



EA Engineering, P.C.
EA Science and Technology

6712 Brooklawn Parkway, Suite 104
Syracuse, New York 13211-2158
Telephone: 315-431-4610
www.eaest.com

12 March 2018

Melvin Alli, P.E., GS-13, DAF
Program Manager (EPA Regions 1 and 2)
Air Force Civil Engineer Center, AFCEC/CZRE
2261 Hughes Avenue, Suite 155
Joint Base San Antonio, TX 78236-9853

RE: Additional Remedial Injections at Site 5 (DS004), Site 8 (DS002), and Site 10 (FT005)

Dear Mr. Alli:

EA Engineering, P.C. and its affiliate EA Science and Technology (EA) and its teaming partner Versar, Inc. are providing this letter as notification that EA will be implementing additional remedial actions (RAs) consisting of injections of emulsified vegetable oil (EVO) and zero valent iron (ZVI) (EZVI) at Site 5 (DS004), Site 8 (DS002), and Site 10 (FT005). The purpose of the injection is to further reduce chlorinated volatile organic compound (CVOC) concentrations at the subject sites. This work is being performed under Contract No. FA8903-09-D-8588, Task Order 0006, and is a component of the Performance-Based Remediation (PBR) Contract activities at the Niagara Falls Air Reserve Station (NFARS) in Niagara Falls, New York, for the United States Department of the Air Force, Air Force Civil Engineer Center (AFCEC), on behalf of the 914th Air Refueling Wing Mission Support Group/Civil Engineering-Environmental. The injections detailed in this letter are a continuation of injections performed in September 2015. The injections will be conducted in accordance with the RA Quality Assurance Project Plan (QAPP) for Sites FT005, LF008, ST010, SS014, DS002, and DS004 (EA 2015)¹.

This letter presents the following items:

- The original technical approach for the 2015 RAs
- A brief site description and remedial history for each site
- An overall description of the 2015 RAs and subsequent results
- A description of the proposed 2018 RAs for each site.

1. ORIGINAL TECHNICAL APPROACH

RAs were performed in August and September 2015. The remedial approach for Site 5 (DS004), Site 8 (DS002), and Site 10 (FT005) included the targeted treatment of site-specific CVOCs through the *in situ* application of a synergistic mixture of EZVI to target residual source material and reduce overburden and shallow bedrock groundwater concentrations.

¹ EA. 2015. *Remedial Action Quality Assurance Project Plan for Sites FT005, LF008, ST010, SS014, DS002, DS004*. Niagara Falls Air Reserve Station. Niagara Falls, New York. August.



The EZVI injections included Z-Loy™ MicroMetal product, which is a glycerol based ZVI product used to specifically promote the breakdown of CVOCs in groundwater through both abiotic chemical reaction, as well as through biotic enhancement. When mixed with EVO, the vegetable oil provides another source of organic carbon for biotic enhancement. *In situ* chemical reduction typically occurs more readily than microbial reduction or *in situ* chemical oxidation processes on CVOCs such as tetrachloroethene and trichloroethene. Where abiotic reduction processes dominate, more complete reduction occurs more quickly. With a biogenically enhanced ZVI, the carbon source stimulates microbial reduction processes, while the ZVI (a very strong reductant) promotes abiotic reduction processes; thereby, maximizing the reduction process, while minimizing the formation of additional *cis*-1,2-dichloroethene or vinyl chloride. Most reduction is expected to occur within 1 year of injection due to the relative mass of available CVOCs. As described in the site results below, the targeted reapplications are aimed at site hot spots, which are evident following 2 years of performance monitoring.

2. SITE 5 (DS004)

2.1 SITE BACKGROUND AND OBJECTIVE

Site 5 (DS004) was the primary launching site for Boeing /Michigan Aeronautical Research Center (BOMARC) missiles and currently houses vehicle maintenance buildings and a petroleum, oil, and lubricant storage area for JP-8 jet fuel. Investigations of the site began with the discovery of CVOC contamination in soil near missile Shelter F-5, but continued when it was observed in groundwater downgradient near missile Shelter F-6.

The primary objective of the second round of injections at Site 5 (DS004) is to further reduce contaminant mass in the subsurface by enhancing natural attenuation processes so that groundwater at the site can reach alternative termination criteria, as defined in the Site Management Plan (SMP) (EA 2017)², for four consecutive events.

The alternative termination criteria for Site 5 (DS004) include the following:

1. The chemical concentration of hazardous waste constituents in the monitoring wells associated with that recovery system/well indicate the Zero Slope Condition as defined in the SMP (EA 2017); and
2. The total concentration of site contaminant of concern is no greater than 100 parts per billion (ppb), and no single organic compound concentration exceeds 50 ppb for a minimum of four consecutive quarterly sampling events or frequency as approved by New York State Department of Environmental Conservation (NYSDEC); and
3. NFARS submits, and the NYSDEC approves an analysis, which indicates the residual groundwater contamination would not result in an unacceptable risk to human health and the environment.

