the tubing and well cap attached for ease of deployment. Well identifications (supplied by customer) are located on tags connected to the tubing, and on the tubing bags.

If not pre-attached, at the wellhead connect the airline tubing to air line connection at the top of the Bladder Pump (see Figure 1-2). The letter “A” has been stamped near the airline port on the top of each pump. See *Section 6: System Specifications* for air line system sizes.

Next, attach the discharge line to the discharge line connection at the top of pump (see Figure 1-2).

Failure to attach air and fluid lines to the appropriate ports could result in damage to the bladder.

Compression Fitting Installation

1. Ensure tubing is cut at a square, 90° angle.
2. Attach nut, back ferrule, and front ferrule to the tubing.
3. Ensure the front of the ferrule is touching the inlet, then slide the nut over the ferrule and tighten it finger-tight.
4. Mark the nut with a line.
    - This line will indicate the initial start point of the nut.
5. Hold the fitting body steady with a wrench. Turn the nut 1 ¼ turns.
    - Do not overtighten.
    - If re-installing compression fitting after repair/regular maintenance, turn the nut 1 turn after hand-tightening.

Safety Cable

Before deploying any sampling pump, secure a safety cable from an anchoring point at or near the wellhead to the top of the pump.

Carefully lower the Bladder Pump into the well using the Reverse Coil Method to avoid kinking, until the desired depth is achieved or until the well cap seats Reverse Coil Method

When lowering the pump into the well, it is important to reverse the natural bend of the coiled tubing so that the tubing straightens as it is lowered (see Figure 2-1). As the pump and tubing are lowered into the well, the direction of the bend should be reversed from the direction in which it is coiled. If the tubing is allowed to uncoil naturally and the natural bend not interrupted, the tubing will continue its coil into the well. Using the reverse coil method will avoid any difficulty while lowering the pump into the well, especially when the well is not completely vertical, or has come out of alignment for any reason.

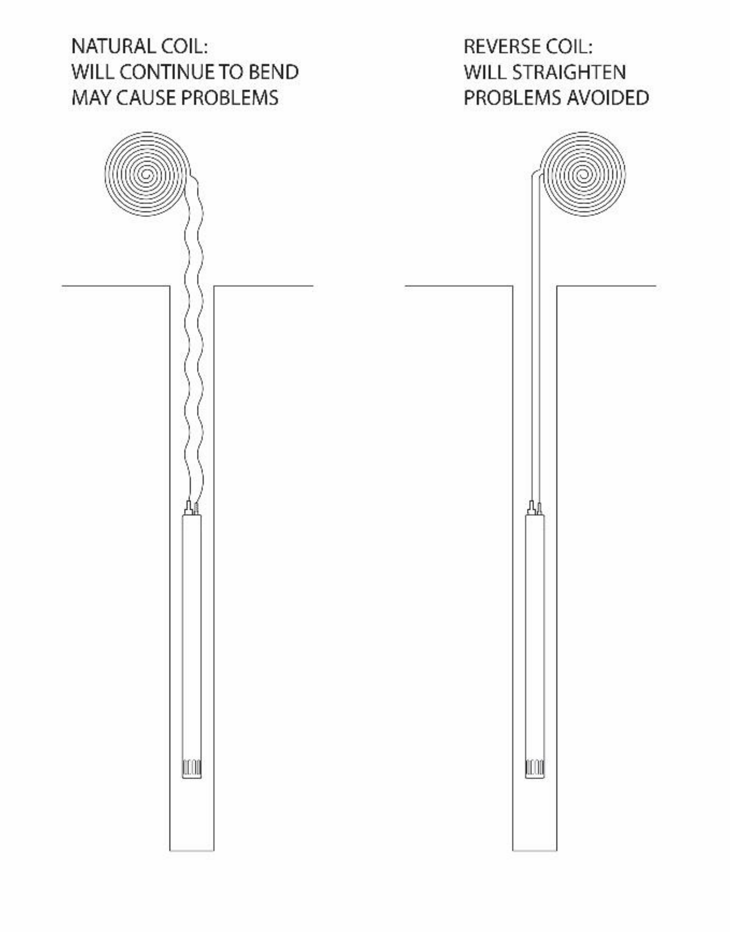


Figure 2-1: Reverse Coil Method

Optional Drop Tube Assembly

If a Drop Tube Intake Assembly is employed, a third tubing line is necessary to connect from the bottom of the bladder pump to the top of the drop tube intake.

For deployment of optional Drop Tube Intake Assembly, attach desired length of drop tube between the intake’s hose barb and hose barb on bottom of pump. For added security, a safety cable may be installed to support the drop tube intake to the bottom of pump.

Send the drop tube intake down the well followed by the drop tube tubing, then the pump, and finally the air and fluid discharge line.

Section 3: System Operation

Bladder Pump Operation

Fluid enters the pump through the fluid inlet check valve at the bottom of the pump body via hydrostatic pressure. The pump MUST be submerged to operate. The bladder then fills with fluid. Compressed air enters the space between the bladder and the interior of the pump housing. The intake check valve closes and the discharge check valve (top) opens. Compressed air squeezes the bladder, pushing the fluid to the surface. The discharge check valve prevents back flow from the discharge tubing.

Selecting an Air Source

Air consumption depends on the volume of tubing and the size of deployed Bladder Pump. Follow the general guidelines and examples below to calculate the air consumption for specific sampling configurations.

Air Volume of Tubing

	TUBING LENGTH					
TUBE I.D.	1 ft/ 0.3 m	10 ft/ 3 m	50 ft/ 15 m	100 ft/ 30 m	250 ft/ 76 m	500 ft/ 152 m
0.17 in/ 0.43 cm	0.3 in³/ 5 cm³	3 in³/ 50 cm³	15 in³/ 246 cm³	30 in³/ 492 cm³	75 in³/ 1230 cm³	150 in³/ 2460 cm³
0.25 in/ 0.64 cm	0.6 in³/ 10 cm³	6 in³/ 100 cm³	30 in³/ 492 cm³	60 in³/ 984 cm³	150 in³/ 2460 cm³	300 in³/ 4920 cm³

Air Volume of Bladder Pumps

BP DIAMETER	BP LENGTH	VOLUME (in³)
1.66 in/ 4 cm	36 in/ 91 cm	78 in³/ 1278 cm³
1.66 in/ 4 cm	18 in/ 46 cm	39 in³/ 640 cm³
0.85 in/ 4 cm	18 in/ 46 cm	10 in³/ 164 cm³
0.675 in/ 4 cm	18 in/ 46 cm	6 in³/ 100 cm³

Calculation guideline:
Volume of Tubing (in³/cm³)
+ Volume of Bladder Pump (in³/ cm³)
= Air Consumption per cycle (in³/ cm³)

If planning to use an air compressor, use one with a reserve tank to insure proper air supply to the pump. If using a Nitrogen Tank, see Figure 3-1 for Nitrogen Tank Volume vs. Bladder Pump consumption.

Determining Operation Pressure

Determine the air pressure needed to operate the Bladder Pump based on the length of the air supply line to the pump (well depth).

Use the simplified formula:

0.5 PSI (per foot) + 10 PSI (to account for tubing friction) = required PSI
0.12 bar (per meter) + 0.7 bar (to account for tubing friction) = required bar

As mentioned above, the additional 10 PSI (0.7 bar) is to account for the pump itself and friction loss along the air line tubing. When the length of the airline is 50' (15m) or less, there is no need for the additional pressure.

To determine minimum operating pressures for the specific Bladder Pump model you are using, consult the pump's specifications. Typically, the minimum operating pressure will be 5 PSI (0.4 bar) above static head.

The formulas stated above are not absolute, and are meant to provide baseline information.

Flow Rates

Bladder Pump flow rates are influenced by pump size (diameter and length); pump depth and submergence, as well as controller selection (i.e. compressor performance, valve flow coefficient). Generally, a large pump at shallow depths will produce the most flow, and a small pump at maximum depths will produce the least amount of flow.

Example flow rates:

Pump Size:	**Depth: (3ft (0.9m) submergence)**	**Tubing Size**		**Flow Rate:**
		Air line:	**Discharge:**	
1.66 x 36"	@ 275 ft (84 m)	.17"ID x 1/4"OD (4.3mm x 6.4mm)	1/4"ID x 3/8"OD (6.4mm x 9.5mm)	22 oz/min (0.7 L/min)
	@ 500 ft (152 m)	1/4"ID x 3/8"OD (6.4mm x 9.5mm)		17 oz/min (0.5 L/min)
1.66 x 18"	@ 275 ft (84 m)	.17"ID x 1/4"OD (4.3mm x 6.4mm)	1/4"ID x 3/8"OD (6.4mm x 9.5mm)	12 oz/min (0.4 L/min)
	@ 500 ft (152 m)	1/4"ID x 3/8"OD (6.4mm x 9.5mm)		8 oz/min (240 mL/min)
.850 x 18"	@ 150 ft (46 m)	.17"ID x 1/4"OD (4.3mm x 6.4mm)		2 oz/min (59 mL/min)
.675 x 18"	@ 150 ft (46 m)	.17"ID x 1/4"OD (4.3mm x 6.4mm)		1 oz/min (27 mL/min)

The above example flow rates are based on 3' (0.9 m) of pump submergence. Typically, field environments will provide greater submergence (more than 10' (3 m)), which will dramatically increase flow.

Factors that increase flow:

- increased submergence (depth of pump below water line)
- a strong compressor, like the Geocontrol PRO, will enable fast pressure build up in the air line tubing and pump cavity
- a clean intake screen will maximize the amount of water entering into the pump

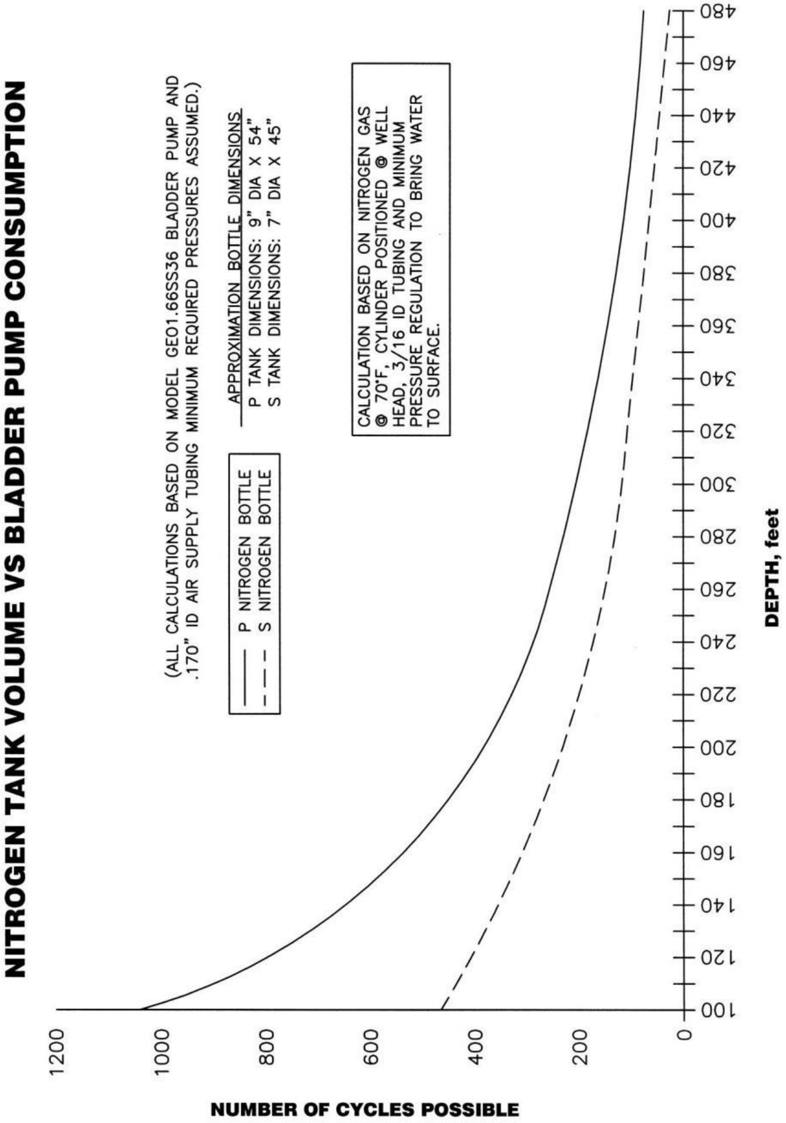


Figure 3-1: Tank Volume vs. BP Consumption

Section 4: System Maintenance

Bladder Pump

As with any pump, scheduled or periodic maintenance should be performed according to your sampling program and specific site conditions. Generally, the more turbid or sandy the water, the more maintenance and cleaning are required.

