Draft

Area 1 ISCR Pilot Study Summary Report

Eckles Road Site
Livonia, Michigan

RACER Trust

14496 Sheldon Road, Suite 200, Plymouth, Michigan 48170

012607 | T02Y15 | 001 | Report No 68 | January 2016

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1. Introduction

GHD Services Inc. (GHD), on behalf of Revitalizing Auto Communities Environmental Response (RACER) Trust, has prepared this Area 1 In-Situ Chemical Reduction (ISCR) Pilot Study Report for the RACER facility at 13000 Eckles Road Site in Livonia, Michigan (Site) to document the activities and results of the Area 1 ISCR Field Pilot Study. The ISCR Pilot Study involved in-situ chemical injections of sodium dithionite and/or sodium sulfide in the north portion of Area 1 to precipitate dissolved hexavalent chromium (chromium VI) and nickel in groundwater utilizing different injection techniques. The scope of work for the field pilot study was described in the Draft Area 1 Expanded Pilot Study Work Plan – Former Plating Area dated February 2015 (Work Plan) and was subsequently approved by the United States Environmental Protection Agency (USEPA) on April 22, 2015.

Figure 1.1 presents the Site Location. Figure 1.2 identifies Area 1.

1.1 Background

The Site was historically used for the production of vehicle bumpers, leaf springs and strut assemblies, with Area 1 being used for chrome plating. As a result of the plating operations, the groundwater within the area is impacted with chromium VI and nickel. The southern portion of Area 1 contains the existing groundwater extraction and treatment system, which consists of a below grade perforated collection pipe (French drain) and aboveground treatment building. Groundwater collected by the treatment system (GWTP) is treated by pH adjustment with sulfuric acid, followed by addition of sodium bisulfite, recycled solids, lime and polymer flocculent in subsequent tanks, the solids are settled in a clarifier, and the effluent passes through a sand filter prior to discharge. When the treatment system is operating, the water is treated continuously at an average rate of approximately 40 gallons per minute (gpm) and accumulated in a tank following clarification. The initially treated water is then polished through the sand filter in approximately 800 gallon batches and discharged to the DWSD sanitary sewer. Nickel and chromium are precipitated out as a sludge and processed in a filter press. The non-hazardous filter cake is collected in a 20-cubic yard roll-off box and disposed of at a local landfill on an as necessary basis.

As an interim measure, to more effectively reduce the potential migration of nickel-impacted groundwater, especially at the eastern edge of the French drain, a groundwater cut-off barrier wall (soil-bentonite and jet grout) was installed around Area 1 to provide complete containment.

Groundwater quality and the effectiveness of the Area 1 barrier wall have been monitored through routine groundwater sampling events of on and off-Site monitoring wells, specifically for the concentration of nickel and chromium. The Area 1 barrier wall appears to have effectively supplemented the French Drain and limited off-Site migration of nickel-impacted groundwater. Chromium VI has not been detected in off-Site groundwater samples at concentrations greater than generic screening criteria. There has been some variability in the concentrations of nickel in groundwater samples collected from immediately downgradient of Area 1 although nickel concentrations have been significantly reduced since the installation of the Area 1 barrier wall.

Even though there are no complete pathway exceedances and the existing GWTP and soil-bentonite barrier wall are controlling the migration of impacted groundwater, RACER would like to proactively reduce the on-Site concentrations of chromium VI and nickel and determine the most efficient way to eliminate the need for ongoing operation and maintenance (O&M) of the GWTP to control the migration of impacted groundwater.

A laboratory treatability study was previously performed which identified sodium dithionite as the most cost effective reagent for in-situ treatment of dissolved chromium and nickel in the source area at the Site. A field pilot study was conducted in 2010 to determine the effectiveness and potential radius of influence for full-scale in-situ chemical precipitation at the Site. Based on the results of the 2010 pilot, a subsequent pilot was performed in 2013 to evaluate an increased concentration and quantity of sodium dithionite solution. Based on the laboratory and field pilot studies to date, recommendations for supplemental pilot study implementation included a downgradient spacing of 25 feet and a side-gradient spacing of 10 feet for the injection of 800 gallons of solution. The material to be injection included a 20 percent sodium dithionite solution and 29 percent solution in areas with dissolved nickel and chromium, and a 29 percent sodium sulfide solution in areas with only dissolved nickel concentrations as detailed in the Work Plan.

1.2 Objectives

The objectives of the pilot study activities were to: 1) achieve a reduction of chromium and/or nickel concentrations through the use of individual or a combination of injected reagents; and 2) evaluate and identify the direct injection technique most effective at achieving an acceptable radius of influence optimizing injection point spacing for full-scale remediation of the chromium VI and nickel impacted groundwater.

2. Scope of Work

The scope of work for activities associated with the ISCR Pilot Study Report was presented in the February 2015 Draft Area 1 Expanded Pilot Study Work Plan – Former Plating Area A and the results are discussed in the following sections of this report.

2.1 Monitoring Well Installation

Monitoring well installation activities were conducted from May 6 to May 12, 2015 and included the installation of 24 wells within the northern portion of Area 1. Monitoring wells MW42D-15 through MW65D-15 were installed to supplement the existing monitoring well network and provide sampling locations to evaluate the effectiveness of the chemical injections and the radius of influence of the injection technologies. Monitoring wells were drilled using Geoprobe direct push technology. The Geoprobe rigs utilized hollow-stem auger (HSA) and direct-push drilling techniques. Completed monitoring wells were constructed of 2-inch diameter, 10-ft long, 0.01-inch slot, Schedule 40 polyvinyl chloride (PVC) screen threaded to a 2-inch diameter PVC riser pipe extending approximately 2 feet above the ground surface. The monitoring wells were set so that the screened intervals sat on top of the clay layer, from approximately 15 to 25 feet below ground surface (bgs). Upon completion, each monitoring well was developed to a silt-free condition using bailing, surging, and/or pumping techniques. Field parameters consisting of pH, specific conductivity, temperature, and turbidity were monitored during development. Development was considered complete once the field parameters stabilized, and the water was clear of sediments. The monitoring well locations are shown on Figure 2.1. Monitoring well construction logs are included in Appendix A and a monitoring well construction summary is included in Table 2.1.

2.2 Chemical Injection Methodology

Chemical injections were concentrated within three specific sub-areas in the northern portion of Area 1: A) groundwater impacted with only chromium VI in the northwest portion of Area 1 (Sub-Area A); B) groundwater impacted with both chromium VI and nickel in the north-central portion of Area 1 (Sub-Area B); and C) groundwater impacted with only nickel in the northeast portion of Area 1 (Sub-Area C). These Sub-Areas are depicted by the estimated extents of nickel and chromium concentrations on Figure 2.2.

Chemical injection points were advanced using direct push tooling (Geoprobe®) and injections were completed through a Geoprobe Screen Point 16 (SP16) sleeve with 42-inch screen or utilizing the Badger Injection (Badger) system. Fourteen injection points were completed by Superior Environment Corp. (Superior) using the proprietary Badger system. The remaining injections were completed by GHD utilizing a Screen Point 16 (SP16) sleeve with 42-inch screen for direct push. Twelve sodium dithionite, six sodium sulfide and five combined (sodium dithionite and sodium sulfide) injection points were installed in Sub-Area A. Six sodium dithionite, thirteen sodium sulfide and seven combined injection points were installed in Sub-Area B. Thirty-four sodium sulfide injection locations were installed in Sub-Area C. The injected solution in thirty of the injection points installed around monitoring well locations contained 0.1 percent bromide as a tracer. A detailed summary of the ISCR injections for Sub-Areas A, B, and C is described below. Injection point locations are shown on Figure 2.2 and a summary of the injection points is included in Table 2.3. Badger's injection delivery summary sheets are included in Appendix B.

2.2.1 Sub-Area A

- In the western half and southern portion of Sub-Area A, the injection zone was an 8 to 10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium.
  - A total 12 locations.
  - In the 10-foot thick injection zone, 840 gallons of a 20 percent sodium dithionite solution were injected into each direct push location. The solution consisted of 1,320 pounds of sodium dithionite and 800 gallons of water.
- In the central portion, the injection zone was an 8 to 10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium.
  - A total of six locations.
  - In the 10-foot thick injection zone, 900 gallons of a 29 percent sodium sulfide solution were injected into each direct push location. The solution consisted of 2,000 pounds of sodium sulfide and 800 gallons of water.
- In the northeastern portion of Sub-Area A, the injection zone was an 8 to10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium.
  - A total of five locations.
  - In the 10-foot thick injection zone, 975 gallons of a 20 percent sodium dithionite and 29 percent sodium sulfide solution were injected into each direct push location. The solution consisted of 1,320 pounds of sodium dithionite, 2,000 pounds of sodium sulfide, and 800 gallons of water.

2.2.2 Sub-Area B

- In the northwestern portion of Sub-Area B, the injection zone was an 8 to10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium and dissolved nickel.
  - A total of seven locations.
  - In the 10-foot thick injection zone, 975 gallons of a 20 percent sodium dithionite and 29 percent sodium sulfide solution were injected into each direct push location. The solution consisted of 1,320 pounds of sodium dithionite, 2,000 pounds of sodium sulfide, and 800 gallons of water.
- In the southwestern portion of Sub-Area B, the injection zone was an 8 to 10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium and dissolved nickel.
  - A total of six locations.
  - In the 10-foot thick injection zone, 840 gallons of a 20 percent sodium dithionite solution were injected into each direct push location. The solution consisted of 1,320 pounds of sodium dithionite and 800 gallons of water.
- In the eastern portion of Sub-Area B, the injection will be into an 8 to10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved chromium and dissolved nickel.
  - A total of 13 locations.
  - In the 10-foot thick injection zone, 900 gallons of a 29 percent sodium sulfide solution were injected into each direct push location. The solution consisted of 2,000 pounds of sodium sulfide and 800 gallons of water.

2.2.3 Sub-Area C

- In the entire portion of Sub-Area C, the injection zone was an 8 to10 feet thick zone from approximately 15 to 25 feet bgs and targeted dissolved nickel.
  - A total of 34 locations
  - In the 10-foot thick injection zone, 900 gallons of a 29 percent sodium sulfide solution was injected into each direct push location. The solution consisted of 2,000 pounds of sodium sulfide and 800 gallons of water.
  - Fourteen locations were installed by Superior utilizing the Badger system
  - Twenty locations were installed with a Geoprobe® utilizing a 42-inch screen.

2.3 Groundwater Monitoring

Groundwater monitoring was conducted to monitor the effectiveness of the ISCR Field Pilot Study and injection technology effectiveness. Prior to initiating the injection activities, one round of baseline groundwater monitoring was completed to establish the initial constituent concentrations. Following chemical injections, groundwater monitoring was conducted at 1 week, 3 weeks and 3 months post-injections.

Low-Flow sampling techniques were used to collect the groundwater samples. Each monitoring well was purged at approximately 100-200 milliliters/minute in accordance with low-flow protocols. Groundwater quality parameters collected during purging included pH, conductivity, temperature, turbidity, dissolved oxygen, and ORP. Field parameters were monitored during purging to ensure stabilization of the groundwater occurred within each monitoring well prior to sampling for the laboratory analysis of total and dissolved metals (chromium, iron, manganese, nickel, and sodium), chromium VI, bromide, sulfate, and sulfide. A groundwater sample key is included in Table 2.2.

In addition to the field parameters monitored during the post-injection groundwater sampling events, 8 YSI EX01 Multiparameter Sondes were utilized within the monitoring wells that recorded real-time field data before, during and after the chemical injections. The Sondes were programmed to collect field data every 15 minutes and field parameters logged included temperature, conductivity, specific conductivity, pH and ORP. The eight eastern monitoring wells (MW54D-15 through MW61D-15) utilized the Sondes from May 15, 2015 to June 16, 2015.The Sondes that were placed in MW56D-15 and MW61D-15 malfunctioned and data collection stopped on May 20 and June 2, 2015, respectively. Six western monitoring wells (MW42D-15, MW44D-15 through MW47D-15 and MW49D-15) utilized the Sondes from June 17, 2015 to July 6, 2015. Graphs showing the data collected from the Sondes are included in Appendix C.

2.4 Electrical Conductivity Borings

Electrical conductivity (EC) readings were completed by utilizing a real-time EC down-hole probe supplied and operated by Stock Drilling, Inc. (Stock). The EC probe was used to identify sodium as an indicator of the presence of sodium sulfide to determine the effectiveness of the injection systems. By identifying the presence of increased EC readings as a field indicator of the presence of the injected sodium sulfide solution in step-out EC borings, the optimal tooling, average radius of influence and vertical distribution could be assessed.

In total, 22 EC borings were conducted in the vicinity of various injection locations at varying directions (typically down-gradient and cross-gradient) around five sodium sulfide injection points (INJ-17, 33, 53, 75 and 79). INJ-17, 75 and 79 were completed using the Badger system and INJ-33 and 53 were completed using a Geoprobe® with a 42-inch screen. The initial boring was generally placed 5 feet from the injection point and when EC readings indicated sodium was present, a 2.5- and/or 5-foot incremental step out boring(s) was advanced. EC boring locations are shown on Figure 2.3. The summary report of the EC borings provided by Stock is included in Appendix D.

2.5 Surveying

The location, ground surface, and top of pipe elevations for the monitoring wells were surveyed to the nearest 0.01 ft for inclusion in the master Site plan. Additionally the location and ground surface of the injection points and electrical conductivity borings were surveyed to the nearest 0.01 ft for inclusion in the master Site plan.

3. Results

A detailed summary of chromium and nickel concentration reductions within the monitoring network is provided in the attached *Review of In Situ Chemical Reduction Field Pilot Study Monitoring Data 13000 Eckles Road Site, Livonia, Michigan* memorandum, included as Appendix E. The following section will provide a brief overview of results from the pilot study.

3.1 Injection Technique

Based on the EC data presented in Appendix D, the SP 16 with the 42-inch screen and the Badger System equally dispersed the chemical solutions into the formation. It appears that neither technique was better at the horizontal or vertical dispersion. The EC boring logs show the sodium sulfide solution had an approximate 5-foot vertical dispersion range (approximately 19 to 24 feet bgs) and the horizontal range extended to approximately 10 feet (and occasionally 15 feet) beyond the injection point. A summary of EC boring readings are provided in Table 3.1 and a copy of the EC boring logs is included in Appendix D.

MW54D-15 thru MW57D-15 were installed in the center of injection points completed by GHD and MW58D-15 thru MW61D-15 were installed in the center of the injection points completed by Superior to allow for evaluation of the different injection techniques in Sub-Area C. As shown on Figure 3.1, nickel concentrations in both well groupings were reduced following the injections.

3.2 Chemical Distribution

A radius of influence of 15 feet was achieved through both injection techniques. Reductions in chromium and nickel were observed in monitoring wells within close proximity of the injection locations. Additionally, EC borings completed near injection points confirmed increased EC readings were present within 15 feet of injection locations. Analytical results indicate injection material reached 25 feet downgradient during the 3-week post-injection sampling event. Reductions in metals concentrations were observed in some downgradient monitoring wells up to 60 feet away from the injection point by the 3-month post-injection sampling event.

Bromide was injected along with the reagent during the injection event as a conservative tracer to track the flow of the injected reagents. A high detection limit was encountered for bromide analysis due to the high concentrations of sulfate and sulfide in the groundwater samples. Therefore there were few detections of bromide and bromide was not a good indicator of reagent distribution.

3.3 Groundwater Chemistry

Analytical results from the pilot study are provided in Appendix F, shown on Figure 3.1 and in Table 3.2. Up to 99.9 percent reductions in dissolved chromium and/or nickel were achieved in monitoring wells included in the pilot study. Rebound in dissolved chromium and nickel was observed in some monitoring wells during the 3-month post-injection sampling event. Increases in pH and decreased oxidation-reduction potential (ORP) were observed in a majority of monitoring locations following chemical injection. The pH was observed to be decreasing in some locations during the 3-month post-injection sampling event; however levels remained well above the baseline levels. ORP levels decreased at most monitoring well locations and remained below the baseline levels. A brief summary of the groundwater analytical monitoring at each Sub-Area is presented below.

3.4 Total and Dissolved Metals

Based on the results shown on Figure 3.1 and in Table 3.2 and discussed below, the sodium sulfide and sodium dithionite/sodium sulfide mixtures were effective in reducing groundwater concentrations of dissolved chromium and dissolved nickel. It appears that the sodium sulfide solution alone was not effective at reducing elevated concentrations of dissolved chromium and there are no monitoring wells located in the immediate areas where the sodium dithionite only solution was injected. Results in specific monitoring wells and monitoring well clusters varied based on proximity to an injection point, which chemicals were used, and the concentration of metals prior to injection activities. In general, dissolved chromium and nickel concentrations were reduced to below the 0.1-milligram per liter (mg/L) screening criteria in the middle of the treatment area while untreated areas remained at the periphery of the treatment area. Total metals results were generally higher than their associated dissolved metals concentrations indicating insoluble metals may not have precipitated out of the groundwater by the time the samples were collected. Results from specific monitoring well clusters and injection areas are summarized below and discussed in detail in Appendix E.

- Sub-Area A (MW-42D-15 through MW-45D-15)
    - Sodium Sulfide injection to treat chromium-impacted groundwater
    - Dissolved chromium and hexavalent chromium were not effectively treated, with the exception of one monitoring well which showed a 97 percent decrease in dissolved chromium
    - Nickel was less than 1 ppm in groundwater samples prior to and after injection activities
    - Probe refusals and difficulties with injections in this area suggest that some underground structure may be present which limited injections and may have limited dispersion.
- West Sub-Area B (MW-46D-15 through MW-49D-15)
    - Sodium dithionite and sodium sulfide injection to treat nickel and chromium-impacted groundwater
    - Dissolved chromium reduced by more than 95 percent-99 percent and hexavalent chromium (where initially present) reduced by 81 percent->99 percent
    - Nickel was reduced to non-detect levels in all four monitoring wells
- East Sub-Area B (MW-50D-15 through MW-53D-15)
    - Sodium sulfide injection to treat nickel and chromium-impacted groundwater
    - Dissolved chromium and hexavalent chromium both reduced to concentrations less than 0.1 ppm or non-detect levels (>95 percent reductions)
    - Nickel was reduced to non-detect levels in all four monitoring wells (>90 percent reductions)
- West Sub-Area C (MW-54D-15 through MW-57D-15)
    - Sodium sulfide injection to treat nickel-impacted groundwater
    - Dissolved chromium and hexavalent chromium where less than 0.1 ppm or non-detect in all groundwater samples
    - Nickel was reduced to non-detect levels or less than 0.1 ppm in all four monitoring
- East Sub-Area C (MW-58D-15 through MW-61D-15)
    - Sodium sulfide injection to treat nickel-impacted groundwater
    - Dissolved chromium and hexavalent chromium where less than 0.1 ppm or non-detect in all groundwater samples, with the exception of MW-61D-15, which contained 0.3 ppm in one groundwater sample
    - Nickel was reduced by more than 97 percent in three of the monitoring wells and by 76 percent in MW-61D-15, which did not have an injection point to the northeast (upgradient direction), which may have led to incomplete treatment at this location

3.5 Overall General Analysis

As detailed in the attached Pilot Study Monitoring Data Memo (Appendix E), the following trends and observations were made:

- Dissolved chromium and nickel concentrations in the treatment area were generally reduced to below the 0.1-mg/L screening criteria.
- Reductions in chromium and nickel concentrations of up to 99.9 percent were observed.
- An injection radius of influence of at least 15 feet was observed for both injection technologies used.
- The injected material travelled up to 25 feet downgradient by the July monitoring event and up to 63 feet downgradient by the September monitoring event.
- Satisfactory reductions in dissolved metals concentrations were not observed at the MW42D-15 to MW45D-15 well clusters, and the monitoring data suggest that the injected material reached these wells; however, sodium sulfide only was injected into the wells in the vicinity of these wells. The data suggest that the addition of sodium dithionite is required to treat high concentrations of dissolved chromium.
- Wells where dissolved chromium and nickel concentrations were reduced also showed increases in sulfate, sulfide, and sodium concentrations, and an increase in pH, which indicated that the injected sodium sulfide material made good contact with the area. Sodium and sulfate are soluble, therefore their concentrations in the treatment area will decrease over time as they disperse out of the treatment area. Metal sulfides are typically insoluble. The sulfide from sodium sulfide is expected to react with the metals present in the treatment area such as iron and precipitate them as their metal sulfides therefore sulfide is not expected to be detected in groundwater over the long term.
- Samples collected on July 20 and in September, showed slightly lower pH levels indicating that the high pH conditions caused by the sodium sulfide were abating. Sodium dithionite does not cause as significant a rise in pH as sodium sulfide.
- Some rebound in dissolved chromium and nickel concentrations was observed in results from the September monitoring event, which is expected since this was a pilot test and all areas of the Site were not treated therefore, untreated groundwater containing higher dissolved chromium and nickel concentrations would be migrating back into the treatment area.
- The high pH levels observed in the wells where reductions in chromium and nickel were observed suggested that these wells were contacted by sodium sulfide. No monitoring wells were located in the immediate areas of the sodium dithionite only injections because the effects of sodium dithionite injections were examined in the previous pilot studies performed at this Site.

4. Conclusions

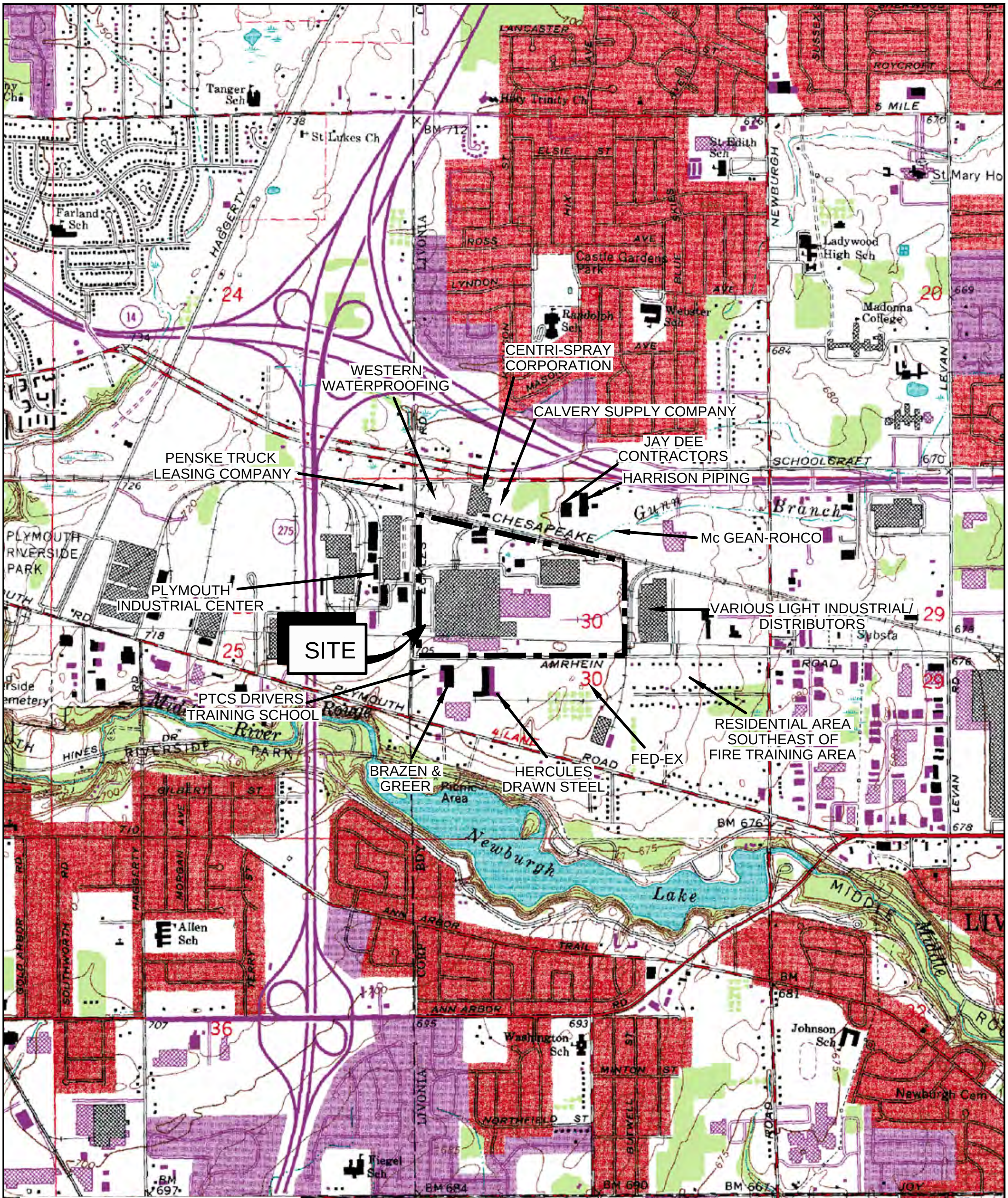
As summarized in the attached memorandum, analytical results show a sodium dithionite/sodium sulfide mixture is effective in reducing groundwater concentrations with a mixture of dissolved chromium and dissolved nickel. Treatment of chromium and nickel-impacted groundwater was observed 15 feet from injection points and up to 25 feet downgradient in the month after the injections and up to 67 feet from the injection points 3 months after the injections. Based on the observed 15-foot radius of influence, a 30-foot side-gradient and downgradient spacing is recommended for injection points for the full-scale application. As summarized in the attached memorandum, for the full-scale application, treatment with 800 gallons of 29 percent sodium sulfide is recommended for the areas with nickel impacts and areas where chromium concentrations are less than approximately 20 mg/L. A mixture of 20 percent sodium dithionite and 29 percent sodium sulfide is recommended for the areas where both chromium and nickel concentrations are elevated. Analytical results indicate a sodium sulfide solution was not effective in reducing groundwater with elevated chromium concentrations greater than approximately 20 mg/L. For areas with elevated chromium concentrations and no nickel impacts, a 20 percent sodium dithionite solution is recommended for full-scale application.

Thirteen injections points were completed by Superior utilizing the Badger injection system adjacent to an area where a traditional injection technique utilizing a 42-inch screen was utilized. Monitoring wells MW54-15 thru MW61-15 were used to compare injection techniques. Analytical results from each grouping of wells show both technologies were effective at significantly reducing the concentration of nickel in groundwater surrounding the injection points. The Badger injection system was able to inject the mixed solution at a greater rate than the traditional method, and Superior determined they would have had a greater radius of influence than what was identified in the field if they had more solution available to inject at each point. This evaluation may also be applicable to the traditional injection method completed at the remainder of the injection points. Based on the results of the field evaluation of the injection techniques, the pilot study was inconclusive on determining the most effective injection technique. Further consideration of injection method cost, effectiveness, and time should be completed when developing the full-scale application work plan and bidding process.

Mixing of the sodium dithionite and sodium sulfide in batch volumes for one injection was a time-consuming portion of pilot study and consideration should be given to ensure it is not a limiting factor during full-scale implementation. Make-up water for the injections was sourced from the groundwater treatment plant treated effluent and residuals may have contributed to difficulties mixing the injection solution.

A downgradient PRB is being considered for this Area. A potential reactive matrix for the PRB is zero valent iron (ZVI). ZVI creates reducing conditions therefore treatment using the chemical reducing agents sodium sulfide and sodium dithionite would be compatible with this technology. If conditions in the groundwater reaching the PRB were already reducing, the life of the PRB would be extended since less of the ZVI would be oxidized. Residual sulfate from the injections is likely to be reduced to sulfide via abiotic and biological mechanisms in and around the ZVI barrier leading to a decrease in sulfate concentrations at the barrier. However it is expected that the amount of ZVI consumed by the sulfate will be minimal since biological sulfate reduction will be the primary mechanism. However, the sulfide would precipitate from the groundwater. Since sulfide particles are very small, it is not expected that the sulfide would clog the barrier. Residual sulfide from the injections would likely not reach a downgradient barrier due to its low solubility in water.

The primary risk that the sodium sulfide and sodium dithionite injections would pose to a ZVI barrier would be from the increased turbidity in the groundwater which would result in a lowering of the permeability of the barrier. For this reason it is recommended that the injections are not performed within 20 feet immediately upgradient of the barrier. At a distance of 20 feet from the injection locations, the turbidity would have abated sufficiently that the permeability of the barrier would not be affected.



SOURCE: USGS QUADRANGLE MAPS;
NORTHVILLE AND WAYNE, MICHIGAN, 1980

0 1000 2000ft

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13000 ECKLES ROAD SITE
LIVONIA, MICHIGAN

012607-T02

Nov 17, 2015

SITE LOCATION

FIGURE 1.1

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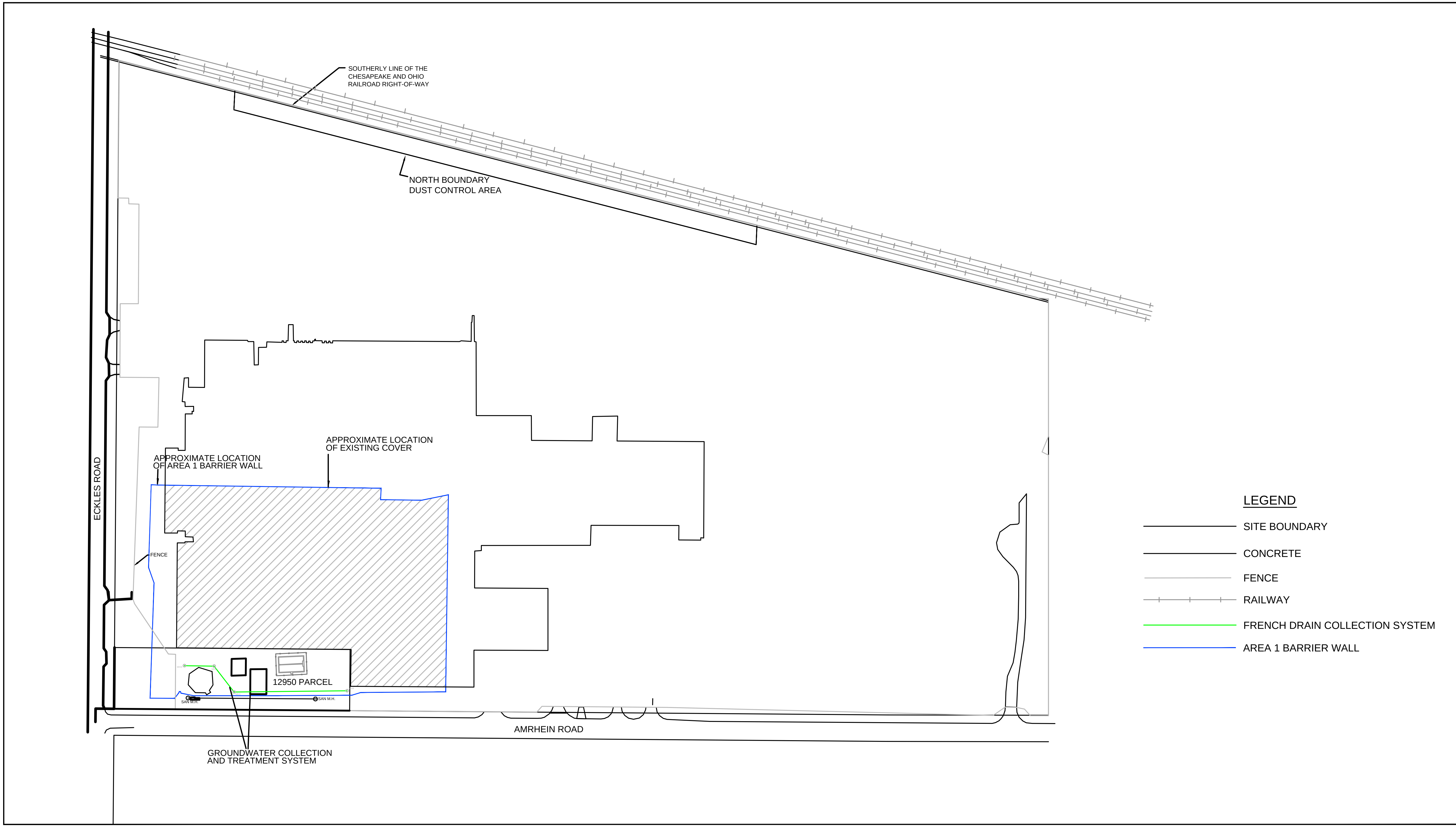

0 150 300ft

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13000 ECKLES ROAD SITE
LIVONIA, MICHIGAN

AREA 1 SITE PLAN

012607-T02

Nov 17, 2015

FIGURE 1.2

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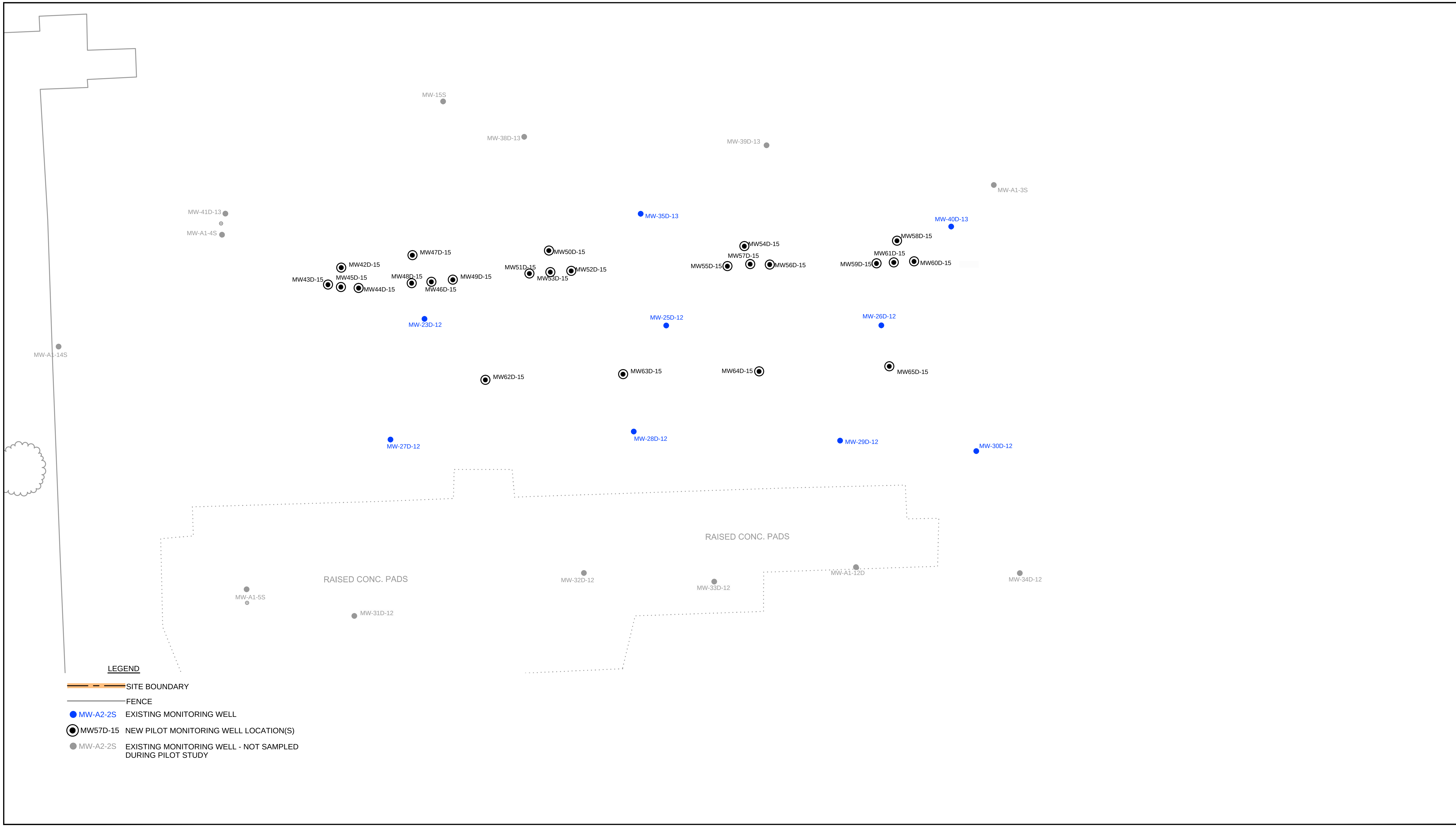

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012607-T02
Nov 17, 2015

AREA 1 PILOT STUDY MONITORING WELL LOCATIONS

FIGURE 2.1

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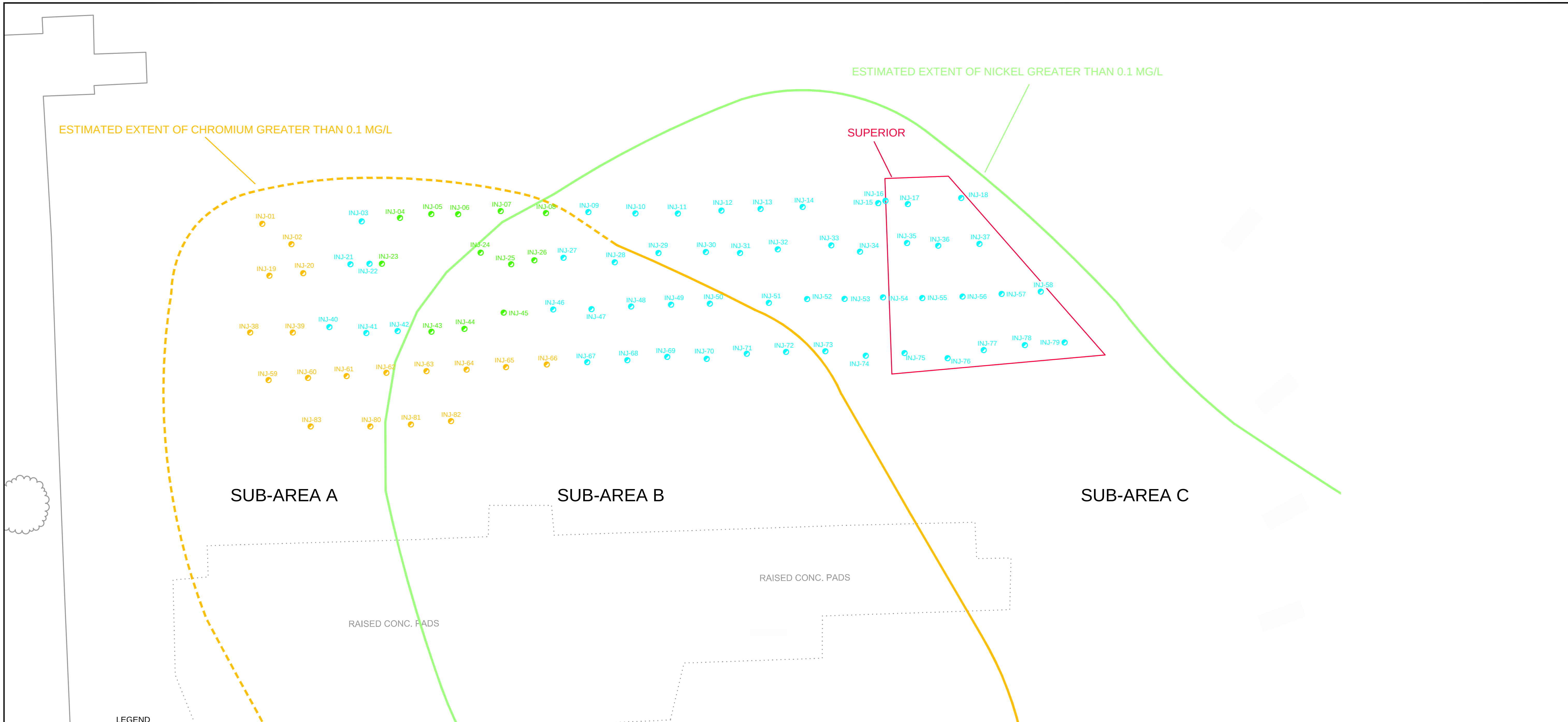

LEGEND

SITE BOUNDARY
FENCE
INJ-34 INJECTION WELL
EX-A1-1 EXTRACTION WELL
DIRECT INJECTION POINT-SODIUM DITHIONITE
DIRECT INJECTION POINT - SODIUM DITHIONITE AND SODIUM SULFIDE
DIRECT INJECTION POINT-SODIUM SULFIDE

ESTIMATED EXTENTS OF NICKEL-IMPACTED GROUNDWATER > 0.1 MG/L
ESTIMATED EXTENTS OF CHROMIUM-IMPACTED GROUNDWATER > 0.1 MG/L

NOTES:
ESTIMATED EXTENTS OF CHROMIUM AND NICKEL-IMPACTED GROUNDWATER WERE DEVELOPED BY INCORPORATING HISTORIC (RFI) ANATLYCIAL RESULTS AND MORE RECENT RESULTS, WHERE AVAILABLE

0 25 50ft

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AREA 1 PILOT STUDY INJECTION LOCATIONS

012607-T02
Dec 28, 2015

FIGURE 2.2

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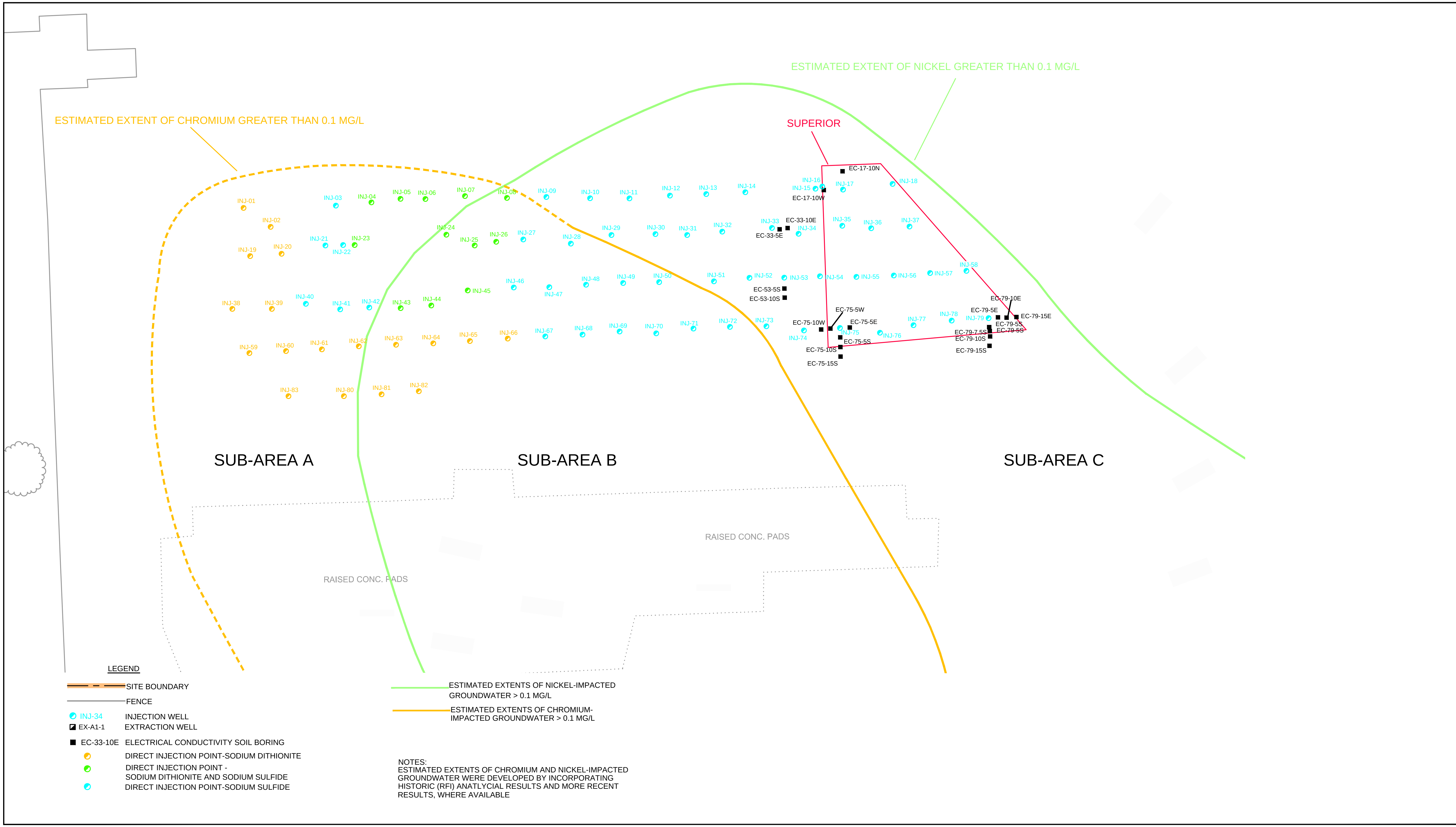