² EA. 2015. *Site Management Plan*. Niagara Falls Air Reserve Station. Niagara Falls, New York. April



2.2 2015 REMEDIAL ACTION RESULTS

The first EZVI injection was performed in September 2015. Direct-push technology (DPT) was used to deliver 23,680 gallons of EZVI mixture to target remaining residual sources and groundwater impacts in the overburden and shallow, fractured bedrock. Approximately 400 gallons of EZVI mixture was also delivered into four bedrock core holes (100 gallons per core hole) to further target residual CVOCs in the shallow bedrock (**Figure 1**). Following 1 year of quarterly performance monitoring (September 2015 to September 2016) concentrations at Site 5 (DS004) were reduced by > 90 percent; however, concentrations have since rebounded in certain areas within the injection zones.

The 2017 performance monitoring data indicate EZVI has been effective in reducing CVOC concentrations at the site. However, current data (**Figure 1**) indicate elevated concentrations remain, especially at monitoring wells MW5-5D, and RW5-1, suggesting residual source material is present near these wells.

The total organic carbon (TOC) and dissolved organic carbon (DOC) concentrations, which are a measure of the remaining concentration of the EVO in the injection area, are indicative of the longer term anaerobic conditions supporting the microbial degradation of CVOCs by the *Dehalococcoides* species. TOC/DOC concentrations of 40 milligrams per liter (mg/L) or greater are targeted for biotic enhancement. The 2017 TOC/DOC data (**Figure 1**) illustrate adequate levels of organic carbon; however, there does appear to be some lower levels (<40 mg/L in June 2017) in performance monitoring wells MW5-5D and RW5-1.

2.3 PROPOSED 2018 TECHNICAL APPROACH

Based on the overall results of the 2015 injection using EZVI at Site 5 (DS004), a second injection consisting of 10,000 to 12,000 gallons of EZVI, will be conducted to target specific areas where CVOC concentrations remain elevated, and where TOC/DOC indicates that the EVO has been depleted (**Figure 2**). The EZVI will be injected in two areas of approximately 4,500 square feet (ft²) and 3,500 ft² (total area approximately 8,000 ft²) using DPT. The EZVI mixture will contain approximately 3,000 to 3,500 pounds (lb) of Z-Loy™ MicroMetal product and 9,000 to 10,000 lb of EVO. The target treatment areas are located between the BOMARC missile Shelters F-5 and F-6, adjacent to performance monitoring wells MW5-5D and RW5-1. The target depths for the second injection is the bedrock and overburden interface zone that was targeted in 2015. The injection will include 30–40 points spaced approximately 15 to 20 feet (ft) apart, with total depths ranging from 10 to 15 ft below ground surface and will cover a zone approximately 5 feet thick. It is anticipated that each point will receive approximately 250 gallons of EZVI, based on information from the 2015 injection.

A second round of bedrock injections will also be conducted to refresh EZVI in the shallow bedrock. Injections of approximately 200 gallons each are proposed for bedrock core holes, CH5-01 and CH5-02, to further address the CVOC observed in shallow bedrock. These bedrock injections should continue to mitigate the groundwater impacts to the shallow bedrock at the site, as well as mitigate potential plume migration.



2.4 PERFORMANCE MONITORING

Performance monitoring at the Site 5 (DS004) will continue in concurrence with the RA QAPP (EA 2015)¹. Groundwater samples will be collected from the performance monitoring wells (MW5-5D, RW5-1, RW5-2, and RW5-4) quarterly, beginning not longer than 30 days following treatment, and continue for a period of 1 year. Groundwater will be sampled using passive diffusion bags (PDBs) on a quarterly basis, and analyzed for volatile organic compounds by U.S. Environmental Protection Agency (EPA) Method 8260C.

3. SITE 8 (DS002)

3.1 SITE BACKGROUND AND OBJECTIVE

Site 8 (DS002) is the former Building 202 Drum Storage Yard. This area was used by New York Air National Guard as a short-term hazardous waste accumulation point between 1978 and 1982. In 1988, a new asphalt/concrete overlay was placed on top of the old pad. Currently, the site is used as a repository for construction materials and assorted scrap, and for vehicle parking. *In situ* bioremediation (injection of hydrogen into the subsurface) was performed in September 2002 and July 2005 to address CVOC contamination at the site.

The primary objective of the second round of injection is to reduce the groundwater concentrations of CVOCs in the overburden and shallow bedrock to below the NYSDEC Class GA groundwater standards for four quarterly events, as defined in the SMP (EA 2017)².

3.2 2015 REMEDIAL ACTION RESULTS

The first injection was performed in September 2015. DPT was used to deliver 9,060 gallons of EZVI mixture to address remaining CVOC sources in the overburden and the shallow bedrock interface in two separate areas of the site (**Figure 3**). One hundred gallons of the EZVI mixture was also delivered to one bedrock core hole (CH8-01) to treat residual CVOCs in the shallow bedrock.

The current performance monitoring data from 2017 indicate that EZVI has continued to be effective in reducing CVOC concentrations at the site in most wells. However, overburden groundwater in the vicinity of well MW8-1 continues to be elevated above NYSDEC Class GA groundwater standards.

The 2017 data for Site 8 (DS002) illustrate that the concentrations of CVOCs exhibit some seasonality in the data trends. The concentrations of CVOCs increase in the overburden wells (MW8-8 and MW8-1) in June 2017, which coincide with a higher groundwater event. This indicates that the overburden groundwater, which is most likely rising into the vadose zone, is coming into contact with low-level CVOCs trapped in the soil matrix.

