ARCADIS Design & Consultancy for natural and built assets

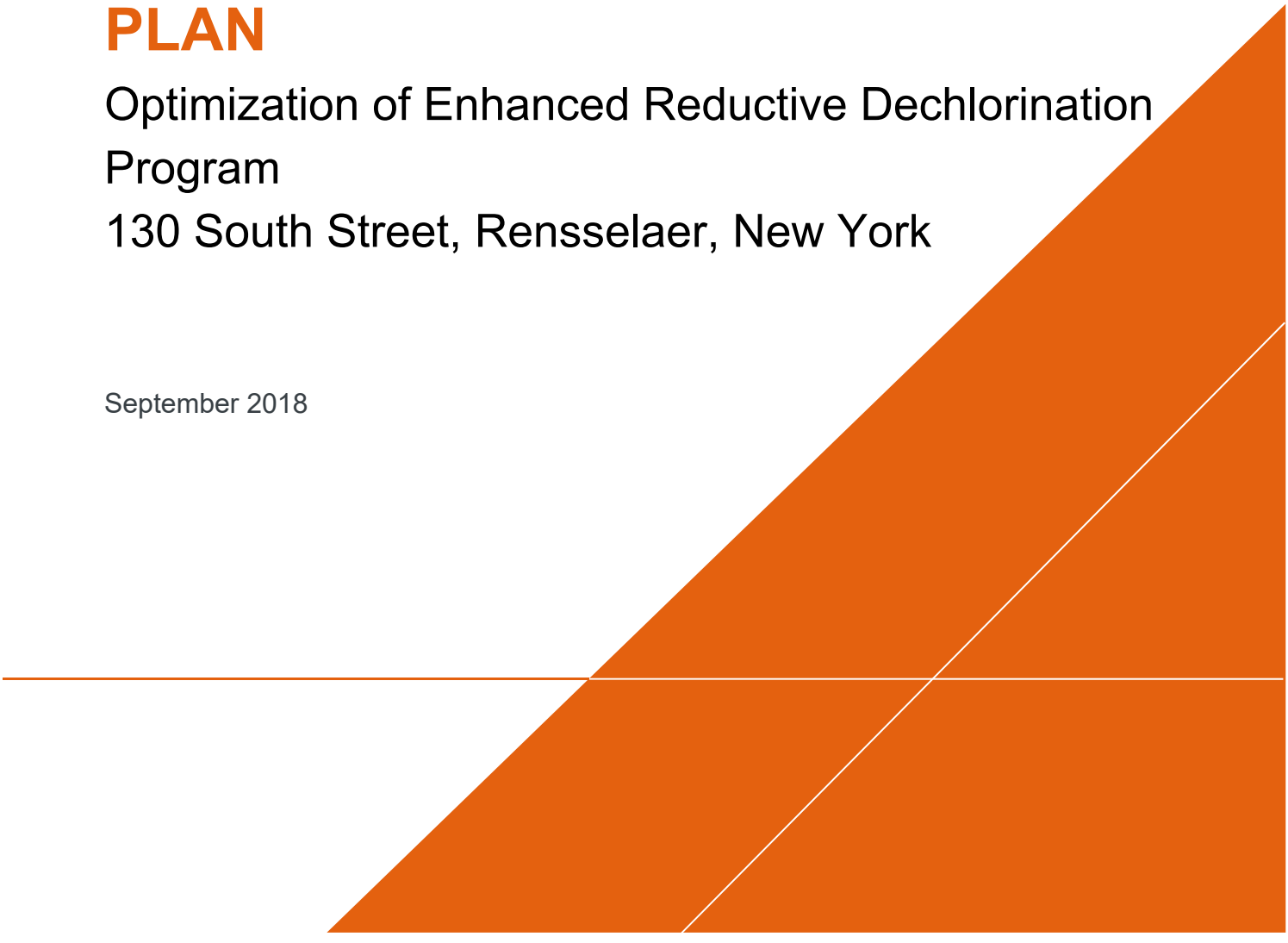
Ashland LLC

ERD SYSTEM OPTIMIZATION WORK PLAN

Optimization of Enhanced Reductive Dechlorination Program

130 South Street, Rensselaer, New York

September 2018



CERTIFICATION STATEMENT

I, Cullen Flanders_certify that I am currently a NYS registered professional engineer as in defined in 6 NYCRR Part 375 and that this ERD System Optimization Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

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_____NYSPE

9/21/2018
_____DATE

ERD SYSTEM OPTIMIZATION WORK PLAN

Optimization of Enhanced Reductive Dechlorination Program
130 South Street, Rensselaer, New York

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Prepared for:

Ashland LLC

Prepared by:

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Our Ref.:

OH009018.RRTM

Date:

September 2018

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APPENDIX

1 INTRODUCTION

The corrective measures at the former Ashland LLC (Ashland) facility located at 130 South Street in Rensselaer, New York (site) currently includes enhanced reductive dechlorination (ERD) of chlorinated volatile organic compounds (CVOCs) in groundwater. This document provides a work plan to optimize the current site remedy by expanding injections into targeted CVOC mass flux areas and source zones identified during site characterization activities completed in 2017. Arcadis U.S. Inc. (Arcadis), on behalf of Ashland, is requesting approval of this work plan from the New York State Department of Environmental Conservation (NYSDEC) prior to implementation.

2 BACKGROUND AND PREVIOUS INVESTIGATIONS

The Corrective Measures Implementation Work Plan for the site was approved by the United Stated Environmental Protection Agency (USEPA) in a letter dated March 16, 2010. Groundwater remediation activities commenced in 2010, aimed at addressing potential off-site migration of CVOCs in groundwater by implementing an ERD program along the downgradient portion of the site.

Multiple supplemental investigations were completed in 2017 to update the project Conceptual Site Model (CSM) and provide data to optimize the ERD program as necessary. The supplemental data were used to evaluate potential source area CVOC extents. Activities completed in 2017 included:

- CVOC Soil vapor screening using GoreTM Modules;
- Aquifer permeability and mass flux evaluation using hydraulic profiling tool (HPT) and membrane interface probe (MIP);
- Vertical aquifer profiling (VAP) and soil sampling using direct-push drilling;
- Well installation, groundwater sampling and testing; and,
- Limited-scale injection of a carbon substrate (molasses) and a tracer (Rhodamine WT).

The soil vapor screening for CVOCs was completed in January 2017, as outlined in the Supplemental Source Evaluation (Arcadis, 2016). This evaluation consisted of soil vapor sampling using Gore™ Modules at three site areas; the qualitative results are presented in the Supplemental Source Evaluation Summary Report (Arcadis 2017). The conclusions from the evaluation included the following:

- Residual CVOC sources may be present in three locations at the site (north, south and central).
- Natural attenuation confirmed as occurring due to dechlorination daughter products presence.

A supplemental site evaluation was completed in August 2017 using high-resolution site characterization (MiHPT and VAP) to evaluate aquifer permeability and mass flux conditions at the site, as outlined in Supplemental Site Evaluation Work Plan (Arcadis, 2017). The MiHPT tool provides a high-resolution, real-time analysis of site hydrostratigraphy and a simultaneous screening-level evaluation of organic contaminant distribution and was used to evaluate CVOC distribution and site hydrostratigraphy to support revision of the CSM and system expansion as needed. The investigation included the following elements:

- MiHPT borings were advanced at both onsite and offsite locations to total depths ranging from 15 to 35 feet below ground surface (bgs). Estimates of hydraulic conductivity and depth to water were established using dissipation test data obtained at various depths during boring advancement.
- Seven locations were selected for follow-up VAP borings based on the MiHPT investigation. VAP sampling included grab soil and groundwater sample collection from borings adjacent to MiHPT borings with sample intervals based on observed impacts. Field staff collected 23 groundwater and 13 soil samples during VAP and were submitted to TestAmerica, Inc. located in Buffalo, New York and analyzed for volatile organic compounds (VOCs).
- Arcadis installed three dual-purpose injection/monitoring wells (MW-22, MW-23, MW-24) following MiHPT and VAP investigations to further refine understanding of the site potentiometric surface and to provide additional information to assess ERD progress and monitored natural attenuation (MNA) parameters in site groundwater. Wells MW-22, MW-23, and MW-24 were constructed consistent as 4-inch inner diameter wells with stainless steel screens ranging from 10 to 15 feet in length. The wells were screened across the water-bearing zone with screen depths ranging from approximately 17 to 29 feet bgs. The wells were developed via surging and purging following installation, then sampled and analyzed for VOCs and geochemical parameters.

The results of the supplemental investigations were presented to the NYSDEC and USEPA (by phone) during a meeting in Albany, New York on October 18, 2017. The results indicated two areas of residual CVOC impacts and a potential mass flux pathway not targeted by the existing ERD remedy. Arcadis proposed a limited-scale injection event for the fourth quarter of 2017 using the newly installed wells to evaluate ERD reagent (molasses) delivery into the deeper aquifer zone which could be a contributing pathway to off-site impacts. Arcadis completed a limited-scale deep zone molasses injection event in the fall of 2017 at all three of the newly installed wells. A conservative tracer (Rhodamine WT dye) was added to the injection solution to evaluate groundwater flowpaths. Post-injection performance monitoring was completed for six months to obtain ERD remedy optimization parameters. The injection event was implemented as outlined in the Injection Work Plan (Arcadis 2017), which was approved by the NYSDEC on October 27, 2017 via email.

The results from these multiple supplemental investigations were used to propose an expansion of injection well network meant to optimize the existing ERD program. The objectives and activities of the proposed optimization, consisting of deep injection well installation and source treatment evaluation, are presented in this work plan.

3 CONCEPTUAL SITE MODEL UPDATE

Arcadis reviewed historical and current site conditions to develop a revised CSM based on historical results and the supplemental evaluations detailed above. Supplemental evaluation data supported the following findings which have been incorporated into the revised CSM and used to optimize the site remedy. The results of the supplemental evaluations and the limited-scale injection event completed in the fall of 2017 were presented to project stakeholders on a conference call on August 22, 2018. The call included representatives of Ashland, NYSDEC, USEPA and the New York State Department of Health. A PowerPoint presentation utilized to present the analytical data, CSM revisions and proposed path forward during this call is presented as Attachment A.