0 25 50ft

N

GHD

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AREA 1 PILOT STUDY ELECTRICAL CONDUCTIVITY LOCATIONS

012607-T02

Dec 28, 2015

FIGURE 2.3

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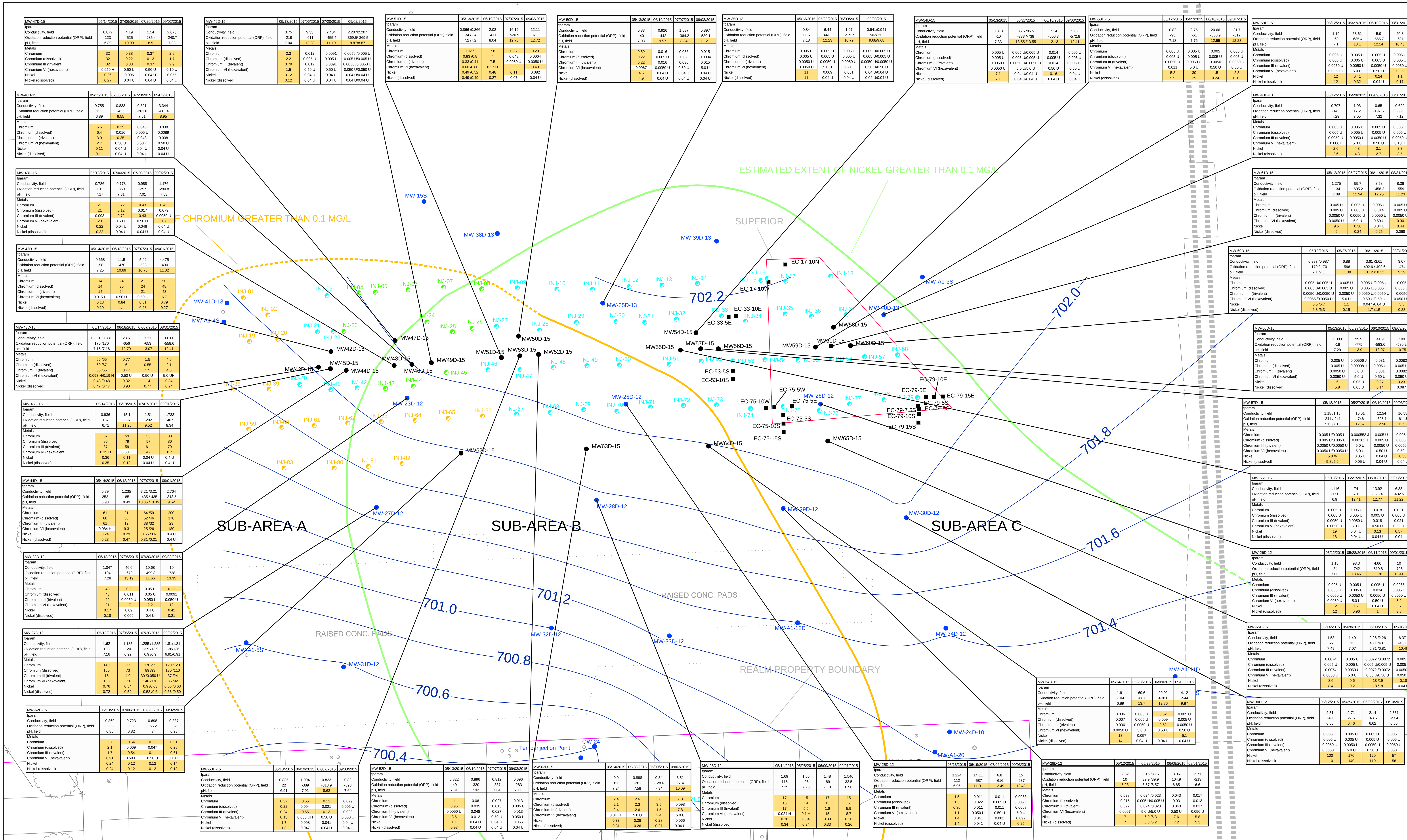

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Client
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LIVONIA, MICHIGAN

Project
13000 ECKLES ROAD SITE

No.	Issue	Drawn	Approved	Date
-	-	-	-	-

Drawn DRAWN
Designer DESIGNED
Drafting Check DRAFT_CHECK
Design Check DESIGN_CHECK
Project Manager PM
Date Dec 28, 2015
This document shall not be used for construction unless signed and sealed for construction.
Scale AS SHOWN
Original Size ANSI D
Bar is one inch on original size drawing 0 1"

Project No. 012607-T02

Title
AREA 1 PILOT STUDY
GROUNDWATER MONITORING RESULTS

Sheet No.
FIGURE 3.1
Sheet 1 of 1

STATUS

Groundwater Screening Criteria

	Non-Residential Health-Based Drinking Water Criteria (mg/L)	Site-Specific Risk-Based Grounwater Criteria (mg/L)
Chromium	0.1	28
Chromium VI (hexavalent)	0.1	28
Nickel	0.1	2,400

LEGEND

- SITE BOUNDARY
- FENCE
- MW-A2-2S EXISTING MONITORING WELL
- INJ-34 INJECTION WELL
- EX-A1-1 EXTRACTION WELL
- EC-33-10E ELECTRICAL CONDUCTIVITY SOIL BORING
- DIRECT INJECTION POINT-SODIUM DITHIONITE
- DIRECT INJECTION POINT - SODIUM DITHIONITE AND SODIUM SULFIDE
- DIRECT INJECTION POINT-SODIUM SULFIDE
- MW57D-15 NEW PILOT MONITORING WELL LOCATION(S)
- INJECTIONS WITHIN THIS AREA COMPLETED BY SUPERIOR ENVIRONMENTAL
- RESULT IS GREATER THAN THE GROUNDWATER SCREENING CRITERIA
- ESTIMATED EXTENTS OF NICKEL-IMPACTED GROUNDWATER > 0.1 MG/L
- ESTIMATED EXTENTS OF CHROMIUM-IMPACTED GROUNDWATER > 0.1 MG/L
- 701.0 GROUNDWATER ELEVATION CONTOUR AUGUST 27 AND SEPTEMBER 30, 2013
- U NOT DETECTED AT THE ASSOCIATED REPORTING LIMIT
- J ESTIMATED CONCENTRATION
- H SAMPLE WAS PREPPED OR ANALYZED BEYOND THE SPECIFIED HOLDING TIME

NOTES:
ESTIMATED EXTENTS OF CHROMIUM AND NICKEL-IMPACTED GROUNDWATER WERE DEVELOPED BY INCORPORATING HISTORIC (RFI) ANALTYCIAL RESULTS AND MORE RECENT RESULTS, WHERE AVAILABLE

Table 2.1

Monitoring Well Construction Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Monitoring Well ID	Northing	Easting	Well Completion Date	Total Borehole Depth (feet)	Well Material	Well Dia. (in)	Screen Length (ft)	Ground Surface Elevation (ft. AMSL)	Top of Casing (TOC) Elevation (ft. AMSL)	Screened Interval (ft bgs)			Screened Interval (ft. AMSL)			Final Const.
MW42D-15	320489.065	13376568.85	5/11/2015	22.8	PVC	2	10	706.42	708.83	12.75	-	22.75	693.67	-	683.67	ST
MW43D-15	320479.727	13376561.39	5/12/2015	22.8	PVC	2	10	706.41	708.25	12.75	-	22.75	693.66	-	683.66	ST
MW44D-15	320477.834	13376578.01	5/11/2015	22.8	PVC	2	10	706.50	709.26	12.75	-	22.75	693.75	-	683.75	ST
MW45D-15	320478.859	13376568.57	5/11/2015	24.0	PVC	2	10	706.41	708.61	12.75	-	22.75	693.66	-	683.66	ST
MW46D-15	320481.403	13376617.32	5/7/2015	25.0	PVC	2	10	706.68	708.80	13.00	-	23.00	693.68	-	683.68	ST
MW47D-15	320495.614	13376607.23	5/12/2015	23.0	PVC	2	10	706.49	708.45	13.00	-	23.00	693.49	-	683.49	ST
MW48D-15	320480.727	13376606.7	5/12/2015	23.0	PVC	2	10	706.40	709.03	13.00	-	23.00	693.40	-	683.40	ST
MW49D-15	320482.444	13376628.97	5/12/2015	23.0	PVC	2	10	708.81	709.03	13.00	-	23.00	695.81	-	685.81	ST
MW50D-15	320498.261	13376681.13	5/8/2015	23.5	PVC	2	10	706.78	708.81	13.50	-	23.50	693.28	-	683.28	ST
MW51D-15	320485.496	13376670.89	5/8/2015	23.5	PVC	2	10	707.06	708.70	13.50	-	23.50	693.56	-	683.56	ST
MW52D-15	320487.364	13376693.08	5/6/2015	25.0	PVC	2	10	706.89	709.40	13.50	-	23.50	693.39		683.39	ST
MW53D-15	320486.517	13376681.87	5/7/2015	23.5	PVC	2	10	706.86	708.96	13.50	-	23.50	693.36		683.36	ST
MW54D-15	320500.332	13376787.33	5/7/2015	24.5	PVC	2	10	706.90	708.95	14.50	-	24.50	692.40		682.40	ST
MW55D-15	320489.992	13376778.03	5/7/2015	24.5	PVC	2	10	707.09	709.14	14.50	-	24.50	692.59		682.59	ST
MW56D-15	320490.761	13376800.74	5/7/2015	25.0	PVC	2	10	707.03	708.98	14.50	-	24.50	692.53		682.53	ST
MW57D-15	320490.769	13376790.12	5/7/2015	24.5	PVC	2	10	707.01	708.91	14.50	-	24.50	692.51		682.51	ST
MW58D-15	320503.644	13376869.6	5/6/2015	25.5	PVC	2	10	706.87	708.39	15.50	-	25.50	691.37		681.37	ST
MW59D-15	320491.778	13376858.82	5/6/2015	25.5	PVC	2	10	707.02	708.98	15.50	-	25.50	691.52		681.52	ST
MW60D-15	320492.619	13376879.79	5/6/2015	26.8	PVC	2	10	706.88	709.19	15.50	-	25.50	691.38		681.38	ST
MW61D-15	320492.371	13376868.19	5/6/2015	25.5	PVC	2	10	706.95	708.94	15.50	-	25.50	691.45		681.45	ST
MW62D-15	320428.296	13376646.7	5/8/2015	25.0	PVC	2	10	706.59	709.00	13.00	-	23.00	693.59		683.59	ST
MW63D-15	320430.777	13376721.72	5/12/2015	23.5	PVC	2	10	706.68	708.10	13.50	-	23.50	693.18		683.18	ST
MW64D-15	320432.526	13376794.78	5/12/2015	24.0	PVC	2	10	706.63	708.81	14.00	-	24.00	692.63		682.63	ST
MW65D-15	320435.541	13376866.19	5/12/2015	25.0	PVC	2	10	708.36	706.89	15.00	-	25.00	693.36		683.36	ST
MW23D-12	320461.22	13376614.44	12/12/2012	25.0	PVC	2	10	706.69	706.34	15.20		25.20	691.49		681.49	FM
MW25D-12	320457.64	13376745.33	12/12/2012	24.5	PVC	2	10	706.68	706.29	16.00		26.00	690.68		680.68	FM
MW26D-12	320457.66	13376861.86	12/12/2012	17.0	PVC	2	10	706.49	706.22	16.00		26.00	690.49		680.49	FM
MW27D-12	320395.907	13376596.21	12/13/2012	25.0	PVC	2	10	706.63	706.50	14.20		24.20	692.43		682.43	FM
MW28D-12	320400.393	13376727.88	12/12/2012	28.0	PVC	2	10	706.33	706.51	17.50		27.50	688.83		678.83	FM
MW29D-12	320395.26	13376839.50	12/11/2012	24.0	PVC	2	10	706.64	706.18	16.00		26.00	690.64		680.64	FM
MW30D-12	320389.64	13376913.22	12/12/2012	29.0	PVC	2	10	706.61	706.34	18.00		28.00	688.61		678.61	FM
MW35D-13	320518.08	13376731.49	8/23/2013	25.0	PVC	2	10	--	705.93	14.00		24.00	--		--	FM
MW40D-13	320511.15	13376899.70	11/12/2013	30.0	PVC	2	10	--	706.83	18.00		28.00	--		--	FM

Notes:
Ft. BGS - Feet below ground surface.
Ft. AMSL - Feet above mean sea level.
TOC - Top of casing.
FM - Flushmouunt
ST - Stick up
-- Data Not Available
Datum: State Plane Coordinate System MI South NAD83/NAVD88 International feet.

Table 2.2

Sample Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample ID	Location Description	Collection Date (mm/dd/yy)	QA/QC	Parent ID	Analysis
GW-12607-051215-DC-001	MW-30D-12	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-002	MW-29D-12	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-003	MW-60D-15	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-004	MW-60D-15	5/12/2015	Duplicate	GW-12607-051215-DC-003	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-005	MW-59D-15	5/12/2015	MS/MSD		Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-006	MW-61D-15	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-007	MW-58D-15	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-008	MW-40D-13	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051215-DC-009	MW-26D-12	5/12/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-010	MW-55D-15	5/13/2015	MS/MSD		Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-011	MW-54D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-012	MW-57D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-013	MW-57D-15	5/13/2015	Duplicate	GW-12607-051315-DC-012	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-014	MW-56D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-015	MW-25D-12	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-016	MW-35D-13	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-017	MW-52D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-018	MW-53D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-019	MW-50D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-020	MW-51D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-021	MW-51D-15	5/13/2015	Duplicate	GW-12607-051315-DC-020	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-022	MW-49D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-023	MW-46D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-024	MW-48D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-025	MW23D-12	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-026	MW-62D-15	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051315-DC-027	MW27D-12	5/13/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-028	MW-43D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-029	MW-43D-15	5/14/2015	Duplicate	GW-12607-051315-DC-028	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-030	MW-44D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-031	MW-45D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-032	MW-42D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-033	MW-47D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-034	MW-28D-12	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate

Table 2.2

Sample Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample ID	Location Description	Collection Date (mm/dd/yy)	QA/QC	Parent ID	Analysis
GW-12607-051415-DC-035	MW-63D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-036	MW-64D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-051415-DC-037	MW-65D-15	5/14/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-001	MW-61D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-002	MW-60D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-EM-003	MW-58D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-004	MW-59D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-005	MW-54D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-006	MW-54D-15	5/27/2015	Duplicate	GW-12607-052715-DR-005	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-007	MW-55D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-008	MW-56D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052715-DR-009	MW-57D-15	5/27/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052815-DR-010	MW-65D-15	5/28/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052815-DR-011	MW-26D-12	5/28/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052815-DR-012	MW-64D-15	5/28/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052815-DR-013	MW-63D-15	5/28/2015	MS/MSD		Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052815-DR-014	MW-28D-12	5/28/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052915-EM-015	MW-40D-13	5/29/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052915-EM-016	MW-35D-13	5/29/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052915-EM-017	MW-30D-12	5/29/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052915-EM-018	MW-29D-12	5/29/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-052915-EM-019	MW-29D-12	5/29/2015	Duplicate	GW-12607-052915-EM-018	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-001	MW-30D-12	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-002	MW-29D-12	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-003	MW-65D-15	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-004	MW-65D-15	6/9/2015	Duplicate	GW-12607-060915-SK-003	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-005	MW-64D-15	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-006	MW-63D-15	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-007	MW-28D-12	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-008	MW-35D-13	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-009	MW-40D-13	6/9/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-010	MW-56D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-011	MW-54D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-012	MW-57D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-013	MW-55D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-014	MW-59D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-015	MW-58D-15	6/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-016	MW-61D-15	6/11/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-017	MW-60D-15	6/11/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-060915-SK-018	MW-60D-15	6/11/2015	Duplicate	GW-12607-060915-SK-017	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate

Table 2.2

Sample Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample ID	Location Description	Collection Date (mm/dd/yy)	QA/QC	Parent ID	Analysis
GW-12607-060915-SK-019	MW-26D-12	6/11/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061815-DT-001	MW-44D-15	6/18/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061815-DT-002	MW-42D-15	6/18/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061815-DT-003	MW-45D-15	6/18/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061815-DT-004	MW-43D-15	6/18/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061915-DT-005	MW-51D-15	6/19/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061915-DT-006	MW-53D-15	6/19/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061915-DT-007	MW-50D-15	6/19/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061915-DT-008	MW-52D-15	6/19/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-061915-DT-009	MW-25D-12	6/19/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-001	MW-62D-15	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-002	MW27D-12	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-003	MW23D-12	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-004	MW-46D-15	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-005	MW-47D-15	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-006	MW-48D-15	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-007	MW-49D-15	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070615-SK-008	MW-25D-12	7/6/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-009	MW-42D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-010	MW-43D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-011	MW-45D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-012	MW-44D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-013	MW-44D-15	7/7/2015	Duplicate	GW-12607-070715-SK-012	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-014	MW-51D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-015	MW-50D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-016	MW-53D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-070715-SK-017	MW-52D-15	7/7/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-001	MW-48D-15	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-002	MW-47D-15	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-003	MW-46D-15	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-004	MW23D-12	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-005	MW-49D-15	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-006	MW27D-12	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-007	MW27D-12	7/20/2015	Duplicate	GW-012607-072015-DT-006	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-012607-072015-DT-008	MW-62D-15	7/20/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-083115-EM-001	MW-43D-15	8/31/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-083115-EM-002	MW-60D-15	8/31/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-083115-EM-003	MW-61D-15	8/31/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-083115-EM-004	MW-59D-15	8/31/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-083115-EM-005	MW-40D-13	8/31/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-006	MW-45D-15	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate

Table 2.2

Sample Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample ID	Location Description	Collection Date (mm/dd/yy)	QA/QC	Parent ID	Analysis
GW-12607-0901015-EM-007	MW-44D-15	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-008	MW-42D-15	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-009	MW-58D-15	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-010	MW-26D-12	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-011	MW-29D-12	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-0901015-EM-012	MW-28D-12	9/1/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-013	MW27D-12	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-014	MW27D-12	9/2/2015	Duplicate	GW-12607-090215-EM-013	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-015	MW-47D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-016	MW-48D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-017	MW-46D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-018	MW-62D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-019	MW-63D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-020	MW-49D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-021	MW-49D-15	9/2/2015	Duplicate	GW-12607-090215-EM-020	Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090215-EM-022	MW-64D-15	9/2/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-023	MW23D-12	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-024	MW-25D-12	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-025	MW-55D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-026	MW-57D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-027	MW-56D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-028	MW-54D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-029	MW-35D-13	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-030	MW-35D-13	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-031	MW-52D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-032	MW-53D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-033	MW-50D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-090315-EM-034	MW-51D-15	9/3/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-091015-SK-001	MW-30D-12	9/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate
GW-12607-091015-SK-002	MW-65D-15	9/10/2015			Metals (T/D), Chromium (Tri/Hex), Bromide, Sulfide, Sulfate

Notes:
Metals (T/D) - Total and Dissolved Metals
Chromium (Tri/Hex) - Trivalent and Hexavalent Chromium
Dissolved Metals were field filtered

Table 2.3

ISCR Injection Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Injection ID	Depth Interval (Ft BGS)	Contractor/Method	Amount Injected (Gallons)	Chemical/quantities	Injection Date	Time Start	Time Finished
INJ-01	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/23/2015	14:54	16:43
INJ-02	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/23/2015	13:42	15:19
INJ-03	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/15/2015	12:44	15:24
INJ-04	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/24/2015	15:14	17:20
INJ-05	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/25/2015	12:47	16:26
INJ-06	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/25/2015	14:52	6/26/2015 9:05:00 AM
INJ-07	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/26/2015	15:12	17:16
INJ-08	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/26/2015	16:10	18:29
INJ-09	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/22/2015	8:45	10:34
INJ-10	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	15:10	17:22
INJ-11	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	14:35	16:15
INJ-12	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	9:18	13:10
INJ-13	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	8:30	11:34
INJ-14	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	14:12	16:08
INJ-15	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	14:26	16:59
INJ-16	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/27/2015	9:23	11:08
INJ-17	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/19/2015	11:22	11:59

Table 2.3

ISCR Injection Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Injection ID	Depth Interval (Ft BGS)	Contractor/Method	Amount Injected (Gallons)	Chemical/quantities	Injection Date	Time Start	Time Finished
INJ-18	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	9:09	9:50
INJ-19	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/23/2015	9:43	11:41
INJ-20	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/23/2015	11:14	13:09
INJ-21	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/15/2015	13:17	16:22
INJ-22	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/28/2015	12:30	14:02
INJ-23	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/24/2015	10:16	14:50
INJ-24	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/25/2015	9:49	11:48
INJ-25	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/29/2015	10:40	12:52
INJ-26	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums	6/29/2015	13:24	15:35
INJ-27	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/22/2015	12:08	14:20
INJ-28	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/27/2015	10:20	12:10
INJ-29	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/27/2015	12:21	15:04
INJ-30	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	8:14	10:52
INJ-31	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	8:48	11:40
INJ-32	15-25	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	12:52	15:31
INJ-33	15-25	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	16:38	18:20
INJ-34	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/27/2015	12:23	14:41
INJ-35	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/19/2015	10:18	11:00

Table 2.3

ISCR Injection Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Injection ID	Depth Interval (Ft BGS)	Contractor/Method	Amount Injected (Gallons)	Chemical/quantities	Injection Date	Time Start	Time Finished
INJ-36	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	11:21	11:56
INJ-37	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	8:13	8:56
INJ-38	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/19/2015	11:40	13:15
INJ-39	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/22/2015	10:58	12:55
INJ-40	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/28/2015	10:44	12:35
INJ-41	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	14:40	16:52
INJ-42	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/28/2015	8:14	10:09
INJ-43	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/25/2015	9:17	11:21
INJ-44	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/24/2015	9:23	11:23
INJ-45	15'-25'	GHD/42"Screen	975	Sulfide/Dithionite 2000 lbs/1320 lbs 1 supersack/6 drums Bromide - 6.5 lbs	6/26/2015	10:18	12:38
INJ-46	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/27/2015	10:26	12:09
INJ-47	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/27/2015	8:51	10:51
INJ-48	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/21/2015	12:48	14:41
INJ-49	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	8:52	11:23
INJ-50	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	11:30	14:04
INJ-51	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	13:54	16:25
INJ-52	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/20/2015	8:27	11:29

Table 2.3

ISCR Injection Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Injection ID	Depth Interval (Ft BGS)	Contractor/Method	Amount Injected (Gallons)	Chemical/quantities	Injection Date	Time Start	Time Finished
INJ-53	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/19/2015	13:49	15:37
INJ-54	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	9:00	11:40
INJ-55	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	14:34	15:32
INJ-56	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	16:24	17:30
INJ-57	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack Bromide - 6.5 lbs	5/18/2015	16:24	17:26
INJ-58	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/18/2015	14:35	15:34
INJ-59	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/19/2015	14:50	16:59
INJ-60	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/19/2015	9:55	11:30
INJ-61	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/18/2015	15:40	17:24
INJ-62	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/22/2015	9:11	10:44
INJ-63	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/22/2015	13:20	15:00
INJ-64	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/23/2015	8:43	10:47
INJ-65	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/22/2015	12:08	14:10
INJ-66	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/22/2015	8:48	10:18
INJ-67	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	12:57	15:30
INJ-68	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	8:47	10:43
INJ-69	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	11:43	13:45
INJ-70	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	13:57	15:53
INJ-71	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	10:49	13:08

Table 2.3

ISCR Injection Summary
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Injection ID	Depth Interval (Ft BGS)	Contractor/Method	Amount Injected (Gallons)	Chemical/quantities	Injection Date	Time Start	Time Finished
INJ-72	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/20/2015	14:12	16:14
INJ-73	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/21/2015	8:28	11:58
INJ-74	15'-25'	GHD/42"Screen	900	Sulfide - 2000 lbs 1 supersack	5/22/2015	8:08	10:13
INJ-75	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/18/2015	11:28	13:45
INJ-76	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/19/2015	10:18	11:00
INJ-77	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/19/2015	9:09	9:50
INJ-78	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/19/2015	8:13	8:56
INJ-79	15'-25'	Superior	900	Sulfide - 2000 lbs 1 supersack	5/18/2015	11:32	13:50
INJ-80	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/19/2015	13:32	15:42
INJ-81	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/19/2015	8:40	10:37
INJ-82	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/18/2015	13:53	15:31
INJ-83	15'-25'	GHD/42"Screen	840	Dithionite-1320 lbs 6 drums	6/29/2015	10:10	12:40

Notes:
20% Sodium Dithionite = 1335 lbs of Sodium Dithionite (6 drums) + 800 gallons of water
29% Sodium Sulfide = 1935 lbs of sodium sulfide (1 super sack - 2000 lbs) + 800 gallons of water
0.1% Sodium Bromide = 6.7 lbs Sodium Bromide in select injection points

Table 3.1

Electrical Conductivity Boring Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

ISCO Injection Point Location	ISCO Injection Tool Type	Injection Interval (ft bgs)	Solution Volume (Gallons)	EC Boring Location	EC Boring Distance From ISCO Injection Point (ft)	Depth Interval EC Boring Detected Sodium (ft bgs)	Max EC reading ($mS/m \times 10^3$)
INJ-75	Badger	25-15	900	75-5W.EC	5 feet West	18-22	2.5-2.8
				75-10S.EC	10 feet South	20-22	2.2
				75-10W.EC	10 feet West	22-25	0.09
				75-5E.EC	5 feet East	21	1.5
				75-15S.EC	15 feet South	11-15	0.02-0.03
				75-15S.EC	15 feet South	24-25	0.09
INJ-79	Badger	25-15	900	79-5S.EC	5 feet South	19-23	2.4-3.2
				79-7.5S.EC	7.5 feet South	19.5-23	0.45-0.9
				79-10S.EC	10 feet South	10-16	0.025-.035
				79-10S.EC	10 feet South	22-25	.06-.1
				79-15S.EC	15 feet South	10-16	0.03
				79-15S.EC	15 feet South	24-25	0.075-.08
INJ-17	Badger	25-15	900	17-10N.EC	10 feet North	21-22	3
				17-10W.EC	10 feet West	1-3	0.028-0.049
				17-10W.EC	10 feet West	24-25	0.07
INJ-33	GHD	25-15	900	33-5E.EC	5 feet East	18-19	0.3
				33-5E.EC	5 feet East	24-25	1.15
				33-10E.EC	10 feet East	24-25	0.75
INJ-53	GHD	25-15	900	53-5S.EC	5 feet South	21-22	2.4
				53-5S.EC	5 feet South	23-24	1.8
				53-10S.EC	10 feet South	8-14	0.02-0.039
				53-10S.EC	10 feet South	22-25	0.03-0.079

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		MW-23D-12	MW-23D-12	MW-23D-12	MW-23D-12	MW-25D-12	MW-25D-12	MW-25D-12	MW-25D-12	MW-26D-12	MW-26D-12
Sample ID:		GW-12607-051315-DC-025	GW-12607-070615-SK-003	GW-012607-072015-DT-004	GW-12607-090315-EM-023	GW-12607-051315-DC-015	GW-012607-061915-DT-009	GW-12607-070615-SK-008	GW-12607-090315-EM-024	GW-12607-051215-DC-009	GW-12607-052815-DR-011
Sample Date:		5/13/2015	7/6/2015	7/20/2015	9/3/2015	5/13/2015	6/19/2015	7/6/2015	9/3/2015	5/12/2015	5/28/2015
Event:		Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection
Parameters	**Units**										
Field Parameters											
Conductivity, field	umhos/cm	1.047	46.6	10.68	10	1.224	14.11	6.8	15	1.15	98.3
Dissolved oxygen (DO), field	mg/L	0.86	0.05	-0.2	0.38	0.2	0.02	0.05	0.82	0.1	0
Oxidation reduction potential (ORP), field	millivolts	104	-679	-499.8	-728	112	-587	-616	-637	-34	-742
pH, field	S.U.	7.28	13.19	11.66	13.35	6.96	11.01	12.49	12.43	7.06	13.46
Temperature, field	Deg C	12.12	18.3	21.95	21.62	11.91	17.71	18.91	22.02	12	14.05
Turbidity, field	NTU	0.32	10.9	3.97	162	4.79	9.21	8.08	27.9	0.75	14.7
Metals											
Chromium	ug/L	43000	200	50 U	110	1500	11	11	6.8	5.0 U	5.0 U
Chromium (dissolved)	ug/L	43000	11	50 U	9.1	1500	22	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	22	0.0050 U	0.050 U	0.050 U	0.36	0.011	0.011	0.0068	0.0050 U	0.0050 U
Chromium VI (hexavalent)	mg/L	21	17	2.2	12	1.1	0.050 U	0.50 U	5.0 U	0.0050 U	5.0 U
Iron	ug/L	180	6300	1500	2200	100 U	170	300	110	1100	2200
Iron (dissolved)	ug/L	100 U	6000	1200	2600	100 U	130	100 U	100 U	920	100 U
Manganese	ug/L	500	15 U	150 U	150 U	120	15 U	15 U	61	130	15 U
Manganese (dissolved)	ug/L	520	15 U	150 U	15 U	130	15 U	15 U	15 U	140	15 U
Nickel	ug/L	170	90	400 U	420	1400	41	82	92	12000	1700
Nickel (dissolved)	ug/L	180	69	400 U	210	1400	41	40 U	250	12000	960
Sodium	ug/L	45000	11000000	3500000	33000000	85000	1900000	1300000	3400000	60000	16000000
Sodium (dissolved)	ug/L	45000	13000000	3400000	23000000	86000	2100000	1400000	8800000	62000	11000000
General Chemistry											
Bromide	mg/L	0.50 U	62	50 U	140	0.50 U	25 U	50 U	50 U	0.50 U	50 U
Sulfate	mg/L	31	1000	330	1700	200	400	380	670	410	6100
Sulfide	mg/L	3.0 U	6600	3000 U	150000	3.0 U	3000 U	3000 U	30000 U	3.0 U	13000

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-26D-12**	**MW-26D-12**	**MW-27D-12**	**MW-27D-12**	**MW-27D-12**	**MW-27D-12**	**MW-27D-12**	**MW-27D-12**	**MW-28D-12**	**MW-28D-12**
Sample ID:		**GW-12607-061115-SK-019**	**GW-12607-090115-EM-010**	**GW-12607-051315-DC-027**	**GW-12607-070615-SK-002**	**GW-012607-072015-DT-006**	**GW-012607-072015-DT-007**	**GW-12607-090215-EM-013**	**GW-12607-090215-EM-014**	**GW-12607-051415-DC-034**	**GW-12607-052815-DR-014**
Sample Date:		**6/11/2015**	**9/1/2015**	**5/13/2015**	**7/6/2015**	**7/20/2015**	**7/20/2015**	**9/2/2015**	**9/2/2015**	**5/14/2015**	**5/28/2015**
Event:		**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Week Post Injection (Duplicate)**	**3-Month Post Injection**	**3-Month Post Injection (Duplicate)**	**Baseline**	**1-Week Post Injection**
Parameters	**Units**										
Field Parameters											
Conductivity, field	umhos/cm	4.66	10	1.62	1.185	1.285	1.285	1.81	1.81	1.69	1.66
Dissolved oxygen (DO), field	mg/L	4.31	0.2	0.43	0.09	0.39	0.39	0.39	0.39	0.22	0.62
Oxidation reduction potential (ORP), field	millivolts	-519.8	-725	108	120	13.9	13.9	136	136	115	-96
pH, field	S.U.	11.38	13.41	7.16	6.92	6.9	6.9	6.91	6.91	7.39	7.23
Temperature, field	Deg C	16.6	22.09	12.5	18.1	21.4	21.4	19.87	19.87	13.38	15.77
Turbidity, field	NTU	61.2	63.5	5.67	4.03	2.88	2.88	-	-	0.62	5.62
Metals											
Chromium	ug/L	5.0 U	6.6	140000	77000	170000	99000	120000	120000	17000	15000
Chromium (dissolved)	ug/L	34	5.0 U	150000	73000	89000	93000	130000	110000	16000	14000
Chromium III (trivalent)	mg/L	0.0050 U	0.0050 U	15	4.0	30	0.050 U	37	24	17	5.5
Chromium VI (hexavalent)	mg/L	0.50 U	5.2	130	73	140	170	86	92	0.024 H	9.1 H
Iron	ug/L	100 U	780	470	250	1000 U	1000 U	1000 U	1000 U	100 U	100 U
Iron (dissolved)	ug/L	2900	450	100 U	100 U	1000 U	1000 U	1000 U	1000 U	100 U	100 U
Manganese	ug/L	15 U	31	400	480	470	520	640	620	150	150
Manganese (dissolved)	ug/L	48	15 U	430	470	500	500	620	600	150	160
Nickel	ug/L	40 U	5700	760	540	900	630	650	630	360	340
Nickel (dissolved)	ug/L	1000	3800	720	520	580	600	680	590	340	340
Sodium	ug/L	1200000	26000000	100000	72000	88000	73000	130000	120000	140000	130000
Sodium (dissolved)	ug/L	1200000	27000000	99000	70000	68000	69000	120000	110000	130000	110000
General Chemistry											
Bromide	mg/L	50 U	50 U	0.50 U	50 U	50 U	50 U	50 U	50 U	0.50 U	50 U
Sulfate	mg/L	480	8100	83	100 U	100 U	100 U	120	110	310	230
Sulfide	mg/L	3000 U	15000	3.0 U	3000 U	3000 U	3000 U	3000 U	3000 U	3.0 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		MW-28D-12	MW-28D-12	MW-29D-12	MW-29D-12	MW-29D-12	MW-29D-12	MW-29D-12	MW-30D-12	MW-30D-12	MW-30D-12	MW-30D-12
Sample ID:		GW-12607-060915-SK-007	GW-12607-090115-EM-012	GW-12607-051215-DC-002	GW-12607-052915-EM-018	GW-12607-052915-EM-019	GW-12607-060915-SK-002	GW-12607-090115-EM-011	GW-12607-051215-DC-001	GW-12607-052915-EM-017	GW-12607-060915-SK-001	GW-12607-091015-SK-001
Sample Date:		6/9/2015	9/1/2015	5/12/2015	5/29/2015	5/29/2015	6/9/2015	9/1/2015	5/12/2015	5/29/2015	6/9/2015	9/10/2015
Event:		3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	3-Week Post Injection (Duplicate)	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	1.48	1.546	2.82	3.16	3.16	3.06	2.71	2.51	2.71	2.14	2.551
Dissolved oxygen (DO), field	mg/L	0.27	1.62	0	0	0	0.18	0.43	0	0	0.2	0.64
Oxidation reduction potential (ORP), field	millivolts	-89	32.5	10	39.9	39.9	104.9	-213	-40	27.6	-43.6	-23.4
pH, field	S.U.	7.18	6.96	5.23	6.57	6.57	6.65	6.6	6.56	6.46	6.62	6.55
Temperature, field	Deg C	16.6	19.54	13.15	16.6	16.6	18.1	20.61	13.22	17.54	17	22.62
Turbidity, field	NTU	5.62	3.07	2.33	1.72	1.72	1.59	1.45	0.73	2.02	1.32	2
Metals												
Chromium	ug/L	17000	15000	28	24	23	43	17	5.0 U	5.0 U	5.0 U	5.0 U
Chromium (dissolved)	ug/L	15000	6000	15	5.0 U	5.0 U	30	13	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	1.6	5.9	0.022	0.024	0.023	0.043	0.017	0.0050 U	0.0050 U	0.0050 U	0.0050 U
Chromium VI (hexavalent)	mg/L	15	8.7	0.0067	5.0 U	5.0 U	0.50 U	0.050 U	0.0050 U	5.0 U	0.50 U	0.050 U
Iron	ug/L	100 U	100 U	340	260	260	290	440	6400	9300	7500	7900
Iron (dissolved)	ug/L	100 U	100 U	290	100 U	100 U	230	370	6500	100 U	7300	8000
Manganese	ug/L	140	150	1400	1400	1300	1600	1200	830	1200	920	910
Manganese (dissolved)	ug/L	130	170	1400	1300	1300	1600	1100	860	1000	900	920
Nickel	ug/L	390	360	7000	6900	6300	7600	5800	100000	170000	120000	57000
Nickel (dissolved)	ug/L	330	260	7000	6300	6200	7200	5300	110000	140000	110000	56000
Sodium	ug/L	160000	140000	180000	180000	150000	200000	150000	120000	140000	110000	110000
Sodium (dissolved)	ug/L	150000	120000	190000	160000	160000	190000	150000	130000	110000	110000	110000
General Chemistry												
Bromide	mg/L	50 U	50 U	0.50 U	500 U	500 U	50 U	50 U	0.50 U	500 U	50 U	50 U
Sulfate	mg/L	300	260	1600	1000 U	1000 U	1200	770	770	1000 U	720	720
Sulfide	mg/L	30000 U	3000 U	3.0 U	3000 U	3000 U	30000 U	3000 U	3.0 U	3000 U	30000 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		MW-35D-13	MW-35D-13	MW-35D-13	MW-35D-13	MW-35D-13	MW-40D-13	MW-40D-13	MW-40D-13	MW-40D-13	MW-42D-15	MW-42D-15
Sample ID:		GW-12607-051315-DC-016	GW-12607-052915-EM-016	GW-12607-060915-SK-008	GW-12607-090315-EM-029	GW-12607-090315-EM-030	GW-12607-051215-DC-008	GW-12607-052915-EM-015	GW-12607-060915-SK-009	GW-12607-083115-EM-005	GW-12607-051415-DC-032	GW-012607-061815-DT-002
Sample Date:		5/13/2015	5/29/2015	6/9/2015	9/3/2015	9/3/2015	5/12/2015	5/29/2015	6/9/2015	8/31/2015	5/14/2015	6/18/2015
Event:		Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	3-Month Post Injection (Duplicate)	Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	0.84	6.44	1.07	0.941	0.941	0.707	1.03	0.65	0.622	0.668	11.5
Dissolved oxygen (DO), field	mg/L	0.08	0	0.32	0.39	0.39	0.1	0.01	0.34	0.15	0.28	0.55
Oxidation reduction potential (ORP), field	millivolts	11.5	-441.1	-215.7	-502	-502	-143	17.2	-197.5	-99	158	-470
pH, field	S.U.	7.18	12.23	10.72	9.68	9.68	7.29	7.05	7.32	7.12	7.25	10.69
Temperature, field	Deg C	11.2	15.53	16.8	19.69	19.69	11.92	16.62	16.1	20.44	11.29	20.05
Turbidity, field	NTU	1.72	4.02	8	138	138	2.78	4.75	13.2	1.78	2.44	79
Metals												
Chromium	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	14000	24000
Chromium (dissolved)	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	14000	30000
Chromium III (trivalent)	mg/L	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	14	24
Chromium VI (hexavalent)	mg/L	0.0050 U	5.0 U	0.50 U	0.50 U	0.50 U	0.0067	5.0 U	0.50 U	0.10 H	0.015 H	0.50 U
Iron	ug/L	110	100 U	100 U	570	570	1200	1800	1700	1400	100 U	6200
Iron (dissolved)	ug/L	100 U	100 U	100 U	200	140	800	100 U	980	1300	100 U	9300
Manganese	ug/L	250	15 U	39	130	130	58	92	66	68	180	190
Manganese (dissolved)	ug/L	240	15 U	20	19	68	58	87	58	72	180	250
Nickel	ug/L	11000	69	51	40 U	40 U	2600	4800	3100	3300	180	840
Nickel (dissolved)	ug/L	11000	40 U	40 U	40 U	40 U	2600	4300	2700	3500	190	1100
Sodium	ug/L	13000	1000000	230000	250000	320000	64000	94000	77000	60000	18000	2500000
Sodium (dissolved)	ug/L	12000	940000	220000	290000	230000	64000	82000	70000	65000	18000	2800000
General Chemistry												
Bromide	mg/L	0.50 U	500 U	50 U	50 U	50 U	0.50 U	500 U	50 U	50 U	0.50 U	50 U
Sulfate	mg/L	200	1000 U	100 U	100 U	100 U	41	1000 U	100 U	100 U	12	560
Sulfide	mg/L	3.0 U	3000 U	30000 U	30000 U	30000 U	3.0 U	3000 U	30000 U	3000 U	3.0 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		MW-42D-15	MW-42D-15	MW-43D-15	MW-43D-15	MW-43D-15	MW-43D-15	MW-43D-15	MW-44D-15	MW-44D-15	MW-44D-15	MW-44D-15
Sample ID:		GW-12607-070715-SK-009	GW-12607-090115-EM-008	GW-12607-051415-DC-028	GW-12607-051415-DC-029	GW-012607-061815-DT-004	GW-12607-070715-SK-010	GW-12607-083115-EM-001	GW-12607-051415-DC-030	GW-012607-061815-DT-001	GW-12607-070715-SK-012	GW-12607-070715-SK-013
Sample Date:		7/7/2015	9/1/2015	5/14/2015	5/14/2015	6/18/2015	7/7/2015	8/31/2015	5/14/2015	6/18/2015	7/7/2015	7/7/2015
Event:		3-Week Post Injection	3-Month Post Injection	Baseline	Baseline (Duplicate)	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	3-Week Post Injection	3-Week Post Injection (Duplicate)
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	5.92	4.475	0.831	0.831	23.6	3.21	11.11	0.89	1.235	3.21	3.21
Dissolved oxygen (DO), field	mg/L	0.18	0.37	0.63	0.63	0.34	0	0.16	0.33	0.09	0.12	0.12
Oxidation reduction potential (ORP), field	millivolts	-533	-430	170	170	-656	-653	-558.6	252	-85	-435	-435
pH, field	S.U.	10.76	11.02	7.16	7.16	12.79	13.07	12.41	6.93	8.49	10.35	10.35
Temperature, field	Deg C	18.62	19.69	12.48	12.48	20.3	17.83	18.78	11.9	18.5	15.81	15.81
Turbidity, field	NTU	14.3	76	6.18	6.18	112	13.6	17.4	5.51	525	538	538
Metals												
Chromium	ug/L	21000	50000	66000	65000	770	1500	4600	61000	21000	64000	59000
Chromium (dissolved)	ug/L	24000	48000	69000	67000	6000	550	2100	60000	30000	52000	46000
Chromium III (trivalent)	mg/L	21	43	66	65	0.77	1.5	4.6	61	12	38	32
Chromium VI (hexavalent)	mg/L	0.50 U	6.7	0.093 H	0.19 H	0.50 U	0.50 U	5.0 UH	0.084 H	9.3	25	26
Iron	ug/L	3300	2800	100 U	100 U	100 U	2600	2300	100 U	240	1100	1000
Iron (dissolved)	ug/L	1400	1500	100 U	100 U	390	910	750	100 U	760	310	100
Manganese	ug/L	120	93	220	220	15 U	99	110	180	21	29	26
Manganese (dissolved)	ug/L	130	79	220	220	16	35	41	170	60	15 U	15 U
Nickel	ug/L	510	790	480	480	320	1400	840	240	290	650	600
Nickel (dissolved)	ug/L	280	270	470	470	930	770	240	230	470	310	210
Sodium	ug/L	1500000	1200000	19000	19000	8600000	5000000	2800000	24000	230000	760000	710000
Sodium (dissolved)	ug/L	1800000	1200000	19000	19000	8700000	5900000	3000000	23000	250000	750000	660000
General Chemistry												
Bromide	mg/L	50 U	50 U	0.50 U	0.50 U	92	57	50 U	0.50 U	50 U	50 U	50 U
Sulfate	mg/L	220	140	37	40	1100	1200	630	39	100 U	120	120
Sulfide	mg/L	3000 U	3000 U	3.0 U	3.0 U	4000	3000 U	3000 U	3.0 U	3000 U	3000 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-44D-15**	**MW-45D-15**	**MW-45D-15**	**MW-45D-15**	**MW-45D-15**	**MW-46D-15**	**MW-46D-15**	**MW-46D-15**	**MW-46D-15**	**MW-47D-15**	**MW-47D-15**
Sample ID:		**GW-12607-090115-EM-007**	**GW-12607-051415-DC-031**	**GW-012607-061815-DT-003**	**GW-12607-070715-SK-011**	**GW-12607-090115-EM-006**	**GW-12607-051315-DC-023**	**GW-12607-070615-SK-004**	**GW-012607-072015-DT-003**	**GW-12607-090215-EM-017**	**GW-12607-051415-DC-033**	**GW-12607-070615-SK-005**
Sample Date:		**9/1/2015**	**5/14/2015**	**6/18/2015**	**7/7/2015**	**9/1/2015**	**5/13/2015**	**7/6/2015**	**7/20/2015**	**9/2/2015**	**5/14/2015**	**7/6/2015**
Event:		**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	2.764	0.936	15.1	1.51	1.733	0.755	0.833	0.821	3.344	0.872	4.19
Dissolved oxygen (DO), field	mg/L	0.09	0.36	0.36	0.13	0.24	0.51	0.06	0.02	0.76	0.41	0.07
Oxidation reduction potential (ORP), field	millivolts	-313.5	187	-597	-292	140.5	122	-433	-261.8	-413.4	123	-525
pH, field	S.U.	9.62	6.71	11.25	9.52	8.34	6.89	9.55	7.61	8.95	6.89	10.99
Temperature, field	Deg C	19.92	11.74	19.51	16.24	18.6	11.74	20.03	23.39	19.82	12.48	18.27
Turbidity, field	NTU	134	3.35	569	21.7	34.7	3.03	6.5	4.72	51	6.87	4.12
Metals												
Chromium	ug/L	200000	87000	59000	53000	88000	6600	250	48	38	32000	380
Chromium (dissolved)	ug/L	170000	86000	79000	57000	80000	6400	16	5.0 U	8.9	32000	220
Chromium III (trivalent)	mg/L	23	87	59	6.1	79	3.9	0.25	0.048	0.038	32	0.38
Chromium VI (hexavalent)	mg/L	180	0.15 H	0.50 U	47	8.7	2.7	0.50 U	0.50 U	0.50 U	0.050 H	0.50 U
Iron	ug/L	1000 U	100 U	100 U	870	1000	190	520	470	1700	100 U	100 U
Iron (dissolved)	ug/L	1000 U	100 U	160	540	1000 U	100 U	100 U	100 U	100 U	100 U	100 U
Manganese	ug/L	150 U	150	15 U	110	150 U	420	230	710	790	360	15 U
Manganese (dissolved)	ug/L	150 U	140	40	81	150 U	440	250	690	750	370	15 U
Nickel	ug/L	400 U	360	110	40 U	400 U	110	40 U	40 U	40 U	260	96
Nickel (dissolved)	ug/L	400 U	350	180	40 U	400 U	110	40 U	40 U	40 U	270	40 U
Sodium	ug/L	650000	24000	6900000	120000	740000	34000	140000	83000	610000	26000	940000
Sodium (dissolved)	ug/L	610000	25000	5000000	130000	800000	36000	110000	84000	2000000	26000	920000
General Chemistry												
Bromide	mg/L	50 U	0.50 U	50 U	50 U	50 U	0.50 U	50 U	50 U	50 U	0.50 U	50 U
Sulfate	mg/L	190	37	910	100 U	260	22	100 U	100 U	360	21	100
Sulfide	mg/L	3000 U	3.0 U	4000	3000 U	3000 U	3.0 U	3000 U	3000 U	3000 U	3.0 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-47D-15**	**MW-47D-15**	**MW-48D-15**	**MW-48D-15**	**MW-48D-15**	**MW-48D-15**	**MW-49D-15**	**MW-49D-15**	**MW-49D-15**	**MW-49D-15**	**MW-49D-15**
Sample ID:		**GW-012607-072015-DT-002**	**GW-12607-090215-EM-015**	**GW-12607-051315-DC-024**	**GW-12607-070615-SK-006**	**GW-012607-072015-DT-001**	**GW-12607-090215-EM-016**	**GW-12607-051315-DC-022**	**GW-12607-070615-SK-007**	**GW-012607-072015-DT-005**	**GW-12607-090215-EM-020**	**GW-12607-090215-EM-021**
Sample Date:		**7/20/2015**	**9/2/2015**	**5/13/2015**	**7/6/2015**	**7/20/2015**	**9/2/2015**	**5/13/2015**	**7/6/2015**	**7/20/2015**	**9/2/2015**	**9/2/2015**
Event:		**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**3-Month Post Injection (Duplicate)**
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	1.14	2.075	0.786	0.778	0.988	1.176	0.75	9.33	2.404	2.207	2.207
Dissolved oxygen (DO), field	mg/L	0.02	2.34	0.53	0.2	0.08	1.65	0.15	0.04	-0.02	0.78	0.78
Oxidation reduction potential (ORP), field	millivolts	-285.4	-240.7	101	-360	-257	-280.8	-219	-611	-455.4	-369.5	-369.5
pH, field	S.U.	8.9	7.33	7.17	7.81	7.01	7.53	7.04	12.28	11.19	8.87	8.87
Temperature, field	Deg C	22.77	20.98	11.38	17.79	19.8	20.63	11.5	18.43	22.98	20.28	20.28
Turbidity, field	NTU	11.7	100	4.11	6.6	31.3	3.88	3.4	4.97	2.6	2.5	2.5
Metals												
Chromium	ug/L	370	2900	21000	720	430	450	2300	12	9.1	5.6	5.0 U
Chromium (dissolved)	ug/L	130	1700	21000	120	17	79	2200	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	0.37	2.9	0.093	0.72	0.43	0.0050 U	0.79	0.012	0.0091	0.0056	0.0050 U
Chromium VI (hexavalent)	mg/L	0.50 U	0.10 U	20	0.50 U	0.50 U	1.7	1.5	0.50 U	0.50 U	0.050 U	0.050 U
Iron	ug/L	180	1500	550	2900	4900	1100	560	100 U	100 U	100 U	100 U
Iron (dissolved)	ug/L	100 U	110	100 U	790	3200	130	210	100 U	100 U	100 U	100 U
Manganese	ug/L	280	710	470	700	720	380	490	15 U	15 U	61	56
Manganese (dissolved)	ug/L	200	750	480	660	730	390	490	15 U	15 U	62	58
Nickel	ug/L	40 U	55	220	40 U	46	40 U	120	40 U	40 U	40 U	40 U
Nickel (dissolved)	ug/L	40 U	40 U	220	40 U	40 U	40 U	120	40 U	40 U	40 U	40 U
Sodium	ug/L	200000	330000	24000	55000	92000	290000	38000	2000000	500000	450000	430000
Sodium (dissolved)	ug/L	200000	340000	25000	57000	93000	210000	39000	2000000	510000	430000	560000
General Chemistry												
Bromide	mg/L	50 U	50 U	0.50 U	50 U	50 U	50 U	0.50 U	50 U	50 U	50 U	50 U
Sulfate	mg/L	100 U	100 U	19	100 U	100 U	100 U	17	140	100 U	180	130
Sulfide	mg/L	3000 U	3000 U	3.0 U	3000 U	3000 U	3000 U	3.0 U	3000 U	3000 U	3000 U	3000 U