The TOC/DOC data also indicate that the EVO has been depleted at the site, where concentrations are consistently below 10 mg/L in three of the four performance monitoring wells. The next round



of injections will target the area where CVOC concentrations continue to persist above NYSDEC Class GA groundwater standards.

3.3 PROPOSED 2018 TECHNICAL APPROACH

Based on the results of the 2015 injection, the second injection of 4,000 to 4,750 gallons of EZVI will target specific areas where CVOC concentrations remain elevated, and where TOC/DOC indicates that the EVO has been depleted. The EZVI will be injected in one area of approximately 3,000 ft² using DPT. The EZVI mixture will contain approximately 775 to 1,000 lb of Z-Loy™ MicroMetal product and 2,300 to 2,800 lb of EVO. As the 2017 CVOC and organic carbon data indicate, the target area is the same area which was targeted during the 2015 injection (**Figure 4**). However, based on the seasonality observed in the CVOC and TOC/DOC data, the 2018 injections will target the upper portion of the overburden where CVOCs are likely trapped in the soil matrix, 4 to 5 ft higher (shallower) than the 2015 injection depths. The 2018 injections will include 14 to 17 points spaced approximately 15 ft apart. The points will target terminal depths of approximately 8 to 10 ft below ground surface and will cover a zone approximately 5 feet thick. It is anticipated that each point will receive approximately 200 to 250 gallons of EZVI, based on information from the 2015 injection.

A second round of bedrock injections will also be conducted to refresh EZVI in the shallow bedrock. Injections of approximately 200 gallons are proposed for bedrock core hole CH8-01 to further address the CVOC observed in shallow bedrock. This bedrock injection should continue to mitigate the groundwater impacts to the shallow bedrock at the site, as well as mitigate potential plume migration.

3.4 PERFORMANCE MONITORING

Performance monitoring at the Site 8 (DS002) will continue in accordance with the RA QAPP (EA 2015)¹. Groundwater samples will be collected from the performance monitoring wells (MW8-1, MW8-8, CH8-01, and MW8-10D) quarterly, beginning not longer than 30 days following treatment, for a period of 1 year. Groundwater will be sampled using PDBs on a quarterly basis, and analyzed for VOCs by EPA Method 8260C.

4. SITE 10 (FT005)

4.1 SITE BACKGROUND AND OBJECTIVE

Operations at the Site 10 (FT005) fire-training area (1955–1963) included the burning of waste oil, solvents, and jet fuel as part of fire-training exercises. The former burn pit is approximately 100 ft in diameter. This site is currently unused and covered with heavy grass and weed growth. Surface drainage flows to the south and discharges into Cayuga Creek. An Interim Corrective Measure Implementation was completed in 1996 that used a six-phase soil heating followed by additional treatments in 1998 and 2002. A groundwater treatment system was installed in 2002 to pump and treat groundwater from the source area in the former fire pit. The groundwater treatment system was in operation through September 2015.



The primary objective for the second round of injections at Site 10 (FT005) is to reduce remaining contamination in the overburden and shallow bedrock using enhanced natural attenuation processes.

4.2 2015 REMEDIAL ACTION RESULTS

The first injection was completed in September 2015. DPT was used to deliver 7,920 gallons of EZVI mixture to address remaining CVOC sources in the former fire-training pit (**Figure 5**). Following 1 year of quarterly performance monitoring (September 2015 to September 2016), the percent reduction of total CVOCs in the shallow bedrock performance monitoring wells was >90 percent.

The current performance monitoring data from 2017 indicate that the EZVI injections are continuing to successfully destroy residual CVOCs in the former fire-training pit. However, concentrations in performance monitoring well MW10-10D remain high (approximately 1,000 micrograms per liter total CVOCs).

The TOC/DOC data also indicate that the EVO has not been depleted at the site, where concentrations are consistently above 40 mg/L 2 years following initial application.

4.3 PROPOSED 2018 TECHNICAL APPROACH

Based on the 2017 groundwater data, the second injection of 5,000 to 6,500 gallons of EZVI will target specific areas where CVOC concentrations remain elevated. The EZVI will be injected in one area of approximately 3,000 to 4,000 ft² using DPT. The EZVI mixture will contain approximately 950 to 1,250 lb of Z-Loy™ MicroMetal product and 2,800 to 3,800 lb of EVO. As the 2017 data indicate, the remaining target area for a second injection is around monitoring well MW10-10D (**Figure 6**). The injection will be focused on the area hydraulically upgradient (to the north) of CVOC contamination observed in monitoring well MW10-10D. The injection zone will also extend farther to the east in order to mitigate CVOC impacts beyond the eastern extent of the 2015 injection zone. The depths for the second injection will also target the same zone at the bedrock and overburden interface as was targeted in 2015. The injection will include 15 to 25 points spaced approximately 15 to 20 ft apart, with depths ranging 8 to 10 ft and will cover a zone approximately 5 feet thick. It is anticipated that each point will receive approximately 250 gallons of EZVI, based on information from the 2015 injection.

Furthermore, an EZVI application of approximately 300 gallons is also proposed for the groundwater extraction trench near pumping well PW10-1. This application will create a passive reactive barrier in the trench to help mitigate potential CVOC releases to Cayuga Creek. While the current data trends in PZ10-7, which acts as a site sentinel well for Site 10 (FT005), indicate that CVOCs are not migrating from the former fire-training pit, the EZVI barrier would provide an additional measure of protection to Cayuga Creek.