The work completed resulted in the following revisions to the CSM:

- CVOC source mass was delineated onsite laterally and vertically using the data from the MIP sensor. Two discrete areas of CVOC mass were identified; a northern source area and a southern source area. The northern source area is upgradient of current ERD injection transect B, and the southern source area is upgradient of current injection well transect A. The third centrally located potential source area (identified during the January 2017 qualitative investigation) was later determined to be limited and of insignificant mass.
- The supplemental investigation results indicated that source mass was present at deeper intervals than previously understood and that a likely mass flux zone was present below the existing ERD treatment zone.
- The limited-scale injection event confirmed that the deeper source zone and mass flux zones identified during the supplemental investigation were conducive to injection of reagent to promote ERD in those intervals.
- During post-injection monitoring, rhodamine dye was detected in downgradient wells, confirming that deeper CVOC source and mass flux pathways identified during the supplemental evaluation are the likely source of off-site impacts.

Based on the results of the investigation and revised CSM, Arcadis proposes to implement an expansion of the existing ERD remedy. The optimized ERD system will include source area injection wells to promote degradation of source mass, combined with deeper injection well transects at the property boundary to target mass flux zones that are hydraulically connected to downgradient wells.

Arcadis proposes an injection event into the newly installed injection wells following completion of installation and development of the wells. Arcadis proposes that the injection event include only newly installed wells to establish downgradient effects of injection into the expanded ERD system and not the pre-existing shallow wells. Based on review of the data from the proposed injection event, subsequent injections may include use of a combination of the newly installed injection wells and pre-existing shallow injection wells.

4 OBJECTIVES

The proposed ERD optimization plan is laid out in the following sections. The objectives of the work described in this work plan include the following:

- Proposed expansion of existing ERD system infrastructure to include 17 additional injection wells targeting source areas and mass flux zones as defined by elevated MIP response and analytical data collected during the supplemental investigation.
- Completing an injection event into the newly installed monitoring wells using emulsified vegetable oil (EVO) to establish and promote in-situ remediation zones (IRZ) to treat CVOC source mass and mass flux zones.
- Evaluating groundwater flowpaths, groundwater velocity and organic carbon consumption rates utilizing a conservative tracer included in source area injections. Data generated during the tracer evaluation will be utilized for subsequent injection events as needed.

5 FIELD ACTIVITIES

5.1 Health and Safety

Prior to the performance of any field activities, Arcadis will revise the site-specific health and safety plan (HASP) as needed to outline any additional hazards anticipated. A community air monitoring plan is not necessary since no significant odors are anticipated during the injection or drilling events. However air monitoring will be conducted in accordance with the HASP (available upon request) ensuring that the community will be protected.

5.2 Utility Location and Clearance

Utility location and clearance will be required to provide a line of evidence for subsurface utilities in advance of drilling activities and to locate potential buried pipelines, utilities (i.e. water supply, sewer, and storm), tanks, and drums. Electromagnetic (EM), ground penetrating radar (GPR), and radio frequency (RF) detection geophysical techniques, at a minimum, are to be used. Each proposed location will also be hand cleared to a depth of five feet bgs with a vacuum truck or hand augur as applicable prior to drilling.

5.3 Well Installation and Testing

Seventeen new injection wells and one monitoring well will be installed at the site as shown on Figure 1 to support the expansion of the ERD system. Each well will be constructed with screens targeting CVOC mass and/or mass flux pathways based on the results of the supplemental investigation. Target injection well depths and screen intervals were determined based on evaluation of MIP and HPT data and application of a 15-foot target radius of influence (ROI), consistent with observed injection ROIs from the existing remedy. Soil will be logged for lithologic properties including soil type, color, and moisture content. Additional observations regarding observed odor, staining, and relative VOC concentrations as measured with a photoionization detector (PID) will be noted. Retrieved soils will be logged by experienced field personnel under the supervision of the project geologist. The target screened interval for each well is presented on Table 1. However, final screened intervals will be determined during well installation and based on field observations in conjunction with consultation of the Arcadis technical team.

Each injection well will be constructed with 4-inch diameter wire-wrapped 20-slot stainless steel screen and Schedule 40 polyvinyl chloride (PVC) riser pipe. Screen lengths are anticipated to range from 10 to 15 feet in length. The annular space will be filled with 8/12 silica sand to one foot above the top of the well screen. A fine sand pack measuring one foot in thickness will be placed above the sand pack to prevent migration of grout into the well screen interval. The remaining annular space will then be tremie grouted with neat cement to about six inches bgs. The concrete mix will be approximately 5 gallons of water for every 94-pound bag of cement used; 5% drilling gel will be added to prevent shrinkage, ensure a proper seal, and prevent migration of injection solution to the surface. Each well will be fitted with a locking well cap. Two of the injection wells being installed in a potentially high traffic area will be completed using a traffic-rated flush-mounted well monument. The remaining 15 injection wells will be completed as above grade injection wells without a protective casing to facilitate injection setup.

In addition to the injection wells, Arcadis will install one monitoring well (MW-25) at the location shown on Figure 2. MW-22 was previously installed in this area in 2017 during the supplemental investigation but will be utilized as an injection well moving forward. MW-25 is proposed to provide adequate monitoring points for CVOC concentration trends and groundwater elevation, as well as provide a monitoring point to assess ERD reagent delivery and treatment effectiveness in this area. MW-25 will be constructed with identical screened interval as MW-22 but will be completed with 2-inch 10-slot PVC screen and Schedule 40 polyvinyl chloride (PVC) riser pipe. Consistent with the injection wells, the final screened interval will be determined during implementation based on field observations. MW-25 will be fitted with a locking well cap and will be completed using a traffic-rated flush-mounted well monument.

5.3.1 Well Development

The newly installed injection wells will be developed via jetting completed by the drilling subcontractor. Jetting includes the introduction of clean water to the well screen at a high velocity while simultaneously extracting water from the well to promote hydraulic connection between the well, filter pack and surrounding aquifer. Monitoring well MW-25 will be developed using standard surge and purge methodology by the drilling subcontractor.

Water generated during well development will be containerized in 55-gallon steel drums and staged on site for disposal; see the below section on Investigative Derived Waste for details.

5.3.2 Baseline Sampling

Baseline groundwater samples will be collected prior to the injections in accordance with the current semi-annual groundwater sampling program. In addition, monitoring well MW-25 will be sampled for laboratory analysis of VOCs, dissolved gases including ethene, ethane, and methane, and total organic carbon (TOC). Field parameters including pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, and depth to groundwater will also be collected. The sample will be collected per the semi-annual sampling program.

5.3.3 Well Infrastructure Survey

The location and elevation of the newly installed wells, along with the wells installed during the supplemental evaluation, will be surveyed by a licensed land surveyor following installation activities. The wells will be surveyed to the nearest 0.01-foot vertically and 0.1-foot horizontally, referenced to the North American Vertical Datum (NAVD) of 1988 and North American Datum (NAD) of 1983 respectively.

5.4 Injection Event

Injection into the newly installed wells will commence following installation, development, and testing. The injection will be completed using a mobile injection trailer and/or dedicated injection manifolds and tanks. Injection equipment will consist of the following:

- Injection solution mixing tank(s)
- Injection pump(s) as needed

- Solution delivery piping or hoses
- Wellhead assemblies
- Instruments necessary to monitor injection progress (e.g., flow totalizers, pressure gauges)

Injection solution will be prepared on site using potable water, EVO (approximately 2% by volume in the injection solution), and conservative tracers Eosin and fluorescein split between the north and south injection areas (40 parts per million [ppm] in the injection solution). It is estimated that approximately 4,900 gallons of injection solution will be injected per well for a total of up to 88,000 gallons that will be prepared. EVO, and fluorescein and Eosine fluorescent dye tracers will be provided by Ozark Underground Laboratory (OUL). The actual injection solution volume may be adjusted based on injection progress and monitoring during field implementation.

5.4.1 Injection Monitoring

Field staff will measure achievable and sustainable injection flow rates, wellhead injection pressures, and cumulative injection volumes periodically during injection at all wells. Injection will occur simultaneously into groupings of six wells at a time, resulting in three injection batches. Injection solution samples will be collected periodically from solution mixing tanks for TOC and dye (fluorescein or Eosine as applicable) analysis to verify injection solution reagent strength. The proposed injection monitoring plan is summarized in Table 2. Monitoring wells near injection wells will be visually inspected during injection for presence of tracer.

5.5 Post-Injection Performance Monitoring

Post-injection performance monitoring will be completed periodically for a duration of up to one year after the injection event to support the site ERD optimization, and will include:

- TOC and tracer (fluorescein or Eosine as applicable) sample collection via grab sampling in five monitoring wells (MW-19, MW-21, MW-23, MW-24 and MW-25). Samples will be collected three days post-injection, weekly for one month, monthly for three months, and then quarterly for one year following injection.
- TOC and tracer (fluorescein or Eosine as applicable) sampling in four off-site monitoring locations (MW-16, MW-18, IMP-3 and IP-1). TOC samples will be collected via grab sampling, and dye samples will be collected via carbon trap samplers (provided by OUL). Samples will be collected three days post-injection, weekly for one month, monthly for three months, and then quarterly for one year following injection.
- CVOC sample collection via grab sampling in four on-site monitoring wells (MW-19, MW-21, MW-23, and MW-24) and four off-site monitoring wells (MW-16, MW-18, IMP-3 and IP-1). Samples will be collected quarterly for one year following injection.
- Collection of field parameters including pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, conductivity, turbidity, color, and depth to groundwater will be recorded during each monitoring event following the one well-volume purge.

Actual sampling locations, parameters, and frequency may be adjusted based on post-injection monitoring results evaluation. Monitoring wells surrounding injection wells will additionally be visually inspected during the post-injection performance monitoring events to assess status of tracer distribution at these locations.

Groundwater samples will be submitted under chain-of-custody protocol certified laboratory and analyzed for parameters as outlined on Table 2.