<u>Notes</u>:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-50D-15**	**MW-50D-15**	**MW-50D-15**	**MW-50D-15**	**MW-51D-15**	**MW-51D-15**	**MW-51D-15**	**MW-51D-15**	**MW-51D-15**	**MW-52D-15**	**MW-52D-15**
Sample ID:		**GW-12607-051315-DC-019**	**GW-012607-061915-DT-007**	**GW-12607-070715-SK-015**	**GW-12607-090315-EM-033**	**GW-12607-051315-DC-020**	**GW-12607-051315-DC-021**	**GW-012607-061915-DT-005**	**GW-12607-070715-SK-014**	**GW-12607-090315-EM-034**	**GW-12607-051315-DC-017**	**GW-012607-061915-DT-008**
Sample Date:		**5/13/2015**	**6/19/2015**	**7/7/2015**	**9/3/2015**	**5/13/2015**	**5/13/2015**	**6/19/2015**	**7/7/2015**	**9/3/2015**	**5/13/2015**	**6/19/2015**
Event:		**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**Baseline (Duplicate)**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	0.83	0.926	1.587	5.897	0.866	0.866	2.08	16.12	12.11	0.822	0.896
Dissolved oxygen (DO), field	mg/L	0.11	0.12	-0.6	0.48	0.223	0.223	0.81	-0.5	0.17	0.29	0.11
Oxidation reduction potential (ORP), field	millivolts	-40	-442	-364.2	-580.1	-34	-34	-411	-520.9	-611	-40	-320
pH, field	S.U.	7.03	9.57	8.84	11.21	7.2	7.2	8.04	12.78	12.72	7.31	7.92
Temperature, field	Deg C	11.3	21.69	15.9	18.78	11.35	11.35	17.73	16.34	19.04	11.08	18.8
Turbidity, field	NTU	9.45	76.9	5.54	55.5	4.75	4.75	273	14.7	10	1.27	5.22
Metals												
Chromium	ug/L	590	16	36	15	920	1000	7800	370	230	1000	60
Chromium (dissolved)	ug/L	220	5.0 U	20	9.4	830	800	4000	43	6.4	960	35
Chromium III (trivalent)	mg/L	0.22	0.016	0.036	0.015	0.33	0.41	7.5	0.0050 U	0.0050 U	0.0050 U	0.048
Chromium VI (hexavalent)	mg/L	0.0067	0.0050 U	0.50 U	5.0 U	0.60	0.60	0.27 H	11	0.40	8.6	0.012
Iron	ug/L	2000	230	750	690	1000	980	850	960	160	210	760
Iron (dissolved)	ug/L	770	100 U	250	190	350	350	430	100 U	100 U	100 U	390
Manganese	ug/L	390	150	240	270	750	770	430	160	15 U	470	550
Manganese (dissolved)	ug/L	400	82	220	79	730	750	250	15 U	15 U	460	520
Nickel	ug/L	4600	40 U	40 U	40 U	490	520	480	110	82	1100	40 U
Nickel (dissolved)	ug/L	4900	40 U	40 U	40 U	490	490	270	70	40 U	930	40 U
Sodium	ug/L	37000	170000	310000	1400000	22000	23000	350000	3100000	2100000	42000	100000
Sodium (dissolved)	ug/L	37000	170000	300000	1600000	21000	22000	390000	3300000	2000000	42000	100000
General Chemistry												
Bromide	mg/L	0.50 U	1.1	50 U	50 U	0.50 U	0.50 U	2.5 U	50 U	50 U	0.50 U	0.50 U
Sulfate	mg/L	50	21	100 U	200	9.1	9.1	44	1300	250	33	49
Sulfide	mg/L	3.0 U	3000 U	3000 U	30000 U	3.0 U	3.0 U	3000 U	3000 U	30000 U	3.0 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		MW-52D-15	MW-52D-15	MW-53D-15	MW-53D-15	MW-53D-15	MW-53D-15	MW-54D-15	MW-54D-15	MW-54D-15	MW-54D-15	MW-54D-15
Sample ID:		GW-12607-070715-SK-017	GW-12607-090315-EM-031	GW-12607-051315-DC-018	GW-012607-061915-DT-006	GW-12607-070715-SK-016	GW-12607-090315-EM-032	GW-12607-051315-DC-011	GW-12607-052715-DR-005	GW-12607-052715-DR-006	GW-12607-061015-SK-011	GW-12607-090315-EM-028
Sample Date:		7/7/2015	9/3/2015	5/13/2015	6/19/2015	7/7/2015	9/3/2015	5/13/2015	5/27/2015	5/27/2015	6/10/2015	9/3/2015
Event:		3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	3-Week Post Injection	3-Month Post Injection	Baseline	1-Week Post Injection	1-Week Post Injection (Duplicate)	3-Week Post Injection	3-Month Post Injection
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	0.812	0.696	0.835	1.094	0.823	0.82	0.813	85.5	85.5	7.14	9.02
Dissolved oxygen (DO), field	mg/L	0.35	0.36	0.36	0.57	-0.7	0.19	0.24	0	0	0.45	0.5
Oxidation reduction potential (ORP), field	millivolts	-337	-283	22	-389	-313.9	-393	-10	-738	-738	-606.3	-572.8
pH, field	S.U.	7.64	7.11	6.91	7.91	8.63	7.64	7.33	13.55	13.55	12.13	12.41
Temperature, field	Deg C	16.34	18.79	11.36	16.63	15.6	18.06	11.35	15.08	15.08	17.6	17.56
Turbidity, field	NTU	2.49	21.2	6.71	70.1	11.7	5.11	0.66	4.29	4.29	11.1	4.92
Metals												
Chromium	ug/L	27	13	370	650	130	29	5.0 U	5.0 U	5.0 U	14	5.0 U
Chromium (dissolved)	ug/L	13	5.0 U	220	94	21	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	0.027	0.013	0.24	0.65	0.13	0.029	0.0050 U	0.0050 U	0.0050 U	0.014	0.0050 U
Chromium VI (hexavalent)	mg/L	0.50 U	0.050 U	0.13	0.050 UH	0.50 U	0.050 U	0.0050 U	5.0 U	5.0 U	0.50 U	0.50 U
Iron	ug/L	1600	1800	700	620	350	2000	100 U	100 U	100 U	450	100 U
Iron (dissolved)	ug/L	1400	1700	260	110	100 U	100 U	100 U	100 U	100 U	100 U	100 U
Manganese	ug/L	600	480	520	230	180	350	210	15 U	15 U	31	15 U
Manganese (dissolved)	ug/L	590	490	520	200	170	370	210	15 U	15 U	15 U	15 U
Nickel	ug/L	40 U	55	1700	98	41	40 U	7100	40 U	40 U	160	40 U
Nickel (dissolved)	ug/L	40 U	40 U	1800	47	40 U	40 U	7100	40 U	40 U	40 U	40 U
Sodium	ug/L	65000	58000	50000	200000	150000	81000	37000	12000000	13000000	2200000	1900000
Sodium (dissolved)	ug/L	64000	56000	48000	200000	150000	76000	37000	12000000	11000000	2300000	1500000
General Chemistry												
Bromide	mg/L	50 U	50 U	0.50 U	2.5 U	50 U	50 U	0.50 U	500 U	500 U	50 U	50 U
Sulfate	mg/L	100 U	100 U	39	27	100 U	100 U	170	1000 U	1000 U	240	270
Sulfide	mg/L	3000 U	30000 U	3.0 U	3000 U	3000 U	30000 U	3.0 U	45000	13000	5900	30000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-55D-15**	**MW-55D-15**	**MW-55D-15**	**MW-55D-15**	**MW-56D-15**	**MW-56D-15**	**MW-56D-15**	**MW-56D-15**	**MW-57D-15**	**MW-57D-15**	**MW-57D-15**
Sample ID:		**GW-12607-051315-DC-010**	**GW-12607-052715-DR-007**	**GW-12607-061015-SK-013**	**GW-12607-090315-EM-025**	**GW-12607-051315-DC-014**	**GW-12607-052715-DR-008**	**GW-12607-061015-SK-010**	**GW-12607-090315-EM-027**	**GW-12607-051315-DC-012**	**GW-12607-051315-DC-013**	**GW-12607-052715-DR-009**
Sample Date:		**5/13/2015**	**5/27/2015**	**6/10/2015**	**9/3/2015**	**5/13/2015**	**5/27/2015**	**6/10/2015**	**9/3/2015**	**5/13/2015**	**5/13/2015**	**5/27/2015**
Event:		**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**Baseline (Duplicate)**	**1-Week Post Injection**
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	1.116	74	13.92	6.83	1.083	99.9	41.9	7.09	1.18	1.18	10.01
Dissolved oxygen (DO), field	mg/L	0.29	0.01	0.17	0.75	1.86	0	0.58	0.46	0.12	0.12	0.07
Oxidation reduction potential (ORP), field	millivolts	-171	-701	-626.4	-482.5	-18	-775	-583.6	-530.2	-241	-241	-746
pH, field	S.U.	6.9	12.41	12.77	11.22	7.29	13.9	13.07	10.75	7.13	7.13	12.57
Temperature, field	Deg C	11.44	16.61	16.1	19.6	12.61	14.09	18	19.52	11.5	11.5	15.95
Turbidity, field	NTU	1.76	3.74	16.8	19	1.16	3.4	15.7	4.54	1.78	1.78	5.35
Metals												
Chromium	ug/L	5.0 U	5.0 U	18	21	5.0 U	5.06 J	31	8.2	5.0 U	5.0 U	0.553 J
Chromium (dissolved)	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	9.08 J	5.0 U	5.0 U	5.0 U	5.0 U	3.62 J
Chromium III (trivalent)	mg/L	0.0050 U	0.0050 U	0.018	0.021	0.0050 U	5.0 U	0.031	0.0082	0.0050 U	0.0050 U	5.0 U
Chromium VI (hexavalent)	mg/L	0.0050 U	5.0 U	0.50 U	0.50 U	0.0050 U	5.0 U	0.50 U	0.050 U	0.0050 U	0.0050 U	5.0 U
Iron	ug/L	100 U	100 U	130	300	100 U	75.0 J	190	100 U	100 U	100 U	43.3 J
Iron (dissolved)	ug/L	100 U	100 U	100 U	100 U	100 U	100	100 U	100 U	100 U	100 U	64.1 J
Manganese	ug/L	340	15 U	27	56	240	20.7 J	28	66	480	500	36.6 J
Manganese (dissolved)	ug/L	410	15 U	15 U	22	240	0.12 J	15 U	92	490	490	17.9 J
Nickel	ug/L	19000	40 U	130	570	6000	50 U	270	230	5800	6000	50 U
Nickel (dissolved)	ug/L	18000	40 U	40 U	40	5800	50 U	140	87	5800	5900	50 U
Sodium	ug/L	30000	10000000	2800000	1900000	50000	42700000 B	9100000	2800000	60000	61000	64100000 B
Sodium (dissolved)	ug/L	40000	12000000	2900000	1600000	52000	45400000 B	9400000	1800000	61000	61000	61700000 B
General Chemistry												
Bromide	mg/L	0.50 U	500 U	50 U	50 U	0.50 U	500 U	51	50 U	0.50 U	0.50 U	500 U
Sulfate	mg/L	350	1500	310	330	240	11000	510	510	370	370	14000
Sulfide	mg/L	3.0 U	32000	5900	30000 U	3.0 U	25000	5900	30000 U	3.0 U	3.0 U	37000

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-57D-15**	**MW-57D-15**	**MW-58D-15**	**MW-58D-15**	**MW-58D-15**	**MW-58D-15**	**MW-59D-15**	**MW-59D-15**	**MW-59D-15**	**MW-59D-15**	**MW-60D-15**
Sample ID:		**GW-12607-061015-SK-012**	**GW-12607-090315-EM-026**	**GW-12607-051215-DC-007**	**GW-12607-052715-DR-003**	**GW-12607-061015-SK-015**	**GW-12607-090115-EM-009**	**GW-12607-051215-DC-005**	**GW-12607-052715-DR-004**	**GW-12607-061015-SK-014**	**GW-12607-083115-EM-004**	**GW-12607-051215-DC-003**
Sample Date:		**6/10/2015**	**9/3/2015**	**5/12/2015**	**5/27/2015**	**6/10/2015**	**9/1/2015**	**5/12/2015**	**5/27/2015**	**6/10/2015**	**8/31/2015**	**5/12/2015**
Event:		**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**
Parameters	**Units**											
Field Parameters												
Conductivity, field	umhos/cm	12.54	16.58	0.82	2.75	20.66	21.7	1.19	68.61	5.9	20.8	0.987
Dissolved oxygen (DO), field	mg/L	0.21	0.49	0.14	0.09	0.12	0.17	0.09	0	0.19	0.08	0.16
Oxidation reduction potential (ORP), field	millivolts	-625.1	-611.5	-93	-61	-650.9	-617	-68	-635.4	-555.7	-621	-170
pH, field	S.U.	12.56	12.52	7.18	7.76	12.55	12.23	7.1	13.1	12.14	10.43	7.1
Temperature, field	Deg C	18.3	19.89	11.9	14.84	22.2	19.7	12	16.76	19.5	20.54	11.41
Turbidity, field	NTU	20.9	22	1.05	9.01	16.6	38.9	4.15	5.03	22.3	39.6	0.78
Metals												
Chromium	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chromium (dissolved)	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050 U
Chromium VI (hexavalent)	mg/L	0.50 U	0.50 U	0.011	5.0 U	0.50 U	0.50 U	0.0050 U	5.0 U	0.50 U	0.25	0.0055
Iron	ug/L	100 U	600	260	8000	990	460	2000	100 U	150	720	260
Iron (dissolved)	ug/L	100 U	100 U	260	100 U	100	410	2000	100 U	100 U	410	230
Manganese	ug/L	15 U	200	260	470	130	53	320	15 U	15 U	140	250
Manganese (dissolved)	ug/L	15 U	15 U	270	480	15 U	18	320	15 U	15 U	15 U	250
Nickel	ug/L	40 U	550	5800	30000	1500	2300	12000	410	240	1100	6500
Nickel (dissolved)	ug/L	40 U	40 U	5900	29000	240	150	12000	320	40 U	170	6300
Sodium	ug/L	2700000	3500000	57000	190000	4300000	4400000	82000	11000000	1300000	5000000	69000
Sodium (dissolved)	ug/L	25000	3400000	58000	180000	3900000	4200000	82000	14000000	1300000	5200000	69000
General Chemistry												
Bromide	mg/L	50 U	50 U	0.50 U	500 U	50 U	50 U	0.50 U	500 U	50 U	50 U	0.50 U
Sulfate	mg/L	280	1100	170	1000 U	1400	2200	350	2100	280	3100	180
Sulfide	mg/L	3000 U	30000 U	3.0 U	3000 U	3100	3000 U	3.0 U	28000	3000 U	3000	3.0 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-60D-15**	**MW-60D-15**	**MW-60D-15**	**MW-60D-15**	**MW-60D-15**	**MW-61D-15**	**MW-61D-15**	**MW-61D-15**	**MW-61D-15**	**MW-62D-15**
Sample ID:		**GW-12607-051215-DC-004**	**GW-12607-052715-DR-002**	**GW-12607-061115-SK-017**	**GW-12607-061115-SK-018**	**GW-12607-083115-EM-002**	**GW-12607-051215-DC-006**	**GW-12607-052715-DR-001**	**GW-12607-061115-SK-016**	**GW-12607-083115-EM-003**	**GW-12607-051315-DC-026**
Sample Date:		**5/12/2015**	**5/27/2015**	**6/11/2015**	**6/11/2015**	**8/31/2015**	**5/12/2015**	**5/27/2015**	**6/11/2015**	**8/31/2015**	**5/13/2015**
Event:		**Baseline (Duplicate)**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Week Post Injection (Duplicate)**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**
Parameters	**Units**										
Field Parameters											
Conductivity, field	umhos/cm	0.987	6.88	3.61	3.61	3.07	1.275	55.7	3.58	8.36	0.869
Dissolved oxygen (DO), field	mg/L	0.16	0	6.1	6.1	0.11	0.32	0	6.68	0.1	0.16
Oxidation reduction potential (ORP), field	millivolts	-170	-596	-492.6	-492.6	-474	-134	-605.2	-458.2	-559	-293
pH, field	S.U.	7.1	11.38	10.12	10.12	9.39	7.09	12.94	12.25	11.23	6.85
Temperature, field	Deg C	11.41	15.36	15.8	15.8	21.01	11.76	17.14	15.7	20.16	11.78
Turbidity, field	NTU	0.78	5.9	34.4	34.4	192	0.61	4.43	16.6	29.2	11.7
Metals											
Chromium	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0	5.0 U	5.0 U	5.0 U	5.0 U	2700
Chromium (dissolved)	ug/L	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	14	5.0 U	2100
Chromium III (trivalent)	mg/L	0.0050 U	0.0050 U	0.0050 U	0.0050 U	0.0050	0.0050 U	0.0050 U	0.0050 U	0.0050 U	1.7
Chromium VI (hexavalent)	mg/L	0.0050 U	5.0 U	0.50 U	0.50 U	0.050 UH	0.0050 U	5.0 U	0.50 U	0.30	0.91
Iron	ug/L	230	780	120	100 U	1200	1300	240	100 U	700	2000
Iron (dissolved)	ug/L	230	100 U	1100	990	100 U	1200	100 U	260	200	650
Manganese	ug/L	260	49	61	57	110	230	15 U	15 U	210	830
Manganese (dissolved)	ug/L	250	15 U	100	96	55	220	15 U	21	71	860
Nickel	ug/L	6700	1100	47	40 U	5500	9500	360	40 U	440	240
Nickel (dissolved)	ug/L	6300	150	1700	1500	230	9000	240	250	68	240
Sodium	ug/L	72000	1700000	1000000	1000000	750000	76000	8700000	700000	1900000	24000
Sodium (dissolved)	ug/L	70000	1500000	1000000	1000000	700000	73000	9200000	780000	2000000	24000
General Chemistry											
Bromide	mg/L	0.50 U	500 U	50 U	50 U	50 U	0.50 U	500 U	50 U	50 U	0.50 U
Sulfate	mg/L	180	1000 U	660	620	600	310	1600	120	790	43
Sulfide	mg/L	3.0 U	3000 U	3000 U	3000 U	3000 U	3.0 U	3900	3000 U	3000 U	3.0 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-62D-15**	**MW-62D-15**	**MW-62D-15**	**MW-63D-15**	**MW-63D-15**	**MW-63D-15**	**MW-63D-15**	**MW-64D-15**	**MW-64D-15**
Sample ID:		**GW-12607-070615-SK-001**	**GW-012607-072015-DT-008**	**GW-12607-090215-EM-018**	**GW-12607-051415-DC-035**	**GW-12607-052815-DR-013**	**GW-12607-060915-SK-006**	**GW-12607-090215-EM-019**	**GW-12607-051415-DC-036**	**GW-12607-052815-DR-012**
Sample Date:		**7/6/2015**	**7/20/2015**	**9/2/2015**	**5/14/2015**	**5/28/2015**	**6/9/2015**	**9/2/2015**	**5/14/2015**	**5/28/2015**
Event:		**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**
Parameters	**Units**									
Field Parameters										
Conductivity, field	umhos/cm	0.723	0.698	0.837	0.9	0.898	0.84	3.51	1.61	69.6
Dissolved oxygen (DO), field	mg/L	0.09	0.05	0.22	0.12	0.33	0.24	0.13	0.2	0
Oxidation reduction potential (ORP), field	millivolts	-117	-65.2	-82	81	-261	-128.6	-514	-104	-687
pH, field	S.U.	6.82	7	6.98	7.24	7.58	7.34	10.09	6.89	13.7
Temperature, field	Deg C	18.81	20.83	22.8	13.1	15.13	18	22.99	12.64	14.91
Turbidity, field	NTU	16.2	2.4	10.7	4.83	7.9	8.36	187	3.75	47.5
Metals										
Chromium	ug/L	540	110	610	2400	2600	3800	7800	36	5.0 U
Chromium (dissolved)	ug/L	69	47	280	2100	2300	3500	98	7.0	5.0 U
Chromium III (trivalent)	mg/L	0.54	0.11	0.61	2.4	2.6	1.5	7.8	0.036	0.0050 U
Chromium VI (hexavalent)	mg/L	0.50 U	0.50 U	0.10 U	0.011 H	5.0 U	2.4	5.0 U	0.0050 U	5.0 U
Iron	ug/L	4100	3100	2700	100 U	150	570	450	110	100 U
Iron (dissolved)	ug/L	2500	2500	820	100 U	100 U	100 U	280	100 U	100 U
Manganese	ug/L	700	750	770	260	300	240	30	360	190
Manganese (dissolved)	ug/L	750	700	720	250	300	250	15 U	360	15 U
Nickel	ug/L	120	120	140	330	280	280	66	13000	57
Nickel (dissolved)	ug/L	120	120	130	310	260	270	40 U	14000	40 U
Sodium	ug/L	19000	19000	24000	44000	50000	62000	750000	53000	13000000
Sodium (dissolved)	ug/L	20000	18000	24000	44000	49000	62000	800000	53000	11000000
General Chemistry										
Bromide	mg/L	50 U	50 U	50 U	0.50 U	50 U	50 U	50 U	0.50 U	50 U
Sulfate	mg/L	100 U	100 U	100 U	110	100 U	110	400	750	2600
Sulfide	mg/L	3000 U	3000 U	3000 U	3.0 U	3000 U	30000 U	3000 U	3.0 U	6000

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond
the specified holding time.

Table 3.2

Groundwater Analytical Results
Area 1 ISCR Pilot Study Summary Report
RACER Eckles Road Site
Livonia, Michigan

Sample Location:		**MW-64D-15**	**MW-64D-15**	**MW-65D-15**	**MW-65D-15**	**MW-65D-15**	**MW-65D-15**	**MW-65D-15**
Sample ID:		**GW-12607-060915-SK-005**	**GW-12607-090215-EM-022**	**GW-12607-051415-DC-037**	**GW-12607-052815-DR-010**	**GW-12607-060915-SK-003**	**GW-12607-060915-SK-004**	**GW-12607-091015-SK-002**
Sample Date:		**6/9/2015**	**9/2/2015**	**5/14/2015**	**5/28/2015**	**6/9/2015**	**6/9/2015**	**9/10/2015**
Event:		**3-Week Post Injection**	**3-Month Post Injection**	**Baseline**	**1-Week Post Injection**	**3-Week Post Injection**	**3-Week Post Injection (Duplicate)**	**3-Month Post Injection**
Parameters	**Units**							
Field Parameters								
Conductivity, field	umhos/cm	20.02	4.12	1.58	1.49	2.26	2.26	6.371
Dissolved oxygen (DO), field	mg/L	0.18	0.13	0.31	0.23	0.21	0.21	0.2
Oxidation reduction potential (ORP), field	millivolts	-638.8	-544	65	13	48.1	48.1	-460.9
pH, field	S.U.	12.86	9.87	7.49	7.07	6.81	6.81	10.46
Temperature, field	Deg C	16.4	21.11	13.44	15.33	18.8	18.8	22.17
Turbidity, field	NTU	45	601	4.7	4.91	9.15	9.15	3.7
Metals								
Chromium	ug/L	520	5.0 U	7.4	5.0 U	7.2	7.2	5.0 U
Chromium (dissolved)	ug/L	9.0	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chromium III (trivalent)	mg/L	0.52	0.0050 U	0.0074	0.0050 U	0.0072	0.0072	0.0050 U
Chromium VI (hexavalent)	mg/L	0.50 U	0.50 U	0.0050 U	5.0 U	0.50 U	0.50 U	0.050 U
Iron	ug/L	4000	670	100 U	100 U	210	250	100 U
Iron (dissolved)	ug/L	100 U	100 U	100 U	100 U	130	130	100 U
Manganese	ug/L	590	350	320	320	610	650	15 U
Manganese (dissolved)	ug/L	34	15 U	310	320	610	610	15 U
Nickel	ug/L	4400	5100	8600	9600	18000	19000	180
Nickel (dissolved)	ug/L	40 U	40 U	8400	9200	18000	18000	40 U
Sodium	ug/L	420000	960000	61000	82000	130000	130000	810000
Sodium (dissolved)	ug/L	2100000	910000	60000	71000	130000	130000	810000
General Chemistry								
Bromide	mg/L	50 U	50 U	0.50 U	50 U	50 U	50 U	50 U
Sulfate	mg/L	2300	1000	670	300	730	710	610
Sulfide	mg/L	30000 U	4400	3.0 U	3000 U	30000 U	30000 U	3000 U

Notes:
U - Not detected at the associated reporting limit.
J - Estimated concentration.
H - Sample was prepped or analyzed beyond the specified holding time.

Appendices

Appendix A
Monitoring Well Construction Logs

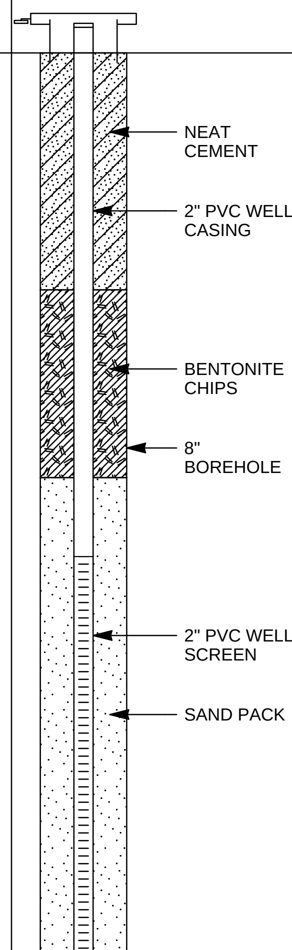
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW42D-15
DATE COMPLETED: May 11, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	NOT LOGGED - AUGER PLUGGED (0.0 to 22.75ft BGS)						
	END OF BOREHOLE @ 22.8ft BGS	22.75					

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
12.75 to 22.75ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 10.75ft BGS
Material: BENTONITE CHIPS
Sand Pack:
10.75 to 22.75ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

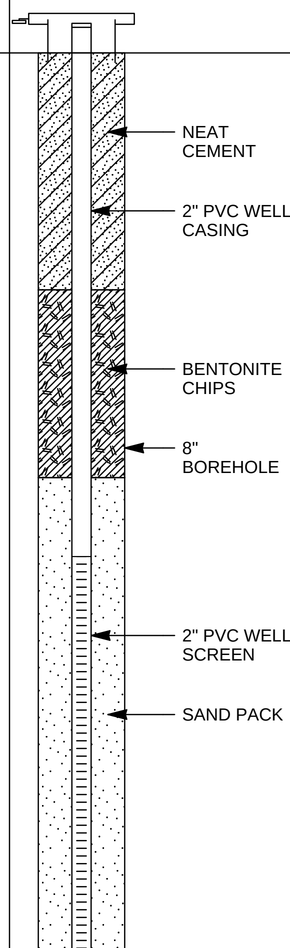
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW43D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0–22.75	NOT LOGGED - AUGER PLUGGED (0.0 to 22.75ft BGS)						
22.75	END OF BOREHOLE @ 22.8ft BGS	22.75					

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
12.75 to 22.75ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 10.75ft BGS
Material: BENTONITE CHIPS
Sand Pack:
10.75 to 22.75ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD

PROJECT NUMBER: 012607

CLIENT: RACER TRUST

LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW44D-15

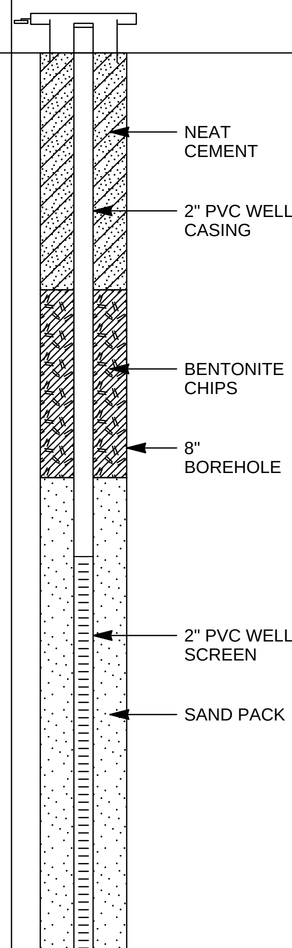
DATE COMPLETED: May 11, 2015

DRILLING METHOD: HSA

FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0–22.75	NOT LOGGED - AUGER PLUGGED (0.0 to 22.75ft BGS)	22.75					
	END OF BOREHOLE @ 22.8ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS

Screened interval:
12.75 to 22.75ft BGS

Length: 10ft

Diameter: 2in

Slot Size: 0.010

Material: PVC

Seal:
6.00 to 10.75ft BGS

Material: BENTONITE CHIPS

Sand Pack:
10.75 to 22.75ft BGS

Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

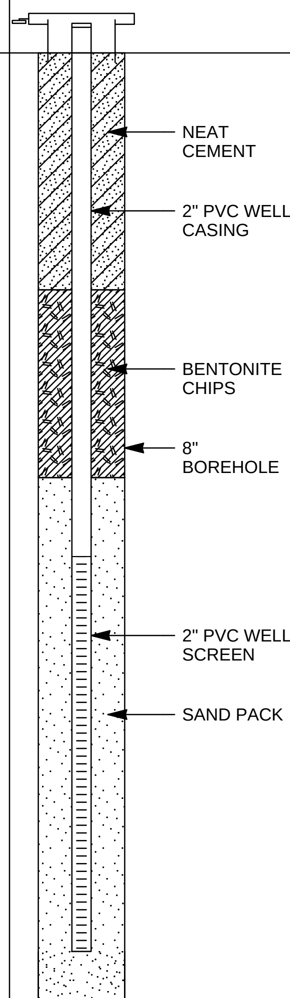
OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW45D-15
DATE COMPLETED: May 11, 2015
DRILLING METHOD: DIRECT PUSH/HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0.0–19.0	NOT LOGGED - SOLID POINT AUGER (0.0 to 19.0ft BGS)						
19.0–22.75	SP-SAND, with <10% fines, fine to medium grained, dark brown, wet	19.00					
22.75–24.0	CL-CLAY, stiff, dark brownish gray, moist	22.75					
24.0	END OF BOREHOLE @ 24.0ft BGS	24.00					



WELL DETAILS
Screened interval:
12.75 to 22.75ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 10.75ft BGS
Material: BENTONITE CHIPS
Sand Pack:
10.75 to 24.00ft BGS
Material: SAND

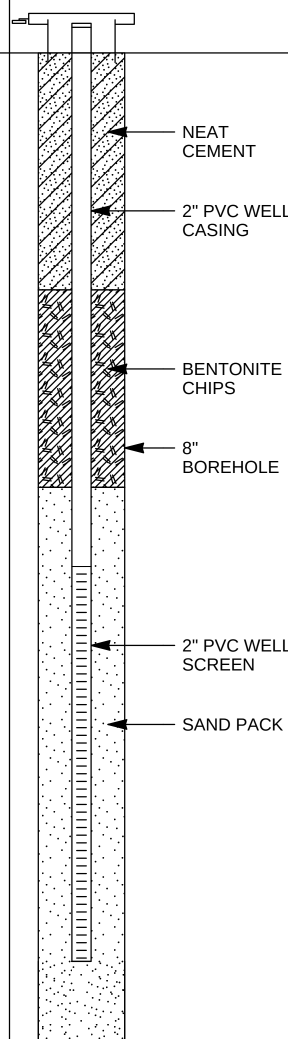
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW46D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: DIRECT PUSH/HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.33					
2	NOT LOGGED - SOLID POINT AUGER (1.3 to 15.0ft BGS)						
4							
6							
8							
10							
12							
14		15.00					
16	SP-SAND, fine to medium grained, dark brown, wet						
18							
20							
22	- fines from 22.0 to 23.0ft BGS						
24		25.00					
26	END OF BOREHOLE @ 25.0ft BGS						
28							
30							
32							
34							



WELL DETAILS
Screened interval:
13.00 to 23.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.00 to 25.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

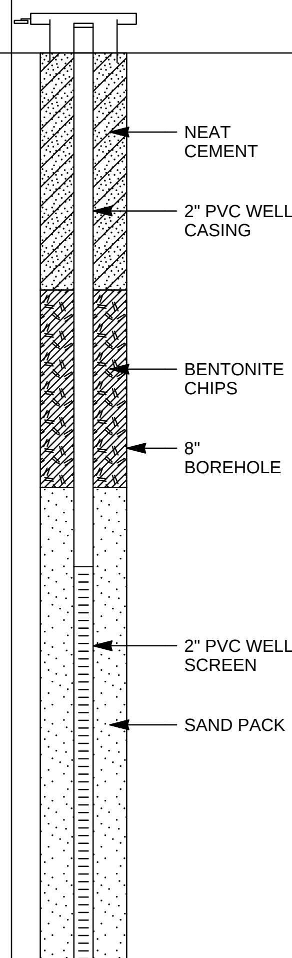
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW47D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0.0–23.0	NOT LOGGED - AUGER PLUGGED (0.0 to 23.0ft BGS)						
23.0	END OF BOREHOLE @ 23.0ft BGS	23.00					

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
13.00 to 23.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.00 to 23.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

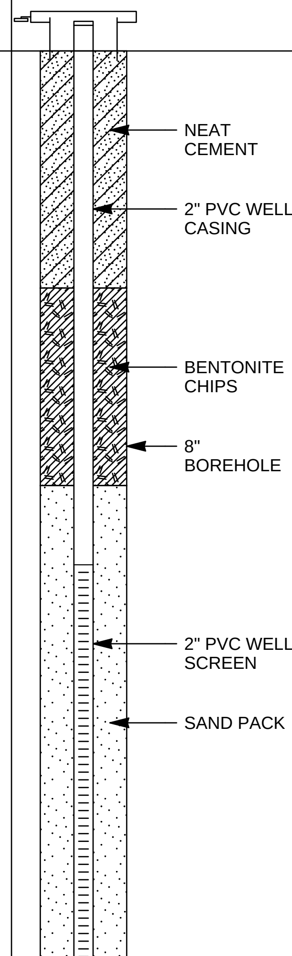
OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW48D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2	NOT LOGGED - AUGER PLUGGED (1.3 to 23.0ft BGS)						
4							
6							
8							
10							
12							
14							
16							
18							
20							
22		23.00					
24	END OF BOREHOLE @ 23.0ft BGS						
26							
28							
30							
32							
34							



WELL DETAILS
Screened interval:
13.00 to 23.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.00 to 23.00ft BGS
Material: SAND

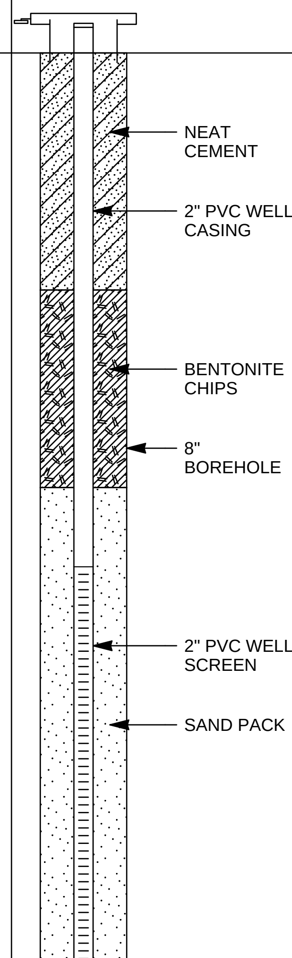
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD	HOLE DESIGNATION: MW49D-15
PROJECT NUMBER: 012607	DATE COMPLETED: May 12, 2015
CLIENT: RACER TRUST	DRILLING METHOD: HSA
LOCATION: LIVONIA, MI	FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
	NOT LOGGED - AUGER PLUGGED (1.3 to 23.0ft BGS)	23.00					
	END OF BOREHOLE @ 23.0ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
13.00 to 23.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.00 to 23.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

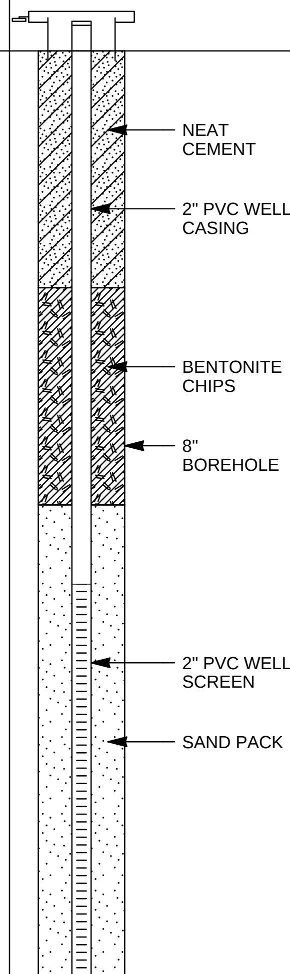
STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW50D-15
DATE COMPLETED: May 8, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0.0–23.5	NOT LOGGED - AUGER PLUGGED (0.0 to 23.5ft BGS)						
23.5	END OF BOREHOLE @ 23.5ft BGS	23.50					

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
13.50 to 23.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.50 to 23.50ft BGS
Material: SAND

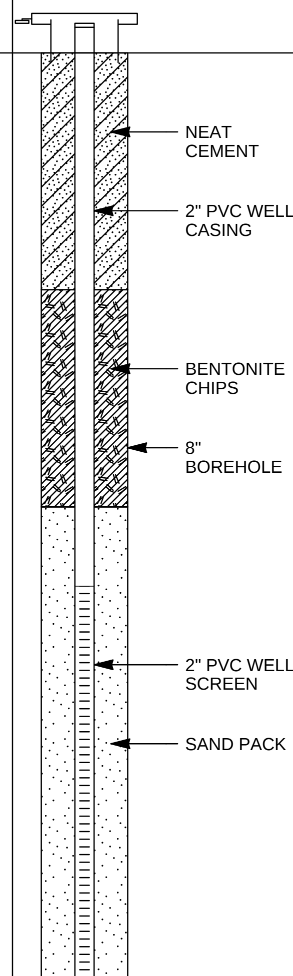
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW51D-15
DATE COMPLETED: May 8, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0–23.5	NOT LOGGED - AUGER PLUGGED (0.0 to 23.5ft BGS)						
23.5	END OF BOREHOLE @ 23.5ft BGS	23.50					



Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34

WELL DETAILS
Screened interval:
13.50 to 23.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.50 to 23.50ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

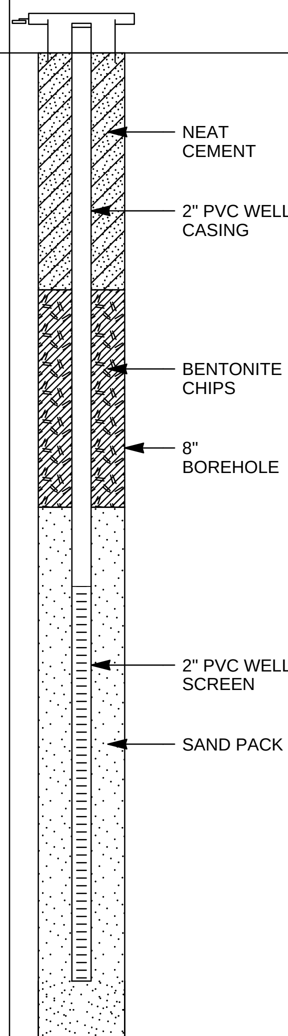
STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW52D-15
DATE COMPLETED: May 6, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.33					
2	NOT LOGGED - DRIVE POINT AUGER (1.33 to 20.0ft BGS)	20.00					
20	SP-SAND, 5-10% fines, fine to medium grained, brown, wet	23.50					
24	CL-CLAY, stiff, low plasticity, gray, moist	25.00					
	END OF BOREHOLE @ 25.0ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
13.50 to 23.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.50 to 25.00ft BGS
Material: SAND

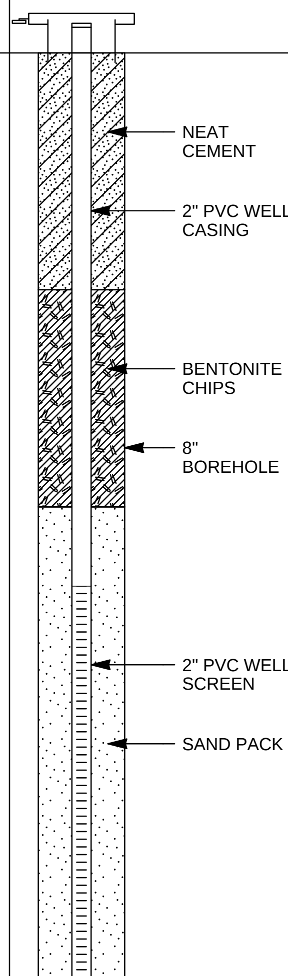
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW53D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.17					
2	NOT LOGGED - AUGER PLUGGED (1.17 to 23.5ft BGS)	23.50					
	END OF BOREHOLE @ 23.5ft BGS						



WELL DETAILS
Screened interval:
13.50 to 23.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.50 to 23.50ft BGS
Material: SAND

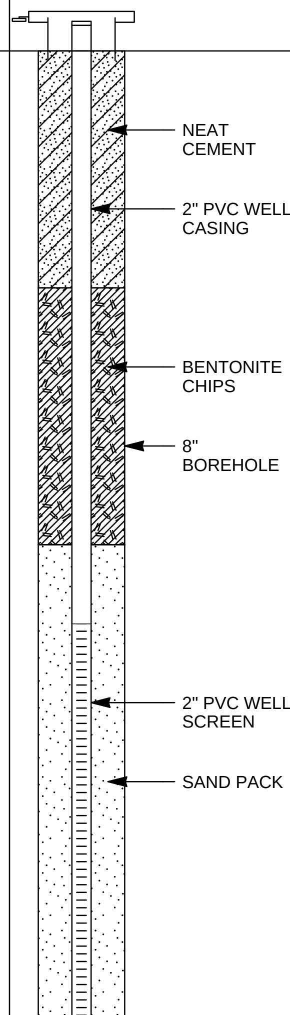
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW54D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2 – 24	NOT LOGGED - AUGER PLUGGED (1.3 to 24.5ft BGS)	24.50					
26 – 34	END OF BOREHOLE @ 24.5ft BGS						



WELL DETAILS
Screened interval:
14.50 to 24.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 12.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
12.50 to 24.50ft BGS
Material: SAND

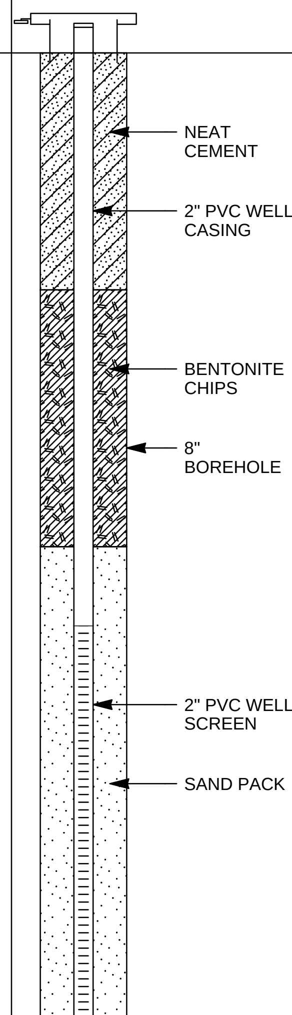
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW55D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24	NOT LOGGED - AUGER PLUGGED (1.3 to 24.5ft BGS)	24.50					
26, 28, 30, 32, 34	END OF BOREHOLE @ 24.5ft BGS						



WELL DETAILS
Screened interval:
14.50 to 24.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 12.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
12.50 to 24.50ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