Replacement bladders, as well as other key components, can be found in *Section 7: Replacement Parts List*.

Disassemble Bladder Pump per instructions in this section, decontaminate or replace parts as needed, then reassemble.

Inspect O-rings and check balls for damage.
Replace Bladder if torn, ripped, or excessively worn.

Replacing the Bladder

1.66" Models

Pull pump from the well, it is not necessary to remove the air and sample lines from the pump. Take care, as the pump may be filled with fluid.

1. Hold the pump by its head with a towel or use the wrench flats, and turn the screen intake counter-clockwise to remove (see Figure 4-1).
    - The intake may be snug due to the high-pressure O-ring seal. Once the seal is broken, then intake should disengage easily.

2. Hold the pump by its head and slide or twist the housing off the pump body (see Figure 4-1).

3. Locate the Bladder clamps (see #3 on Figure 4-1).

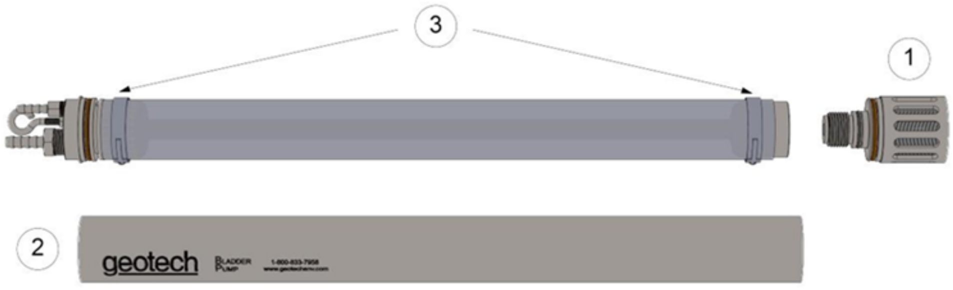


Figure 4-1: Accessing the Bladder Assembly

4. Obtain the clamp pincher tool (Geotech part # 11150031).

5. Pinch the tension hook and lift the end of the clamp until it releases from the retaining hooks (see Figure 4-2).

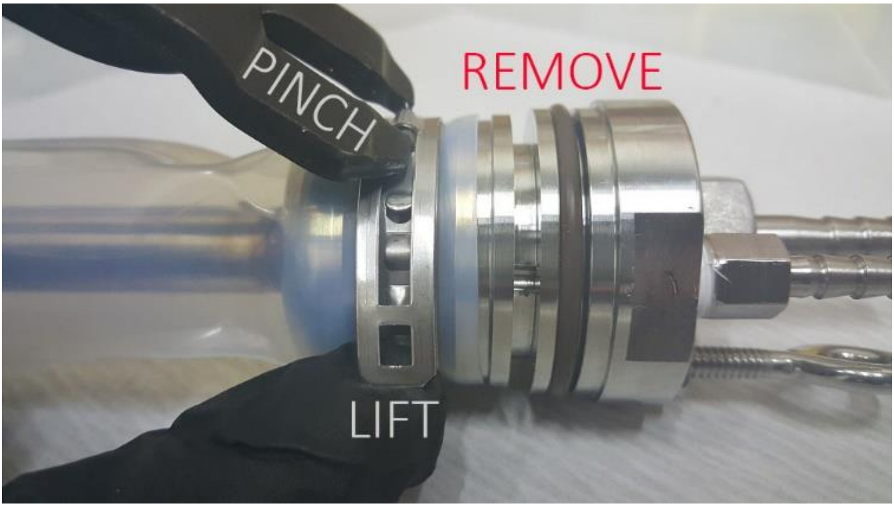


Figure 4-2: Removing the Bladder Clamp

6. Slide clamp off bladder.
   - Do this for both the top and the bottom bladder clamps.

7. Set the clamps aside, they are reusable.

8. Slide the bladder down over the pump body, decontaminate or replace as necessary.

9. Inspect O-rings for damage.

10. Replace O-rings as necessary.

<u>Reassemble the 1.66" Models:</u>

1. Slide the decontaminated or new bladder up the pump body and over the O-rings.

2. Ensure the O-rings are not dislodged and the bladder covers both O-rings with at least a 1/4" (.6cm) of clearance.

3. Slide the bladder clamps over the bladder and position each clamp over an O-ring, making sure the clamp and O-ring are aligned on center.

4. Using the clamp tool (Geotech part # 11150031). Pinch the tension hook and use your thumb to guide the end of the clamp over the retaining hooks until the clamp is locked in place (see Figure 4-4).

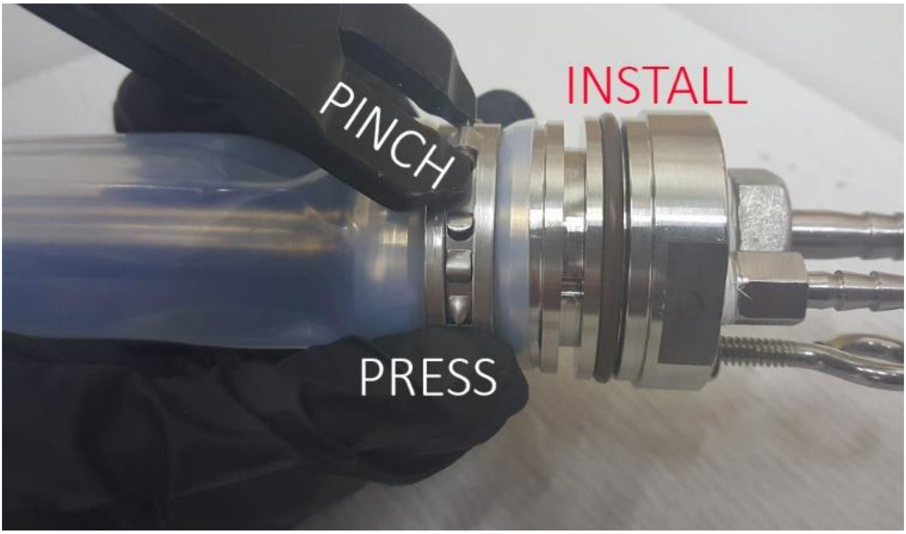


Figure 4-4: Installing the Bladder Clamp

5. Slide the housing over the pump body.

6. Lubricate the upper cap's O-ring using deionized water to ensure a pressure-ready installation.

7. Twist the housing on the body until it is flush with the upper cap.

8. Install the screen intake by lubricating the O-rings with deionized water and then turning clockwise into the pump's body.

9. Hold the pump by its head to ensure the screen intake is fully secured.
   - There should be no gaps between the outer housing and top or bottom caps.

10. Ensure the pump's fittings and safety cable are in good condition.

The pump is ready for service.

.850 and .675 Models

Pull pump from the well. It is not necessary to remove the air and sample lines from the pump. The pump may be filled with fluid.

1. Remove the lower screen and housing by turning the housing in a counter clockwise direction.
    - Use your hand or a strap wrench.

2. Remove the lower compression ring by pulling off end of the internal center tube assembly.

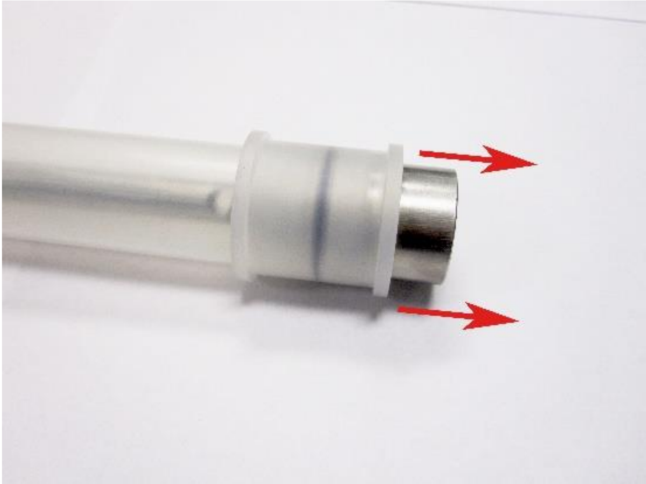


Figure 4-5: Inner Tube Center Assembly

3. Remove the upper compression ring by sliding it over the bladder and over the end of the internal center tube assembly.

Figure 4-6: Removing upper compression ring

4. Pulling from the lower end of the bladder, slide the bladder off the internal center tube weldment assembly.

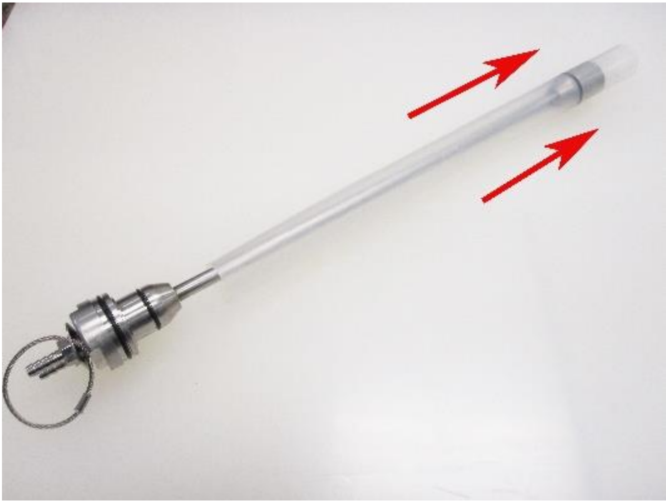


Figure 4-7: Removing the bladder

The bladder can now be replaced or serviced.

Inspect the bottom intake for worn or damaged O-rings, clean the intake screen as needed, and inspect the PTFE disc for damage.

Reassemble .850 and .675 Models:

1. Install O-ring to upper end of the center tube weldment assembly.

Figure 4-7: Installing O-Ring

2. Install O-ring on the upper end of the center tube weldment assembly

Figure 4-8: Install second O-ring

3. Install O-ring on the lower end of the center tube weldment assembly.

Figure 4-9: Install O-ring on lower end of center tube weldment

4. Slide bladder onto the center tube assembly and over the O-ring on the upper end of the center tube assembly.
    - Do not roll the O-rings
    - If needed, use Deionized water or a silicone based lubricant on the O-ring seals to help the bladder slide over the O-rings.

Figure 4-10a: Sliding bladder on

Figure 4-10b: Bladder entirely on

5. Slide a compression ring over the bladder over the bladder to the upper end of the center tube weldment assembly.

Figure 4-11a: Compression Ring on Bladder

Figure 4-11b: Compression ring secured

6. Slide the compression ring over the bladder until it seats flush with the bottom of the center tube assembly.

Figure 4-12: Bottom Compression Ring

7. Lubricate the upper cap's O-ring with deionized water to ensure pressure-ready installation.

8. Replace the outer housing.

- Be sure the outer housing is sealed against the upper cap.

Figure 4-16a: Incorrect Installation

Figure 4-16b: Correct Installation

9. Twist the housing on the body until it is flush with the upper cap.

10. Replace the bottom intake assembly by screwing it into the bottom of the pump.
- There should be no gaps between the outer housing and top or bottom caps.

Compression Fittings

Tubing can wear out over time if compression fittings are overtightened. After repair, ensure that compression fittings are “snug”. One full rotation after hand tightening of the nut should be enough to tighten the compression fitting.