During this time, Arcadis will also continue routine groundwater monitoring events completed as part of the current remedy.

6 WELL ABANDONMENT

In addition to the well installation and injections, six wells are proposed to be abandoned; IW-A1, IW-A5, IW-A6, IW-A7, PZ-1, and PZ-2. The wells need to be abandoned to accommodate the construction activities on the bridge adjacent to the site. These wells are associated with past environmental investigations and/or remedial activities and are currently not critical to the remedy. If deemed necessary, the wells will be replaced in the future following the construction efforts on the adjacent bridge.

A New York State licensed well driller will perform the well abandonment activities. An on-site inspector will document all monitoring well decommissioning activities, including daily reports, photographs, and sketches as necessary. The wells will be decommissioned using the steps described below, which are in conformance with NYSDEC *CP-43: Groundwater Monitoring Well Decommissioning Policy*.

Abandonment will include the following procedures:

1. Review the well construction details for each well to be abandoned, to confirm as-built well depth, screen interval, and surface seal information.
2. The wells will be positively identified before initiating the abandonment.
3. Water levels and well depths will be measured using a well sounder.
4. The well casing will be cut and removed to a depth of two feet below ground surface.
5. Cement or bentonite grout will be used to backfill (via tremie pipe) each well from the bottom up.
6. Surface completion materials will be removed (e.g., flush mounts and concrete pads) from each well location.
7. Ground surface around each abandoned well will be repaired to match the surrounding areas.

Well abandonment documentation will be included in the next semi-annual report for 2018 and submitted to NYSDEC.

7 INVESTIGATIVE DERIVED WASTE

Investigation-derived waste (IDW) generated during field activities may include soil cuttings, decontamination fluids, purge water, personal protective equipment (PPE), and other disposable sampling materials. Soil cuttings derived from drilling, wastewater from decontamination procedures, and purge water from the collection of groundwater samples will be placed in properly labelled 55-gallon

drums. PPE (e.g., nitrile gloves, disposable supplies, paper, plastic) will be treated as municipal waste. Containerized waste will be disposed of in accordance with waste hauler, waste handling facility, and state and federal requirements.

8 SCHEDULING AND REPORTING

Arcadis will document well installation in a technical memorandum to be submitted following completion of field activities. Documentation will include the following:

- Figure with surveyed well locations
- Table with well infrastructure details
- Discussion of installation and development activities
- Discussion of any departures from approved work plan, as applicable

Subsequent monitoring data and analysis will be included in the annual groundwater monitoring report. At a minimum, the documentation will include the reporting of field sampling activities and summary of analytical results.

Once the proposed injection event is complete and adequate analytical data has been collected to determine the next steps for the site, Arcadis proposes a follow up teleconference between all project stakeholders to discuss the outcome of the injection event and path forward for the site.

Upon your email or written approval of this effort, Arcadis will implement this evaluation. The field activities are tentatively scheduled to start in mid to late September; however, the actual schedule is dependent on the weather and regulatory approval. If you have any question or comments regarding this technical memorandum, please contact Shannon Lloyd with Ashland at (614) 790-3148.

9 REFERENCES

Arcadis. 2010. Corrective Measures Implementation Work Plan. March 2009.

Arcadis. 2016. Technical Memorandum. Supplemental Source Evaluation December 20, 2016.

Arcadis. 2017. Supplemental Source Evaluation Summary Report. March 8, 2017.

Arcadis. 2017. Technical Memoranda. Supplemental Site Evaluation Work Plan. June 30, 2017.

Arcadis. 2017. Injection Work Plan. October 24, 2017.

NYSDEC. 2009. Commissioner's Policy 43: Groundwater Monitoring Well Decommissioning Policy November 3, 2009.

TABLES

Table 1
Proposed Injection and Monitoring Well Construction
Ashland LLC
130 South Street
Rensselaer, New York

Well ID	Total Depth (ft bgs)	Ground Elevation (ft amsl)	TOC Elevation (ft amsl)	Screen Interval (ft bgs)	Screen Length (ft)	Screen Size (inch)	Screen Material	Slot Size
Injection Wells Northern Source Area								
IW-B06	30	--	--	20 - 30	10	4	SS	0.020
IW-B07	29	--	--	20 - 30	10	4	SS	0.020
IW-B08	29	--	--	20 - 30	10	4	SS	0.020
IW-B09	31	--	--	20 - 30	10	4	SS	0.020
IW-B10	30	--	--	15 - 30	15	4	SS	0.020
IW-B11	30	--	--	15 - 30	15	4	SS	0.020
IW-B12	24	--	--	10 - 25	15	4	SS	0.020
IW-B13	24	--	--	10 - 25	15	4	SS	0.020
IW-B14	23	--	--	10 - 25	15	4	SS	0.020
IW-B15	23	--	--	10 - 25	15	4	SS	0.020
Injection Wells Southern Source Area								
IW-A08	27	--	--	17 - 27	10	4	SS	0.020
IW-A09	24	--	--	15 - 25	10	4	SS	0.020
IW-A10	25	--	--	8 - 23	15	4	SS	0.020
IW-A11	30	--	--	15 - 30	15	4	SS	0.020
IW-A12	32	--	--	15 - 30	15	4	SS	0.020
IW-A13	25	--	--	10 - 20	10	4	SS	0.020
IW-A14	18	--	--	10 - 20	10	4	SS	0.020
Monitoring Well Southern Source Area								
MW-25	17	--	--	7-17	10	2	Sch. 40 PVC	0.010

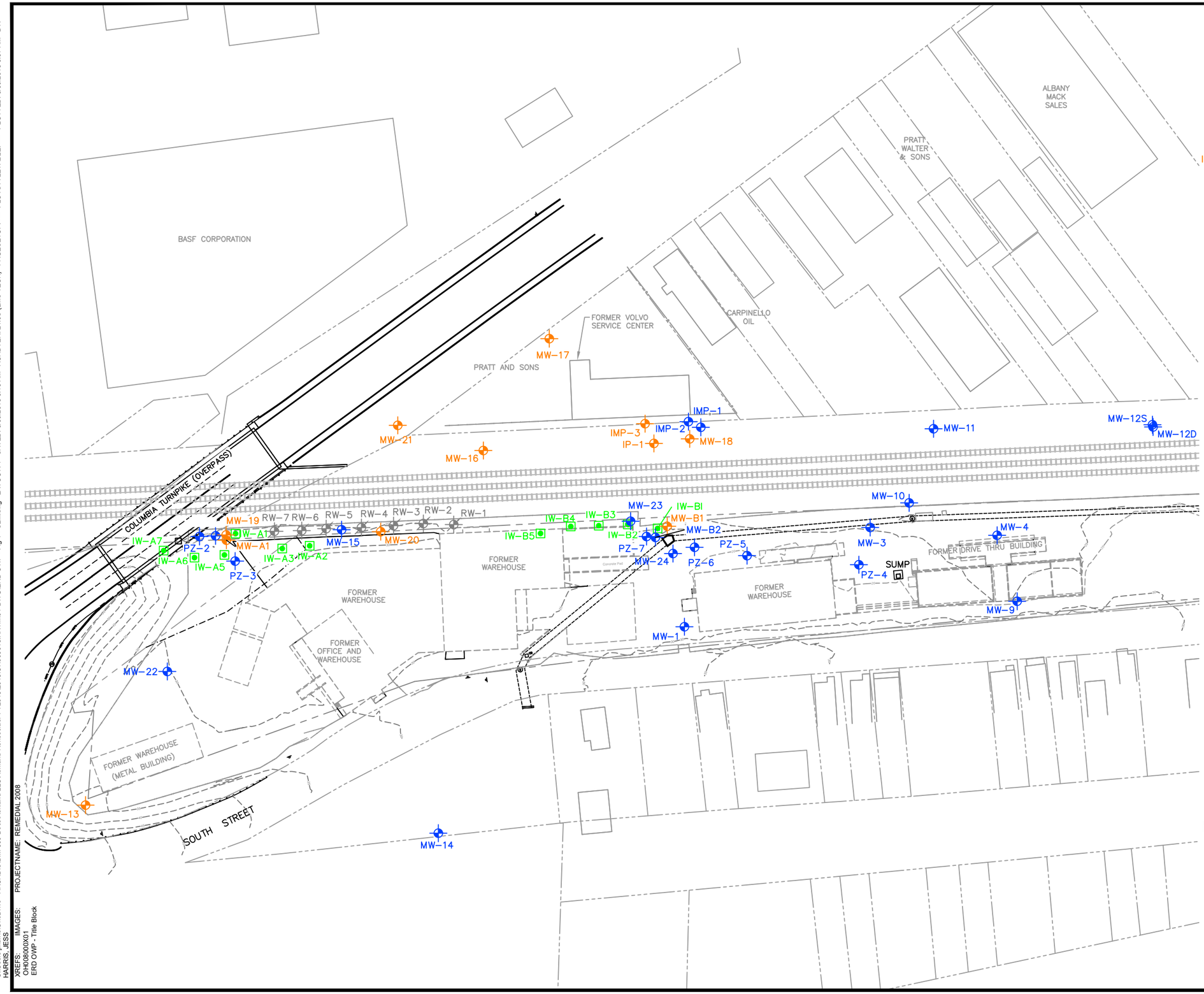
NOTES:
1) Final well installation may be adjusted in the field based on review of site lithology.
amsl = above mean sea level
bgs = below ground surface
ft = feet
PVC = polyvinyl chloride
SS = stainless steel
TOC = top of casing

Table 2
Proposed Injection Test Monitoring Plan
Ashland LLC
130 South Street
Rensselaer, New York

