Chemours™

The Chemours Company
P.O. Box 788
Lewiston, NY 14092

(716) 221-4723t
chemours.com

April 30, 2019

Mr. Stanly Radon
New York State Department of
Environmental Conservation
270 Michigan Avenue
Buffalo, NY 14203-2999

Dear: Mr. Radon:

NIAGARA PLANT GROUNDWATER REMEDIATION SYSTEM
2018 PERIODIC REVIEW REPORT

Enclosed please find one copy of the Groundwater Remediation System (GWRS) Periodic Review Report (PRR) for The Chemours Niagara Plant pursuant to Order on Consent No. B9-0206-87-09. This report presents a summary of the system operations and monitoring data collected in 2018. The report demonstrates compliance with remedial objectives and includes affirmation of the site institutional and engineering controls. Chemours has followed the PRR guidance provided by the NYSDEC but included the detailed discussion and analysis as Attachment 3 which is similar to previously submitted "Annual" reports.

The overall effectiveness of the GWRS and Olin Production Well has been established for many years. Hydraulic control has been maintained, such that, remedial goals continued to be achieved in 2018. Decreasing concentration trends discussed in previous annual reports continued to be recognized in the overburden and bedrock water-bearing zones during 2018. The overall decreasing trend of TVOC concentrations in the West Plant and the East Plant is significant and likely attributed to the combined effects of the GWRS and Olin Production Well achieving hydraulic control of contaminant source areas and the gradual reduction in all areas through natural attenuation.

Please contact me at (716) 221-4723 if you have any questions or comments regarding this submittal.

Sincerely,

Chemours

Paul F. Mazierski
Project Director

Enc. NIAGARA 2018 PRR (Report.hw932013.2019-04.NIA_2018_Annual_PRR.pdf)

cc: Brian Sadowski/NYSDEC (elec.)
Charlotte Bethoney/NYSDOH (elec.)
Dawn Hettrick/NYSDOH (elec.)
Chemours Records Retention (elec.)

PARSONS

GROUNDWATER REMEDIATION SYSTEM PERIODIC REVIEW REPORT - 2018

NIAGARA PLANT
NIAGARA FALLS, NEW YORK

Prepared for:

THE CHEMOURS COMPANY FC LLC
CORPORATE REMEDIATION GROUP

Buffalo Avenue and 26th Street
Niagara Falls, NY 14302

Prepared by:

PARSONS
40 La Riviere Drive, Suite 350
Buffalo, NY 14202

April 2019

Chemours PN 507070
Parsons PN 450328

Table of Contents

FIGURES

ATTACHMENTS

ACRONYMS

Acronym	Definition / Description
ACO	Administrative Consent Order
BFBT	Blast Fractured Bedrock Trench
CatOx	Catalytic Oxidizer
COC	Chemicals of concern
CRG	(Chemours) Corporate Remediation Group
DNAPL	Dense non-aqueous phase liquid
DuPont	E. I. du Pont de Nemours and Company
FST	Falls Street Tunnel
GAC	Granular activated carbon
gpm	Gallons per minute
GWRS	Groundwater Remediation System
lbs/Mgal	Pounds per million gallons
μg/l	Micrograms per liter
NECCO	Niagara Electrochemical Company
NYPA	New York Power Authority
NYSDEC	New York State Department of Environmental Conservation
ºF	Degrees Fahrenheit
PCE	Tetrachloroethene
PRR	Periodic Review Report
QA/QC	Quality assurance/quality control
ROD	Record of Decision
RTO	Regenerative Thermal Oxidizer
SPDES	State Pollutant Discharge Elimination System
TOC	Total organic carbon
TVOC	Total volatile organic compounds
VOCs	Volatile organic compounds
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

1.1 Brief Summary of Site, Nature and Extent of Contamination, Remedial History

This Periodic Review Report (PRR) was prepared in response to a request from the New York State Department of Environmental Conservation's (NYSDEC) dated February 25, 2010. The PRR Institutional and Engineering Controls (IC/EC) Certification information (Attachment 1) has been revised with correct parcel identification numbers based on the Niagara County On-Line Mapping System. Parcel detail reports from the County's system are provided in Attachment 2. Parcels that are considered in this PRR and the annual groundwater remediation system monitoring report (Attachment 3) are consistent with the parcels identified in the Administrative Order on Consent (ACO) No. B9-0206-87-09 (1989). Figure 1 presents the site property boundaries. This report covers the 2018 calendar year. The Groundwater Remediation System 2018 Monitoring Annual Report (Attachment 3) is a detailed account of monitoring activities and conditions during 2018. Since much of the information provided in the annual report is similar to that recommended for the PRR, Attachment 3 will be referred to, where appropriate, to limit duplication.

The Niagara Plant (the "Plant") is located in Niagara Falls, New York, and bordered by Buffalo Avenue to the north and the Robert Moses Parkway to the south. Figure 1 is the site property map and a site location map is provided in Attachment 3. The Plant has been in continuous operation since 1896 when the Niagara Electrochemical Company (NECCO) began the manufacture of metallic sodium there. At some point in time, the R&H Chemical Company acquired NECCO. E. I. du Pont de Nemours and Company (DuPont) acquired the Plant from the R&H Chemical Company in 1930. DuPont spun off its Performance Chemicals businesses into a new entity during 2Q15, The Chemours Company FC LLC (Chemours). This includes remediation obligations at a number of properties including the Niagara Plant Site. As of July 1, 2015, Chemours now exists as a completely separate and independent company.

In 1978, DuPont searched its records to determine possible waste disposal areas within the Plant and completed a survey that detailed information on production areas, time of use, process chemistry, and waste disposal practices. In the early 1980s, NYSDEC wells were installed downgradient of the Plant along the Robert Moses Parkway. Results from these wells initiated several subsurface investigations. To date, Chemours has completed more than 60 integrated studies of subsurface contamination or related conditions. Multiple remedial events have occurred at the Plant including the groundwater pump-and-treat systems that are the subject of this PRR.

The focus of the current remedial system is the hydraulic control of contamination in the overburden and bedrock groundwater. Groundwater at the Plant contains various constituents, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals. In 1989, DuPont and the NYSDEC entered into an ACO (No. B9-0206-87-09). This ACO directed DuPont to take the necessary steps to mitigate the offsite migration of contaminated groundwater. The NYSDEC issued an Interim Record of Decision (ROD) in December 1989. The ROD included use of a groundwater pump-and-treat system to serve as the groundwater remedy. The remedy was completed in 1992 and included two hydraulic control components: one for the overburden groundwater and another for the bedrock groundwater. The two components are the Groundwater Remediation System (GWRS) and the Olin Production Well described below:

- The GWRS was designed to reduce the offsite migration of contaminants from the overburden and top of bedrock by pumping groundwater from collection wells. The water is then treated in a treatment facility built as part of the remedial action.
- Groundwater in the bedrock zones in the western plant area is controlled by the Olin Production Well. Water is treated by carbon absorption prior to use as non-contact cooling water by Olin and discharged to a State Pollutant Discharge Elimination System (SPDES) permitted outfall.

Between 1992 and the present, multiple improvements have been made to the collection system including: treatment system upgrades, adding pumping wells, and installing blast fractured bedrock trenches (BFBTs) with pumping wells. Section 2.3 provides details on the post-ROD remedy improvements.

Reactive Metals Solutions (RMS) continuous production of bulk sodium and lithium ended in October 2016 at the Chemours Niagara Plant. Reactive metals continued decommissioning and dismantlement activities of the facility throughout 2018. Olin continues to operate as a site tenant. An additional tenant, Ontario Specialty Contracting (OSC) began leasing portions of the property in 2018 under an access agreement between Chemours and OSC. Their activities are minimal at this point, having minor use of West Plant buildings without any subsurface activities or other actions related to the remediation covered under this PRR. Chemours groundwater remediation relevant to ACO covered by this PRR will continue regardless of tenant occupancy. A notification of change of use will be submitted to NYSDEC when more is known about potential property transfer.

1.2 Effectiveness of the Remedial Program

The groundwater pump-and-treat systems are effective at meeting the remedial goals (defined in Section 2.0). The monitoring that has been conducted for more than 20 years has demonstrated the effectiveness of the GWRS and the Olin Production Well and their associated treatment systems to meet remedial goals. Chemours has made multiple improvements to the systems as part of their commitment to meeting the remedial goals and maintaining an effective remedial program. Each year, Chemours submits quarterly data packages and an annual report (PRR) to the NYSDEC. This 2018 PRR includes a full report on the previous year and the four quarterly 2018 data packages provided updates and data (Parsons 2018b through 2018d). Each of these documents provides updated information related to effectiveness of the remedial program such that the NYSDEC is fully aware of the status of the remedial systems. The most recent annual report (Attachment 3) provides 2018 and historical groundwater monitoring results demonstrating the effectiveness of the remedial program.

1.3 Recommendations

It is recommended that Chemours continues to operate under the current pumping scheme with a combination of the BFBTs and conventional pumping wells for A-zone groundwater, Olin Deep well for bedrock zones in the west plant, and monitored natural attenuation in the east plant bedrock. It is also recommended that Chemours continue with its plan to replace existing pumping wells in the east plant and PW-18, -19 with a total of three BFBTs.

2.0 SITE OVERVIEW

The Plant site is located along the south side of Buffalo Avenue north of the Robert Moses Parkway in Niagara Falls, NY. Gill Creek intersects the Plant, and the Niagara River is to the south. The area is heavily industrialized with numerous chemical manufacturing plants and remedial sites. As stated in the ROD (issued by the NYSDEC in 1989), there are two separate operable units: overburden and bedrock. Both units are impacted with chemical of concern (COCs), primarily VOCs, SVOCs, and metals.

The basic remedial chronology and noteworthy remedial changes are provided below:

Niagara Plant Remedial Chronological Summary

DATE	ACTION
1978	Waste management practices and waste disposal areas are evaluated
1980 – 1989	Targeted Initial Remedial Program (B-107 Area, Gill Creek and B-310 Area, West Yard capping, Adams Avenue sewer cutoff wall)
Late 1982/1983	NYSDEC wells installed along Robert Moses Parkway
1983-1988	Remedial Investigation (hydrogeologic and manmade passageways investigations, groundwater modeling)
1984-1988	Remedial Studies
September 1989	Administrative Order on Consent signed
January 1990	NYSDEC Record of Decision signed
1990/1991	GWRS Construction
October-December 1991	GWRS startup and prove-out
1992-present	Long-term operation and maintenance (O&M) of remedy
Chemours Niagara Plant Noteworthy Remedy Changes	
January 1, 1992	Continuous operation of remedy begins
1993	Interceptor trench installed between Staub Road and the railroad bridge on west bank of Gill Creek and added to the GWRS (PW-36).
1995	Pumping wells PW-10, PW-18, PW-19 deepened into A-Zone top-of-bedrock
1996	Continuous acid addition and pH adjustment system added to GWRS for control of calcium carbonate scaling
1996/1997	Pumping well level control upgrade and switch to on/off operation
2002-2005	BFBTs installed in SW Plant to enhance GWRS hydraulic control
2005	Air emissions controls (catalytic oxidizer [CatOx] and scrubber) added to pretreatment system to address increased load from BFBTs

2007	GWRS overhaul completed: pretreatment technology changed from steam stripping to air stripping; replacement of the CatOx with a regenerative thermal oxidizer (RTO), majority of groundwater conveyance piping system and heat trace replaced; and installation of Honeywell Experion™ Process Knowledge System (PKS) for process control and storage of operations data
October 2008	Initiation of the six-month test to asses hydraulic control of BFBTs without west header wells.
3Q14 – 1Q15	Pumping well conveyance line upgrade project, including PW-36 converted to cascade program
July 1, 2015	Completion of spin-off from DuPont to The Chemours Company FC LLC (Chemours)
2016	A liner was installed in the 140,000-gallon equalization (EQ) tank NYSDEC accepted revisions to the sampling program, such that, lower frequency parameters and wells are completed all on the same 5-year cycle.
2018	Chemours effectively completed shut down and deacon of Reactive Metals Operations. The RTO was replaced with a new unit

2.1 Remedial Objective

As outlined in the ROD, the interim remedial system has the following basic remedial objectives:

<u>Plant Site Overburden</u>

- "Create a hydraulic barrier in the overburden (A-zone) that will reduce lateral off-plant contaminant migration by pumping groundwater from a line of 22 collection wells to a new water treatment facility."
- "Install and operate a new water treatment facility to strip and condense contaminants present in groundwater. Periodically, condensed organics will be shipped off-plant as hazardous waste."

<u>Plant Site Bedrock</u>

- "Off-site migration of contaminants from bedrock zones in the western plant area will continue to be controlled by pumping the Olin Production Well."
- "Water from the bedrock zone is treated by carbon adsorption, prior to use by Olin as non-contact cooling water, and then it is discharged to a SPDES permitted outfall." There is an agreement between Chemours and Olin that the Olin Production Well will be operated at an average of 500 gallons per minute (gpm).

2.2 Post-ROD Remedy Changes

Subsequent to the 1992 Gill Creek remediation, it was determined that increased capture was appropriate between pumping well PW-35 and Gill Creek. Therefore a sheet pile wall and interceptor trench, referred to as PW-36, were installed in this area.

After approximately seven years of performance review, DuPont recommended increasing the groundwater control in the southwest plant in the vicinity of Staub Road (Southwest Plant area). After evaluating several alternate technologies, BFBTs were selected to improve hydraulic control. In BFBTs, *in-situ* detonation of explosive charges are used to create fractures in the bedrock to enhance hydraulic conductivity. These enhanced hydraulic conductivities allow for more efficient and effective groundwater collection and hydraulic control than can be achieved using conventional single point groundwater pumping wells.

In 2002, a BFBT (PW-37) was installed just north of Staub Road, southwest of Building B-130. A second BFBT (PW-39) was installed in 2004 along Staub Road just west of Gill Creek. These two new wells were put into production in 2005. During and after the implementation of these BFBTs, various hydraulic tests were completed to determine the effectiveness of capturing the plume. The BFBTs proved to be a sufficient solution to improving groundwater capture at the Plant (DuPont 2006). The improvement was significant enough that a BFBT hydraulic test was started on October 1, 2008, to test the hydraulic effectiveness of PW-37 and PW-39 without West Plant wells PW-1 through PW-14, PW-16 and PW-35. A report summarizing the results of the test was submitted to the NYSDEC in the Modified Operations Evaluation Report (MOE) (DuPont 2009).

Results of the BFBT tests indicated an improved performance in hydraulic control. The percent captured has increased due to the BFBTs, and there is an increase in drawdown in the areas with the highest concentrations of total VOCs. The MOE (2009) report concluded that the BFBTs achieved sufficient hydraulic control without pumping from West Plant wells PW-1 through PW-14, PW-16 and PW-35. Subsequent quarterly and annual reports further support the conclusions that the BFBTs provide sufficient control. NYSDEC responded to the 2009 MOE and the comments were addressed in an updated evaluation: MOE – 2013 Update Report (Parsons, 2013). In 2Q2013 pumping well PW-35 was re-commissioned and placed online to improve hydraulic control in the area near Gill Creek. Chemours is continuing operation of PW-16, PW-18, PW-19, PW-35, PW-36, PW-37, and PW-39 for groundwater control in the West Plant area.

3.0 EVALUATE REMEDY PERFORMANCE EFFECTIVENESS AND PROTECTIVENESS

3.1 Summary

Each year, the annual report provides details and demonstration of the performance, effectiveness and protectiveness of the Niagara Plant remedy. The overall effectiveness of the GWRS and the Olin Production Well in controlling off-site groundwater flow has been demonstrated through hydraulic head and groundwater quality monitoring during 26 years of operation. The GWRS 2018 operations are summarized below and support the remedy's performance, effectiveness, and protectiveness:

- System uptime was 96 percent for the 23 original pumping wells that are still in use.
- PW-37 uptime was 93 percent.
- PW-39 uptime was 75 percent.
- Olin Production Well system uptime was 99.9% percent.
- Operation of BFBT pumping wells PW-37 and PW-39 continued throughout 2018 along with a reduced number of the original 23 pumping wells, with improved capture at the Plant.
- Hydraulic control was exercised over 94 percent of the Plant area for 2018.
- Monitoring of dense non-aqueous phase liquid (DNAPL) conducted in 2018 indicated no DNAPL was present at PW-39.

The GWRS has been effective in removing chemical mass from the subsurface groundwater by providing hydraulic control. Mass removal continues to be greater than before the installation and operation of the BFBTs in 2005. In 2018, approximately 2.9 tons of organic compounds were removed from groundwater by the GWRS. There was a clear increase in mass recovery rates after the installation of the BFBTs. By comparison, an average of 1.5 tons/year was removed from 2000 to 2005.

In comparison, the Olin Production Well has exhibited an asymptotic rate of mass removal. The yearly estimated mass of organic compounds removed has remained essentially unchanged since 1998 (0.5 tons were removed in 2018).

The combined effect of the GWRS (including outfall 023) and the Olin Production Well resulted in the removal of approximately 3.6 tons of organic compounds in 2018.

3.2 Compliance with Remedial Objectives

Extensive water-level data collected over the 26 years of system operation have illustrated that hydraulic heads in both the A-Zone overburden and A-Zone bedrock are depressed in the vicinity of operating GWRS pumping wells. As a result, off-site groundwater flow has been reduced by hydraulic control, and COC concentrations are decreasing as the result of groundwater control. In 2018, the hydraulic control in the A-zone overburden and bedrock was 94%. The Olin Production Well was operational 99.9 percent of the year at average flow rates greater than 500 gpm. Hydraulic heads in the bedrock zone confirm the hydraulic effectiveness established by pumping this well, details are provided in Attachment 3 (2017 Annual Report). Off-site COC migration from the West Plant area is controlled, confirming that the remedial objectives established in the ACO are met.

Groundwater from the GWRS pumping wells (A-Zone wells) is treated through stripping and discharged to the City of Niagara Falls Wastewater Treatment Plant. Water from the bedrock zone is treated by carbon adsorption prior to use by Olin as non-contact cooling water and is subsequently discharged to an SPDES permitted outfall. In 2018, these activities demonstrated compliance with the remedial objectives.

4.0 IC/EC PLAN COMPLIANCE PLAN REPORT

The IC/EC compliance plan is integrated into the O&M Plan, as detailed in the ACO (1989) and the ROD (1990), as well as given in Box 3 and Box 4 of the NYSDEC Institutional and Engineering Control Certificate (Attachment 1).

Box 4 of the NYSDEC Institutional and Engineering Control Certificate provides control descriptions for each of the properties associated with the Plant, as follows:

> Chemours Niagara Plant site is fenced and has a 24 hour security. The Plant has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit. Remedial Action Consent Order (1989) signed September 22, 1989 and the Record of Decision issued December 1989.

The Plant controls remained the same in 2018 with a 24 hour security system, and a pump-and-treat system that discharges to the City of Niagara Falls POTW after pre-treatment. Therefore, the Plant remains in compliance with the site controls.

Further information regarding the IC/EC compliance is given in the O&M Compliance section of this PRR and in Attachment 3.

5.0 MONITORING PLAN REPORT

The overall monitoring plan is presented in Attachment A to the ACO (Woodward-Clyde 1989) and in the agency approved Quality Assurance Project Plan for groundwater monitoring at the Plant (DuPont 1999). The scope of the monitoring program is to document groundwater levels for evaluating hydraulic control of the pumping systems and to collect water samples (groundwater, surface water, and process) to analyze for COC concentrations.

Groundwater elevation monitoring and groundwater sampling were conducted during 2018 in accordance with the monitoring schedules presented in Attachment 3. Water level measurements and groundwater samples are taken to assess the effectiveness of the GWRS and Olin Production Well pumping systems in controlling groundwater flow. Approximately 180 water level locations were monitored each quarter to assess hydraulic control. Ninety-four locations were sampled for COC concentrations during 2018. Attachment 3 provides data, discusses the monitoring program, and demonstrates compliance with the AOC monitoring scope.

Each year, Chemours submits quarterly data packages and an annual report (PRR) to the NYSDEC. In 2018, each of these documents provided updated, detailed information related to effectiveness of the remedial program (Parsons 2018b through 2018e).

6.0 OPERATIONS AND MAINTENANCE PLAN REPORT

The O&M plan is integrated into the operations and maintenance portion of the ACO (Woodward-Clyde 1989). The details of the O&M plan are summarized in three categories for overburden groundwater: (1) system start-up; (2) normal operations; and (3) temporary shutdowns. The system start-up applied to the early period of groundwater pumping and is therefore no longer applicable to the current system. In normal operations, "the level control will be set in each well as determined appropriate" (NYSDEC 1989). The appropriate level is dictated by achievement of the remedial goals for groundwater, which is reducing the offsite migration of COCs.

Temporary shutdowns of the overburden GWRS and the Olin Production Well are allowable under the ACO. Shutdowns of up to one week will have minimal impact, but reasonable efforts are made to limit the duration of scheduled and unscheduled downtime. Requirements in the O&M plan, including updates in 2012 (see Attachment 3) specify that the NYSDEC be immediately notified of periods of downtime longer than 48 hours for pumping well(s). Other scheduled and unscheduled treatment system downtime will be documented in the quarterly data packages and annual PRR reports. This minor change is justified by the GWRS equalization tank which has capacity to store several days of water from pumping well operation while treatment maintenance is performed. For bedrock groundwater, the Olin system is to operate at an average monthly flow rate of 500 gpm. Additionally, the NYSDEC is notified if there are changes in the status of the Olin system's hydraulic control.

The system operated in compliance with the O&M plan during the period reported in this PRR. Details of the 2018 O&M activities are provided in Attachment 3. System uptime was 96 percent for the 23 original pumping wells that are still in use. PW-37 uptime was 93 percent, and PW-39 uptime was 75 percent. Olin Production Well system uptime was 99.9 percent. Operation of BFBT pumping wells PW-37 and PW-39 continued along with a reduced number of the original 23 pumping wells throughout 2018, with improved capture at the Plant. The NYSDEC was notified of all applicable changes to the site remediation system.

Each year Chemours submits quarterly data packages and an annual report to the NYSDEC. Each of these documents provides updated information related to effectiveness of the remedial program.

7.0 PRR CONCLUSIONS

Conclusions

The requirements of the Plant ACO, ROD and subsequent correspondence with the NYSDEC (NYSDEC 2005, 2008, 2011, and 2016) were met during 2018. The Plant remains an industrial use property with a 24-hour security system. There have been no significant changes in property use during 2018 that would necessitate alteration of the remedy or constitute an unacceptable risk to people or the environment. Components of the O&M plan are in compliance with the ACO as demonstrated in this PRR and in Attachment 3. The average up-time for the GWRS, BFBTs and Olin well was greater than 87% in 2018, and the NYSDEC was notified of systems down-times as appropriate. Without considering PW-39, which had more downtime that other pumping wells, the average uptime was 96 percent. The Olin Production Well average rate was greater than 500 gpm in 2018. The remedial requirements are in compliance; therefore, no corrective measures are needed.

Extensive water-level and chemical data have been collected over 26 years of system operation. These data have illustrated that the remedial objectives of the Plant are being attained. Off-site groundwater flow has been reduced by hydraulic control, and COC concentrations are decreasing as the result of groundwater control. In 2018, the hydraulic control in the A-zone overburden and bedrock was approximately 94%, and the Olin Production Well continued to meet the remedial objectives in the bedrock zones. The BFBTs continue to provide sufficient control in the West Plant as outlined in the MOE report (DuPont 2009) and the MOE 2013 Update Report (Parsons, 2003).

8.0 REFERENCES

DuPont Corporate Remediation Group (CRG). 1999. Quality Assurance Project Plan: Groundwater Monitoring Program, DuPont Niagara Plant, Version 4.0. May 1999.

_____. 2006. Results of BFBT Optimization Step Tests, correspondence to M. Hinton. December 21, 2006.

______. 2009. DuPont Niagara Modified Operating Evaluation Report. August 6, 2009

New York State Department of Environmental Conservation (NYSDEC). 1989. Administrative Order on Consent No. B9-0206-87-09.

_____. 2005. M. Hinton. Correspondence RE: Catalytic Oxidizer Repair. November 23, 2005.

_____. 2008. M. Hinton. Correspondence RE: Removal of Wells from Sampling Program. July 7, 2008.

_____. 2011. M. Hinton. Correspondence RE: Proposal for Activated Carbon Utilization Study, April 24, 2011.

Parsons 2013. Blast Fractured Bedrock Trench Modified Operations Evaluation – 2013 Update. February, 2013.

_____. 2018a. Groundwater Remediation System Periodic Review Report 2017, Chemours Niagara Plant. March 2018.

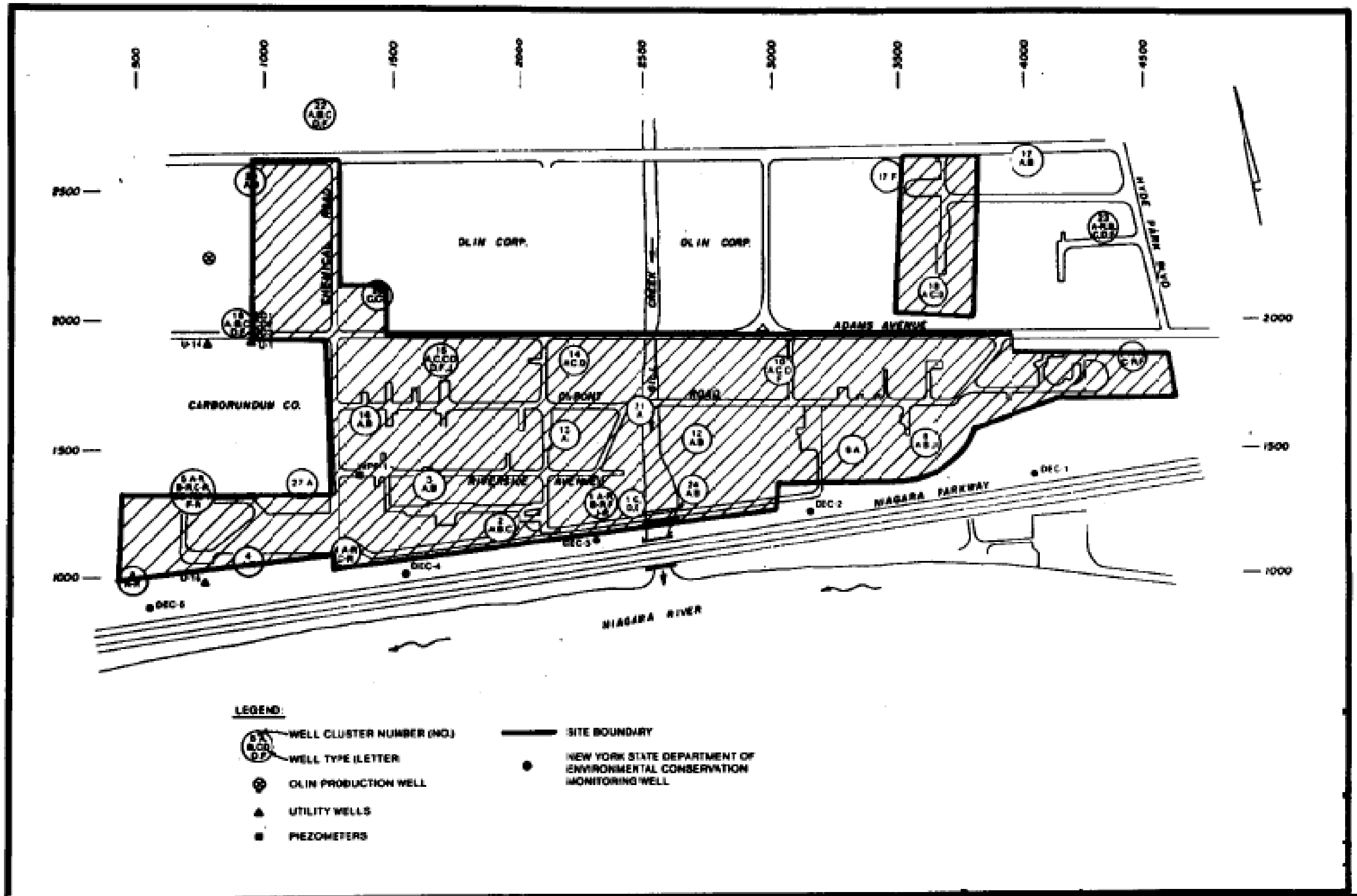
_____. 2018b. Chemours Niagara Plant Groundwater Remediation System First Quarter 2018 Data Package. May 31, 2018.

_____. 2018c. Chemours Niagara Plant Groundwater Remediation System Second Quarter 2018 Data Package. August 30, 2018.

_____. 2018d. Chemours Niagara Plant Groundwater Remediation System Third Quarter 2018 Data Package. November 20, 2018.

Woodward-Clyde 1989. Final Report DuPont Niagara Falls Plant Interim Remedial Program, September 1989.

FIGURES

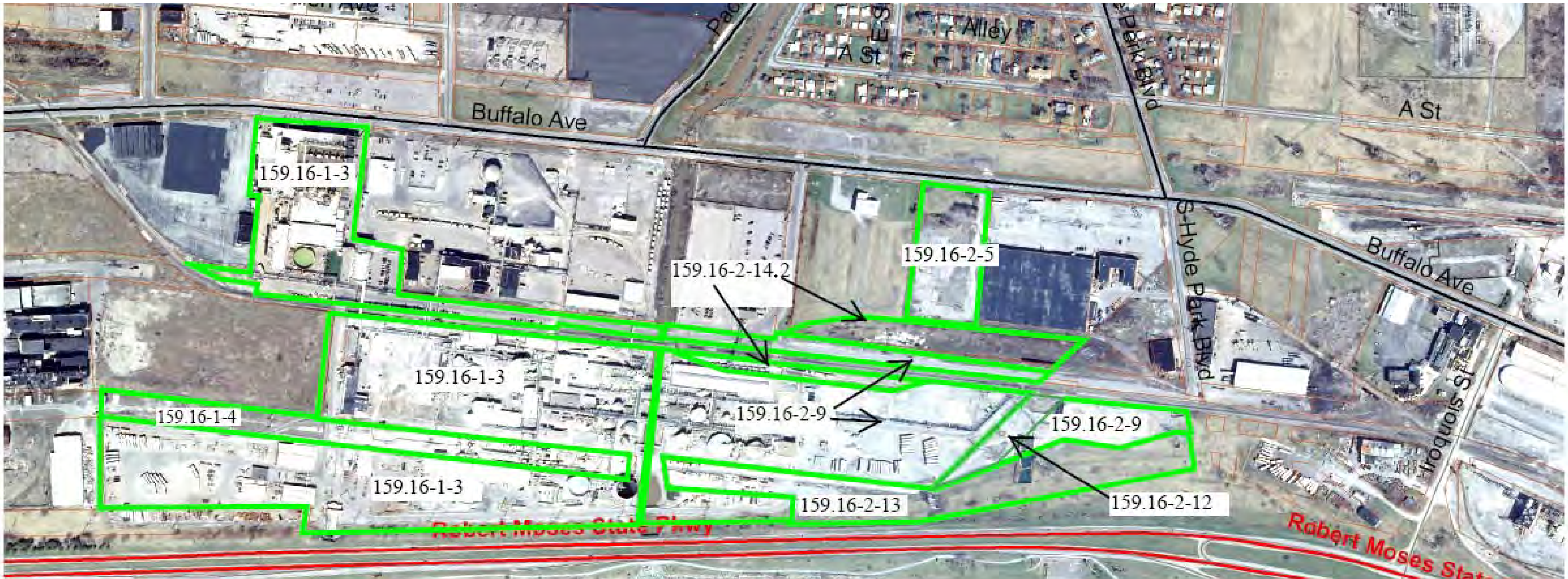


Source: Administrative Order on Consent No. B9-0206-87-09 (1989)

FIGURE 1

SITE BOUNDARIES MAP
CHEMOURS NIAGARA PLANT SITE
NIAGARA FALLS, NY

PARSONS
40 La Riviere Dr., Suite 350 Buffalo, NY 14202



0.3 0 0.14 0.3 Miles

Niagara County and its officials and employees assume no responsibility or legal liability for the accuracy, completeness, reliability, timeliness, or usefulness of any information provided. Tax parcel data was prepared for tax purposes only and is not to be reproduced or used for surveying or conveyancing.

NIAGARA COUNTY, NEW YORK
DEPARTMENT OF REAL PROPERTY SERVICES

Parcel ID	Owner
159.16-1-3	Chemours
159.16-1-4	Chemours
159.16-2-5	Chemours
159.16-2-9	Chemours
159.16-2-12	Niagara Mohawk
159.16-2-13	Chemours
159.16-2-14.2	Chemours

Source: Niagara County Online Mapping System
http://gis2.erie.gov/GC/NiagaraCountyNY/PublicLaunchpage.aspx

FIGURE 2

SITE PARCELS MAP
CHEMOURS NIAGARA PLANT SITE
NIAGARA FALLS, NY

PARSONS
40 La Riviere Dr., Suite 350 Buffalo, NY 14202

ATTACHMENT 1
INSTITUTIONAL AND ENGINEERING CONTROLS
CERTIFICATION FORMS

Enclosure 2
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Site Management Periodic Review Report Notice
Institutional and Engineering Controls Certification Form

Site Details | **Box 1**

Site No. **932013**

Site Name **Chemours Plant (former DuPont Plant Site)**

Site Address: Buffalo Avenue Zip Code: 14302
City/Town: Niagara Falls
County: Niagara
Site Acreage: 52.000

Reporting Period: ~~March 31, 2018 to March 31, 2019~~

January 1, 2018 - December 31, 2018

		YES	NO
1.	Is the information above correct?	☐	☒
	If NO, include handwritten above or on a separate sheet.		
2.	Has some or all of the site property been sold, subdivided, merged, or undergone a tax map amendment during this Reporting Period?	☐	☒
3.	Has there been any change of use at the site during this Reporting Period (see 6NYCRR 375-1.11(d))?	☐	☒

Chemours chemical production at the Site is in the final stages of closure and preparation for future use (unknown). Notification of Change of Use Document will be submitting to NYSDEC prior to change.

		YES	NO
4.	Have any federal, state, and/or local permits (e.g., building, discharge) been issued for or at the property during this Reporting Period?	☐	☒

If you answered YES to questions 2 thru 4, include documentation or evidence that documentation has been previously submitted with this certification form.

		YES	NO
5.	Is the site currently undergoing development?	☐	☒

Box 2

		YES	NO
6.	Is the current site use consistent with the use(s) listed below? Commercial and Industrial	☒	☐
7.	Are all ICs/ECs in place and functioning as designed?	☒	☐

IF THE ANSWER TO EITHER QUESTION 6 OR 7 IS NO, sign and date below and DO NOT COMPLETE THE REST OF THIS FORM. Otherwise continue.

A Corrective Measures Work Plan must be submitted along with this form to address these issues.

____________________________________ ________________
Signature of Owner, Remedial Party or Designated Representative Date

SITE NO. 932013 Box 3

Description of Institutional Controls

Parcel	Owner	Institutional Control
159.16-1-4 (partial)	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

159.16-2-12	Niagara Mowhawk Power Corp.	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

159.16-2-13 (partial)	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

159.16-2-14.2	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

159.16-2-5	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and Record of Decision issued December 1989.

159.16-2-9	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

159.16-1-3	The Chemours Company FL LLC	Monitoring Plan O&M Plan

Remedial Action Consent Order signed September 22, 1989 and the Record of Decision issued December 1989.

Box 4

Description of Engineering Controls

Parcel	Engineering Control
159.16-1-4 (partial)	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. The site has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit.

159.16-2-12	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. The site has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit.

159.16-2-13 (partial)	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. The site has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit.

159.16-2-14.2	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. The site has a pump and treat system to contain and treat groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial permit.

159.16-2-5	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. The has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit.

159.16-2-9	
	Groundwater Treatment System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and had manned 24 hour security. The site has a pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit. Note: Areas considered under the ACO(1989) are given in Figure 1. Where parcel extents are larger then the areal extent of the remedial action, the remedial controls may only apply to the area of the parcel that is within the remedial action delineation (Figure1).