Section 5: System Troubleshooting

Problem: Air is cycling through controller but will not pump.
Solutions

- Discharge and Fill times are not set correctly. Check and adjust Discharge and Fill cycle times (i.e. if Discharge time is too long or if Fill and Discharge time is too short).
- Possible compromise in air line tubing. Check airline pumps for leaks. If needed, repair using compression union or replace tubing.
- Check pump intake screen for blockage and clean as needed.

Problem: Controller is cycling but the pump stops producing water.
Solutions

- Check drawdown level of water in the well. Ensure the pump is fully submerged and off of the bottom of the well.
- Check air pressure at the regulator and adjust as necessary (See *Section 3: Determining Operation Pressure*.)
- Check for kinks in the discharge line.
- Check pump intake screen for obstructions.
- Discharge time is too long or Fill time is too short; causes pressure build up in pump, causing the pump not to fill.
- Check power source, assure a strong reliable power supply. If using old or weak battery, the control valves may not operate properly.

Problem: Getting air bubbles in sample line.
Solutions

- Overcharging pump. Reduce discharge cycle time so the discharge cycle ends as fluid discharge trails off. Inspect pump for compromised bladder or O-rings.
- Pump is being over pressurized. Reduce air pressure to what is necessary to overcome pumping head.
- Check discharge line for holes or kinks. Repair using compression union or replace tubing.
- Ensure Bladder clamps are properly installed.

Problem: Discharge line drains back into pump.
Solution

- Check valve at the top of the pump is compromised. Remove hose barb on pump discharge outlet. Check the check ball seat for debris. Clean and re-install.
- Check the upper ball for roundness, pitting or scaling.

Problem: Discharge sucks up water at sampling end, especially during fill cycle.
Solution
The compression fitting ferrule has cut into the tubing. Follow installation instructions in *Section 2: System Installation*.

If you are experiencing other problems than mentioned above, please call Geotech Technical Support for immediate assistance, (800) 833-7958.

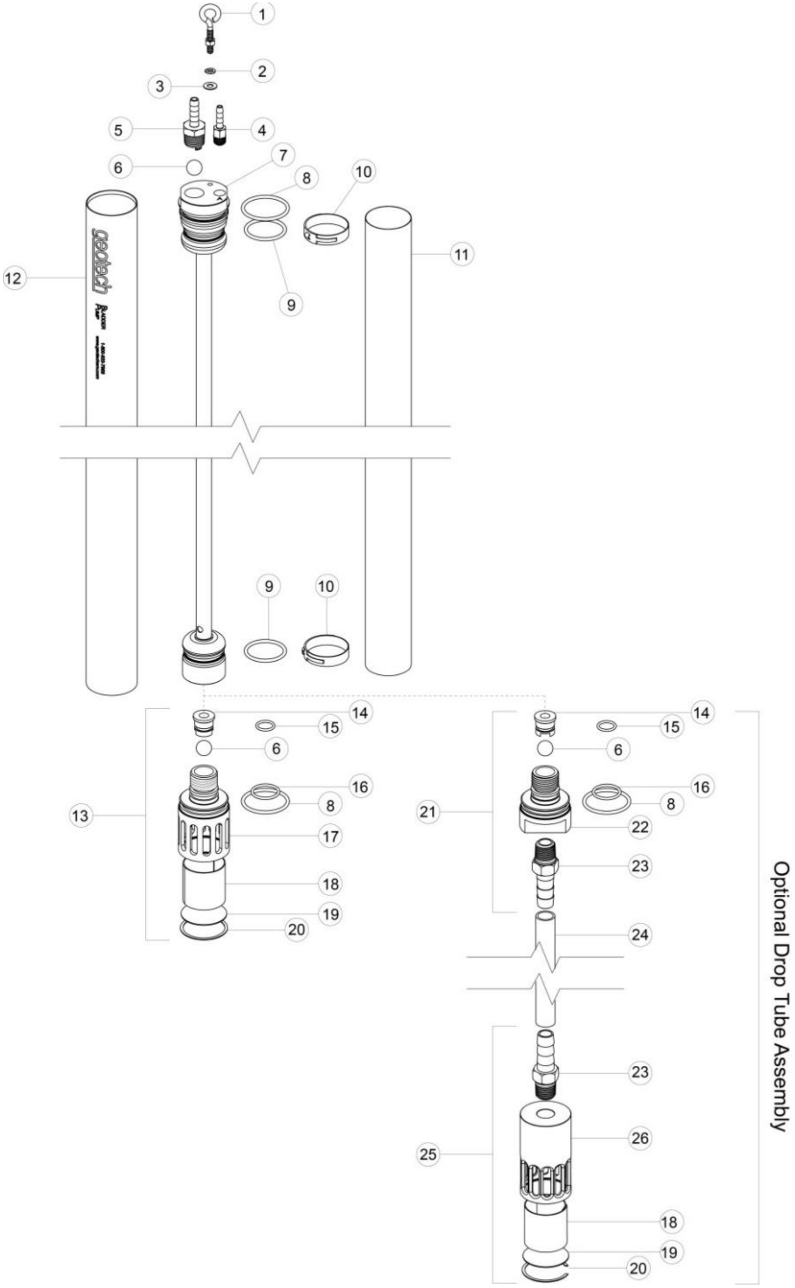
Section 6: System Specifications

	1.66 36"		1.66 18"		0.850"	0.675"
	High Pressure	Low Pressure	High Pressure	Low Pressure		
Pump Body	316 SS					
Fittings	316 SS					
Fitting Type	Compression	Hose barb	Compression	Hose barb	Hose barb	
Bladder Material	PTFE *Optional PE*					
Bladder Retainer	316 SS Clamp				PTFE Collar	
Pump O.D.	1.66" (4.2 cm)				.850" (2.2 cm)	.675" (1.7 cm)
Length	38" (96.5 cm)		20" (51 cm)		18 5/8" (47.3 cm)	18 3/4" (47.6 cm)
Weight	5.5 lbs. (2.5 kg)		3.5 lbs. (1.6 kg)		1.1 lbs. (0.5 kg)	.8 lbs. (0.4 kg)
Volume/ Cycle	22 oz. (650 mL)		11 oz. (325 mL)		1 oz. 29 mL	0.5 oz. 15 mL
Max Operating Temp.	PTFE Bladder: 32°F-212°F (0°C-100°C) *PE Bladder: 32°F -185°F (0°C -85°C*)					
Min. Well I.D.	2" (5 cm)				1" (2.5 cm)	.75" (1.9 cm)
Max. Sample Depth	1000 ft. (305 m)	290 ft. (88 m)	1000 ft. (305 m)	290 ft. (88 m)	200' (61 m)	
Min. Operating Pressure	5 psi ash* (.34 bar)					
Max. Operating Pressure	500 psi (34 bar)	125 psi (8.6 bar)	500 psi (34 bar)	125 psi (8.6 bar)	100 psi (7bar)	
Proof Pressure	675 psi (46 bar)	187 psi (13 bar)	675 psi (46 bar)	187 psi (13 bar)	150 psi (10 bar)	
Burst Pressure	1000 psi (69 bar)	300 psi (21 bar)	1000 psi (69 bar)	300 psi (21 bar)	300 psi (20 bar)	
Tubing Size (I.D. x O.D.)						
Air Line	1/4" x 3/8" (6 x 10 mm)	.17" x 1/4" (4 x 6 mm)	1/4" x 3/8" (6 x 10 mm)	.17" x 1/4" (4 x 6 mm)	.17" x 1/4" (4 x 6 mm)	
Discharge Line		1/4" x 3/8" (6 x 10 mm)		1/4" x 3/8" (6 x 10 mm)		

*ash = above static head

Section 7: Replacement Parts List

1.66 Bladder Pump Components (36” & 18” LOW Pressure Models)



Bladder Pump, 1.66, Stainless Steel, 36", Low Pressure - 81150120

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	HOSEBARB, SS6, .170 x 1/8" MPT, AIR LINE	21150019
5	1	HOSEBARB, SS6, MOD, 1/4" x 3/8 MPT, DISCHARGE	21150145
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166x36"	21150143
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS36,DEDICATED	51150139
12	1	HOUSING, SS6, DED, 166x36"	51150142
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS, 1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

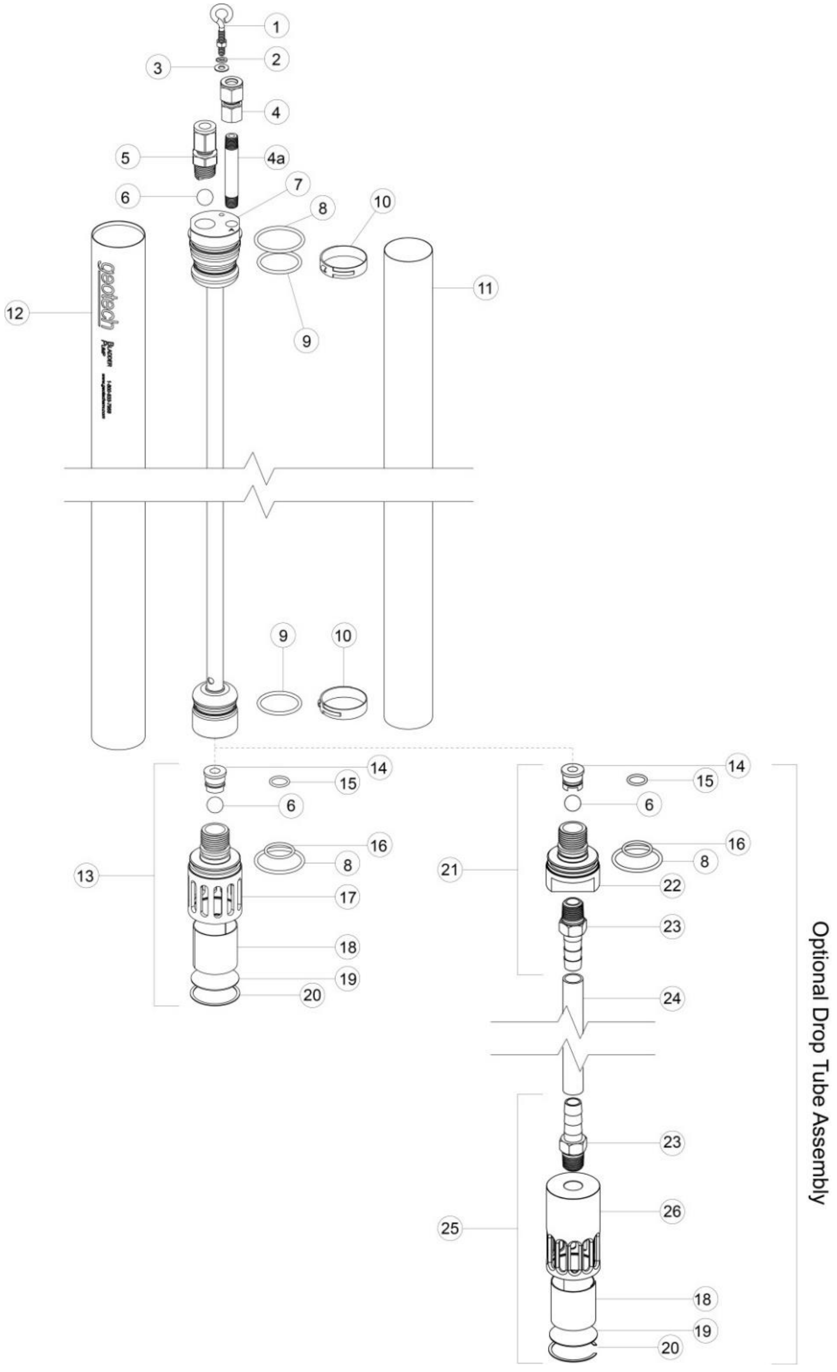
§ *= Sold Separately*

Bladder Pump, 1.66, Stainless Steel, 18", Low Pressure - 81150122

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	HOSEBARB, SS6, .170 x 1/8" MPT, AIR LINE	21150019
5	1	HOSEBARB, SS6, MOD, 1/4 x 3/8" MPT, DISCHARGE	21150145
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166 x 18"	21150147
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS18, DEDICATED	51150140
12	1	HOUSING, SS6, DED, 166 x 18"	51150143
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mm x 20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS, 1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