4.4 PERFORMANCE MONITORING

Performance monitoring at the Site 10 (FT005) will continue in accordance with the RA QAPP (EA 2015)². Groundwater samples will be collected from the performance monitoring wells (MW10-10D, MW10-1DA, PW10-2, MW10-2, and sentinel well PZ10-7) quarterly, beginning not longer than 30 days following treatment, for a period of 1 year. Groundwater will be sampled using PDBs on a quarterly basis, and analyzed for VOCs by EPA Method 8260C.

5. 2018 REMEDIAL ACTION FIELD ACTIVITIES AND INJECTION SCHEDULE

The RAs are scheduled to begin in May 2018 and will be conducted in accordance with the RA QAPP (EA 2015)¹. Field activities will be conducted in accordance with the Health and Safety Plan Addendum included as Appendix C in the RA QAPP (EA 2015)¹. While the SMP (EA 2017)² typically requires community air monitoring for all intrusive activities, the proposed injection activities include advancing direct-push tooling and applying EZVI using positive pressure to the subsurface. The activities do not include excavation of any soil, which mitigates dust generation; and the positive pressure of the EZVI injection mitigates the potential for vapor release. As such, a Community Air Monitoring Plan (CAMP) will not be required.

The results of the second round of injections, including actual injection locations, EZVI injectate dosages and volumes will be detailed in a subsequent injection summary memorandum (Summer 2018). Following the period of performance monitoring, a technical evaluation of the effectiveness of the second round of injections will be provided in a subsequent injection summary report (Summer 2019). Interim performance data will also be provided in the Annual Report required by the SMP.

If you have any questions, please call me at 315-431-4610.

Sincerely yours,

EA SCIENCE AND TECHNOLOGY

A handwritten signature in blue ink, appearing to read 'Ben Young'.