Parcel	Engineering Control
~~159.16-3~~ 159.16-1-3	Groundwater Treatment System Cover System Groundwater Containment Fencing/Access Control Monitoring Wells

The site is fenced and has manned 24 hour security. Site has pump and treat system to contain and treat contaminated groundwater. Discharge from the GWRS is to the City of Niagara Falls POTW under an industrial pretreatment permit. The West Yard has a cover system.

Box 5

Periodic Review Report (PRR) Certification Statements

1. I certify by checking "YES" below that:

a) the Periodic Review report and all attachments were prepared under the direction of, and reviewed by, the party making the certification;

b) to the best of my knowledge and belief, the work and conclusions described in this certification are in accordance with the requirements of the site remedial program, and generally accepted engineering practices; and the information presented is accurate and compete.

YES	NO
☑	☐

2. If this site has an IC/EC Plan (or equivalent as required in the Decision Document), for each Institutional or Engineering control listed in Boxes 3 and/or 4, I certify by checking "YES" below that all of the following statements are true:

(a) the Institutional Control and/or Engineering Control(s) employed at this site is unchanged since the date that the Control was put in-place, or was last approved by the Department;

(b) nothing has occurred that would impair the ability of such Control, to protect public health and the environment;

(c) access to the site will continue to be provided to the Department, to evaluate the remedy, including access to evaluate the continued maintenance of this Control;

(d) nothing has occurred that would constitute a violation or failure to comply with the Site Management Plan for this Control; and

(e) if a financial assurance mechanism is required by the oversight document for the site, the mechanism remains valid and sufficient for its intended purpose established in the document.

YES	NO
☑	☐

IF THE ANSWER TO QUESTION 2 IS NO, sign and date below and DO NOT COMPLETE THE REST OF THIS FORM. Otherwise continue.

A Corrective Measures Work Plan must be submitted along with this form to address these issues.

____ ____________________

Signature of Owner, Remedial Party or Designated Representative Date

IC CERTIFICATIONS
SITE NO. 932013

Box 6

SITE OWNER OR DESIGNATED REPRESENTATIVE SIGNATURE

I certify that all information and statements in Boxes 1,2, and 3 are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. Note that Parcel 159.16-3 is actually 159.16-1-3

I PAUL F MAZIERSKI at PO BOX 788 LEWISTON NY 14092,
print name print business address

am certifying as CHEMOURS CRG PROJECT DIRECTOR - REMEDIAL PARTY (Owner or Remedial Party)

for the Site named in the Site Details Section of this form.

[signature] 4/26/19

Signature of Owner, Remedial Party, or Designated Representative Rendering Certification

Date

IC/EC CERTIFICATIONS

Box 7

Qualified Environmental Professional Signature

I certify that all information in Boxes 4 and 5 are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law.

I James W Schuetz at 40 La Riviere Dr., Suite 350 Buffalo NY 14202
print name / print business address

am certifying as a Qualified Environmental Professional for the Chemours
(Owner or Remedial Party)

[signature]
Signature of Qualified Environmental Professional, for the Owner or Remedial Party, Rendering Certification

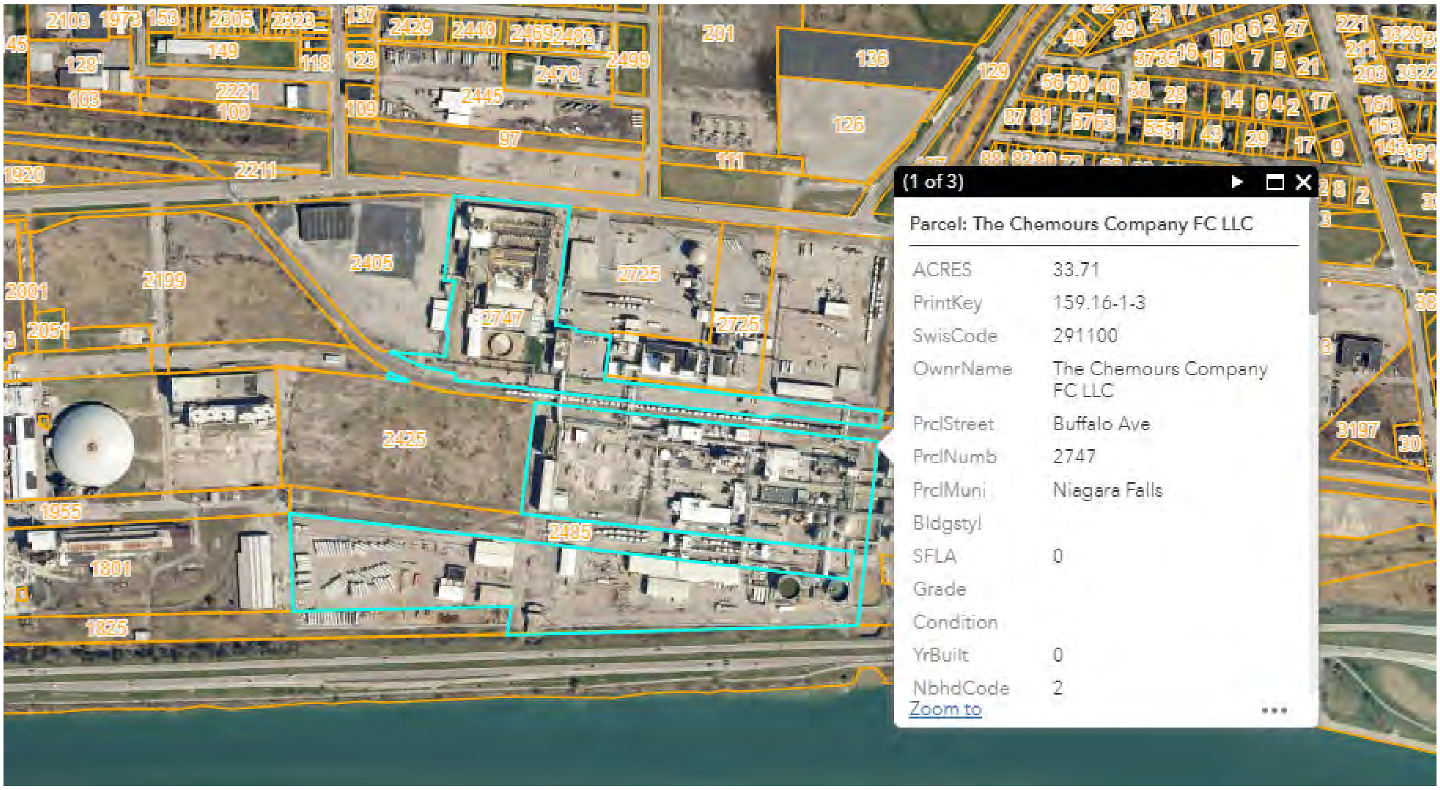
Stamp
(Required for PE)

4/29/19
Date

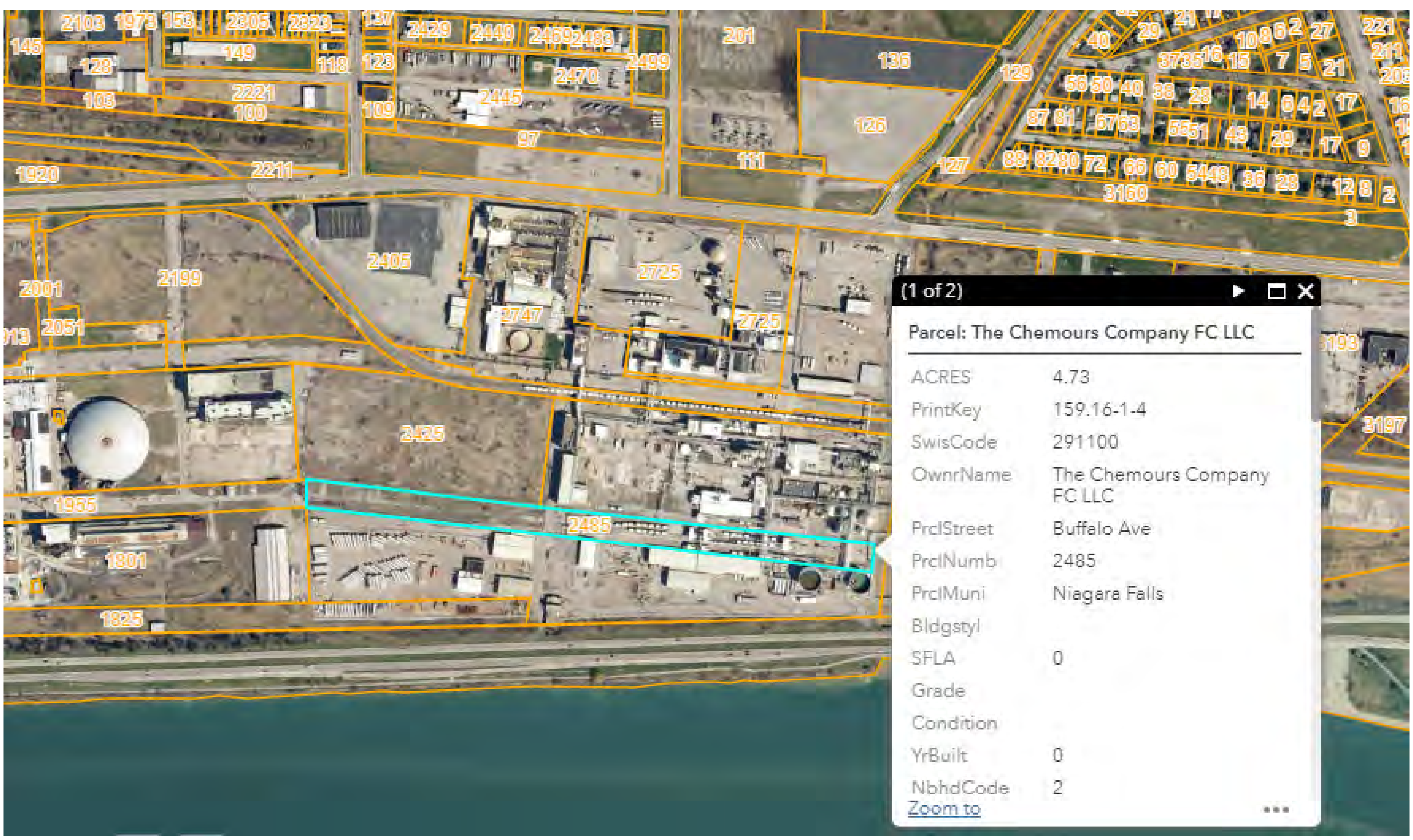
ATTACHMENT 2
NIAGARA COUNTY ON-LINE MAPPING SYSTEM
PARCEL DETAIL REPORTS

2018 Chemours Annual PRR
Niagara County On-Line Mapping
System Parcel Detail Reports - 2018

Chemours Parcel 159.16-1-3



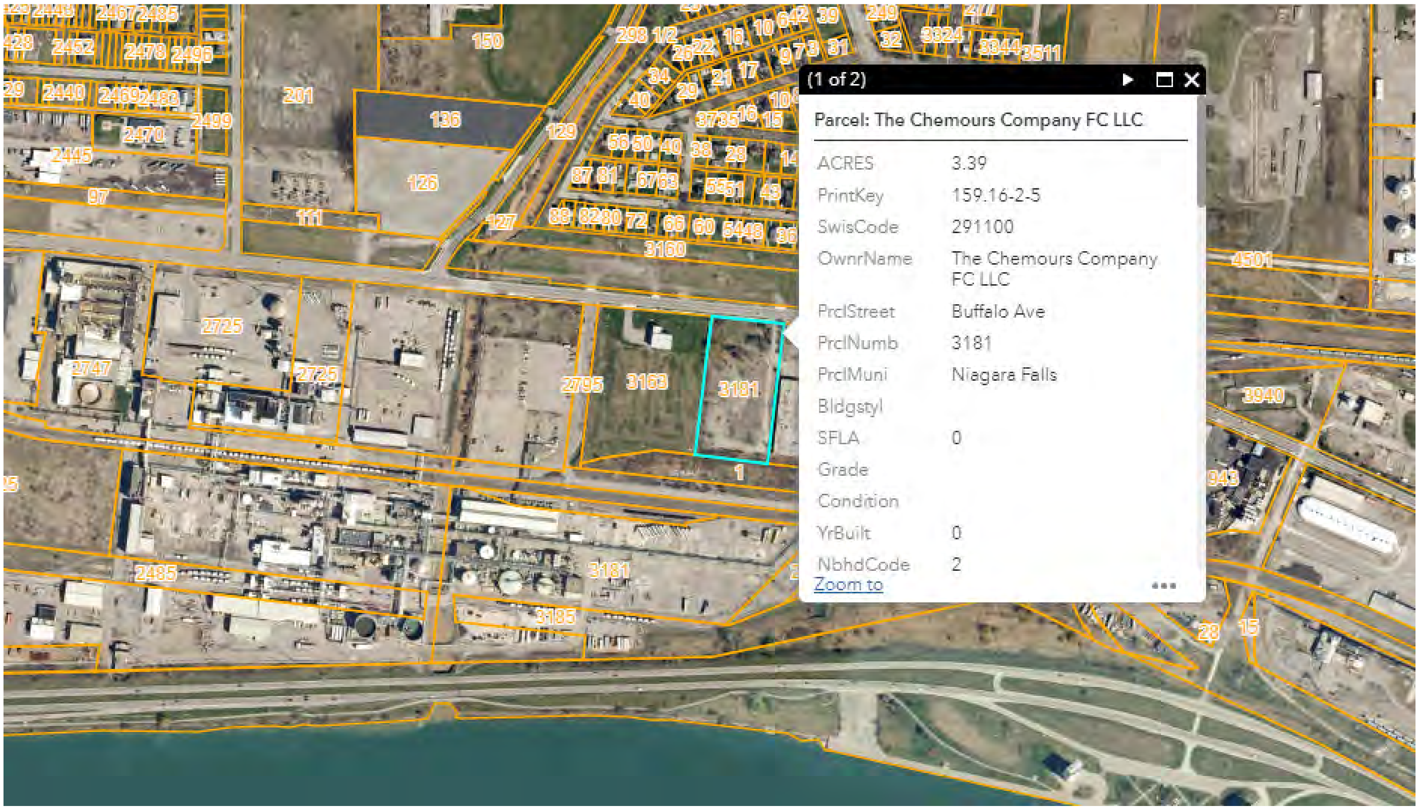
Chemours Parcel 159.16-1-4



http://www.niagara.oarsystem.com/SearchOARS.aspx[niagara.oarsystem.com]

2018 Chemours Annual PRR
Niagara County On-Line Mapping
System Parcel Detail Reports - 2018

Chemours Parcel 159.16-2-5

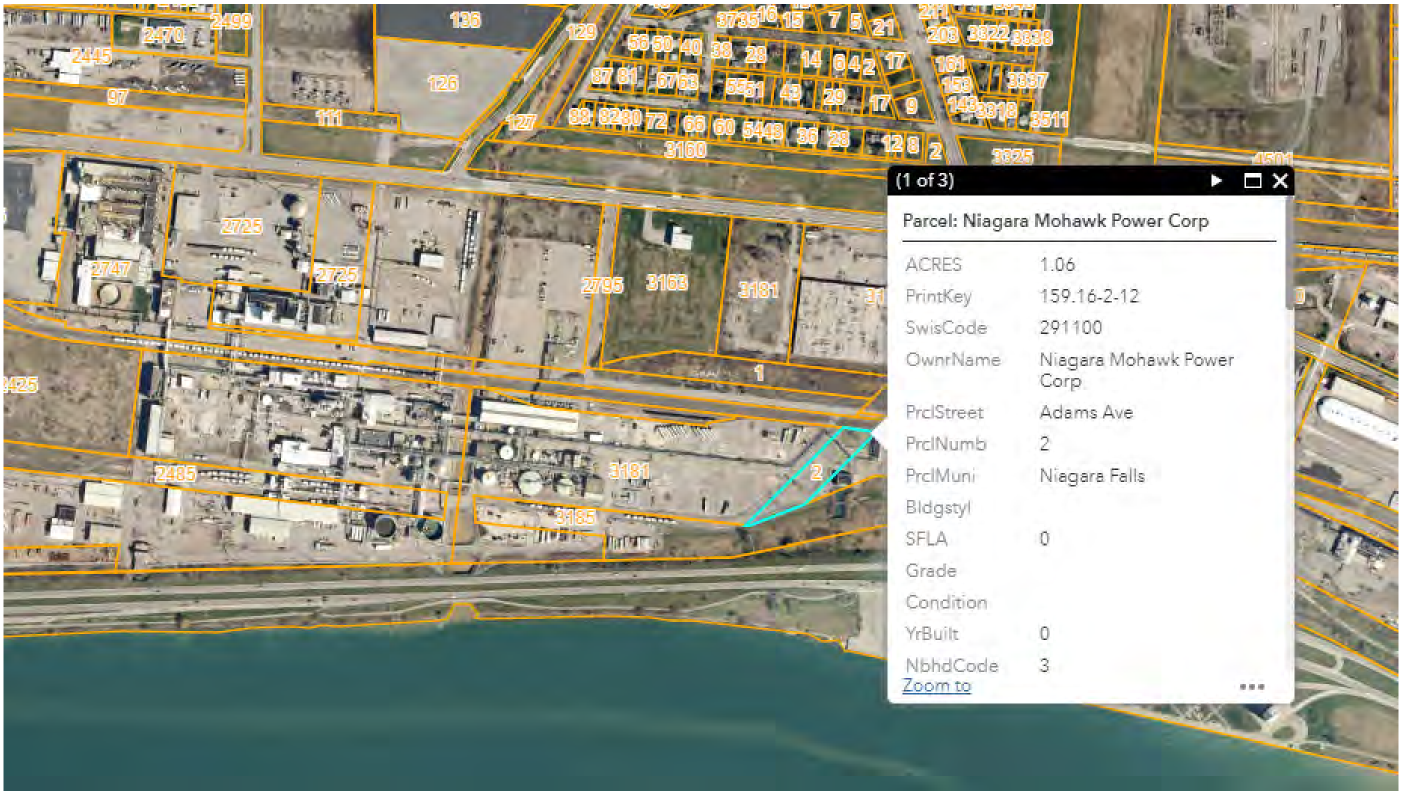


Chemours Parcel 159.16-2-9

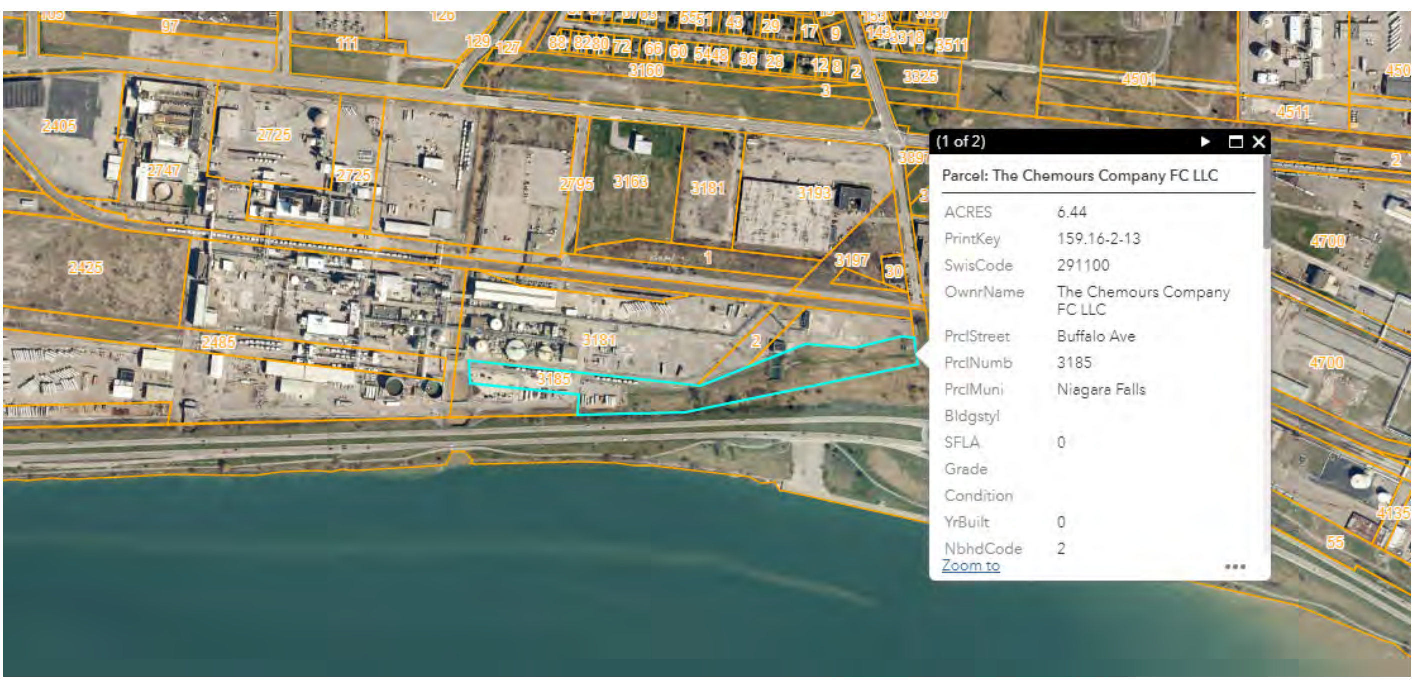
http://www.niagara.oarsystem.com/SearchOARS.aspx[niagara.oarsystem.com]

2018 Chemours Annual PRR
Niagara County On-Line Mapping
System Parcel Detail Reports - 2018

Chemours Parcel 159.16-2-12



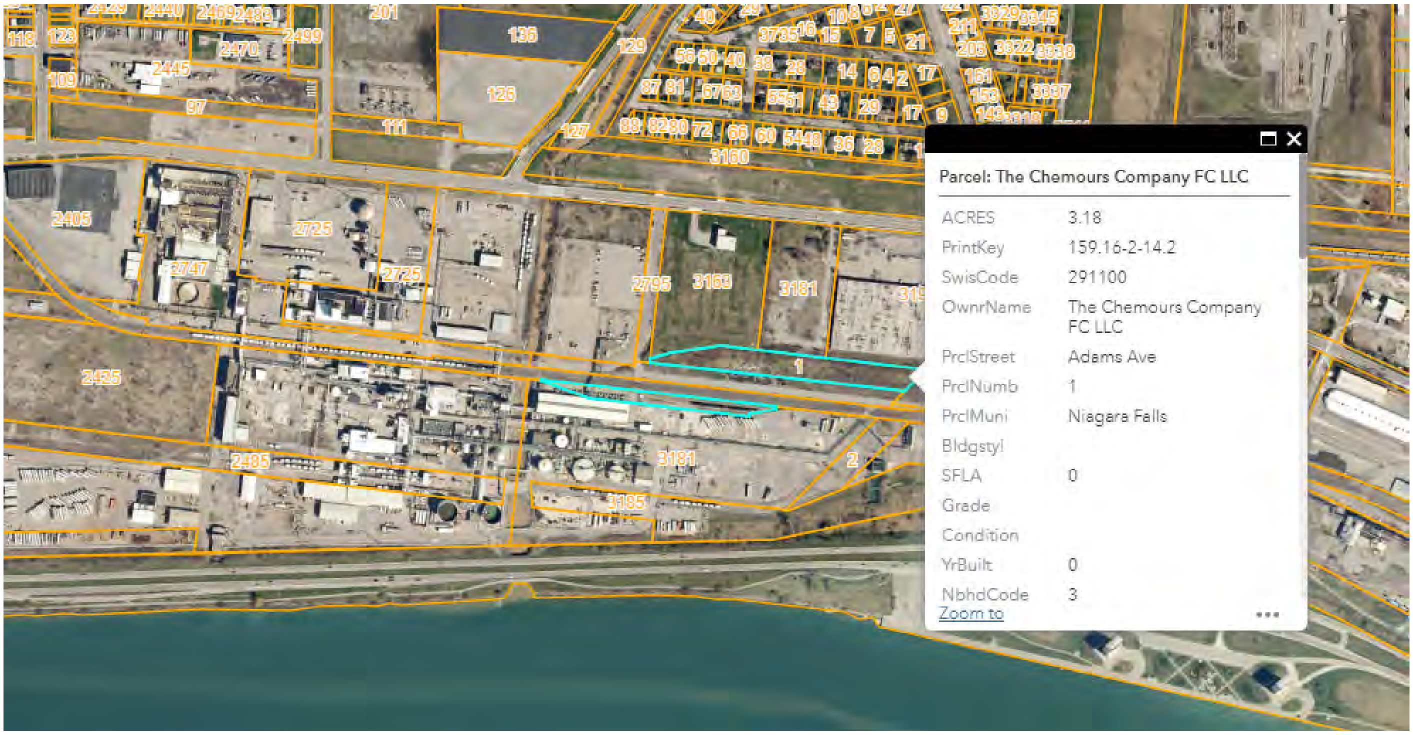
Chemours Parcel 159.16-2-13



http://www.niagara.oarsystem.com/SearchOARS.aspx[niagara.oarsystem.com]

2018 Chemours Annual PRR
Niagara County On-Line Mapping
System Parcel Detail Reports - 2018

Chemours Parcel 159.16-2-14.2



http://www.niagara.oarsystem.com/SearchOARS.aspx[niagara.oarsystem.com]

ATTACHMENT 3
GROUNDWATER REMEDIATION SYSTEM
2018 ANNUAL MONITORING REPORT

PARSONS

Groundwater Remediation System 2018 Annual Monitoring Report

Niagara Plant
Niagara Falls, New York

Prepared for:

THE CHEMOURS COMPANY FC LLC
CORPORATE REMEDIATION GROUP

Buffalo Avenue and 26th Street
Niagara Falls, New York 14302

Prepared by:

PARSONS
40 La Riviere Drive, Suite 350
Buffalo, NY 14202

March 2019

Chemours PN 507070
Parsons PN 450326

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS

Acronym	Definition / Description
4Q18	Fourth quarter of 2018
ACO	Administrative Consent Order
BFBT	Blast Fractured Bedrock Trench
CatOx	Catalytic oxidizer
CRG	Corporate Remediation Group
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquid
DuPont	E. I. du Pont de Nemours and Company
FST	Falls Street Tunnel
GAC	Granular activated carbon
GWRS	Groundwater Remediation System
μg/l	Micrograms per liter
MNA	Monitored natural attenuation
MOE	(BFBT) Modified Operations Evaluation
NYPA	New York Power Authority
NYSDEC	New York State Department of Environmental Conservation
PCE	Tetrachloroethene
QA/QC	Quality assurance/quality control
RTO	Regenerative Thermal Oxidizer
TCE	Trichloroethene
THT	Tetrahydrothiophene
TVOC	Total volatile organic compounds
VC	Vinyl chloride
VOCs	Volatile organic compounds
WWTP	(City of Niagara Falls) Wastewater Treatment Plant

EXECUTIVE SUMMARY

This report summarizes system operation and groundwater monitoring data collected during 2018 at the Chemours Niagara Plant (the Plant) for the Groundwater Remediation System (GWRS) and Olin Production Well. This report was prepared in accordance with the Interim Remediation Program for the Plant pursuant to an Administrative Consent Order (ACO) with the New York State Department of Environmental Conservation, Index Number B9-0206-87-09.

The Niagara GWRS and the Olin Production Well continued to operate per the requirements of the above-referenced ACO during 2018. In 2018, a new Regenerative Thermal Oxidizer (RTO) was installed within the GWRS to replace the original RTO that was near the end of its useful life. Approximately 2.9 tons of volatile organic compounds (VOCs) were removed and treated by GWRS.

GWRS uptime during 2018 was 96 percent for the original 23 pumping wells, 93 percent for pumping well PW-37, and 75 percent for pumping well PW-39. No unscheduled and one scheduled treatment system shutdown greater than 24 hours occurred during 2018. The scheduled shutdown, from March 25 to April 19, 2018 for approximately 575 hours (with the wells shutdown for 550.5 hours) allowed for replacement of the RTO. One well, PW-39, was down for greater than 48 hours in 1Q18 due to the failure of the pump as a result of precipitate buildup on the impellers. A procedure for cleaning this scaling at PW-39 with a low volume acid addition procedure was developed and improved uptime. PW-39 ran intermittently during the beginning 1Q18 while the scaling issue was being addressed. The cumulative downtime related to scaling was 223 hours.

The quantitative evaluation of the GWRS hydraulic effectiveness presented in this report illustrates that inward gradients occur in approximately 94 percent of the entire Plant where total VOCs concentrations are observed in the A-Zone overburden and A-Zone bedrock.

The 2018 monitoring data reinforce the conclusions drawn during the BFBT Modified Operations Evaluations (MOE) provided in 2009 and updated in 2013. Since implementation of the modified operations, the West Plant pumping system has operated at more efficient pumping rates using fewer pumping wells, increased mass removal, and achieved equivalent or better hydraulic control. These results demonstrate the improved hydraulic effectiveness of BFBT pumping wells PW-37 and PW-39.

While the overall hydraulic effectiveness of the GWRS and Olin Production Well systems have been established for many years, decreasing concentration trends also demonstrate the systems' effectiveness. Analytical results depict gradually reducing total VOC (TVOC) concentrations in the A-Zone overburden, A-Zone bedrock, and deeper bedrock water-bearing zones (B- through F-Zones). Declining TVOC concentrations are also attributed to gradual contaminant reduction through attenuation processes such as dispersion and biologic/abiotic degradation. The plant-wide groundwater chemistry in the deeper bedrock zones (D- and F-Zones) is dominated by degradation compounds. This indicates that source materials are naturally attenuating.

Data from 2000 through 2018 continue to indicate that intrinsic bioremediation and natural attenuation of chlorinated hydrocarbon constituents in the East Plant area are actively maintaining either stable or shrinking bedrock groundwater plumes. Because no groundwater users are located in Niagara Falls between the Plant and the presumed discharge point for any plume (Falls Street Tunnel/New York Power Authority conduit drain), it is recommended that continued monitoring of natural attenuation in East Plant bedrock is appropriate. The frequency of the monitoring for specific monitored natural attenuation parameters (inorganic parameters, dissolved gases, total organic carbon, and alkalinity) will remain at once every five years (next monitored in 2023), concurrent with a detailed data evaluation to verify conditions have not changed. VOC data and field parameters will still be collected annually to monitor plume distribution and VOC attenuation.

The only remaining business unit at the Site, Chemours Reactive Metals Solutions (RMS) ceased production of sodium and lithium in October 2016. RMS continued decontamination of process equipment into 2018 and was nearly completed by the end of the year. Olin continues to operate as a site tenant on a significant portion of the Site property. Additionally, Chemours began leasing portions of the property to a contracting company (Ontario Specialty Contracting) in 2018 under an access agreement. Their activities are minimal at this point, having minor use of buildings without any subsurface or other activities related to the remediation covered under this PRR. Chemours groundwater remediation relevant to ACO covered by this PRR will continue regardless of tenant occupancy.

1.0 INTRODUCTION

This report summarizes 2018 system operation and groundwater monitoring data for the Chemours Company FC LLC (Chemours) Niagara Plant (the Plant) Groundwater Remediation System (GWRS) and Olin Production Well system. System performance and remedial effectiveness are also evaluated. This report was prepared in accordance with the Interim Remediation Program for the Plant pursuant to an Administrative Consent Order (ACO) with the New York State Department of Environmental Conservation (NYSDEC), Index Number B9-0206-87-09. The Plant location is shown in Figure 1-1.

Details of the 2018 system operations data were previously submitted to the NYSDEC in quarterly data packages (Parsons 2018b, 2018c, and 2018d). The fourth quarter 2018 (4Q18) data package is included in the Periodic Review Report (PRR) as Attachment 4, of which this Annual Report is Attachment 3.

Operational data for 2018 are summarized in Section 2.0. System performance monitoring data are presented and system effectiveness is discussed in Section 3.0. Conclusions and recommendations are presented in Section 4.0. References cited in this report are provided in Section 5.0.

Chemours Reactive Metals Solutions (RMS) continuous production of bulk sodium and lithium ended in October 2016 at the Niagara Plant. RMS continued decommissioning and dismantlement activities of the facility throughout 2018. Olin continues to operate as a site tenant. Additionally, Chemours began leasing portions of the property to a contracting company (Ontario Specialty Contracting) in 2018 under an access agreement. Their activities are minimal at this point, having minor use of West plant buildings without any subsurface activities or other actions related to remediation covered under this PRR. Chemours groundwater remediation relevant to ACO covered by this PRR will continue regardless of tenant occupancy.

This page intentionally left blank

2.0 GWRS OPERATIONS SUMMARY FOR 2018

During 2018, the GWRS collected and pre-treated 10.6 million gallons of groundwater prior to discharge to the City of Niagara Falls Wastewater Treatment Plant (WWTP). The quantity of organics removed from groundwater in 2018 continues to be greater than the removal observed prior to the installation and start-up of the Blast Fractured Bedrock Trenches (BFBTs) in 2005 (Figure 2-1). Operations data from 1992 through 2018 are summarized in Table 2-1.

Niagara Plant GWRS uptime (Table 2-1) includes calculated uptime for the original 23 pumping wells and BFBT pumping wells PW-37 and PW-39. Uptime is calculated based on recorded water levels within each of the original pumping wells as they operate in an "on/off" sequence to maintain a consistent well level. Uptime for pumping wells PW-37 and PW-39 is calculated using data derived from in-line flow meters and continuous groundwater elevation tracking. Each BFBT well is determined to be in operation when flow is demonstrated, and dynamic level setpoints are achieved. This method of calculating pumping well uptime represents operational conditions and provides a consistent indicator of the hydrogeological effectiveness of the pumping operation. According to this uptime determination, 2018 uptime was 96 percent for the original 23 pumping wells, 93 percent for pumping well PW-37, and 75 percent for pumping well PW-39.

An assessment of the hydraulic effectiveness of operating the BFBTs was completed in 2009. Details were submitted to the NYSDEC (DuPont Corporate Remediation Group [CRG] 2009) with recommendations to continue operating the system using the BFBT pumping wells and to reduce the number of the original 23 pumping wells. Comments on this report were received from the NYSDEC in July 2012, and DuPont submitted a revised and updated Modified Operation Evaluation (MOE) Report on February 27, 2013. The updated report included data generated since the report was initially submitted and lines of evidence beyond those that were included in the initial report. Pumping wells continue to operate as they did during the test while the NYSDEC reviews the revised report, including responses to the comments on the updated report.

Details of system operations data for the first three quarters of 2018 were provided to NYSDEC in the quarterly data packages (Parsons 2018b, 2018c, and 2018d), and the fourth quarter is provided in the PRR Attachment 4. Quarterly performance details for the GWRS, Olin Production Well, and Plant Outfall 023 during 2018 are summarized in the table below.

Operational Statistics	1Q18+	2Q18+	3Q18+	4Q18+	2018 Total+
GWRS					
Original 23 Pumping Wells Uptime	94%	88%	99.7%	100%	**96%**
PW-37 Uptime	92%	81%	99 %	100%	**93%**
PW-39 Uptime	23%	79%	99%	100%	**75%**
Total Gallons Pumped (millions)	2.34	2.02	2.52	3.69	**10.57**
Estimated Pounds of Organics Removed from Groundwater*	1,454	1,410	1,321	1,609	**5,794**
Number of Unscheduled System Shutdowns > 24 hours	0	0	0	0	**0**

Operational Statistics	1Q18+	2Q18+	3Q18+	4Q18+	2018 Total+
GWRS					
Number of Scheduled System Shutdowns > 24 hours	1	1	0	0	**1****
Pump Replacements	1	1	0	1	**3**
Pump Repairs Requiring > 48 Hours	1	0	0	0	**1**
Olin System					
Pumping System Uptime	100.0%	100.0%	99.8%	100%	**99.9%**
Estimated Pounds of Organics Treated	270	176	218	283	**947**
Outfall 023					
Estimated Pounds of Organics Treated	241	45	145	67	**498**
Total Estimated Pounds of Organics Removed / Treated	1,965	1,631	1,684	1,959	**7,239**

+Excludes shutdown of wells PW-1 thru PW-12, PW-14 since 4Q08.
* Based on quarterly influent/effluent analyses.
** Only one scheduled shutdown which overlapped quarters one and two.