§ *= Sold Separately*

1.66 Bladder Pump Components (36" & 18" HIGH Pressure Models)



Bladder Pump, 1.66, Stainless Steel, 36", High Pressure - 81150119

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	CMPRSN FITTING, SS6, 3/8 TUBE x 1/8 FPT	11150446
4a	1	NIPPLE, SS6, 1/8" NPT x 2.5"	11150447
5	1	CMPRSN FITTING, MOD, SS6, 3/8 TUBE x 3/8" MPT	21150144
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166 x 36"	21150143
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS36,DEDICATED	51150139
12	1	HOUSING, SS6, DED, 166x36"	51150142
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC ,SS, 1.66,PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	FERRULE SETS, SS6, 3/8"	57200010
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Item 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

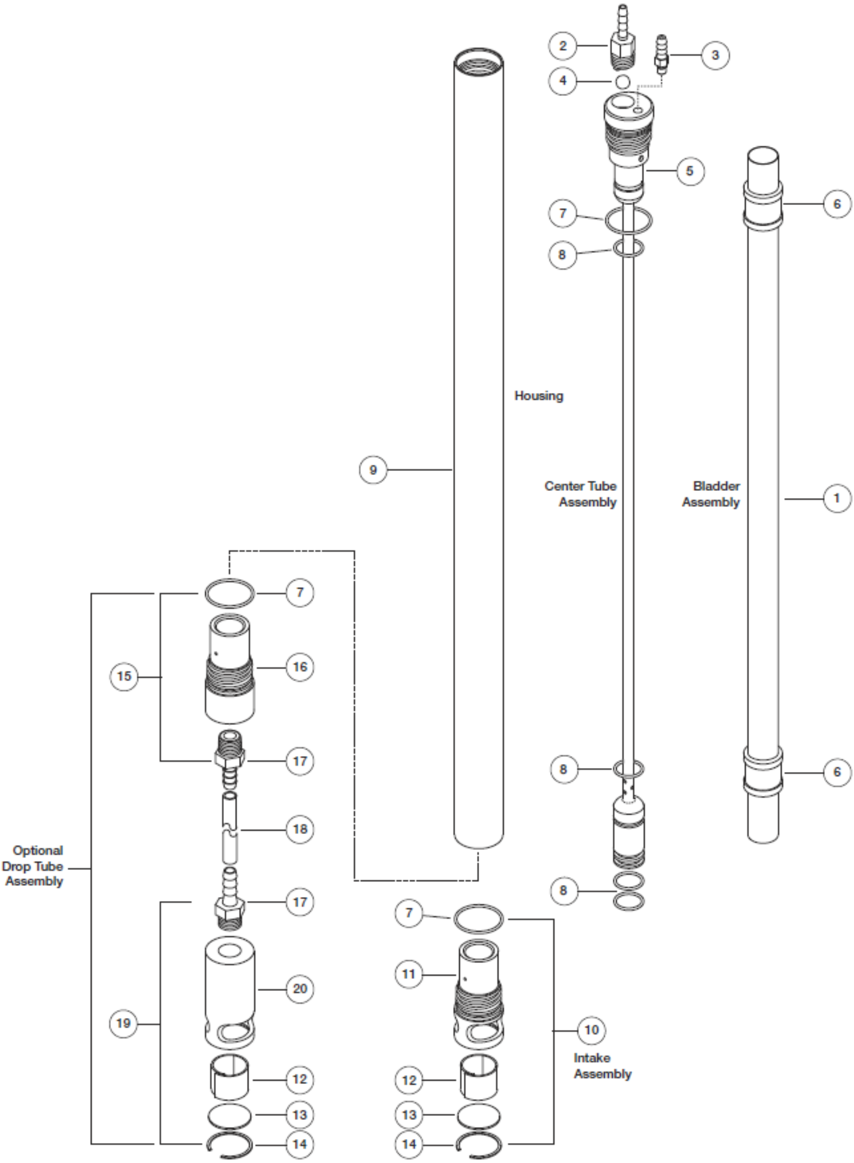
§ *= Sold Separately*

Bladder Pump, 1.66, Stainless Steel, 18", High Pressure - 81150121

Item	Qty	Description	Part No.
1	1	EYEBOLT, SS6, 10-24, 1" SHANK	16600347
2	1	WASHER, SS6, #10, LOCK	11150449
3	1	WASHER, SS6, #10	11150450
4	1	CMPRSN FITTING, SS6, 3/8 TUBE x 1/8 FPT	11150446
4a	1	NIPPLE, SS6, 1/8" NPT x 2.5"	11150447
5	1	CMPRSN FITTING, MOD, SS6, 3/8 TUBE x 3/8" MPT	21150144
6	2	BALL, SS6, 1/2"	17500082
7	1	CAP, UPPER WELDMENT, SS, 166x18"	21150147
8	2	O-RING, VITON, 2.5mm x 36mm, BROWN	11150318
9	2	O-RING, VITON, #123, BROWN	11200299
10	2	CLAMP, SS6, LOW PROFILE	11150444
11	1	BLADDER, PTFE, BP, 166SS18, DEDICATED	51150140
12	1	HOUSING, SS6, DED, 166x18"	51150143
13	1	ASSY, BOTTOM INTAKE, 166 BP	51150067
14	1	PLUG, BALL RETAINER, 166 BP	21150096
15	1	O-RING, VITON, #014, BROWN	17500119
16	1	O-RING, VITON, 2mmx20mm	11150332
17	1	CAP, LOWER, SS6, 166 BP	21150094
18	1	SCREEN, INTAKE, SS6, 166 BP	21150095
19	1	DISC, SS,1.66, PBP	21150148
20	1	RING, SNAP, SS6, INTERNAL, 166 BP	11150051
21	§	ASSY,LOWER CAP,166 DROP TUBE WITH 1/2" HOSEBARB	51150128
22	§	DROPTUBE, CAP LOWER, SS6, 166	21150098
23	§	HOSEBARB, SS6, 1/2 x 3/8" MPT	16600217
24	§	TUBING, PE, 1/2 x 5/8"	87050504
25	§	ASSY, INTAKE, 166, DROP TUBE, WITH 1/2" HOSE BARB	51150071
26	§	INTAKE, DROPTUBE, SS6, 166	21150113
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	TOOL, BLADDER PUMP, PINCER, 5mm	11150031
	§	FERRULE SETS, SS6, 3/8"	57200010
	§	KIT, 166 SS BP, O-RING SET, O-RING SERVICE SET [Items 8 (2), 9 (2), 15 (1), 16 (1)]	91150023

§ *= Sold Separately*

.850 Stainless Steel Bladder Pump Components

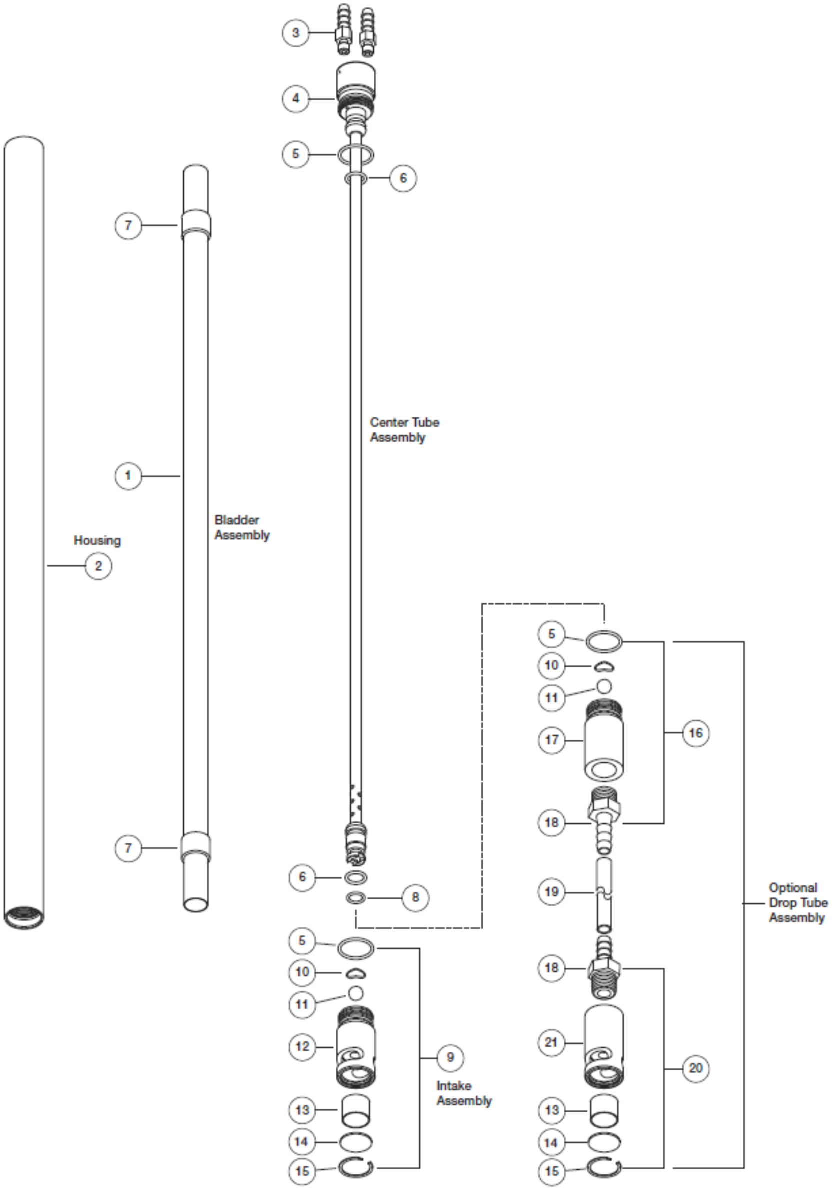


Bladder Pump, .850, Stainless Steel, Screened - 81150115

Item	Qty	Description	Part No.
1	1	BLADDER ,PTFE, .85 BP	51150051
1	§	BLADDER, PE, .85 BP, EA	21150100
1	§	BLADDER, PE, .85, CE, 12PK	21150099
2	1	HOSEBARB, SS6, MOD, .170 X 1/8 NPT DISCHARGE	11150118
3	1	HOSEBARB, SS6, .170 X 10/24 AIR	17200245
4	2	BALL, SS6, 1/4"	17500079
5	1	CAP UPPER WELDMENT, SS6, .85 BP	21150045
6	2	RING, COMPRESSION, PTFE, .850, CE, BP	21150048
7	2	O-RING, VITON, CS .0629, ID 17.1MM	17500112
8	4	O-RING, VITON, #012	17500111
9	1	HOUSING, SS6, .850, BP	21150047
10	1	ASSY, BOTTOM INTAKE, .85 BP	51150118
11	1	CAP, LOWER, SS6, .850, BP	21150046
12	1	SCREEN, INTAKE, SS6, .85 BP	21150050
13	1	DISC, PTFE, .85 BP	21150049
14	1	RING, SNAP, SS6, INTERNAL, .85 BP	11150053
15	§	ASSY, LOWER CAP, .850 BP, DROP TUBE, CE, W/ 1/4" HOSEBARB	51150129
16	§	DROP TUBE, CAP LOWER, .850 BP, CE SS	21150109
17	§	HOSEBARB, SS6, 1/4 X 1/8 MPT	17200072
18	§	TUBING, PE, 1/4 X 3/8, FT POLYETHYLENE	87050502
19	§	ASSY, INTAKE, .850 BP, DROP TUBE, CE, W/ 1/4" HOSEBARB	51150069
20	§	INTAKE, DROP TUBE, .850 BP, CE, SS	21150111
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	SPARE PARTS KIT, .85, BP, CE [Items 4 (2), 6 (2), 7 (2), 8 (4), 12, 13, 14]	51150123
	§	KIT, .85 BP, O-RING SET, CE, O-RING SERVICE KIT [Items 7 (2), 8 (4)]	91150013