Benjamin Young
Project Manager

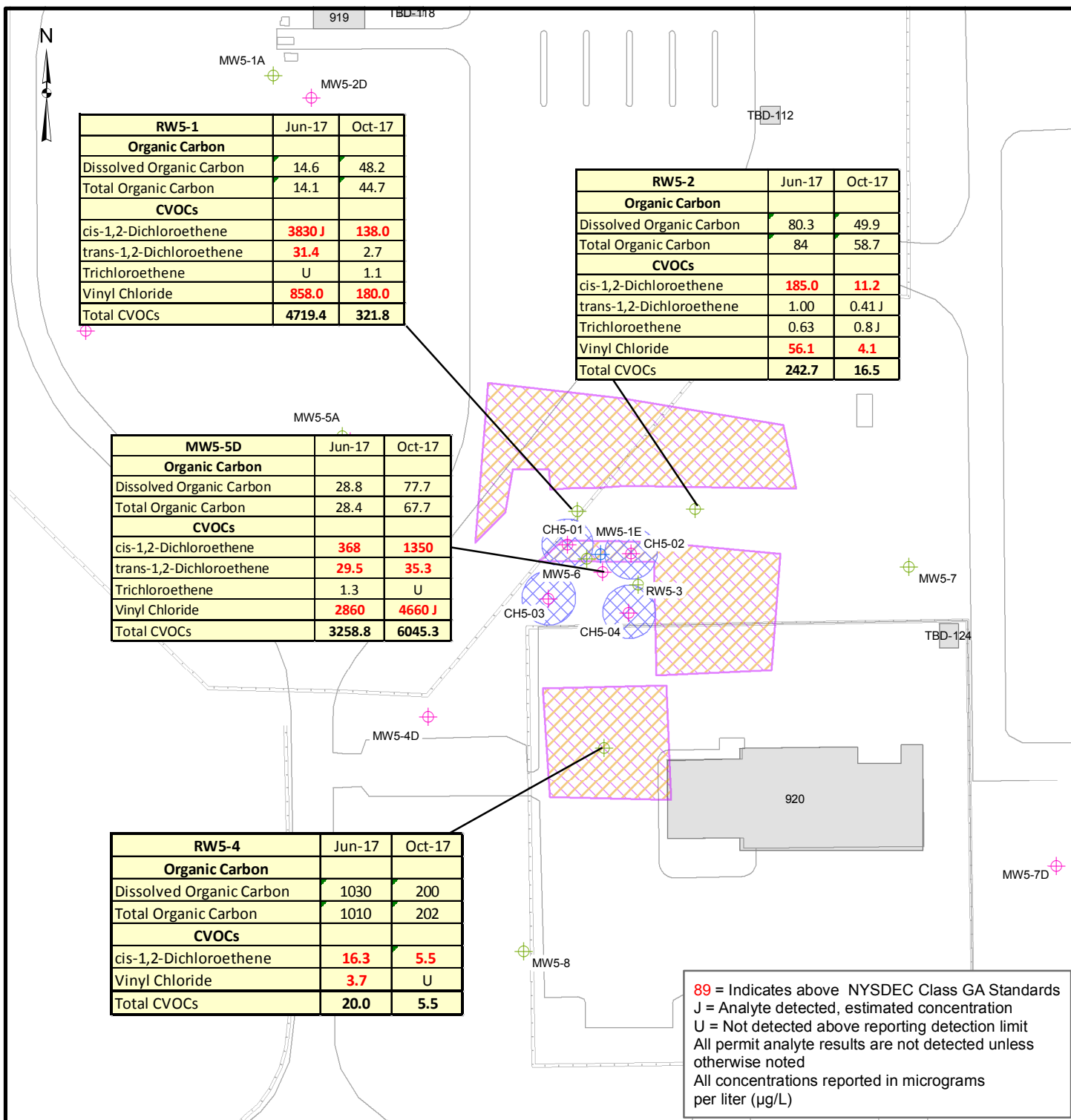
Attachment – Figures

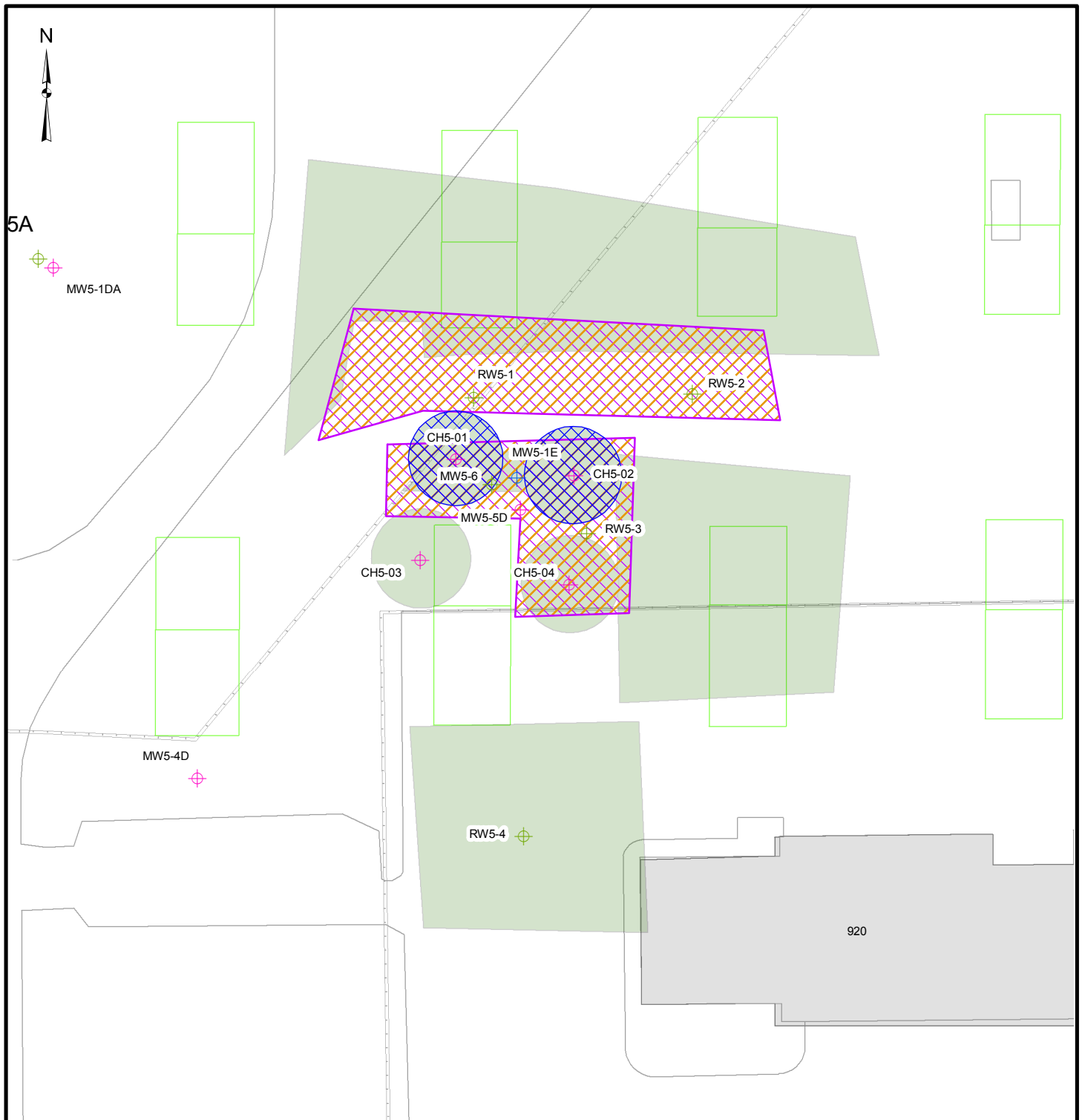
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A. Salisbury, AFCEC
J. Davis, AFCEC
N. Glenn, Versar
F. DeSantis, EA