In addition to the high uptimes discussed above, approximately 7,239 pounds (3.6 tons) of organic compounds were removed and treated during 2018. The annual total organics treated by the system (combined GWRS, Olin system, and Outfall 023) are shown Figure 2-1. The time series plot demonstrates the total removed organics between 1992 and 2018. Key observations are made:

- From 1992 to 2004, the annual mass removed decreased over time. This is typical of groundwater treatment systems as they are known to eventually reach asymptotical recovery levels.
- The mass removal rate significantly increased after 2004-2005 when the BFBTs were being brought online. This demonstrates that the BFBTs are extracting more mass of volatile organic compounds (VOCs) than pumping from the west header wells was able to accomplish. The increase in mass has been sustained since the installation, indicating the BFBTs continue to be more effective at mass removal than the west header wells alone. There was no decrease in mass removal rates associated with turning west header wells off during the MOE.
- The small decrease in 2018 is related to less flow due to downtime of the replacement of the RTO, as well as downtimes related to scaling at PW-39 which was mitigated in the beginning of 2Q18. The decrease in mass associated with the decrease in flow, indicates that mass removal efficiency is constant and can be controlled by flow.

These observations demonstrate the capture improvement of the BFBTs and the effectiveness of the GWRS.

2.1 System Shutdowns

Due to the ample capacity of the GWRS equalization tank, there were no unscheduled treatment system shutdowns in 2018 that were greater than 24 hours. There was one scheduled treatment system shutdown that extended from the first quarter of 2018 into the second quarter. Between March 25 and April 19, 2018 the treatment system was shut down for approximately 575 hours (with the wells shutdown for 550.5 hours) to replace the GWRS Regenerative Thermal Oxidizer (RTO). During this downtime, the operations team took the opportunity to perform ancillary system maintenance on the caustic scrubber, air strippers, select pumping wells, and the process control system (see sections below for additional detail). There was only one unscheduled pumping well shutdown greater than 48 hours in 2018. During 1Q18 PW-39 began experiencing more frequent short-term shutdowns as the result of accumulation of calcium carbonate on the pump impellers. A manual acid addition process was installed at the pump intake which has prevented further PW-39 outages. As appropriate, scheduled and unscheduled shutdowns were reported to the NYSDEC via email and documented in the quarterly data packages.

2.2 Air Emissions

Air emissions from the GWRS originate from two sources: (1) the stack downstream of the pre-treatment and Regenerative Thermal Oxidizer (RTO) systems, and (2) emissions vented during filling of the GWRS Equalization Tank. Activities associated with these two emission points are summarized below.

2.2.1 Regenerative Thermal Oxidizer

As described in correspondence between NYSDEC and DuPont (NYDEC 2008), the Catalytic Oxidizer System (CatOx) was replaced with the RTO in August 2008. The RTO destruction removal efficiencies are similar or better than those of the CatOx, with much greater uptime and without the expensive catalyst issues. As mentioned above the RTO installed in 2008 had reached the end of its useful life and was replaced in 2018.

The new RTO was designed and constructed (at an off-site vendor facility - Amherst Stainless Fabrication Co. with design by Adwest Corp.) as a replacement in-kind for the existing unit. Based on previous observations and operations-based modifications to the existing RTO, design improvements were incorporated into the new RTO. The new RTO was installed in 1Q18 and 2Q18 with the system beginning operation with the new RTO on April 19.

2.2.2 Air Emission Contingency Plan

Groundwater pumped from the BFBTs led to increased VOC chemical loading to the GWRS pre-treatment system. Air emission modeling to assess substantive compliance with applicable New York State regulations required the installation of an off-gas treatment technology following the on-set of pumping from the BFBTs. The original modeling effort was conducted when the GWRS used steam stripping as the technology to remove VOCs from groundwater and a CatOx for off-gas treatment. In 2005, the NYSDEC requested that a contingency plan be prepared to allow continued pumping from select GWRS pumping wells even when the CatOx unit was not operational (NYSDEC 2005). The RTO replaced the CatOx in 2008, and the Air Emission Contingency Plan remained the same. Based on chemical loading to the pre-treatment system, implementing the contingency plan requires the shutdown of PW-37 to ensure that long-term air emission guidelines are achieved.

At no time during 2018 was the system operated in contingency mode.

2.2.3 Equalization Tank Vent

The equalization tank serves as the initial collection point for groundwater prior to pre-treatment. This tank is vented to the atmosphere through two 200-pound carbon canisters connected in series (Emission Point 88002). The following table summarizes dates of the carbon canister replacements during 2018:

Date of Change-Out
3/13/18
6/8/18
9/24/18
12/5/18

The quarterly canister replacement schedule was based on the pilot test completed from 2011 to 2013.

2.3 Pumping Wells

The following pump replacement occurred during 2018:

Pump Replacements		
Pumping Well	**Replacements**	**Quarter of Replacement**
PW-39	1	1Q18
PW-39	1	2Q18
PW-34	1	4Q18
Total	**3**	

2.4 Olin Production Well and Carbon Vessels

The Olin Production Well treatment system maintained 99.9% uptime during 2018. The pumping well was operated at an average monthly flow rate of greater than 500 gallons per minute.

Groundwater pumped from the production well is treated in six carbon vessels, each of which contains 20,000 pounds of granular activated carbon (GAC). The vessels in the system are separated into two banks of three vessels each, all in a parallel operational mode. The groundwater is treated through one bank at a time (that is, only three vessels are used). This allows carbon in the unused vessels to be removed and replaced, ready to be placed online within an hour if necessary. Six carbon vessel change-outs (two banks) were completed during 2018.

The discharge from the Olin Production Well treatment system is used as noncontact cooling water in Olin Corporation's industrial process. A summary of when the changed carbon was placed online is shown below.

Olin Carbon Vessel Dates Placed On-line	
V-5, -6, -7	3/15/18
V-2, -3, -4	9/17/18

3.0 SYSTEM PERFORMANCE MONITORING

Water-level measurements and groundwater sampling are conducted to assess the effectiveness of the GWRS and Olin Production Well pumping systems in controlling groundwater flow. The 2018 groundwater elevation monitoring and chemistry sampling was conducted at locations in accordance with the monitoring schedules presented in Tables 3-1 and 3-2, respectively. Chemical monitoring analytical parameters are presented in Table 3-3. The groundwater monitoring well, pumping well and piezometer plan is depicted on Figure 3-1. The program for 2018 represented the first 5-year monitoring event per the revised sampling program, accepted by NYSDEC (December 9, 2016).

3.1 Groundwater Elevations Monitoring

Routine groundwater elevation measurements are the basis for determining the extent of physical control of groundwater flow in the overburden and bedrock flow zones. Water levels are measured quarterly and are used to generate potentiometric surface contour maps that show the aerial extent of hydraulic control. The data presentation facilitates determining both the spatial and temporal extents of hydraulic control for the Niagara Plant in all water-bearing zones of concern.

Quarterly groundwater-level measurements collected for the first three quarters of 2018 were included in the quarterly data packages submitted to NYSDEC (Parsons 2018b, 2018c, and 2018d). Water level measurements from 4Q18 are included in the 2018 PRR as Attachment 4.

3.1.1 Potentiometric Surface Maps

This section discusses the potentiometric surface maps presented in the quarterly data packages. These maps are used to understand groundwater flow patterns at the Plant and the GWRS effectiveness to contain Plant groundwater.

A-Zone Overburden and A-Zone Bedrock

Water level monitoring data collected in the A-Zone Overburden and A-Zone Bedrock during all four quarters of 2018 were consistent with previous reporting periods. Hydraulic heads in both zones were depressed in the vicinity of operating pumping wells. This confirmed that an inward gradient has been maintained along a majority of the Plant property, and off-site groundwater flow has decreased during the operation of the GWRS (see Figures 1 and 2 in 2018 quarterly data packages). Hydraulic control is discussed in greater detail in Section 3.1.2 below.

A-Zone total volatile organic compound (TVOC) isoconcentration contours for 3Q18 have been superimposed over potentiometric surface contours for the A-Zone overburden and A-Zone bedrock (August 23, 2018) and are presented in Figures 3-2 and 3-3, respectively. Groundwater potentiometric surface and TVOC concentration contour maps illustrate the impact of the GWRS and its effectiveness in reducing off-site migration of chemical constituents. Figures 3-2 and 3-3 both illustrate that the hydraulic cones-of-depression associated with GWRS pumping wells coincide with areas of moderate and high TVOC concentrations. Additionally, both figures illustrate the improved effectiveness of the GWRS with the addition of the BFBTs as indicated by the geographic alignment of the areas of highest TVOC concentrations and the location of the BFBTs. This is supported by Figure 2-1 which demonstrates an increase in mass removal after installation and operation of the BFBTs. The small decrease in 2018 was the result of lower total volume pumped at PW-39 and downtime associated with the RTO replacement.

In the West Plant, inward gradients have developed toward the BFBT pumping wells (PW-37 and PW-39), toward the line of pumping wells PW-16, PW-18, and PW-19, and also toward PW-35, which was brought back online in 2Q13. In the East Plant, inward gradients have developed in the line of pumping wells from PW-20 (just east of Gill Creek) to PW-34 (in the eastern portion of the Plant). Potentiometric surface maps indicate that hydraulic control is achieved in a majority of the Plant. Hydraulic control is discussed in greater detail in Section 3.1.2.

Bedrock Water-Bearing Zone

Flow patterns remain similar to previous years in the East Plant B-Zone and lower zones. The B-Zone hydraulic gradients are generally to the north toward the groundwater pumping system located at the Solvent Chemical site (immediately north of EPO-6 and EPO-7) and the Falls Street Tunnel (FST), which is located approximately 1,400 feet north of the Plant. In the absence of active pumping, the dominant B-Zone flow gradients would be generally to the north. These gradients would be consistent with the fact that the Buffalo Avenue Sewer and FST act as horizontal drains to the upper bedrock. Pumping from the PW-39 induces a groundwater capture zone in the southeast section of the west plant, providing groundwater capture in this area.

In general, hydraulic heads and gradients in the C/CD- and F-Zones are also similar to those measured on previous dates. Groundwater flow in the C/CD-Zone is generally to the northwest toward the Olin Production Well in the West Plant and north/northeast in the East Plant toward the intersection of the FST and the New York Power Authority (NYPA) conduits (FST/NYPA Intersection). Groundwater flow in the D-Zone exhibited similar trends as those observed in previous reporting periods, with flow generally toward the north and northwest. Groundwater elevations in the F-Zone are similar to those observed in previous reporting periods, with the direction of groundwater flow north to northwest in the West Plant and north to northeast in the East Plant, toward the FST/NYPA Intersection.

3.1.2 Hydraulic Control

Figure 3-4 depicts the total area of the Plant where the hydraulic effectiveness evaluation was conducted. The far eastern portion of the Plant (former Power House area), the West Yard, and Sodium Shop were not included in area calculations because the GWRS was not specifically designed to provide hydraulic control in these areas. Potentiometric surface contour maps for the A-Zone overburden and A-Zone bedrock illustrating the areas of hydraulic control for each quarter in 2018 are presented in Figures 3-5 through 3-12. Results of the hydraulic effectiveness evaluations for 2018 are summarized in Table 3-4. Overall, there are slight changes in capture from year to year, sometimes increasing, sometimes decreasing, but generally in the 1 to 2% range. The percent capture changes are likely due to subtle differences in the flow field and likely do not indicate a meaningful difference. The most notable changes are increases due to BFBTs in the West Plant and increases in the East Plant after 2006. Changes will continue to be tracked over time to identify trends.

The A-zone overall (overburden and bedrock) percentage of West Plant effectiveness was 92 percent, which was similar to the previous 6 years. This capture percentage is higher than the typical capture effectiveness from 2000 to 2005 prior to installation of the BFBTs, which ranged from 88 to 91 percent. As discussed in the MOE, capture areas were maintained along downgradient edges of the property, with the exception of a small areas west of 16A towards 5AR where concentrations have decreased to about 600 microgram per liter (µg/L) TVOCs or less in the A-Zone.

The East Plant overall effectiveness percentage was 96 percent for 2018. This is the same as the average value from 2011 through 2016 and is higher than the pre-2006 average of 91 percent.

The Plant-wide hydraulic effectiveness estimate for 2018 was 94 percent, which is in range with the estimates for 2006 through 2017 (93 to 94 percent). These effectiveness estimates represent a continuation of improved capture percentage when compared to those reported in 2005 and before (a combined average of 92 percent). The continued improvement is attributed to the BFBT remedy enhancement and the re-commissioning of PW-35 in the West Plant area. Results demonstrate there are no negative effects from shutting down West header wells PW-1 through PW-14, and PW-16. The East Plant containment improvements are attributed to the increased pumping uptime from pre-2006 to post 2006 most notably in the East Plant Overburden.

3.1.3 West Plant Hydraulic Control - Modified Operation Evaluation

Testing of the hydraulic effectiveness of BFBT wells PW-37 and PW-39 operating without West Plant wells PW-1 through PW-14, PW-16 and PW-35 began on October 1, 2008, and ran for six months under what was termed Modified Operation Evaluation (MOE). A report summarizing the results of the test was submitted to the NYSDEC in 2009 (DuPont CRG 2009). Results of the BFBT tests indicate improved performance in hydraulic control. The capture effectiveness and efficiency has increased due to the BFBTs, and there is an increase in drawdown in the areas with the highest concentrations of total VOCs (see Figures 3-2 and 3-3 and discussion above). The NYSDEC comments on the MOE report were received July 24, 2012, and DuPont submitted a revised MOE on February 27, 2013. The updated MOE report included data through 2013 as well as additional lines of evidence. The revised BFBT pumping configuration will continue to be used and monitored.

3.2 Groundwater Chemistry Monitoring

Groundwater sampling was conducted during 2018 in accordance with the monitoring schedule summarized in Table 3-2. Analytical parameters are summarized in Table 3-3. Analytical results for the 2018 annual sampling event are included in Appendix A. Appendix A also contains analytical results for the Gill Creek surface water sampling event. In accordance with the sampling program modifications implemented in 2006, 2011, and 2016, the following particulars to the sampling program were followed, in addition to the typical annual samples:

- In accordance with the five-year frequency, active pumping wells were sampled in 2018. These wells will next be sampled in 2023. Inactive west header pumping wells (PW-1, PW-3, PW-4, PW-6, PW-8, PW-9, PW-10, PW-11, PW-12, and PW-14) were not sampled (as described in correspondence from DuPont to NYSDEC dated June 15, 2011).
- Wells 6AR and 27A were sampled in 2018. Wells 6AR and 27A are on a five-year sampling schedule and the next sampling event for these wells will occur in 2023.

- Dissolved barium was analyzed in samples from wells 5AR and 21A. Dissolved barium at 5AR and 21A was analyzed every other year but has been moved to the five-year program beginning in 2018.

Analytical data were reviewed in accordance with quality assurance/quality control (QA/QC) procedures described in the Niagara Plant Quality Assurance Project Plan (Woodward-Clyde Diamond 1999).

3.2.1 A-Zone Overburden and A-Zone Bedrock Results

A-Zone groundwater analytical results for 2018 are consistent with past monitoring results, with the highest TVOC concentrations observed in mainly in four areas, two of which are located in the southern West Plant:

- Immediately west of Gill Creek near monitoring well 14A
- South of the Olin brine storage tanks (well 1AR3)
- East Plant well location 24A
- East Plant well location 8A

The distribution of groundwater chemistry concentrations for the A-Zone overburden and A-Zone bedrock are shown in Figures 3-2 and 3-3, respectively. A summary of the 2018 TVOC results by zone from monitoring well sampling is presented below. Groundwater chemistry trends for all monitored zones are discussed in Section 3.3.

3.2.2 Chemical Mass Removal

As a consequence of providing hydraulic control, the GWRS has been effective in removing chemical mass from groundwater. Mass removal continues to be greater than before the installation and operation of the BFBTs in 2005 (BFBTs, PW-16, PW-18, PW-19, PW-35 and PW-36 in the West Plant). In 2018, the GWRS removed approximately 5,794 pounds (2.9 tons) of organic compounds from groundwater.

In comparison, the Olin Production Well has exhibited an asymptotic rate of mass removal. The yearly estimated mass of organic compounds removed (947 pounds in 2018) has remained essentially unchanged since 1998. This is consistent with what is anticipated in the higher capacity fracture bedrock zones under long term pumping (Olin Deep well has been operating since the 1970’s).

The combined effect of the GWRS and the Olin Production Well resulted in the removal and treatment of approximately 7,239 pounds (3.6 tons) of organic compounds in 2018 (including Outfall 023). An estimated 127.4 tons of organic compounds have been collected and treated since the GWRS began continuous operation in 1992. Figure 2-1 depicts the of mass removal over time as a percent of total. The increase in mass removal rates decreased after start-up, but then significantly increased in 2006 likely due to startup of the BFBTs. This improved performance has been maintained from 2006 to 2018.

3.3 Groundwater Elevation and Chemistry Trends

An analysis of short-term and long-term groundwater chemistry trends has been completed to assess the effectiveness of the GWRS in reducing organic compound concentrations in groundwater through pumping for source control. This analysis used TVOC concentration data from monitoring wells and addressed trends in the A-Zone overburden, A-Zone bedrock, and bedrock water-bearing zones (i.e., B- through F-Zones). The evaluation also serves to identify locations where TVOC concentrations exhibit significant changes (generally, changes greater than an order of magnitude). TVOC concentration versus time plots for A-Zone overburden, A-Zone bedrock, and bedrock B- through F-Zone monitoring wells are presented in Appendix B.

Operation of the Olin Production Well and GWRS to control groundwater, supplemented by natural attenuation mechanisms, has resulted in an overall trend of declining TVOC concentrations in the overburden / top-of-bedrock, and bedrock fracture zones. In general, the West Plant, where the highest TVOC concentrations have historically been reported, exhibits the greatest decline in TVOC concentrations. This is consistent with the fact that operation of the Olin Production Well results in the direct hydraulic control in bedrock fractures zones beneath this area of the Plant. Natural attenuation processes also demonstrate that conditions remain favorable for natural attenuation of chlorinated hydrocarbons.

3.3.1 A-Zone Overburden and A-Zone Bedrock

The overall hydraulic effectiveness of the GWRS to gradually reduce TVOC concentrations in groundwater has been established for many years via the evaluation of TVOC concentration trends. While monitoring points exhibit some degree of scatter in TVOC concentration data over time, there is an overall trend of decreasing TVOC concentrations in A-Zone monitoring wells. Long-term TVOC concentrations have decreased in 21 of the 24 well locations in direct response to GWRS operation. These declines in TVOC concentrations indicate effective hydraulic control created by the GWRS over the 24 years of operation and source material depletion through dispersive and biodegradation processes. The hydraulic control remedy enhancement in the southern West Plant continues to show its effectiveness in removing chemical mass.

The greatest TVOC decline over time has occurred at southern West Plant well 28A (immediately south of BFBT PW-37) where TVOC concentrations have steadily decreased from 1,865,000 μg/l in 2000 to 8,590 μg/l in 2018 (Appendix B). A similar declining TVOC trend is evident at nearby offsite well DEC-4R as shown in the TVOC trend plot for this well (Appendix B). Since activation of the BFBTs, the rate of decline in DEC-4R has appeared to increase, indicating an improved performance as a result of the BFBTs.

At well DEC-3R (south of PW-39 BFBT), sample results demonstrate significant variability in TVOC; however, 2018 concentrations (710,000 µg/l) are appreciably lower than 1992 levels (greater than 2,000,000 µg/l), and there appears to be a decreasing trend. The concentrations in on-site well 1AR3 (northeast of DEC-3R and PW-39) (610,000 μg/l in 2018) had shown an increasing trend between 2010 and 2015 but significantly decrease in 2016 (50,900 μg/L) and again in 2017 (102.4 μg/L). TVOCs increased in 2018 (compared to 2016 and 2017) but have remained lower relative to the peak in 2002 (826,000 µg/l). Well 2A, which is between the two BFBTs, has had TVOCs declining since 2004 when concentrations were 25,790 μg/l to between 583 μg/l and 7,250 μg/l the last nine years. Well 3A (12.3 μg/l in 2018), which is north of PW-37, has had TVOC concentrations decline from in the 1,000's μg/l to being less than 10 μg/l five of the seven years between 2012 and 2018.

Significant historical TVOC decreases have been observed in East Plant wells 8A and 9AR where TVOC concentrations are mainly attributed to the presence of THT. TVOC concentrations at these locations have been stable over the last 10 years.

TVOC concentrations at well 18A in 2018 (242 μg/l) decreased to concentrations similar to those observed between 2008 to 2011 and 2013 to 2016 when concentrations were 260 μg/l or less. Single year increases were observed in 2007 (4,190 μg/l), 2012 (2,920 μg/l), and 2016 (3,000 μg/l). THT and related compounds were the only VOCs detected at well 18A in 2018. THT and related compounds chlorobenzene were the only compounds detected at 17A in 2018. Concentrations at 17A have demonstrated a downward trend since 2000 and were the lowest observed since 1998 in 2018 (187 μg/l).

East Plant well 24A is near Gill Creek and TVOCs identified include vinyl chloride and DCE. TVOC concentrations at this location have been under 10,000 μg/l the last six years after observing a slight spike in 2012 of 79,500 μg/l and higher previous concentrations of up to 141,200 in 1992. The 2018 concentration of 700 μg/l was the lowest observed since 1995 at well 24A.

Well 20AR was not sampled between 1994 and 2017 due to a lack of water in the well. In 2017, adequate water was available to be sampled and the historically lowest TVOC concentration at 20AR was observed (3 μg/l). Similar TVOC concentrations were found in 2018 (3.5 μg/l).

At well 21A (near Gill Creek in the West Plant) 2018 VOCs were34.4 μg/l. TVOC concentrations at 21A show a decreasing trend and have been as high as 18,680 μg/l and were below 100 μg/l the previous five years.

3.3.2 Bedrock Water-Bearing Zones

B-Zone Bedrock

B-Zone monitoring wells 1BR, 2B, 3B, 5BR, 8B, 12B, 14B, 16B, 19B, 20B, 22B, 23B, 24B, 25B, 29B, and 30B continue to show a steady decline or stable TVOC concentrations. Decreases at well location 8B and other East Plant bedrock wells are attributed to natural attenuation processes as described in detail in Section 3.3.3. From an overall perspective, long-term TVOC concentration decreases have been observed at 14 of the 16 B-Zone wells in the five-year monitoring program.

In the West Yard, near the western edge of the West Plant, TVOC concentrations in well 5BR were greater than 10,000 μg/l in the early to mid-1990s, but decreased during the remediation. The concentrations have been near and/or below 100 μg/l for the last thirteen years and less than 15 μg/l the six of the last seven years. In 2018, TVOC concentrations at well 5BR decreased to 11.4 μg/l after concentrations increased to 110 μg/l in 2017. In 2016, the lowest concentration was observed to date (2.4 μg/l), representing a four orders of magnitude decline in concentration. Also, on the western side of the Site, TVOC concentrations in wells 16B and 19B have continued to decline. Decreases at these wells provide further evidence that the plume is controlled by the pumping systems and contracting at the fringes. The lowest observed TVOC concentrations have been observed at well 16B the last three times the well has been sampled (2015, 2016, and 2018). Concentrations at this location have declined from over 100,000 μg/l in 1992 to 173 μg/l in 2018, representing a three orders of magnitude decline. TVOC concentrations at well 19B in 2018 (6.1 μg/l) were the lowest observed since 1998.

Well 20B, in the northwestern corner of the West Plant, has shown TVOCs decline from over 10,000 μg/l in 1998 to less than 3,500 μg/l over the last nine years. West Plant well 14B has maintained consistent TVOC concentrations between 335,000 μg/l and 500,000 μg/l over the last 16 years. The TVOC result at well 14B in 2018 (376,000 μg/l) was down slightly from the 2017 result but up slightly from the 2016 result that was the lowest observed since 2001. Well 1BR in the southern part of the West Plant near Gill Creek, has demonstrated a declining trend in TVOCs with the last twelve years below 200,000 μg/l while TVOCs previously have been as high as over 600,000 μg/l. Well 3B is north of PW-37 in the West Plant and has demonstrated declining TVOCs from approximately year 2000. TVOC concentrations have been as high as 7,490,000 μg/l in 2002 and have been under 2,000,000 μg/l since that time. In 2018, the concentration at 3B was lower than recent results at 1,051 μg/l. This was the lowest result since 1994 and represents a three orders of magnitude drop in TVOCs.

The most notable historical decrease in the East Plant is apparent at well location 8B, where TVOC concentrations are dominated by the presence of THT. Historical concentrations have exceeded 500,000 μg/l but have been less than 8,000 μg/l the last ten years. TVOC concentrations at other locations remained below historical with typical fluctuations

C/CD-Zone Bedrock

An analysis of historical groundwater chemistry trends in the C/CD-Zone indicates an overall decline in TVOC concentrations, particularly in the East Plant. East Plant monitoring wells 7CR and 23C, located near the downgradient boundary of the Plant, continue to exhibit long-term declines in TVOC concentrations. TVOC concentrations are mainly attributed to the presence of THT with the exception of 23C where benzene, DCE, and VC were detected. Wells 7CR and 23C are relatively low in TVOC concentrations (less than 50 µg/l). Well 25C/CD has shown a decreasing trend over time, but has shown some anomalously high readings. The TVOC concentration in 2012 at 25C/CD (14,500 μg/l) were the highest identified at this location, but TVOC concentrations declined to below 3,000 μg/l between 2016 and 2018, with the lowest TVOC concentration observed at 25CD occurring in 2016. Well 17B is north of the East Plant and has shown a decline in TVOC concentrations since its high of 540 µg/l observed in 2000 with the 2018 TVOC concentration of 39.5 µg/l.

Well 12C/CD is in the East Plant near Gill Creek and indicates a highly variable range and a decreasing trend overall. The 2016 TVOC concentration of 11,990 µg/l and the 2017 TVOC concentration of 8,300 μg/l represent the lowest TVOC concentrations observed at this location two years in a row. The 2018 TVOC concentration was similar at 10,500 μg/l. Downgradient well 18C continues to show a decreasing trend of TVOC concentrations. TVOC concentrations in 2018 at 18C (960 µg/l) consisted of THT and vinyl chloride only. Well 18C has been sampled since 1992 and the 2018 TVOC concentrations were the lowest observed.

After TVOC concentrations in 2016 at well 22C returned to concentrations similar to the short-term increase of TVOC concentrations observed in 2004 and 2005, 2017 saw a decrease to the lowest observed TVOC concentration at 22C since 1997 (256.0 μg/l). In 2018, TVOC concentrations dropped further to the lowest observed at well 22C (67.3 μg/l). TVOC concentrations had decreased from 48,520 µg/l in 2004 to 2,167 µg/l in 2008. In 2014, the TVOC concentration at 22C further decreased to 500.1 µg/l, the lowest observed since 2001 but increased to near 20,000 µg/l in 2015 and 2016. The concentrations remain well below the peaks of approximately 50,000 µg/l in 1992 and 2004.

Long-term TVOC reductions in West Plant can be attributed to the effectiveness of the Olin Production Well in achieving hydraulic control in the West Plant and the gradual removal of chemical constituents via natural attenuation processes throughout the Plant.

West Plant well 15CD has increased in TVOCs over the last 5 years to 368,000 µg/l. This well is located within the Olin Deep Well capture zone and increases here appear to be the result of long-term migration of the plume towards the pumping well. Similar observations have occurred at other well such as 19CD1 and 26CD, also located upgradient from the Olin well. However, in2018 TVOC results indicate stabilization or reversal to a declining trend, and suggest the conditions maybe temporary.

Well 4CR (west of PW-37) has historically shown a wide range of TVOC concentrations and has shown a potential and slight increasing trend over the years, however in 2018 the concentrations were similar to those observed in 1992. Flow in in this area has been demonstrated to flow towards the Olin pumping is therefore within the capture zone. Meanwhile, at West Plant well 5CDR (located on the north side of the west yard), a decreasing trend of TVOC concentration is evident from 2002 to the present. TVOC concentrations decreased significantly in this well from a peak of 4,900 µg/l in 2002 to 1.9 µg/l in 2018. Concentrations have been less than 10 µg/l the last six years indicating retraction of the plume.

D-Zone Bedrock

For years the TVOC data from the D-Zone wells have demonstrated declining or stabilizing TVOC indicating the plume is captured and/or retracting in this zone. Concentrations in 2018 support these observations. Chemistry results from 2000 to 2018 indicate are dominated by degradation product such as DCE and VC which demonstrates the active natural attenuation in the D-Zone.

At East Plant well 18D have varied between approximately 25 µg/l and 550 µg/l, however a discernible slight decreasing trend is observed. The 2017 TVOC concentration at 18D was 27.9 µg/l, the lowest since 2003 and the last three years have been very similar with TVOC concentrations between 27.9 and 31.0 µg/l. TVOCs at this location have historically included DCE, THT, and VC, however, only DCE and VC were identified the last two years.

F-Zone Bedrock

F-Zone wells show a dominant downward trend in TVOC concentrations at all nine wells in the 5-year program (Appendix B). This decreasing trend in the F-Zone is evident in that eight of the nine wells are at or below TVOC concentrations of 253 µg/l, and only one well, 17F, remains elevated at 7,030 µg/l. Well 17F is north of the East Plant and has concentrations of mainly chlorobenzene and related compounds, which have declined over time.

This general trend of declining TVOC concentrations in both the West and East Plants may be attributed to hydraulic control of the West Plant bedrock created by the Olin Production Well. Declining TVOC concentrations are also attributed to gradual contaminant reduction through attenuation processes such as dispersion, biodegradation and, potentially, abiotic degradation. The presence of degradation compounds, indicating attenuation of source materials, dominate groundwater chemistry plant-wide in the deeper bedrock zones (both the D- and the F-Zones).

3.3.3 East Plant Bedrock Monitoring

As described in the 2000, 2004, 2008, and 2013 annual reports, results of the monitored natural attenuation (MNA) assessment are strongly indicative of continued constituent attenuation through biodegradation and natural dispersive mechanisms in all the East Plant bedrock water-bearing zones. Stable or declining concentrations are a clear indication that any constituent plume is either stable or shrinking in size. Both geochemical and biological data provide sufficient evidence to support active intrinsic bioremediation in the various fracture zones. Results from the 2018 groundwater sampling event have been used to provide an update of MNA evaluation. Results of this evaluation are provided in Appendix C. The next full MNA sampling and analysis is scheduled for 2023.

Evidence complied during the past five years of the natural attenuation assessment are indicative of continued constituent attenuation through biodegradation and natural dispersive mechanisms in all the East Plant bedrock water-bearing zones. Stable or declining concentrations are a clear indication that any constituent plume is either stable or is shrinking in size. Both geochemical and biological data provide sufficient evidence to support active intrinsic bioremediation in the various fracture zones.

3.4 Dense Non-Aqueous Phase Liquid (DNAPL) Monitoring

Weekly observations are made at pumping well PW-39 and are completed as part of routine maintenance inspections. DNAPL was last observed at PW-39 on November 9, 2006.

3.5 Gill Creek Surface Water Monitoring

Samples are collected from two locations in Gill Creek as shown in Figure 3-1 (sample locations SW-1 and SW-2). The surface water samples collected during the annual well sampling events were analyzed for full list indicator parameters (see Table 3-3).

Sample SW-1, collected upstream of the Niagara Plant at the Adams Avenue Bridge indicated no volatile organic compounds, semi-volatile organic compounds, pesticides, or PCBs. Downstream sample SW-2 has a reported TVOC concentration of 11.1 μg/l which included PCE at 6.0 µg/l and TCE at 5.1 µg/l. No pesticides, semi-volatile organic compounds, or PCBs were found. These results are consistent with the results from previous sampling events.

A review of the SW-2 data between 2000 and 2018 shows that the TVOC concentrations have been fluctuating between 1 μg/l and 178 μg/l. In 2011, 2013, and 2014 the concentrations were at or near the high end of the range, but there is no apparent trend.

4.0 CONCLUSIONS

4.1 GWRS Effectiveness

The overall effectiveness of the GWRS in controlling off-site groundwater flow has been demonstrated through hydraulic head and groundwater quality monitoring during 27 years of operation. The 2018 GWRS operations are summarized as follows:

- System uptime was 96 percent for the 23 original pumping wells that are still in use.
- PW-37 uptime was 93.0 percent.
- PW-39 uptime was 75.3 percent.
- Olin Production Well system uptime was 99.9 percent.
- Operation of BFBT pumping wells PW-37 and PW-39 continued throughout 2018, along with a reduced number of the original 23 pumping wells.
- The improved reliability of the system by the completion of upgrades to the RTO during 2009 has continued through 2018.
- Hydraulic control in A-Zone Overburden and the A-Zone Bedrock was exercised over 94 percent of the Plant's area for 2018.
- Approximately 3.6 tons of organic compounds were removed and treated during 2018. This includes the GWRS (2.9 tons), Olin system (0.5 tons), and outfall 023 (0.3 tons).
- DNAPL monitoring conducted in 2018 indicated no DNAPL was present at PW-39.

Extensive water-level data collected over 27 years of system operation have illustrated that hydraulic heads in both the A-Zone overburden and A-Zone bedrock are depressed in the vicinity of operating GWRS pumping wells. The resulting inward flow gradient that has developed in most areas of the Plant has decreased off-site groundwater flow. A quantitative evaluation of GWRS hydraulic effectiveness (first developed in 1995) indicates that groundwater capture was observed in approximately 94 percent of the entire Plant in 2018 (A-Zone overburden and bedrock, East and West Plant). Furthermore, in the West Plant (where a majority of contaminants are observed) groundwater capture was established in the A-Zone for approximately 92 percent of the area. Areas outside the capture in the West Plant are isolated to areas where concentrations are considerably lower than the remainder of the site. These results are similar or slightly improved relative to hydraulic effectiveness evaluation findings presented in historic reports prior to operation of the BFBTs. As such, these most recent findings reinforce the conclusions of the BFBT MOE (DuPont CRG 2009), the BFBT MOE – 2013 Update (Parsons, 2013).

An estimated 127.4 5tons of organic compounds have been removed and treated as part of the Plant's remediation efforts since the GWRS began continuous operation in 1992. The estimated 3.6 tons of organic compounds removed and treated as part of the Plant's remediation efforts during 2018 equates to 2.8 percent of the total estimated organic compounds removed from groundwater since the system began operating.

4.2 East Plant Bedrock MNA

Prior evaluations have provided strong evidence that natural attenuation and intrinsic bioremediation are occurring in the subsurface and are a primary mechanism for removal of chlorinated hydrocarbons in the East Plant bedrock. Data were collected annually from 2001 through 2004 to monitor MNA progress in the East Plant bedrock and to confirm continued intrinsic bioremediation of the chlorinated hydrocarbon plume areas. Consistent with U.S. Environmental Protection Agency guidance, a five-year review of the data was completed following collection of the 2008 and 2013 annual data. The review provided herein, utilizing data collected in 2018, confirmed that MNA processes, including intrinsic bioremediation of the chlorinated hydrocarbons, is still actively removing plume mass from the fractured bedrock system in the East Plant. Stable or declining concentrations indicate that any constituent plume is either stable or is shrinking in size. Both geochemical and biological data provide sufficient evidence to support active intrinsic bioremediation in the various fracture zones.

There are no groundwater users located between the Plant and the presumed discharge point (FST/NYPA conduit drain) for any potential offsite plume. Therefore the periodic monitoring of natural attenuation parameters in East Plant bedrock is the appropriate course of action. MNA parameters are next scheduled to be monitored in 2023. VOC data and field parameters will still be collected annually to monitor plume distribution and VOC attenuation.

4.3 DNAPL Monitoring

The observation of DNAPL in pumping well PW-39 in April 2006 prompted a monitoring and recovery program. Approximately 118 gallons of DNAPL were removed from well PW-39 in 2006. Monitoring at nearby well locations completed in 2006 indicate that the DNAPL was limited to well PW-39. The last observation and recovery at PW-39 occurred on November 9, 2006. Based on the monitoring results compiled to date, DuPont proposed routine monitoring limited to pumping well PW-39 beginning in 2Q08. The frequency of DNAPL assessments will be determined by the monitoring results and is currently completed weekly. No DNAPL was found in PW-39 in 2018.