Sampling Location	Sampling Schedule	Sampling Method	Total Organic Carbon[a]	Tracer	Water Level	Field Parameters	Volatile Organic Compounds[b]	Injection Rate / Volume	Wellhead Pressure
During Injection									
Injection Solution Tanks	4[c]	Grab	X	X	--	X	--	--	--
IW	1 per 2 hours[c]	--	--	--	--	--	--	X	X
Post Injection - Onsite Monitoring Wells									
MW-19	3 days post-injection, then on weeks: 1, 2, 3, 4, 8, 12, 24, 36, 48	Grab sampling	X	X	X	X	--	--	--
MW-21			X	X	X	X	--	--	--
MW-23			X	X	X	X	--	--	--
MW-24			X	X	X	X	--	--	--
MW-25			X	X	X	X	--	--	--
MW-19	Quarterly for 1 year		--	--	--	--	X	--	--
MW-21			--	--	--	--	X	--	--
MW-23			--	--	--	--	X	--	--
MW-24			--	--	--	--	X	--	--
Post Injection - Off-Site Monitoring Wells									
IP-1	3 days post-injection, then on weeks: 1, 2, 3, 4, 8, 12, 24, 36, 48	Grab Sampling for TOC; Carbon trap sampler for tracer	X	X	X	X	--	--	--
IMP-3			X	X	X	X	--	--	--
MW-16			X	X	X	X	--	--	--
MW-18			X	X	X	X	--	--	--
IP-1	Quarterly for 1 year		--	--	--	--	X	--	--
IMP-3			--	--	--	--	X	--	--
MW-16			--	--	--	--	X	--	--
MW-18			--	--	--	--	X	--	--

NOTES:
a = analyzed by EPA 9060
b = analyzed by EPA 8260C
c = number of samples to be spread over injection event
TOC = total organic carbon
X = selected criteria is applicable

FIGURES



LEGEND:

- IMP-1/MW-1/PZ-1 — GROUNDWATER GAUGING WELL
- IP-1/IMP-3/MW-16 — PERFORMANCE MONITORING GROUNDWATER SAMPLING LOCATIONS
- IW-B1 — INJECTION WELL LOCATION
- SURFACE CONTOUR
- RAILROAD TRACK
- CULVERTED STREAM PIPE
- PROPERTY LINE
- FORMER BUILDINGS AND STRUCTURES
- RECOVERY WELLS ABANDONED IN 2016

NOTE:

LOCATIONS AND TOPOGRAPHY EAST OF CSX RAILROAD PROPERTY AND WEST OF AND INCLUDING SOUTH STREET, SURVEYED BY THEW ASSOCIATES PE-LS, PLLC (OCTOBER 2008). TWO NEW MONITORING WELLS, MW-20 & MW-21, AND TEN NEW INJECTION WELLS, IW-A2 THRU IW-A7 & IW-B2 THRU IW-B5, WERE SURVEYED ON JULY 2, 2010 BY THEW ASSOCIATES. REFERENCED HORIZONTALLY TO THE NORTH AMERICAN DATUM OF 1983 (NAD83) AND PROJECTED ON THE NEW YORK STATE PLANE COORDINATE SYSTEM (EAST ZONE). VERTICAL REFERENCE TO NGVD 1929. ASHLAND PROPERTY BOUNDARY ESTABLISHED BY THEW ASSOCIATES SURVEY AND DEED RESEARCH (OCTOBER 2008). OTHER PROPERTY LINES AND MAP FEATURES ARE FROM RENSSELAER COUNTY TAX MAPPING AND NEW YORK STATE CLEARING-HOUSE AERIAL PHOTOGRAPHY.

0 100' 200'

GRAPHIC SCALE

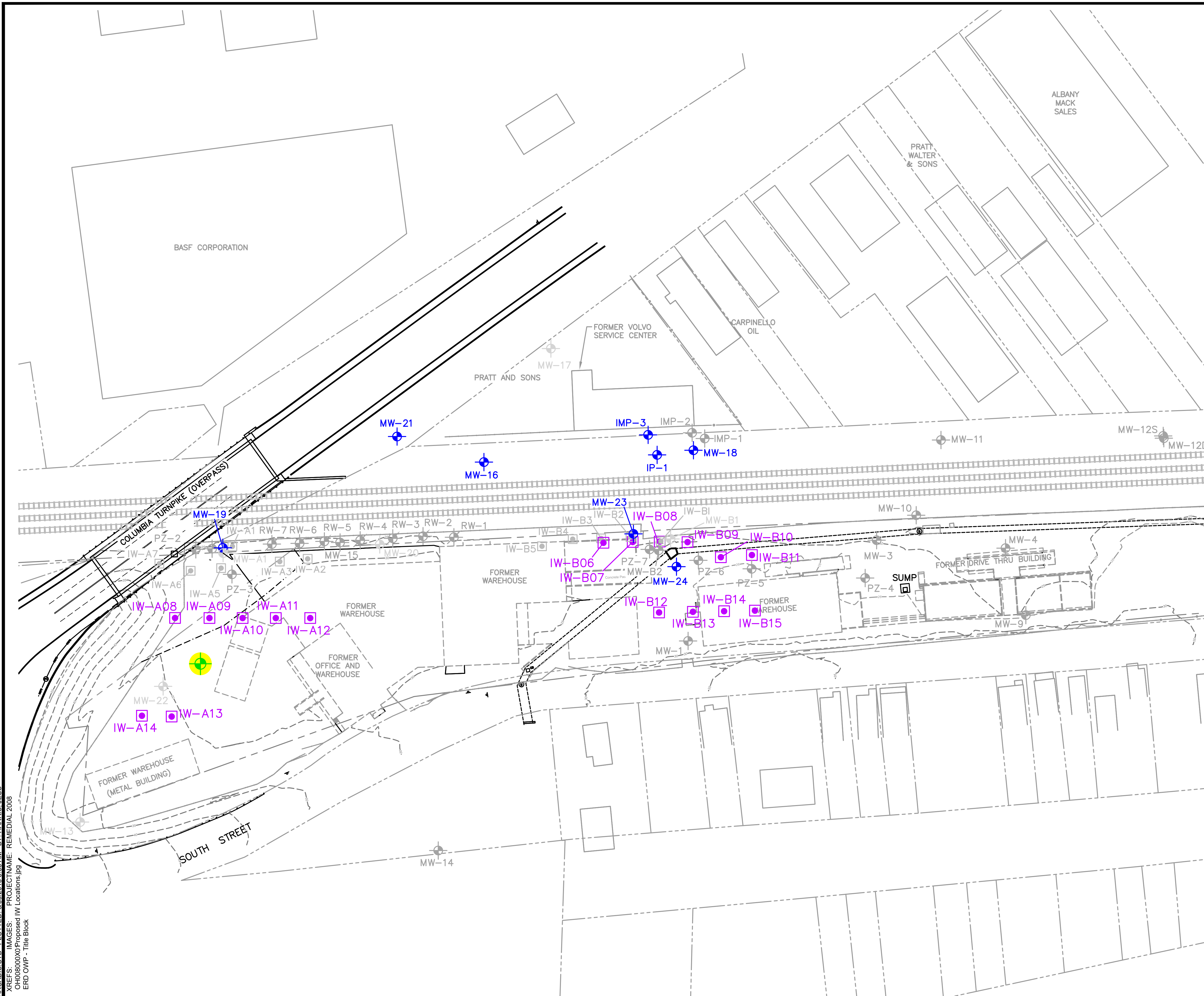
ASHLAND INC.
RENSSELAER, NEW YORK

ERD OPTIMIZATION WORK PLAN

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE 1



LEGEND:

IMP-1/MW-1/PZ-1	GROUNDWATER GAUGING WELL
IP-1/IMP-3/MW-16	PERFORMANCE MONITORING GROUNDWATER SAMPLING LOCATIONS
IW-B1	INJECTION WELL LOCATION
	SURFACE CONTOUR
	RAILROAD TRACK
	CULVERTED STREAM PIPE
	PROPERTY LINE
	FORMER BUILDINGS AND STRUCTURES
	RECOVERY WELLS ABANDONED IN 2016
MW-21	PROPOSED REMEDIAL OPTIMIZATION MONITORING WELL
IW-A14	PROPOSED INJECTION WELL
	PROPOSED MONITORING WELL

NOTE:

LOCATIONS AND TOPOGRAPHY EAST OF CSX RAILROAD PROPERTY AND WEST OF AND INCLUDING SOUTH STREET, SURVEYED BY THEW ASSOCIATES PE-LS, PLLC (OCTOBER 2008). TWO NEW MONITORING WELLS, MW-20 & MW-21, AND TEN NEW INJECTION WELLS, IW-A2 THRU IW-A7 & IW-B2 THRU IW-B5, WERE SURVEYED ON JULY 2, 2010 BY THEW ASSOCIATES. REFERENCED HORIZONTALLY TO THE NORTH AMERICAN DATUM OF 1983 (NAD83) AND PROJECTED ON THE NEW YORK STATE PLANE COORDINATE SYSTEM (EAST ZONE). VERTICAL REFERENCE TO NGVD 1929. ASHLAND PROPERTY BOUNDARY ESTABLISHED BY THEW ASSOCIATES SURVEY AND DEED RESEARCH (OCTOBER 2008). OTHER PROPERTY LINES AND MAP FEATURES ARE FROM RENSSELAER COUNTY TAX MAPPING AND NEW YORK STATE CLEARING-HOUSE AERIAL PHOTOGRAPHY.