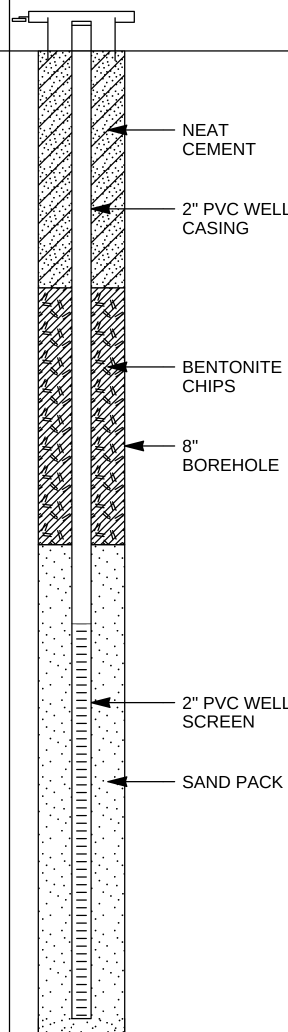
OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW56D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: DIRECT PUSH/HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2	NOT LOGGED - SOLID POINT AUGER (1.3 to 20.0ft BGS)						
4							
6							
8							
10							
12							
14							
16							
18							
20	SP-SAND, with little to no fines, fine to medium grained, light olive brown, grading to light gray, saturated	20.00					
22	- light gray at 23.0ft BGS						
24		24.25					
	CL-CLAY, stiff, low plasticity, gray, moist	24.50					
	ML-SILT, trace fine sand, gray, saturated	24.75					
26	CL-CLAY, stiff, gray, moist	25.00					
	END OF BOREHOLE @ 25.0ft BGS						
28							
30							
32							
34							



WELL DETAILS
Screened interval:
14.50 to 24.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 12.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
12.50 to 25.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

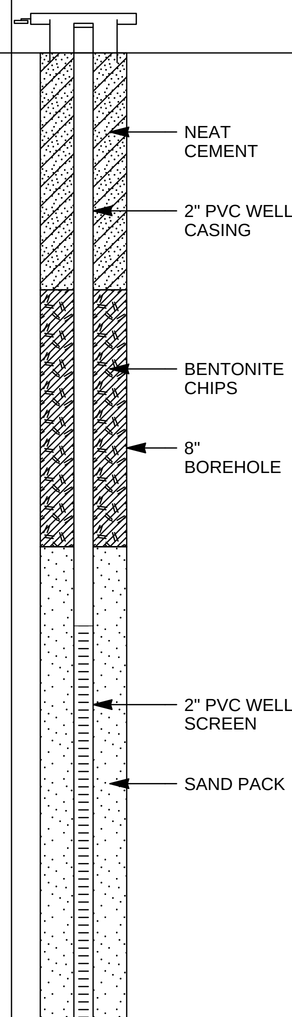
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW57D-15
DATE COMPLETED: May 7, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
	NOT LOGGED - AUGER PLUGGED (1.3 to 23.5ft BGS)	24.50					
	END OF BOREHOLE @ 24.5ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
14.50 to 24.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 12.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
12.50 to 24.50ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD

PROJECT NUMBER: 012607

CLIENT: RACER TRUST

LOCATION: LIVONIA, MI

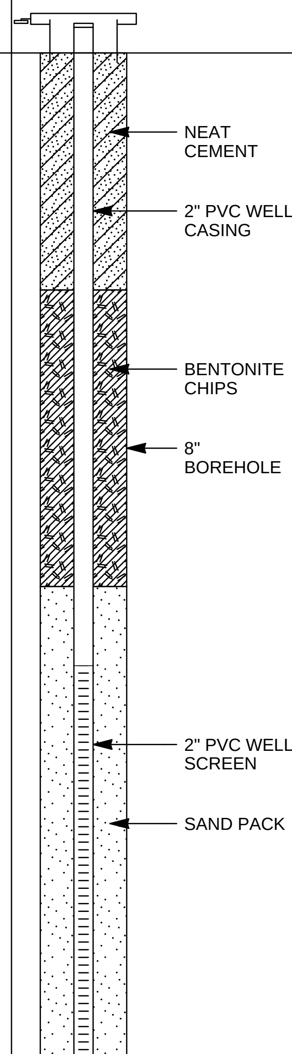
HOLE DESIGNATION: MW58D-15

DATE COMPLETED: May 6, 2015

DRILLING METHOD: HSA

FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24	NOT LOGGED - AUGER PLUGGED (1.3 to 25.5ft BGS)	25.50					
26, 28, 30, 32, 34	END OF BOREHOLE @ 25.5ft BGS						



WELL DETAILS

Screened interval:
15.50 to 25.50ft BGS

Length: 10ft

Diameter: 2in

Slot Size: 0.010

Material: PVC

Seal:
6.00 to 13.50ft BGS

Material: BENTONITE CHIPS

Sand Pack:
13.50 to 25.50ft BGS

Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

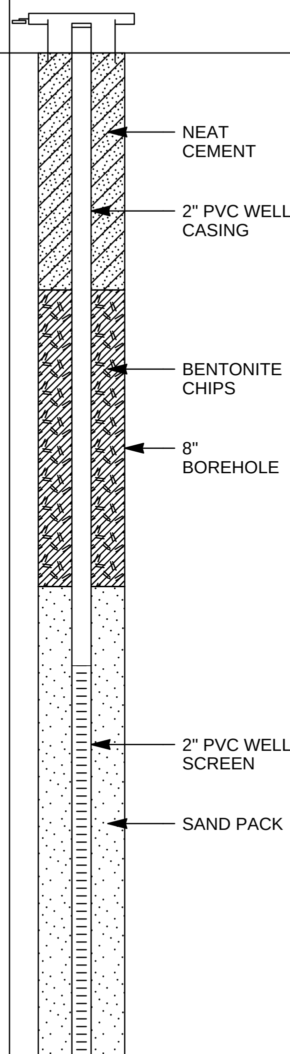
STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW59D-15
DATE COMPLETED: May 6, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
	NOT LOGGED - AUGER PLUGGED (1.3 to 25.5ft BGS)	25.50					
	END OF BOREHOLE @ 25.5ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
15.50 to 25.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 13.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
13.50 to 25.50ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD

PROJECT NUMBER: 012607

CLIENT: RACER TRUST

LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW60D-15

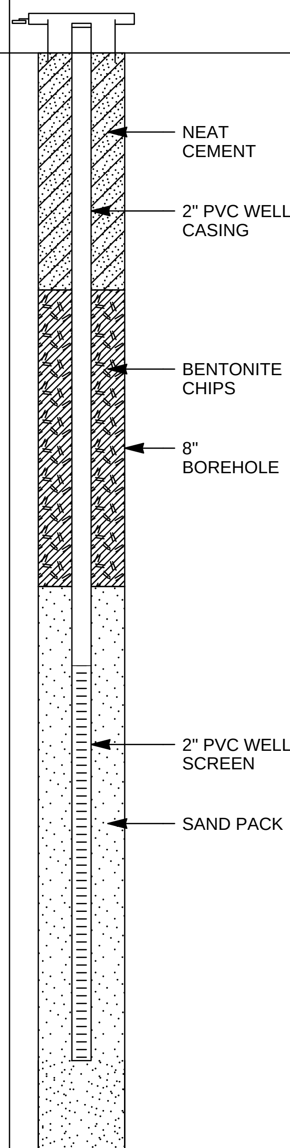
DATE COMPLETED: May 6, 2015

DRILLING METHOD: DIRECT PUSH/HSA

FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS
	CONCRETE	1.30
2	NOT LOGGED - SOLID POINT AUGER (1.3 to 15.5ft BGS)	
4		
6		
8		
10		
12		
14		15.50
16	SP-SAND, with 10% fines, fine to medium grained, light gray, saturated	17.75
18	SW-SAND, fine to coarse grained, black, saturated	18.00
	SP-SAND, 5% fines, fine to medium grained, coarsening with depth, gray, saturated	19.00
20	NO RECOVERY - SLOUGHING (19.0 to 25.0ft BGS)	
22		
24		25.00
26	CL-CLAY, stiff, light gray, moist	26.75
	END OF BOREHOLE @ 26.8ft BGS	
28		
30		
32		
34		

MONITORING WELL



WELL DETAILS
Screened interval:
15.50 to 25.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 13.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:

SAMPLE			
NUMBER	INTERVAL	REC (%)	'N' VALUE

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW60D-15
DATE COMPLETED: May 6, 2015
DRILLING METHOD: DIRECT PUSH/HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
36			13.50 to 27.83ft BGS Material: SAND				
38							
40							
42							
44							
46							
48							
50							
52							
54							
56							
58							
60							
62							
64							
66							
68							

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

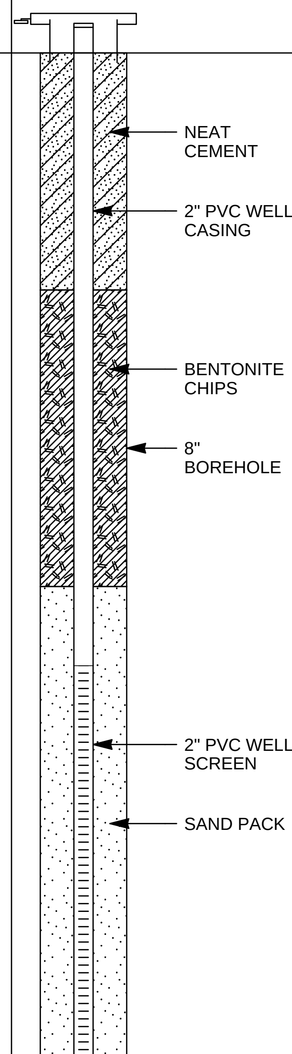
STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW61D-15
DATE COMPLETED: May 6, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
	NOT LOGGED - AUGER PLUGGED (1.3 to 25.5ft BGS)	25.50					
	END OF BOREHOLE @ 25.5ft BGS						

Depth scale (ft BGS): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
15.50 to 25.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 13.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
13.50 to 25.50ft BGS
Material: SAND

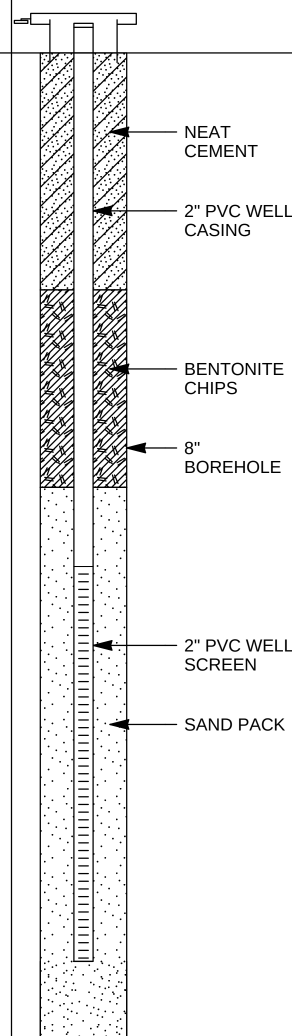
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD	HOLE DESIGNATION: MW62D-15
PROJECT NUMBER: 012607	DATE COMPLETED: May 8, 2015
CLIENT: RACER TRUST	DRILLING METHOD: DIRECT PUSH/HSA
LOCATION: LIVONIA, MI	FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0.0	NOT LOGGED - SOLID POINT AUGER (0.0 to 20.0ft BGS)						
20	SP/SM-SAND, with 10-15% fines, fine to medium grained, light olive brown, wet, grading to clay in last 6"	20.00					
23.25	CL-CLAY, stiff, light gray, moist	23.25					
25	END OF BOREHOLE @ 25.0ft BGS	25.00					



WELL DETAILS
Screened interval:
13.00 to 23.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.00 to 25.00ft BGS
Material: SAND

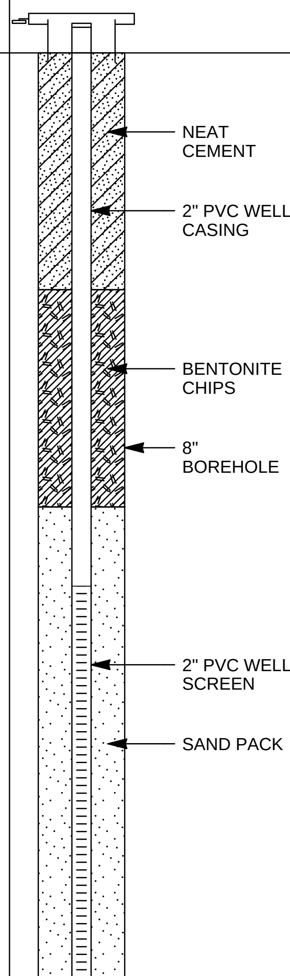
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW63D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
	CONCRETE	1.30					
2	NOT LOGGED - AUGER PLUGGED (1.3 to 23.5ft BGS)						
4							
6							
8							
10							
12							
14							
16							
18							
20							
22		23.50					
24	END OF BOREHOLE @ 23.5ft BGS						
26							
28							
30							
32							
34							



WELL DETAILS
Screened interval:
13.50 to 23.50ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 11.50ft BGS
Material: BENTONITE CHIPS
Sand Pack:
11.50 to 23.50ft BGS
Material: SAND

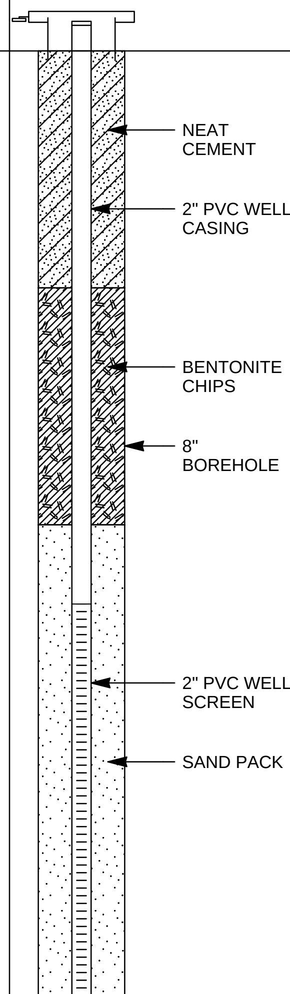
NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW64D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0.0–24.0	NOT LOGGED - AUGER PLUGGED (0.0 to 24.0ft BGS)						
24	END OF BOREHOLE @ 24.0ft BGS	24.00					



WELL DETAILS
Screened interval:
14.00 to 24.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 12.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
12.00 to 24.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

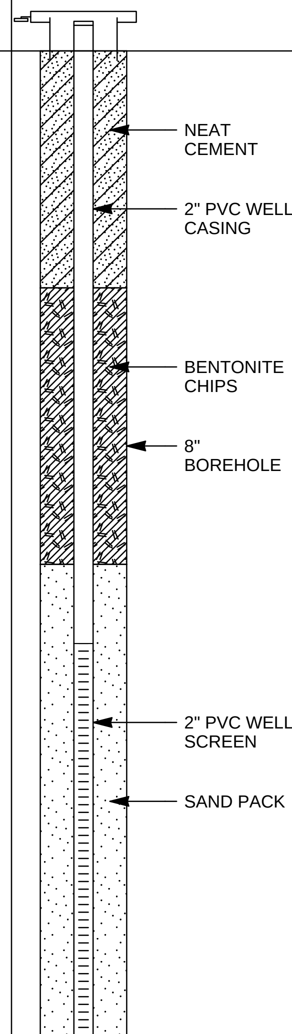
STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME: ECKLES RD
PROJECT NUMBER: 012607
CLIENT: RACER TRUST
LOCATION: LIVONIA, MI

HOLE DESIGNATION: MW65D-15
DATE COMPLETED: May 12, 2015
DRILLING METHOD: HSA
FIELD PERSONNEL: B. RICHARDSON

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	DEPTH ft BGS	MONITORING WELL	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' VALUE
0–25	NOT LOGGED - AUGER PLUGGED (0.0 to 25.0ft BGS)						
25	END OF BOREHOLE @ 25.0ft BGS	25.00					

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34



WELL DETAILS
Screened interval:
15.00 to 25.00ft BGS
Length: 10ft
Diameter: 2in
Slot Size: 0.010
Material: PVC
Seal:
6.00 to 13.00ft BGS
Material: BENTONITE CHIPS
Sand Pack:
13.00 to 25.00ft BGS
Material: SAND

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

OVERBURDEN LOG 012607-WI-RACER.GPJ CRA_CORP.GDT 11/18/15

Appendix B
Badger Injection Summary Sheets

Badger Injection Delivery Summary

Conestoga Rovers & Associates   Plymouth Mi   FS1761.00   Racer Trust, 13000 Eckles Rd,   Livonia MI

View Point Data

CSV: FMC   Configuration = *Radial*   Provider Project#: *FS1761.00*   Badger Unit: *HD*

IPL-55	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	59	0	««Θ»»	N	0.15	5/18/03	10.00%	27.50	Detect	1.59	30.00	17.25	22.43	» «	12.24
2	18	450	65	10	««Θ»»	N	0.14	5/18/03	0.00%	25.00	Detect	1.45	32.14	17.25	22.43	» «	13.11
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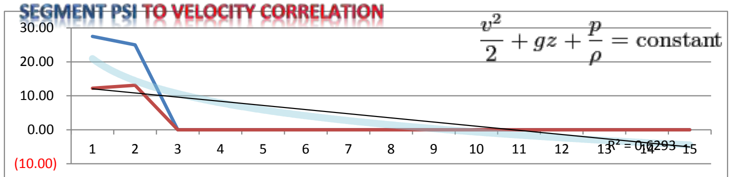
Powered by B.I.T.S.

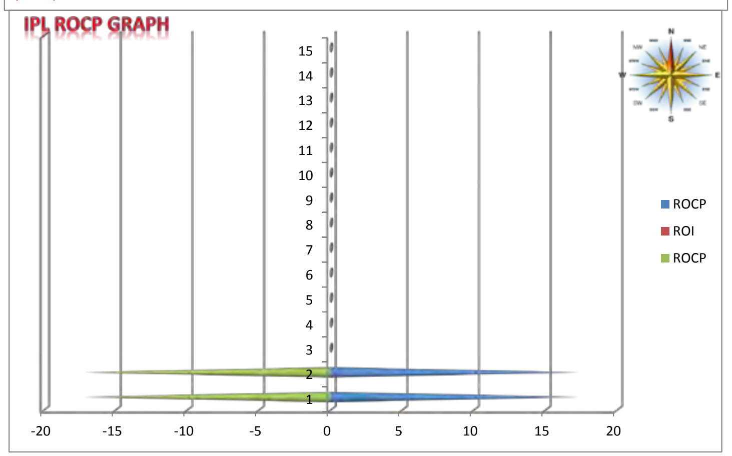
(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox

SEGMENT PSI TO VELOCITY CORRELATION



$$\frac{v^2}{2} + gz + \frac{p}{\rho} = \text{constant}$$

IPL ROCP GRAPH



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

- **IPL -** Injection Point Location designation number
- **ZONE-BLS -** Center target zone for Lateral Shot Line (LSL) injection material placement
- **VOL-DR -** Volume of Injection Material Delivered in the LSL
- **SUB RESISTANCE -** Resistance Return from KAPSDIDS (equivalent to ECD)
- **BERN DIFF -** Bernoulli differential calibrated constant (Incompressible Flow Equation)
- **RADIAL/TARGETED -** ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
- **C-DIR -** Compass direction of the segmented VVDN
- **Time-Log -** Minutes required to complete LSL
- **Date -** Date of the actual LSL completion
- **Source Diff % -** Percentage of Source Increases or Decreases in Flow Rate
- **OLH-SEG-PSI -** Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
- **Q Detect-** Q = the ability to apply a negative polarity to the subsurface resistance
- **ATpsi ROCP -** Attenuated last known OLH-SEG-PSI across the lateral ROCP
- **T-Flow Rate-** Total flow rate in gallons per minute accomplished in the LSL
- **e ROCP -** Estimated Radius of Contact Potential
- **e K-LOCK -** Estimated Subsurface Kinetic Lock boundary
- **e CFG-PERF -** System performance based on historical data for similar configuration
- **Seg EV-Ft/Sec -** Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates | Plymouth Mi | FS1761.00 | Racer Trust, 13000 Eckles Rd, | Livonia MI

View Point Data

CSV: FMC | Configuration = *Radial* | Provider Project#: *FS1761.00* | Badger Unit: *HD*

IPL-56	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	55	10	««Θ»»	N	0.29	5/18/03	15.00%	28.75	Detect	1.67	32.14	17.25	22.43	» «	13.11
2	18	450	59	10	««Θ»»	N	0.14	5/18/03	10.00%	27.50	Detect	1.59	32.14	17.25	22.43	» «	13.11
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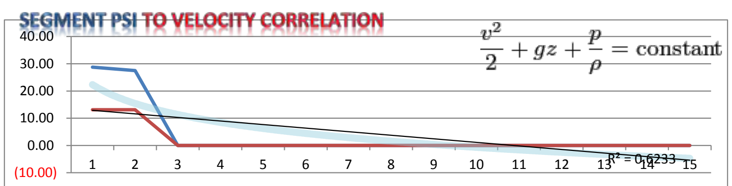
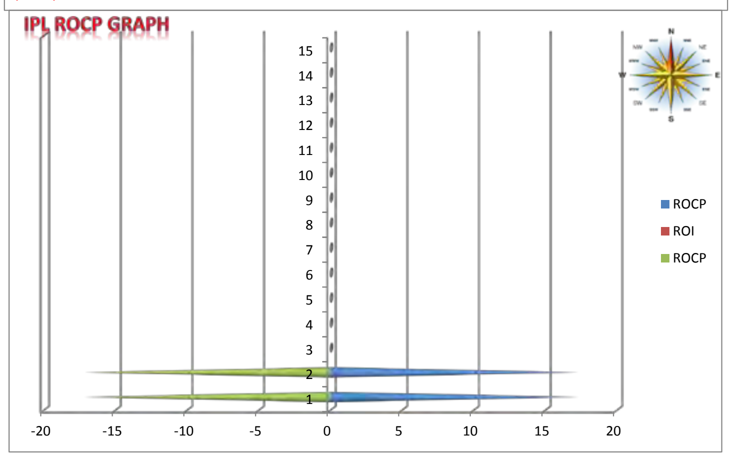
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
SUB RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
BERN DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-SEG-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
ATpsi ROCP - Attenuated last known OLH-SEG-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
e ROCP - Estimated Radius of Contact Potential
e K-LOCK - Estimated Subsurface Kinetic Lock boundary
e CFG-PERF - System performance based on historical data for similar configuration
Seg EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates | Plymouth Mi | FS1761.00 | Racer Trust, 13000 Eckles Rd, | Livonia MI

View Point Data

CSV: FMC | Configuration = *Radial* | Provider Project#: *FS1761.00* | Badger Unit: *HD*

IPL-57	ZONE-BLS	VOL-DR	^{SUB} RESIS	^{Bern} DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	80	0	««Θ»»	N	0.15	5/18/03	-22.50%	19.38	Detect	1.16	30.00	16.75	21.78	» «	12.24
2	18	450	85	0	««Θ»»	N	0.15	5/18/03	-30.00%	17.50	Detect	1.04	30.00	16.75	21.78	» «	12.24
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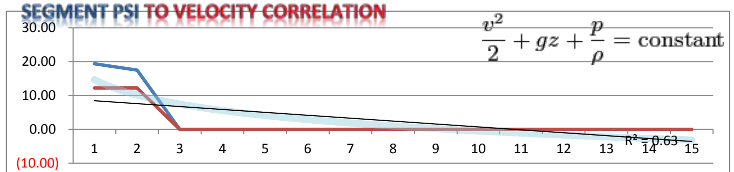
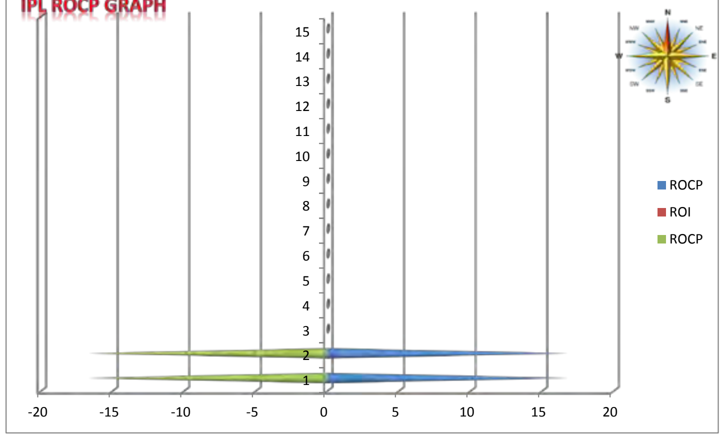
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	16.75	Dave Mokma	Steve Cox	Cecil Cox

SEGMENT PSI TO VELOCITY CORRELATION



IPL ROCP GRAPH



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

- **IPL -** Injection Point Location designation number
- **ZONE-BLS -** Center target zone for Lateral Shot Line (LSL) injection material placement
- **VOL-DR -** Volume of Injection Material Delivered in the LSL
- **^{SUB} RESISTANCE -** Resistance Return from KAPSDIDS (equivalent to ECD)
- **^{BERN} DIFF -** Bernoulli differential calibrated constant (Incompressible Flow Equation)
- **RADIAL/TARGETED -** ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
- **C-DIR -** Compass direction of the segmented VVDN
- **Time-Log -** Minutes required to complete LSL
- **Date -** Date of the actual LSL completion
- **Source Diff % -** Percentage of Source Increases or Decreases in Flow Rate
- **OLH-^{SEG}-PSI -** Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
- **Q Detect-** Q = the ability to apply a negative polarity to the subsurface resistance
- **^{ATpsi}ROCP -** Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
- **T-Flow Rate-** Total flow rate in gallons per minute accomplished in the LSL
- **^{e}ROCP -** Estimated Radius of Contact Potential
- **^{e}K-LOCK -** Estimated Subsurface Kinetic Lock boundary
- **^{e}CFG-PERF -** System performance based on historical data for similar configuration
- **^{Seg}EV-Ft/Sec -** Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates **Plymouth Mi** **FS1761.00** **Racer Trust, 13000 Eckles Rd,** **Livonia MI**

View Point Data

CSV: FMC **Configuration =** *Radial* **Provider Project#:** *FS1761.00* **Badger Unit:** *HD*

IPL-58	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	62	0	««Θ»»	N	0.15	5/18/03	5.00%	26.25	Detect	1.52	30.00	17.25	22.43	» «	12.24
2	18	450	57	0	««Θ»»	N	0.15	5/18/03	12.50%	28.13	Detect	1.63	30.00	17.25	22.43	» «	12.24
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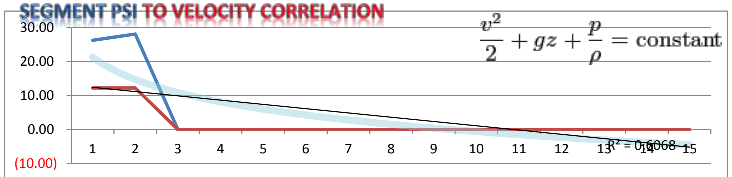
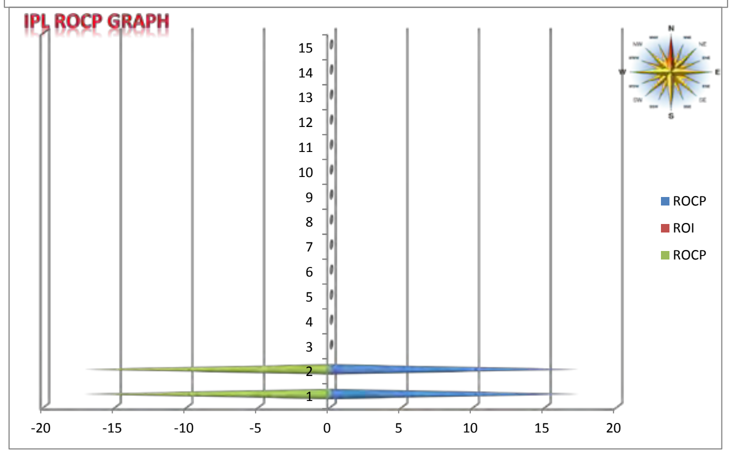
(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox

SEGMENT PSI TO VELOCITY CORRELATION



IPL ROCP GRAPH



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
SUB RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
BERN DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-SEG-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
ATpsi ROCP - Attenuated last known OLH-SEG-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
e ROCP - Estimated Radius of Contact Potential
e K-LOCK - Estimated Subsurface Kinetic Lock boundary
e CFG-PERF - System performance based on historical data for similar configuration
Seg EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Contact Information
Phone (352) 343-0336
Fax: (352) 343-0346

Badger Injection Solutions, LLC
24621 Ranch Rd
Astatula, Florida 34705

Badger Injection Delivery Summary

Conestoga Rovers & Associates Plymouth Mi FS1761.00 Racer Trust, 13000 Eckles Rd, Livonia MI

View Point Data

CSV: FMC Configuration = *Radial* Provider Project#: *FS1761.00* Badger Unit: *HD*

IPL-75	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	55	27	««Θ»»	N	0.25	5/18/03	15.00%	28.75	Detect	1.69	34.62	17	22.10	» «	14.12
2	18	450	62	27	««Θ»»	N	0.13	5/18/03	5.00%	26.25	Detect	1.54	34.62	17	22.10	» «	14.12
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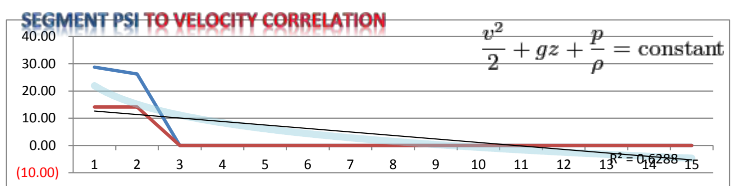
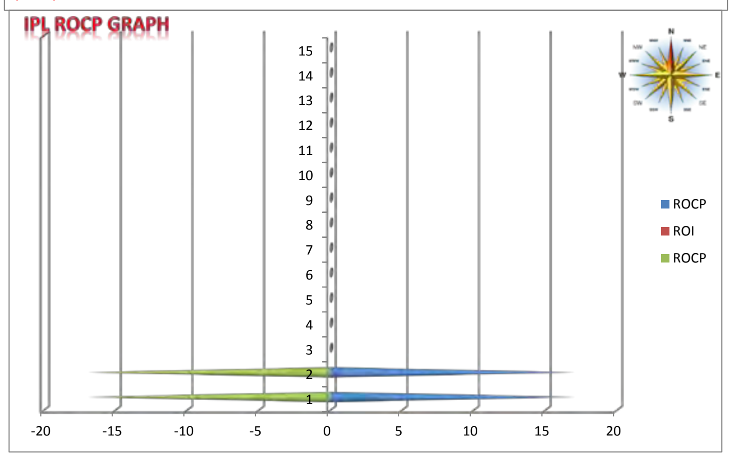
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.00	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

- **IPL -** Injection Point Location designation number
- **ZONE-BLS -** Center target zone for Lateral Shot Line (LSL) injection material placement
- **VOL-DR -** Volume of Injection Material Delivered in the LSL
- **SUB RESISTANCE -** Resistance Return from KAPSDIDS (equivalent to ECD)
- **BERN DIFF -** Bernoulli differential calibrated constant (Incompressible Flow Equation)
- **RADIAL/TARGETED -** ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
- **C-DIR -** Compass direction of the segmented VVDN
- **Time-Log -** Minutes required to complete LSL
- **Date -** Date of the actual LSL completion
- **Source Diff % -** Percentage of Source Increases or Decreases in Flow Rate
- **OLH-SEG-PSI -** Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
- **Q Detect-** Q = the ability to apply a negative polarity to the subsurface resistance
- **ATpsi ROCP -** Attenuated last known OLH-SEG-PSI across the lateral ROCP
- **T-Flow Rate-** Total flow rate in gallons per minute accomplished in the LSL
- **e ROCP -** Estimated Radius of Contact Potential
- **e K-LOCK -** Estimated Subsurface Kinetic Lock boundary
- **e CFG-PERF -** System performance based on historical data for similar configuration
- **Seg EV-Ft/Sec -** Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates Plymouth Mi FS1761.00 Racer Trust, 13000 Eckles Rd, Livonia MI

View Point Data

CSV: FMC Configuration = *Radial* Provider Project#: *FS1761.00* Badger Unit: *HD*

IPL-79	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	63	0	««ʘ»»	N	0.15	5/18/03	2.86%	25.71	Detect	1.49	30.00	17.25	22.43	» «	12.24
2	18	450	61	10	««ʘ»»	N	0.14	5/18/03	5.71%	26.43	Detect	1.53	32.14	17.25	22.43	» «	13.11
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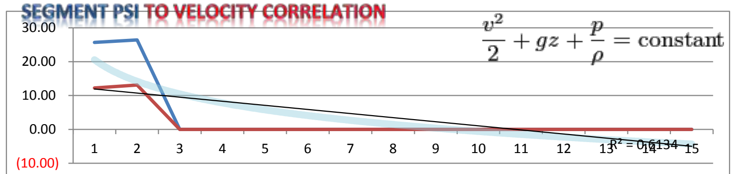
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox

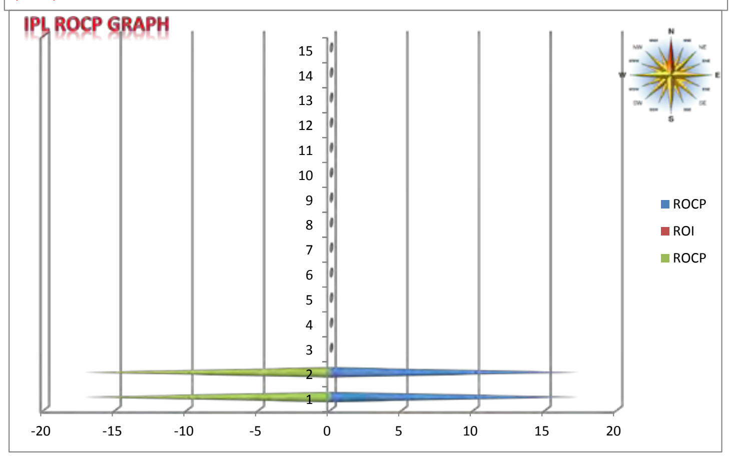
SEGMENT PSI TO VELOCITY CORRELATION



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

IPL ROCP GRAPH



LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
SUB RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
BERN DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««ʘ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-SEG-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
ATpsi ROCP - Attenuated last known OLH-SEG-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
e ROCP - Estimated Radius of Contact Potential
e K-LOCK - Estimated Subsurface Kinetic Lock boundary
e CFG-PERF - System performance based on historical data for similar configuration
Seg EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates **Plymouth Mi** **FS1761.00** **Racer Trust, 13000 Eckles Rd,** **Livonia MI**

View Point Data

CSV: *FMC* **Configuration =** *Radial* **Provider Project#:** *FS1761.00* **Badger Unit:** *HD*

IPL-17	ZONE-BLS	VOL-DR	^{SUB}RESIS	^{Bern}DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	61	10	««Θ»»	N	0.14	5/19/03	6.67%	26.67	Detect	1.55	32.14	17.25	22.43	» «	13.11
2	18	450	63	10	««Θ»»	N	0.14	5/19/03	3.33%	25.83	Detect	1.50	32.14	17.25	22.43	» «	13.11
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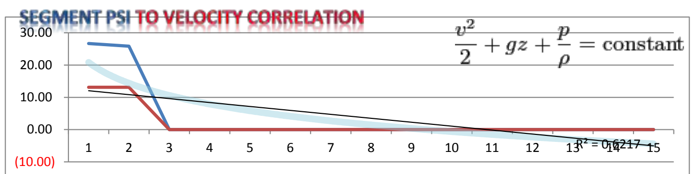
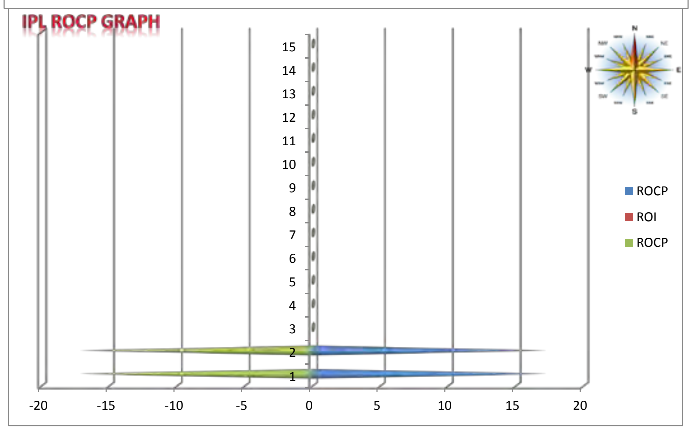
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	sodium sulfide	20.0%	900	h2o	0	17.25	Cecil Cox	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

- **IPL -** Injection Point Location designation number
- **ZONE-BLS -** Center target zone for Lateral Shot Line (LSL) injection material placement
- **VOL-DR -** Volume of Injection Material Delivered in the LSL
- **^{SUB} RESISTANCE -** Resistance Return from KAPSDIDS (equivalent to ECD)
- **^{BERN} DIFF -** Bernoulli differential calibrated constant (Incompressible Flow Equation)
- **RADIAL/TARGETED -** ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
- **C-DIR -** Compass direction of the segmented VVDN
- **Time-Log -** Minutes required to complete LSL
- **Date -** Date of the actual LSL completion
- **Source Diff % -** Percentage of Source Increases or Decreases in Flow Rate
- **OLH-^{SEG}-PSI -** Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
- **Q Detect-** Q = the ability to apply a negative polarity to the subsurface resistance
- **^{ATpsi}ROCP -** Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
- **T-Flow Rate-** Total flow rate in gallons per minute accomplished in the LSL
- **^{e}ROCP -** Estimated Radius of Contact Potential
- **^{e}K-LOCK -** Estimated Subsurface Kinetic Lock boundary
- **^{e}CFG-PERF -** System performance based on historical data for similar configuration
- **^{Seg}EV-Ft/Sec -** Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates **Plymouth Mi** **FS1761.00** **Racer Trust, 13000 Eckles Rd,** **Livonia MI**

View Point Data

CSV: FMC **Configuration =** *Radial* **Provider Project#:** *FS1761.00* **Badger Unit:** *HD*

IPL-18	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	54	0	««Θ»»	N	0.15	5/19/03	16.67%	29.17	Detect	1.69	30.00	17.25	22.43	» «	12.24
2	18	450	56	0	««Θ»»	N	0.15	5/19/03	13.33%	28.33	Detect	1.64	30.00	17.25	22.43	» «	12.24
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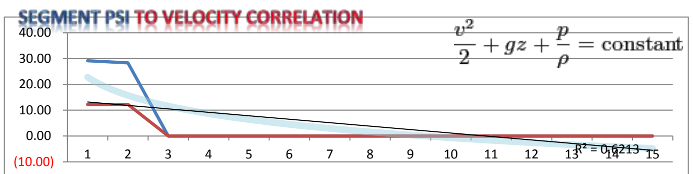
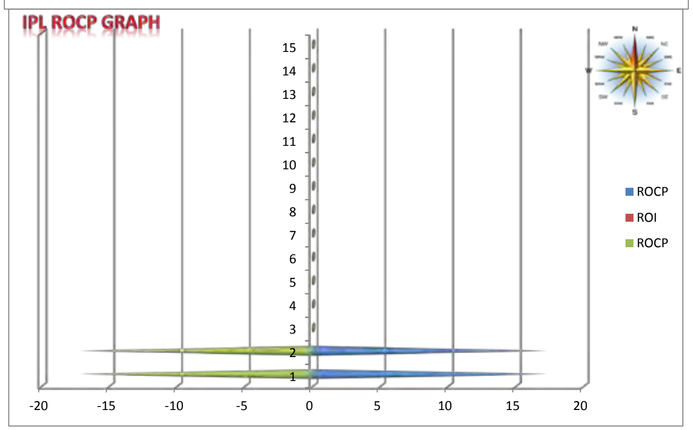
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
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BERN DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-SEG-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
ATpsi ROCP - Attenuated last known OLH-SEG-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
e ROCP - Estimated Radius of Contact Potential
e K-LOCK - Estimated Subsurface Kinetic Lock boundary
e CFG-PERF - System performance based on historical data for similar configuration
Seg EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Internet Access
Registered: www.kapsdids.com.com
Non-Registered: www.badgerlive.com

Contact Information
Phone (352) 343-0336
Fax: (352) 343-0346

Badger Injection Solutions, LLC
24621 Ranch Rd
Astatula, Florida 34705

Badger Injection Delivery Summary

Conestoga Rovers & Associates Plymouth Mi FS1761.00 Racer Trust, 13000 Eckles Rd, Livonia MI

View Point Data

CSV: FMC Configuration = *Radial* Provider Project#: *FS1761.00* Badger Unit: *HD*

IPL-35	ZONE-BLS	VOL-DR	^{SUB}RESIS	^{Bern}DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	63	10	««Θ»»	N	0.14	5/19/03	3.33%	25.83	Detect	1.50	32.14	17.25	22.43	» «	13.11
2	18	450	61	10	««Θ»»	N	0.14	5/19/03	6.67%	26.67	Detect	1.55	32.14	17.25	22.43	» «	13.11
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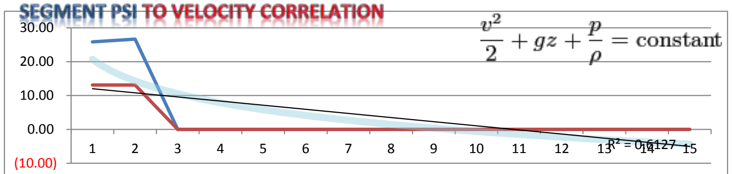
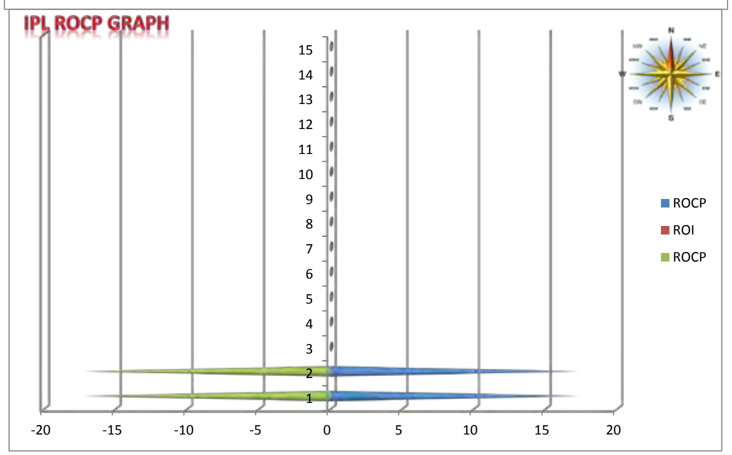
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox

SEGMENT PSI TO VELOCITY CORRELATION



IPL ROCP GRAPH



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
^{SUB} RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
^{BERN} DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-^{SEG}-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
^{ATpsi}ROCP - Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
^{e}ROCP - Estimated Radius of Contact Potential
^{e}K-LOCK - Estimated Subsurface Kinetic Lock boundary
^{e}CFG-PERF - System performance based on historical data for similar configuration
^{Seg}EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates Plymouth Mi FS1761.00 Racer Trust, 13000 Eckles Rd, Livonia MI

View Point Data

CSV: FMC Configuration = *Radial* Provider Project#: *FS1761.00* Badger Unit: *HD*

IPL-36	ZONE-BLS	VOL-DR	^{SUB}RESIS	^{Bern}DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	57	27	««Θ»»	N	0.13	5/19/03	12.00%	28.00	Detect	1.65	34.62	17	22.10	» «	14.12
2	18	450	57	27	««Θ»»	N	0.13	5/19/03	12.00%	28.00	Detect	1.65	34.62	17	22.10	» «	14.12
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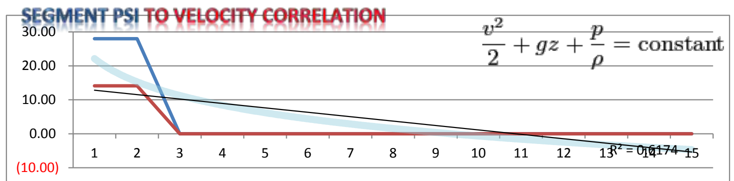
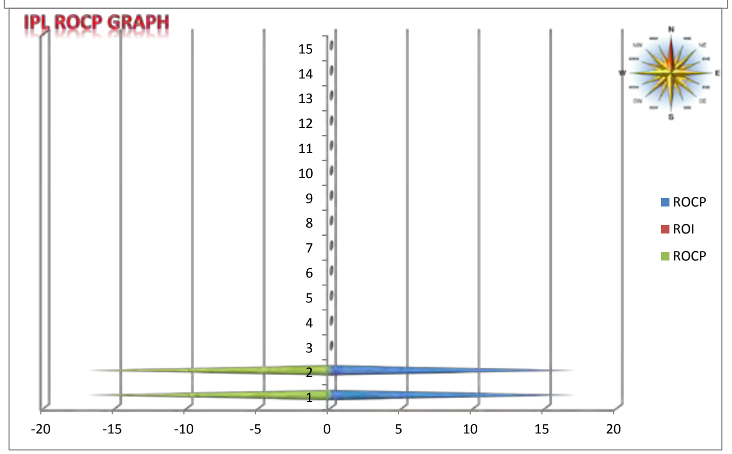
(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.00	Dave Mokma	Steve Cox	Cecil Cox



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		



LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
^{SUB}RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
^{BERN}DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-^{SEG}-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
^{ATpsi}ROCP - Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
^{e}ROCP - Estimated Radius of Contact Potential
^{e}K-LOCK - Estimated Subsurface Kinetic Lock boundary
^{e}CFG-PERF - System performance based on historical data for similar configuration
^{Seg}EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates **Plymouth Mi** **FS1761.00** **Racer Trust, 13000 Eckles Rd,** **Livonia MI**

View Point Data

CSV: FMC **Configuration =** *Radial* **Provider Project#:** *FS1761.00* **Badger Unit:** *HD*