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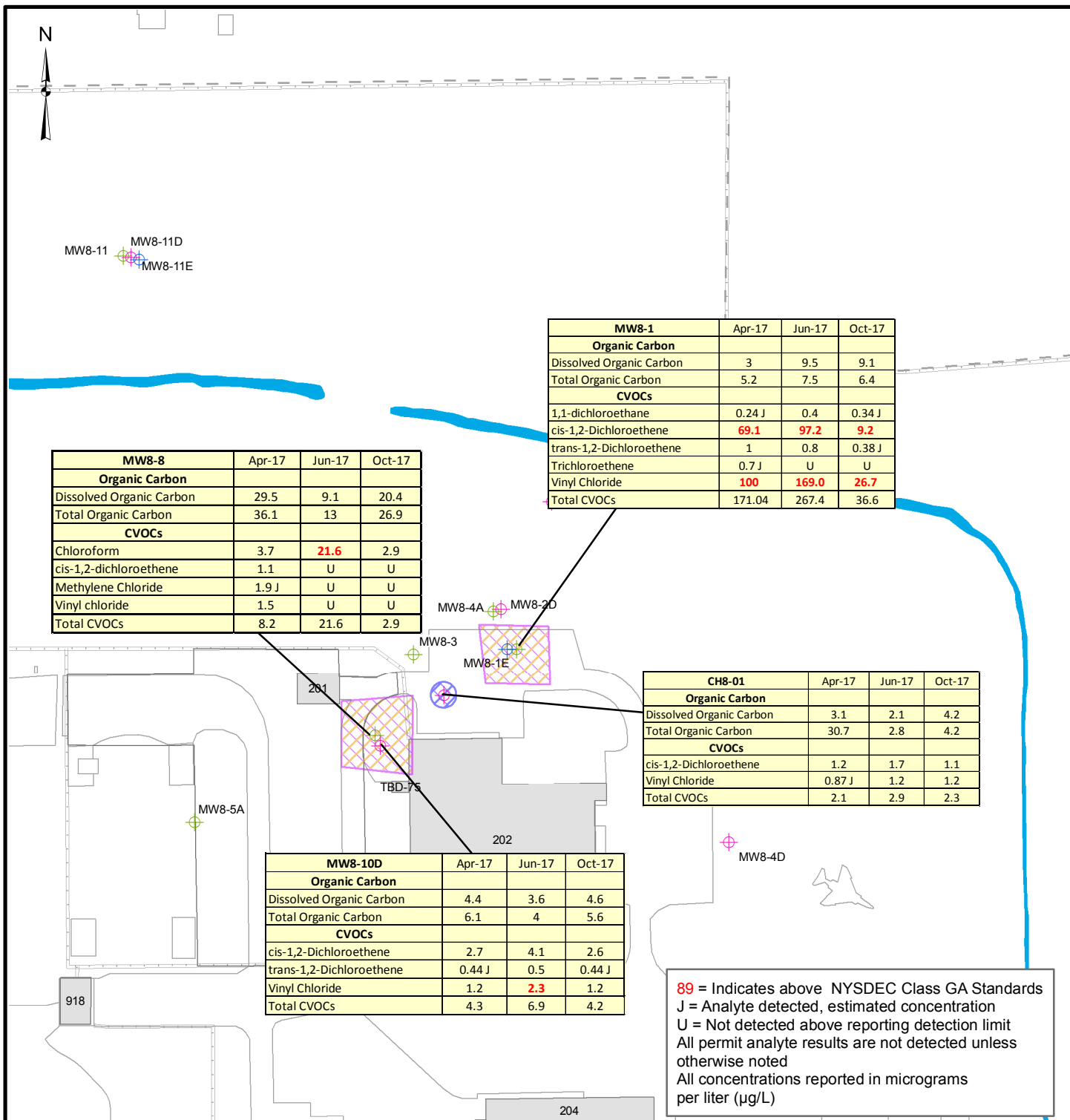
Figures

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Site 8 - DS004
Niagara Falls Air Reserve Station
Niagara Falls, New York