0 100' 200'

GRAPHIC SCALE

ASHLAND INC.
RENSSELAER, NEW YORK

ERD OPTIMIZATION WORK PLAN

PROPOSED WELL INSTALLATION LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE

2

APPENDIX A

August 22 CSM Update Presentation PowerPoint

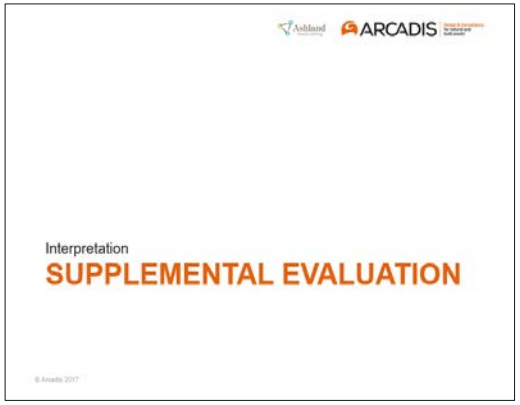
UPDATED CONCEPTUAL SITE MODEL

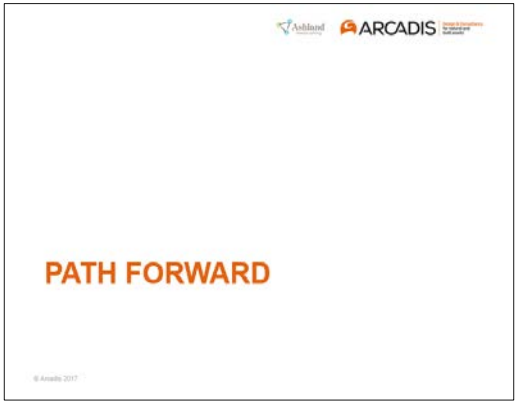
Ashland LLC. Facility; Rensselaer, New York

August 22, 2018

Agenda

- Recent Investigation Summary
- CSM Update/EVS Model Review
- Limited-Scale Injection Results
- Path Forward
- Schedule
- Additional Topics



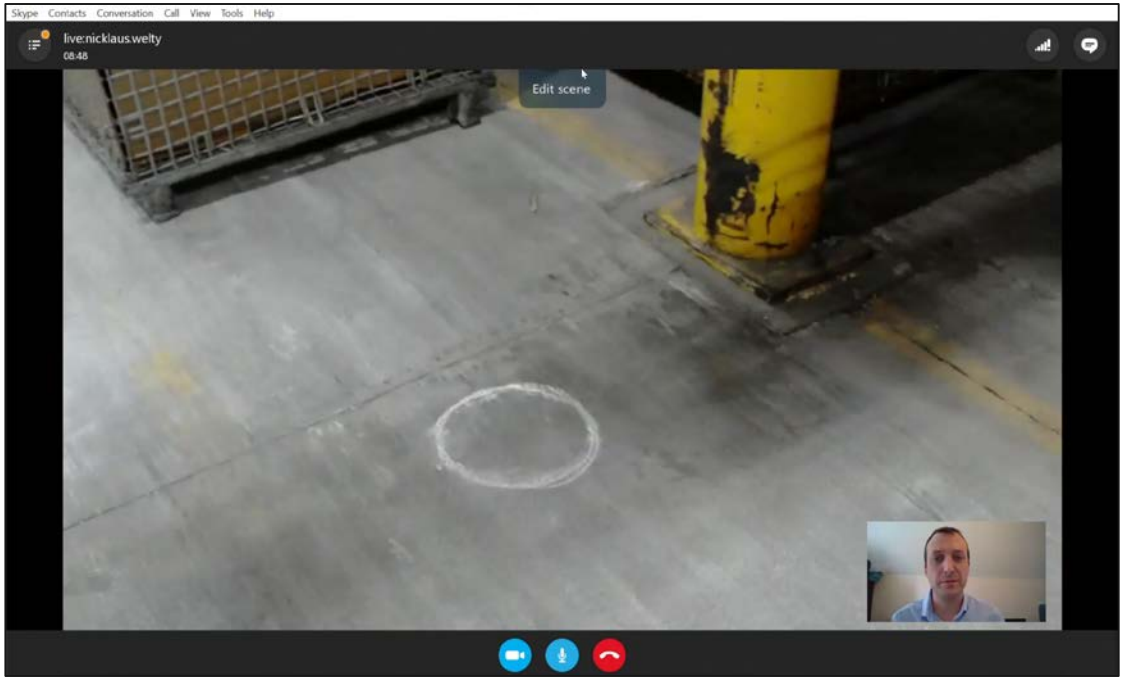


HoloLens Safety

SAFETY MOMENT

HoloLens Safety

- Support field staff with office experts.
- Perform additional stewardship visits.
- Mitigate confusion.
- Safely train staff.

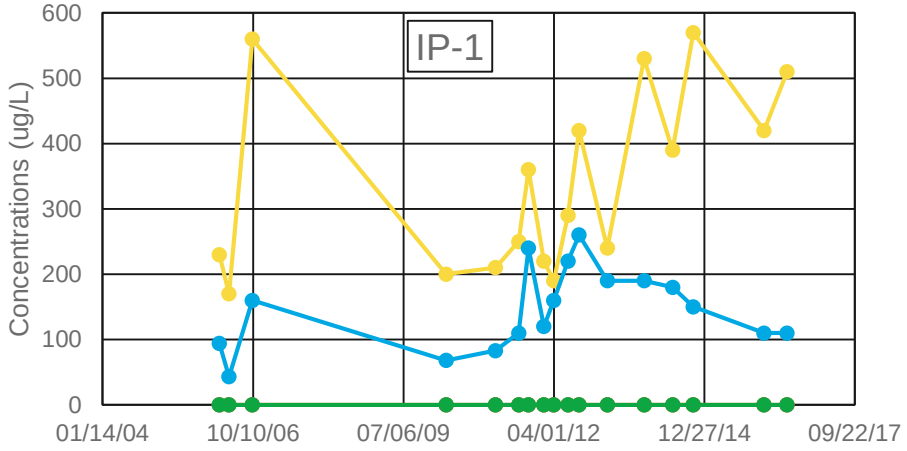


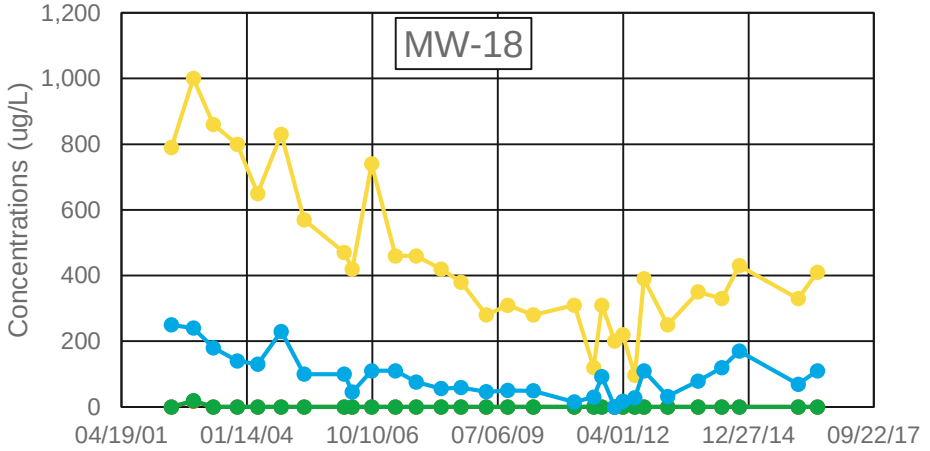
Be aware of surroundings during use!

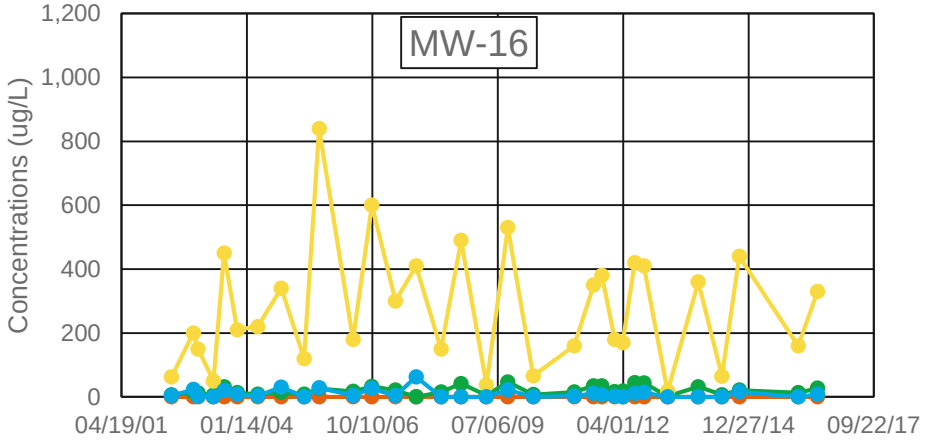
Interpretation

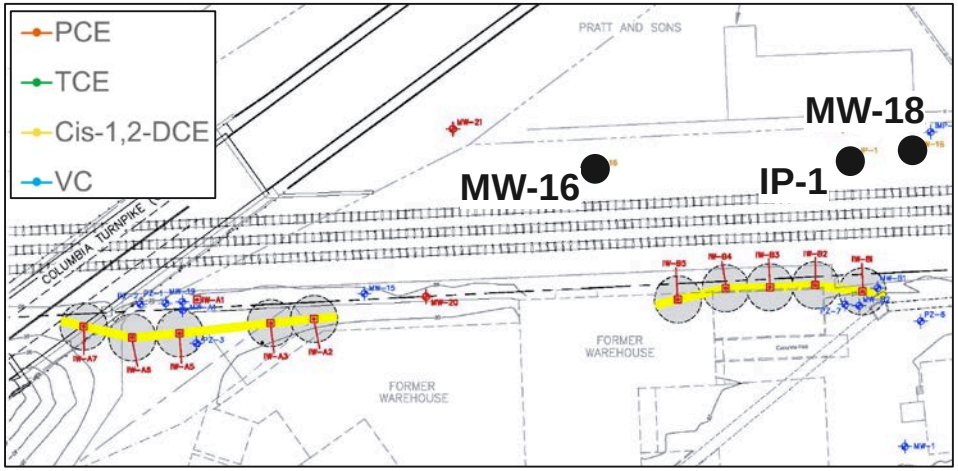
SUPPLEMENTAL EVALUATION

Problem Statement









Existing ERD not successfully mitigating off-site impacts

Objectives of Supplemental Evaluation

Increase Understanding:

- Delineate on-site CVOC source mass.
- Determine if CVOC mass is present outside current ERD remedial footprint.
- Define primary mass flux pathways.
- Evaluate off-site connectivity to source mass.
- Provide data to support remedy expansion as needed.