IPL-37	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	56	0	««Θ»»	N	0.15	5/19/03	13.33%	28.33	Detect	1.64	30.00	17.25	22.43	» «	12.24
2	18	450	61	27	««Θ»»	N	0.13	5/19/03	6.67%	26.67	Detect	1.57	34.62	17	22.10	» «	14.12
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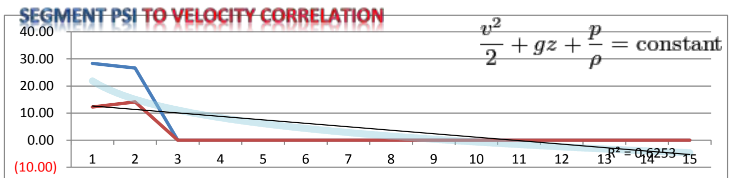
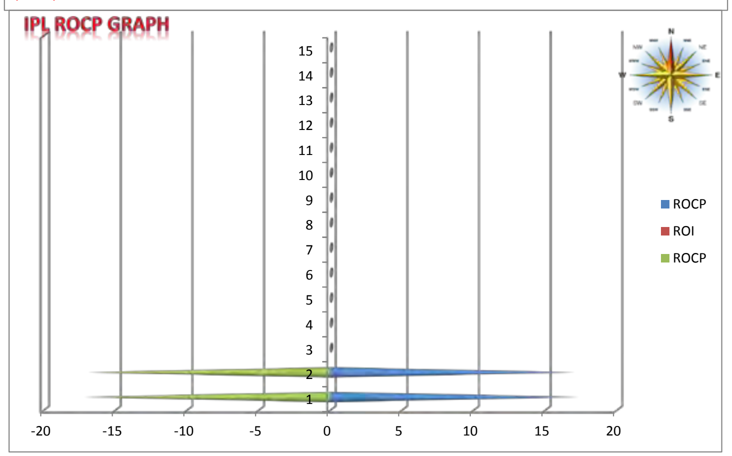
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.13	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

- **IPL -** Injection Point Location designation number
- **ZONE-BLS -** Center target zone for Lateral Shot Line (LSL) injection material placement
- **VOL-DR -** Volume of Injection Material Delivered in the LSL
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- **C-DIR -** Compass direction of the segmented VVDN
- **Time-Log -** Minutes required to complete LSL
- **Date -** Date of the actual LSL completion
- **Source Diff % -** Percentage of Source Increases or Decreases in Flow Rate
- **OLH-SEG-PSI -** Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
- **Q Detect-** Q = the ability to apply a negative polarity to the subsurface resistance
- **ATpsi ROCP -** Attenuated last known OLH-SEG-PSI across the lateral ROCP
- **T-Flow Rate-** Total flow rate in gallons per minute accomplished in the LSL
- **e ROCP -** Estimated Radius of Contact Potential
- **e K-LOCK -** Estimated Subsurface Kinetic Lock boundary
- **e CFG-PERF -** System performance based on historical data for similar configuration
- **Seg EV-Ft/Sec -** Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates Plymouth Mi FS1761.00 Racer Trust, 13000 Eckles Rd, Livonia MI

View Point Data

CSV: FMC Configuration = *Radial* Provider Project#: *FS1761.00* Badger Unit: *HD*

IPL-76	ZONE-BLS	VOL-DR	SUB RESIS	Bern DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-SEG-PSI	Q-DETECT	ATpsi ROCP	T-FLOW RATE	e ROCP	e K-LOCK	e CFG-PERF	Seg EV-Ft/Sec
1	22	450	37	0	««Θ»»	N	0.15	5/19/03	43.33%	35.83	Detect	2.02	30.00	17.75	23.08	» «	12.24
2	18	450	43	10	««Θ»»	N	0.14	5/19/03	33.33%	33.33	Detect	1.90	32.14	17.5	22.75	» «	13.11
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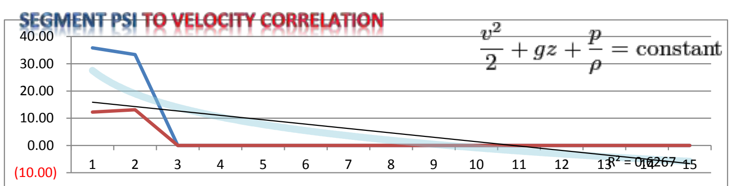
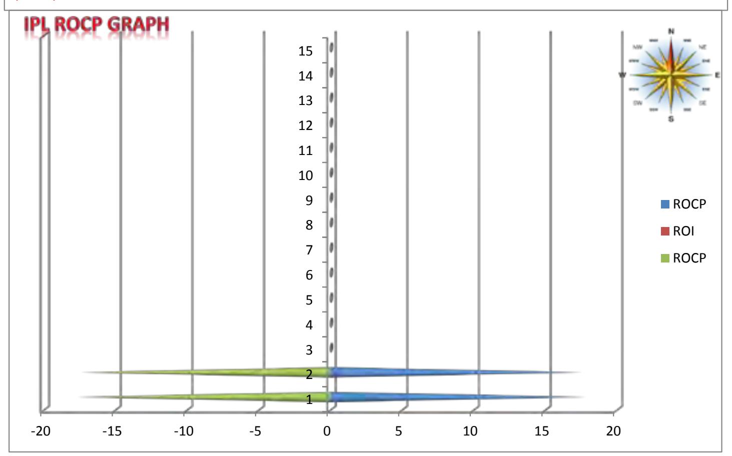
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.63	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
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ATpsi ROCP - Attenuated last known OLH-SEG-PSI across the lateral ROCP
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e K-LOCK - Estimated Subsurface Kinetic Lock boundary
e CFG-PERF - System performance based on historical data for similar configuration
Seg EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates | Plymouth Mi | FS1761.00 | Racer Trust, 13000 Eckles Rd, | Livonia MI

View Point Data

CSV: FMC | Configuration = *Radial* | Provider Project#: *FS1761.00* | Badger Unit: *HD*

IPL-77	ZONE-BLS	VOL-DR	^{SUB}RESIS	^{Bern}DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	61	10	««Θ»»	N	0.14	5/19/03	6.67%	26.67	Detect	1.55	32.14	17.25	22.43	» «	13.11
2	18	450	61	10	««Θ»»	N	0.14	5/19/03	6.67%	26.67	Detect	1.55	32.14	17.25	22.43	» «	13.11
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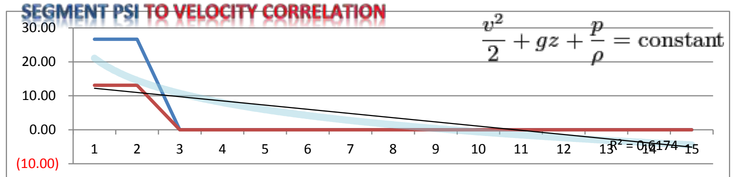
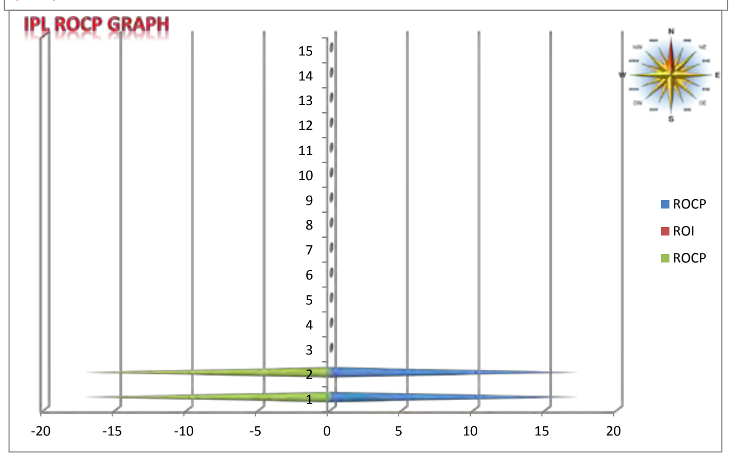
Powered by B.I.T.S.

(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox





Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
^{SUB} RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
^{BERN} DIFF - Bernoulli differential calibrated constant (Incompressible Flow Equation)
RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
Date - Date of the actual LSL completion
Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-^{SEG}-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
^{ATpsi}ROCP - Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
^{e}ROCP - Estimated Radius of Contact Potential
^{e}K-LOCK - Estimated Subsurface Kinetic Lock boundary
^{e}CFG-PERF - System performance based on historical data for similar configuration
^{Seg}EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

Location Notes: -

Badger Injection Delivery Summary

Conestoga Rovers & Associates | Plymouth Mi | FS1761.00 | Racer Trust, 13000 Eckles Rd, | Livonia MI

View Point Data

CSV: FMC | Configuration = *Radial* | Provider Project#: *FS1761.00* | Badger Unit: *HD*

IPL-78	ZONE-BLS	VOL-DR	^{SUB}RESIS	^{Bern}DIFF	RADIAL	C-DIR	TIME-LOG	DATE	SOURCE-DIF%	OLH-^{SEG}-PSI	Q-DETECT	^{ATpsi}ROCP	T-FLOW RATE	^{e}ROCP	^{e}K-LOCK	^{e}CFG-PERF	^{Seg}EV-Ft/Sec
1	22	450	56	0	««Θ»»	N	0.15	5/19/03	13.33%	28.33	Detect	1.64	30.00	17.25	22.43	» «	12.24
2	18	450	59	10	««Θ»»	N	0.14	5/19/03	10.00%	27.50	Detect	1.59	32.14	17.25	22.43	» «	13.11
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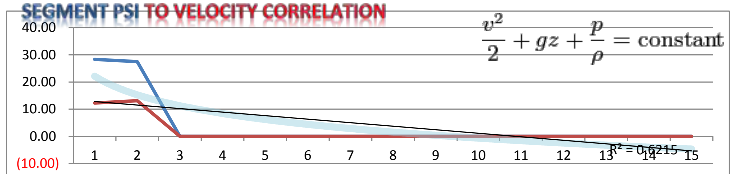
----			----				----										
----			----				----										
----			----				----										
----			----				----										

Powered by B.I.T.S.

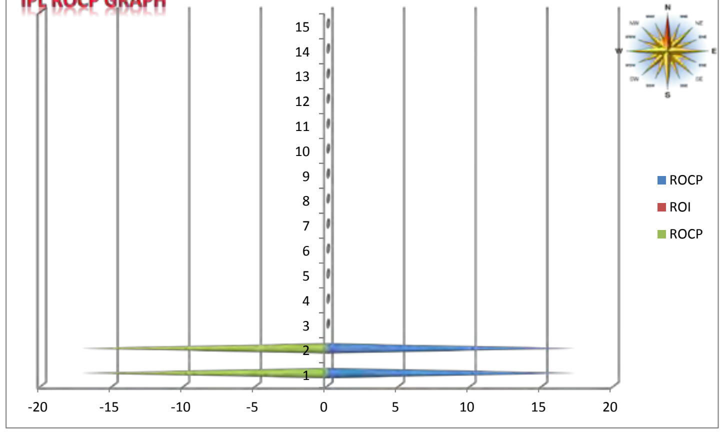
(PROGRAM)	(I.M. TYPE)	(MAT. LOAD)	(IPL GAL)	(DP MAT)	(SST MAT)	(AVG IPL ROCP')	(BCO)	(BAT)	(BTC)
ISCO	Sodium Sulfide	20.0%	900	H2O	N/A	17.25	Dave Mokma	Steve Cox	Cecil Cox

SEGMENT PSI TO VELOCITY CORRELATION

$$\frac{v^2}{2} + gz + \frac{p}{\rho} = \text{constant}$$



IPL ROCP GRAPH



Sensor Array Connection Data

Type	Well ID	DFT	Start	End	Change
Elec. Cond.					
»PSI	»»»	»»»	0		
PH					
»PSI	»»»	»»»	0		
D.O.					
»PSI	»»»	»»»	0		
Temp-F					
»PSI	»»»	»»»	0		

LEGEND

IPL - Injection Point Location designation number
ZONE-BLS - Center target zone for Lateral Shot Line (LSL) injection material placement
VOL-DR - Volume of Injection Material Delivered in the LSL
^{SUB}RESISTANCE - Resistance Return from KAPSDIDS (equivalent to ECD)
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RADIAL/TARGETED - ««Θ»» or ««┴»» to indicate whether the IPL was a targeted injection
C-DIR - Compass direction of the segmented VVDN
Time-Log - Minutes required to complete LSL
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Source Diff % - Percentage of Source Increases or Decreases in Flow Rate
OLH-^{SEG}-PSI - Open Loop Hydraulic Segment PSI's - (Last known PSI at the segment interface)
Q Detect- Q = the ability to apply a negative polarity to the subsurface resistance
^{ATpsi}ROCP - Attenuated last known OLH-^{SEG}-PSI across the lateral ROCP
T-Flow Rate- Total flow rate in gallons per minute accomplished in the LSL
^{e}ROCP - Estimated Radius of Contact Potential
^{e}K-LOCK - Estimated Subsurface Kinetic Lock boundary
^{e}CFG-PERF - System performance based on historical data for similar configuration
^{Seg}EV-Ft/Sec - Segment Velocities of injection material in Ft/Sec to the formation

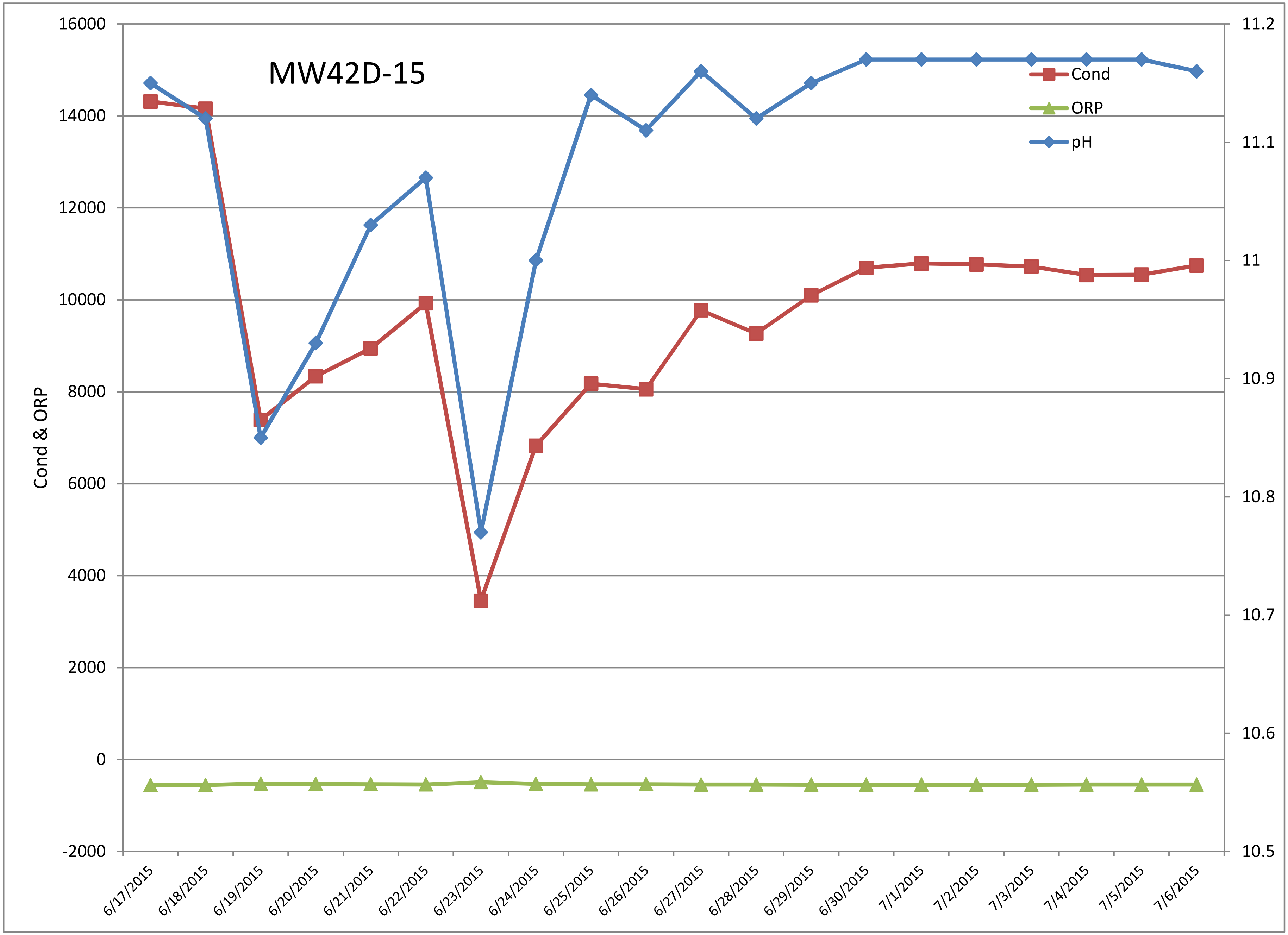
Location Notes: -

Contact Information
Phone (352) 343-0336
Fax: (352) 343-0346

Internet Access
Registered: www.kapsdids.com.com
Non-Registered: www.badgerlive.com

Badger Injection Solutions, LLC
24621 Ranch Rd
Astatula, Florida 34705

Appendix C
Multiparameter Sonde Data Graphs



MW42D-15
Cond
ORP
pH
Cond & ORP
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
11.2
11.1
11
10.9
10.8
10.7
10.6
10.5
6/17/2015
6/18/2015
6/19/2015
6/20/2015
6/21/2015
6/22/2015
6/23/2015
6/24/2015
6/25/2015
6/26/2015
6/27/2015
6/28/2015
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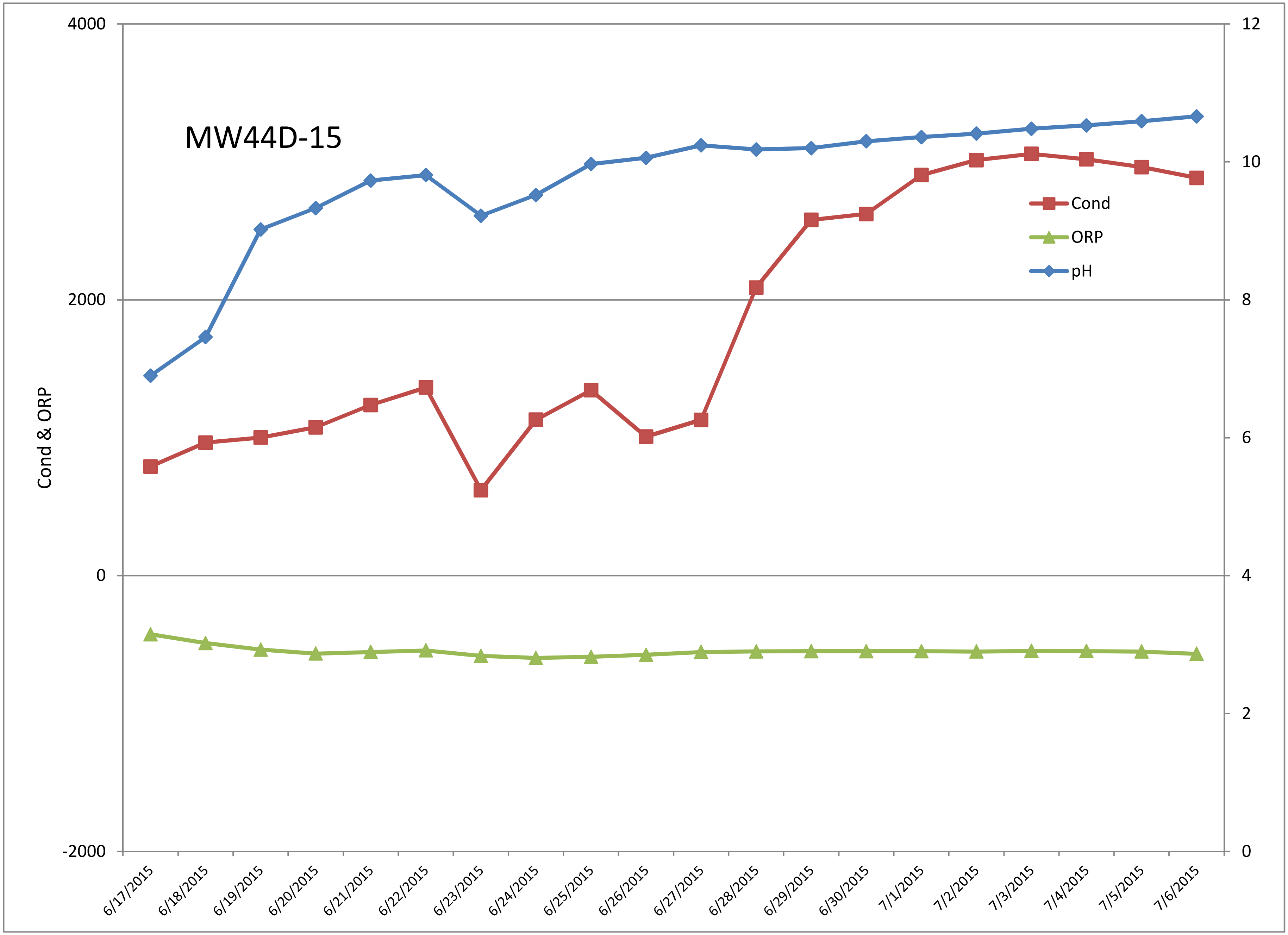
7/5/2015
7/6/2015



MW44D-15
Cond & ORP
4000
2000
0
-2000
12
10
8
6
4
2
0
Cond
ORP
pH
6/17/2015
6/18/2015
6/19/2015
6/20/2015
6/21/2015
6/22/2015
6/23/2015
6/24/2015
6/25/2015
6/26/2015
6/27/2015
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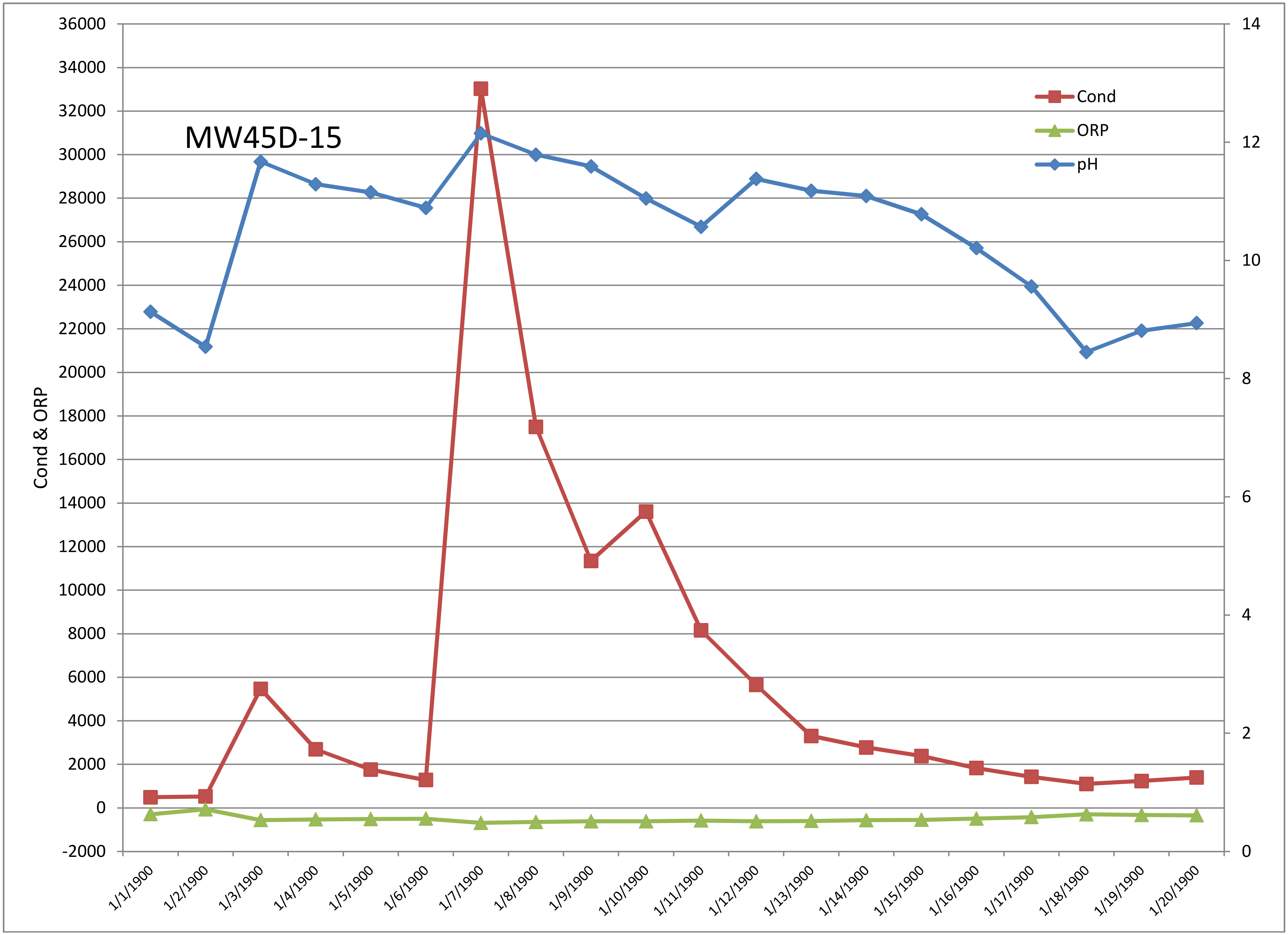
7/5/2015
7/6/2015



MW45D-15
Cond
ORP
pH
Cond & ORP
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
14
12
10
8
6
4
2
0
1/1/1900
1/2/1900
1/3/1900
1/4/1900
1/5/1900
1/6/1900
1/7/1900
1/8/1900
1/9/1900
1/10/1900
1/11/1900
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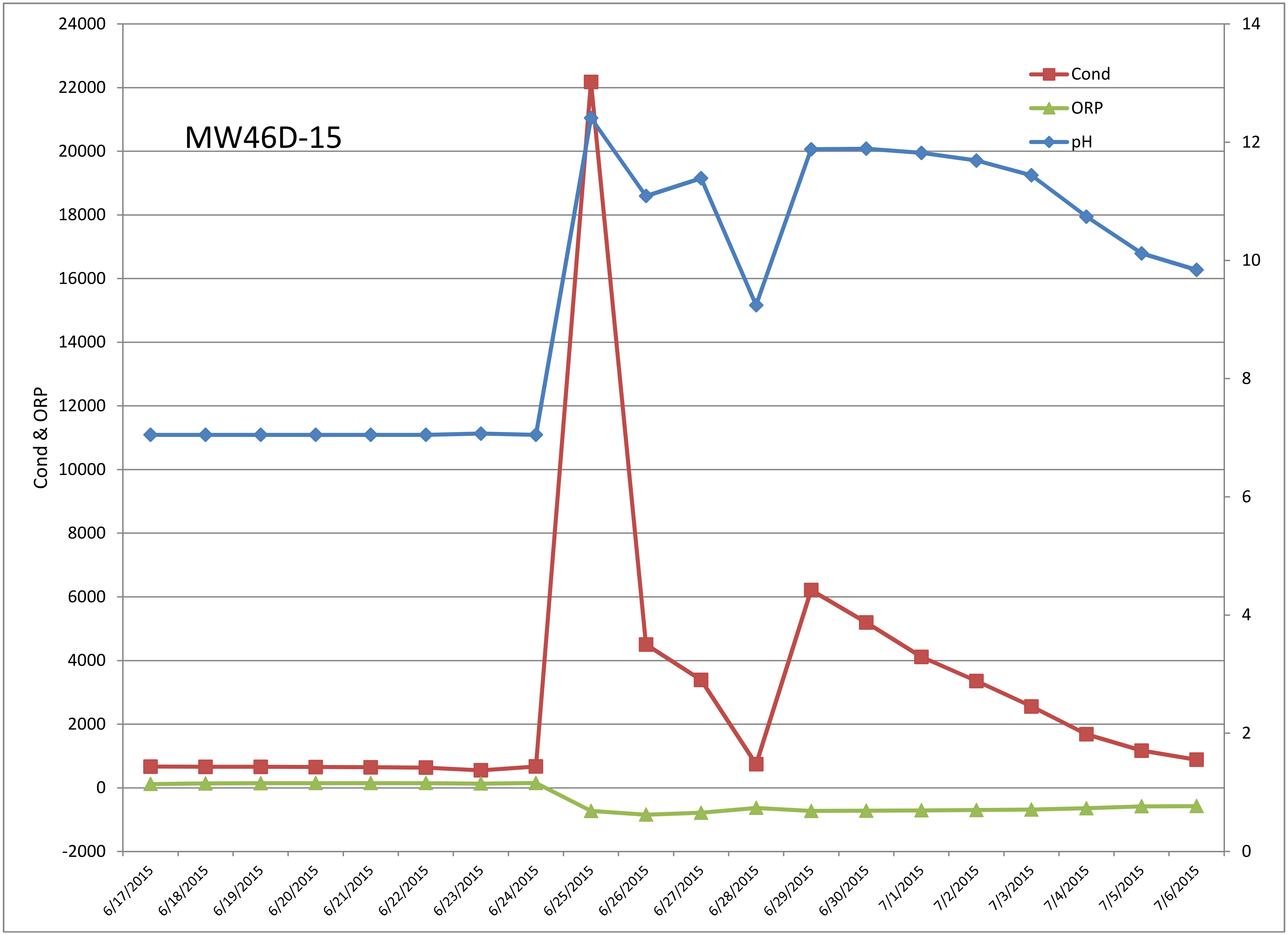
1/19/1900
1/20/1900



MW46D-15
Cond
ORP
pH
Cond & ORP
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
14
12
10
8
6
4
2
0
6/17/2015
6/18/2015
6/19/2015
6/20/2015
6/21/2015
6/22/2015
6/23/2015
6/24/2015
6/25/2015
6/26/2015
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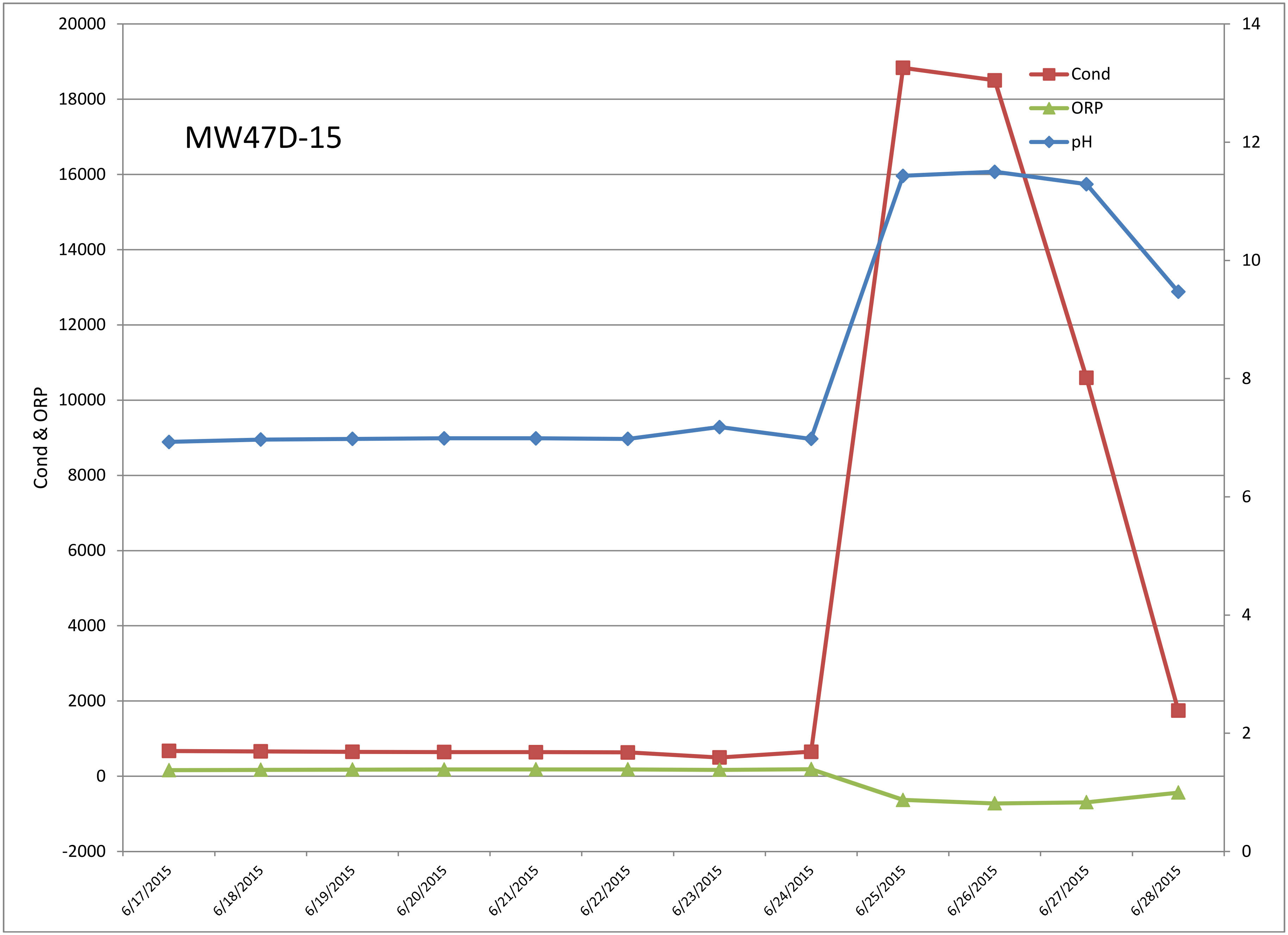
7/5/2015
7/6/2015



MW47D-15
Cond
ORP
pH
Cond & ORP
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
14
12
10
8
6
4
2
0
6/17/2015
6/18/2015
6/19/2015
6/20/2015
6/21/2015
6/22/2015
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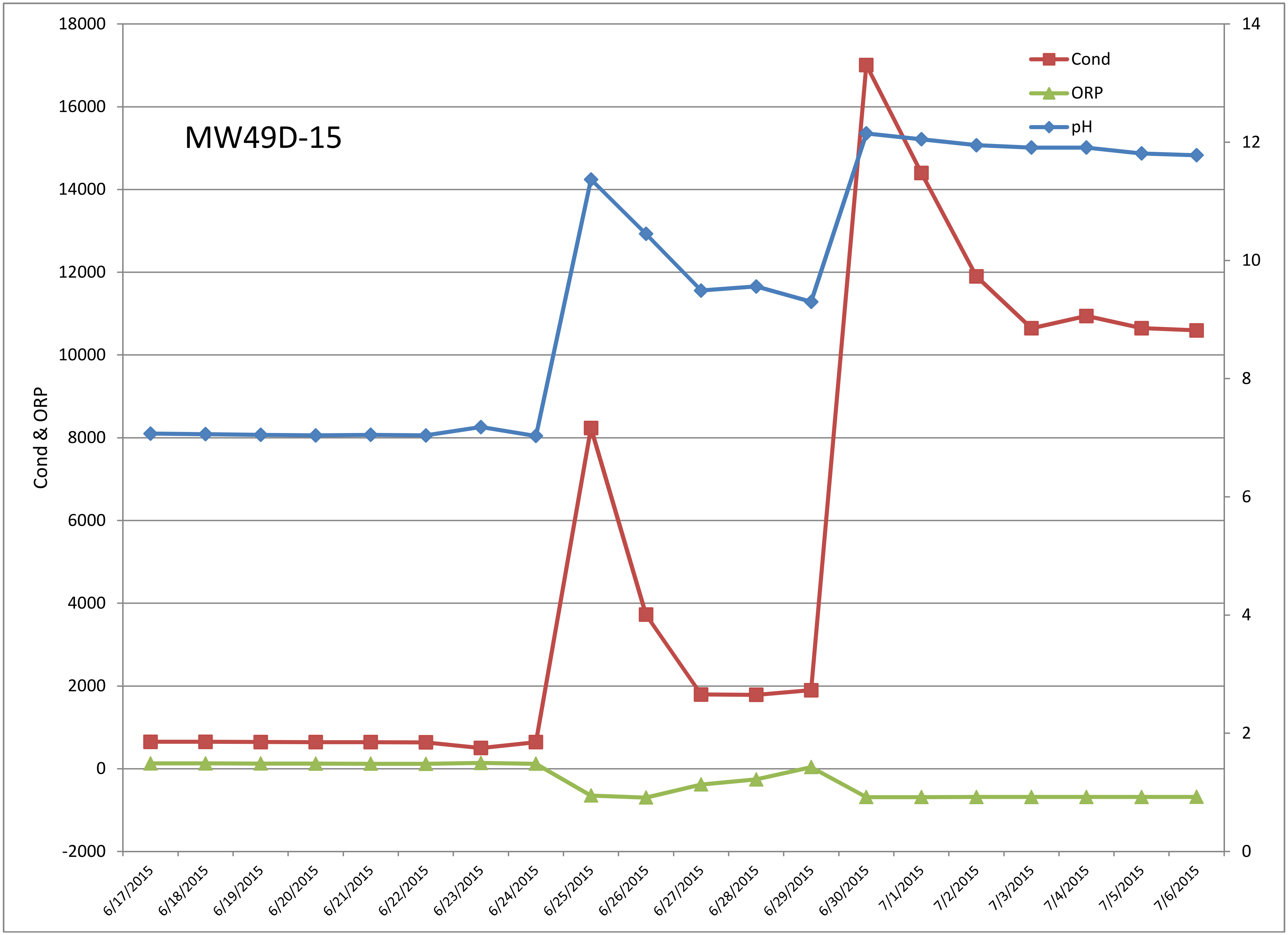
6/27/2015
6/28/2015



MW49D-15
Cond
ORP
pH
Cond & ORP
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
14
12
10
8
6
4
2
0
6/17/2015
6/18/2015
6/19/2015
6/20/2015
6/21/2015
6/22/2015
6/23/2015
6/24/2015
6/25/2015
6/26/2015
6/27/2015
6/28/2015
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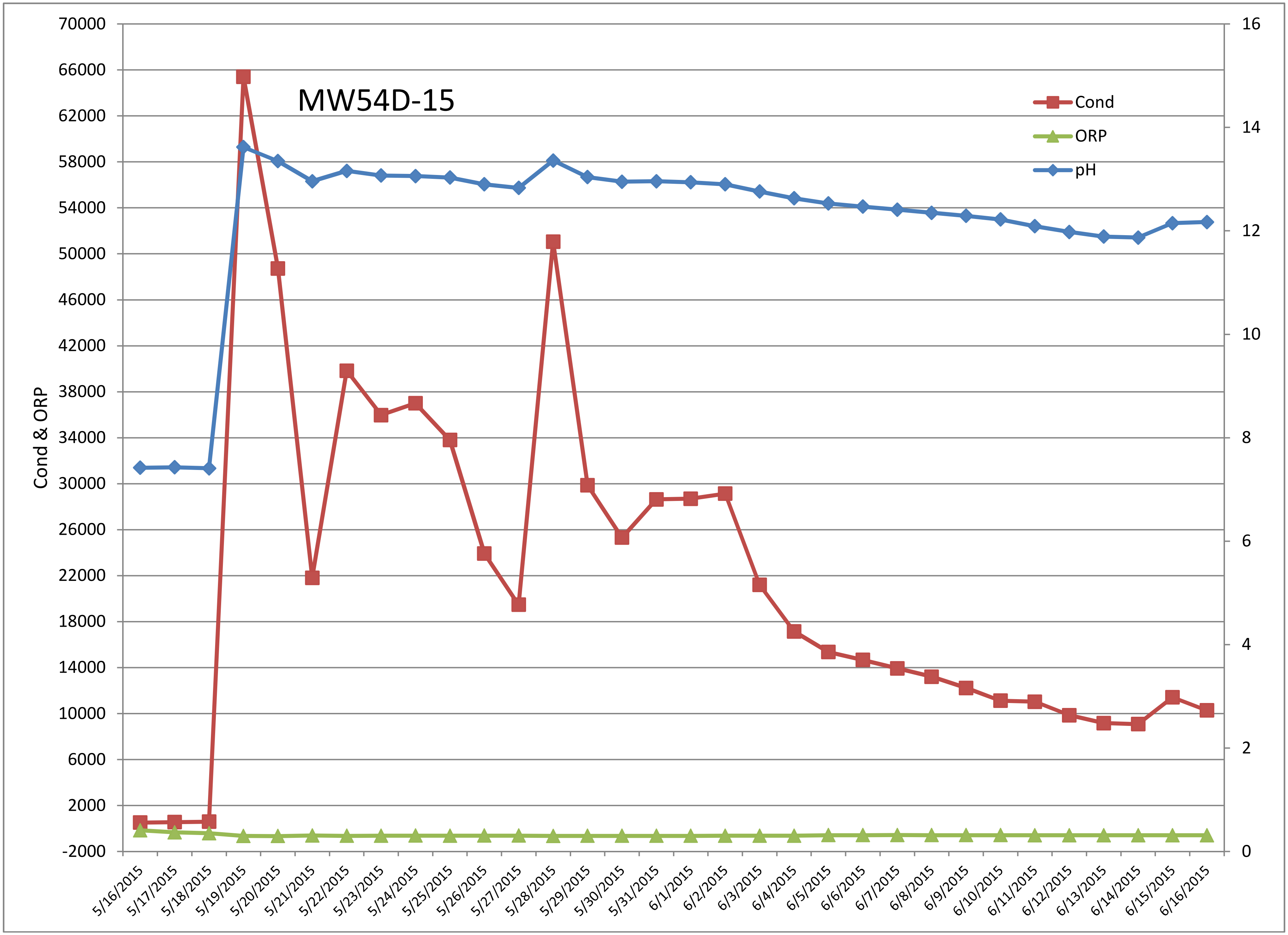
7/5/2015
7/6/2015


MW54D-15
Cond & ORP
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ORP
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66000
62000
58000
54000
50000
46000
42000
38000
34000
30000
26000
22000
18000
14000
10000
6000
2000
-2000
16
14
12
10
8
6
4
2
0
5/16/2015
5/17/2015
5/18/2015
5/19/2015
5/20/2015
5/21/2015
5/22/2015
5/23/2015
5/24/2015
5/25/2015
5/26/2015
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5/30/2015
5/31/2015
6/1/2015
6/2/2015
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6/7/2015
6/8/2015
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6/10/2015
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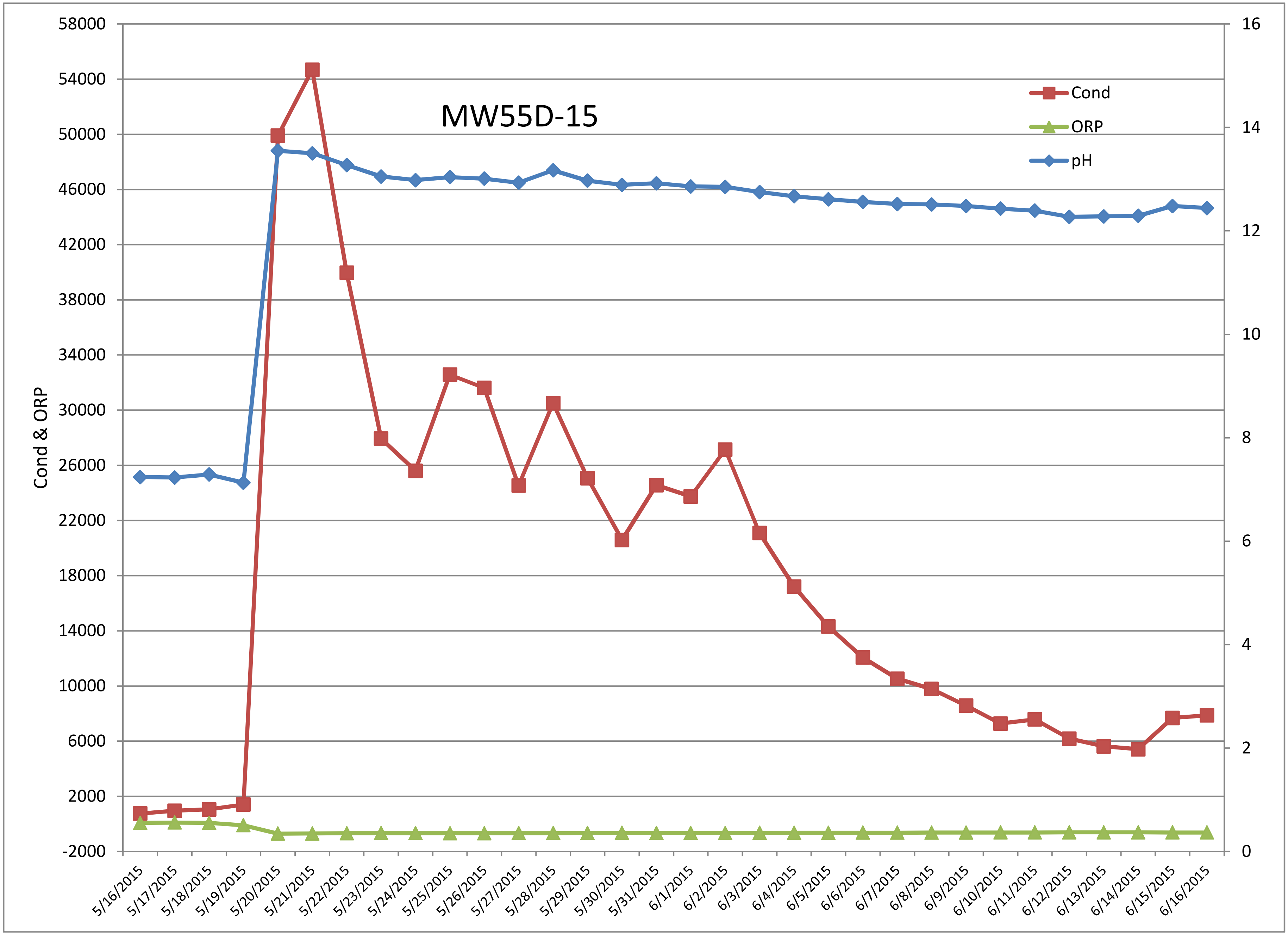
6/14/2015
6/15/2015
6/16/2015