FIGURE 3
2015 Injection Zones
and 2017 Design Data
Site 8 - DS004

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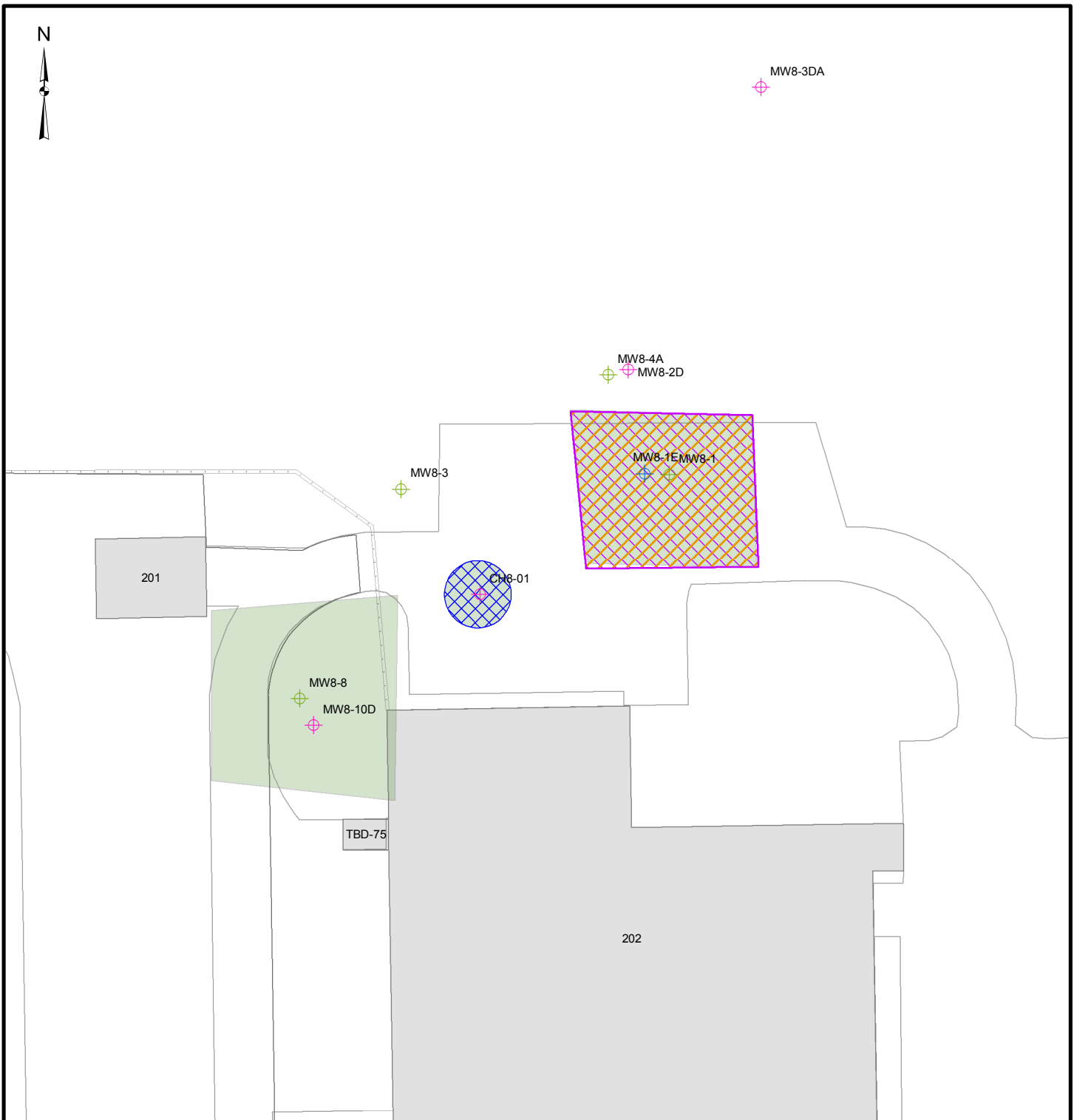
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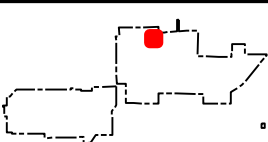