§ = *Sold Separately*

.675 Stainless Steel Bladder Pump Components



Bladder Pump, .675, Stainless Steel, Screened - 81150117

Item	Qty	Description	Part No.
1	1	BLADDER, PTFE, .675, BP, CE	51150126
1	§	BLADDER, PE, .675, EA	21150102
1	§	BLADDER, PE, .675, CE, 12PK	21150101
2	1	HOUSING, SS6, .675, BP	21150032
3	2	HOSEBARB, SS6, .170 X 10/24 AIR	17200245
4	1	WELDMENT, INNER, SS6, .675 BP	51150125
5	2	O-RING, VITON, #014	17500119
6	2	O-RING, VITON, #107	17500604
7	2	RING, COMPRESSION, PTFE, .675 BP, CE	21150106
8	1	O-RING, VITON, #009	17500113
9	1	ASSY, BOTTOM INTAKE, .675, BP	51150120
10	1	RETAINER, BALL, .675 BP, TACO	21150087
11	1	BALL, SS6, 1/4"	17500079
12	1	CAP, LOWER, SS6, .675 BP	21150031
13	1	SCREEN, INTAKE, SS6, .675 BP	11150317
14	1	DISC, PTFE, .675 BP	21150033
15	1	RING, SNAP, SS, .675 BP	11150182
16	§	ASSY, LOWER CAP, .675 BP, DROP TUBE, CE	51150130
17	§	DROP TUBE, CAP LOWER, .675 BP, CE SS	21150110
18	§	HOSEBARB, SS6, 1/4 X 1/8 MPT	17200072
19	§	TUBING, PE, 1/4 X 3/8, FT POLYETHYLENE	87050502
20	§	ASSY, INTAKE .675 BP, DROP TUBE CE	51150070
21	§	INTAKE, DROP TUBE, .675 BP, CE, SS	21150112
Not Shown:			
	1	MANUAL, BLADDER PUMPS	21150035
	§	SPARE PARTS KIT, .675, BP, CE [Items 5(2), 6 (2), 7(2), 8, 10, 11, 13, 14, 15]	51150124
	§	KIT, .675 BP, O-RING SET, CE O-RING SERVICE KIT [Items 5 (2), 6 (2), 8]	91150014

§ = *Sold Separately*

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
Project 1375	Release, SP	3/11/2014
EDCF # 1870	Corrected Replacement Parts List (Ch. 7) for 1.66 pump, SP	2/17/2015
Project # 0992	Updated Manual to show new style 1.66 pump, SP	1/11/2015
#2001	Updated part numbers and minor formatting, SR	10/27/16
Project #1560	Adding temperature spec to Section 6: System Specifications. (185F/85C), PTFE to SS Disc in 1.66 models, StellaR	5/25/2017
Project #1565	Added compression fitting instructions, StellaR	9/18/2017
Project #1597	Added part # 91150023 – O-ring service kit, - StellaR	1/17/2018
Project #1597	Clarified part list – notes between included and items sold separately from pump. Included items in O-ring service kit for 1.66 pumps – StellaR	1/22/2018

The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty**.**

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958 OR 1-800-275-5325.

Model Number: ________________
Serial Number: ________________
Date: ________________

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used.

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Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● **(800) 833-7958** ● FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

Geocontrol PRO

Installation and Operation Manual

Rev 01/13/2015   Part# 11150263

Table of Contents

DOCUMENTATION CONVENTIONS

This manual uses the following conventions to present information:

WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.

CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

NOTICES

CAUTION

In order to ensure that your Controller has a long service life and operates properly, adhere to the cautions below and read this manual before use.

Disconnect from power source when not in use.

Controller power input source must not exceed maximum ratings.

Controller must be wired to a negative ground system.

Controller may not operate properly with excess wiring not supplied by manufacturer.

Avoid spraying fluid directly at controller.

Never submerge controller.

Avoid pulling on wires to unplug controller wiring.

Avoid using controller with obvious physical damage.

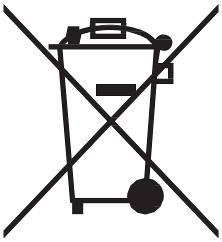
To prevent controller damage, avoid dropping controller.

NOTE

The Geotech Geocontrol PRO cannot be made dangerous or unsafe as a result of failure due to EMC interference.

WARNING

Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.



Notice for consumers in Europe:

This symbol indicates that this product is to be collected separately.

The following apply only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.
- For more information, contact the seller or the local authorities in charge of waste management.

Chapter 1: System Description

Function and Theory

The Geocontrol PRO is a unique controller for operating down well bladder type sampling pumps. When an external 12 VDC power source is connected to the controller, the internal air compressor is capable of producing a pressure of 100 PSI (7 bar). This pressure allows the user to take samples from a depth to 180 feet (55 mm).

The controller offers a variable cycle timer for controlling the portable compressor's on-time and off-time. While the compressor is on, air is pushed down well to the bladder pump, compressing the internal bladder and evacuating the liquid in the pump. When the compressor shuts off, the air pressure in the pump exhausts out of the system, allowing liquids to enter the pump.

Chapter 2: System Installation

WARNING

Verify the 12V system to be used is rated and fuse protected for operation at 15 amps continuous operation. Failure to verify system rating could result in damage to equipment. Over-heated wiring and other materials or components in contact or near by the power delivery system could pose a potential fire or burn hazard.

To operate the Geocontrol PRO, make sure the power switch is in the “off “position (rocker in down position). Plug the power input cord into a fuse protected 12V lighter receptacle on a negatively grounded system. If the controller is to be wired directly to a 12V battery, make sure to connect the positive (red) alligator clip to the positive (red) battery terminal and connect the negative (black) alligator clip to the negative (black) battery terminal. Next, securely plug in the circular plug connector on the opposite end of the cable to the corresponding receptacle on the face of the controller. Continue by plugging the pump’s air hose into the port labeled AIR on the controller’s face. Then plumb the pump’s discharge line into a suitable container. Check all wiring and plumbing for correctness.

Finally, double check to ensure the 12V system positive and negative is not reversed at any connection point.

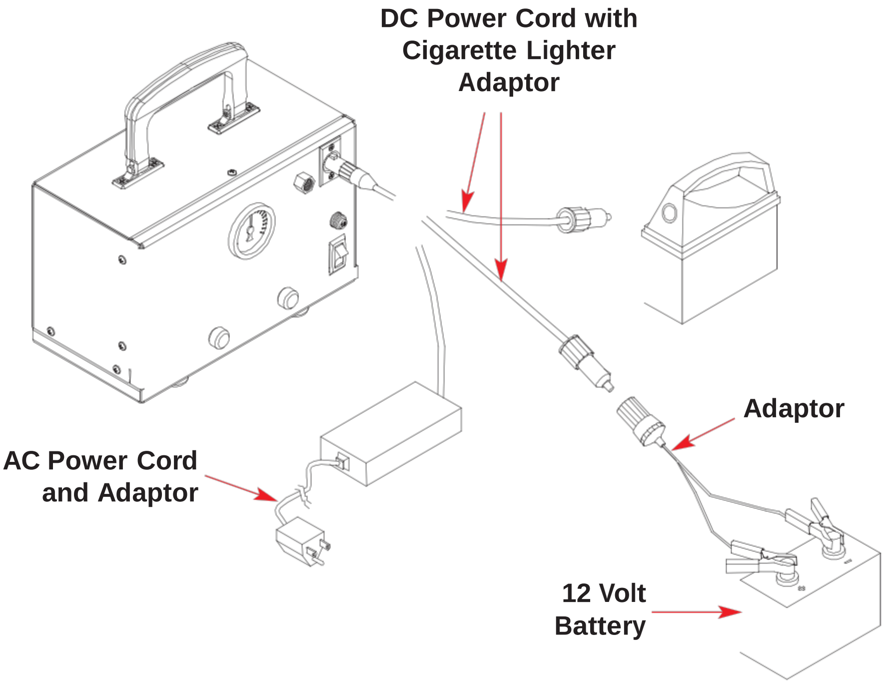


Figure 1
Installation Diagram

Chapter 3: System Operation

WARNING

Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.

CAUTION

Operating the equipment in any way other than that described within this document could potentially damage the equipment.

Disconnect power source when not in use.

Double check 12V systems positive and negative are not reversed at any connection point.

Before turning the power switch “on” turn the Geocontrol PRO’s “Fill” and “Discharge” timer knobs to adjust the cycle times. These knobs are located on the front face of the Geocontrol PRO below the airline pressure gauge. To the left is Discharge time and to the right is Fill time. Use the radial number scales around each timer knob to adjust timer values in seconds.

Discharge Time:
The time it takes to squeeze the bladder and push the water out of the pump. Increase this time with increased depth to water and larger bladder pumps. Decrease this time with lower depth to water and smaller bladder pumps. Timer can be set from approximately 2 to 60 sec.

Fill Time:
The time allowed for the bladder to refill. Increase this time with increased depth to water and larger bladder pumps. Decrease this time with lower depth to water and smaller bladder pumps. Timer can be set from approximately 2 to 60 seconds. Fill rate depends on hydrostatic pressure (pressure from the water above the pump) and will vary depending on pump placement within the water column. Therefore, the more water above the pump the faster it will fill.

Turn the controller power switch ON. In case of long fluid discharge lines it could take multiple cycles for water to reach the outlet. If the fluid discharge from the pump falls off before the discharge cycle is complete, the discharge time is set too high. This could result in a creased bladder that will reduce per cycle pump volumes. Therefore, if the compressor is still running and water has stopped coming out of the discharge tube, the discharge time should be decreased. Pumping efficiency can be maximized by measuring the amount of fluid discharged. If the volume of fluid after one pump cycle is less than the rated volume of the pump being used, then the fill rate can be increased.

The air line pressure gauge can be utilized to maximize efficiency. As a general rule, the pressure indicated on the gauge should not exceed an equivalent depth to water pressure. 1 PSI = 2.31 feet (1 bar=1.02 m) of water. Once the bladder in the pump is empty of liquids the pressure will increase sharply. If a quick pressure increase is noticed, reduce the discharge time until the quick pressure increase is no longer obvious.

For example, if the well you are sampling has a depth to water of 23 feet (7 m) you should not expect to see a reading on the pressure gauge much over 10 PSI (.7 bar). When the discharge cycle begins the reading on the pressure gauge will begin to rise. Once depth to water pressure has been reached the reading will ‘stall’ at that pressure until the bladder is empty or discharged. Once the bladder is compressed completely the pressure will again start to rise. For maximum per cycle liquid pumping volume, this is the optimum point at which the discharge timer would expire and the fill rate timer would begin. Reduced per cycle liquid pumping volume can be achieved by further decreasing the discharge time, thus evacuating only part of the total bladder volume.

CAUTION

For use with negative (-) ground systems only.
Exceeding the recommended duty cycle will cause overheating.
Damage will result if the supply voltage exceeds 14 VDC.

Chapter 4: System Maintenance

Maintenance Procedures

Disconnect power source when not in use.

Unit must be returned to Geotech Environmental Equipment for any service. In order to ensure a long service life, keep the Geocontrol PRO clean. Often a soft, damp cloth can be used to remove dust and dirt from the exterior surfaces of the Geocontrol PRO. In extreme cases, or to remove aged caked on dirt and dust, a mild soap and water solution can be applied to a soft cloth and used to clean the exterior surfaces of the Geocontrol PRO. Do not soak or directly spray liquids on the Geocontrol PRO.

⚠

WARNING

Equipment should be repaired by Geotech Environmental Equipment factory trained repair technicians only. Improper repair of equipment may result in degradation of performance and/or service life. Disassembly exposes potentially dangerous moving components that could injure someone who is not properly trained to repair this equipment.

Solenoid Maintenance

The following procedure outlines how to remove, dis-assemble and clean a stuck or clogged breather vents on the solenoid.

- If you have brass breather vents and would like to replace them with the newer version of stainless steel breather vents, contact Geotech Environmental Equipment and reference part # 11150333.

- Note: The space that you will be working in will be pretty tight, so you will might need to use needle nose pliers to disassemble and reassemble the solenoid.

- Tools needed: Phillips head screwdriver
  1/4” wrench
  7/16” wrench
  Needle nose pliers

Steps:

1. Unplug unit.

2. Remove clear tubing that connects to the compressor and the air pressure gage. Note that you should not remove this tubing at the connections on the solenoid. See Figure 4-1.