MW55D-15
Cond
ORP
pH
Cond & ORP
58000
54000
50000
46000
42000
38000
34000
30000
26000
22000
18000
14000
10000
6000
2000
-2000
16
14
12
10
8
6
4
2
0
5/16/2015
5/17/2015
5/18/2015
5/19/2015
5/20/2015
5/21/2015
5/22/2015
5/23/2015
5/24/2015
5/25/2015
5/26/2015
5/27/2015
5/28/2015
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6/1/2015
6/2/2015
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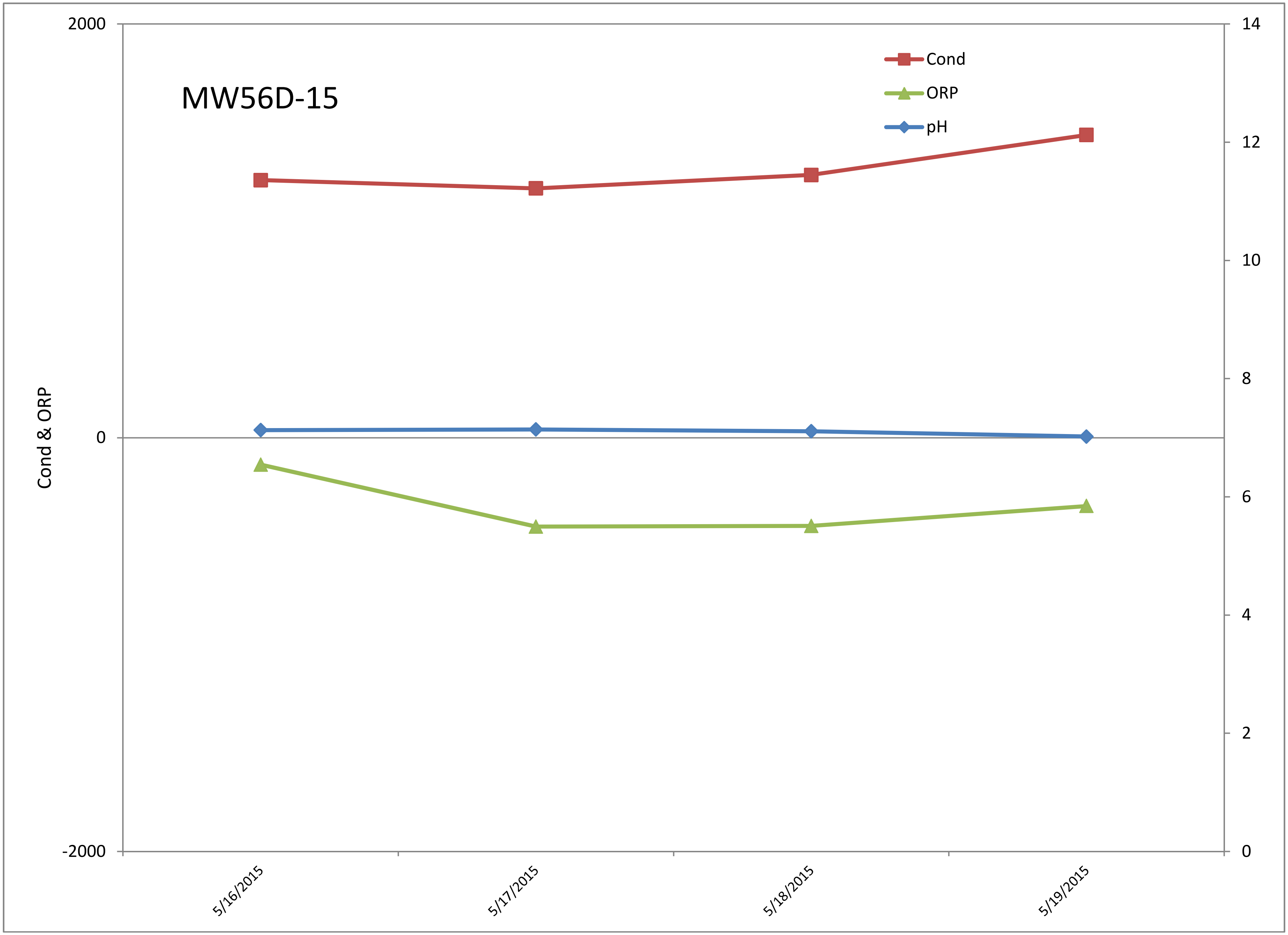
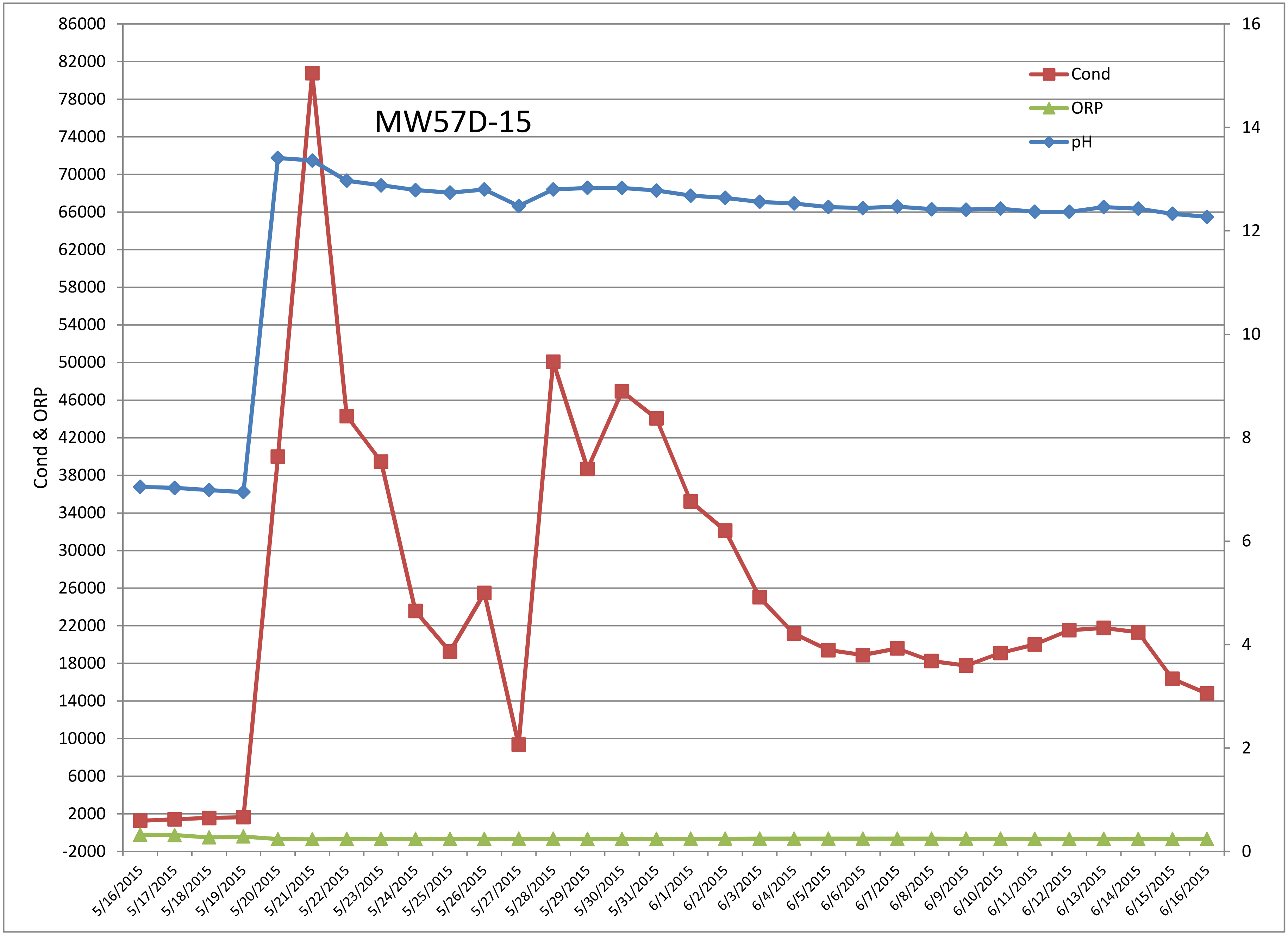
6/15/2015
6/16/2015


MW56D-15
Cond
ORP
pH
Cond & ORP
2000
0
-2000
14
12
10
8
6
4
2
0
5/16/2015
5/17/2015
5/18/2015
5/19/2015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ORP
pH
Cond & ORP
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82000
78000
74000
70000
66000
62000
58000
54000
50000
46000
42000
38000
34000
30000
26000
22000
18000
14000
10000
6000
2000
-2000
16
14
12
10
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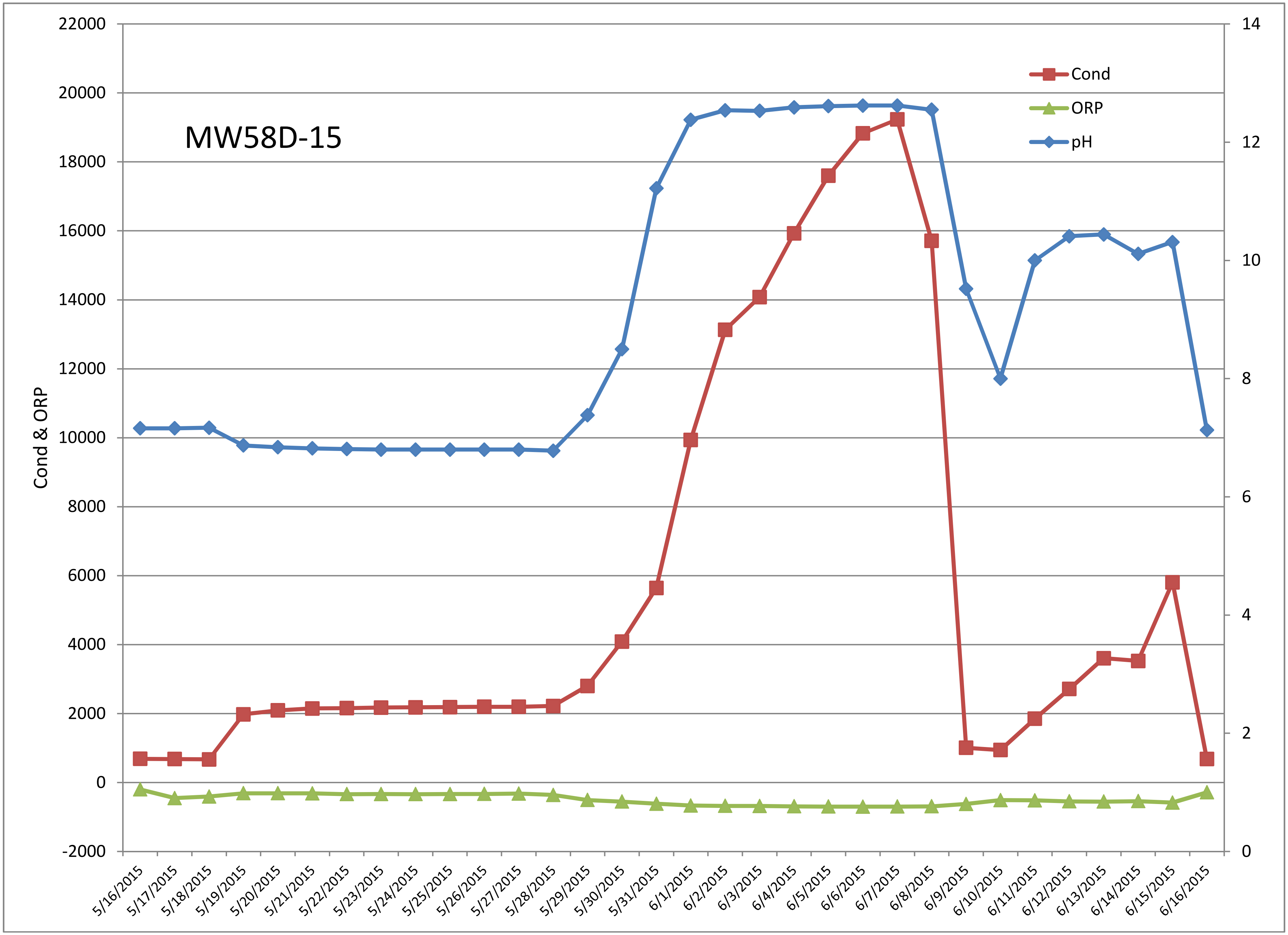
6/16/2015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ORP
pH
Cond & ORP
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16000
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2
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5/18/2015
5/19/2015
5/20/2015
5/21/2015
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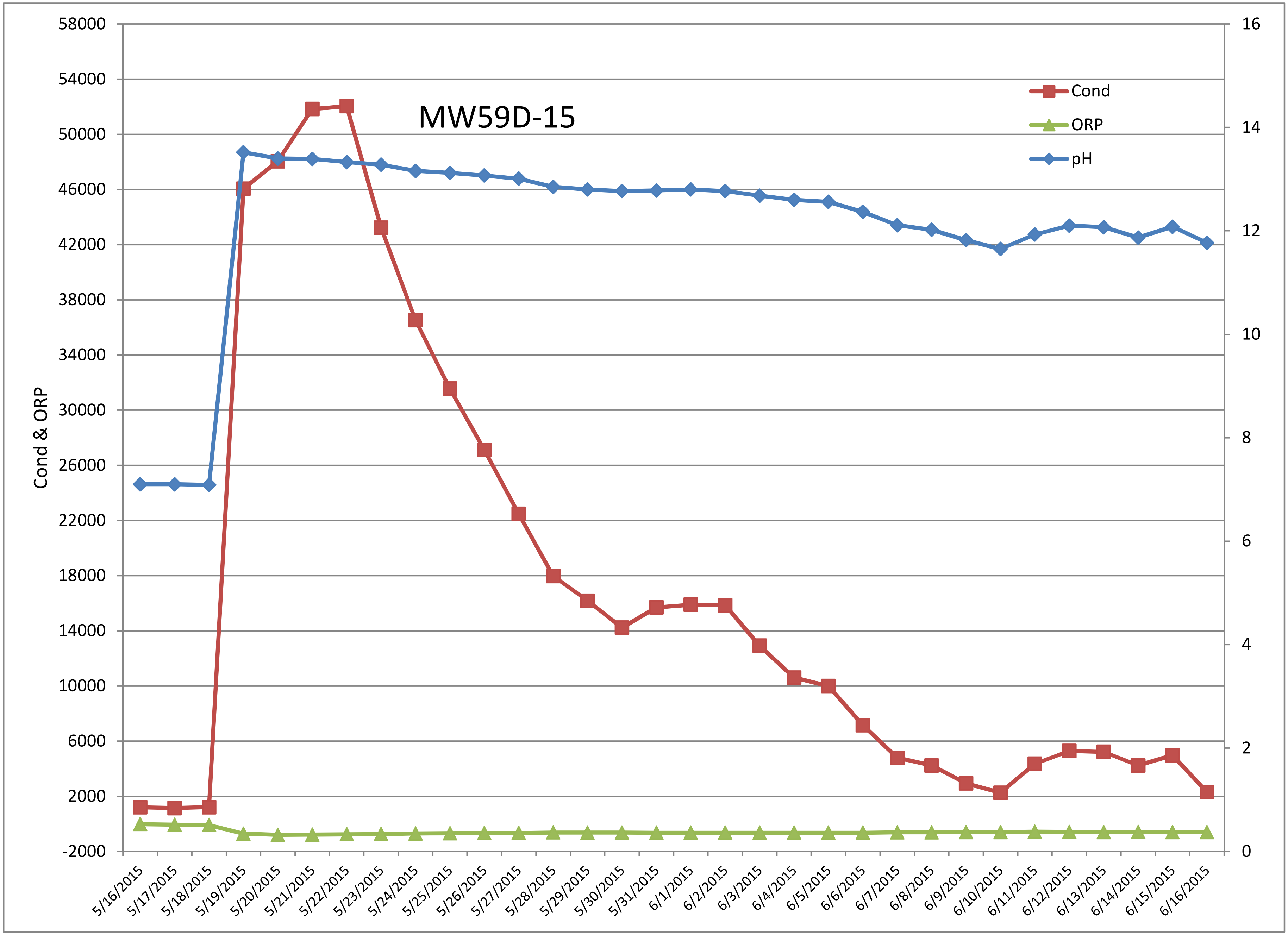

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ORP
pH
Cond & ORP
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46000
42000
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30000
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22000
18000
14000
10000
6000
2000
-2000
16
14
12
10
8
6
4
2
0
5/16/2015
5/17/2015
5/18/2015
5/19/2015
5/20/2015
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5/22/2015
5/23/2015
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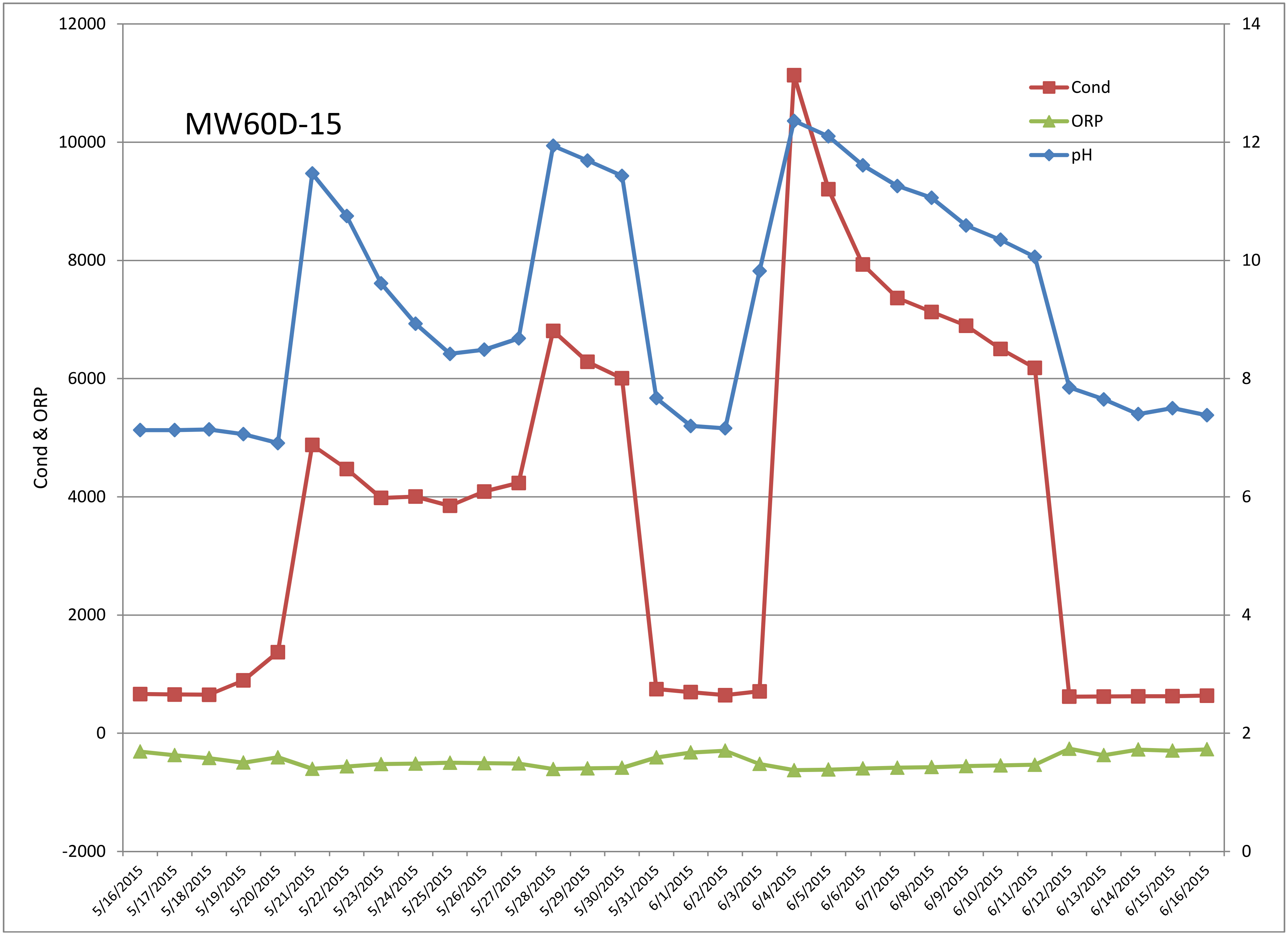
6/16/2015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Cond
ORP
pH
Cond & ORP
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10000
8000
6000
4000
2000
0
-2000
14
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10
8
6
4
2
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5/16/2015
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5/18/2015
5/19/2015
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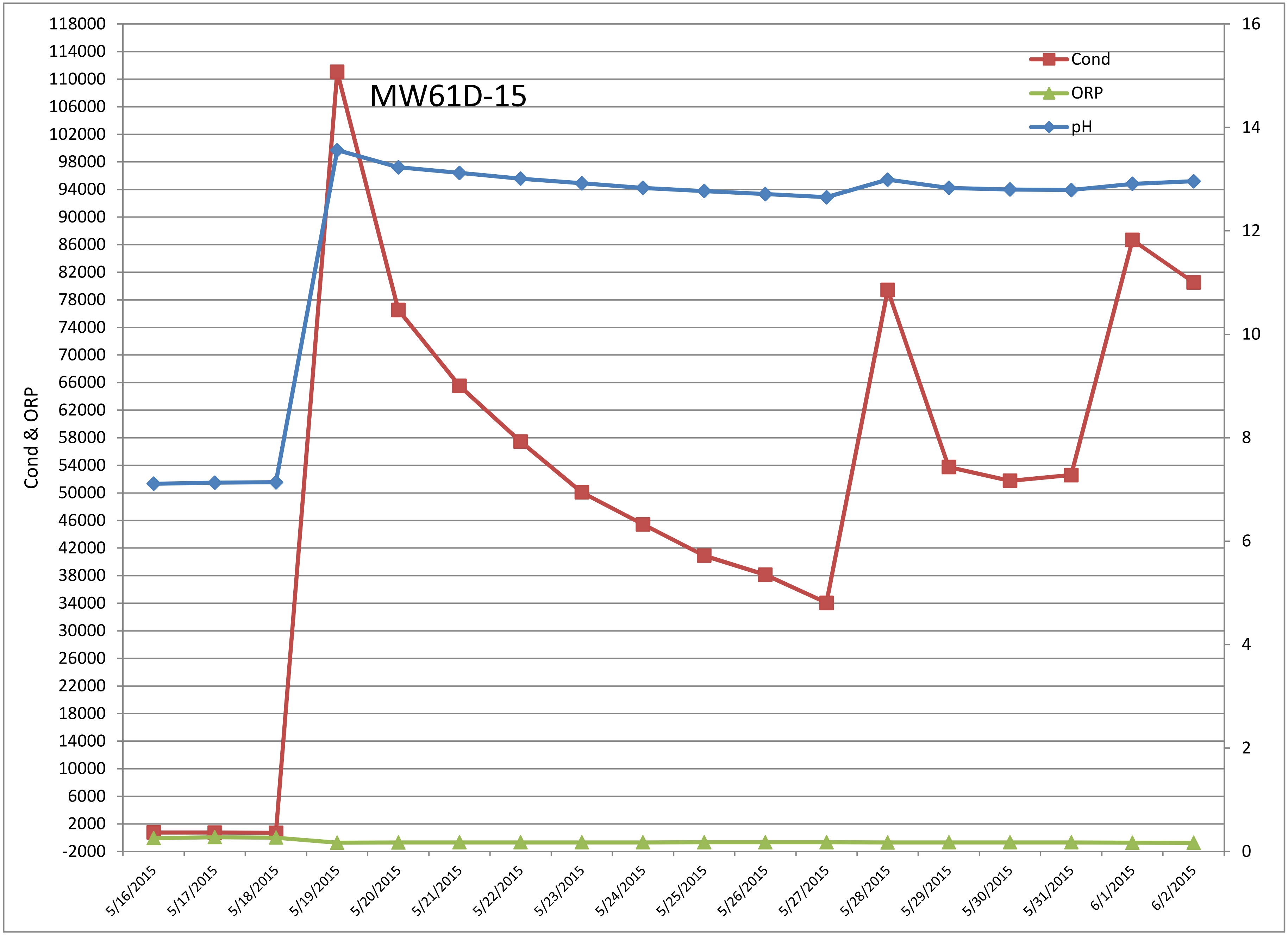
6/15/2015
6/16/2015


MW61D-15
Cond & ORP
118000
114000
110000
106000
102000
98000
94000
90000
86000
82000
78000
74000
70000
66000
62000
58000
54000
50000
46000
42000
38000
34000
30000
26000
22000
18000
14000
10000
6000
2000
-2000
16
14
12
10
8
6
4
2
0
Cond
ORP
pH
5/16/2015
5/17/2015
5/18/2015
5/19/2015
5/20/2015
5/21/2015
5/22/2015
5/23/2015
5/24/2015
5/25/2015
5/26/2015
5/27/2015
5/28/2015
5/29/2015
5/30/2015
5/31/2015
6/1/2015
6/2/2015

Appendix D
Electrical Conductivity Boring Summary

Stock Drilling, Inc.

Electrical Conductivity Boring Summary

Eckles Rd. Injections, Livonia, MI

Prepared for CRA

Prepared by Jonathan Wiley

Stock Drilling Inc.

P.O.Box 186

Ida, MI 48159

(734) 279-2059

www.stockdrilling.com

EC Boring Summary

Eckles Rd. Injections, Livonia, MI

Index:

Introduction

The EC investigation took place on Wednesday, May 20, 2015 and Thursday, May 21, 2015. The investigation consisted of twenty-one EC borings. The number and locations of the borings were specified by the CRA represenitive on site.

Project Summary

Wednesday, May 20, 2015

Prior to beginning work the Health and Safety plan was reviewed. The boring locations were not cored upon our arrival so after a phone call it was decided that CRA would pull a rig from injections and open the locations. On boring 79-15s the string pot data cable snapped and a spare was installed. After boring 79-10s we put the EC probe directly into a bucket with the injected material to see how well it responded since we had not seen anything on the previous locations. The EC responded well as anticipated. After boring 79-7.5s it was decided by CRA that they no longer wanted to use their rig and subcontracted a coring company to core the holes. We waited approximately two hours for two holes to be cored before we could continue. It was then decided that CRA would use their rig to core the remaining holes. On boring 79-10e we encountered refusal @ 15.25'. On boring 79-5e we encountered refusal @ 13.8'. Probing conditions were moderately hard. We completed nine borings for the day with two of them being refusals.

Thursday, May 21, 2015

Prior to beginning work the Health and Safety plan was reviewed. On boring 75-10e we encountered refusal @ 12.3'. On boring 17-10w the string pot malfunctioned and it was replaced with a new one. On boring 17-5w we encountered refusal @ 7.8'. On boring 33-10n we encountered refusal @ 2'. We then stepped over and encountered refusal @ 4'. On boring 33-5n we encountered refusal @ 2'. Probing conditions were hard. We completed a total of twelve borings for the day with four of them being refusals. This wrapped up the project.

General Observations/Notes

Breakdowns/Standbys: Productivity was reasonable.

Safety Incidents/Stop work: N/A

Validation/Sampling: N/A

General Comments:

Overall the investigation went well. The response of the EC was very good at the various locations. We maintained a two man EC crew to expedite progress. Included with this summary is a flash drive including all the files for the project. The DI viewer software that is needed to view and alter the logs in their raw form is available for download at www.Geoprobe.com. There are copies of each log in a PDF format enclosed in the flash drive as well that can be viewed on any PDF reader.

EC Function:

The EC probes come in two different configurations, Dipole Array and Wenner Array, with the same theory of operation. A current is sent through the formation between two probe contacts. This current is measured along with the voltage that results. The conductivity is a ratio of current to voltage times a constant. The resulting reading is in milli-Siemens per meter (mS/m). Soil conductivity, in general, varies with grain size. Finer grained soils, such as silts or clays, tend to produce higher EC signals than coarser grained sand and gravels.

Response Testing of Geoprobe® EC

The EC system must be tested using the following QA procedures before and after each log. Following these procedures ensures that the system was performing correctly and validates the data quality.

Continuity Check: This test looks at the continuity of each of the wires within the system for all 4 dipole arrays.

Probe Isolation Test: This test makes sure that each dipole is isolated from the others.

EC Test Load: This test applies 3 different loads to the system that correlate to low, medium and high conductivity readings that the system will see in the subsurface. This test provides the best information of how the system is calibrated and how it will map the encountered lithology.

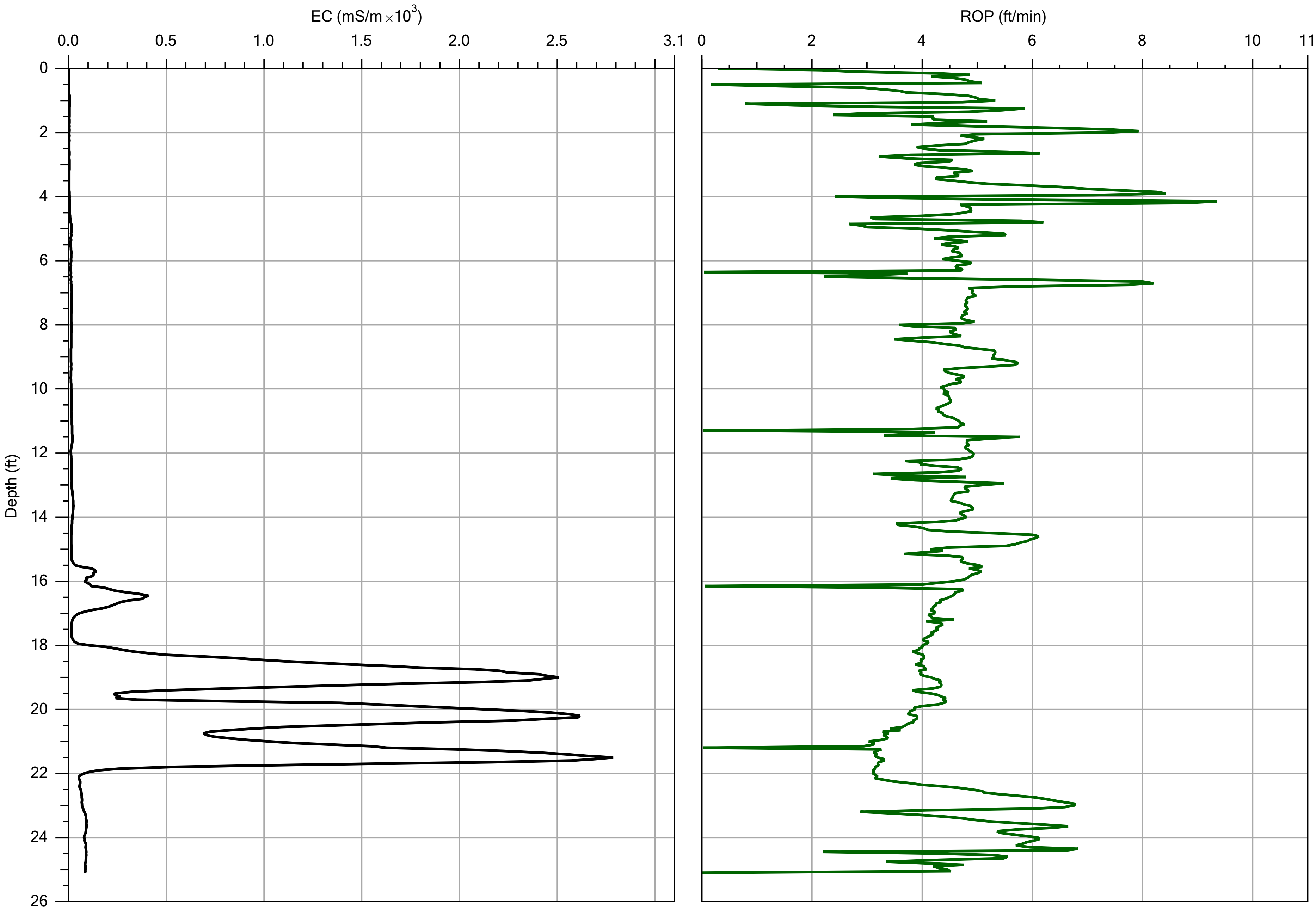
Disclaimer:

The analysis and opinions expressed in this report are based upon data obtained from the samples collected at the indicated locations and from other information discussed in this report. Exceptions, if any, are discussed in the Project Summary. This report is prepared for the exclusive use of our client for their specific application to the project discussed and has been prepared in accordance with generally accepted practices. Reported results shall not be reproduced, except in full, without written approval of Stock Drilling Inc. The sample results relate only to the analytes of locations tested. No warranties, expressed or implied are intended or made.

I certify that the data contained in this final report has been generated and reviewed in accordance with approved methods and our Standard Operating Procedure. Release of this final report is authorized Stock Drilling Inc., which is verified by the following signature.

____ ____________________

Approval Signature Date



STOCK DRILLING SAVE THE EARTH Our Job is Boring!

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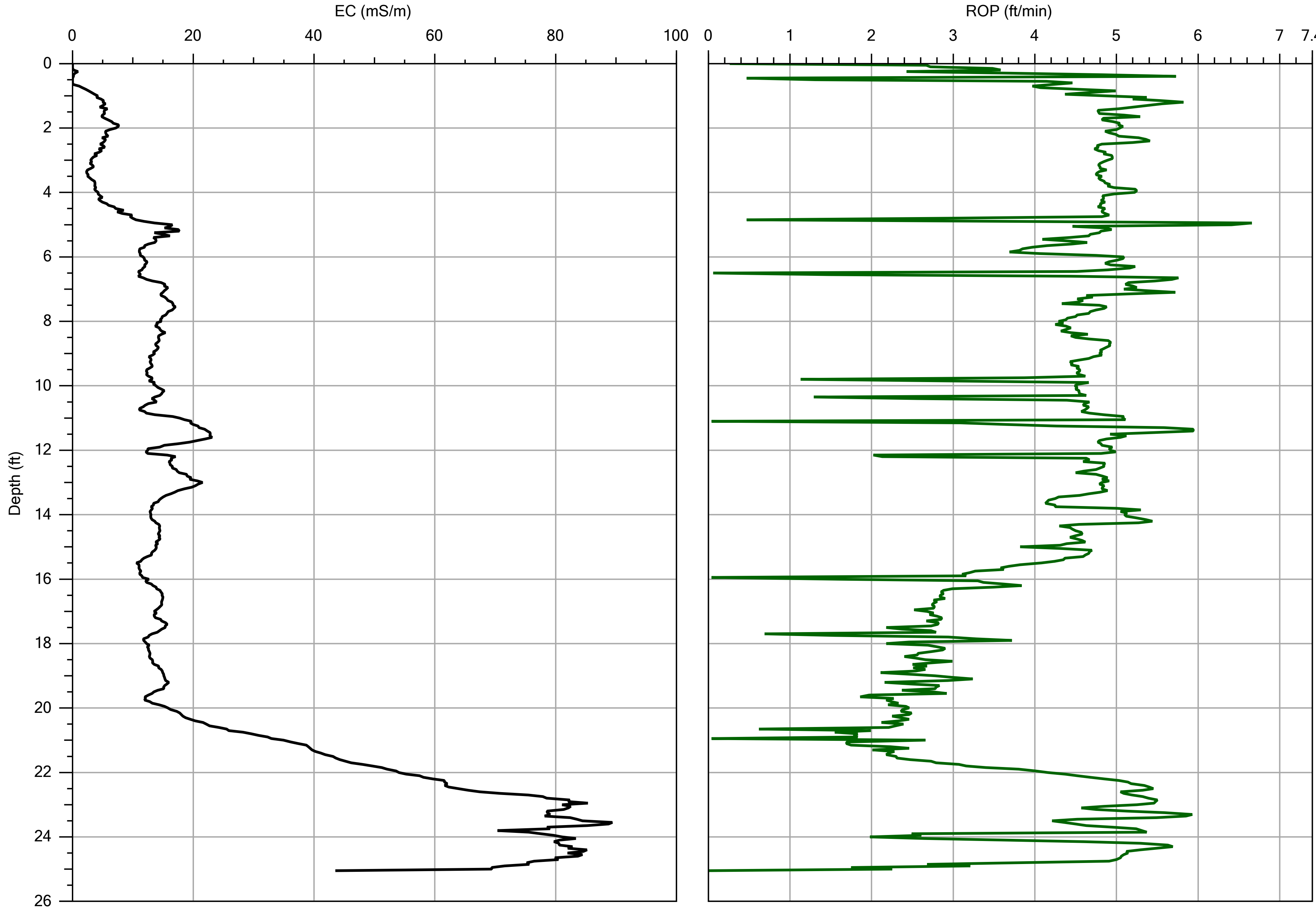
Company: Stock Drilling Inc.	Operator: Jonathan W.	Date: 5/20/2015
Project ID: Eckles Rd. Injections	Client: CRA	Location: 42° 22′ 32″ N, 83° 25′ 42″ W



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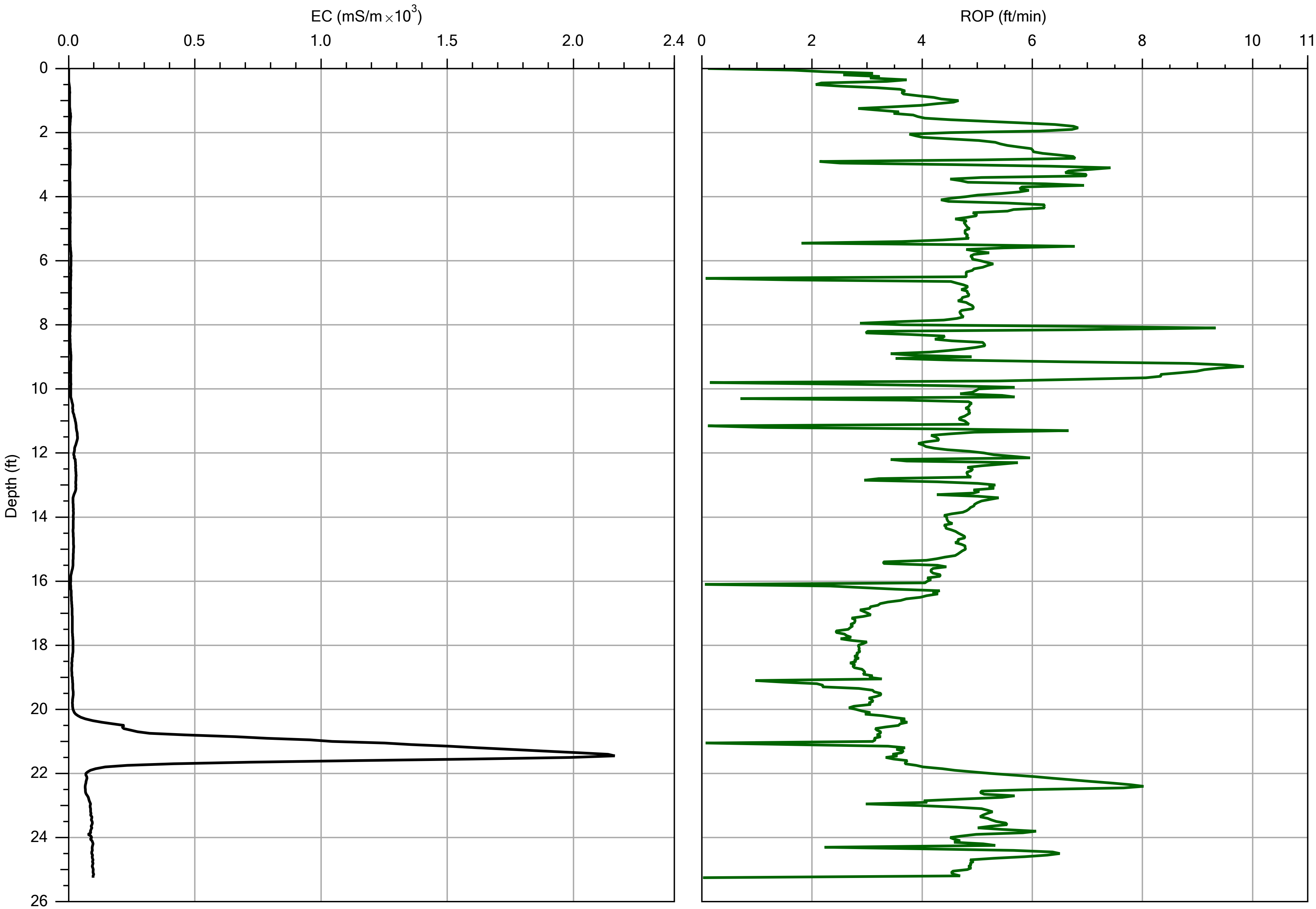

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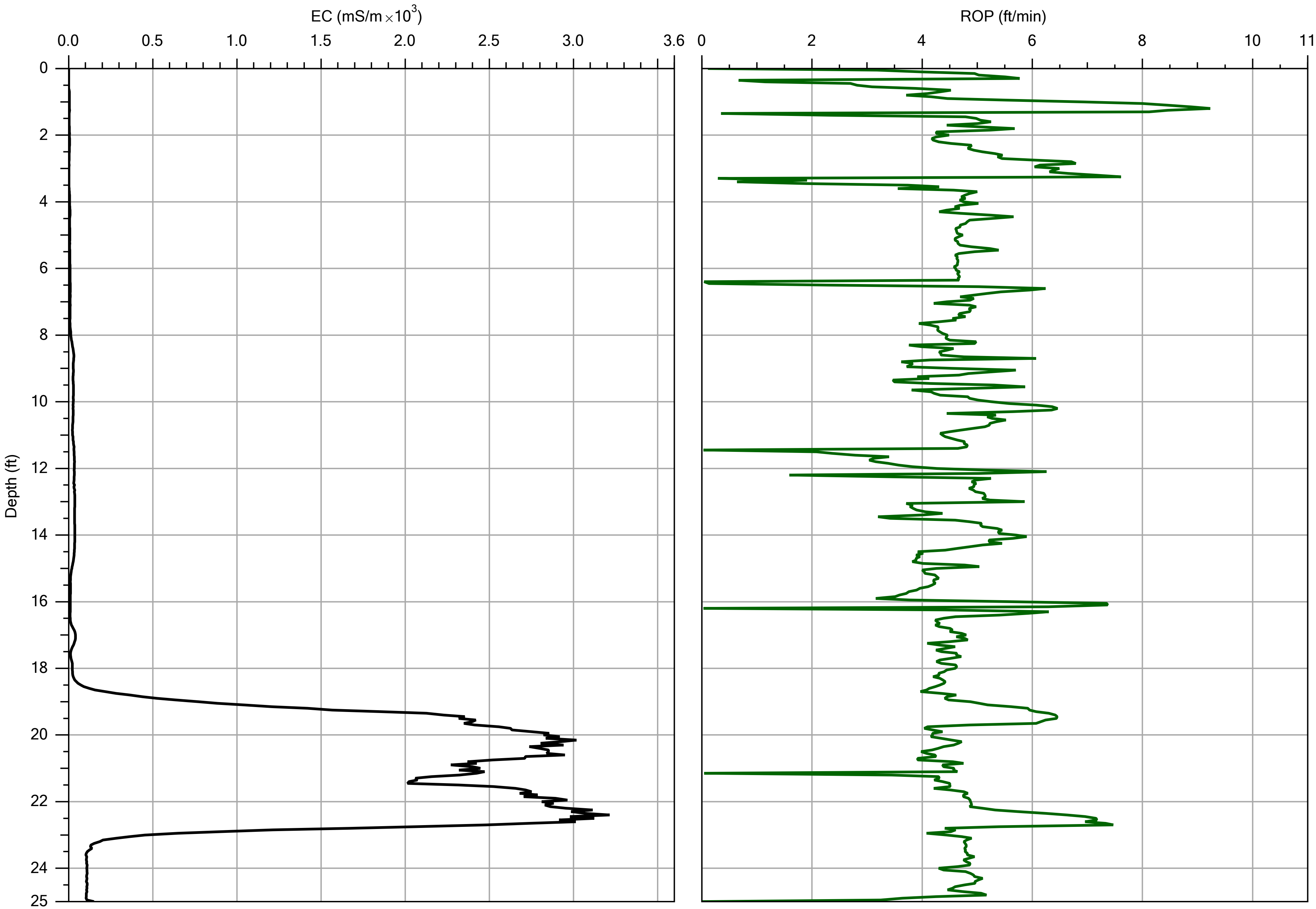

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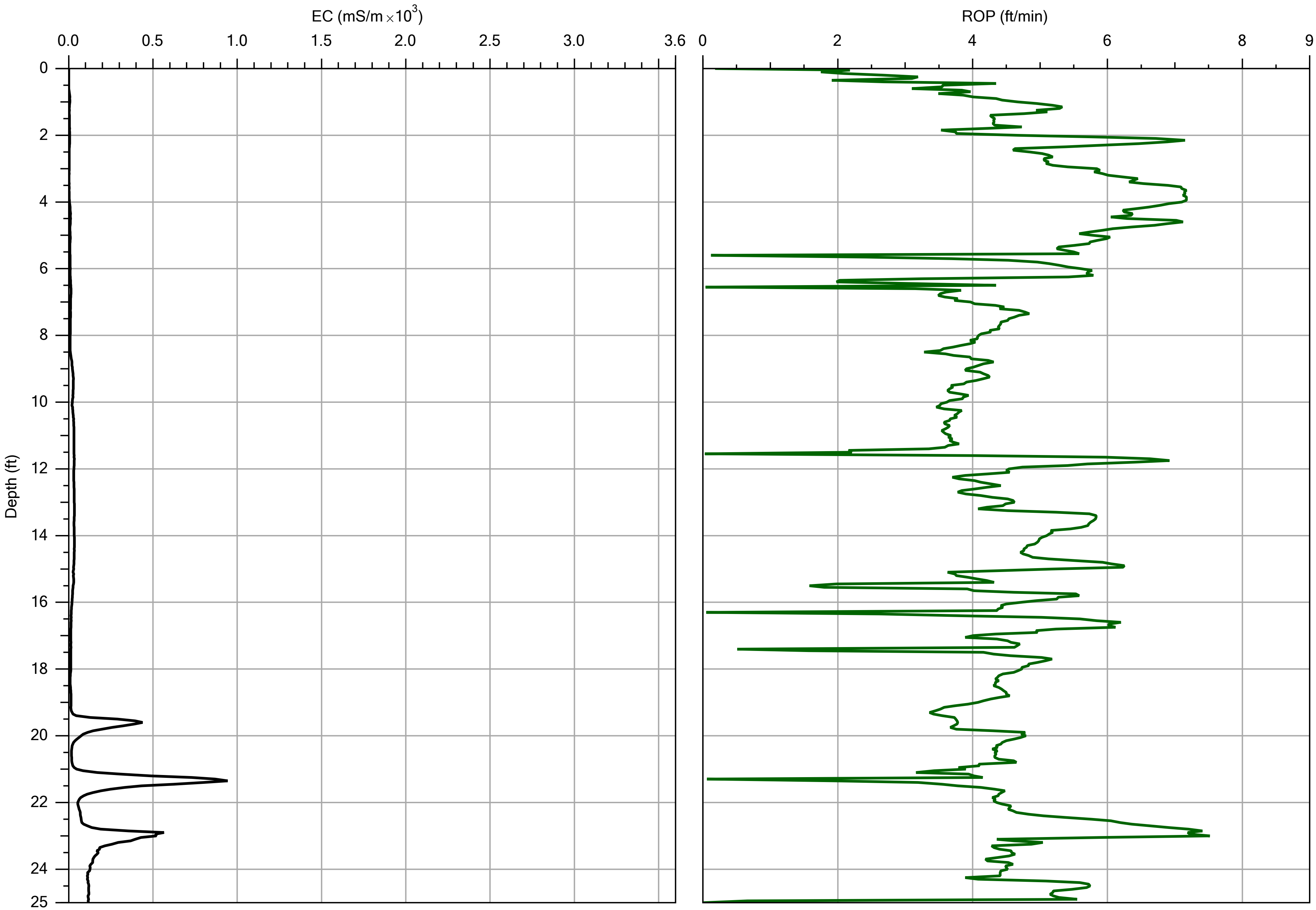