5.0 REFERENCES

Air Force Center for Engineering and the Environment. 2008. Technical Protocol for Enhanced Anaerobic Bioremediation using Permeable Mulch Biowalls and Bioreactors

DuPont CRG. 1999. Quality Assurance Project Plan: Groundwater Monitoring Program, DuPont Niagara Plant, Version 4.0. May.

_____. 2006. Results of BFBT Optimization Step Tests, correspondence to M. Hinton. December 21.

_____. 2009. DuPont Niagara Modified Operating Evaluation Report. August 6.

NYSDEC. 2005. M. Hinton. Correspondence RE: Catalytic Oxidizer Repair. November 23.

_____. 2008. M. Hinton. Correspondence RE: Removal of Wells from Sampling Program. July 7.

_____. 2011. M. Hinton. Correspondence RE: Proposal for Activated Carbon Utilization Study. April 24.

_____. 2016. M. Hinton. Correspondence RE: Recommendations for Reduction of Long Term Groundwater Monitoring Program. December 9.

Parsons. 2013. Blast Fractured Bedrock Trench Modified Operations Evaluation – 2013 Update. February, 2013.

_____. 2018a. Groundwater Remediation System Annual Report 2017 Chemours Niagara Plant. March, 2018.

_____. 2018b. Chemours Niagara Plant Groundwater Remediation System First Quarter 2018 Data Package. May, 2018.

_____. 2018c. Chemours Niagara Plant Groundwater Remediation System Second Quarter 2018 Data Package. August, 2018.

_____. 2018d. Chemours Niagara Plant Groundwater Remediation System Third Quarter 2018 Data Package. November, 2018.

Woodward-Clyde Diamond. 1999. Niagara Plant Quality Assurance Project Plan.

Woodward Clyde. 1989. Final Report DuPont Niagara Falls Plant Interim Remedial Program, September.

ANNUAL REPORT
TABLES

Table 2-1

Historical System Operations Summary
Chemours Niagara Plant

OPERATIONS STATISTIC	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008**	2009**	2010**	2011**	2012**	2013#	2014#	2015#	2016#	2017#	2018#
GWRS																											
23 Original Wells Uptime	75%	76%	89%	93%	96%	97%	90%	71%	78%	86%	91%	79%	79%	64%	75%	75%	98%	100%	99%	96%	100%	99%	96%	98%	93%	97%	96%
PW-37 Uptime	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12%	32%	92%	100%	93%	99%	100%	97%	98%	89%	96%	93%
PW-39 Uptime	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	66%	93%	99%	100%	93%	98%	94%	97%	98%	92%	91%	75%
Total Gallons Pumped (millions)	NR	12.4	16.4	17.3	15.1	15.8	10.8	11.2	12.3	11.6	14.1	14.0	12.8	12.3	22.1	13.3	9.5	11.8	9.1	10.7	11.9	13.4	12.3	11.9	10.1	16.5	10.6
Estimated pounds of Organics Treated*	10,350	7,220	7,320	7,840	9,437	6,463	7,000	3,382	3,025	3,224	3,848	2,820	2,645	2,237	11,589	8,678	7,932	12,128	7,854	9,004	8,254	9,416	8,567	7,995	6,629	10,815	5,794
Number of unscheduled system shutdowns	10	5	2	3	0	0	2	7	8	3	3	1	4	6	4	3	0	0	1	4	1	1	1	0	0	0	0
Number of scheduled system shutdowns	2	2	2	1	1	1	1	2	2	2	2	3	2	3	3	3	1	1	1	1	3	3	5	0	1	1	1
Pump Replacements	26	63	43	40	21	11	7	6	16	13	22	14	17	24	17	5	10	11	7	3	3	3	3	3	5	4	3
Pump Repairs Requiring > 48 Hours	NR	NR	4	3	9	13	3	1	3	10	25	4	11	38	25	23	11	4	2	0	1	5	10	2	2	6	1
OLIN SYSTEM																											
Pumping System Uptime	NR	NR	99.0%	98.7%	99.0%	99.5%	98.7%	89.6%	99.7%	100%	99.5%	100%	99%	100%	100%	99.9%	100%	100%	99.8%	100%	100%	100%	100%	100%	100%	100%	100%
Estimated Pounds of Organics Treated	5,470	3,580	3,527	2,378	2,240	1,887	1,392	1,696	1,214	1,185	1,374	1,124	1,042	1,066	1,096	1,068	1,257	1,222	1,167	1,386	1,137	1,043	1,269	1,197	1,152	1,245	947
OUTFALL 023																											
Estimated Pounds of Organics Treated	2,055	2,417	1,672	899	850	542	569	1,529	376	406	1,091	379	370	405	531	326	544	699	224	355	303	337	355	241	398	570	498
TOTAL Organics All Sources																											
Estimated Pounds of Organics Treated	17,875	13,217	12,519	11,117	12,527	8,892	8,961	6,607	4,615	4,815	6,313	4,323	4,057	3,708	13,216	10,072	9,733	14,049	9,245	10,745	9,695	10,796	10,191	9,433	8,179	12,630	7,239

NA: Not applicable.

NR: Not recorded in the past quarterly or annual reports.

* Includes estimated quantity of organics/water mixture shipped in 3Q98.

** The calculated uptime for the original 23 wells from 4Q08 through all of 1Q13 excludes the shutdown of wells PW-1 through PW-12, PW-14 and PW-35 as part of the Modified Operations Evaluation.

The calculated uptime for the original 23 wells from 2Q13 through 4Q13 excludes the shutdown of wells PW-1 through PW-12, and PW-14 as part of the Modified Operation Evaluation.

Table 3-1
Quarterly Groundwater Level Monitoring Locations
Chemours Niagara Plant

Monitoring Points
Piezometers
WPPO-1, WPPT-2, WPPO-3R, WPPT-4, WPPT-5, EPPT-1, EPPT-2, EPPT-3, WPO-1R, WPT-1R, WPO-2, WPT-2, WPO-3R, WPT-3R, WPO-4, WPT-4, WPO-5, WPT-5, WPO-6, WPT-6, WPO-7, WPT-7, WPO-8, WPT-8, WPO-9, WPT-9R, WPO-10, WPT-10, WPO-11, WPT-11, WPO-12, WPT-12, WPO-13, WPO-14, WPO-15, WPO-16, WPO-17, WPT-17, WPO-18, WPT-18, WPO-19, WPT-19, WPO-20, WPT-20, WPO-21, WPT-21, WPO-22, WPT-22, WPO-23, WPT-23, WPO-24, WPT-24, WPO-25, WPT-25, EPO-1, EPT-1, EPO-2, EPT-2, EPO-3, EPT-3, EPO-4 EPT-4, EPO-5, EPT-5, EPO-6, EPT-6, EPO-7, EPT-7, EPO-8, EPT-8, EPO-9, EPT-9
Pumping wells
PW-1, PW-3, PW-4, PW-6, PW-8, PW-9, PW-10, PW-11, PW-12, PW-14, PW-16, PW-18, PW-19, PW-20, PW-22, PW-24, PW-26, PW-28, PW-30, PW-32, PW-34, PW-35, PW-36, PW-37, PW-38, PW-39, TPW-01
Utility wells
U-1, U-14, U-16
Monitoring wells (A-Zone)
1AR3, 2A, 3A, 4AR, 5AR, 6AR, 7AR2, 8A, 9AR, 10A, 12A, 13A, 14A, 15A, 16A, 17A, 18A, 19A, 20AR, 21A, 23AR, 24A, 27A, 28A
Monitoring wells (B-Zone)
1BR, 2B, 3B, 5BR, 8B, 12B, 14B*, 16B, 19B, 20B, 22B, 23B, 24B, 25B, 29B, 30B, BW-01
Monitoring wells (C/CD-Zone)
1C, 2C, 4CR, 5CDR, 5CR, 7CR, 10C, 10CR, 12C/CD, 14C, 15C, 15CD, 17B, 18C, 19C, 19CD1, 19CD2, 22C, 23C, 25C/CD, 26C, 26CD
Monitoring wells (D-Zone)
1D, 5DR, 10D, 14D, 15D, 18D, 19D, 22D, 23D, 25D
Monitoring wells (F-Zone once every five years)
1F, 5FR, 7FR, 10F, 15F, 17F, 22F, 23F, 25F
DEC wells
DEC-3R, DEC-4R, DEC-5
Olin monitoring wells
OBA-10A, OBA-24A, OBA-24B, OBA-25A, OBA-25B, OBA-26A, OBA-26B
Gill Creek Stilling Wells
GC-1, GC-2 **

* Well added to hydraulic monitoring program in 1Q02.
** Gill Creek stilling well GC-2 installed in 2006.

Table 3-2
Groundwater Quality Monitoring Schedule
Chemours Niagara Plant

Monitoring Point	Sampling Frequency[1]
Olin GAC influent & effluent	Quarterly[2]
GWRS treatment influent & effluent	Quarterly[2]
Pumping wells [3] PW-16, PW-18, PW-19, PW-20, PW-22, PW-24, PW-26, PW-28, PW-30, PW-32, PW-34, PW-35, PW-36, PW-37, PW-39	Every five years (next is 2018)
Utility wells U-1	Annual
Outfall 023	Quarterly
Monitoring wells (A-Zone wells) 1AR3, 2A, 3A, 6AR, 8A, 9AR, 13A, 14A, 15A, 16A, 17A, 18A, 20AR[5], 21A, 24A, 27A, 28A	Annual
Monitoring wells (A-Zone wells) 4AR, 5AR, 7AR[4], 10A, 12A, 19A, 23AR	Every five years[5] (next in 2023)
Monitoring wells (B-Zone wells) 1BR, 3B, 5BR, 8B, 14B, 20B, 24B, 25B, 29B, 30B	Annual
Monitoring wells (B-Zone wells) 2B, 12B, 16B, 19B, 22B, 23B	Every five years[5] (next in 2023)
Monitoring wells (C/CD-Zone wells) 1C, 2C, 4CR, 12 C/CD, 15CD, 18C, 19CD1, 22C, 25C/CD, 26CD	Annual
Monitoring wells (C/CD-Zone wells) 5CDR, 7CR, 17B, 23C	Every five years[5] (next in 2023)
Monitoring wells (D-Zone wells) 1D, 10D, 14D, 18D, 22D, 25D	Annual
Monitoring wells (D-Zone wells) 5DR, 15D, 19D, 23D	Every five years[5] (next in 2023)
Monitoring wells (F-Zone wells) 15F, 17F, 23F, 25F	Annual
Monitoring wells (F-Zone wells) 1F, 5FR, 7FR, 10F, 22F	Every five years[5] (next in 2023)
DEC wells DEC-3R, DEC-4R	Annual
DEC wells DEC-5	Every five years[5] (next in 2023)

[1] All analyses for refined indicator parameters except as noted below.

[2] Samples to be analyzed for the refined indicator parameter list once during any given quarterly sampling event. Samples collected during the remaining quarterly events are analyzed for field parameters and volatile organics. See Table 3-3 for analytical parameters.

[3] In active pumping wells: PW-1, PW-3, PW-4, PW-6, PW-8, PW-9, PW-10, PW-11, PW-12, PW-14 are removed from the program, last sampling was 2011 (corresondance dated June 15, 2011)

[4] Well 7AR replaced in 2008.

[5]Per NYSDEC electronic response July 7, 2008 and letter dated December 8, 2016.

Table 3-3
Chemical Analysis Parameter List
Chemours Niagara Plant

Volatiles	Inorganics and Other Parameters
Benzene	
Carbon tetrachloride	Total cyanide[1]
Chlorobenzene	Soluble barium[2]
Chloroform	pH[3]
Chloromethane	Temperature[3]
1,2-dichlorobenzene	Specific conductivity[3]
1,4-dichlorobenzene	
1,4-dichlorobutane	**Base/Neutrals[1]**
1,1-dichloroethane	bis(2-ethylhexyl)phthalate
1,1-dichloroethene	Naphthalene
trans-1,2-dichloroethene	Hexachlorobutadiene
cis-1,2-dichloroethene	Hexachloroethane
Methylene chloride	
1,1,2,2-tetrachloroethane	**Pesticides/PCBs[1]**
Tetrachloroethene	alpha-BHC
Tetrahydrothiophene	beta-BHC
Toluene	delta-BHC
1,1,1-trichloroethane	gamma-BHC
1,1,2-trichloroethane	PCB-1016
Trichloroethene	PCB-1221
Vinyl chloride	PCB-1232
	PCB-1242
	PCB-1248
	PCB-1254
	PCB-1260

[1] Analyses required once per year for these parameters on select samples for the quaterly sampling program.

[2] With approval from NYSDEC, dissolved barium analysis for the annual event was modified in 2006. Sampling will continue at wells 5AR (5-year schedule) and 21A (annual schedule) for soluble barium analysis.

[3] Field measurement

Table 3-4
2018 Hydraulic Effectiveness Evaluation Results
A-Zone Overburden and A-Zone Bedrock
Chemours Niagara Plant

Aquifer Zone	WEST PLANT		EAST PLANT		ENTIRE PLANT	
	Area Hydraulically Controlled (ft^2)	Percent Captured	Area Hydraulically Controlled (ft^2)	Percent Captured	Area Hydraulically Controlled (ft^2)	Percent Captured
A-Zone overburden, 1Q18	1,002,172	88%	932,154	99%	1,934,326	93%
A-Zone bedrock, 1Q18	1,125,640	99%	844,314	90%	1,969,954	95%
A-Zone overburden, 2Q18	1,044,850	92%	932,965	100%	1,977,815	95%
A-Zone bedrock, 2Q18	959,681	84%	895,313	96%	1,854,994	89%
A-Zone overburden, 3Q18	1,002,845	88%	931,595	99%	1,934,440	93%
A-Zone bedrock, 3Q18	1,074,854	94%	859,472	92%	1,934,326	93%
A-Zone overburden, 4Q18	1,066,657	93%	931,400	99%	1,998,057	96%
A-Zone bedrock, 4Q18	1,133,277	99%	838,590	89%	1,971,867	95%
A-Zone overburden average	90%		99%		94%	
A-Zone bedrock average	94%		92%		93%	
A-Zone average	**92%**		**96%**		**94%**	

Based on Total Areas Below

Area of West Plant	1,141,732	sq ft.
Area of East Plant	937,140	sq ft.
Total Plant Area	2,078,871	sq ft.

Table 3-5
Historical Hydraulic Effectiveness Evaluation Results
Chemours Niagara Plant

Year	West Plant		East Plant		Entire Plant	
	A-Zone Overburden	A-Zone Bedrock	A-Zone Overburden	A-Zone Bedrock	A-Zone Overburden	A-Zone Bedrock
1997	95%	95%	82%	93%	89%	94%
1998	95%	95%	84%	93%	90%	94%
1999	91%	96%	85%	92%	88%	94%
2000	87%	91%	96%	95%	91%	93%
2001	89%	92%	94%	96%	90%	93%
2002	87%	89%	92%	92%	89%	90%
2003	88%	88%	92%	90%	90%	89%
2004	88%	89%	92%	89%	89%	89%
2005	88%	89%	92%	89%	90%	89%
Pre-2006 Average	90%	92%	90%	92%	90%	92%
2006	94%	96%	91%	89%	93%	93%
2007[1]	94%	97%	90%	92%	92%	95%
2008	93%	92%	96%	94%	94%	93%
2009	93%	91%	100%	91%	96%	91%
2010	89%	94%	99%	96%	94%	95%
2011	89%	93%	98%	96%	93%	94%
2012[2]	94%	93%	98%	93%	96%	93%
2013	89%	97%	99%	92%	94%	94%
2014	88%	97%	99%	90%	93%	94%
2015	91%	95%	98%	91%	94%	94%
2016	87%	93%	99%	97%	92%	95%
2017	90%	97%	100%	97%	95%	97%
2018	90%	94%	99%	92%	94%	93%

Notes:

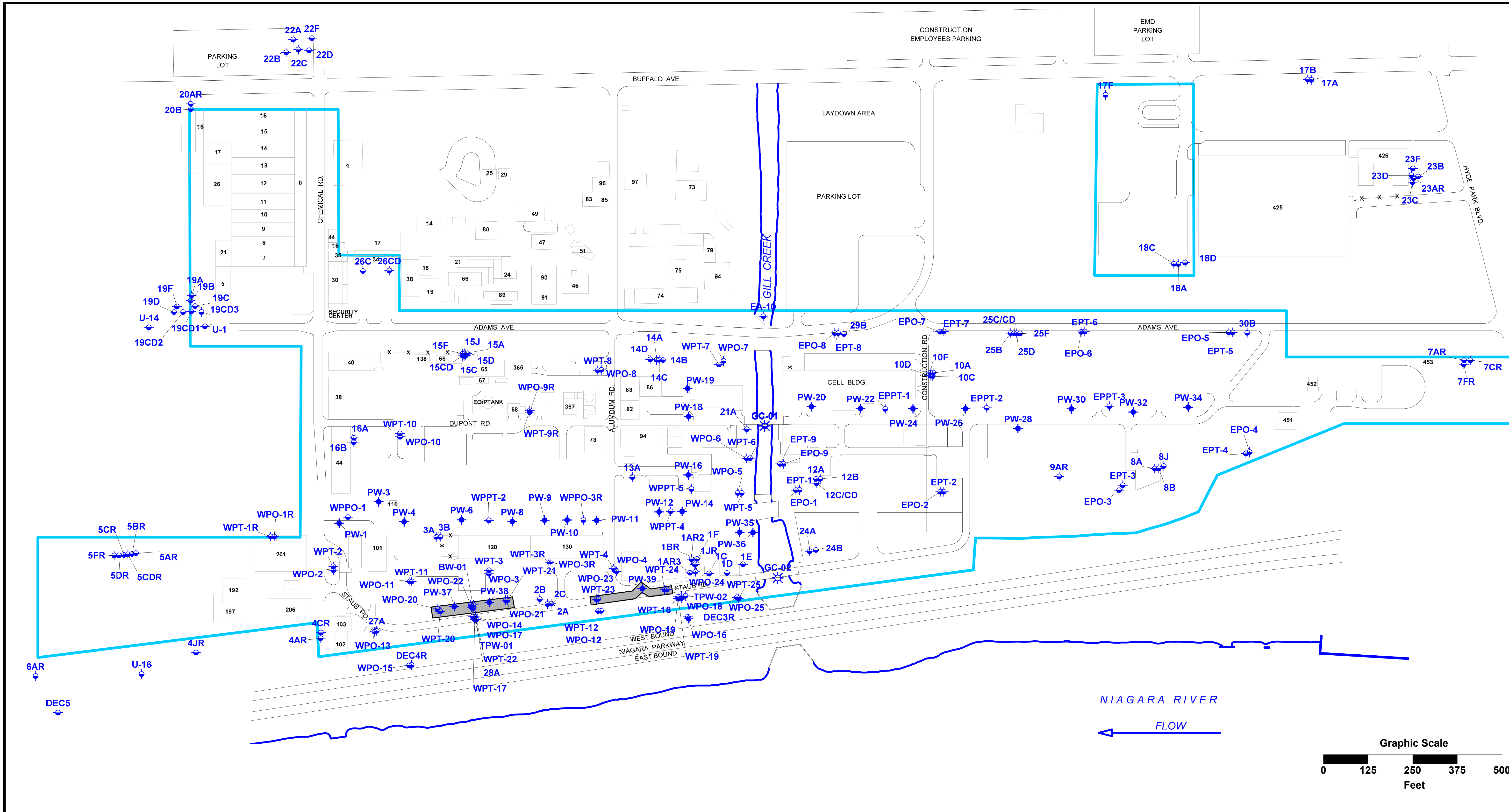
1) Averages from 2007 do not include 4Q07 data. Reduced uptime in October, including a system shutdown related to the GWRS modification construction that extended into 2008, resulted in the 4Q07 monitoring event not being completed.

2) Average from 2012 excluded 1Q12 which was biased low due to anomalous flow patterns near 16A.

ANNUAL REPORT FIGURES

PARSONS 40 La Riviere Dr, Suite 350 Buffalo, NY 14202 (716) 541-0730	Created by: JWS	Date: 02-06-12	**FIGURE 1-1** **SITE LOCATION MAP** **NIAGARA PLANT** **NIAGARA FALLS, NY**
	Checked by: RBP	Date: 02-08-12	
	Project Manager: EAF	Date: 02-22-12	
	Job number: 445356.02023		

DuPont/Niagara/hydrogeo/mapping/Site_location_map.srf



PARSONS

40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: JWS	Date: 02-06-12
Checked by: RBP	Date: 02-08-12
Project Manager:EAF	Date:
Job number: 445356.02023	

LEGEND

- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER
- PIEZOMETER/MONITORING WELL
- PUMPING WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH

FIGURE 3-1
GROUNDWATER MONITORING WELL, PUMPING WELL AND PIEZOMETER PLAN
NIAGARA PLANT, NIAGARA FALLS, NY

DuPont/Niagara/hydrogeo/mapping/Nia-Basemap2011.srf

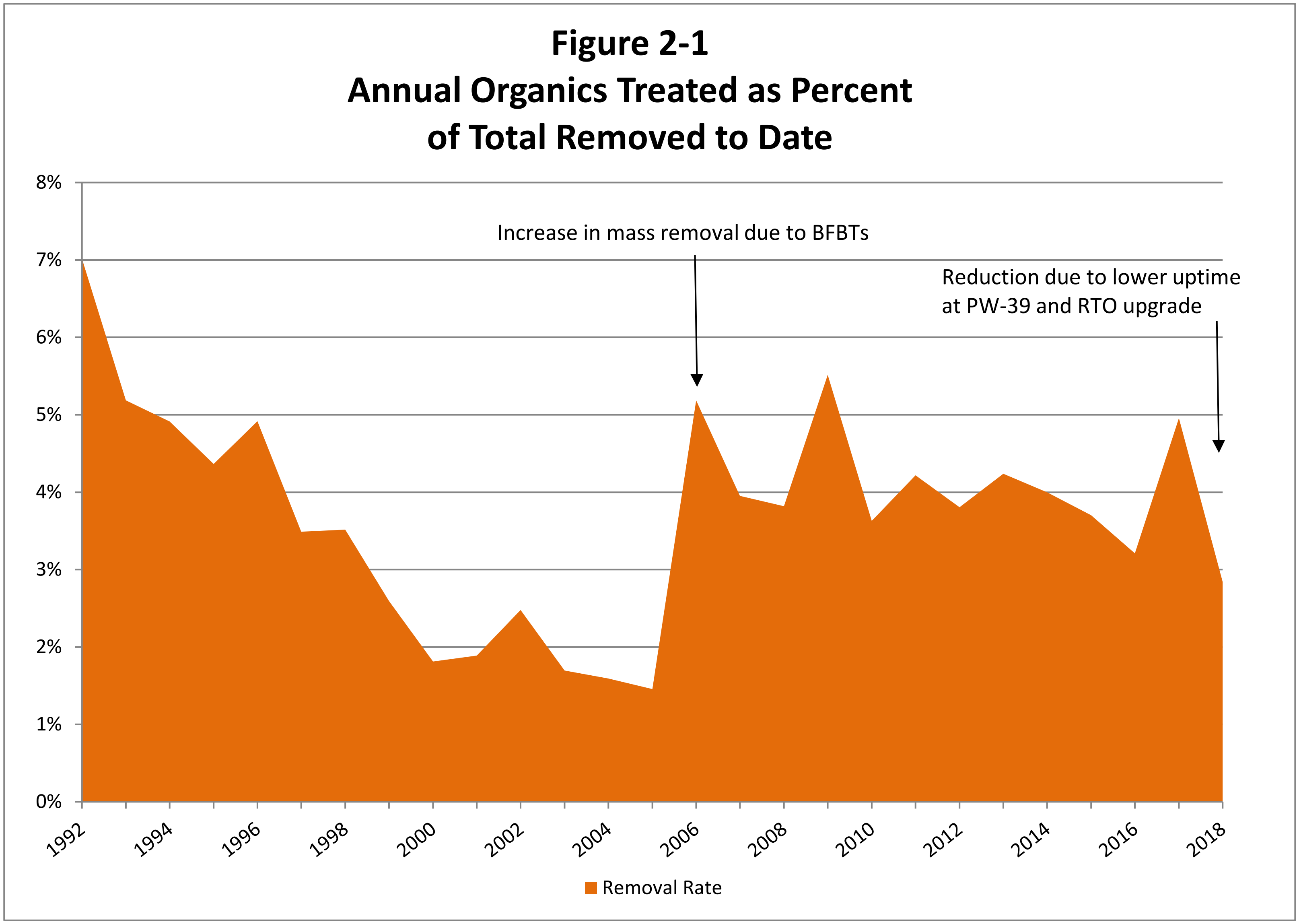
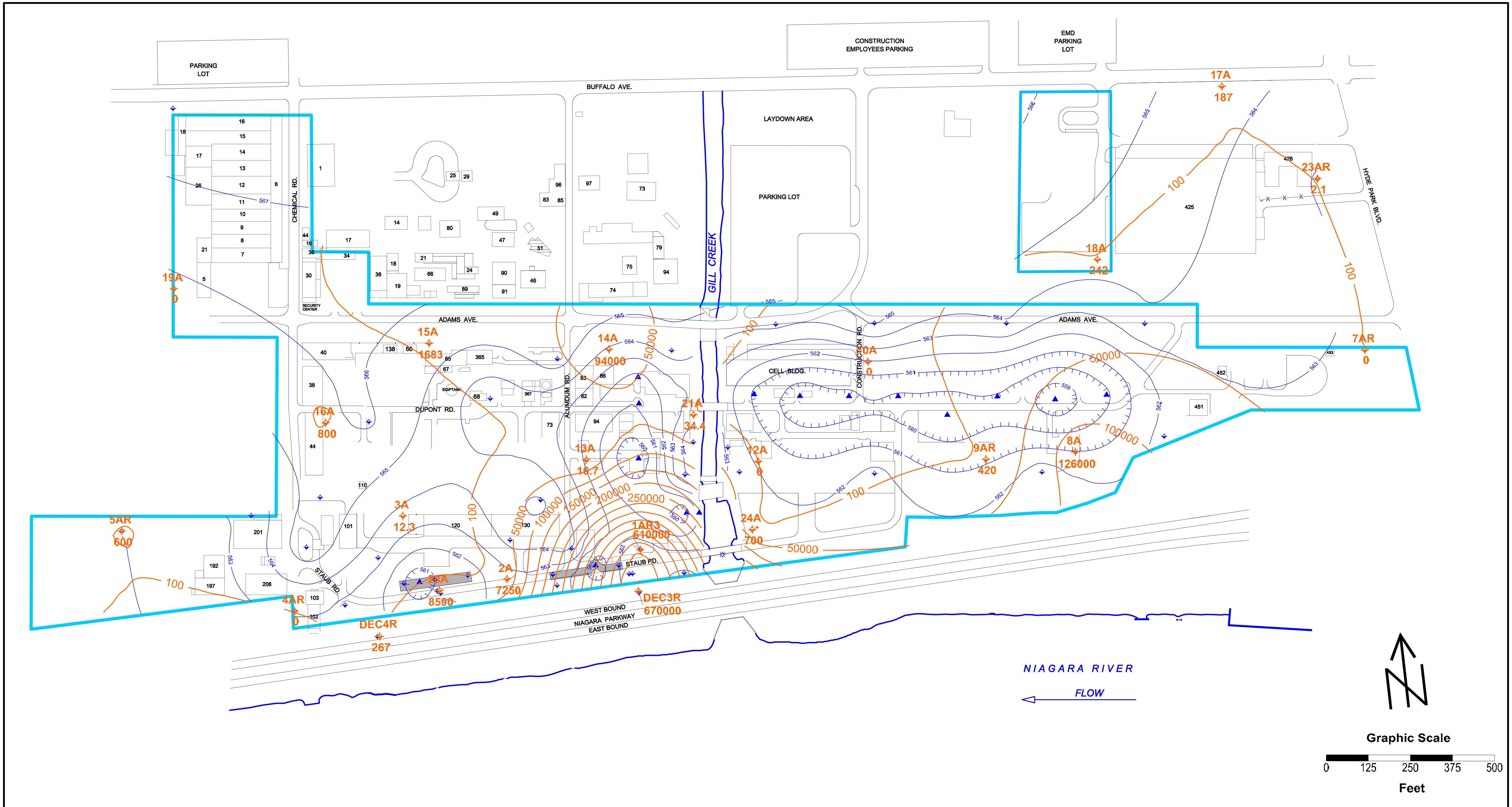


Figure 2-1
Annual Organics Treated as Percent
of Total Removed to Date
8%
7%
6%
5%
4%
3%
2%
1%
0%
Increase in mass removal due to BFBTs
Reduction due to lower uptime
at PW-39 and RTO upgrade
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Removal Rate



PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 2/04/2019
Checked by: JWS	Date: 2/11/2019
Project Manager: EAF	Date: 2/11/2019
Job number: 451477.02024	

LEGEND

- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER
- 563 GROUNDWATER CONTOUR ELEVATION

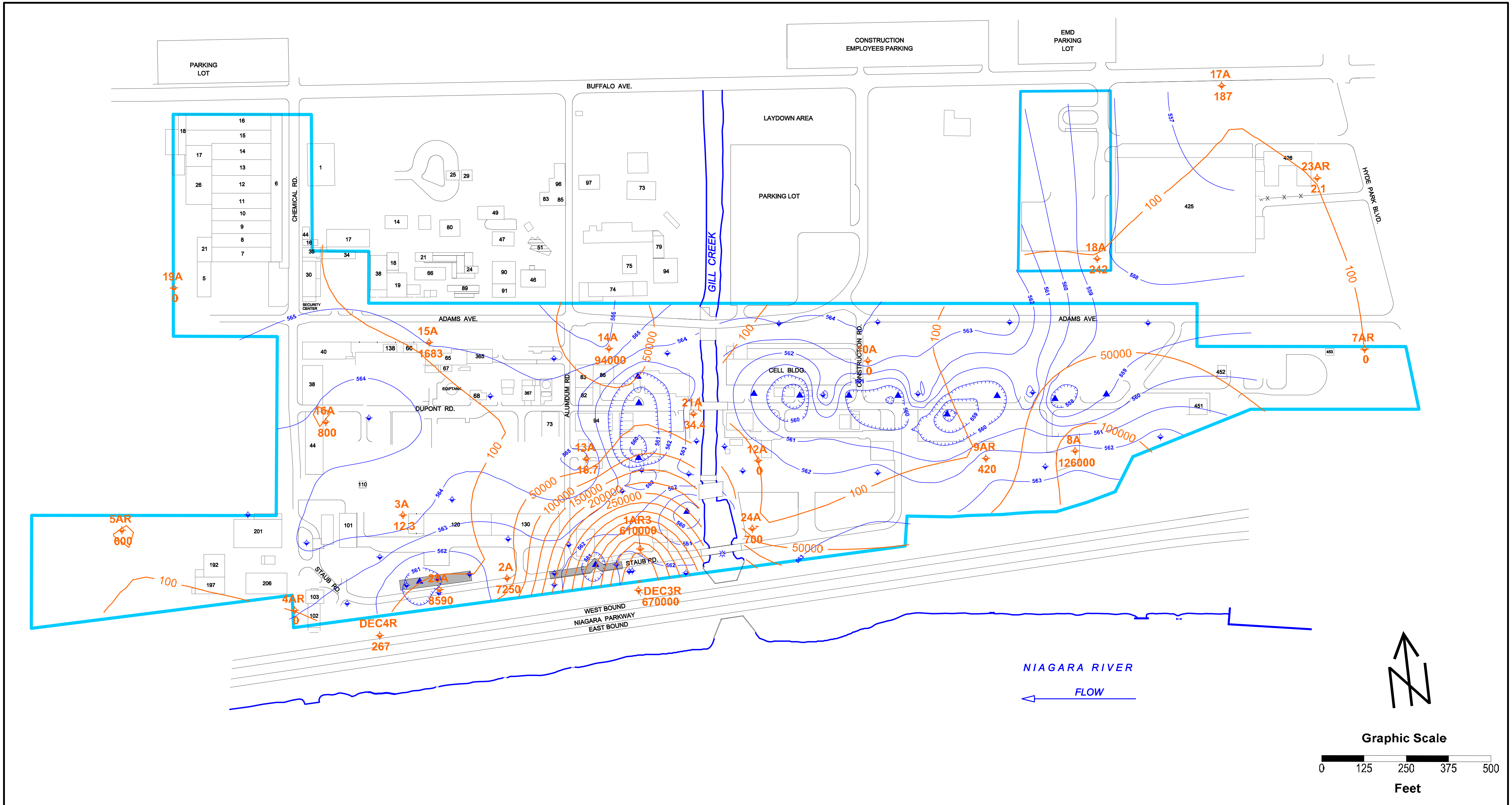
CHEMOURS WELLS

- 1AR3 WELL ID
- WELL/PIEZOMETER - TVOC SAMPLE
- WELL/PIEZOMETER - WATER LEVEL
- PUMPING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION

- BLAST FRACTURED BEDROCK TRENCH
- TVOC ISOCONCENTRATION CONTOUR (ug/L)
- GROUNDWATER CONTOUR DEPRESSION
- 100000 TVOC CONTOUR CONCENTRATION (ug/L)

FIGURE 3-2
COMBINED POTENTIOMETRIC SURFACE MAP AND TOTAL VOLATILE ORGANIC ISOCONCENTRATION MAP
A-ZONE OVERBURDEN - 3Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

//NYBUF03FS01/Dupont$/Niagara/NiaPlant/Hydrogeo/Hydro/GW_contours/2018_Annual Report/2018 Annual TVOC OBPZ New.srf



PARSONS 40 La Riviere Dr, Suite 350 Buffalo, NY 14202 (716) 541-0730	Created by: RBP	Date: 2/05/2019
	Checked by: JWS	Date: 2/11/2019
	Project Manager: EAF	Date: 2/11/2019
	Job number: 451477.02024	

LEGEND

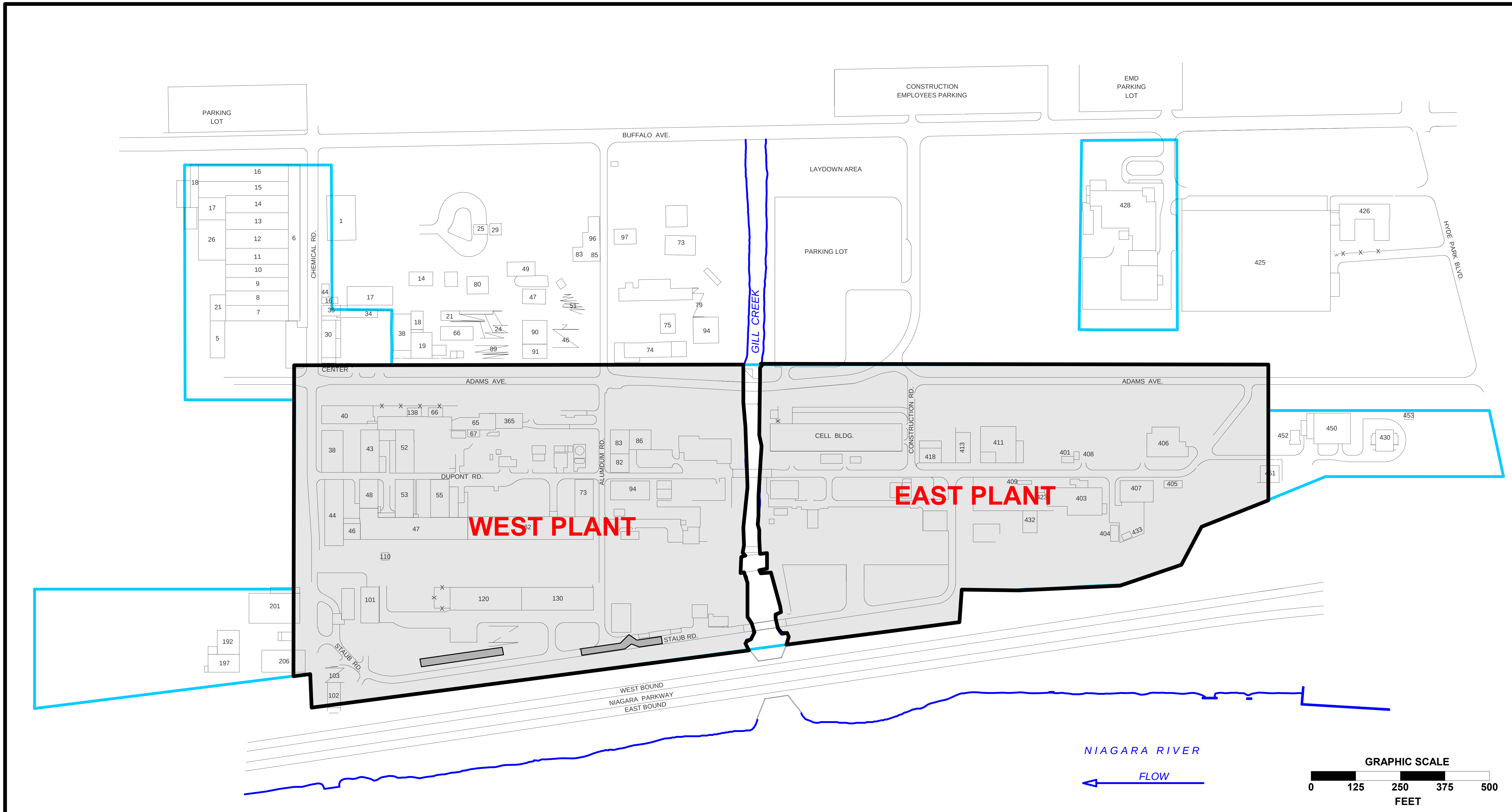
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER
- 563 GROUNDWATER CONTOUR ELEVATION