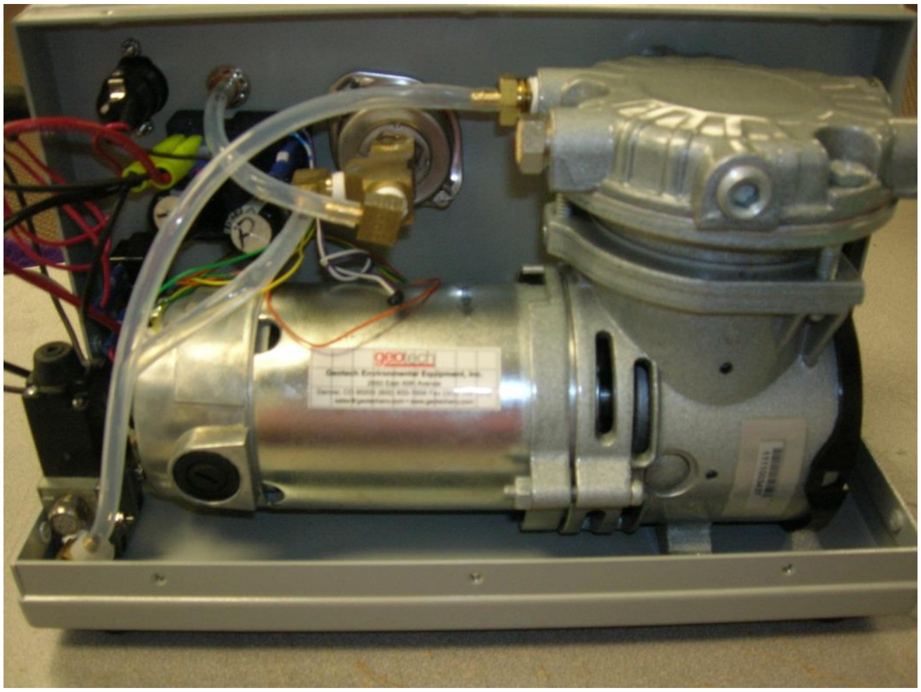


Figure 4-1

3. Remove the two screws that connect the solenoid to the casing. You do not have to disconnect the 3 black wires from the solenoid, they should be long enough to allow you to set the solenoid down on a flat surface for cleaning. See Figure 4-2.

Figure 4-2

4. Unscrew the breather vents from the solenoid using a 7/16” wrench. See Figure 4-3.

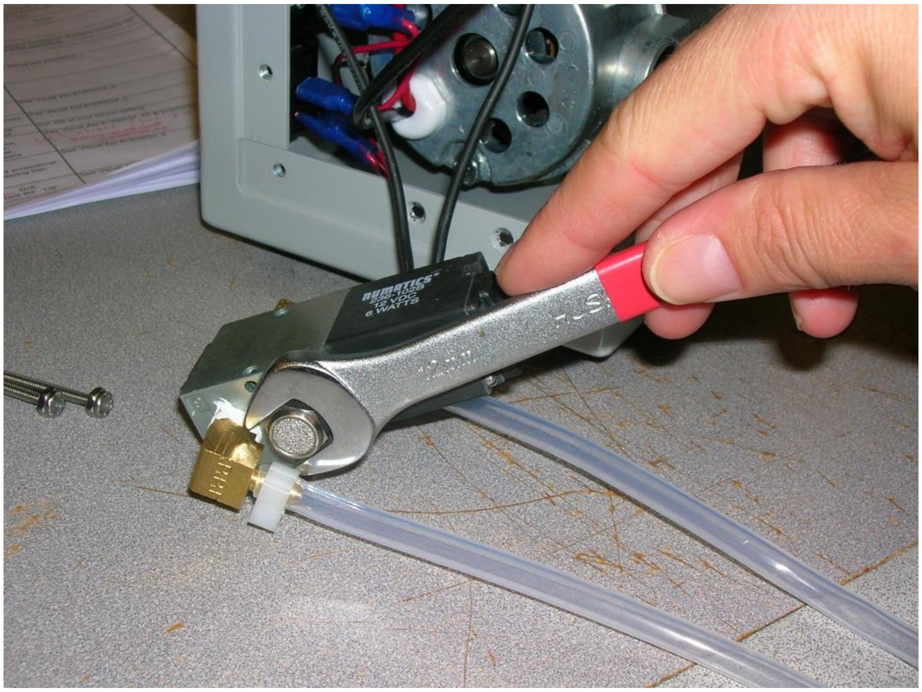


Figure 4-3

5. Clean breather vents with water. Do NOT use alcohol!
6. After cleaning is complete, put the breather vents back on the solenoid. Be sure they are tightened.
7. Attach the solenoid back to the casing using a 1/4” nut driver. Be sure that the clear tubing is pointing toward the compressor (right side).
8. Attach the tubing back to the compressor and the air pressure gage. Note that the longest piece of tubing attaches to the compressor.

If you need further assistance or want to replace the breather screens call Geotech Service at 1-800-833-7958.

Chapter 5: System Troubleshooting

The Geocontrol PRO has been designed and manufactured to provide a long service life and trouble free operation in the field. If the compressor, during charge cycles, becomes sluggish, check supply voltage. If the supply voltage falls below 12 VDC, the compressor's performance will be directly affected. A fully charged battery will produce the best results.

Other sources of low pump output may be 12V lighter receptacles or plugs. Make certain these connections are securely plugged in and clear of any debris. Once securely plugged in, rotating the connection can often help if there is a dead spot in the connector. Also, check for connection and cable fatigue, cracks, surface oxidation, rust etc.

If the compressor does not turn on:

- Double check battery polarity is correct. In other words, the positive and negative cables are connected positive to positive and negative to negative. The Geocontrol PRO is protected from damage due to reverse polarity connection.
- Turn the power switch to the OFF position and let the unit sit in the OFF state for two minutes. This will hard reset the electronic timer module.
- If ambient temperatures are in excess of 104°F (~40°C) then disconnect from power and let sit in a cool location. Do not open the case for any reason. This will not hasten the cooling process, but will invite debris into internal components that could result in reduced life or immediate equipment failure.
- If the compressor still does not turn on the electronic timer module may have failed. Call Geotech Service at 1-800-833-7958 to arrange for the equipment to be sent back to a factory authorized repair location.
- If 15 Amp circuit breaker is tripped, push to reset. If it trips again, call Geotech Service at 1-800-833-7958 to arrange the equipment to be sent back to a factory authorized repair location.

Compressor turns on and fluid is being pumped but no pressure is indicated on the gauge.

- The pressure gauge has failed; however operation of the device may continue even though the gauge feature is not operational. Call Geotech Service at 1-800-833-7958 to arrange for the equipment to be sent back to a factory authorized repair location.

Fluid is not being pumped and the compressor turns on, no pressure is indicated on the gauge.

- Remove the air line from the front of the Geocontrol PRO. Block the air outlet on the front of the Geocontrol PRO while the compressor is running to verify the pressure gauge needle indicates an increase in pressure. Remove the blockage from the air outlet and observe whether or not a small burst of compressed air is released. If pressure cannot be built at the outlet on the front of the Geocontrol PRO, call Geotech Service at 1-800-833-7958 to arrange for the equipment to be sent back to a factory authorized repair location.
- If pressure can be built at the air outlet on the front of the Geocontrol PRO while the compressor is running:

1) Attach the air line only and block the end. Verify the pressure gauge needle indicates an increase in pressure. Remove the blockage from the end of the air line and observe whether or not a small burst of compressed air is released. If pressure cannot be built at the end of the air line, check the air line for cuts, kinks and holes, especially at, and near, the bladder pump hose barb or compression fitting connections.

- If pressure can be built at the end of the air line while the compressor is running:

1) Attach the air line to the bladder pump. Remove the fluid discharge tube from the bladder pump. While the compressor is running, very little air discharge should be felt at the pump discharge fitting. The pressure gauge on the front of the Geocontrol PRO should indicate a rise in pressure. If this does not occur and a continuous air flow can still be felt at the pump fluid discharge fitting, then the bladder, or bladder seal, has been compromised and should be repaired or replaced. Information on this procedure can be found in the product manual specific to the bladder pump being used. Or call Geotech Service at 1-800-833-7958 for further assistance.

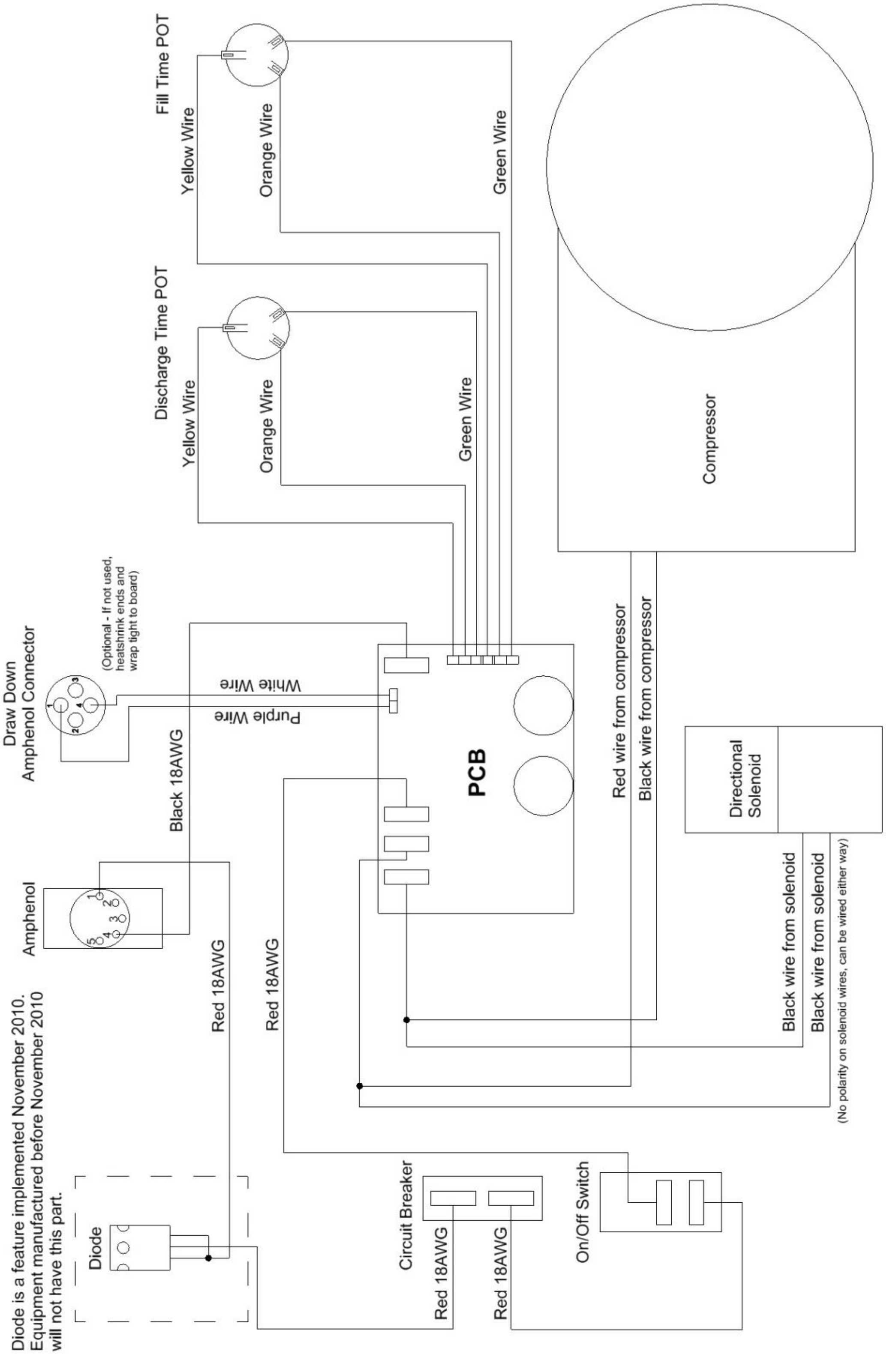
2) **Reminder:** Be careful not to over pressurize and crease the bladder inside the pump as this will reduce the fluid flow during normal operation.