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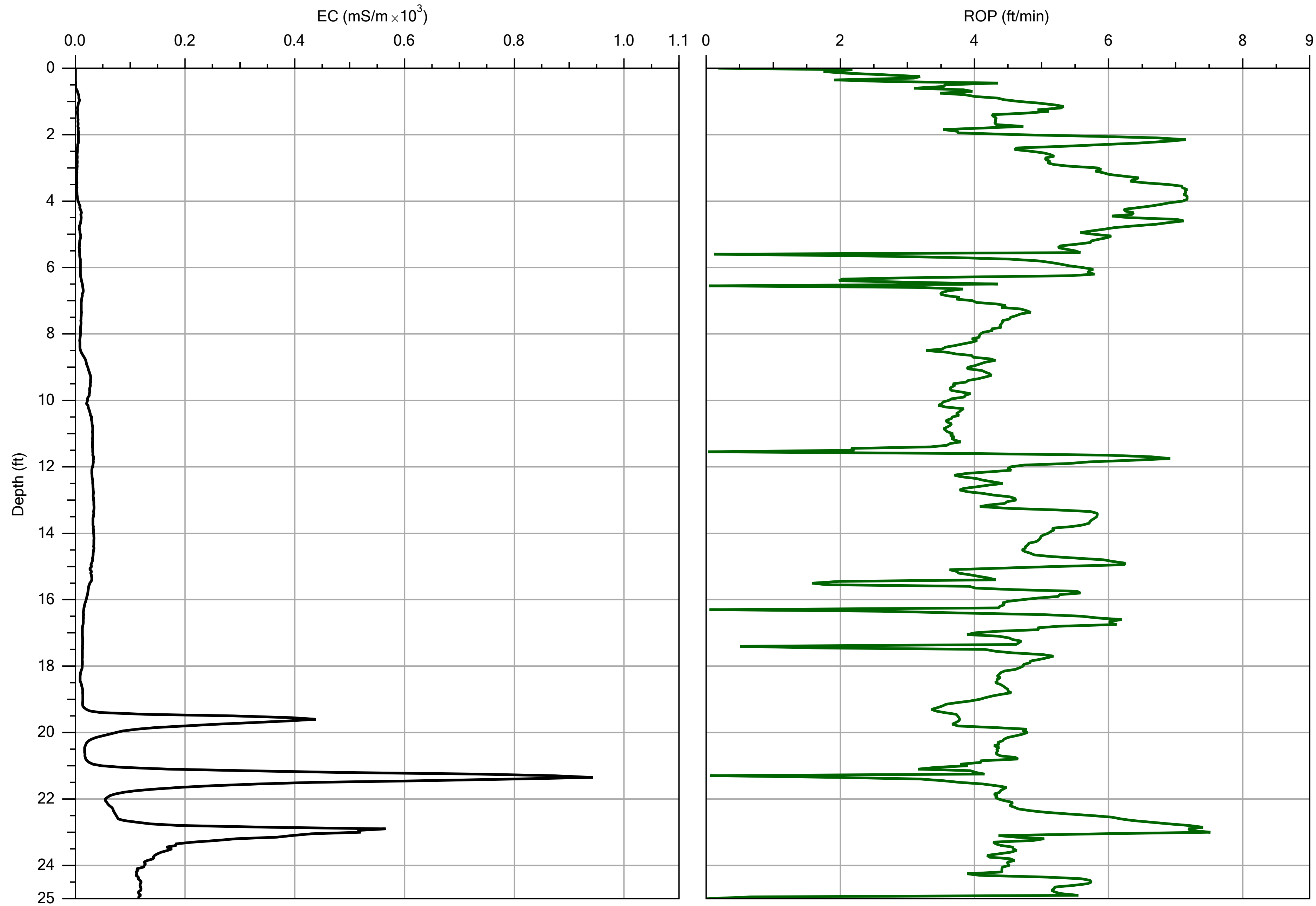

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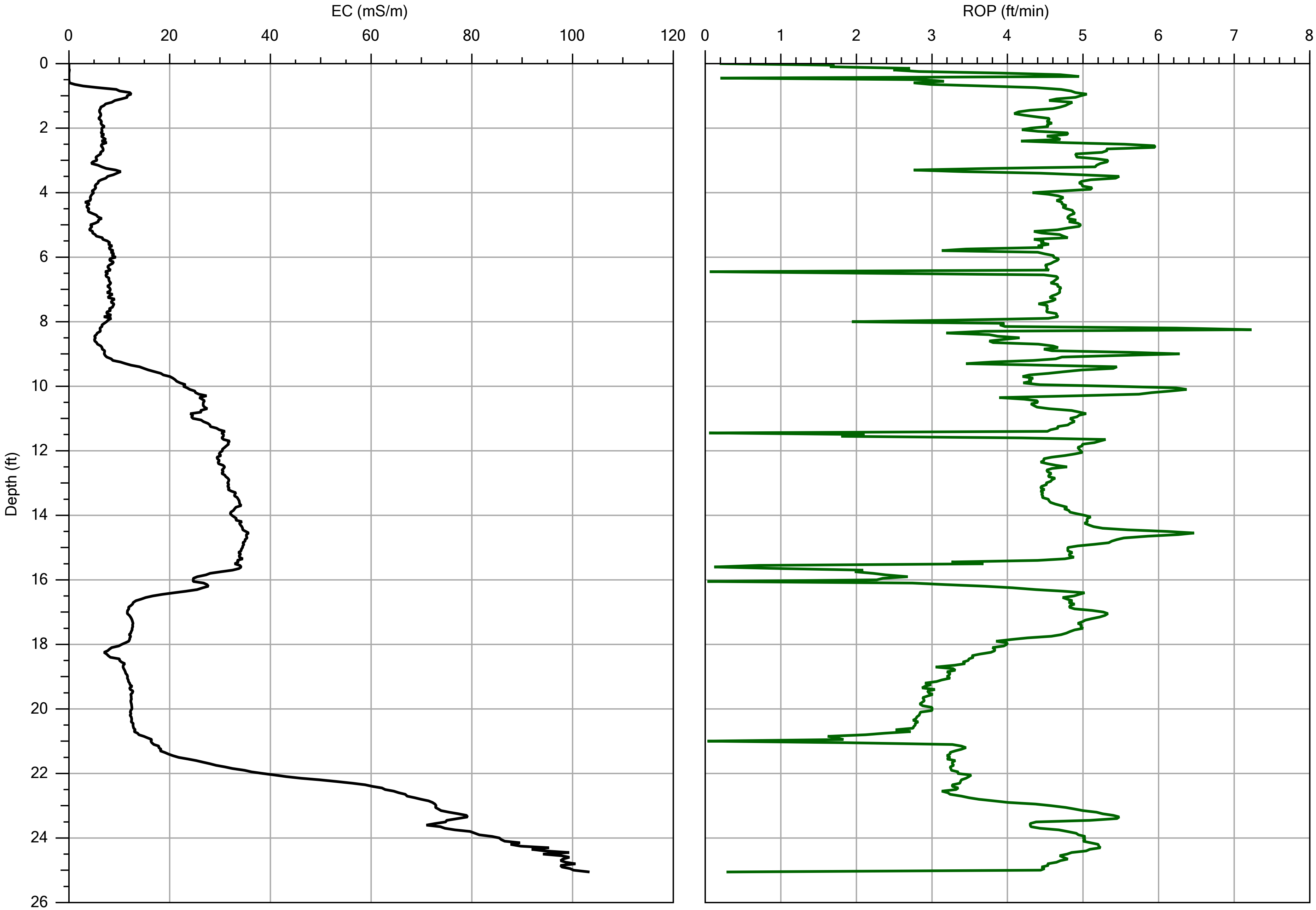

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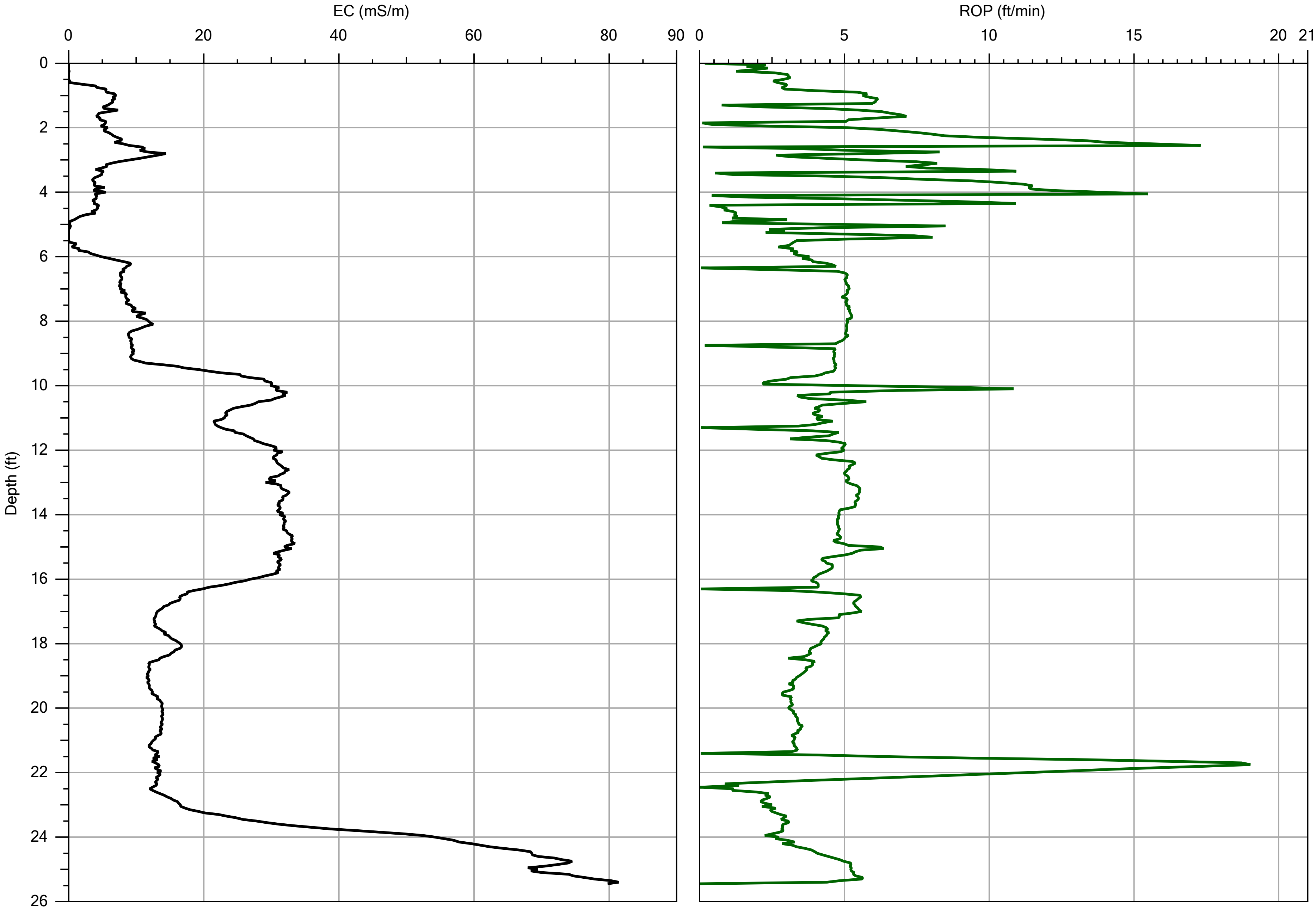

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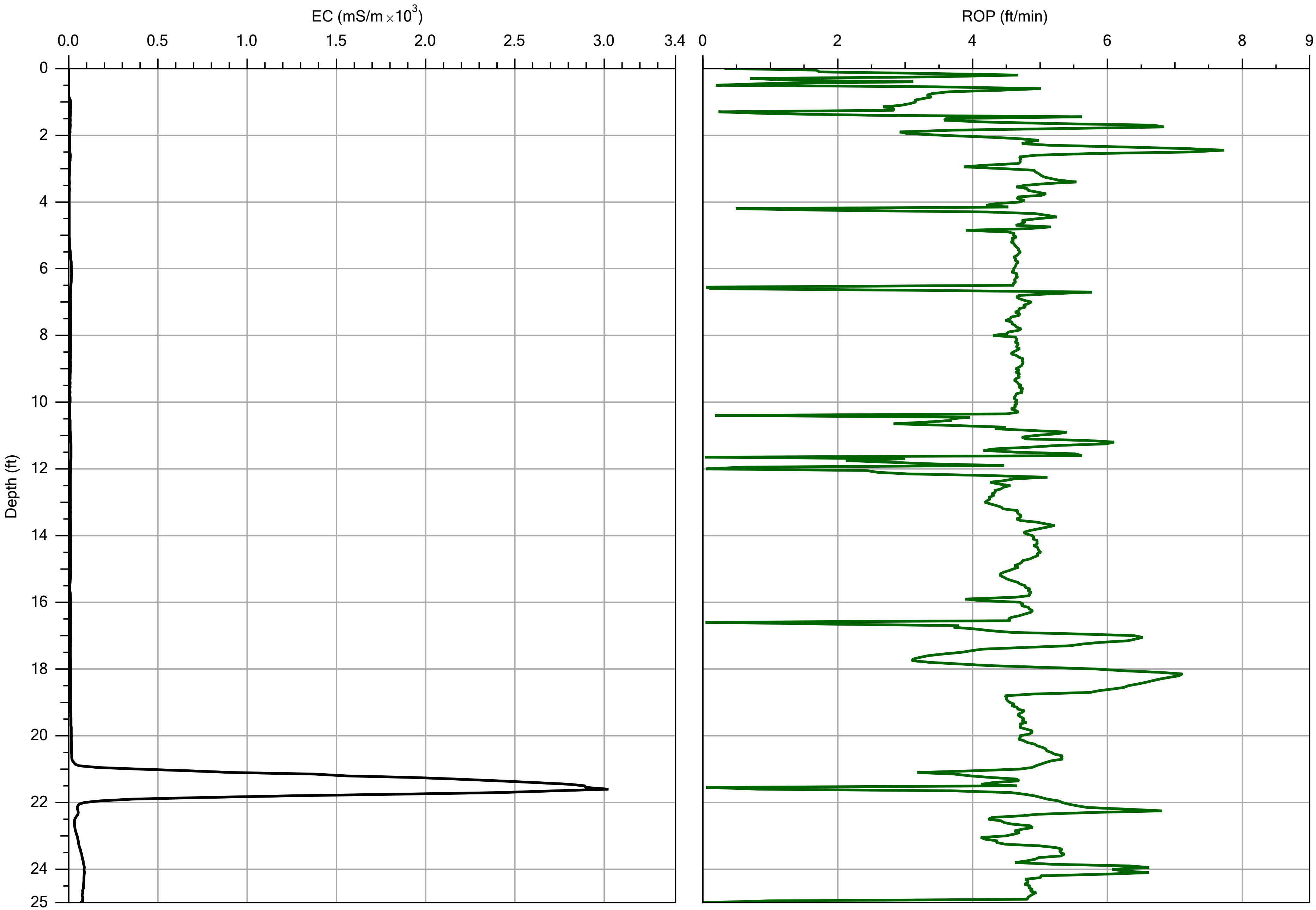

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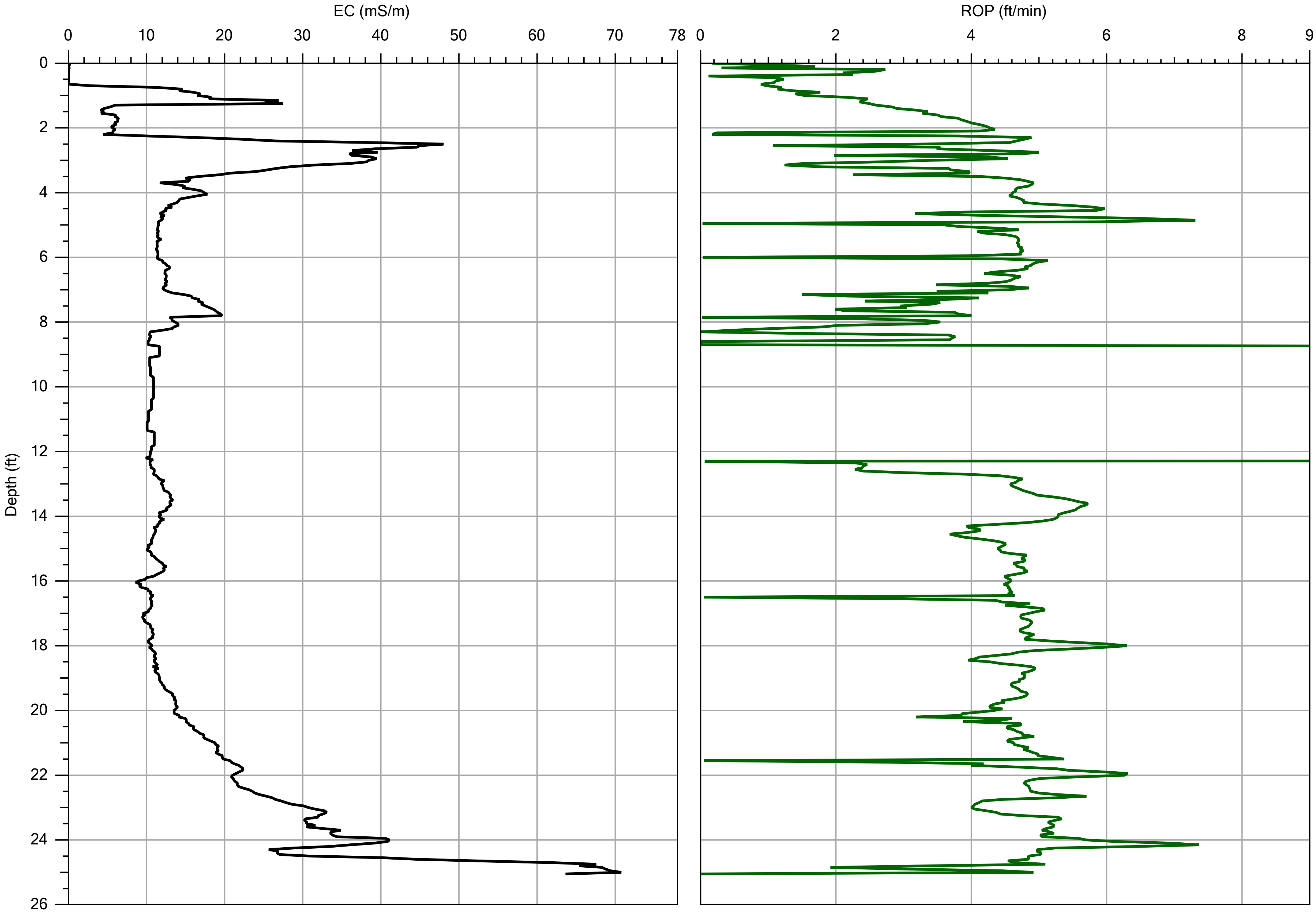
Company: Stock Drilling Inc.	Operator: Jonathan W.	Date: 5/21/2015
Project ID: Eckles Rd. Injections	Client: CRA	Location: 42° 22′ 33″ N, 83° 25′ 42″ W



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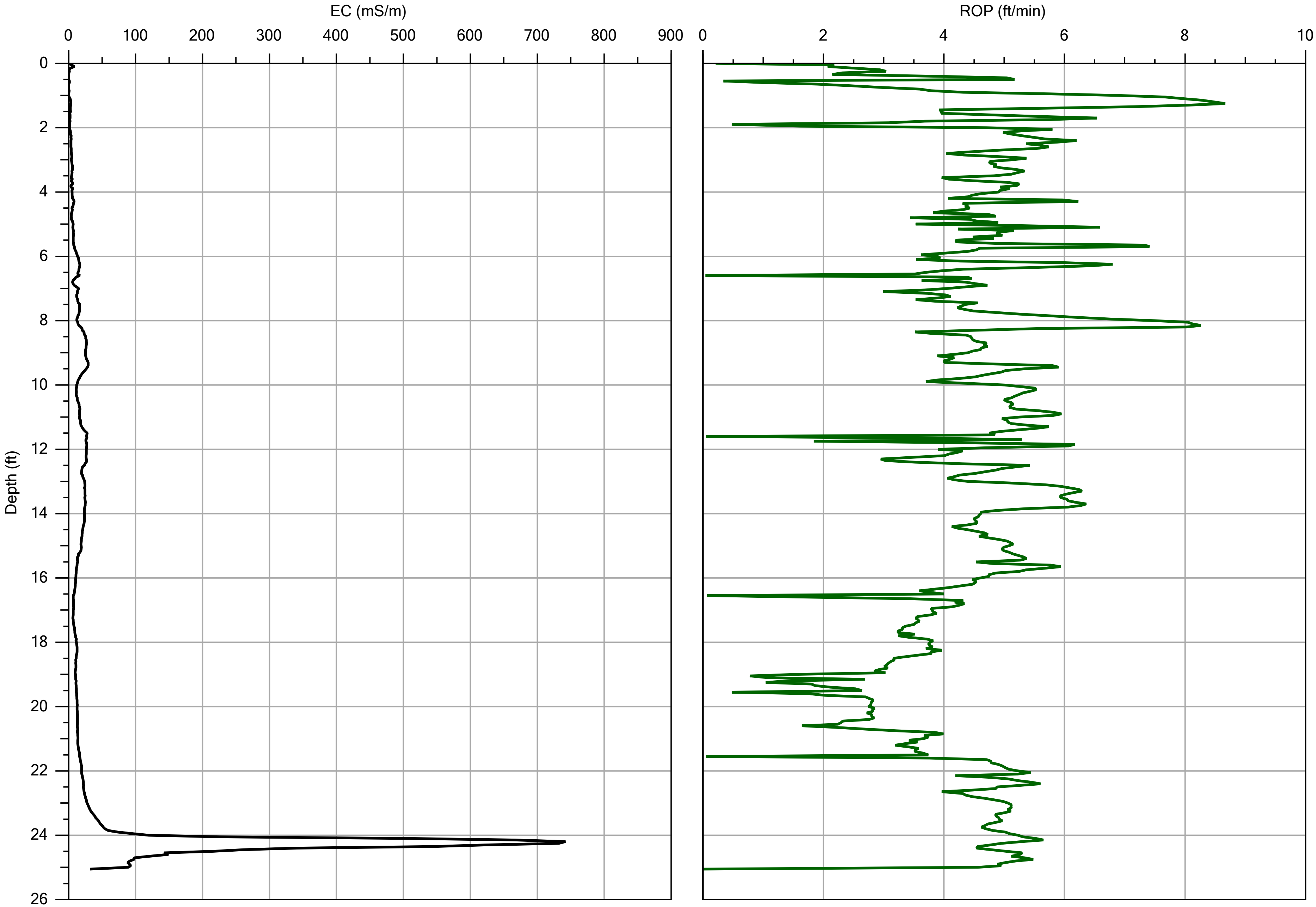

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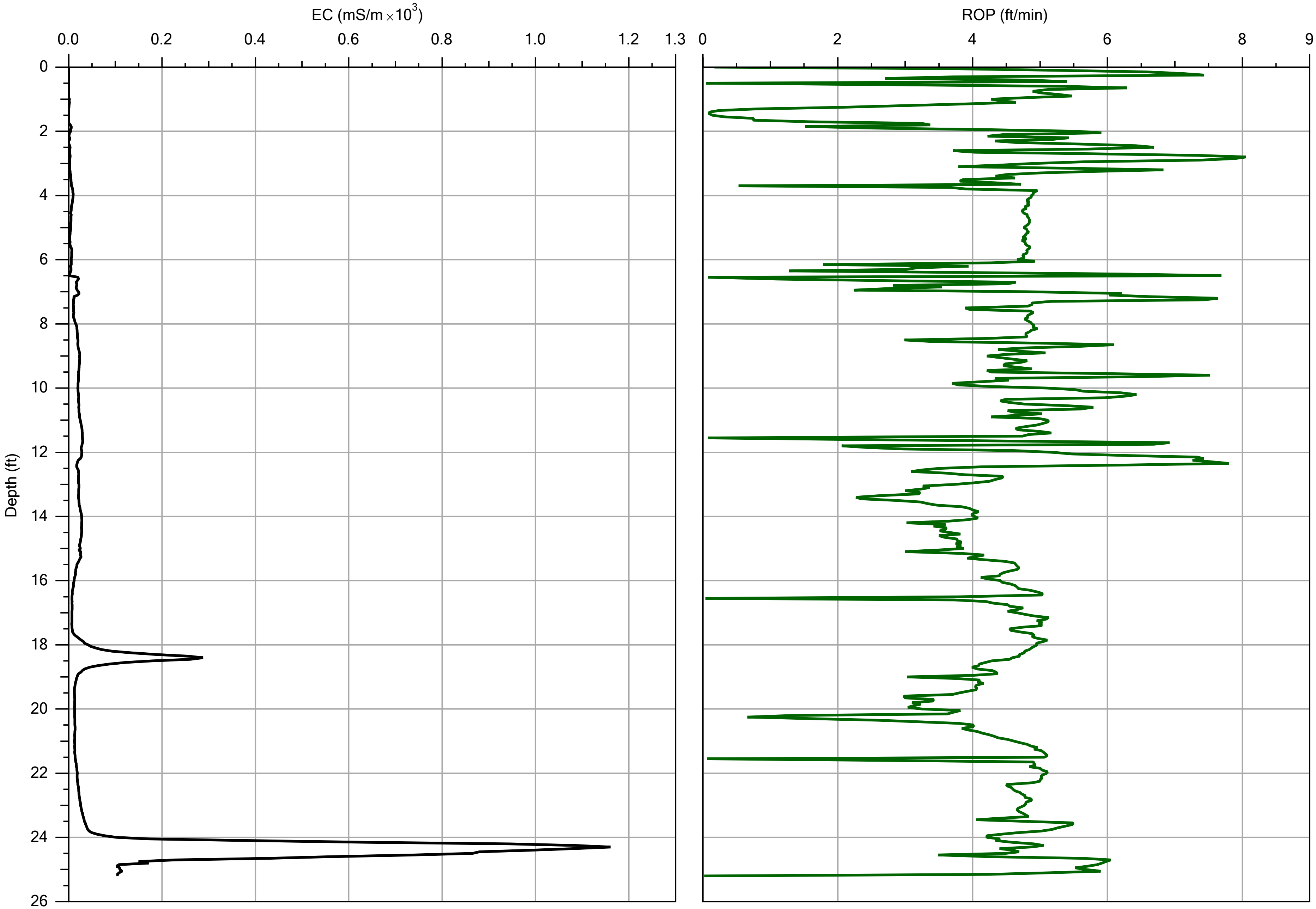

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		File: 33-5E.EC
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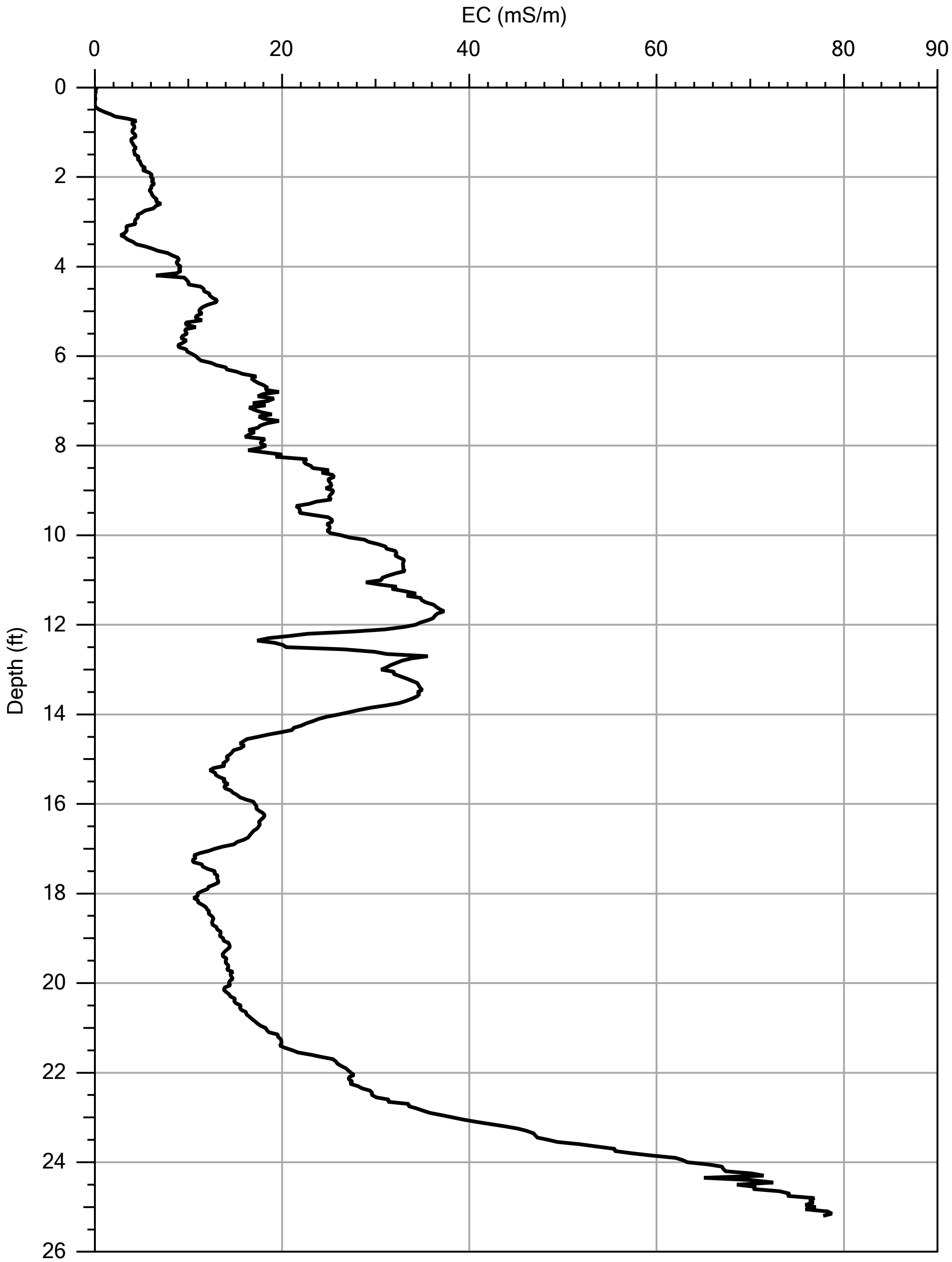
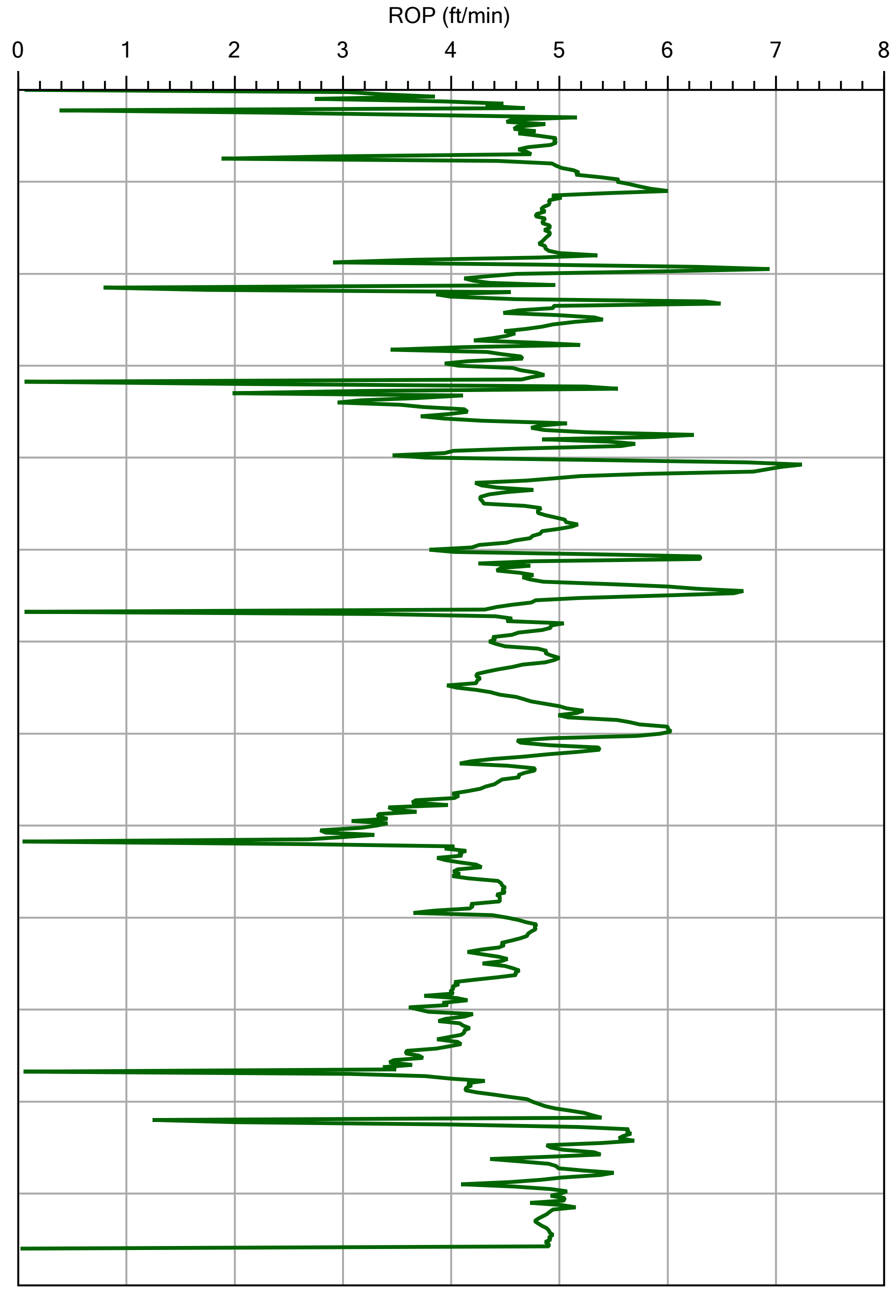
Project ID: Eckles Rd. Injections	Client: CRA	Location: 42° 22′ 32″ N, 83° 25′ 43″ W





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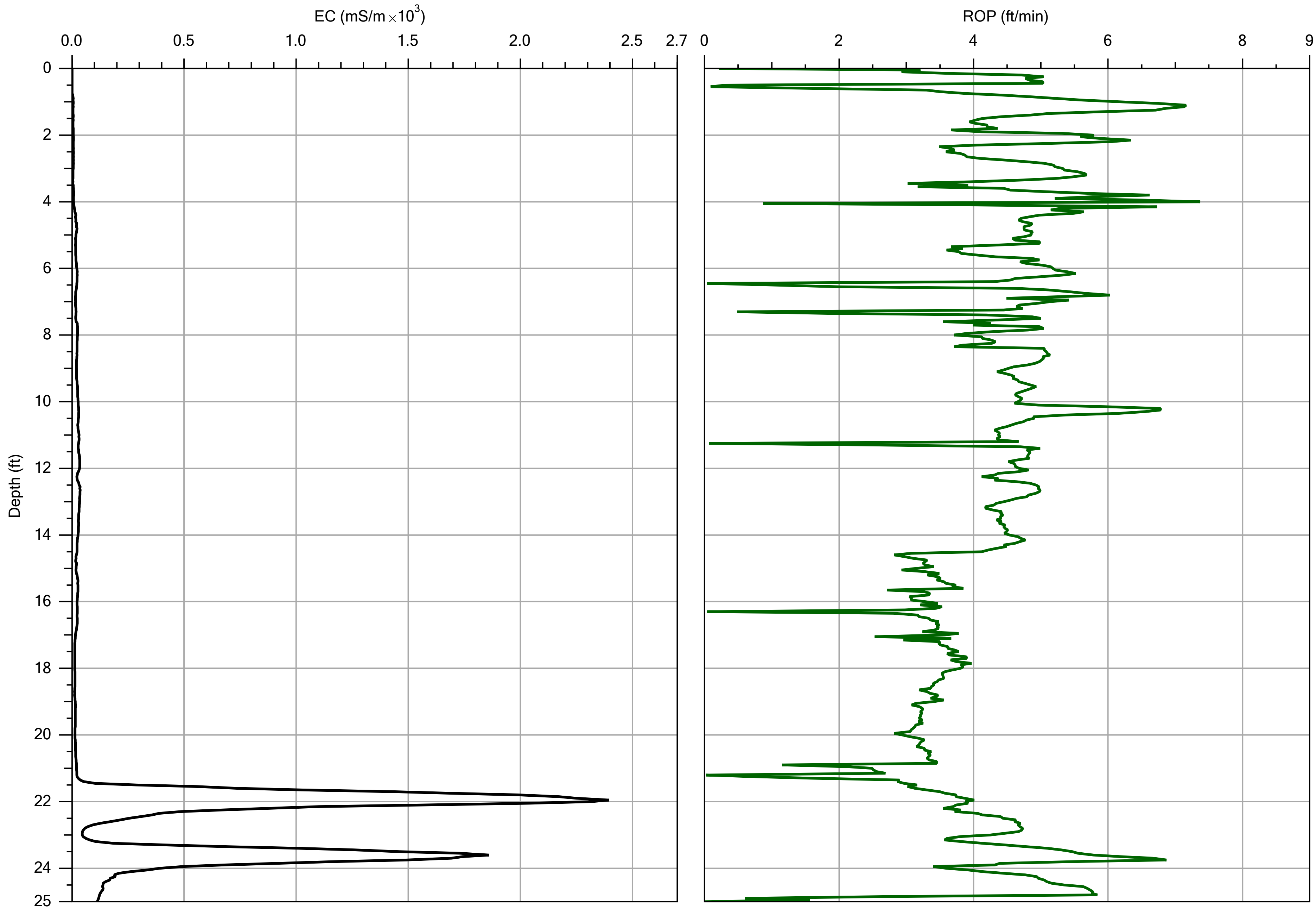

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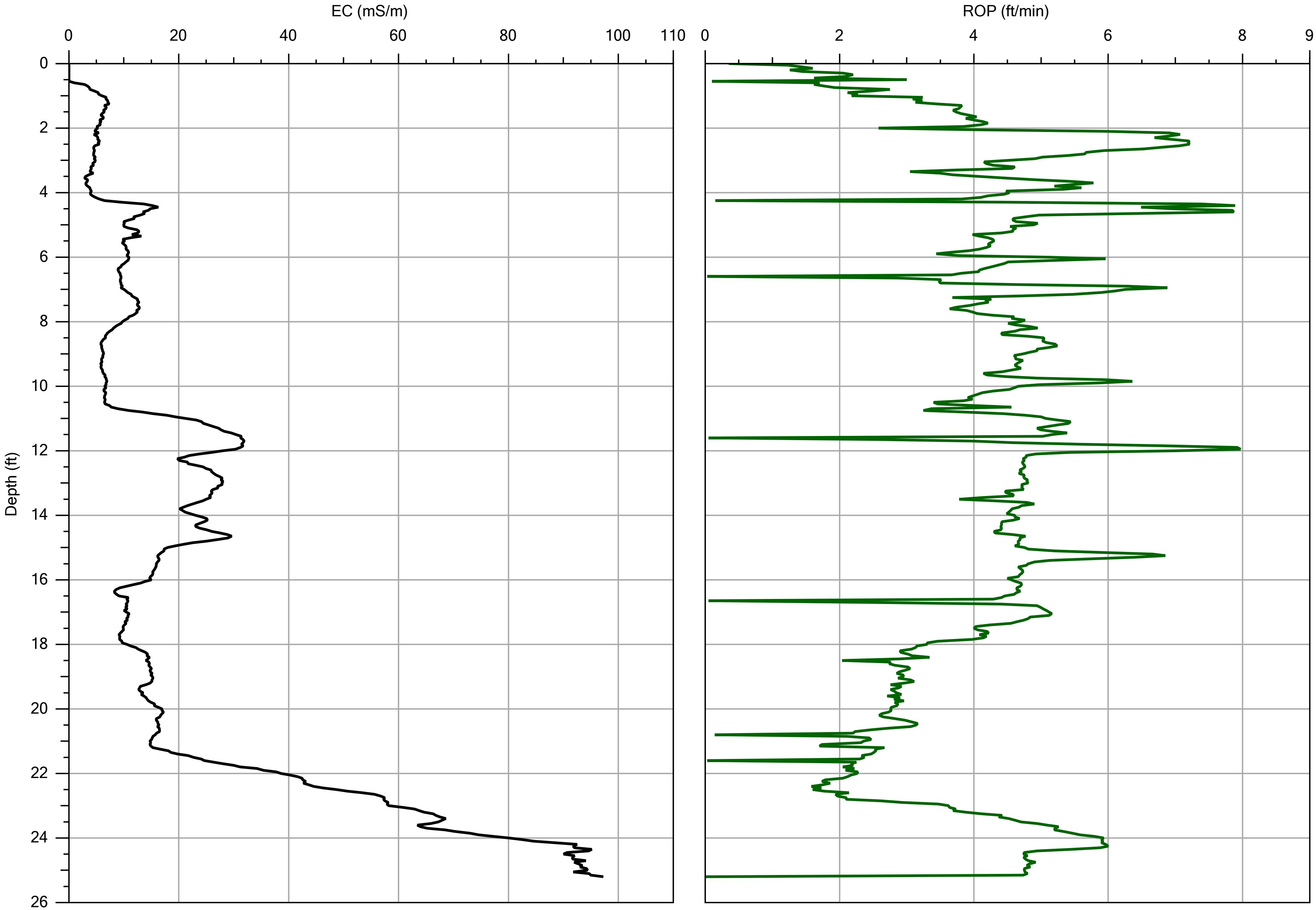
Project ID: Eckles Rd. Injections	Client: CRA	Location: 42° 22′ 32″ N, 83° 25′ 43″ W



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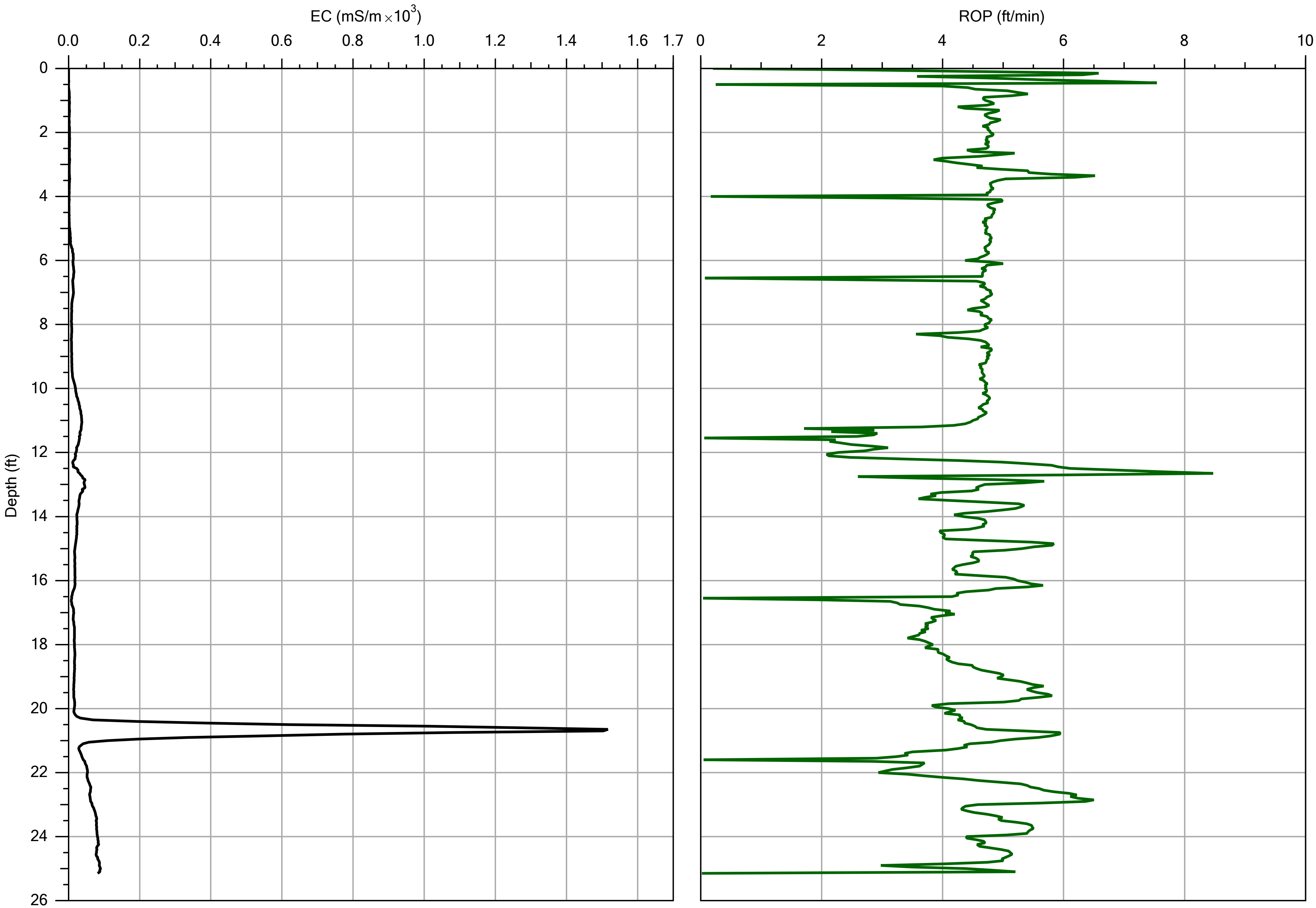
Project ID: Eckles Rd. Injections	Client: CRA	Location: 42° 22′ 32″ N, 83° 25′ 42″ W