Optimize Strategy:

- Evaluate ERD infrastructure
  - Required O&M
  - Alternative substrate supplementation
  - Injection transect expansion
  - Targeted on-site treatment

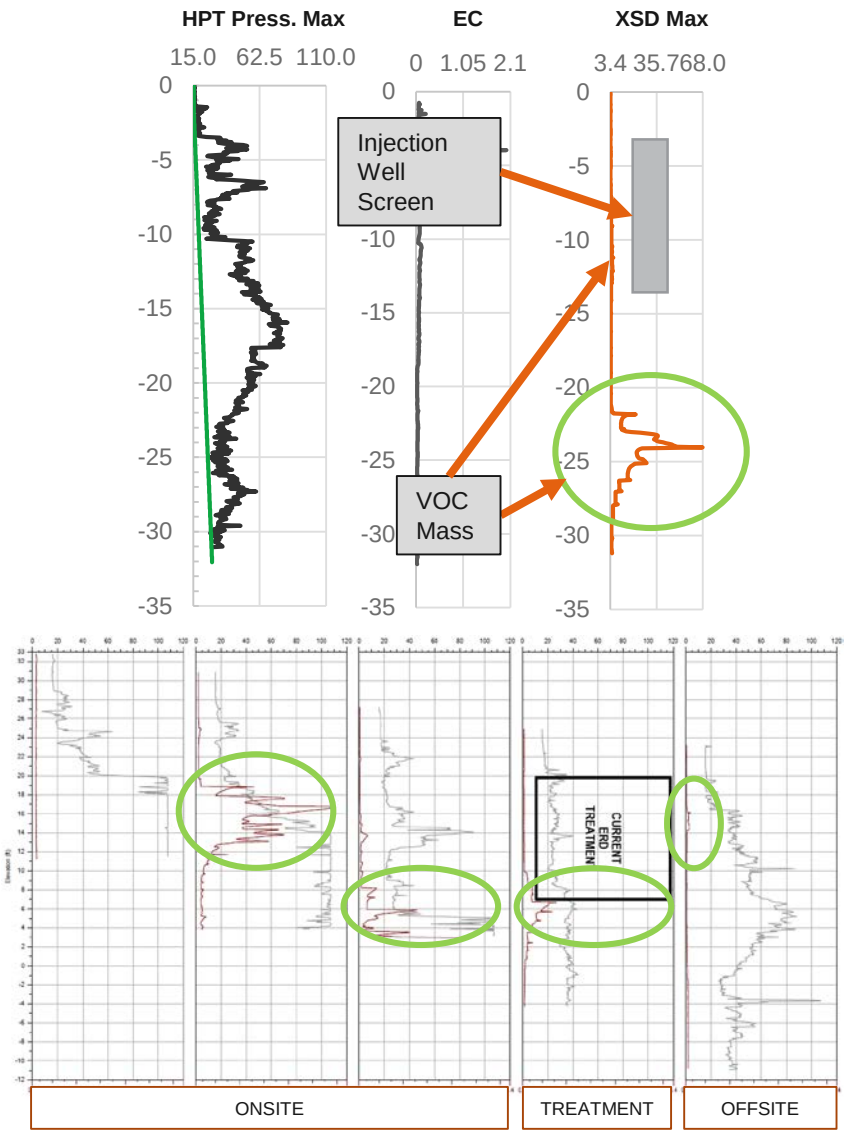
High Resolution Site Investigation

3Q 2017:

- Completed High-Resolution Investigation to assess site conditions and explain under-performing ongoing ERD
- Results indicated two CVOC mass areas:
  - In current treatment interval
  - At depths below current treatment wells
- Results suggested deeper CVOC mass as off-site impacts source

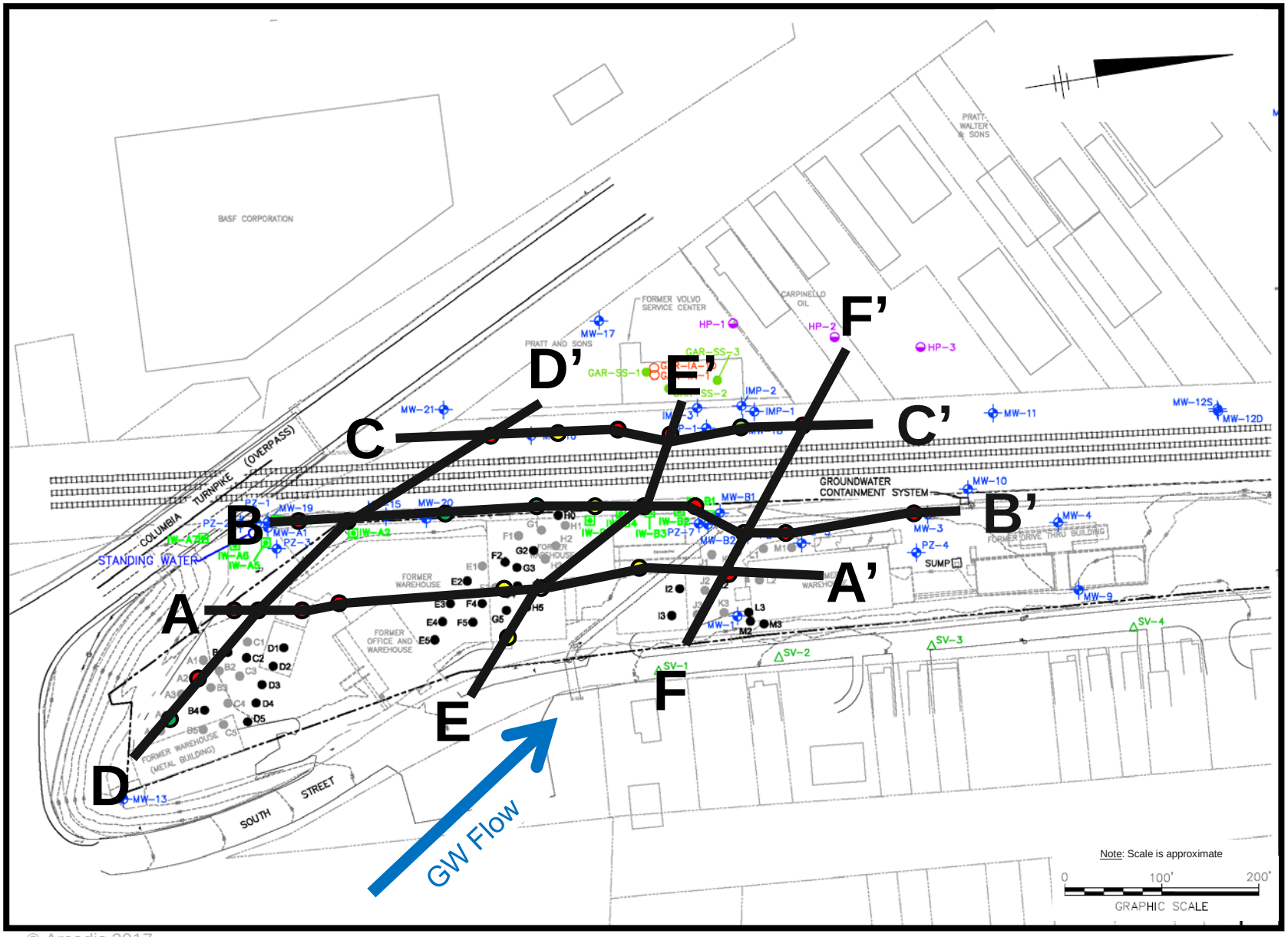
4Q 2017:

- Deeper injection wells
- Injection tests with TOC and dye to confirm flow paths



Transects

ID Map



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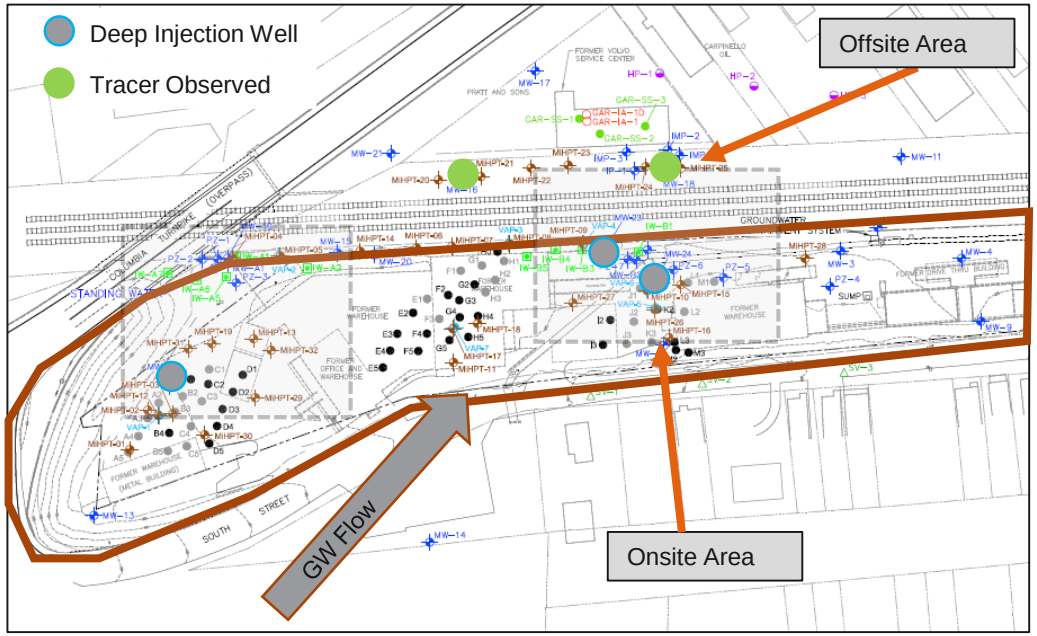
EVS Model

EVS Model

Limited Scale Injections

- Installed injection wells:
  - 1 source area
  - 2 deep
- Injected:
  - Dilute molasses solution
  - Rhodamine dye
- Deeper injection dye observed in off-site wells



Key Points for Path Forward Consideration:

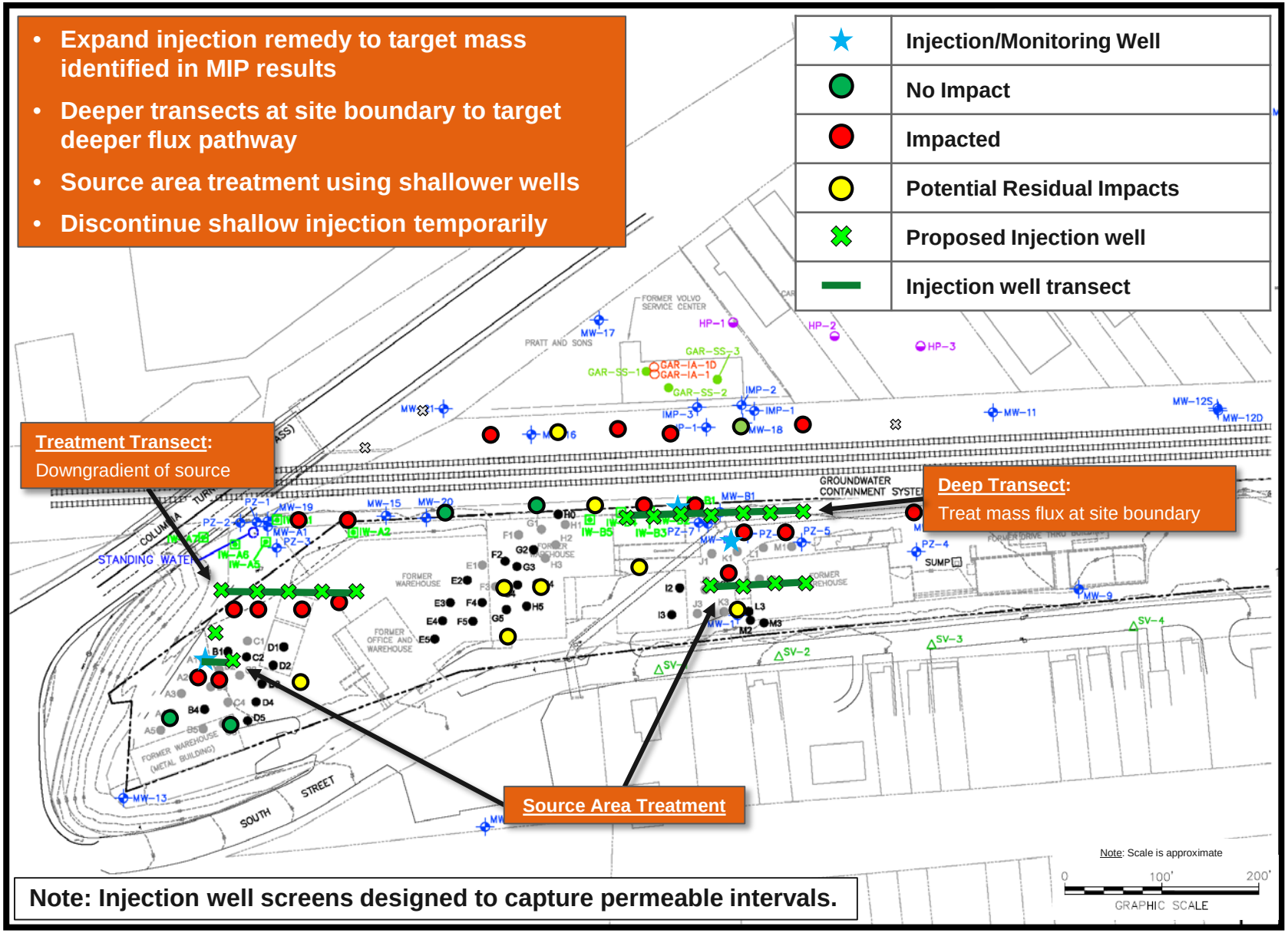
- Mass present below current treatment zone.
- Injection into deeper mass feasible.
- ERD proven for site.
  - Site geochemistry indicates ERD feasible for deeper mass.
- Tracer data indicates connection to off-site area from deeper injection.

PATH FORWARD

Proposed Path Forward

- Expand injection remedy to target mass identified in MIP results
- Deeper transects at site boundary to target deeper flux pathway
- Source area treatment using shallower wells
- Discontinue shallow injection temporarily

★	Injection/Monitoring Well
●	No Impact
●	Impacted
●	Potential Residual Impacts
✖	Proposed Injection well
▬	Injection well transect



Note: Injection well screens designed to capture permeable intervals.

Proposed Path Forward

- ERD Remedy Expansion
  - Installation of expanded injection well infrastructure (18 wells)
  - Target elevated MIP response to treat source mass and flux zones in transects
  - Apply radius of influence assumption (15 ft) from current remedy
  - Utilize existing MWs for dose-response wells
  - Utilize thick cement plugs for injection wells and develop with robust methodology (jetting)
- Injections
  - Discontinue shallow injections at property boundary
  - Utilize injection methodology from Corrective Measures Implementation Work Plan (Arcadis 2010) to guide injection plan
  - Initial injection
    - EVO into new wells to establish IRZ
    - Utilize tracers to confirm flowpaths
    - Develop robust monitoring plan to evaluate TOC delivery, IRZ establishment and TOC consumption rates (1 quarter)
    - Evaluate data and validate plan for successive injections (carbon source, injection frequency)
  - Subsequent injections with EVO based on TOC consumption rates observed during monitoring
- Schedule
  - Develop ERD Optimization Work Plan for DEC submittal 3Q 2018 (in progress)
  - Install wells in 3Q/4Q 2018; Complete initial injection (Weather permitting)

Schedule

DEC Verbal Approval:

8/22/18

Well Installation:

9/19/18 – 10/03/18

Work Plan:

9/05/18 - Submittal
9/12/18 - DEC Approval

Schedule

Injection Event:
10/03/18 – 11/17/18

Data Evaluation:
11/20/18 – 11/20/19

Post-Injection Monitoring:
11/20/18 – 11/20/19

Additional Topics

- Site Management Plan
- Deed Restrictions
- Site Easement

Ashland always solving

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Arcadis.
Improving quality of life.

ADDITIONAL SLIDES

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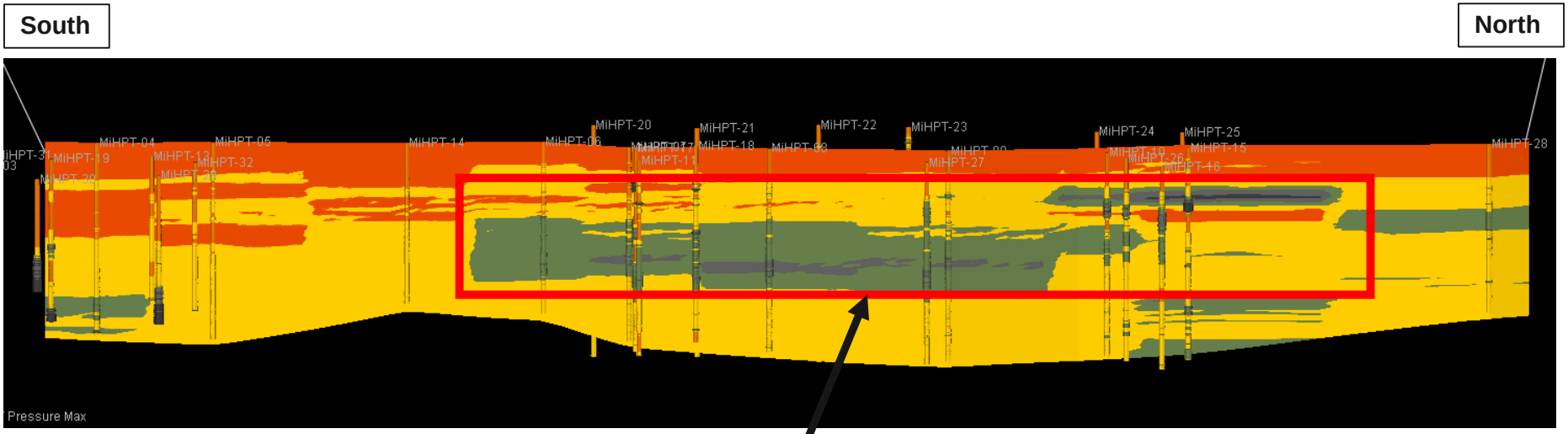
EVS Static Images

Results

- Cross Section B-B’ (view to west down groundwater flow path)