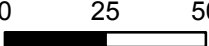

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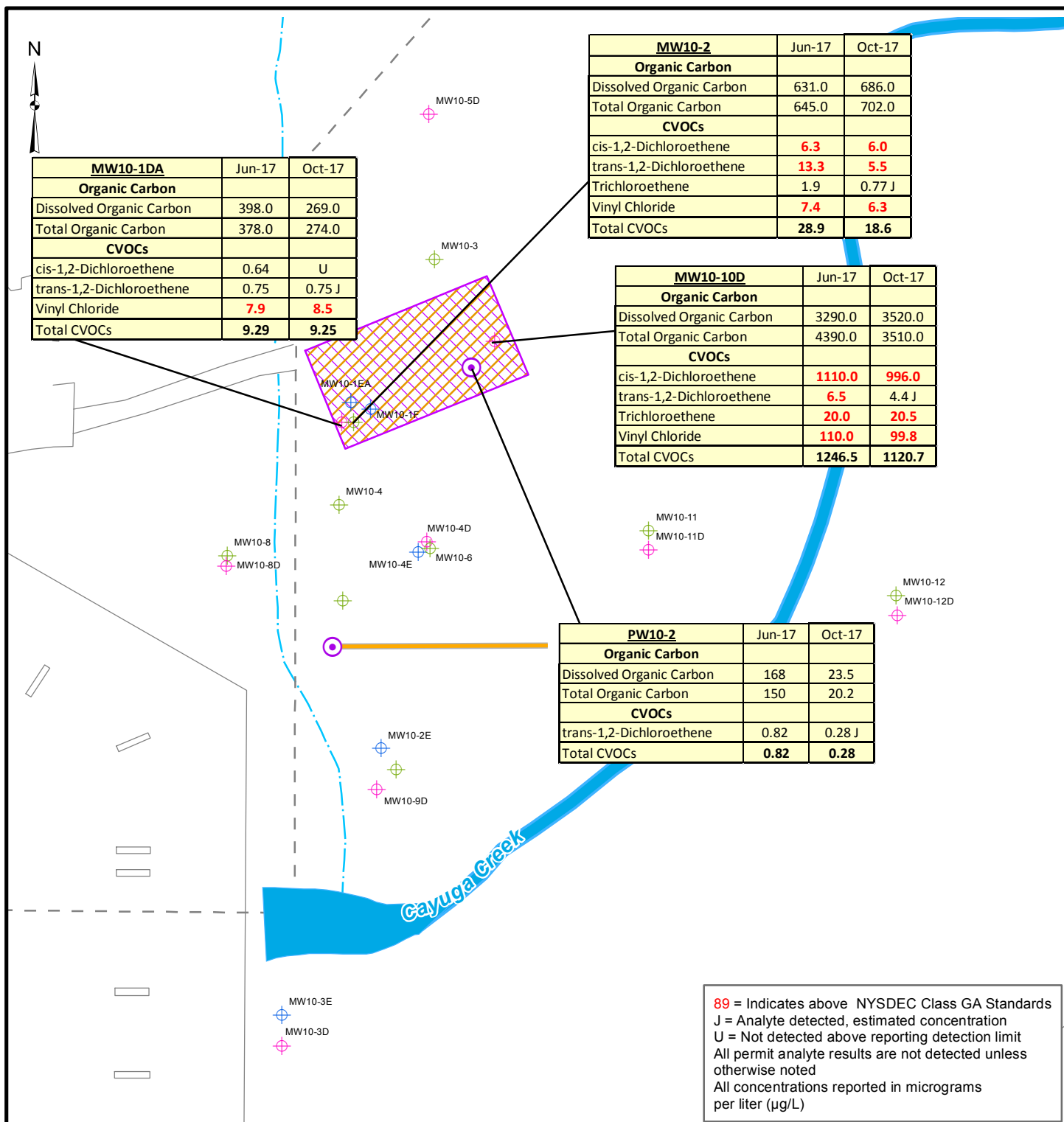
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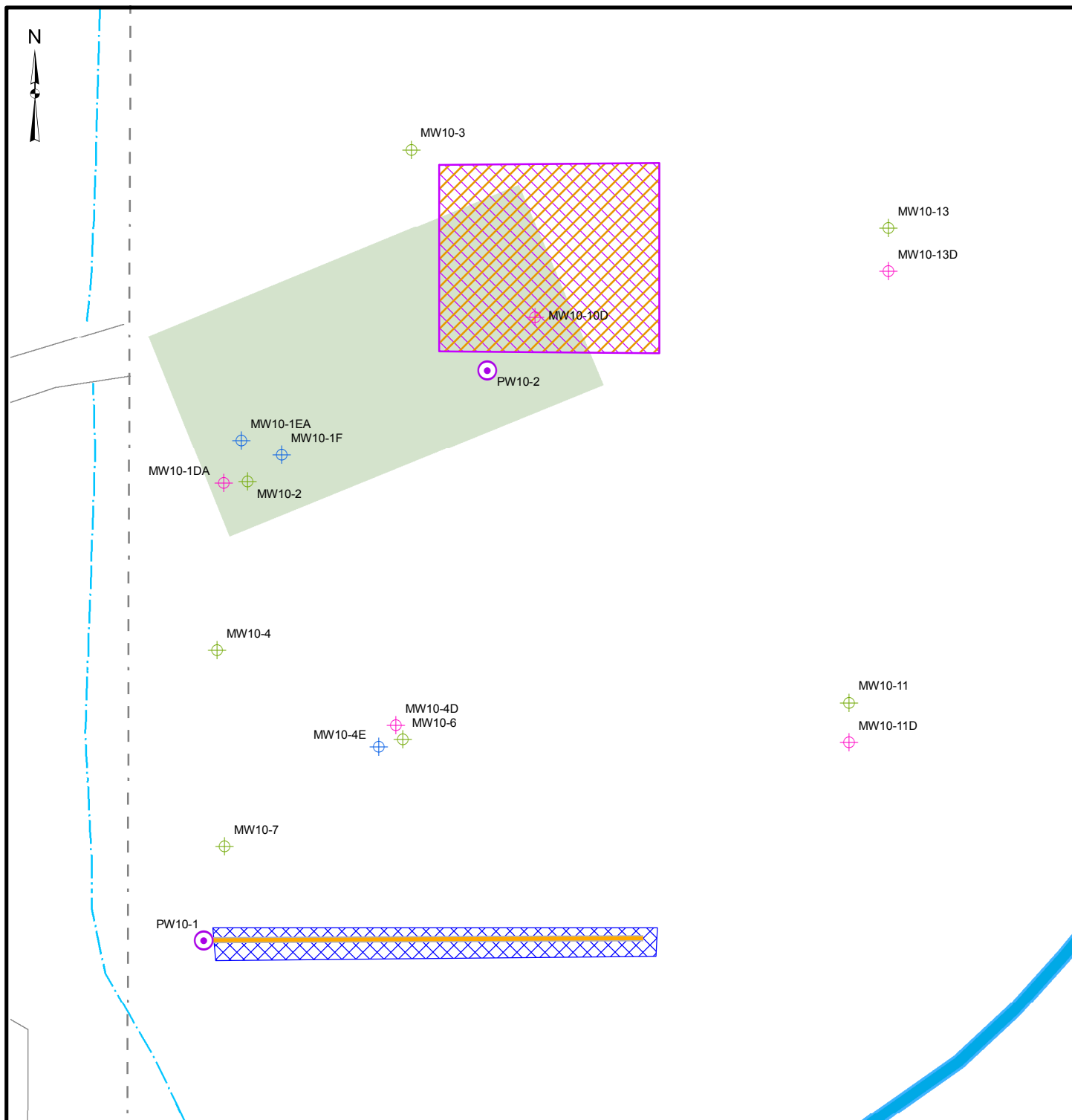
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		 <div>Overburden Well</div> <div>Shallow Bedrock Well</div> <div>Deep Bedrock Well</div>		Proposed Injection Zones <div> Overburden Injection Areas</div> <div> Bedrock Injection Areas</div>		 <div>02550</div> <div>Feet</div>	
		Site 8 - DS002 Niagara Falls Air Reserve Station Niagara Falls, New York				FIGURE 4 2015 Injection Zones and Proposed 2018 Injection Zones Site 8 - DS002	
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		<p>Site 10 - FT005 Niagara Falls Air Reserve Station Niagara Falls, New York</p>				<p>FIGURE 6 2015 Injection Zones and Proposed 2018 Injection Zones Site 10 - FT005</p>	
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