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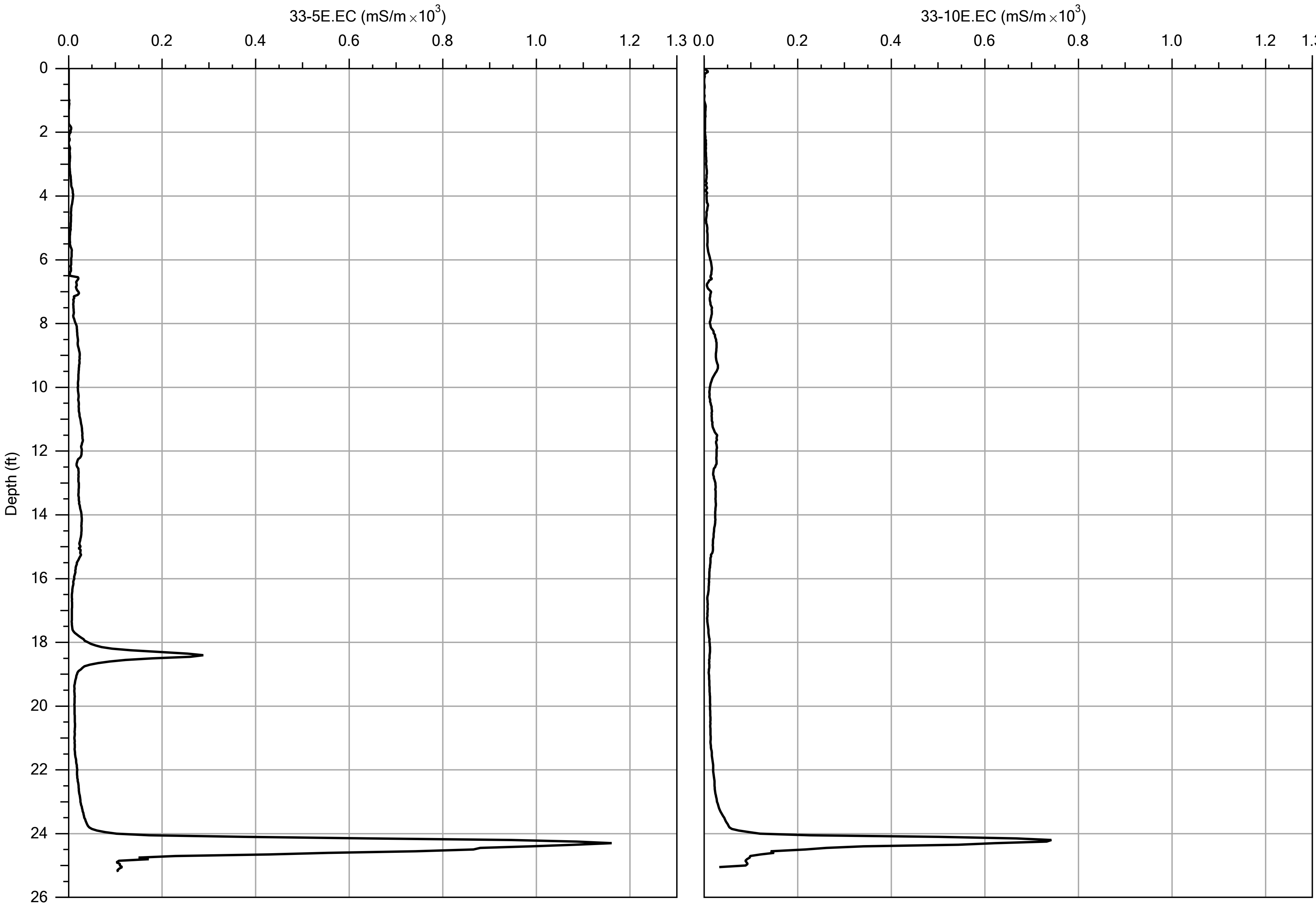

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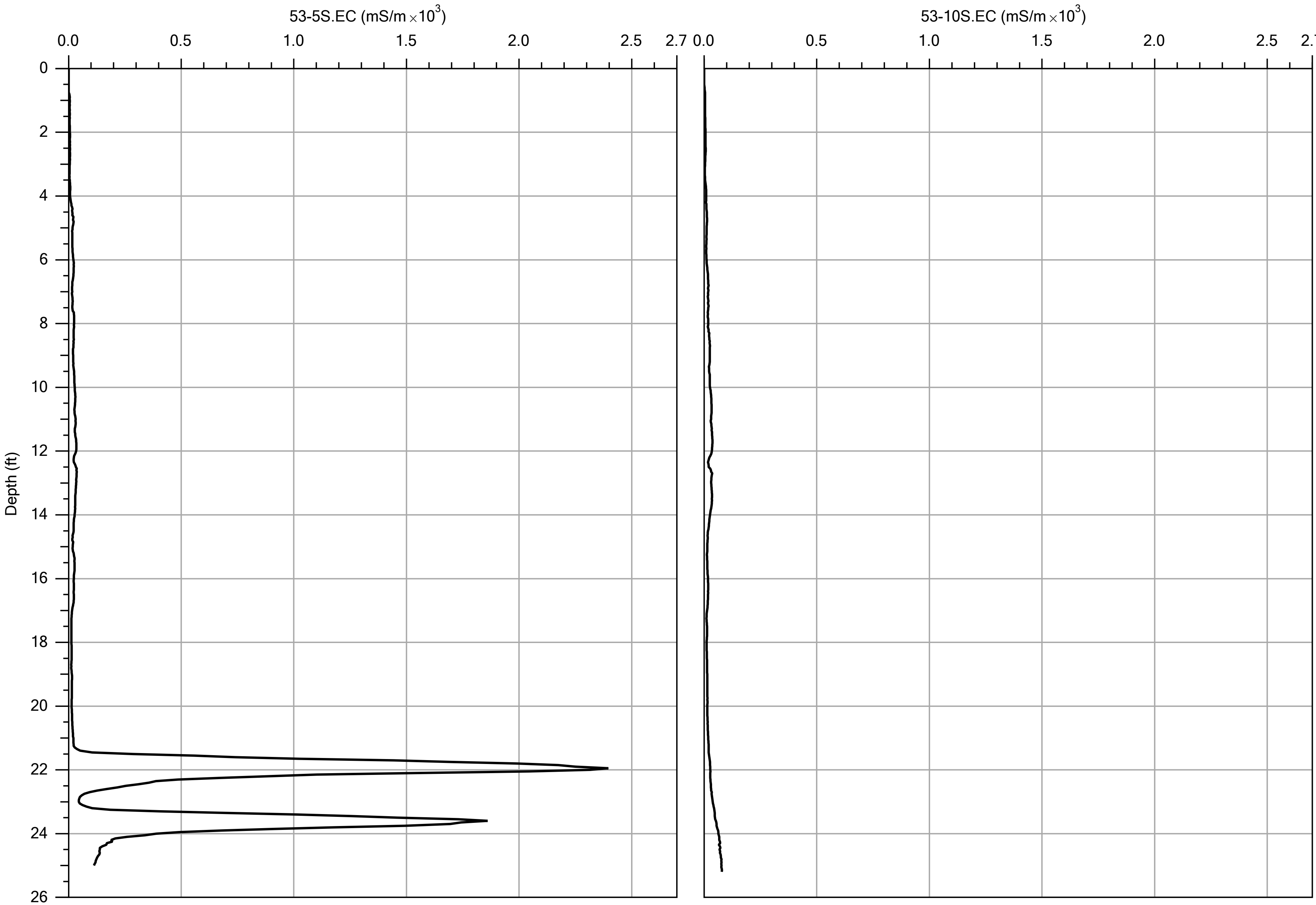
Project ID: Eckles Rd. Injections	Client: CRA	33-10E.EC 5/21/2015 42° 22′ 32″ N, 83° 25′ 43″ W



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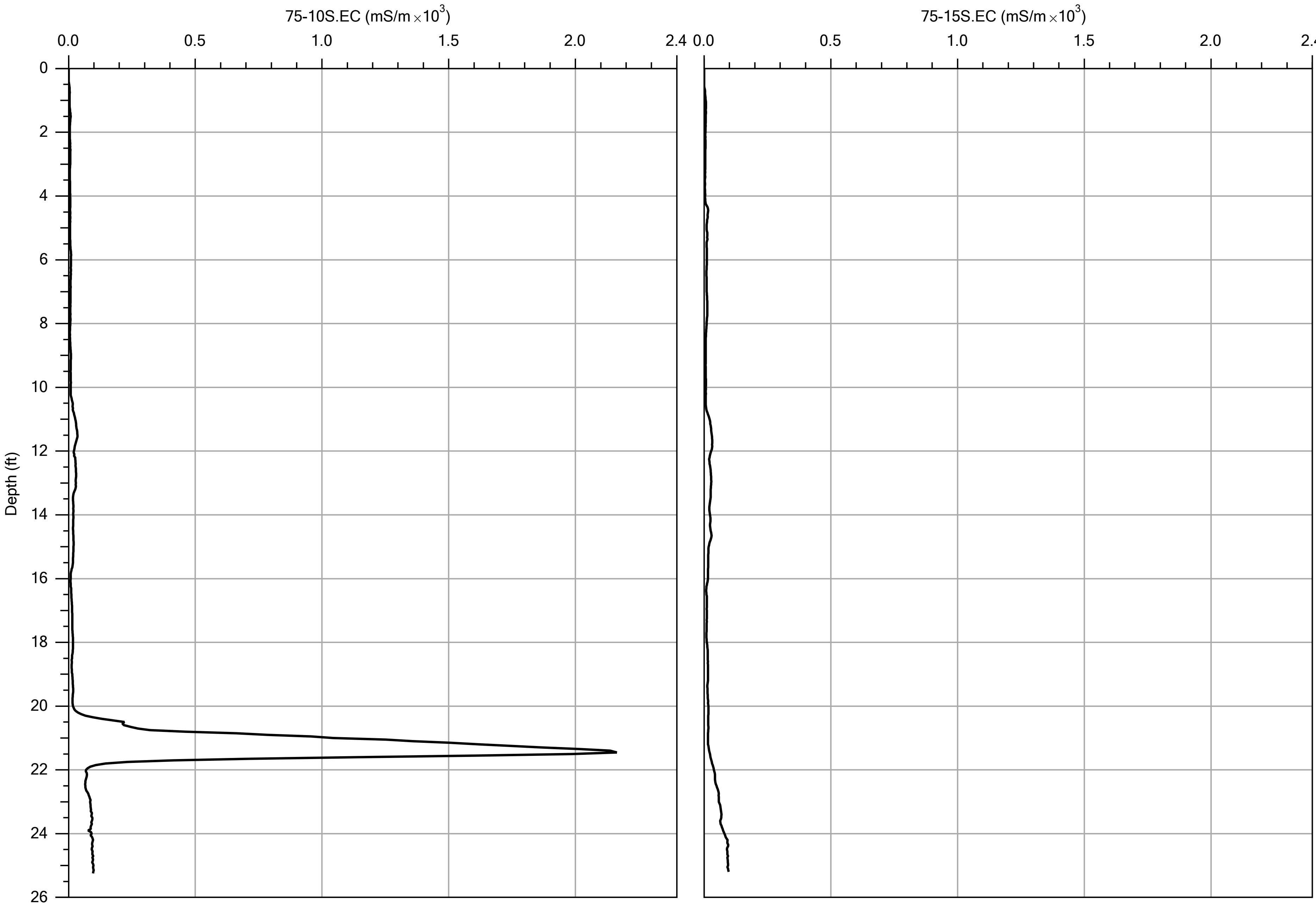

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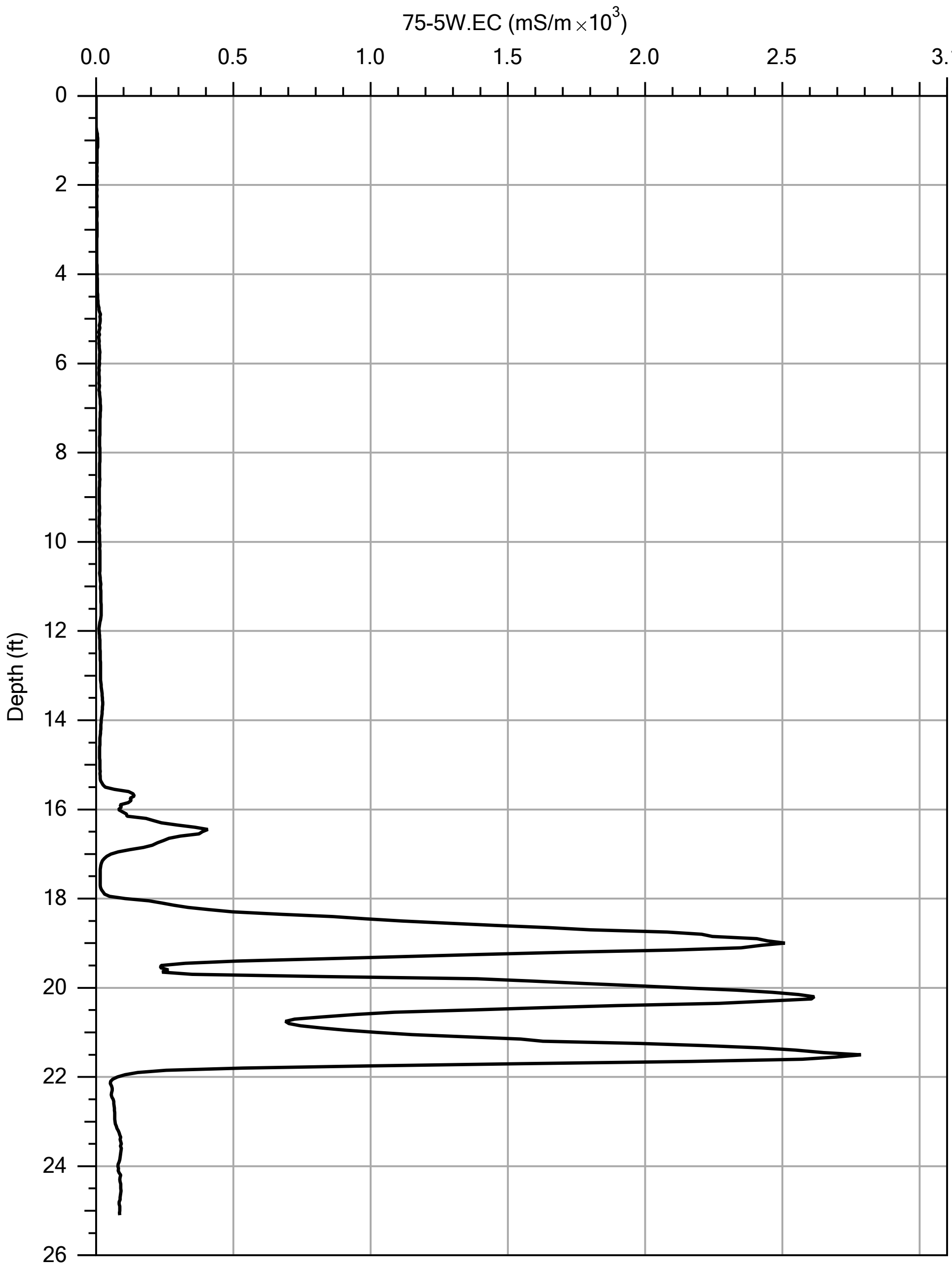

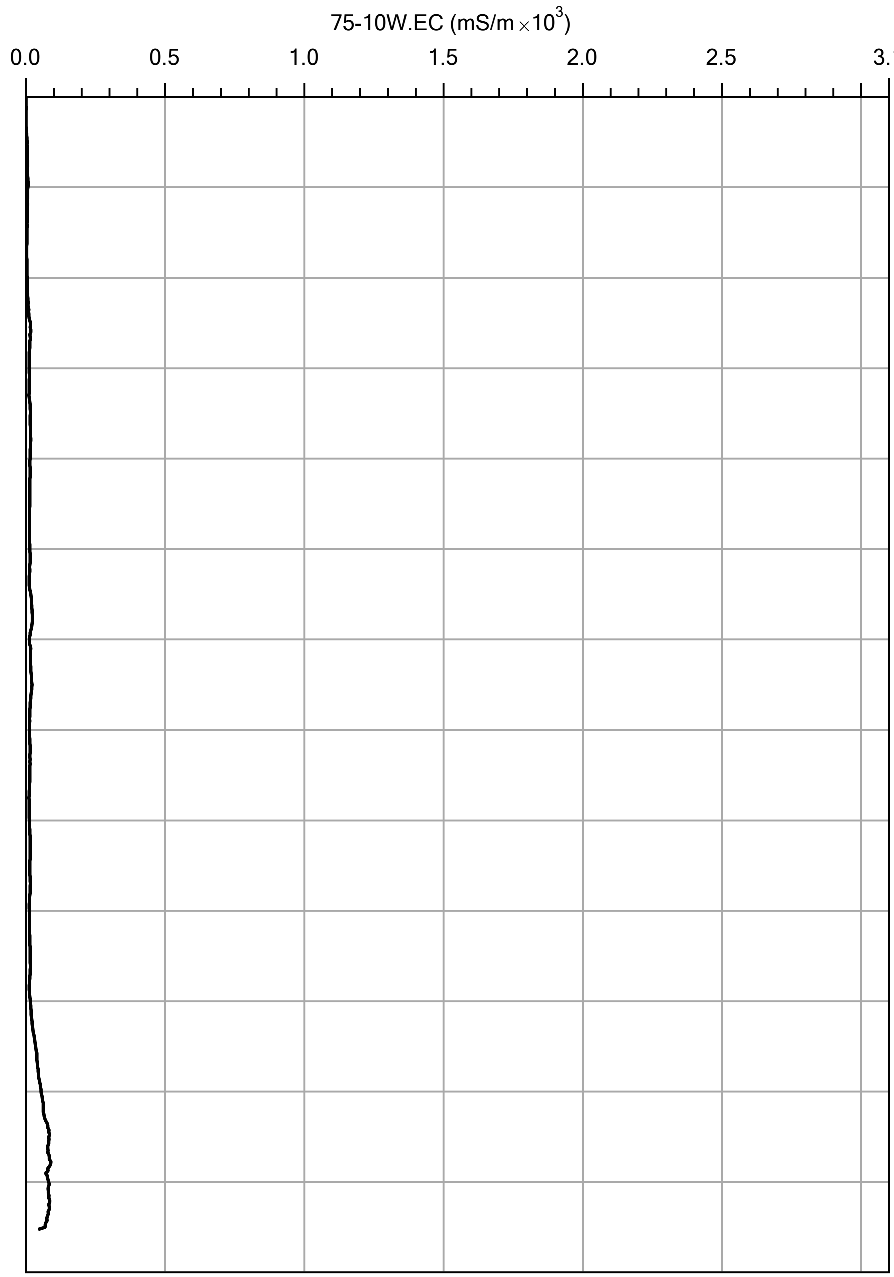

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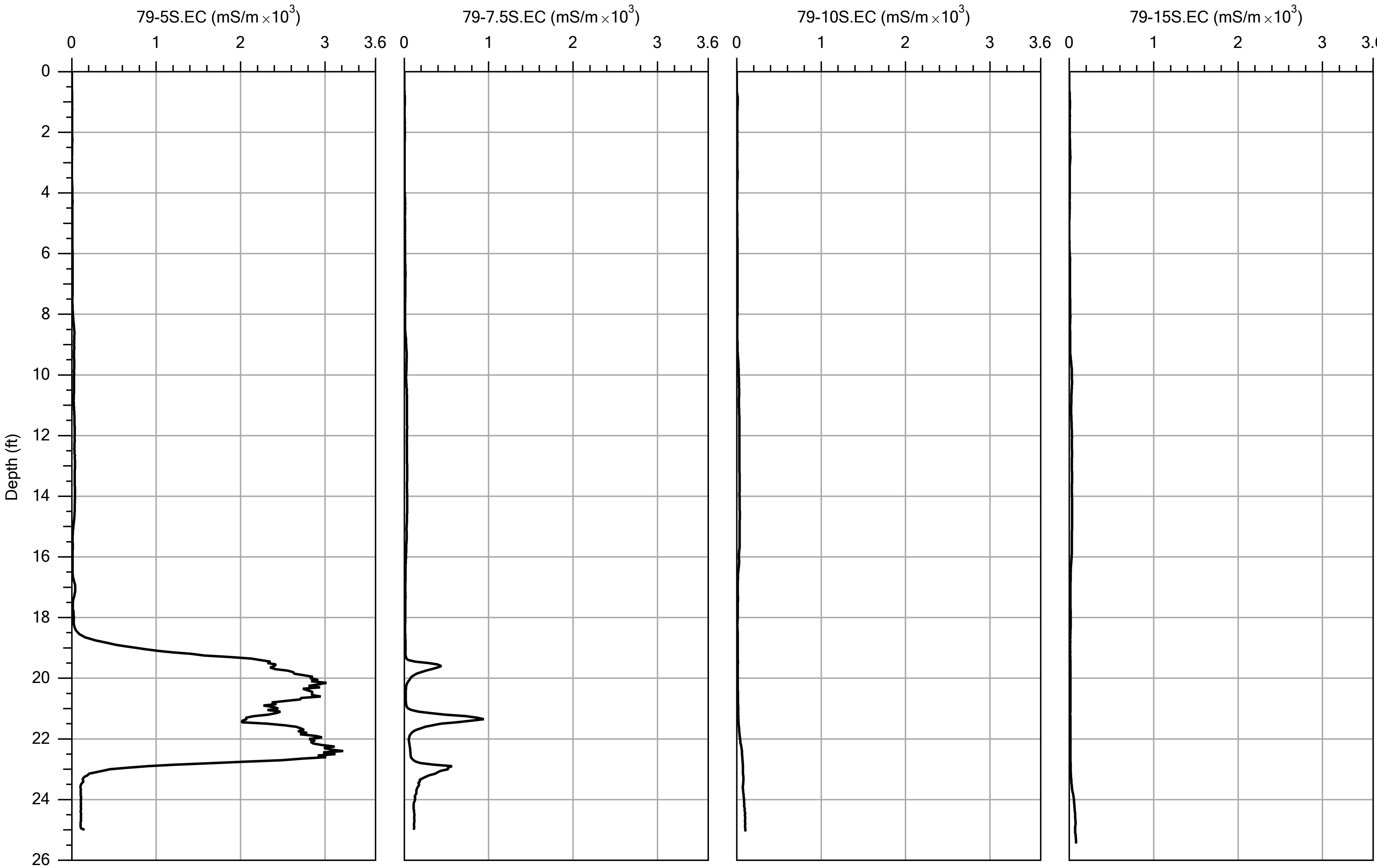

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EC

Company: Stock Drilling Inc.	Operator: Jonathan W.
Project ID: Eckles Rd. Injections	Client: CRA

79-5S.EC 5/20/2015
42° 22′ 32″ N, 83° 25′ 41″ W

79-7.5S.EC 5/20/2015
42° 22′ 32″ N, 83° 25′ 41″ W

79-10S.EC 5/20/2015
42° 22′ 32″ N, 83° 25′ 41″ E

79-15S.EC 5/20/2015
42° 22′ 32″ N, 83° 25′ 41″ W

Appendix E
Memorandum Review of In Situ Chemical Reduction Field Pilot Study Monitoring Data

Memorandum

To:	Chris Meincke	Ref. No.:	012607
From:	Alan Weston/Sophia Dore/km/8	Date:	January 17, 2016
CC:	Kristin Aspinall		

Re: **Review of In Situ Chemical Reduction Field Pilot Study Monitoring Data**
13000 Eckles Road Site
Livonia, Michigan

1. Introduction

Groundwater in Area 1 at the 13000 Eckles Road Site (Site) in Livonia, Michigan contains chromium and nickel. Following the completion of a successful laboratory treatability study in 2003, treatment of the metals with in situ chemical reduction (ISCR) followed by biological polishing was recommended. Field pilot tests were performed in order to test the effectiveness of this technology in situ.

The objective of the field pilot tests were to determine the effectiveness of this alternative for accelerated groundwater treatment to reduce groundwater dissolved concentrations of chromium and nickel within Area 1 of the Site. Groundwater from this area is currently being extracted and treated at a groundwater treatment plant (GWTP); however, the installation of a downgradient permeable reactive barrier (PRB) is being considered in order to eliminate or reduce GWTP operation. In situ treatment of the high dissolved metals concentrations in Area 1 would enhance the effectiveness and extend the life of the PRB and could eliminate the need for the GWTP.

The results of the laboratory treatability study identified that treating the source of groundwater contamination by ISCR using sodium dithionite as a reducing agent resulted in significant reductions in the dissolved metal concentrations.

In November 2010 a field pilot test was performed. Four hundred gallons of a solution containing 5 percent sodium dithionite, 5 percent emulsified soy-lactate, and 0.1 percent sodium bromide (as a tracer) were injected into each of the two injection wells located in Area 1 of the Site. The results of this study showed that sodium dithionite was an effective treatment for reducing groundwater concentrations of hexavalent (dissolved) chromium and dissolved nickel in the areas it contacted. The data suggested that the sodium dithionite was primarily consumed within 10 feet of the injection well, and decreases in metals concentrations were not observed outside this area. No effects of the emulsified soybean oil were observed during the three-week monitoring period; however, sulfur reducing bacteria (SRB) grow slowly so the effects of sulfur reduction would not be expected to be observed in such a short time. Migration of the injected material was fast, up to 20 feet downgradient within the three-week monitoring period.

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Based on this study, it was recommended (Review of ISCR Field Pilot Study Monitoring Data, August 29, 2011) that for future injection events, the sodium dithionite concentration in the injection be increased to 20 percent in order to deliver more reducing agent to the area. Since a downgradient PRB was being considered, it was also recommended that the biological component of the treatment (soy-lactate) be eliminated since polishing would occur in the PRB.

A second pilot study was performed in November 2013. Eight hundred gallons of a 20 percent sodium dithionite solution were injected into one well (IW-A1-1) at the Site. Monitoring was performed prior to and after the pilot study injection. The results of the second pilot study showed that sodium dithionite was a very effective treatment for reducing groundwater concentrations of hexavalent chromium but less effective for reducing the concentration of dissolved nickel. Sodium sulfide was shown to be an effective treatment for the nickel in the treatability study; therefore, it was recommended that sodium sulfide treatment be included in future treatment events. Based on the pilot study results, a downgradient well spacing of 25 feet and a side-gradient well spacing of 10 feet was recommended (Review of Field Pilot Study Monitoring Data, memo from Alan Weston and Sophia Dore to Chris Meincke, March 21, 2014). The dose of 800 gallons of 20 percent sodium dithionite was sufficient to achieve treatment at this spacing, although if the well would accept a greater volume, a larger dose could be injected.

A third, larger scale pilot study was performed in May and June 2015. Eight hundred gallons of a 29 percent sodium sulfide solution were injected at 54 locations where dissolved nickel was the primary compound of concern; 800 gallons of a 20 percent sodium dithionite solution were injected at 18 locations where dissolved chromium was the primary compound of concern, and both sodium sulfide and sodium dithionite were injected at 12 locations where both dissolved nickel and dissolved chromium were present. The sodium sulfide injections were performed in May and included six locations where chromium was the primary compound of concern to evaluate the possibility of using only sodium sulfide for treatment. The injections including sodium dithionite were performed in June.

GHD was requested to review the data from the monitoring events, evaluate the treatment to date, and recommend future actions. This memo contains the evaluation.

2. Reduction of Metals by Injection of a Reducing Agent

The oxidation states of chromium (Cr) range from $CrII^{-}$ to $CrVI^{+}$, but only the $CrIII^{+}$ and $CrVI^{+}$ states are stable under most natural water conditions. Hexavalent Chromium ($CrVI^{+}$) is known to be toxic to humans, animals, and plants, and is more mobile in the environment than $CrIII^{+}$. Conversely, $CrIII^{+}$ is less toxic and readily precipitates as $Cr(OH)_3$ under alkaline or even slightly acidic conditions. Therefore, reduction of $CrVI^{+}$ to $CrIII^{+}$ is a viable option for treatment of sites contaminated with $CrVI^{+}$ and can be accomplished by several methods.

In situ geofixation of chromium is the process of introducing a suitable reducing chemical reagent into the subsurface to reduce $CrVI^{+}$ to $CrIII^{+}$. The reduced chromium would be stable because it undergoes geochemical fixation onto the aquifer solids. Reagents such as calcium polysulfide, sodium dithionite, and sodium bisulfite can be used for the geofixation of chromium. The reduction of the chromium can be monitored by collection of groundwater samples. When the groundwater samples turn gray in color with a distinct, black precipitate, chromium is being reduced. If the samples are yellow, $CrVI^{+}$ is still present. It has also been observed that the amount of other dissolved metals such as iron may increase but their levels are well below their toxicity limit.

Reduction of chromium can also be accomplished by the injection of ferrous iron ($FeII^+$). $CrVI^+$ reduction by $FeII^+$ is of interest because it is found in various soil types and is a primary electron donor in subsurface environments. $FeII^+$ can be released from primary silicates and oxides and secondary layer silicates such as vermiculite and chlorite. Adsorption onto solid surfaces or redox reactions with other oxidants in the solids are two potential reactions that could affect chromium removal by $FeII^+$. Slightly more than stoichiometric amounts of $FeII^+$ and $CrVI^+$ are necessary to achieve near complete removal.

ISCR of metals is the process of introducing a suitable chemical reducing agent into the subsurface to precipitate metals as insoluble metal sulfides, thereby preventing the continued migration of the impacted groundwater. The metal sulfides are stable because they are insoluble and undergo geochemical fixation onto the aquifer soil matrix. Reagents such as sodium sulfide and sodium dithionite can be used for the chemical reduction of metals. For nickel, ISCR is based on the injection of a reducing agent into the aquifer in order to promote the precipitation of soluble nickel and converting it into a stable compound, such as nickel sulfide.

3. Groundwater Monitoring

Groundwater monitoring was performed at the Site on May 12-14 prior to the sodium sulfide injections, on May 27-29 and June 9-11 after the sodium sulfide injections, and on July 6-7, July 20, and September 1-10, 2015 after all injections were complete. All monitoring wells were not sampled at all sampling events.

The locations of the monitoring wells and injection points are shown on Figure 3.1.

4. Assessment of Groundwater Monitoring Results

4.1 Chromium and Nickel

In general, dissolved chromium and nickel concentrations were reduced to below the 0.1 milligram per liter (mg/L) screening criteria in the middle of the treatment area while untreated areas remained at the periphery of the treatment area.

Wells MW46D-15 to MW49D-15 all contained significant concentrations of dissolved chromium prior to the pilot study injections. Dissolved nickel concentrations were lower but still above the 0.1 mg/L screening criterion. After the pilot study injections, the concentrations of dissolved chromium and nickel at these wells had been reduced to below 0.1 mg/L by the July 20 monitoring event. This represented reductions in dissolved chromium concentrations of up to 99.9 percent and reductions in nickel concentrations of up to 92 percent. At the September monitoring event, some rebound in metals concentrations was observed. At wells MW46D-15, MW47D-15, and MW48D-15, the concentration of dissolved chromium had increased significantly; however, the concentrations of hexavalent chromium remained low or non-detect. The concentrations of dissolved chromium still remained at least an order of magnitude below their pretreatment concentrations. At well MW47D-15, the concentration of total nickel increased although the concentration of dissolved nickel remained low. No rebound in metals concentrations was observed at well MW49D-15. Each well in this cluster of monitoring wells is approximately 15 feet from the nearest well. The wells in this area were combined sodium dithionite/sodium sulfide injection wells, and these data indicate that this combination of sodium dithionite and sodium sulfide was effective for the precipitation of both chromium and nickel.

Moving from west to east, the next cluster of monitoring wells consists of wells MW50D-15 to MW53D-15. Prior to the pilot study injections, these wells generally contained dissolved nickel at concentrations greater than 1 mg/L and dissolved chromium at lower concentrations that still exceeded 0.1 mg/L. After the pilot study injections, nickel and chromium concentrations at these wells were all reduced to below 0.1 mg/L by the July 20 monitoring event. At the September monitoring event, further reductions in chromium concentrations were observed at wells MW51D-15, MW52D-15, and MW52D-15. Further reductions in nickel concentrations were also observed at wells MW51D-15 and MW53D-15. No rebound in metals concentrations was observed at this well cluster. Each well in this cluster of monitoring wells is approximately 15 feet from the nearest sodium sulfide injection well. Reductions in concentrations of nickel and chromium were observed at this well cluster before the sodium dithionite injections were performed; therefore, the reductions appear to be largely due to the sodium sulfide.

The next cluster of monitoring wells consists of wells MW54D-15 to MW57D-15. High dissolved nickel concentrations were present in these wells prior to treatment; however, dissolved chromium was not present in these wells. After the injections at the June 10 monitoring event, concentrations of dissolved nickel were reduced to below 0.1 mg/L in all the wells except well MW56D-15 where the dissolved nickel concentration after treatment was 0.14 mg/L. This represented reductions in nickel concentration of up to 99.9 percent. At the September monitoring event, total nickel had decreased at well MW54D-15, but some rebound in the concentrations of total and dissolved nickel was observed at well MW55D-15. At wells MW56D-15 and MW57D-15, concentrations remained unchanged from the June monitoring event except that the total nickel increased at well MW57D-12. Each well in this cluster of monitoring wells is approximately 15 feet from the nearest sodium sulfide injection well.

The eastern well cluster in the treatment area consists of wells MW58D-15 to MW61D-15. As with the previous cluster, high concentrations of dissolved nickel were present at these wells prior to treatment, but dissolved chromium was not detected. By the June monitoring event, concentrations of nickel were reduced to less than 0.1 mg/L in all wells except for well MW58D-15, where dissolved nickel was reduced to 0.24 mg/L. This represented reductions in nickel concentration of up to 99.8 percent. At the September monitoring event, nickel had been further reduced to 0.15 mg/L at well MW58D-15. However, an increase in total nickel was observed at wells MW59D-15, MW60D-15, and MW61D-15 with an increase in dissolved nickel observed at well MW59D-15. Each well in this cluster of monitoring wells is approximately 15 feet from the nearest sodium sulfide injection well.

Wells not located in clusters include the monitoring wells located south of the treatment area, which are wells MW27D-12 to MW30D-12 and MW62D-15 to MW65D-15. Wells MW62D-15 and MW27D-12 are located to the south of the sodium dithionite injection wells. At MW62D-15, which is located approximately 25 feet from the closest sodium dithionite injection well, a 50 percent reduction in dissolved nickel and a 97 percent reduction in dissolved chromium were observed after the injections. By the September monitoring event, the concentration of dissolved chromium had rebounded slightly, however, the dissolved nickel concentration had not. The greater removal of chromium versus nickel is expected when sodium dithionite is used. No treatment was observed at well MW27D-12, which is located approximately 30 feet from the closest sodium dithionite injection well.

The remaining wells are located south of the sodium sulfide injection areas. At MW64D-15, the concentration of dissolved nickel was reduced from 14 mg/L prior to the injections to non-detect (less than 0.04 mg/L) after the injections. No rebound in metals concentrations was observed at this well. The nearest sodium sulfide injection well is located approximately 25 feet from this monitoring well.

Reductions in the concentrations of dissolved chromium and nickel were not observed at the other wells in this group until the September monitoring event, which indicated that the injected sodium sulfide took approximately 4 months to migrate to these wells. The reductions observed were at well MW28D-15, where a 50 percent reduction in dissolved and hexavalent chromium was observed at the September monitoring event; well MW30D-15, where a reduction in nickel concentration of approximately 50 percent was observed; and MW63D, where a 97 percent reduction in dissolved chromium was observed and dissolved nickel was reduced to non-detect levels. Wells MW28D-15 and MW30D-15 are located 53 and 67 feet away, respectively, from the nearest sodium sulfide injection well.

Well MW25D-12 and MW35D-12 are single monitoring wells located close to sodium sulfide injection wells, and concentrations of dissolved chromium and nickel were reduced to below criteria in these wells. By the September monitoring event, the dissolved nickel concentration had rebounded slightly at well MW25D-12, although the dissolved chromium concentration remained low. No rebound was observed at well MW35D-12. Well MW26D-12 is also a single monitoring well located close to the sodium sulfide injection wells. Nickel concentrations were reduced at this well but had rebounded by the September monitoring event.

Well MW23D-12 is a single monitoring well located close to the combined sodium sulfide/sodium dithionite injection area. Dissolved chromium and nickel concentrations were reduced to non-detect levels at this well after the injections. A rebound in both dissolved chromium and nickel concentrations was observed at the September monitoring event. Dissolved nickel had returned to pretreatment levels, but dissolved chromium remained four orders of magnitude below pretreatment concentrations.

The well cluster at the western end of the treatment area consists of wells MW42D-15 to MW45D-15. Prior to treatment, these wells contained high concentrations of dissolved chromium (greater than 10 mg/L) with lower concentration of dissolved nickel that were generally less than 1 mg/L but greater than 0.1 mg/L. Probe refusals and difficulties with injections in this area suggest that some underground structures or obstructions may be present which limited injections and may have limited dispersion. After the injections, no significant reduction in the concentrations of chromium and nickel were observed at wells MW42D-15 or MW44D-15. At well MW43D-15, the concentration of dissolved chromium was reduced from 69 mg/L to 0.55 mg/L after the injections, a 99.2 percent removal; however, it had rebounded slightly by the September monitoring event. No reduction in the nickel concentration was observed at this well. At well MW45D-12, the concentration of dissolved nickel was reduced from 0.36 mg/L to less than 0.04 mg/L, an 88.9 percent reduction. Each well in this cluster of monitoring wells is approximately 15 feet from the nearest sodium sulfide injection well. No sodium dithionite was injected into the area around these wells. These data suggest that sodium dithionite is required for optimum treatment of high concentrations of chromium.

4.2 Bromide, Sulfate, Sulfide and Sodium

Bromide was injected during the injection event as a conservative tracer to track the flow of the injected reagents. An elevated detection limit was encountered for bromide due to the high concentrations of sulfate and sulfide in the samples; therefore, there were few detections of bromide. Bromide was detected at wells MW23D-12 on July 6; MW43D-12 on June 18 and July 7; MW50D-15 on June 19; and MW56D-15 on June

10. These monitoring wells are all located in the treatment area and would be in the area contacted by the injected reagents.

Increases in sulfate, sulfide, and sodium concentrations were observed at the wells where reductions in the concentrations of chromium and nickel were observed. For the wells located south of the treatment area (wells MW27D-12 to MW30D-12 and MW62D-15 to MW65D-15) at the June and July monitoring events, an increase in the concentration of sulfate, sulfide, and sodium was observed only at well MW64D-15, which is the only well where treatment of dissolved metals was observed at these sampling events. These data suggest that the injected material made early contact with this well. Increases in sodium and sulfate concentrations were observed at MW27D-12 at the September monitoring event, and increases in sodium concentrations were observed in wells MW63D-15 and MW65D-15 at the September monitoring event, which correspond to the decreases in chromium and nickel observed at these wells. These data suggest that the injected material took until September to reach these wells and was still creating reducing conditions.

Increases in concentrations of sulfate, sulfide, and sodium were also observed in the MW42D-15 to MW45D-15 well cluster; however, larger increases were observed at wells MW43D-15 and MW45D-15, where reductions in concentrations of dissolved metals were also observed. These data suggest that the injected material did make contact with the wells in this area, which supports the observation that sodium sulfide alone is not the optimum treatment for high levels of chromium.

Sodium and sulfate are soluble; therefore their concentrations in the treatment area will decrease over time as they disperse out of the treatment area. Heavy metal sulfides are typically insoluble. The sulfide from sodium sulfide is expected to react with the heavy metals present in the treatment area such as iron and precipitate them as their metal sulfides therefore sulfide is not expected to be detected in groundwater over the long term.

Increases in dissolved iron were observed in many of the wells as a result of the injection. These increases were expected since iron is more soluble under reducing conditions. The solubilized iron will either react with residual sulfide in the groundwater and precipitate as iron sulfide or, as conditions return to pre-treatment conditions at the Site the iron will be converted to ferric iron and precipitate. The increases in dissolved iron are not expected to persist over the long term. Similar increases in dissolved manganese concentrations were not observed after the pilot study injections.

4.3 Field Data

Field data for pH, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity were monitored during the pilot study. Sodium sulfide has a high pH, and increases in pH were observed at most wells that were contacted by the sodium sulfide solution. Sodium sulfide and sodium dithionite are reducing agents and created reducing conditions at the Site. By the September 2015 monitoring event, the pH was beginning to decrease in most areas but remained well above baseline levels. Increases in pH were not observed at wells MW27D-12 to MW30D-12; however, a decrease in ORP was observed at wells MW27D-12 and MW28D-12 after the injections. By September, the ORP had rebounded slightly. A decrease in ORP at well MW29D-12 was observed in September, indicating that the reducing conditions created by the injections took longer to reach this well. An increase in pH and ORP was not observed at well MW62D-15; however, increases in pH and decreases in ORP were observed at wells MW63D-14 and MW65D-15 at the September monitoring event, and an increase in pH and decrease in ORP were observed at well MW64D-15 at the May and June monitoring events. In September, the pH had decreased and the ORP had increased. Increases in pH were observed at wells MW42D-15, MW44D-15, and MW45D-15, which support the conclusion drawn above that the injected material reached these wells but that sodium sulfide alone was not able to treat the high concentrations of chromium. A decrease in ORP was observed at most of the wells after the injections. Reductions in ORP were observed at some of the wells, where the precipitation of metals, increases in sulfate, sulfide, and sodium, and an increase in pH were not observed including well MW63D-14. These data showed that the chemical injections were creating reducing conditions in areas beyond their radius of influence. Due to dilution of the reagents, direct precipitation of chromium and nickel did not occur in these areas, however these conditions may result in some secondary precipitation of chromium and nickel.

5. Observations

- Dissolved chromium and nickel concentrations in the treatment area were generally reduced to below the 0.1 mg/L screening criteria.
- Reductions in chromium and nickel concentrations of up to 99.9 percent were observed.
- A radius of influence of at least 15 feet was observed for the injections.
- The injected material travelled up to 25 feet downgradient by the July monitoring event and up to 63 feet downgradient by the September monitoring event.
- Satisfactory reductions in dissolved metals concentrations were not observed at the MW42D-15 to MW45D-15 well cluster, and the monitoring data suggested that the injected material reached these wells; however, sodium sulfide only was injected in this area. The data suggest that the addition of sodium dithionite is required to treat high concentrations of dissolved chromium.
- Wells where dissolved chromium and nickel concentrations were reduced also showed increases in sulfate, sulfide, and sodium concentrations, and an increase in pH, which indicated that the injected sodium sulfide material reached the area.
- Samples collected on July 20 and in September showed slightly lower pH levels indicating that the high pH conditions caused by the sodium sulfide were abating.
- Some rebound in dissolved chromium and nickel concentrations was observed at the September monitoring event, which is expected since this was a pilot test and all areas of the Site were not treated; therefore, untreated groundwater containing higher dissolved chromium and nickel concentrations would be migrating back into the treatment area.
- The high pH levels observed in the wells where reductions in chromium and nickel were observed suggested that sodium sulfide reached these wells. No monitoring wells were located in the immediate areas of the sodium dithionite injections because the effects of sodium dithionite injections were examined in the previous pilot studies performed at this Site.

6. Conclusions and Recommendations

The results of the pilot study show that sodium sulfide and sodium dithionite/sodium sulfide mixtures were effective in reducing groundwater concentrations of dissolved chromium and dissolved nickel. No monitoring wells were located in the immediate areas of the sodium dithionite injections. Previous pilot studies performed at the Site have shown that it is an effective treatment for high concentrations of chromium but is less effective for nickel treatment. Treatment of chromium and nickel was observed 15 feet from injection wells and up to 25 feet downgradient in the month after the injections and up to 67 feet from the injection wells 4 months after the injections. Based on the observed 15 foot radius of influence, a 30 foot spacing is recommended for injection wells for the full-scale application. The dose of 800 gallons of 29 percent sodium sulfide was sufficient to achieve treatment in the high nickel areas, and a mixture of 20 percent sodium dithionite and 29 percent sodium sulfide was sufficient to achieve treatment in the areas with elevated concentrations of both chromium and nickel. The data also showed that sodium sulfide alone was not a completely effective treatment for high concentrations of chromium; therefore, sodium dithionite should be added to the solution in areas where chromium concentrations are high. Therefore, for the full-scale application, treatment with 800 gallons of 29 percent sodium sulfide is recommended for the high nickel plume, and a mixture of 20 percent sodium dithionite and 29 percent sodium sulfide is recommended for the area where both chromium and nickel concentrations are elevated. For areas with high chromium but no nickel, a 20 percent sodium dithionite solution is recommended. The results of the pilot study suggest that a single injection event would be sufficient to treat the groundwater, although it is possible that some additional targeted injections would be required in areas where the first injection did not make good contact with the groundwater.

A downgradient PRB is being considered for this Area. A potential reactive matrix for the PRB would be zero valent iron (ZVI). ZVI creates reducing conditions therefore treatment using the chemical reducing agents sodium sulfide and sodium dithionite would be compatible with this technology. If conditions in the groundwater reaching the PRB were already reducing, the life of the PRB would be extended since less of the ZVI would be oxidized. Residual sulfate from the injections is likely to be reduced to sulfide via abiotic and biological mechanisms in and around the ZVI barrier leading to a decrease in sulfate concentrations at the barrier. However, it is expected that the amount of ZVI consumed by the sulfate will be minimal since biological sulfate reduction will be the primary mechanism. However, the sulfide would precipitate from the groundwater. Since sulfide particles are very small, it is not expected that the sulfide would clog the barrier. Residual sulfide from the injections would likely not reach a downgradient barrier due to its low solubility in water.

The primary risk that the sodium sulfide and sodium dithionite injections would pose to a ZVI barrier would be from the increased turbidity in the groundwater which would result in a lowering of the permeability of the barrier. For this reason it is recommended that the injections are not performed within 20 feet immediately upgradient of the proposed barrier location. At a distance of 20 feet from the injection locations, the turbidity would have abated sufficiently that the permeability of the barrier would not be affected.