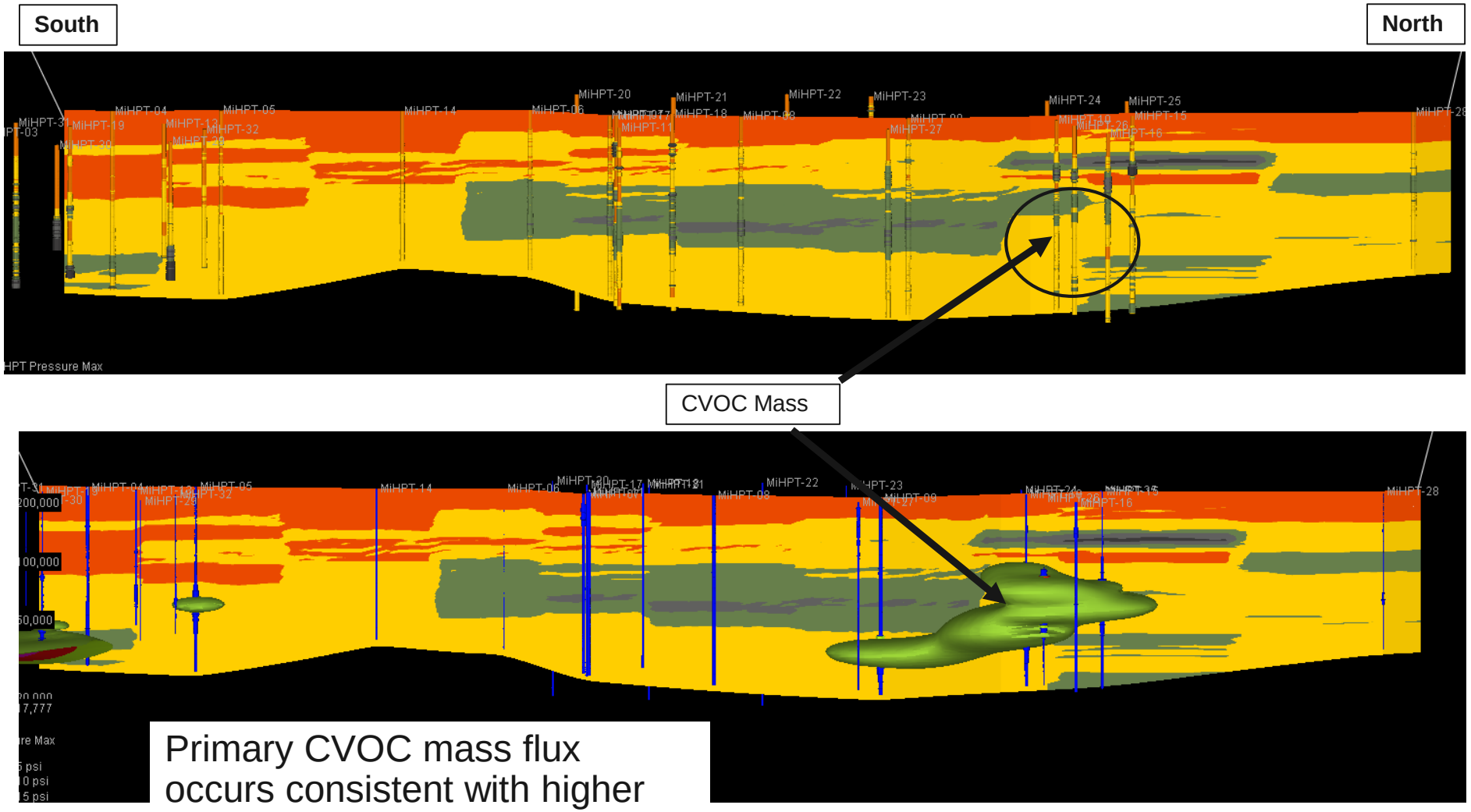


Increased heterogeneity to south, consistent with difficult injection conditions in southern transect

- Increased understanding of site lithologic heterogeneity
- Can apply to remediation well design and target permeable flux pathways

Results

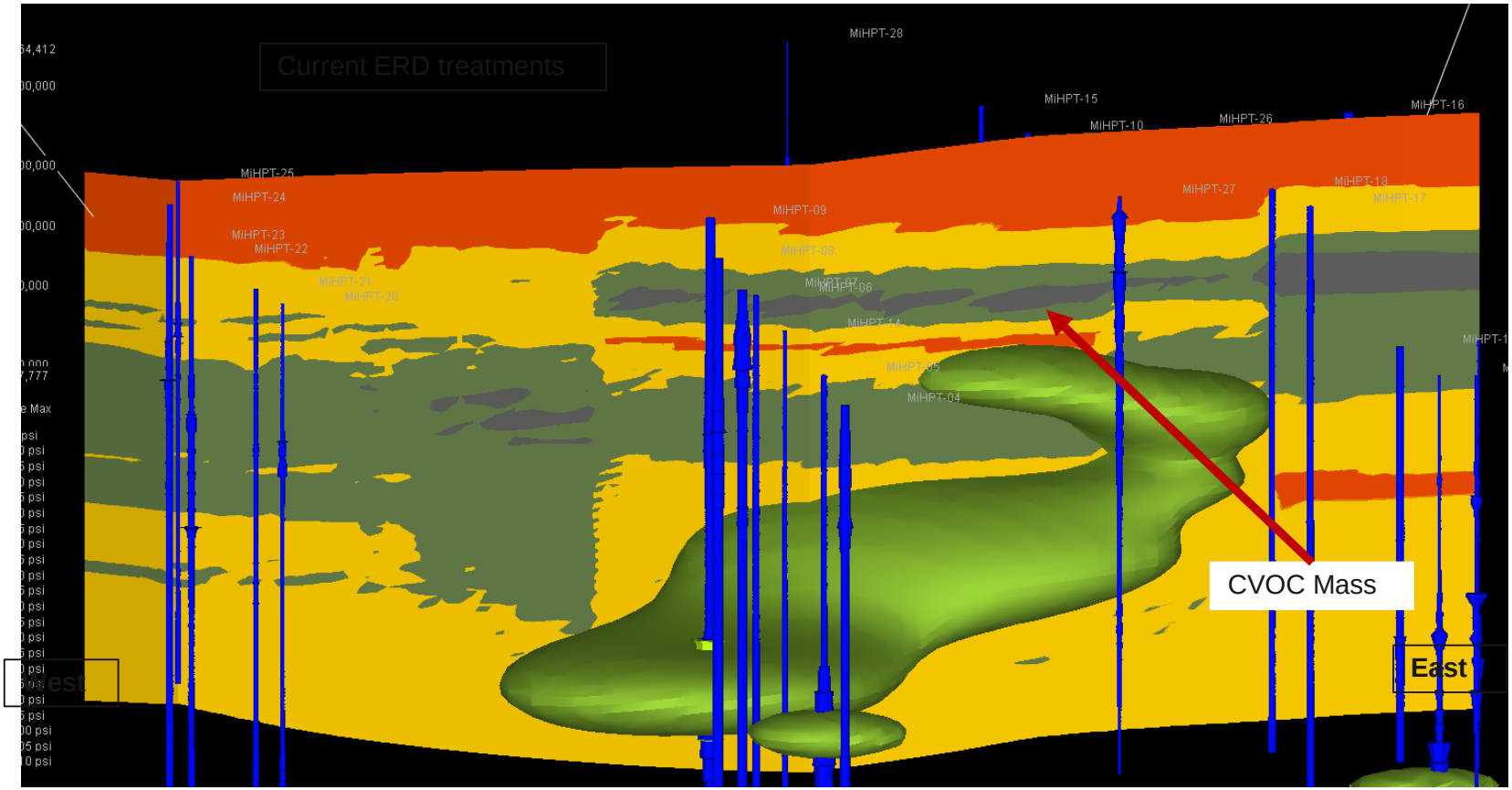
- Cross Section B-B’ (view to west down groundwater flow path)



Primary CVOC mass flux occurs consistent with higher permeability

Results – Northern Source Area

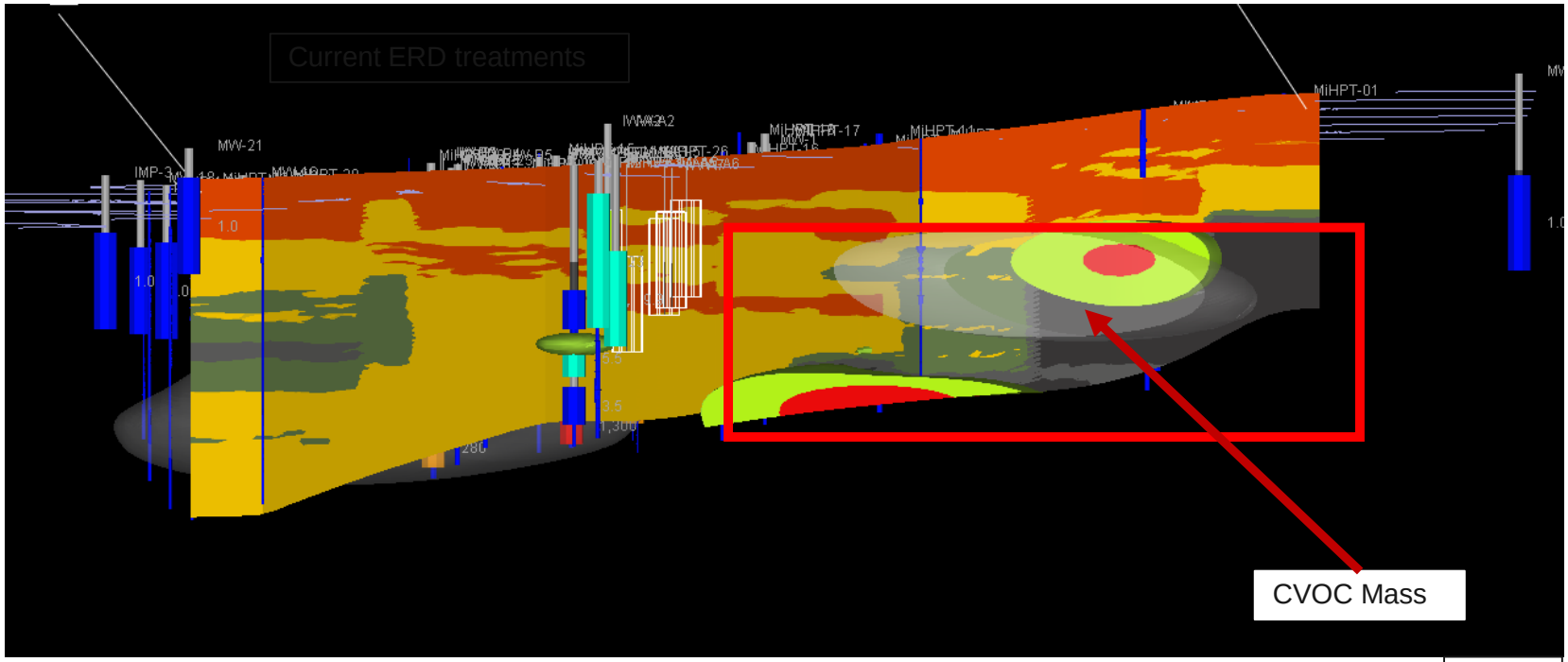
- Cross Section F-F' (view to north down railroad tracks)



- Mass flux below low-permeability unit and treatment areas
- Suggests shallow source area and deeper migration/flux
- Likely require some shallow-source treatment combined with deeper treatment in flux zone/site boundary

Results – Southern Source Area

- Cross Section D-D' (view to north down railroad tracks)



- Upgradient source – mass tied up in low-permeability matrix
- Injection into source was effective – suggest expansion of injection using same MW
- Downgradient results suggest limited impacts, some mass below treatment area
- Suggest treatment downgradient of source mass in high permeability flux zone