CHEMOURS WELLS

- 1AR3 WELL ID
- WELL/PIEZOMETER - TVOC SAMPLE
- WELL/PIEZOMETER - WATER LEVEL
- PUMPING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- TVOC ISOCONCENTRATION CONTOUR (ug/L)
- GROUNDWATER CONTOUR DEPRESSION
- 100000 TVOC CONTOUR CONCENTRATION (ug/L)

FIGURE 3-3
COMBINED POTENTIOMETRIC SURFACE MAP AND TOTAL VOLATILE ORGANIC ISOCONCENTRATION MAP
A-ZONE BEDROCK - 3Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018_Annual Report\2018 Annual TVOC BRPZ New.srf



PARSONS

40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

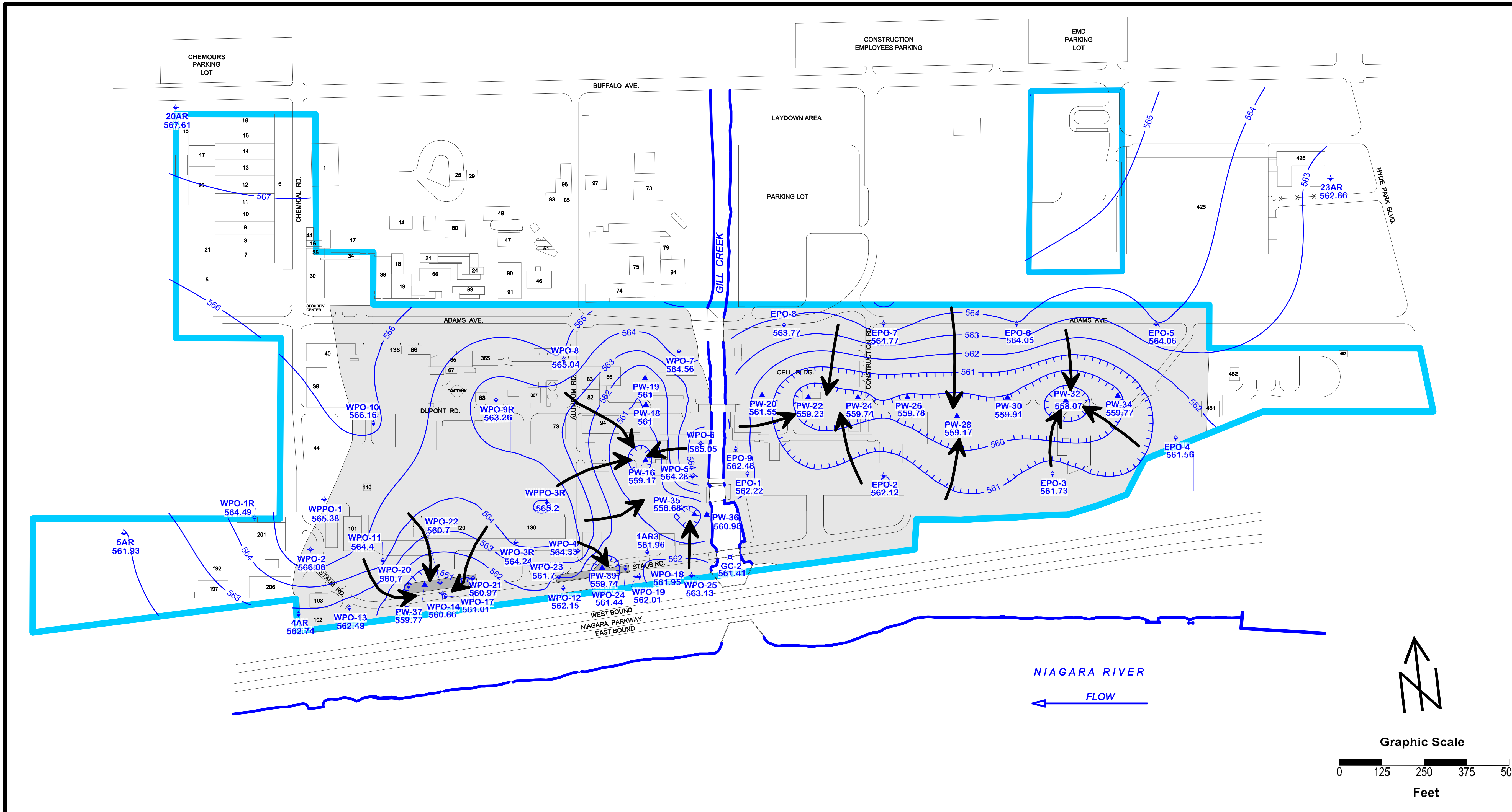
Created by: JWS	Date: 03-04-11
Checked by: EAF	03-07-14
Project Manager: EAF	Date: 03-07-14
	Date:
Job number: 445357.02023	

LEGEND

- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER
- BLAST FRACTURED BEDROCK TRENCH
- AREA OF HYDRAULIC EVALUATION

FIGURE 3-4
Area of Niagara Plant Where Hydraulic Effectiveness Evaluation is Conducted
Chemours Niagara Plant, Niagara Falls, NY

2007-03-01 Basemap.srf



PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 03/26/18
Checked by: JWS	Date: 03/30/18
Project Manager: EAF	Date: 03/30/18
Job number: 450855.02024	

LEGEND

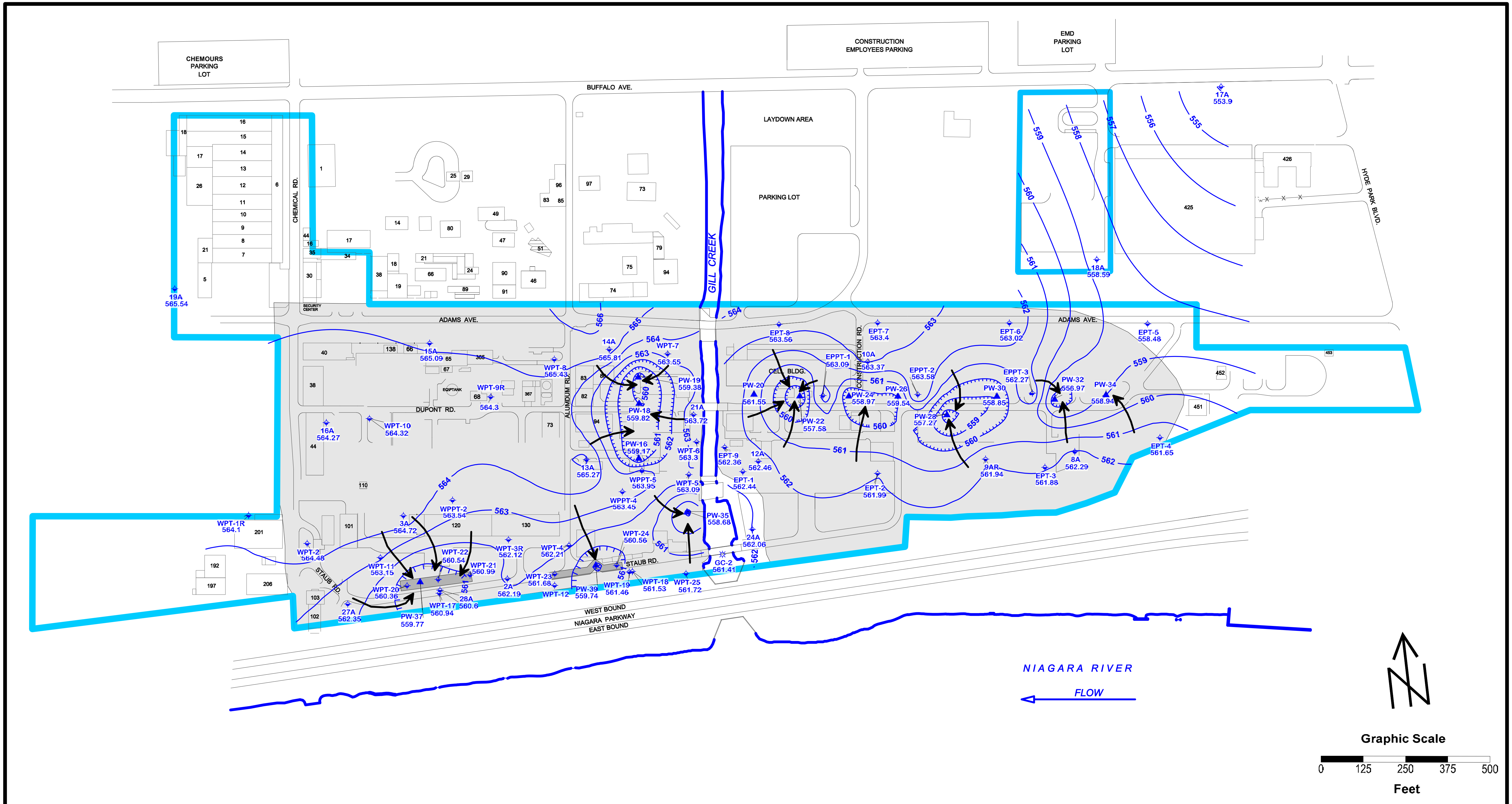
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-5
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE OVERBURDEN - 1Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-03-19 NIA Contour Tool\2018-03-19-OBPZ.srf



PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 03/26/18
Checked by: JWS	Date: 03/30/18
Project Manager: EAF	Date: 03/30/18
Job number: 450855.02024	

LEGEND

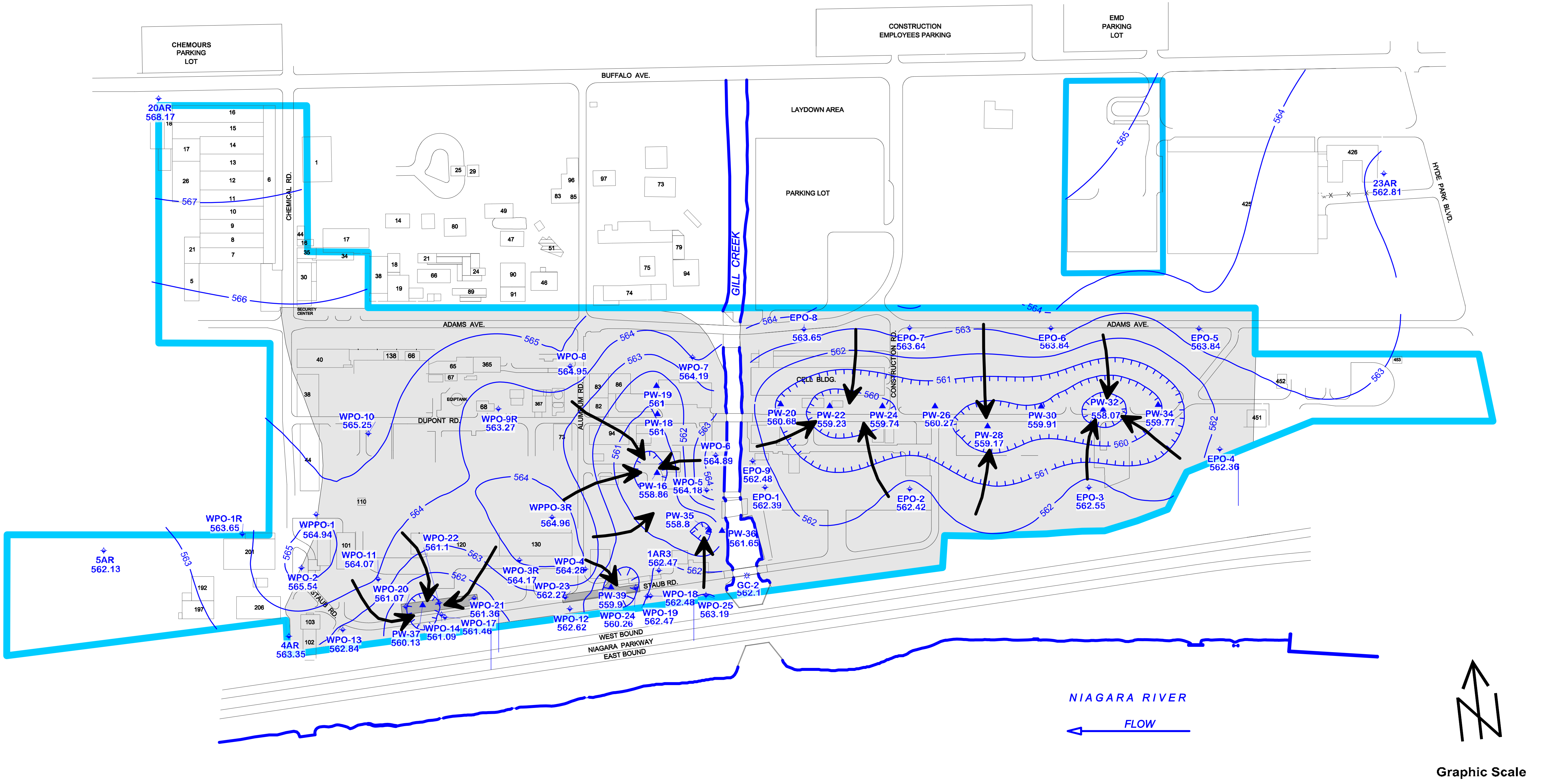
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-6
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE BEDROCK - 1Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

//NYBUF03FS01/Dupont$/Niagara/NiaPlant/Hydrogeo/Hydro/GW_contours/2018-03-19 NIA Contour Tool/2018-03-19-BRPZ.srf



Note:
Hand measured data at PW-39 was anomalous. Experion Data used for water level elevation on 5/30/2018 at 11:00am.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 07/09/18
Checked by: JWS	Date: 07/11/18
Project Manager: EAF	Date: 03/30/18
Job number: 450855.02024	

LEGEND

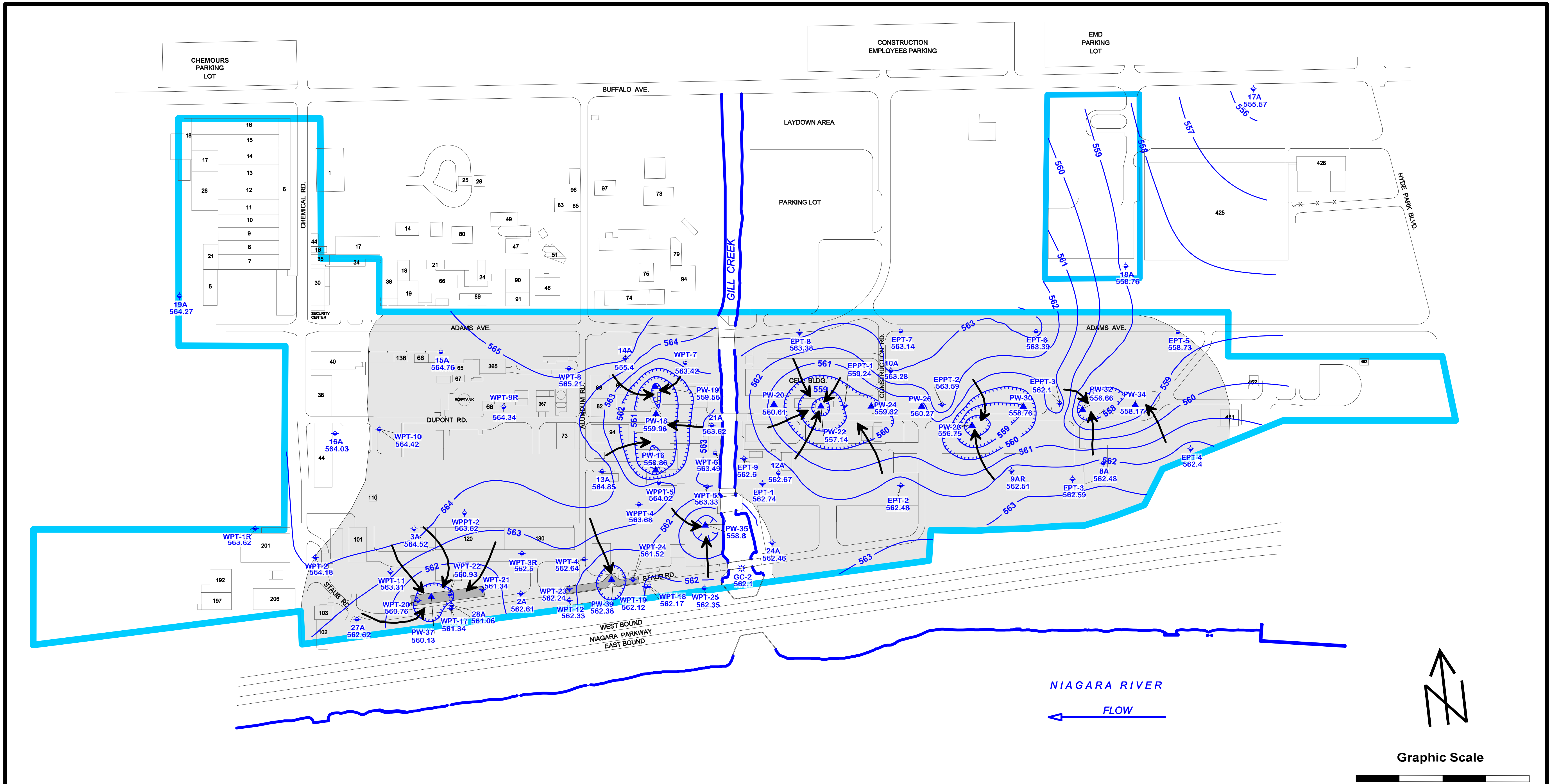
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-7
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE OVERBURDEN - 2Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-05-30 NIA Contour Tool\2018-05-30-OBPZ.srf



Note:
Hand measured data at PW-39 was anomalous. Experion Data used for water level elevation on 5/30/2018 at 11:00am.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 07/09/18
Checked by: JWS	Date: 07/11/18
Project Manager: EAF	Date: 07/11/18
Job number: 450855.02024	

LEGEND

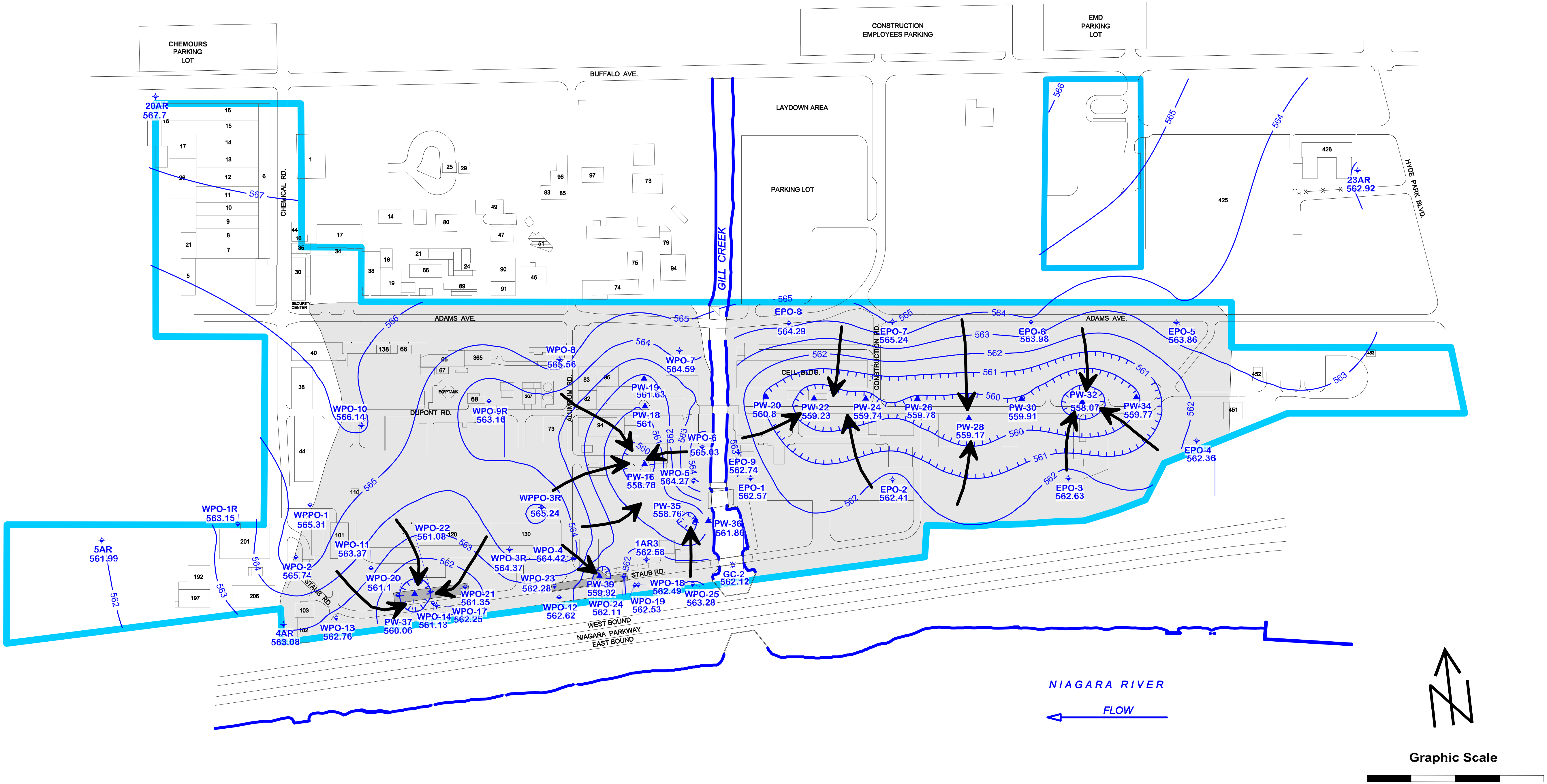
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-8
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE BEDROCK - 2Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-05-30 NIA Contour Tool\2018-05-30-BRPZ.srf



Note:
Hand measured data at PW-39 was anomalous. Experion Data used for water level elevation on 8/23/2018 at 12:00pm.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 10/5/18
Checked by: JWS	Date: 10/10/18
Project Manager: EAF	Date: 10/10/18
Job number: 450855.02024	

LEGEND

BUILDING
ROAD
CHEMOURS PROPERTY BOUNDARY
SURFACE WATER

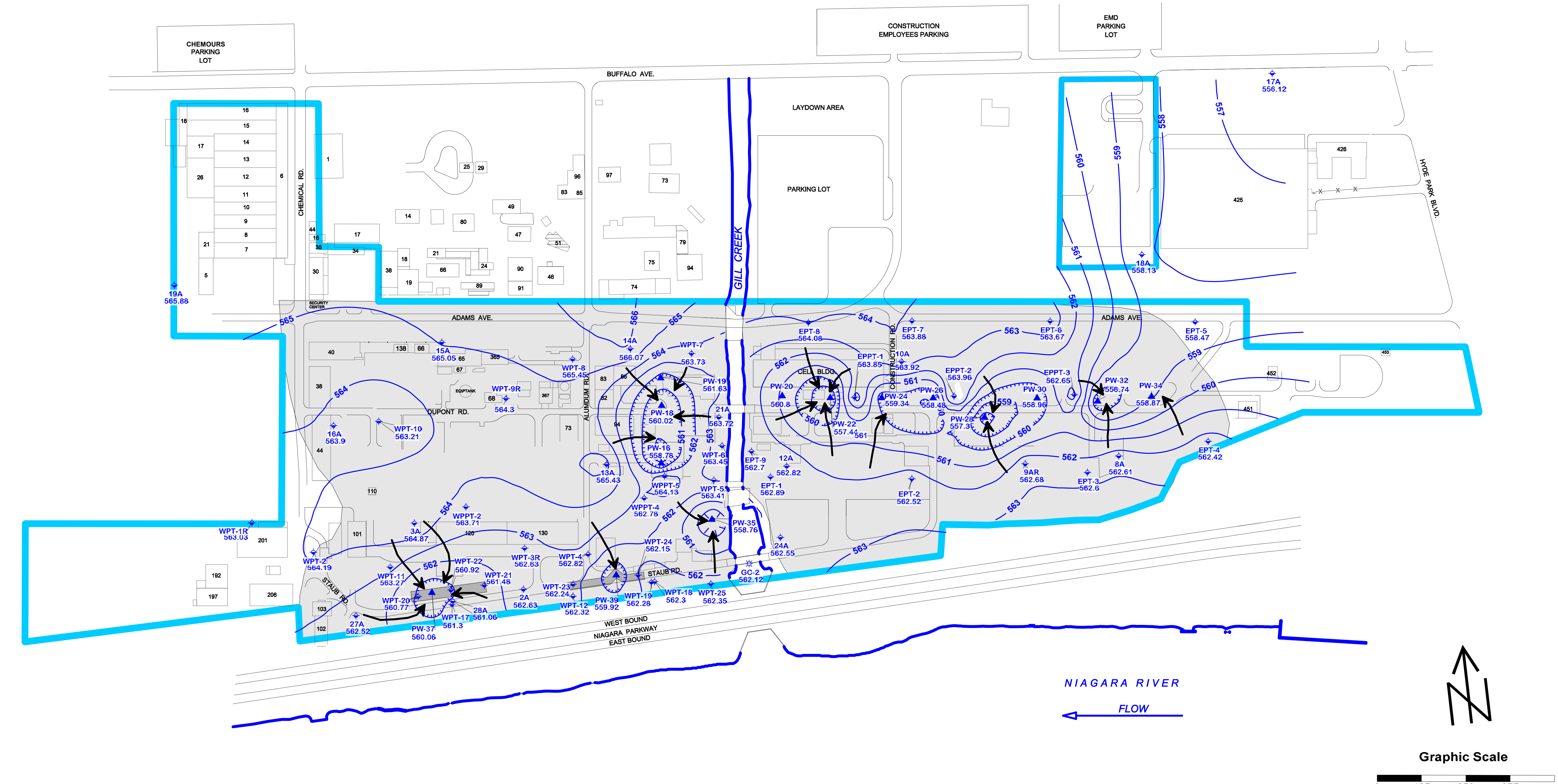
CHEMOURS WELLS

1AR3 WELL ID
PIEZOMETER
PUMPING WELL
MONITORING WELL
UNDERGROUND UTILITY WELL
GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION

BLAST FRACTURED BEDROCK TRENCH
GROUNDWATER CONTOUR
GROUNDWATER CONTOUR DEPRESSION
561 GROUNDWATER CONTOUR ELEVATION

FIGURE 3-9
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE OVERBURDEN - 3Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\DuPont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-08-23 NIA Contour Tool\2018-08-23-OBPZ.srf



Note:
Hand measured data at PW-39 was anomalous. Experion Data used for water level elevation on 8/23/2018 at 12:00pm.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 10/5/18
Checked by: JWS	Date: 10/10/18
Project Manager: EAF	Date: 10/10/18
Job number: 450855.02024	

LEGEND

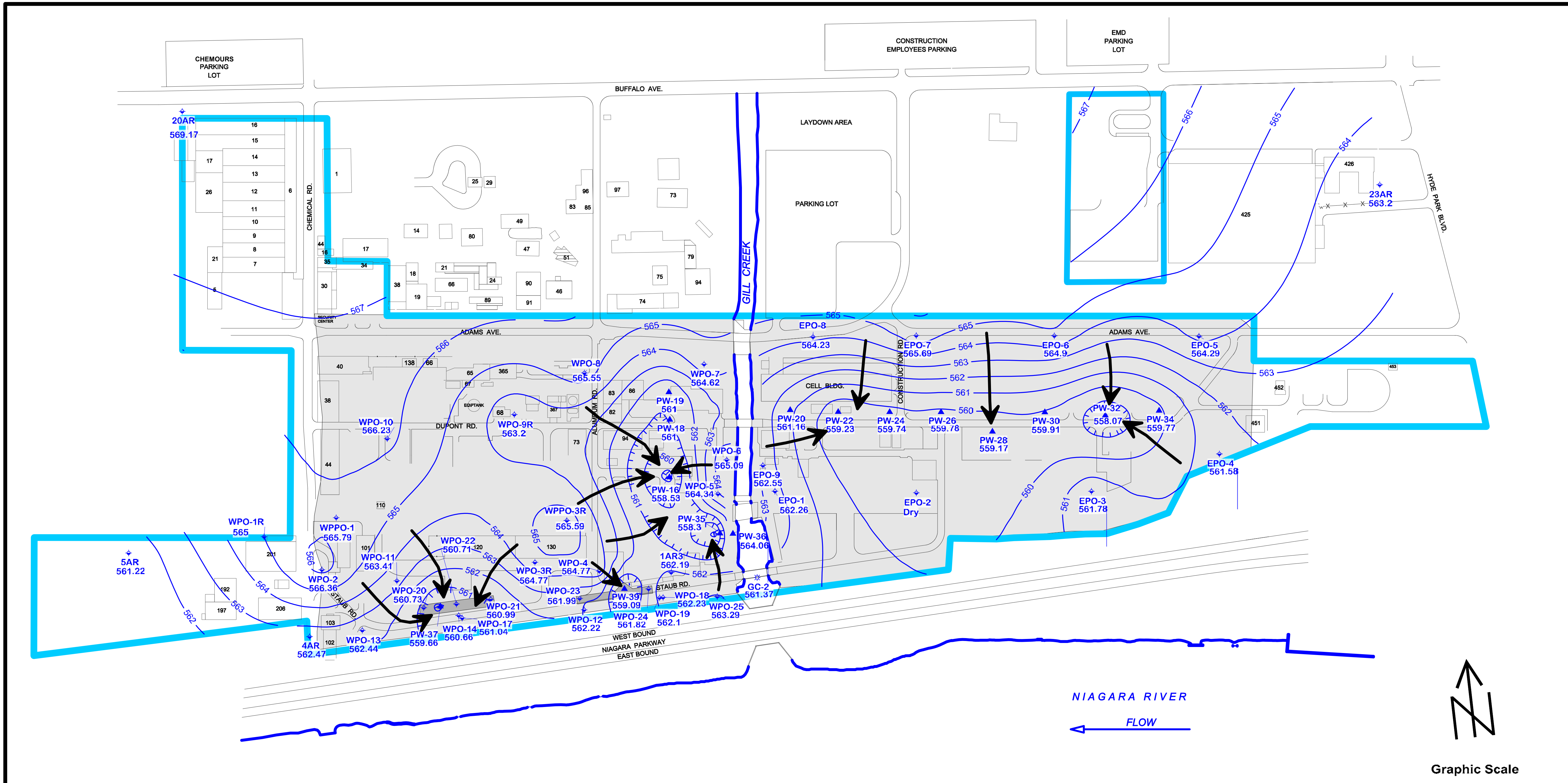
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-10
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE BEDROCK - 3Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-08-23 NIA Contour Tool\2018-08-23-BRPZ.srf



Note:
Experion data recorded the groundwater elevation at PW-36 at 564.20, which confirmed the hand-measured elevation.
Average groundwater elevation for 4Q2018 at PW-36 was 562.40 according to Experion Data.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19

Job number: 451477.02024

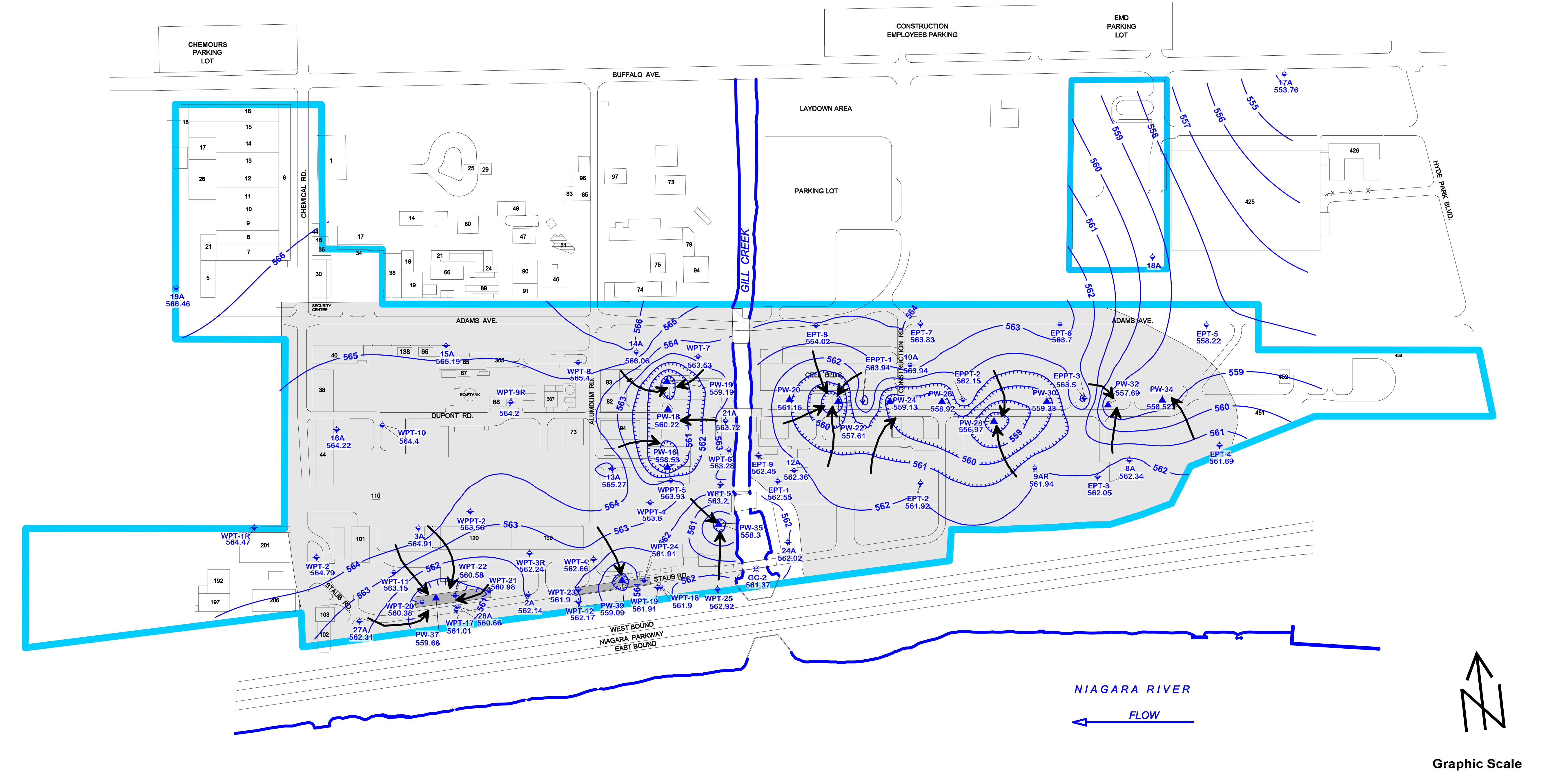
LEGEND
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS
- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION

- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-11
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE OVERBURDEN - 4Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-OBPZ.srf



Note:
Well 18A was not accessible on 12/4/18. Water level measurement for this well was collected on 12/5/18, but was not used to generate the groundwater contours.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND

- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1AR3 — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION
- BLAST FRACTURED BEDROCK TRENCH
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3-12
ESTIMATED AREA OF HYDRAULIC CONTROL
A-ZONE BEDROCK - 4Q2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-BRPZ.srf

ANNUAL REPORT
APPENDIX A
2018 ANALYTICAL RESULTS

APPENDIX A
2018 Analytical Results - Monitoring Wells

		Location	DEC-5	DEC-3R	DEC-3R	DEC-4R	MW-10A	MW-10D	MW-10F	MW-12A	MW-12B	MW-12C/CD	MW-13A	MW-14A	MW-14B
		Date	09/20/2018	09/20/2018	09/20/2018	09/20/2018	09/13/2018	09/13/2018	09/13/2018	09/11/2018	09/11/2018	09/11/2018	09/18/2018	09/13/2018	09/13/2018
Method	Parameter Name	Units	FS	FS	DUP	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	Clear	Clear	Clear	Clear	Clear	Clear	Clear	None	None	None	Clear	Clear	Clear
	ODOR	NONE	Slight	Strong	Strong	Strong	Slight	Slight	Slight	None	None	None	Slight	Slight	Slight
	OXIDATION REDUCTION POTENTIAL	MV	8	49	49	11	-80	26	10	33	90	36	11	12	-7
	PH	STD UNITS	8.3	6.83	6.83	8.35	8.13	8.17	8.63	6.67	7.06	7.26	6.89	7.19	7.47
	SPECIFIC CONDUCTANCE	UMHOS/CM	430	12600	12600	506	1066	3610	640	39330	50840	3690	6044	2643	5125
	TEMPERATURE	DEGREES C	20.3	17.9	17.9	20.1	22.5	20.3	20.3	20.4	20.4	18	22.3	22.6	20.2
	TURBIDITY QUANTITATIVE	NTU	33.5	4.96	4.96	27.8	12.6	16.9	1.3	1	4.3	1.8	75.4	2.1	11.2
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	13000
8260C	1,1,2-Trichloroethane	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,1-Dichloroethane	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,1-Dichloroethene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,2-Dichlorobenzene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,4-Dichlorobenzene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	1,4-Dichlorobutane	UG/L	<1	<50000	<50000	<14	<1	<1000	25	<1	<50	<330	<1	<2500	<10000
8260C	Benzene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	Carbon Tetrachloride	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	Chlorobenzene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	Chloroform	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	17000
8260C	cis-1,2 Dichloroethene	UG/L	<1	100000	120000	180	<1	24000	<5	<1	310	6500	4.1	14000	31000
8260C	Methyl Chloride	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	Methylene Chloride	UG/L	<5	<250000	<250000	<71	<5	<5000	<25	<5	<250	<1700	<5	<13000	<50000
8260C	Tetrachloroethene	UG/L	<1	<50000	<50000	21	<1	<1000	50	<1	690	4000	<1	51000	55000
8260C	Tetrahydrothiophene	UG/L	<2	<100000	<100000	<29	<2	<2000	130	<2	<100	<670	<2	<5000	<20000
8260C	Toluene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	trans-1,2-Dichloroethene	UG/L	<1	<50000	<50000	<14	<1	<1000	<5	<1	<50	<330	<1	<2500	<10000
8260C	Trichloroethene	UG/L	<1	570000	630000	66	<1	9700	48	<1	1000	<330	11	29000	260000
8260C	Vinyl Chloride	UG/L	<1	<50000	<50000	<14	<1	1100	<5	<1	88	<330	1.6	<2500	<10000
	Total VOCs	UG/L	0	670000	750000	267	0	34800	253	0	2088	10500	16.7	94000	376000
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	--	190	<1	--	5.6	86	--	--	--
RSK-175	Ethene	UG/L	--	--	--	--	--	200	5.9	--	270	170	--	--	--
RSK-175	Methane	UG/L	--	--	--	--	--	220	52	--	1000	100	--	--	--
RSK-175	Propane	UG/L	--	--	--	--	--	9.1	<1	--	<1	9.6	--	--	--
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	110000	71000	--	190000	<5000	--	--	--
300	Chloride	UG/L	--	--	--	--	--	1200000	110000	--	32000000	1500000	--	--	--
300	Nitrate	UG/L	--	--	--	--	--	<500	<100	--	<1000	<500	--	--	--
300	Sulfate	UG/L	--	--	--	--	--	1700000	71000	--	3700000	<5000	--	--	--
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	<1000	<1000	--	<1000	<1000	--	--	--
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	1600	7700	--	2600	2600	--	--	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	<110	<5.7	--	--	--	--	--	<5.7	<5.7	--	<71	<71
8270D	Hexachlorobutadiene	UG/L	--	<190	<9.5	--	--	--	--	--	<9.5	11	--	280	120
8270D	Hexachloroethane	UG/L	--	<190	<9.5	--	--	--	--	--	<9.5	<9.5	--	230	330
8270D	Naphthalene	UG/L	--	<190	<9.5	--	--	--	--	--	<9.5	<9.5	--	<120	<120
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	12	7.5	<0.24	--	<2.4	--	--	11	7.1	--	0.96	--
8081B	beta-BHC	UG/L	--	<4.8	<4.8	0.47	--	<2.4	--	--	<0.95	<0.95	--	1.3	--
8081B	delta-BHC	UG/L	--	<4.8	<4.8	<0.24	--	<2.4	--	--	<0.95	<9.5	--	<0.95	--
8081B	Lindane	UG/L	--	<4.8	<4.8	<0.24	--	<2.4	--	--	1.4	<0.95	--	<0.95	--
8082A	PCB 1016	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
8082A	PCB 1221	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
8082A	PCB 1232	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
8082A	PCB 1242	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	2.2	<1.2	--	<9.5	--
8082A	PCB 1248	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
8082A	PCB 1254	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
8082A	PCB 1260	UG/L	--	<9.5	<0.95	<0.095	--	<0.48	--	--	<0.48	<1.2	--	<9.5	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	<200	<200	--	<200	<200	--	--	--
9012B	Cyanide	UG/L	<10	--	--	10	--	32	130	260	640	100	370	29	180
6010C	Iron	UG/L	--	--	--	--	--	26000	31000	--	85000	<200 UJ	--	--	--
6010C	Iron, dissolved	UG/L	--	--	--	--	--	2100	<200	--	3200	7200	--	--	--

< Non detect at stated reporting limit. J Estimated concentration.

B Not detected substantially above the level reported in the laboratory or field blanks.

UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

Method	Parameter Name	Location	MW-14D	MW-15A	MW-15CD	MW-15D	MW-15F	MW-16A	MW-16B	MW-17A	MW-17B	MW-17F	MW-18A	MW-18C	MW-18D
		Date	09/13/2018	09/13/2018	09/13/2018	09/13/2018	09/13/2018	09/11/2018	09/11/2018	08/31/2018	08/31/2018	9/7/2018 & 9/11/2018	08/28/2018	08/28/2018	08/28/2018
Method	Parameter Name	Units	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	Clear	Clear	Clear	Clear	Clear	Brown	Brown	None	Yellowish	None	Clear	Clear	Clear
	ODOR	NONE	Slight	Slight	Slight	Slight	Slight	None	None	None	--	None	Slight	Slight	Slight
	OXIDATION REDUCTION POTENTIAL	MV	33	103	117	102	162	254	174	30	29	32	-124	-81	-110
	PH	STD UNITS	6.76	8.01	7.8	8.27	8.48	11.06	9.61	6.23	6.62	6.82	9.82	7.94	8.89
	SPECIFIC CONDUCTANCE	UMHOS/CM	5443	1776	1950	647	861	5642	2555	2701	1932	2504	1335	1342	270
	TEMPERATURE	DEGREES C	19.7	22.9	19.7	20.6	20	17.32	17.3	17.6	16	18.6	19.01	17.6	16.8
	TURBIDITY QUANTITATIVE	NTU	2.1	8.91	27	3.9	4.4	4.9	0.8	19.8	18.1	12.4	5.24	4.9	4.3
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	1,1,2,2-Tetrachloroethane	UG/L	<500	<40	19000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	1,1,2-Trichloroethane	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	1,1-Dichloroethane	UG/L	<500	<40	<5000	<100	<5	<33	23	<10	<1	<100	<10	<50	<1.7
8260C	1,1-Dichloroethene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	1,2-Dichlorobenzene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	2600	23	<50	<1.7
8260C	1,4-Dichlorobenzene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	1.2	1000	39	<50	<1.7
8260C	1,4-Dichlorobutane	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	Benzene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	330	13	<50	<1.7
8260C	Carbon Tetrachloride	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	Chlorobenzene	UG/L	<500	<40	<5000	<100	<5	<33	<10	17	4.3	2300	47	<50	<1.7
8260C	Chloroform	UG/L	<500	790	48000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	cis-1,2 Dichloroethene	UG/L	16000	370	20000	1400	25	180	150	<10	<1	150	<10	<50	27
8260C	Methyl Chloride	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	Methylene Chloride	UG/L	<2500	<200	30000	<500	<25	<170	<50	<50	<5	<500	<50	<250	<8.4
8260C	Tetrachloroethene	UG/L	<500	73	51000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	Tetrahydrothiophene	UG/L	<1000	<80	<10000	<200	<10	<67	<20	170	34	<200	120	850	<3.3
8260C	Toluene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	trans-1,2-Dichloroethene	UG/L	<500	<40	<5000	<100	<5	<33	<10	<10	<1	<100	<10	<50	<1.7
8260C	Trichloroethene	UG/L	<500	290	200000	<100	<5	620	<10	<10	<1	<100	<10	<50	<1.7
8260C	Vinyl Chloride	UG/L	6000	160	<5000	<100	96	<33	<10	<10	<1	650	<10	110	2.6
	Total VOCs	UG/L	22000	1683	368000	1400	121	800	173	187	39.5	7030	242	960	29.6
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	--	--	--	--	6.7	26	--	4.1	<1
RSK-175	Ethene	UG/L	--	--	--	--	--	--	--	--	<1	220	--	45	<1
RSK-175	Methane	UG/L	--	--	--	--	--	--	--	--	460	890	--	150	<1
RSK-175	Propane	UG/L	--	--	--	--	--	--	--	--	<1	<1	--	<1	<1
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	--	--	--	73000	24000	--	13000	22000
300	Chloride	UG/L	--	--	--	--	--	--	--	--	490000	690000	--	360000	28000
300	Nitrate	UG/L	--	--	--	--	--	--	--	--	<100	<500 UJ	--	<100	<100
300	Sulfate	UG/L	--	--	--	--	--	--	--	--	450000	1500000	--	64000	34000
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	--	--	--	<1000	<1000	--	<1000	<1000
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	--	--	--	6900	<1000	--	1800	<1000
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	<29	--	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	<48	--	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	<48	--	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	140	--	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
9012B	Cyanide	UG/L	11	65	<10	<10	<10	140	10000	72	22	<10	180	200	<10
6010C	Iron	UG/L	--	--	--	--	--	--	--	--	14000	3900	--	12000	5700
6010C	Iron, dissolved	UG/L	--	--	--	--	--	--	--	--	<200 UJ	35000	--	<200	<200

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

		Location	MW-19A	MW-19B	MW-19CD1	MW-19D	MW-1AR3	MW-1BR	MW-1C	MW-1D	MW-1F	MW-20AR	MW-20B	MW-21A	MW-22B
		Date	09/11/2018	09/11/2018	09/11/2018	09/11/2018	09/18/2018	09/18/2018	09/18/2018	09/18/2018	09/18/2018	09/27/2018	09/27/2018	09/18/2018	09/07/2018
Method	Parameter Name	Units	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	None	None	None	None	Clear	Clear	Clear	Clear	Clear	Clear	None	Clear	None
	ODOR	NONE	None	None	None	None	Strong	None	None	None	None	Slight	None	SLIGHT	None
	OXIDATION REDUCTION POTENTIAL	MV	63	81	74	128	100	96	20	37	-291	27	101	62	-34
	PH	STD UNITS	7.47	7.14	6.61	6.87	6.08	8.06	7.36	9.35	9.6	8.17	8.6	6.27	8.4
	SPECIFIC CONDUCTANCE	UMHOS/CM	1632	717	862	170	13250	4466	362	1250	263.1	1856	5807	25930	1667
	TEMPERATURE	DEGREES C	18.3	17.3	17.7	16.6	22.2	21.6	22.1	20.1	20.5	19.6	15.1	21	18.6
	TURBIDITY QUANTITATIVE	NTU	6	2.6	5	3.3	6.14	4.69	5.48	3.48	2.1	27.4	3.8	8.3	3.1
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1	<1	<100	<1	<50000	<10000	65	<50	<5	<1	<200	<1	<1
8260C	1,1,2-Trichloroethane	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,1-Dichloroethane	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,1-Dichloroethene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,2-Dichlorobenzene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,4-Dichlorobenzene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	1,4-Dichlorobutane	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	Benzene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	Carbon Tetrachloride	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	Chlorobenzene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	Chloroform	UG/L	<1	<1	1300	<1	<50000	<10000	<50	<50	18	<1	<200	<1	<1
8260C	cis-1,2 Dichloroethene	UG/L	<1	1.2	800	<1	110000	31000	780	760	8.9	<1	2300	6.7	<1
8260C	Methyl Chloride	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	Methylene Chloride	UG/L	<5	<5	<500	<5	390000	<50000	<250	<250	<25	<5	<1000	<5	<5
8260C	Tetrachloroethene	UG/L	<1	1.5	840	<1	<50000	16000	350	130	33	<1	<200	1.3	2.8
8260C	Tetrahydrothiophene	UG/L	<2	<2	<200	<2	<100000	<20000	<100	<100	<10	<2	<400	<2	<2
8260C	Toluene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	<1	<1
8260C	trans-1,2-Dichloroethene	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	<5	<1	<200	6.8	<1
8260C	Trichloroethene	UG/L	<1	3.4	1900	<1	110000	96000	590	1100	84	3.5	<200	5.6	5.4
8260C	Vinyl Chloride	UG/L	<1	<1	<100	<1	<50000	<10000	<50	<50	5.4	<1	<200	14	<1
	Total VOCs	UG/L	0	6.1	4840	0	610000	143000	1785	1990	149.3	3.5	2300	34.4	8.2
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	17	--
RSK-175	Ethene	UG/L	--	--	--	--	--	--	--	--	--	--	--	150	--
RSK-175	Methane	UG/L	--	--	--	--	--	--	--	--	--	--	--	5500	--
RSK-175	Propane	UG/L	--	--	--	--	--	--	--	--	--	--	--	<1	--
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	--	--	--	--	--	--	25000	--
300	Chloride	UG/L	--	--	--	--	--	--	--	--	--	--	--	13000000	--
300	Nitrate	UG/L	--	--	--	--	--	--	--	--	--	--	--	<1000	--
300	Sulfate	UG/L	--	--	--	--	--	--	--	--	--	--	--	530000	--
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	--	--	--	--	--	--	2000	--
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	--	--	--	--	--	--	1500	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	--	<5.7	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	--	<9.5	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	--	<9.5	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	--	<9.5	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	74	2.7	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	19	<0.95	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	<4.8	1.3	--	--	--	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	49	1.2	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	<0.48	<0.95	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	--	960	--
9012B	Cyanide	UG/L	48	--	<10	<10	52	230	89	<10	15	<10	17	1600	--
6010C	Iron	UG/L	--	--	--	--	--	--	--	--	--	--	--	20000	--
6010C	Iron, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	--	270	--

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

Method	Parameter Name	Location	MW-22C	MW-22D	MW-22F	MW-23AR	MW-23B	MW-23C	MW-23D	MW-23F	MW-24A	MW-24B	MW-24B	MW-25B	MW-25B
		Date	09/07/2018	9/7/2018 & 9/11/2018	09/07/2018	08/28/2018	08/28/2018	08/28/2018	08/28/2018	08/28/2018	10/4/2018 & 10/12/2018	08/31/2018	08/31/2018	9/26/2018 & 10/2/2018	9/26/2018 & 10/2/2018
		Units	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	DUP	FS	DUP
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	10.48	--	--	--	--
	COLOR	NONE	None	None	Brown	Clear	Clear	Clear	Clear	Clear	Clear	None	None	Clear	Clear
	ODOR	NONE	None	None	None	NONE	NONE	Slight	NONE	Slight	Slight	None	None	Slight	Slight
	OXIDATION REDUCTION POTENTIAL	MV	-104	54	-164	--	--	-61	--	-92	-182	9	9	6	6
	PH	STD UNITS	9.4	9.31	7.44	--	--	7.96	--	6.78	7.48	6.5	6.5	7.7	7.7
	SPECIFIC CONDUCTANCE	UMHOS/CM	1117	1132	1816	--	--	694	--	1851	3156	42	42	850	850
	TEMPERATURE	DEGREES C	17.8	17.6	19.8	--	--	18.52	--	19.3	16.72	19.6	19.6	18.9	18.9
	TURBIDITY QUANTITATIVE	NTU	8.5	2.2	41.6	--	--	5.41	--	17	3.2	17.9	17.9	1.9	1.9
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	1,1,2-Trichloroethane	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	1,1-Dichloroethane	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	1,1-Dichloroethene	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	1,2-Dichlorobenzene	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	58	64
8260C	1,4-Dichlorobenzene	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	110	120
8260C	1,4-Dichlorobutane	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	Benzene	UG/L	<1	<33	<5	<1	<2	3.2	<1	<1	<33	<200	<500	<33	<20
8260C	Carbon Tetrachloride	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	Chlorobenzene	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	540	590
8260C	Chloroform	UG/L	7.3	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	cis-1,2 Dichloroethene	UG/L	34	130	8.8	2.1	8.6	1.1	<1	1.2	70	6600	8500	<33	<20
8260C	Methyl Chloride	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	Methylene Chloride	UG/L	<5	<170	<25	<5	<10	<5	<5	<5	<170	<1000	<2500	<170	<100
8260C	Tetrachloroethene	UG/L	1	1000	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	Tetrahydrothiophene	UG/L	<2	<67	<10	<2	31	2 B	<2	6.4 B	<67	<400	<1000	140	170
8260C	Toluene	UG/L	<1	<33	<5	<1	<2	<1	<1	<1	<33	<200	<500	<33	<20
8260C	trans-1,2-Dichloroethene	UG/L	<1	<33	<5	<1	<2	<1	<1	1.4	230	<200	<500	<33	<20
8260C	Trichloroethene	UG/L	12	540	<5	<1	<2	<1	<1	3.2	<33	<200	<500	<33	<20
8260C	Vinyl Chloride	UG/L	13	<33	77	<1	4.4	1.7	<1	3	400	640	900	<33	<20
	Total VOCs	UG/L	67.3	1670	85.8	2.1	44	6	0	8.8	700	7240	9400	848	944
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	<1	--	<1	3.4	--	12	10	4.6	4.3
RSK-175	Ethene	UG/L	--	--	--	--	2	--	<1	18	--	350 J	120 J	<1	<1
RSK-175	Methane	UG/L	--	--	--	--	39	--	7.1	73	--	150 J	51 J	110	95
RSK-175	Propane	UG/L	--	--	--	--	<1	--	<1	<1	--	<1	<1	<1	<1
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	120000	--	63000	79000	--	340000	330000	110000	110000
300	Chloride	UG/L	--	--	--	--	30000	--	14000	180000	--	22000000	21000000	78000	73000
300	Nitrate	UG/L	--	--	--	--	<100	--	<100	<100	--	<5000	<5000 UJ	--	<100
300	Sulfate	UG/L	--	--	--	--	70000	--	<1000	520000	--	1400000	1300000	110000 J	160000 J
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	<1000	--	<1000	<1000	--	4900	3900	--	<1000
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	1300	--	<1000	<1000	--	1000	1200	1400	1600
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	<5.7	--	--	--	--	--	--	<5.7	<57	<1100	--	--
8270D	Hexachlorobutadiene	UG/L	--	<9.5	--	--	--	--	--	--	<9.5	<95	5300	--	--
8270D	Hexachloroethane	UG/L	--	<9.5	--	--	--	--	--	--	<9.5	<95	7900	--	--
8270D	Naphthalene	UG/L	--	<9.5	--	--	--	--	--	--	<9.5	<95	<1900	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	<0.24	50	87	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	<0.24	33	40	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	<0.24	<24	<24	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	<0.24	<24	<24	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	<0.096	<48	<95	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	<0.096	<48	<95	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	<0.096	<48	<95	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	0.19	<48	<95	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	<0.096	300	1800	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	<0.096	<48	<95	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	<0.096	<48	<95	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	200	--	--
9012B	Cyanide	UG/L	<10	<10	<10	--	<10	--	<10	<10	160	5600	5000	25 J	51 J
6010C	Iron	UG/L	--	--	--	--	4700	--	4500	31000	--	32000	21000	--	--
6010C	Iron, dissolved	UG/L	--	--	--	--	<200	--	<200	<200	--	1900	2100	<200	470

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

Method	Parameter Name	Location	MW-25C/CD	MW-25D	MW-25F	MW-26CD	MW-27A	MW-28A	MW-29B	MW-2A	MW-2B	MW-2C	MW-30B	MW-3A	MW-3B
		Date	09/26/2018	09/26/2018	09/26/2018	09/20/2018	9/11/2018 & 10/3/2018	09/27/2018	09/27/2018	09/20/2018	09/20/2018	09/20/2018	09/26/2018	09/18/2018	09/18/2018
		Units	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	Clear	Clear	--	Clear	None	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
	ODOR	NONE	Slight	Slight	Slight	None	None	Slight	Slight	None	Mild	Strong	Slight	Slight	Slight
	OXIDATION REDUCTION POTENTIAL	MV	13	52	93	52	-42	61	24.5	37	6	92	28	46	11
	PH	STD UNITS	6.65	7.09	6.53	7.28	7.76	7.15	6.68	7.32	7.16	6.77	7.1	7.28	7.44
	SPECIFIC CONDUCTANCE	UMHOS/CM	4046	769	241	215	2523	1148	3150	2823	3303	6805	2370	747	223
	TEMPERATURE	DEGREES C	18.7	19.2	18.4	17.4	18.7	18.1	17.1	18.8	18.6	16.7	19.4	21.2	20.5
	TURBIDITY QUANTITATIVE	NTU	15.8	23.5	10.4	4.4	4.4	4.3	24.5	3.3	6.1	1.4	5.47	1.8	--
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	1,1,2,2-Tetrachloroethane	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	1,1,2-Trichloroethane	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	1,1-Dichloroethane	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	1,1-Dichloroethene	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	1,2-Dichlorobenzene	UG/L	<50	<50	<6.7	<40	<1	<170	7.6	<200	<1000	<10000	<2500	<1	<40
8260C	1,4-Dichlorobenzene	UG/L	<50	<50	<6.7	<40	<1	<170	83	<200	<1000	<10000	<2500	<1	<40
8260C	1,4-Dichlorobutane	UG/L	<50	<50	<6.7	<40	<1	<170	8.2	<200	<1000	<10000	<2500	<1	<40
8260C	Benzene	UG/L	210	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	Carbon Tetrachloride	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	Chlorobenzene	UG/L	<50	<50	<6.7	<40	<1	<170	84	<200	<1000	<10000	<2500	<1	<40
8260C	Chloroform	UG/L	<50	<50	<6.7	56	<1	<170	<5	420	<1000	<10000	<2500	<1	230
8260C	cis-1,2 Dichloroethene	UG/L	<50	1400	31	220	<1	3400	<5	3100	22000	200000	<2500	7.7	76
8260C	Methyl Chloride	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	Methylene Chloride	UG/L	<250	<250	<33	<200	<5	<830	<25	<1000	<5000	<50000	<13000	<5	<200
8260C	Tetrachloroethene	UG/L	<50	<50	<6.7	850	<1	1900	<5	<200	6500	13000	<2500	<1	95
8260C	Tetrahydrothiophene	UG/L	1100	<100	<13	<80	<2	<330	19	<400	<2000	<20000	57000	<2	<80
8260C	Toluene	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	trans-1,2-Dichloroethene	UG/L	<50	<50	<6.7	<40	<1	<170	<5	<200	<1000	<10000	<2500	<1	<40
8260C	Trichloroethene	UG/L	<50	<50	<6.7	420	<1	2600	<5	630	24000	<10000	<2500	<1	650
8260C	Vinyl Chloride	UG/L	<50	240	190	<40	<1	690	5.3	3100	2200	<10000	<2500	4.6	<40
	Total VOCs	UG/L	1310	1640	221	1546	0	8590	207.1	7250	54700	213000	57000	12.3	1051
	MNA Parameters														
RSK-175	Ethane	UG/L	11	9.1	20	--	74	--	<1	--	--	--	75	--	--
RSK-175	Ethene	UG/L	280	7.3	25	--	<1	--	20	--	--	--	140	--	--
RSK-175	Methane	UG/L	1100	32	420	--	930	--	170	--	--	--	2600	--	--
RSK-175	Propane	UG/L	2.2	4.8	17	--	1.8	--	<1	--	--	--	3.9	--	--
2320 B-1997	Alkalinity, Total	UG/L	290000	17000	5000	--	170000	--	220000	--	--	--	230000	--	--
300	Chloride	UG/L	880000	160000	770000	--	750000	--	1000000	--	--	--	480000	--	--
300	Nitrate	UG/L	<500	<100	<100	--	<100	--	<500	--	--	--	<100	--	--
300	Sulfate	UG/L	2300000	93000	63000	--	11000	--	500000	--	--	--	470000	--	--
4500-S2 F-2000	Sulfide	UG/L	<1000	<1000	<1000	--	2200	--	<1000	--	--	--	5500	--	--
5310 C-2000	Total Organic Carbon	UG/L	2500	<1000	<1000	--	3500	--	2200	--	--	--	28000	--	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	<5.7	--	--	--	--	--	<5.7	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	<9.5	--	--	--	--	--	<9.5	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	<9.5	--	--	--	--	--	<9.5	--	--	--
8270D	Naphthalene	UG/L	--	--	--	<9.5	--	--	--	--	--	<9.5	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	48	8.7	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	<4.8	<4.8	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	<4.8	<4.8	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	32	<4.8	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	2.3	<0.48	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	<0.48	<0.48	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
9012B	Cyanide	UG/L	<10	<10	<10	<10	--	180	11	690	--	67	1400	1100	13
6010C	Iron	UG/L	50000	5000	50000	--	3800	--	9600	--	--	--	30000	--	--
6010C	Iron, dissolved	UG/L	3700	270	790	--	<200	--	350	--	--	--	1100	--	--

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

		Location	**MW-4AR**	**MW-4CR**	**MW-5AR**	**MW-5BR**	**MW-5CDR**	**MW-5DR**	**MW-5FR**	**MW-6AR**	**MW-7AR**	**MW-7CR**	**MW-7FR**	**MW-7FR**	**MW-8A**
		Date	**09/18/2018**	**09/18/2018**	**10/03/2018**	**09/07/2018**	**09/05/2018**	**09/05/2018**	**09/05/2018**	**09/27/2018**	**08/31/2018**	**08/31/2018**	**08/31/2018**	**08/31/2018**	**09/07/2018**
Method	**Parameter Name**	**Units**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**DUP**	**FS**
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	Clear	Clear	None	Clear	Clear	Clear	Clear	--	None	None	None	None	None
	ODOR	NONE	Slight	Slight	None	Slight	Slight	Strong	Slight	--	None	None	None	None	None
	OXIDATION REDUCTION POTENTIAL	MV	42	12	46	44	102	159	141	--	65	45	45	45	95
	PH	STD UNITS	8.89	7.89	8.23	6.54	6.59	6.01	7.04	--	5.91	5.82	5.39	5.39	7.31
	SPECIFIC CONDUCTANCE	UMHOS/CM	10300	605	2518	1520	323	211	619	--	677	812	1289	1289	3529
	TEMPERATURE	DEGREES C	22.1	21.6	18.1	17.8	18.7	20.01	19.9	--	17.6	18.3	18.7	18.7	21.9
	TURBIDITY QUANTITATIVE	NTU	5.4	42.2	4.6	3.4	3.1	2	2.1	--	13.5	1.6	5.8	5.8	3.9
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,1,2-Trichloroethane	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,1-Dichloroethane	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,1-Dichloroethene	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,2-Dichlorobenzene	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,4-Dichlorobenzene	UG/L	<1	<500	<20	1.1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	1,4-Dichlorobutane	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	3.8	<2	<3.3	16000
8260C	Benzene	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Carbon Tetrachloride	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Chlorobenzene	UG/L	<1	<500	<20	1.9	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Chloroform	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	cis-1,2 Dichloroethene	UG/L	<1	2200	430	1.8	1.9	2.2	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Methyl Chloride	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Methylene Chloride	UG/L	<5	<2500	<100	<5	<5	<5	<5	<5	<5	<5	<10	<17	<25000
8260C	Tetrachloroethene	UG/L	<1	1300	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Tetrahydrothiophene	UG/L	<2	<1000	<40	<2	<2	<2	<2	<2	<2	38	45 J	64 J	110000
8260C	Toluene	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	trans-1,2-Dichloroethene	UG/L	<1	<500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Trichloroethene	UG/L	<1	7500	<20	<1	<1	<1	<1	<1	<1	<1	<2	<3.3	<5000
8260C	Vinyl Chloride	UG/L	<1	<500	170	6.6	<1	<1	5.1	<1	<1	1.3	<2	<3.3	<5000
	Total VOCs	UG/L	0	11000	600	11.4	1.9	2.2	5.1	0	0	43.1	45	64	126000
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	--	--	--	--	--	<1	2	2	--
RSK-175	Ethene	UG/L	--	--	--	--	--	--	--	--	--	<1	7.2	7.2	--
RSK-175	Methane	UG/L	--	--	--	--	--	--	--	--	--	11	110	120	--
RSK-175	Propane	UG/L	--	--	--	--	--	--	--	--	--	<1	<1	<1	--
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	--	--	--	--	9600	<5000	14000 J	--
300	Chloride	UG/L	--	--	--	--	--	--	--	--	--	43000	110000	98000	--
300	Nitrate	UG/L	--	--	--	--	--	--	--	--	--	<100	<100	<100	--
300	Sulfate	UG/L	--	--	--	--	--	--	--	--	--	360000	570000	540000	--
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	--	--	--	--	<1000	<1000	<1000	--
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	--	--	--	--	<1000	<1000	<1000	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	1.2	--	--	--	--	--	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	<0.48	--	--	--	--	--	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	<0.48	--	--	--	--	--	--	--	--	--	--	--
8081B	Lindane	UG/L	--	0.75	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	<0.095	--	--	--	--	--	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	230	--	--	--	--	--	--	--	--	--	--
9012B	Cyanide	UG/L	90000	12	12	50	<10	<10	<10	--	--	--	<10	<10	1300
6010C	Iron	UG/L	--	--	--	--	--	--	--	--	--	--	42000	--	--
6010C	Iron, dissolved	UG/L	--	--	--	--	--	--	--	--	--	<200 UJ	2500	2600	--

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

Method	Parameter Name	Location	MW-8B	MW-9AR	MW-U-1	PW-16	PW-18	PW-19	PW-20	PW-22	PW-24	PW-26	PW-28	PW-30	PW-32
		Date	9/7/2018 & 9/11/2018	09/07/2018	09/11/2018	10/12/2018	10/02/2018	10/02/2018	10/03/2018	10/03/2018	10/03/2018	10/04/2018	10/03/2018	10/03/2018	10/03/2018
		Units	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS	FS
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	None	None	None	--	None	None	None	None	None	None	None	None	None
	ODOR	NONE	None	None	None	--	None	None	None	None	None	None	None	None	None
	OXIDATION REDUCTION POTENTIAL	MV	23	8	96	--	100	146	159	168	167	98	130	102	58
	PH	STD UNITS	7.71	6.86	6.91	--	8.04	8.04	6.9	6.59	6.38	7.31	6.79	7.03	7.04
	SPECIFIC CONDUCTANCE	UMHOS/CM	918	3325	5960	--	1180	3380	2947	3536	2975	1109	2401	483	634
	TEMPERATURE	DEGREES C	22.6	20.7	17.2	--	20.9	20.5	18.6	18.4	18.8	18.9	21.1	18.8	18
	TURBIDITY QUANTITATIVE	NTU	1.3	2.2	6.7	--	1.5	1.46	4.23	4.53	69.3	29.8	4.7	10.4	7.9
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,1,2,2-Tetrachloroethane	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,1,2-Trichloroethane	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,1-Dichloroethane	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,1-Dichloroethene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,2-Dichlorobenzene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,4-Dichlorobenzene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	1,4-Dichlorobutane	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	30	6.2	70
8260C	Benzene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	Carbon Tetrachloride	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	Chlorobenzene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	Chloroform	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	1.9	<1	<5	<67
8260C	cis-1,2 Dichloroethene	UG/L	<330	<50	1	84	4300	13000	<1	<1	<1	4.3	<1	<5	<67
8260C	Methyl Chloride	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	Methylene Chloride	UG/L	<1700	<250	<5	<100	<2500	<17000	<5	<5	<5	<5	<5	<25	<330
8260C	Tetrachloroethene	UG/L	<330	<50	<1	190	4400	39000	<1	<1	<1	1.9	<1	<5	<67
8260C	Tetrahydrothiophene	UG/L	6500	420	<2	<40	<1000	<6700	<2	<2	<2	<2	11	66	1600
8260C	Toluene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	trans-1,2-Dichloroethene	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
8260C	Trichloroethene	UG/L	<330	<50	<1	360	10000	71000	1.2	<1	<1	7.7	<1	<5	<67
8260C	Vinyl Chloride	UG/L	<330	<50	<1	<20	<500	<3300	<1	<1	<1	<1	<1	<5	<67
	Total VOCs	UG/L	6500	420	1	634	18700	123000	1.2	0	0	15.8	41	72.2	1670
	MNA Parameters														
RSK-175	Ethane	UG/L	3	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Ethene	UG/L	29	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Methane	UG/L	140	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Propane	UG/L	<1	--	--	--	--	--	--	--	--	--	--	--	--
2320 B-1997	Alkalinity, Total	UG/L	30000	--	--	--	--	--	--	--	--	--	--	--	--
300	Chloride	UG/L	240000 J	--	--	--	--	--	--	--	--	--	--	--	--
300	Nitrate	UG/L	<100 UJ	--	--	--	--	--	--	--	--	--	--	--	--
300	Sulfate	UG/L	35000 J	--	--	--	--	--	--	--	--	--	--	--	--
4500-S2 F-2000	Sulfide	UG/L	4000	--	--	--	--	--	--	--	--	--	--	--	--
5310 C-2000	Total Organic Carbon	UG/L	6300	--	--	--	--	--	--	--	--	--	--	--	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
9012B	Cyanide	UG/L	920	1800	<10	--	--	--	--	--	--	--	--	--	--
6010C	Iron	UG/L	11000	--	--	--	--	--	--	--	--	--	--	--	--
6010C	Iron, dissolved	UG/L	300	--	--	--	--	--	--	--	--	--	--	--	--