Chapter 6: System Specifications

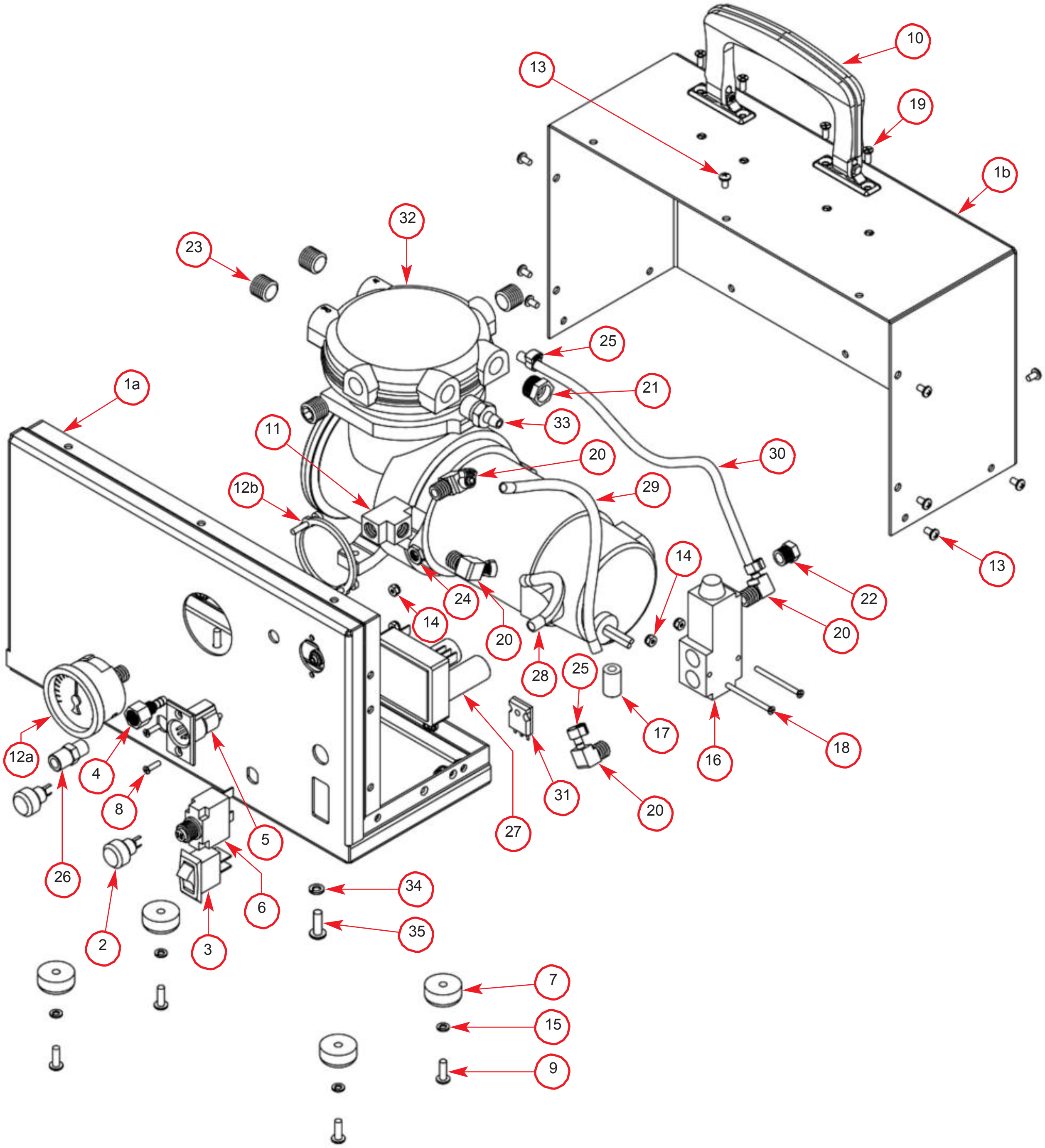
Power Requirements:	72-84 W 12-14 VDC input at 7.5 Amps
Nominal Operating Current:	6 Amps DC
Over Current Protection:	15 Amps
Timer:	
Discharge Time	1.8 sec. min. – 60 sec. max.
Fill Time	1.8 sec. min. – 60 sec. max. (+/- .25% repeatability)
Maximum Operating Depth:	180 ft. (55 m)
Maximum Operating Pressure:	100 PSI (7 bar) (self limited for safety) @ 0.83 CFM (1.41 m^3/h)
Ambient Operational Temperature:	50°F-104°F (10°C-40°C)
Dimensions:	6.70" H x 4.80" x 11.40" W (17.02cm H x 12.92cm D x 28.96cm W)
Weight:	9 lbs. (4 kg) total

Features

- Variable pump Discharge time control.
- Variable pump Fill time control.
- Interchangeable pump connection configurations.
- Operation with dedicated pump systems and special purpose well caps.
- Approx. 45 to 60 minute operation with 8.0Ah lead acid battery (Battery Module w/o Charger, Geotech PN: 77250001).
- Reverse polarity protection.
- AC adapter optional for use with world mains connection.


Fill Time POT
Yellow Wire
Orange Wire
Green Wire
Discharge Time POT
Yellow Wire
Orange Wire
Green Wire
Compressor
Draw Down
Amphenol Connector
(Optional - If not used, heatshrink ends and wrap tight to board)
White Wire
Purple Wire
PCB
Black 18AWG
Amphenol
Red wire from compressor
Black wire from compressor
Directional Solenoid
Black wire from solenoid
Black wire from solenoid
(No polarity on solenoid wires, can be wired either way)
Red 18AWG
Red 18AWG
Diode is a feature implemented November 2010. Equipment manufactured before November 2010 will not have this part.
Diode
Circuit Breaker
Red 18AWG
Red 18AWG
On/Off Switch

Parts Assembly



Chapter 8: Replacement Parts List

MODEL GEOCONTROL PRO – 51150122

Item	Qty	Description	Part No.
1a	1	ENCLOSURE, GEOCONTROL PRO, BACK, CE	51150121
1b	1	ENCLOSURE, GEOCONTROL PRO, BACK, CE	51150121
2	2	POT, 10K, 20% W/KNOB	11150244
3	1	SWITCH, GEOCONTROL PRO	11150248
4	1	HOSEBARB, SS4, BLKHD, .170 X 1/8"	21150021
5	1	CONN, AMP, MALE, PANEL MOUNT	17200014
6	1	CIRCUIT BREAKER, 15AMP GEOCONTROL PRO	11150247
7	4	FOOT, RUBBER, 7/8", W/WASHER	11150262
8	2	SCREW, SS8, 4-40 X 7/16" FH PHIL	16700007
9	4	SCREW SS8, 8-32 X .5", PNH	PPF036001
10	1	HANDLE, PE, NI	11350009
11	1	TEE, BRS, 1/8" NPT, FXFXF	PPP047034
12a	1	GAUGE, PANEL MOUNT, 1-100PSI W/MOUNTING CLAMP	11150254
12b	1	GAUGE, PANEL MOUNT, 1-100PSI W/MOUNTING CLAMP	11150254
13	14	SCREW, SS8, 6-32 X .25", PNH, M/S	17200078
14	4	NUT, HEX, 4-40, NYLOC	17200046
15	4	WASHER, SS8, #8, LOCK	17200081
16	1	SOLENOID, GEOCONTROL PRO	11150249
17	1	STANDOFF, NYL, .187 X .437 X .375	17500355
18	2	SCREW, SS8, 4-40 X 1.25", FLHD	PPF051015
19	4	SCREW, SS8, 6-32 X 3/8", FLH	PPF013034
20	4	HOSEBARB, BRS, 90D.170 X 1/8MPT	17200393
21	1	VENT, BREATHER, 1/4" NPT	11150252
22	2	VENT, BREATHER, 1/8" NPT	11150333
23	4	PLUG, BRS, 1/4"NPT, SOCKET	11150251
24	1	NUT, SS8, 5/16-32, HEX, THIN	11150261
25	5	CLAMP, NYL, 1/4" SNAPPER	11150259
26	1	QCK CNCT, NCKL, 1/4" X 1/8MPT, PUSH/PULL	PPP103001
27	1	ASSY, PCB, GEOCONTROL PRO POTTED	51150054
28	1	TUBING ,FEP, .170 X 1/4, FT FEP	87050509
29	1	TUBING ,FEP, .170 X 1/4, FT FEP	87050509
30	1	TUBING ,FEP, .170 X 1/4, FT FEP	87050509
31	1	DIODE, SCHOTTKY, 100V, 40A, TO-247AC	16550223
32	1	COMPRESSOR, PRO, SIPPER	11150325
33	1	HOSEBARB, BRS, .170 X 1/4MPT	16550032
34	3	WASHER, SS8, #10, LOCK	PPF022003
35	3	SCREW, SS8, 10-32 X 5/8", PNH	PPF037008
N/S	1	WASHER, SS410, 5/16", INTRNL TOOTH	17500339

N/S = Not Shown

Accessories

Description	**Part No.**
GEOCONTROL PRO W/CASE, 1.66, CE, PUMP, 12VDC CORD, BATTERY W/CHRG	91150011
GEOCONTROL PRO W/CASE, .85, CE, PUMP, 12VDC CORD, BATTERY W/CHRG	91150015
GEOCONTROL PRO W/CASE, .675, CE, PUMP, 12VDC CORD, BATTERY W/CHRG	91150016
GEOCONTROL PRO, W/CASE, CE, 12VDC CORD, NO PUMP, NO BATT	91150017
GEOCONTROL PRO, CE, SOLO, CONTROLLER ONLY, NO ACCESSORIES	51150122
POWER SUPPLY, EXTERNAL, AC ADAPT 12V, 100W	51150063
ADAPTOR, CONTROLPRO-WELL CAP INCLUDES 10FT TUBING	81150019
CASE, GEOCONTROL PRO, CE	51150127
ASSY, POWER CORD, DC W/AMP	57500008
ADAPTER, CIGARETTE TO CLIPS	17500035
BATTERY/CHARGER, MODULAR, 12VDC, 7.5Ah, MALE CIG PLUG	77250000
KIT, WLM-BP CONTROLLER LINK LOW DRAW DOWN OPTION	91150001
ASSY, CABLE, WLM, LOGIC UNIT CONT	52050174

Maintenance Accessories

Description	**Part No.**
REBUILD KIT, COMPRESSOR, SIPPER PRO	11150334
REBUILD KIT, SOLENOID, GEOCONTROL PRO	11150433

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Previous Release	10/29/12
1583	Added Compressor Repair Kit to Replacement Parts List. Added Revision History Table - SP	05/24/13
-	Updated back page information, updated EC Declaration of Conformity, added “Maintenance Accessories” under Chapter 8: Replacement Parts List, SP	1/13/15

NOTES

geotech

EC Declaration of Conformity

Manufacturer:

Geotech Environmental Equipment, Inc.
2650 E 40th Avenue
Denver, CO 80205

Declares that the following products,

Product Name: Geocontrol PRO

Model(s):
81150012
81150016
81150017
81150018

Year of manufacture: 2010

Conform to the principle safety objectives of 2006/95/EC Low Voltage Directive (LVD) by application of the following standards:

EN 61010-1: 2010

Year of affixation of the CE Marking: 2010

Conform to the protection requirements of 2004/108/EC Electromagnetic Compatibility (EMC) by application of the following standards:

EN 61000-6-1: 2007
EN 61000-6-3: 2012
EN 61326-1: 2013, emissions Class A

EMC conformity established 08/14/2009.

Production control follows the ISO 9001:2008 regulations and includes required safety routine tests.

This declaration issued under the sole responsibility of Geotech Environmental Equipment, Inc.

Joseph Leonard

Joe Leonard
Product Development

Serial number ________________

CE

THE WARRANTY

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call Geotech Service for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958

Model Number: ______________________________

Serial Number: ______________________________

Date of Purchase: ______________________________

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used.

Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate equipment for a fee, which will be applied to the repair order invoice.

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Printed in the United States of America

APPENDIX F

EPA Region 1 SOP No. GW 004: Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

This document contains direction developed solely to provide guidance to U.S. Environmental Protection Agency (EPA) personnel. EPA retains the discretion to adopt approaches that differ from these procedures on a case-by-case basis. The procedures set forth do not create any rights, substantive or procedural, enforceable at law by party to litigation with EPA or the United States.

Prepared by:__________________________________ ____________
(Robert Reinhart, Quality Assurance Unit) Date

Approved by:__________________________________ ____________
(John Smaldone, Quality Assurance Unit) Date

Revision Page

Date	**Rev #**	**Summary of changes**	**Sections**
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

Table of Contents

1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the “Monitoring Indicator Field Parameters” section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a “best practice”. For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump’s recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A.
If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A “T” connector coupled with a valve is connected between the pump’s tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump’s tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump’s tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 µm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

> **Turbidity** (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
> **Dissolved Oxygen** (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
> **Specific Conductance** (3%),
> **Temperature** (3%),
> **pH** (± 0.1 unit),
> **Oxidation/Reduction Potential** (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

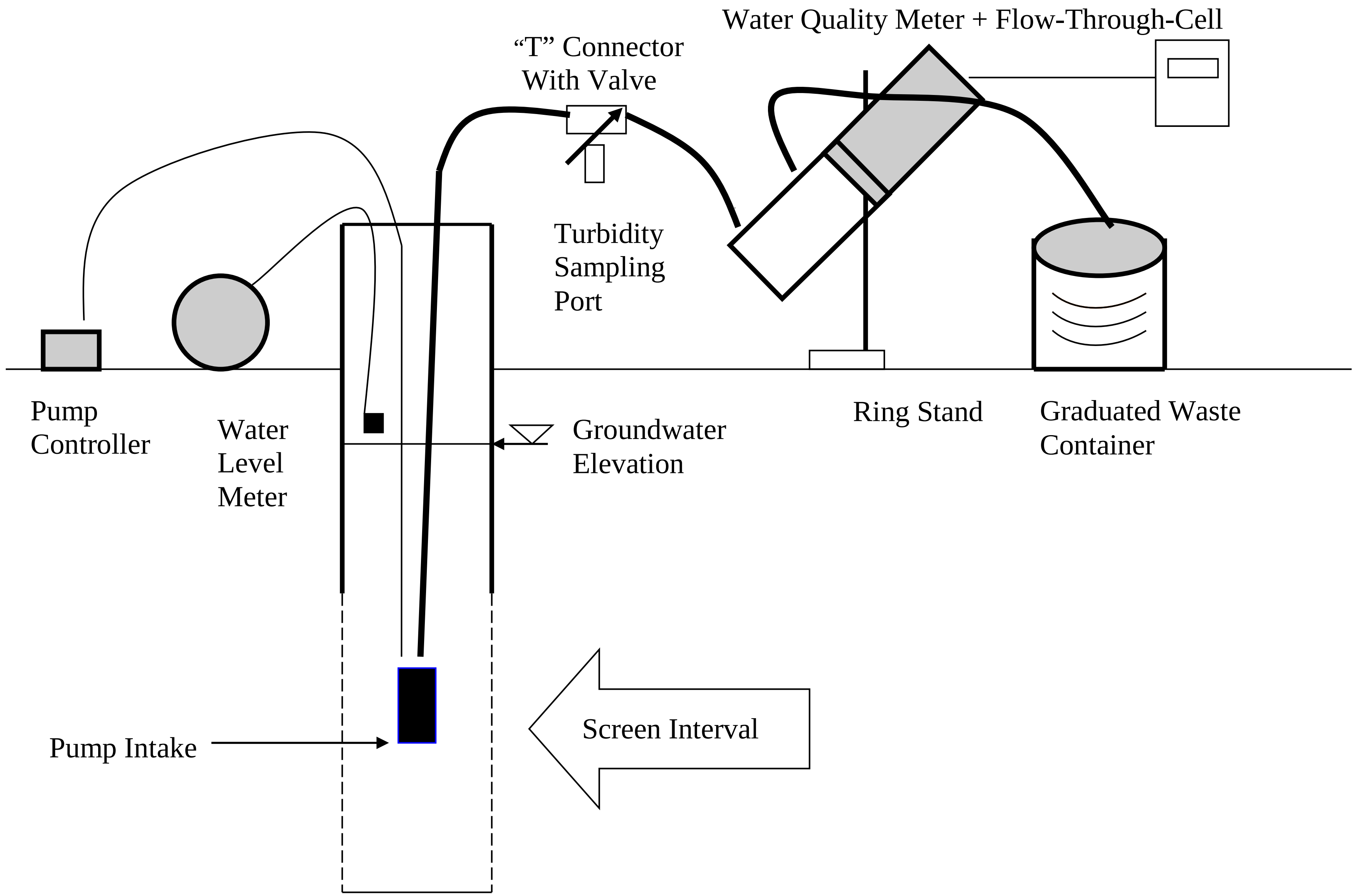
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)________________________________
Well Number_________________ Date________________________
Field Personnel____
Sampling Organization______________________________________
Identify MP____

Depth to ________/_________ of screen
(below MP) top bottom
Pump Intake at (ft. below MP)_________
Purging Device; (pump type)__________
Total Volume Purged _______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	±10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

APPENDIX G

Example Laboratory Data Evaluation Checklist

LABORATORY DATA EVALUATION CHECKLIST (WATER)

Evaluated by:	Reviewed By:

GREAT RIVER ENERGY®

Project Name: ____ Project Number: ____

Evaluator: ____ Validation Date: ____

Laboratory: _________________________SDG #: ________Sample Event/ Date(s): ___________________

Locations Sampled: ____

*******For any NO response further explanation and/or action is required (when in doubt ask the PM or lab)*******

	General	**YES**	**NO**	**NA**
1.	Were results received for all samples?	☐	☐	☐
2.	Were all the requested parameters analyzed?	☐	☐	☐
3.	Were the requested methods used?	☐	☐	☐
4.	Were the requested detection limits used (MDLs and/or PQLs)?	☐	☐	☐
5.	Were the samples received by the laboratory below 6 deg C?	☐	☐	☐
6.	Were the samples preserved correctly?	☐	☐	☐
7.	Are the field parameters on file?	☐	☐	☐
8.	Did field parameters stabilize, following collection of at least 3 readings?	☐	☐	☐
9.	Was drawdown minimized (less than 6” to 1’ in depth)?	☐	☐	☐
10.	Is the lab narrative free from problems that require further explanation or affect sample results?	☐	☐	☐
11.	Were samples analyzed within appropriate hold times (other than pH)?	☐	☐	☐
	Analytical Results (use digital data for 20 and 21)			
12.	Is the ratio of TDS (mg/L) to conductivity (µmhos/cm) between 0.54 and 0.96?	☐	☐	☐
13.	Are the charge balances below 5%?	☐	☐	☐
14.	Are field and lab pH within 0.5 units?	☐	☐	☐
15.	Are field and lab conductivity within 500 µS/cm?	☐	☐	☐
16.	Have total concentrations been measured and reported?	☐	☐	☐
17.	Are calculated results correct (for example Nitrate)?	☐	☐	☐
18.	Are sample results free of flags or qualifiers that require further action (ignore J and U)?	☐	☐	☐
19.	Are all non-detect results reported without dilutions?	☐	☐	☐
20.	Are all concentrations below site specific and/or EPA standards?	☐	☐	☐
21.	Are reported concentrations within the range of historical values? (time series graphs/EQuIS)	☐	☐	☐
	Field QC samples			
22.	What field QC samples were analyzed (blanks, duplicates & rinsates)?____			
23.	Are all field and equipment blank(s) concentrations non-detects?	☐	☐	☐
24.	Are duplicate concentrations comparable to their parent?	☐	☐	☐
	Laboratory QC samples			
25.	What lab QC samples were analyzed? ____			
26.	Was MS/MSD, %R and RPD accuracy criteria met (criteria should be listed on report)?	☐	☐	☐
27.	Are all laboratory and trip blank concentrations non-detect?	☐	☐	☐
28.	Are lab QC results free of flags or qualifiers that require further action?	☐	☐	☐
	Electronic data (EQuIS or other EDD)			
29.	Was electronic data received in the requested format?	☐	☐	☐
30.	If applicable, was the field and laboratory data uploaded to the project’s database?	☐	☐	☐
31.	Do the electronic data match the paper report (results and detection limits)?	☐	☐	☐

This data evaluation is a verification for completeness and confirmation through objective evidence that the specified sampling and analytical requirements have generally been met. This checklist is not an EPA equivalent validation to definitively assess the performance of the sample and analytical process.

Revised 07/12/16

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ATTACHMENT B

Example Field Data Sheet

Field Datasheet - General Groundwater Assessment

Weather:	Temperature: °F / °C	Wind:	Precipitation:	Sunny / Partly Cloudy / Cloudy (circle one)

General Information
Sampling Personnel:
Program Name:
Location/Sample ID:

Purging and Sampling Information		
Purge Date:		**Time Purging Began:**
Well Purged Dry?	Yes / No	Time Purged Dry:
Sample Date:		**Time of Sampling:**

Bottle List:

Well Information		
Well Locked?	Yes	No
Well Labeled?	Yes	No
Casing Straight?	Yes	No
Necessary Repairs:		
Casing Diameter:		

Water Level	
Static Water Level Before Purge:	(±0.01 ft)
Depth to Top of Pump:	(±0.01 ft)
Depth to Bottom of Well:	(±0.01 ft)
Water Level After Sampling:	(±0.01 ft)

Notes:

Purging Method:		Control Settings	
Sampling Method:		Purge:	sec
Dedicated Equipment?	Yes / No	Recover:	sec.
QC Sample?	Yes / No	PSI:	
QC Sample ID:		Pumping Rate:	mL/min

Notes:

Field Measurements and Purge Parameters

Stabilization (Minimum: 3 consecutive)		**Water Temp (°C)**	**Spec. Cond. (_S/cm)**	**pH (S.U.)**	**Turbidity (NTU)**	**DO (mg/L)**	**ORP (mv)**	**Water Level (ft)**	**Volume Purged (mL)**	**Description:** Clarity - Clear, Slightly Turbid, Turbid Color - Brown, Grey, Yellow, Orange Odor, Etc.
Reading #	**Time**	±3%	±3%	±0.1						

Stabilized: Yes No (circle one)

Total Volume Removed: ________ mL

Minimum volume of stagnant water to purge prior to collection of field parameters: 500 mL

Measurements should be recorded with precision of ±0.5° (temp), ±5% (SC), and ±0.1 S.U. (pH)

Comments:

ATTACHMENT C

Chain-of-Custody Forms – Terra Systems Groundwater Samples for Phase 2

No. __ of _

TERRA SYSTEMS, INC. **Chain of Custody**

130 Hickman Road, Suite 1, Claymont, DE 19703 phone 302-798-9553 fax 302-798-9554

Client: WSP USA Inc. (Golder) Project Name: Stanton Station Batch Testing

Project Description: Groundwater Compatibility Project Manager/Contact: Erin Hunter, erin.hunter@wsp.com

Location: Stanton, North Dakota Phone: 720-962-3424

Sampler:

Lot:

								Parameters for Analysis									
Date	Time	Sample Identification	Sample Technique	Matrix	Preser-vative	Container Type	Number of Containers	pH, DO, ORP, bicarbonate alkalinity, total hardness, ferrous iron, and sulfide	GW Alkalinity	GW Total Metals	GW Dissolved Metals	GW TOC	GW Sulfide	GW Sulfate	GW Ferrous iron		Remarks
																	Testing to be conducted per the TSI quote provided April 4, 2025 Invoicing to reference PO P129065US001 Stanton Station

Relinquished by (signature)	Date/time	Received by (signature)	Date/time

Shipped to:

Date/time:

Carrier/Airbill number:

Cooler Temperature: ^{o}C pH: Comments:

wsp.com