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

		Location	PW-34	PW-35	PW-36	PW-37	PW-39	EB	EB	EB	EB	EB	EB	EB	EB
		Date	10/03/2018	10/03/2018	10/04/2018	10/03/2018	10/03/2018	08/28/2018	08/31/2018	09/07/2018	09/11/2018	09/13/2018	09/18/2018	09/26/2018	09/27/2018
Method	Parameter Name	Units	FS	FS	FS	FS	FS	EB	EB	EB	EB	EB	EB	EB	EB
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	None	None	None	None	None	--	--	--	--	--	--	--	--
	ODOR	NONE	None	None	None	None	None	--	--	--	--	--	--	--	--
	OXIDATION REDUCTION POTENTIAL	MV	118	71	129	65	3	--	--	--	--	--	--	--	--
	PH	STD UNITS	7.17	7.28	7.09	8.92	6.85	--	--	--	--	--	--	--	--
	SPECIFIC CONDUCTANCE	UMHOS/CM	394	1691	2851	1764	2843	--	--	--	--	--	--	--	--
	TEMPERATURE	DEGREES C	18.9	17.5	19.1	17.1	16.9	--	--	--	--	--	--	--	--
	TURBIDITY QUANTITATIVE	NTU	3.13	3.71	4.13	7.2	3.52	--	--	--	--	--	--	--	--
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,1,2,2-Tetrachloroethane	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,1,2-Trichloroethane	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,1-Dichloroethane	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,1-Dichloroethene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,2-Dichlorobenzene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,4-Dichlorobenzene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	1,4-Dichlorobutane	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	Benzene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	Carbon Tetrachloride	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	Chlorobenzene	UG/L	<5	<500	<500	130	<1700	--	--	--	--	--	--	--	--
8260C	Chloroform	UG/L	<5	<500	<500	100	<1700	--	--	--	--	--	--	--	--
8260C	cis-1,2 Dichloroethene	UG/L	<5	17000	12000	1800	49000	--	--	--	--	--	--	--	--
8260C	Methyl Chloride	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	Methylene Chloride	UG/L	<25	<2500	<2500	<500	<8300	--	--	--	--	--	--	--	--
8260C	Tetrachloroethene	UG/L	<5	1500	1800	<100	20000	--	--	--	--	--	--	--	--
8260C	Tetrahydrothiophene	UG/L	79	<1000	<1000	<200	<3300	--	--	--	--	--	--	--	--
8260C	Toluene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	trans-1,2-Dichloroethene	UG/L	<5	<500	<500	<100	<1700	--	--	--	--	--	--	--	--
8260C	Trichloroethene	UG/L	<5	5600	5700	130	35000	--	--	--	--	--	--	--	--
8260C	Vinyl Chloride	UG/L	<5	3400	<500	1100	5300	--	--	--	--	--	--	--	--
	Total VOCs	UG/L	79	27500	19500	3260	109300	--	--	--	--	--	--	--	--
	MNA Parameters														
RSK-175	Ethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Ethene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Methane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
RSK-175	Propane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Chloride	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Nitrate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Sulfate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	--	--	--	--	--	--	<200	<200	<200	<200	<200	--	--
9012B	Cyanide	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
6010C	Iron	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
6010C	Iron, dissolved	UG/L	--	--	--	--	--	<200	<200 UJ	<200	<200	<200	<200	<200	<200

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

Method	Parameter Name	Location / Date / Units	EB 10/03/2018 TB	TB 08/28/2018 TB	TB 08/31/2018 TB	TB 09/05/2018 TB	TB 09/07/2018 TB	TB 09/11/2018 TB	TB 09/13/2018 TB	TB 09/18/2018 TB	TB 09/20/2018 TB	TB 09/26/2018 TB	TB 09/27/2018 TB	TB 10/02/2018 TB	TB 10/03/2018 TB
	Field Measurements														
	DEPTH TO WATER	Feet	--	--	--	--	--	--	--	--	--	--	--	--	--
	COLOR	NONE	--	--	--	--	--	--	--	--	--	--	--	--	--
	ODOR	NONE	--	--	--	--	--	--	--	--	--	--	--	--	--
	OXIDATION REDUCTION POTENTIAL	MV	--	--	--	--	--	--	--	--	--	--	--	--	--
	PH	STD UNITS	--	--	--	--	--	--	--	--	--	--	--	--	--
	SPECIFIC CONDUCTANCE	UMHOS/CM	--	--	--	--	--	--	--	--	--	--	--	--	--
	TEMPERATURE	DEGREES C	--	--	--	--	--	--	--	--	--	--	--	--	--
	TURBIDITY QUANTITATIVE	NTU	--	--	--	--	--	--	--	--	--	--	--	--	--
	Volatile Organics														
8260C	1,1,1-Trichloroethane	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,1,2,2-Tetrachloroethane	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,1,2-Trichloroethane	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,1-Dichloroethane	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,1-Dichloroethene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,2-Dichlorobenzene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,4-Dichlorobenzene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	1,4-Dichlorobutane	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Benzene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Carbon Tetrachloride	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Chlorobenzene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Chloroform	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	cis-1,2 Dichloroethene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Methyl Chloride	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Methylene Chloride	UG/L	--	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
8260C	Tetrachloroethene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Tetrahydrothiophene	UG/L	--	2.2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
8260C	Toluene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	trans-1,2-Dichloroethene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Trichloroethene	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
8260C	Vinyl Chloride	UG/L	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Total VOCs	UG/L	--	2.2	0	0	0	0	0	0	0	0	0	0	0
	MNA Parameters														
RSK-175	Ethane	UG/L	--	<1	<1	--	<1	<1	<1	<1	--	<1	<1	--	--
RSK-175	Ethene	UG/L	--	<1	<1	--	<1	<1	<1	<1	--	<1	<1	--	--
RSK-175	Methane	UG/L	--	<1	<1	--	<1	<1	<1	<1	--	<1	<1	--	--
RSK-175	Propane	UG/L	--	<1	<1	--	<1	<1	<1	<1	--	<1	<1	--	--
2320 B-1997	Alkalinity, Total	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Chloride	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Nitrate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
300	Sulfate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
4500-S2 F-2000	Sulfide	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
5310 C-2000	Total Organic Carbon	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Semivolatile Organics														
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8270D	Naphthalene	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Pesticides/PCBs														
8081B	Alpha-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	beta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	delta-BHC	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8081B	Lindane	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1016	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1221	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1232	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1242	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1248	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1254	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
8082A	PCB 1260	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
	Inorganics														
6010C	Barium, dissolved	UG/L	<200	--	--	--	--	--	--	--	--	--	--	--	--
9012B	Cyanide	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
6010C	Iron	UG/L	--	--	--	--	--	--	--	--	--	--	--	--	--
6010C	Iron, dissolved	UG/L	<200	--	--	--	--	--	--	--	--	--	--	--	--

< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

APPENDIX A
2018 Analytical Results - Monitoring Wells

		Location	TB	TB
		Date	10/04/2018	10/12/2018
Method	Parameter Name	Units	TB	AB
	Field Measurements			
	DEPTH TO WATER	Feet	--	--
	COLOR	NONE	--	--
	ODOR	NONE	--	--
	OXIDATION REDUCTION POTENTIAL	MV	--	--
	PH	STD UNITS	--	--
	SPECIFIC CONDUCTANCE	UMHOS/CM	--	--
	TEMPERATURE	DEGREES C	--	--
	TURBIDITY QUANTITATIVE	NTU	--	--
	Volatile Organics			
8260C	1,1,1-Trichloroethane	UG/L	<1	<1
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1	<1
8260C	1,1,2-Trichloroethane	UG/L	<1	<1
8260C	1,1-Dichloroethane	UG/L	<1	<1
8260C	1,1-Dichloroethene	UG/L	<1	<1
8260C	1,2-Dichlorobenzene	UG/L	<1	<1
8260C	1,4-Dichlorobenzene	UG/L	<1	<1
8260C	1,4-Dichlorobutane	UG/L	<1	<1
8260C	Benzene	UG/L	<1	<1
8260C	Carbon Tetrachloride	UG/L	<1	<1
8260C	Chlorobenzene	UG/L	<1	<1
8260C	Chloroform	UG/L	<1	<1
8260C	cis-1,2 Dichloroethene	UG/L	<1	<1
8260C	Methyl Chloride	UG/L	<1	<1
8260C	Methylene Chloride	UG/L	<5	<5
8260C	Tetrachloroethene	UG/L	<1	<1
8260C	Tetrahydrothiophene	UG/L	<2	<2
8260C	Toluene	UG/L	<1	<1
8260C	trans-1,2-Dichloroethene	UG/L	<1	<1
8260C	Trichloroethene	UG/L	<1	<1
8260C	Vinyl Chloride	UG/L	<1	<1
	Total VOCs	UG/L	0	0
	MNA Parameters			
RSK-175	Ethane	UG/L	--	--
RSK-175	Ethene	UG/L	--	--
RSK-175	Methane	UG/L	--	--
RSK-175	Propane	UG/L	--	--
2320 B-1997	Alkalinity, Total	UG/L	--	--
300	Chloride	UG/L	--	--
300	Nitrate	UG/L	--	--
300	Sulfate	UG/L	--	--
4500-S2 F-2000	Sulfide	UG/L	--	--
5310 C-2000	Total Organic Carbon	UG/L	--	--
	Semivolatile Organics			
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--
8270D	Hexachlorobutadiene	UG/L	--	--
8270D	Hexachloroethane	UG/L	--	--
8270D	Naphthalene	UG/L	--	--
	Pesticides/PCBs			
8081B	Alpha-BHC	UG/L	--	--
8081B	beta-BHC	UG/L	--	--
8081B	delta-BHC	UG/L	--	--
8081B	Lindane	UG/L	--	--
8082A	PCB 1016	UG/L	--	--
8082A	PCB 1221	UG/L	--	--
8082A	PCB 1232	UG/L	--	--
8082A	PCB 1242	UG/L	--	--
8082A	PCB 1248	UG/L	--	--
8082A	PCB 1254	UG/L	--	--
8082A	PCB 1260	UG/L	--	--
	Inorganics			
6010C	Barium, dissolved	UG/L	--	--
9012B	Cyanide	UG/L	--	--
6010C	Iron	UG/L	--	--
6010C	Iron, dissolved	UG/L	--	--

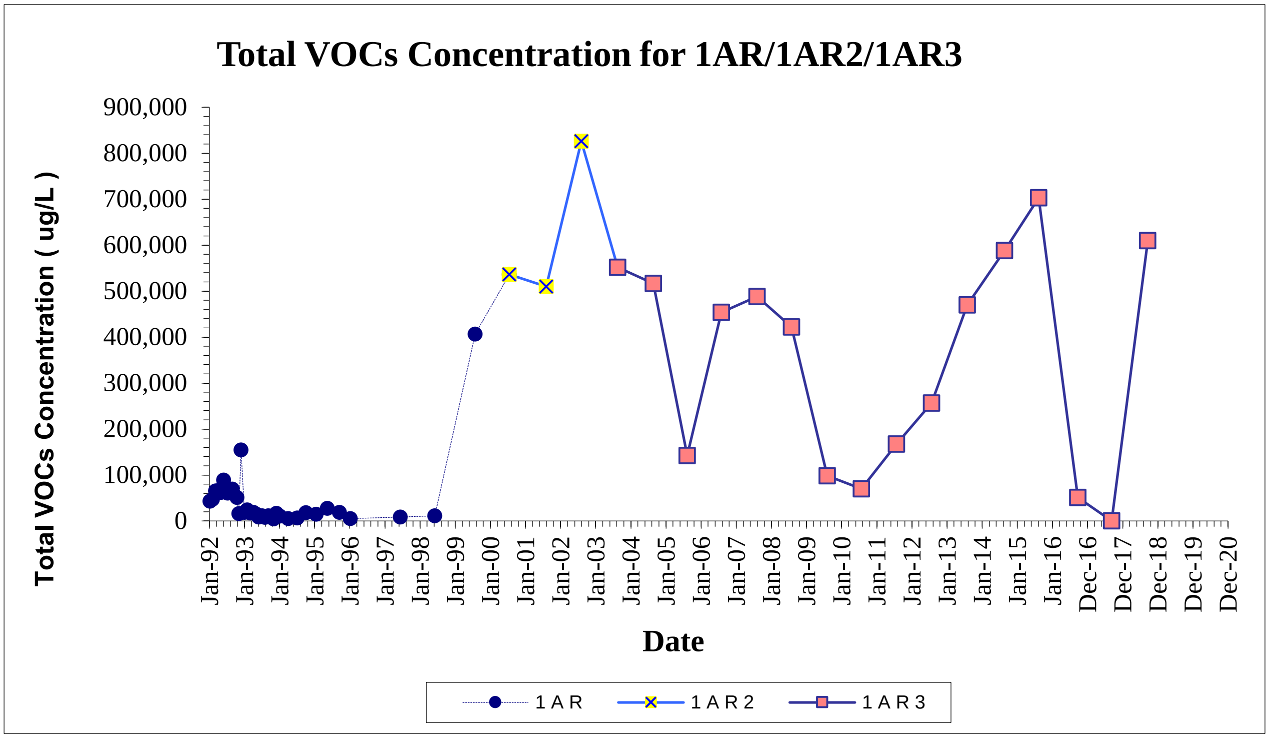
< Non detect at stated reporting limit. J Estimated concentration.
B Not detected substantially above the level reported in the laboratory or field blanks.
UJ Undetected-estimated reporting limit.

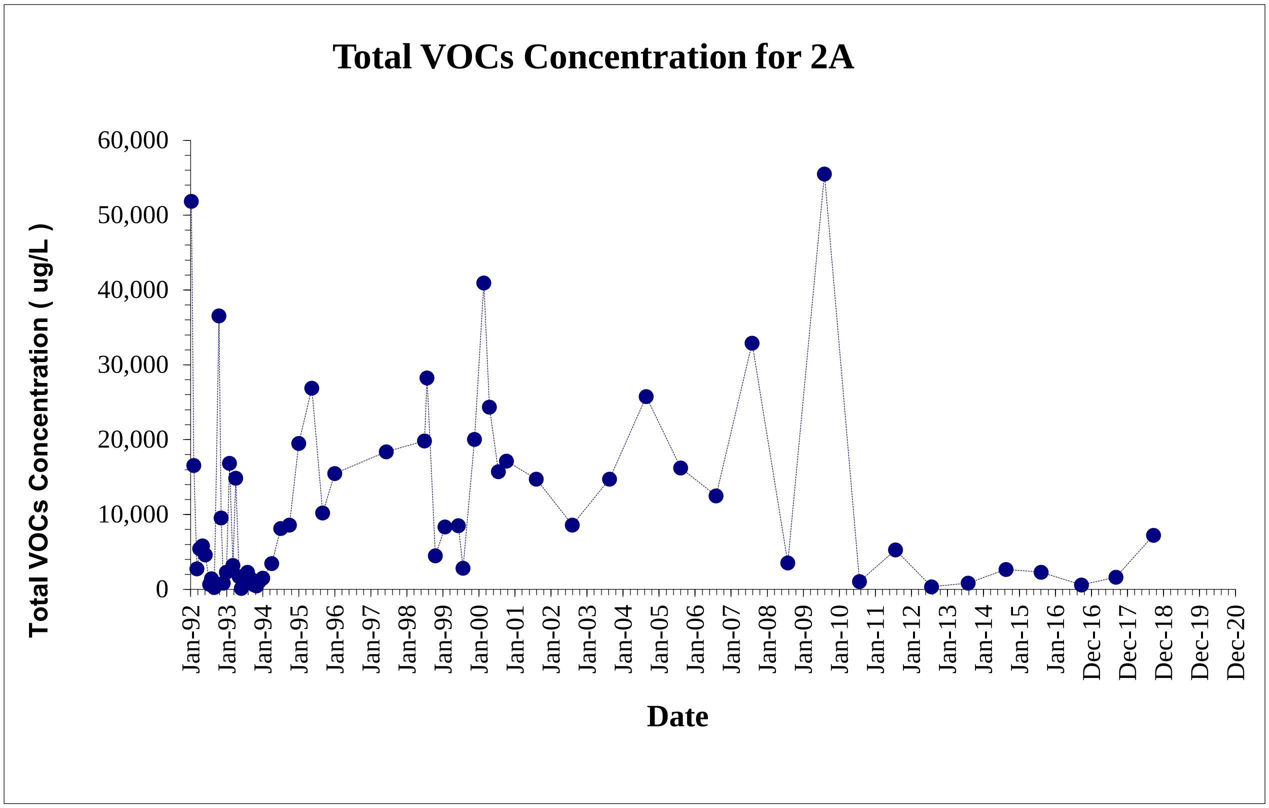
APPENDIX A
2018 Analytical Results - Surface Water Samples

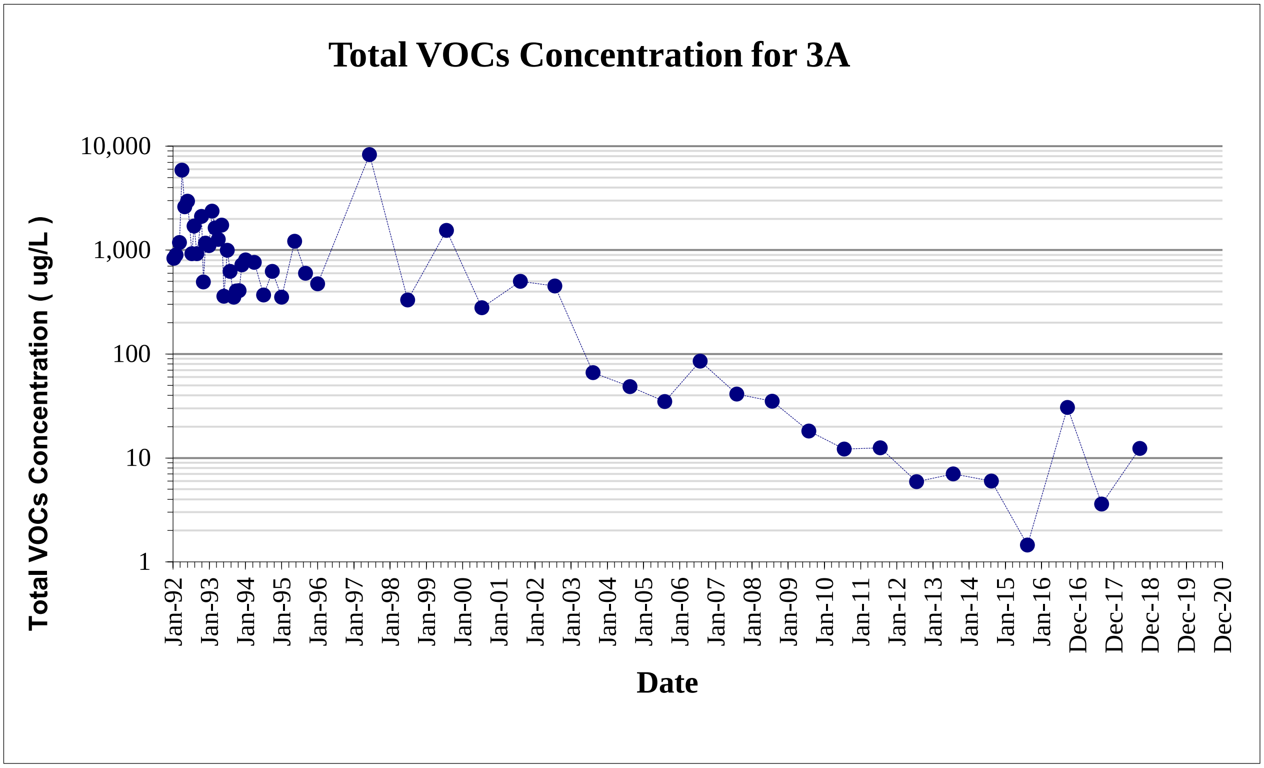
	Location	SW-1	SW-2	SW-2	EB	TB
	Date	10/02/2018	10/02/2018	10/02/2018	10/02/2018	10/02/2018
Analyte	**Units**	FS	FS	DUP	EB	TB
Volatile Organics						
1,1,1-Trichloroethane	UG/L	<1.0	<1.0	<1.0		<1.0
1,1,2,2-Tetrachloroethane	UG/L	<1.0	<1.0	<1.0		<1.0
1,1,2-Trichloroethane	UG/L	<1.0	<1.0	<1.0		<1.0
1,1-Dichloroethane	UG/L	<1.0	<1.0	<1.0		<1.0
1,1-Dichloroethene	UG/L	<1.0	<1.0	<1.0		<1.0
1,2-Dichlorobenzene	UG/L	<1.0	<1.0	<1.0		<1.0
1,4-Dichlorobenzene	UG/L	<1.0	<1.0	<1.0		<1.0
1,4-Dichlorobutane	UG/L	<1.0	<1.0	<1.0		<1.0
Benzene	UG/L	<1.0	<1.0	<1.0		<1.0
Carbon Tetrachloride	UG/L	<1.0	<1.0	<1.0		<1.0
Chlorobenzene	UG/L	<1.0	<1.0	<1.0		<1.0
Chloroform	UG/L	<1.0	<1.0	<1.0		<1.0
cis-1,2 Dichloroethene	UG/L	<1.0	2.3	2.1		<1.0
Methyl Chloride	UG/L	<1.0	<1.0	<1.0		<1.0
Methylene Chloride	UG/L	<5.0	<5.0	<5.0		<5.0
Tetrachloroethene	UG/L	<1.0	6	5.7		<1.0
Tetrahydrothiophene	UG/L	<2.0	<2.0	<2.0		<2.0
Toluene	UG/L	<1.0	<1.0	<1.0		<1.0
trans-1,2-Dichloroethene	UG/L	<1.0	<1.0	<1.0		<1.0
Trichloroethene	UG/L	<1.0	5.1	4.8		<1.0
Vinyl Chloride	UG/L	<1.0	<1.0	<1.0		<1.0
Total Volatiles		NA	13.4	12.6		NA
Semivolatile Organics						
Bis(2-Ethylhexyl)Phthalate	UG/L	<5.7	<5.7	<5.7		
Hexachlorobutadiene	UG/L	<9.5	<9.5	<9.5		
Hexachloroethane	UG/L	<9.5	<9.5	<9.5		
Naphthalene	UG/L	<9.5	<9.5	<9.5		
Pesticides/PCBs						
Alpha-BHC	UG/L	<0.48	<0.048	<2.4		
beta-BHC	UG/L	<0.48	<0.048	<2.4		
delta-BHC	UG/L	<0.48	<0.048	<2.4		
Lindane	UG/L	<0.48	<0.048	<2.4		
PCB 1016	UG/L	<0.095	<0.095	<0.095		
PCB 1221	UG/L	<0.095	<0.095	<0.095		
PCB 1232	UG/L	<0.095	<0.095	<0.095		
PCB 1242	UG/L	<0.095	<0.095	<0.095		
PCB 1248	UG/L	<0.095	<0.095	<0.095		
PCB 1254	UG/L	<0.095	<0.095	<0.095		
PCB 1260	UG/L	<0.095	<0.095	<0.095		
Inorganics						
Barium, dissolved	UG/L	<200	<200	<200	<200	
Cyanide, total	UG/L	<10	<10	<10		
Iron, total	UG/L	2000	230	270		
Iron, dissolved	UG/L	<200	<200	<200	<200	
Alkalinity, Total	UG/L	100000	92000	93000		
Chloride	UG/L	36000	19000	19000		
Nitrate	UG/L	110	<100	<100		
Sulfate	UG/L	33000	23000	23000		
Sulfide	UG/L	<1000	<1000	<1000		
Total Organic Carbon	UG/L	4500	2400	2500		

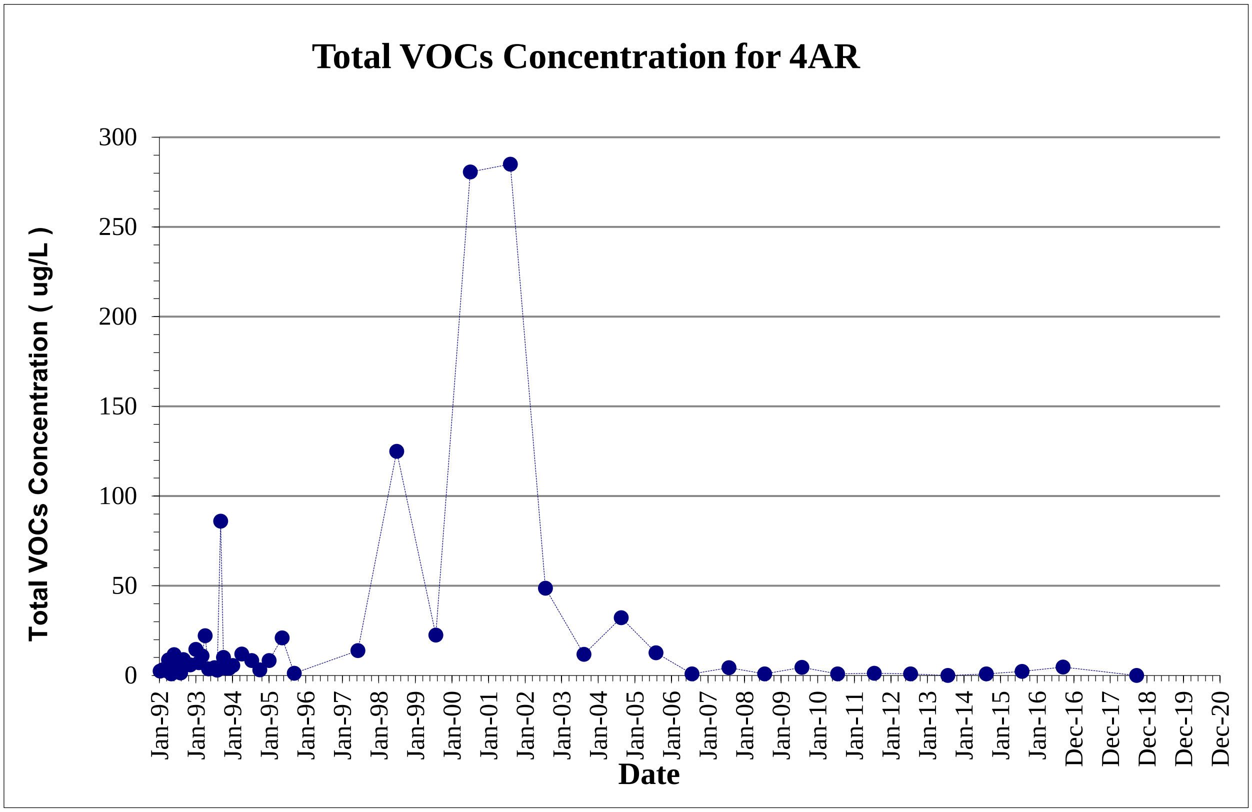
< Non detect at stated reporting limit
J: Estimated concentration
B: Not detected substantially above the level reported in the laboratory or field blanks
UJ: Undetected-estimated reporting limit.

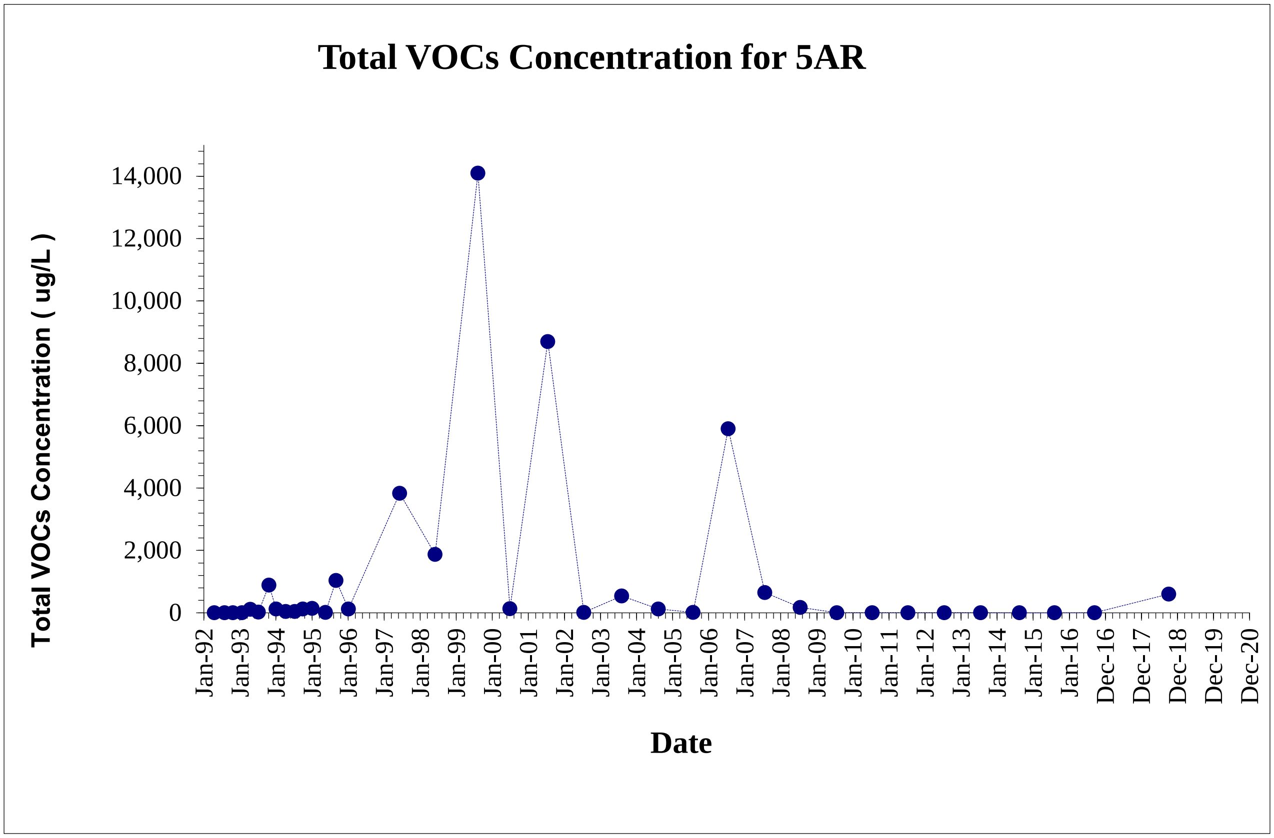
ANNUAL REPORT
APPENDIX B
TVOC CONCENTRATION TREND PLOTS

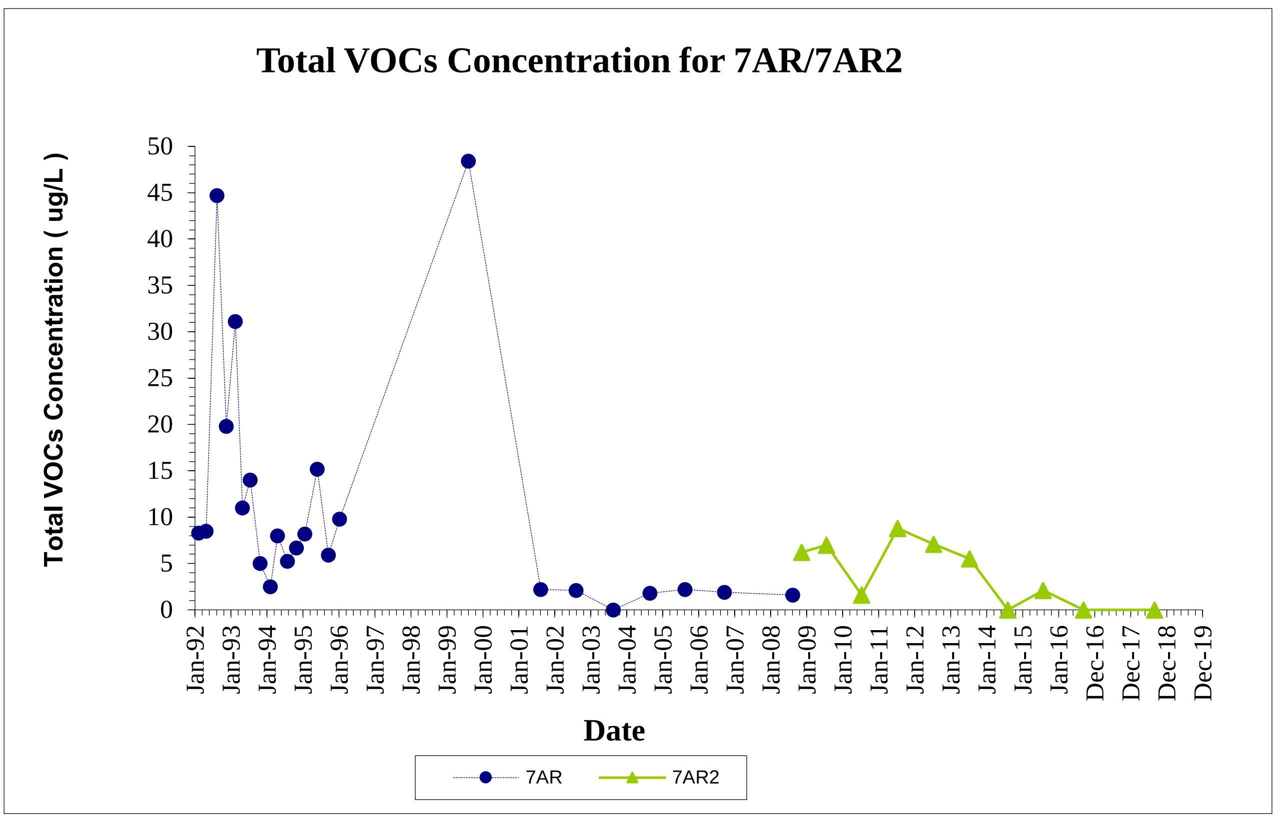

Total VOCs Concentration for 1AR/1AR2/1AR3
Total VOCs Concentration (ug/L)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date
1AR
1AR2
1AR3

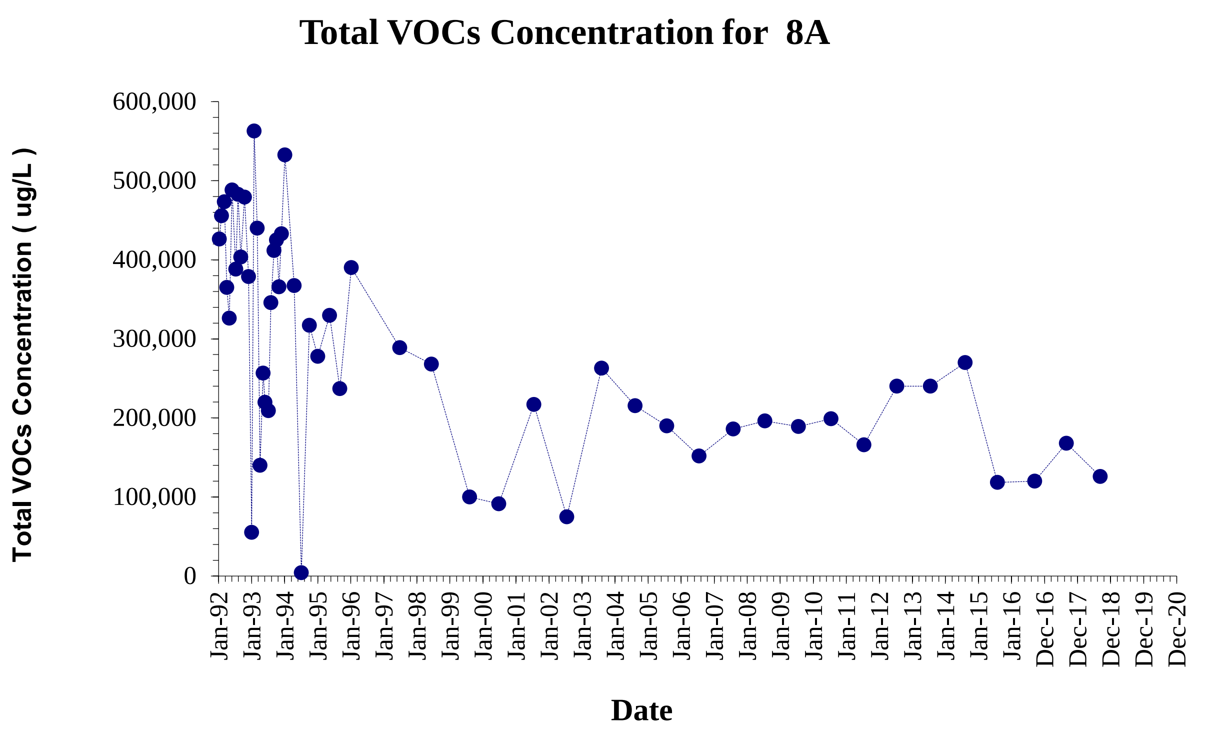

Total VOCs Concentration for 2A
Total VOCs Concentration (ug/L)
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date


Total VOCs Concentration for 3A
Total VOCs Concentration (ug/L)
10,000
1,000
100
10
1
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

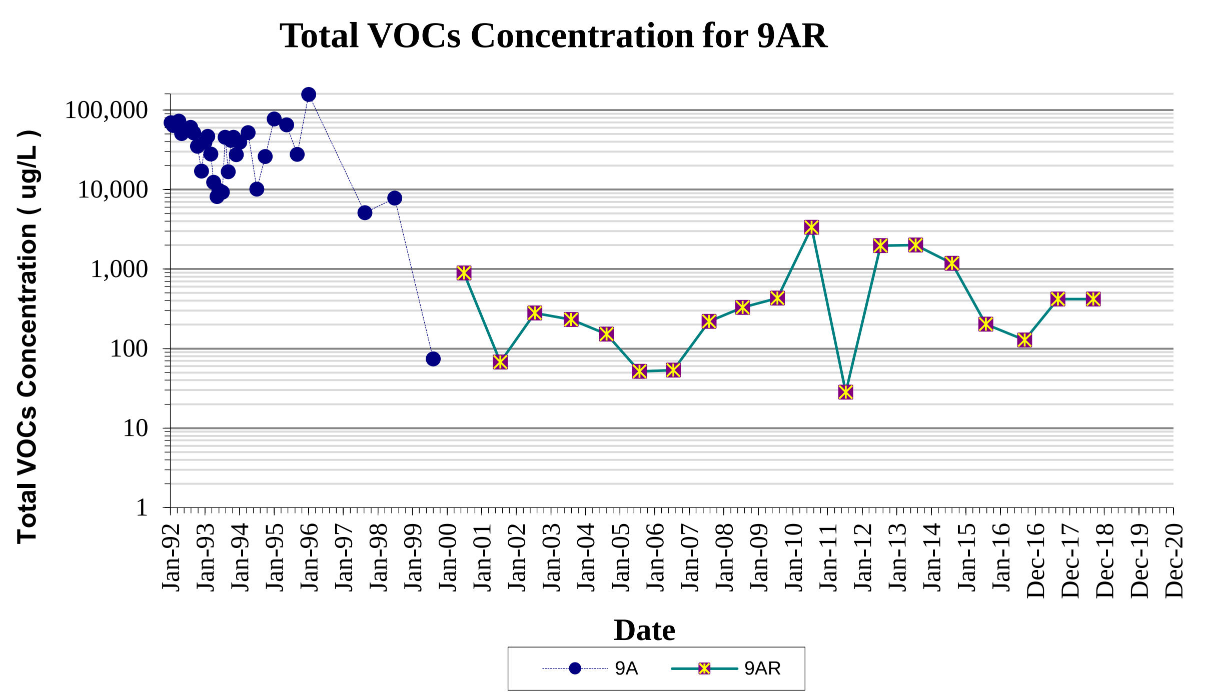

Total VOCs Concentration for 4AR
Total VOCs Concentration (ug/L)
300
250
200
150
100
50
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date


Total VOCs Concentration for 5AR
Total VOCs Concentration (ug/L)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date


Total VOCs Concentration for 7AR/7AR2
Total VOCs Concentration (ug/L)
0
5
10
15
20
25
30
35
40
45
50
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19
Date
7AR
7AR2

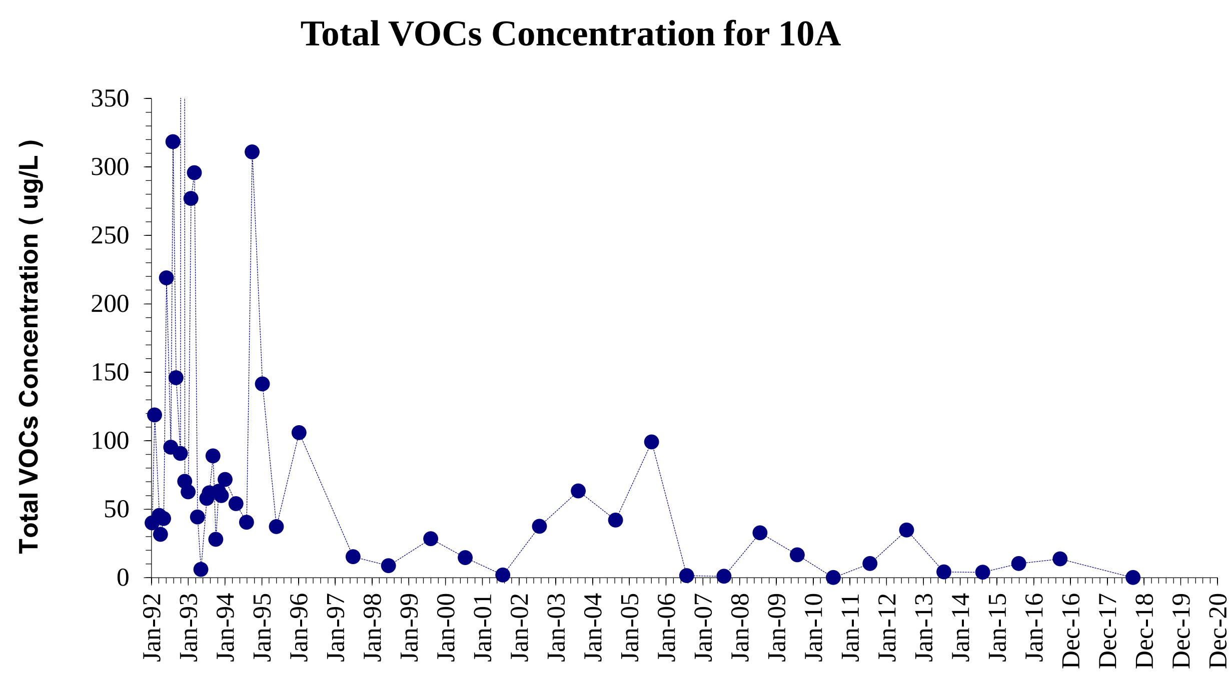


Note: the only detected VOCs were tetrahydrothiophene and 1,4-dichlorobutane

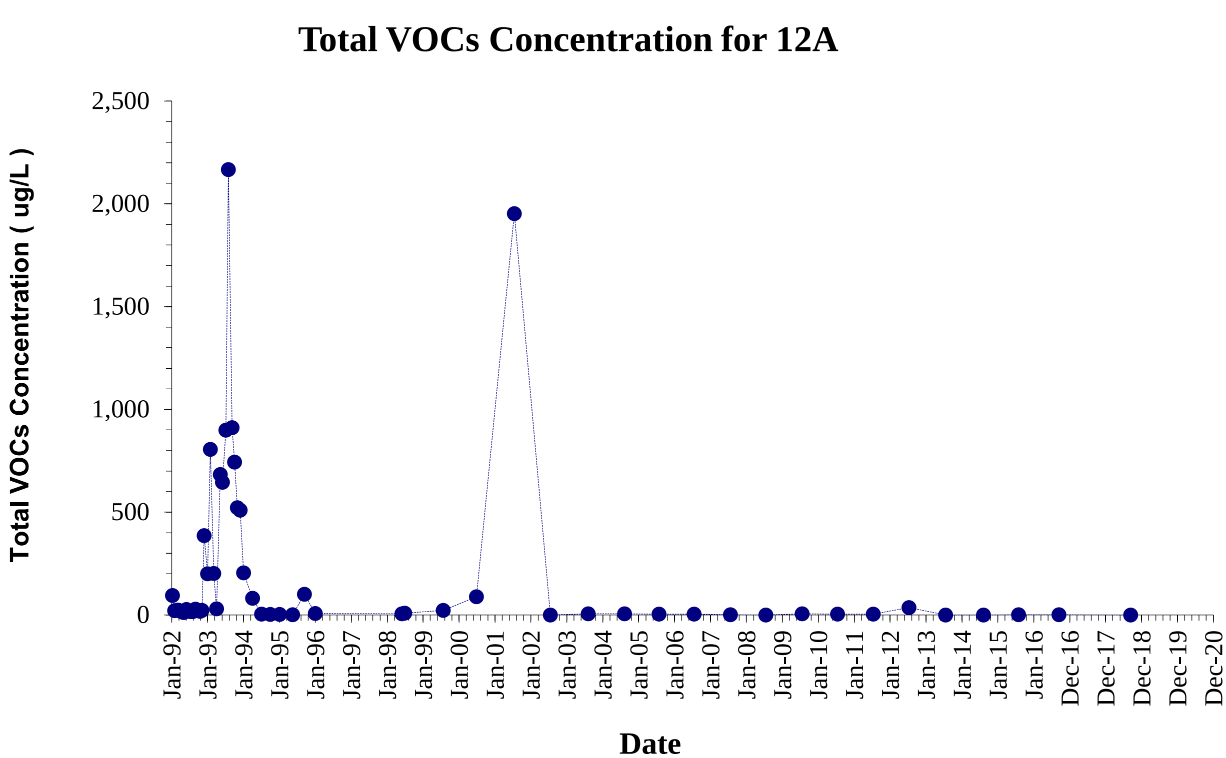


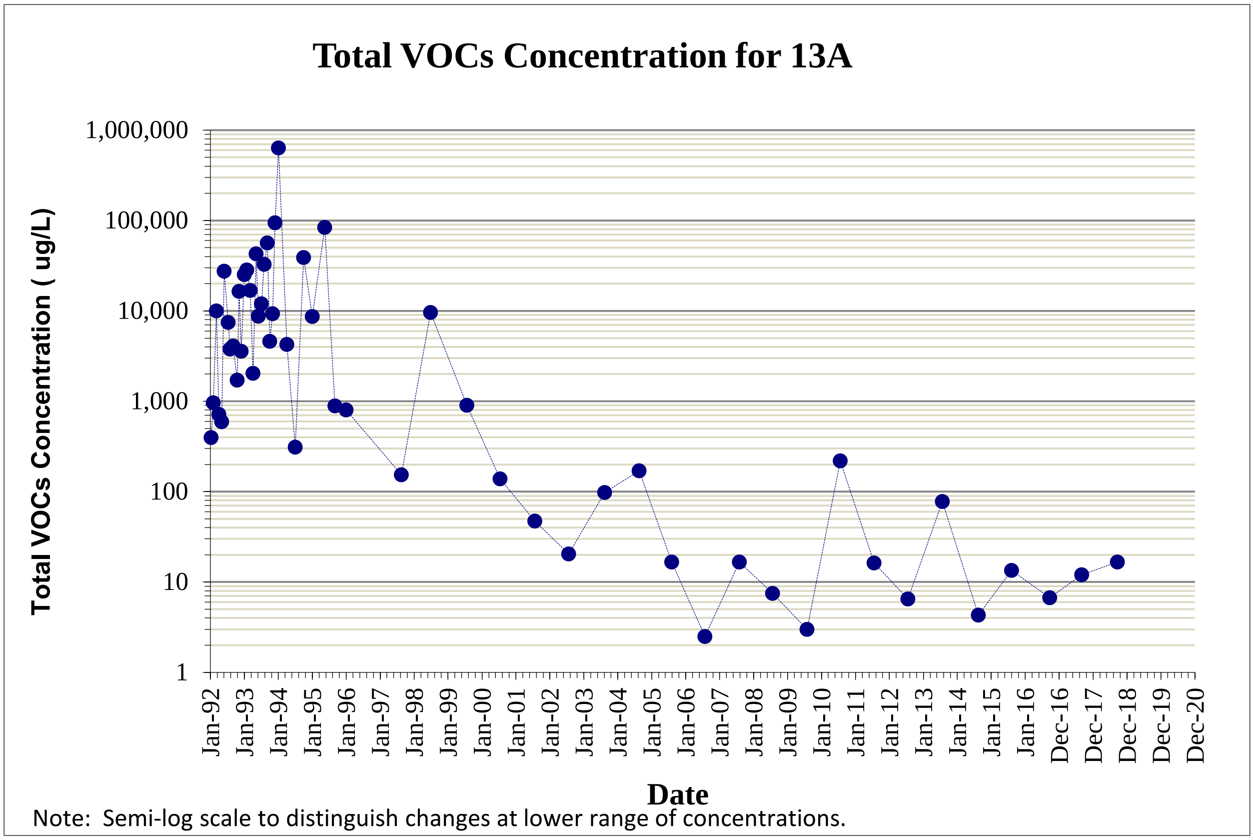
Note: the only VOC detected was THT

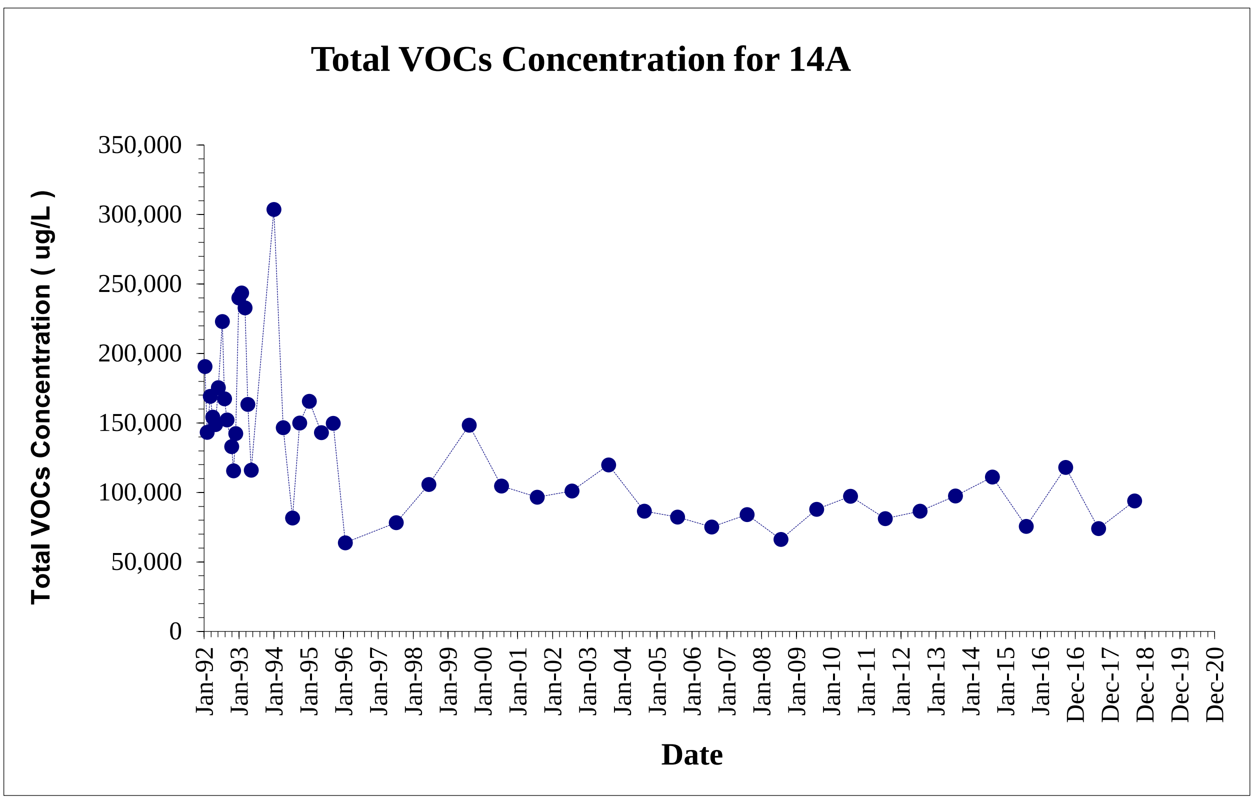
Note: Semi-log scale to distinguish changes at lower range of concentrations.

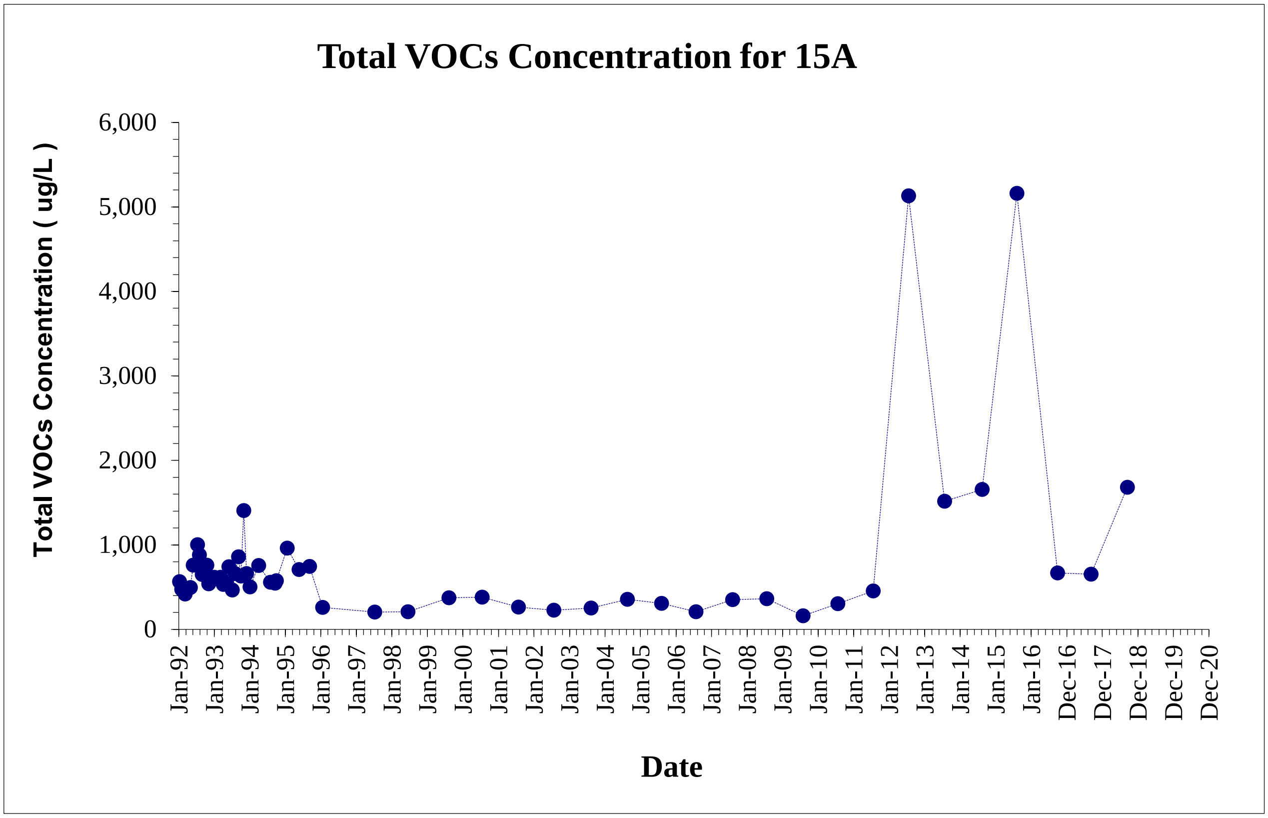


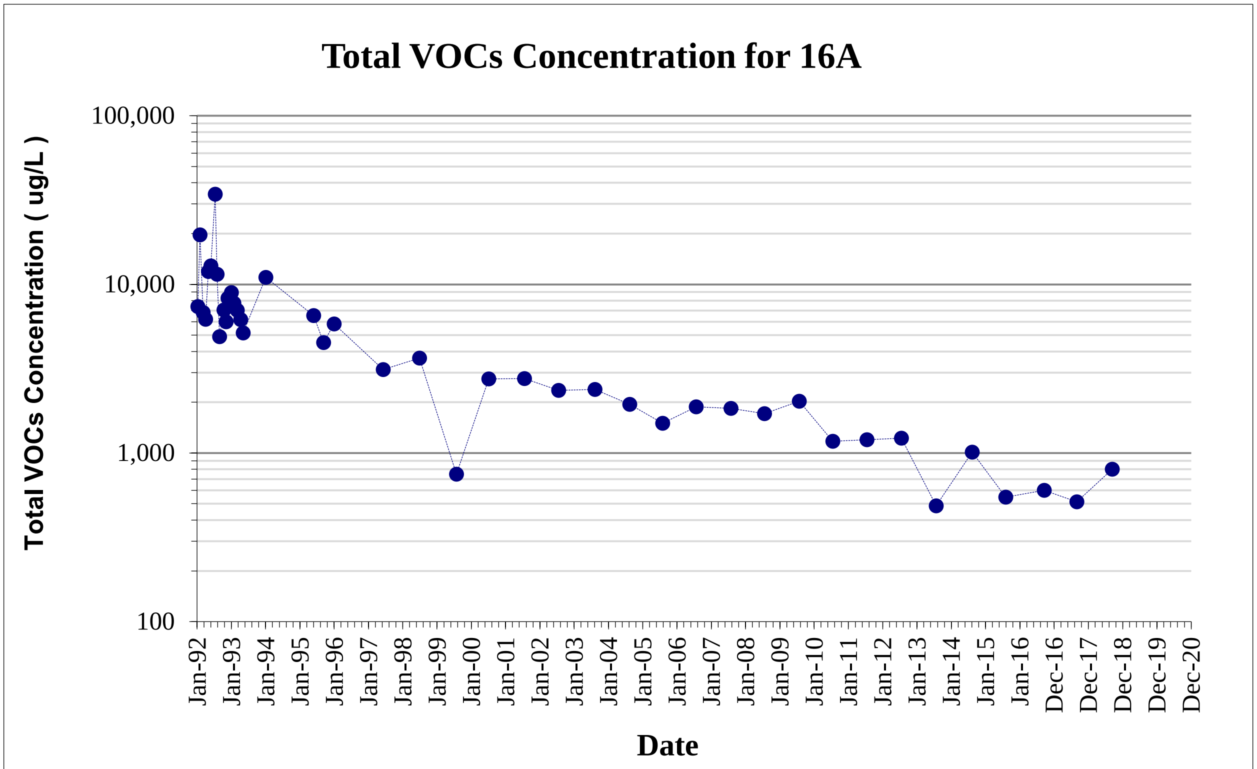
Note: the November 10, 1992 results of 3,842 ug/L are beyond y-axis scale.



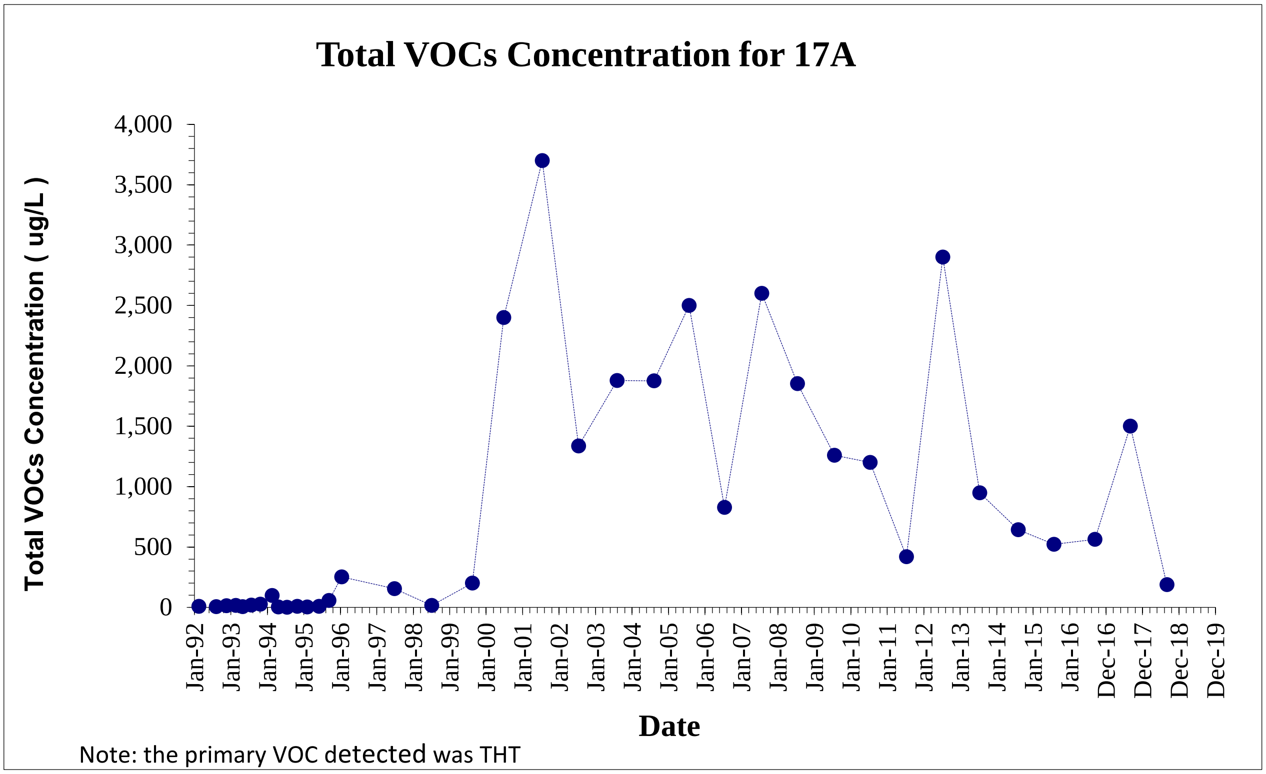

Total VOCs Concentration for 13A
Total VOCs Concentration (ug/L)
1,000,000
100,000
10,000
1,000
100
10
1
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date
Note: Semi-log scale to distinguish changes at lower range of concentrations.

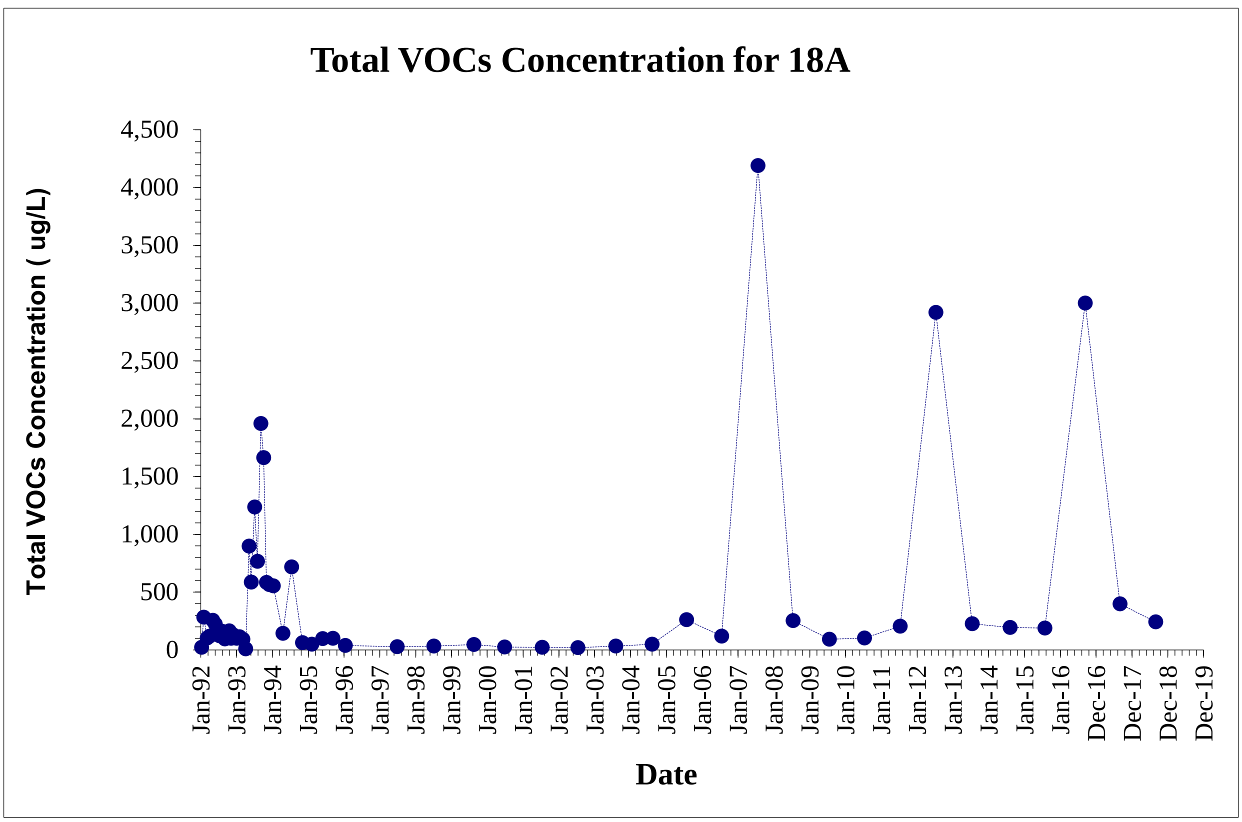

Total VOCs Concentration for 14A
Total VOCs Concentration (ug/L)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

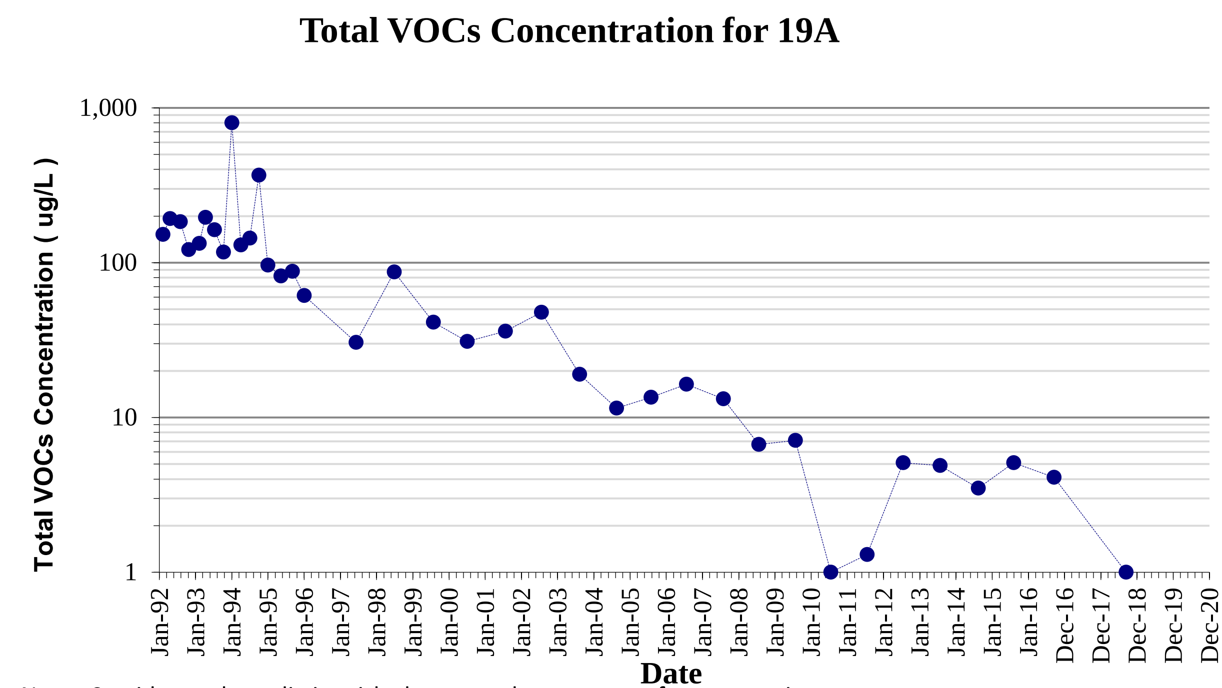




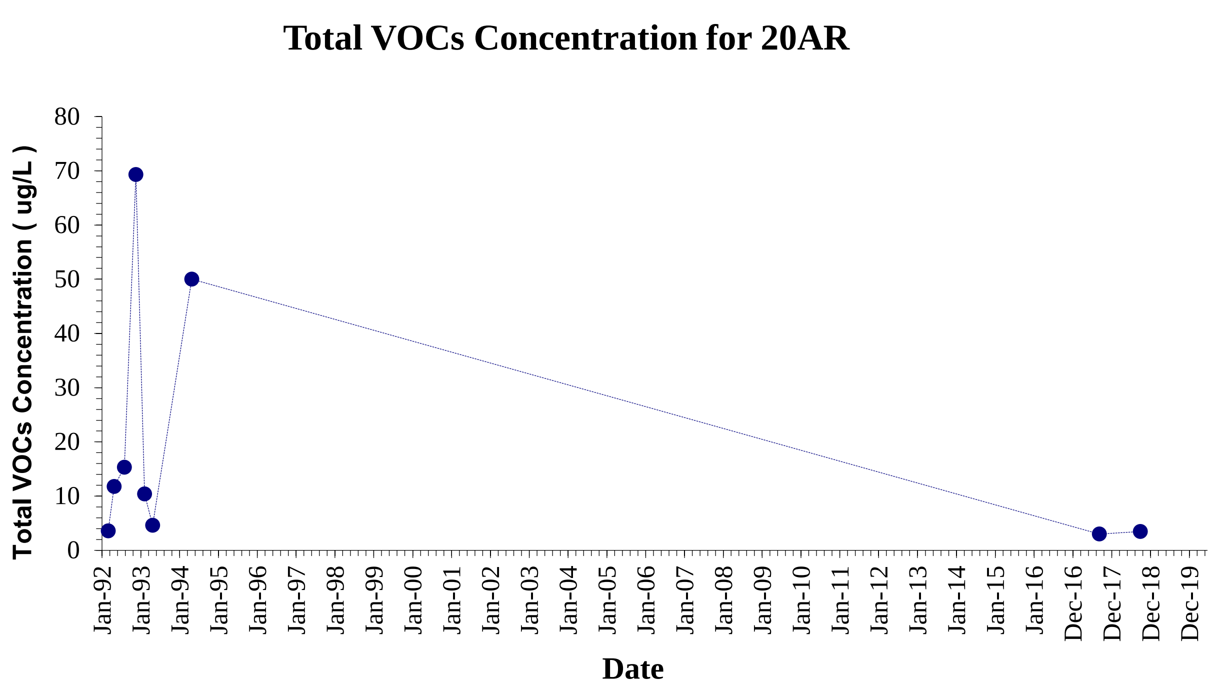
Note: Semi-log scale to distinguish changes at lower range of concentrations.


Total VOCs Concentration for 17A
Total VOCs Concentration (ug/L)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19
Date
Note: the primary VOC detected was THT

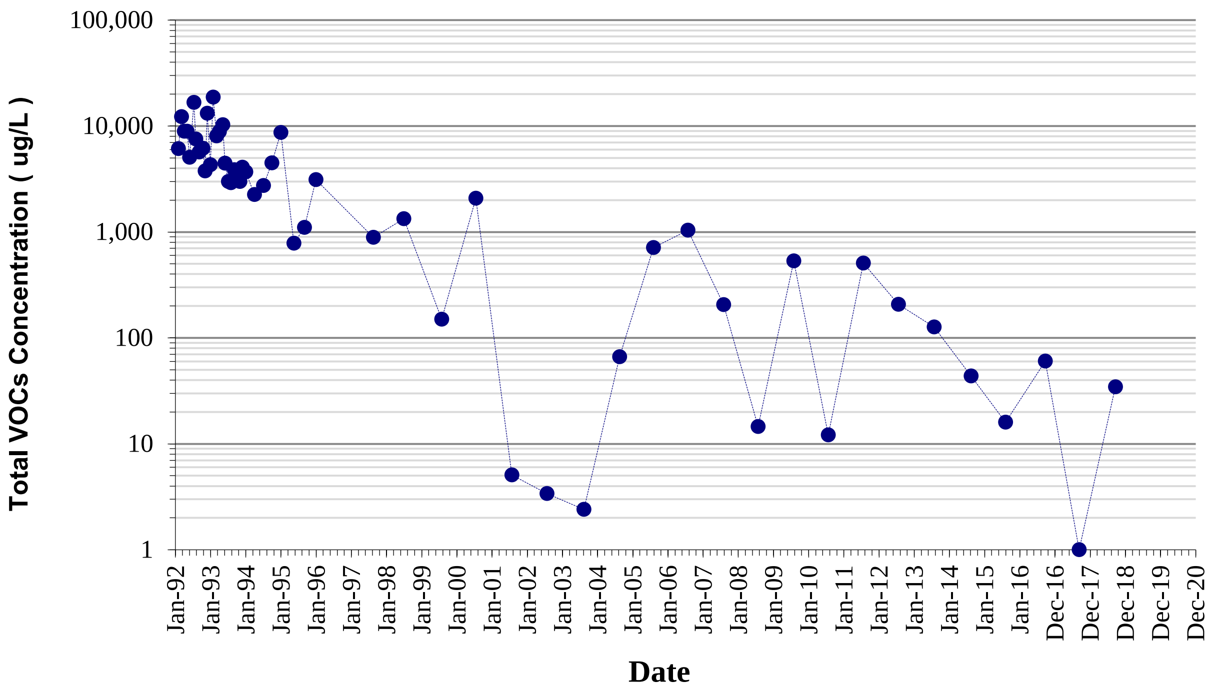

Total VOCs Concentration for 18A
Total VOCs Concentration (ug/L)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19
Date



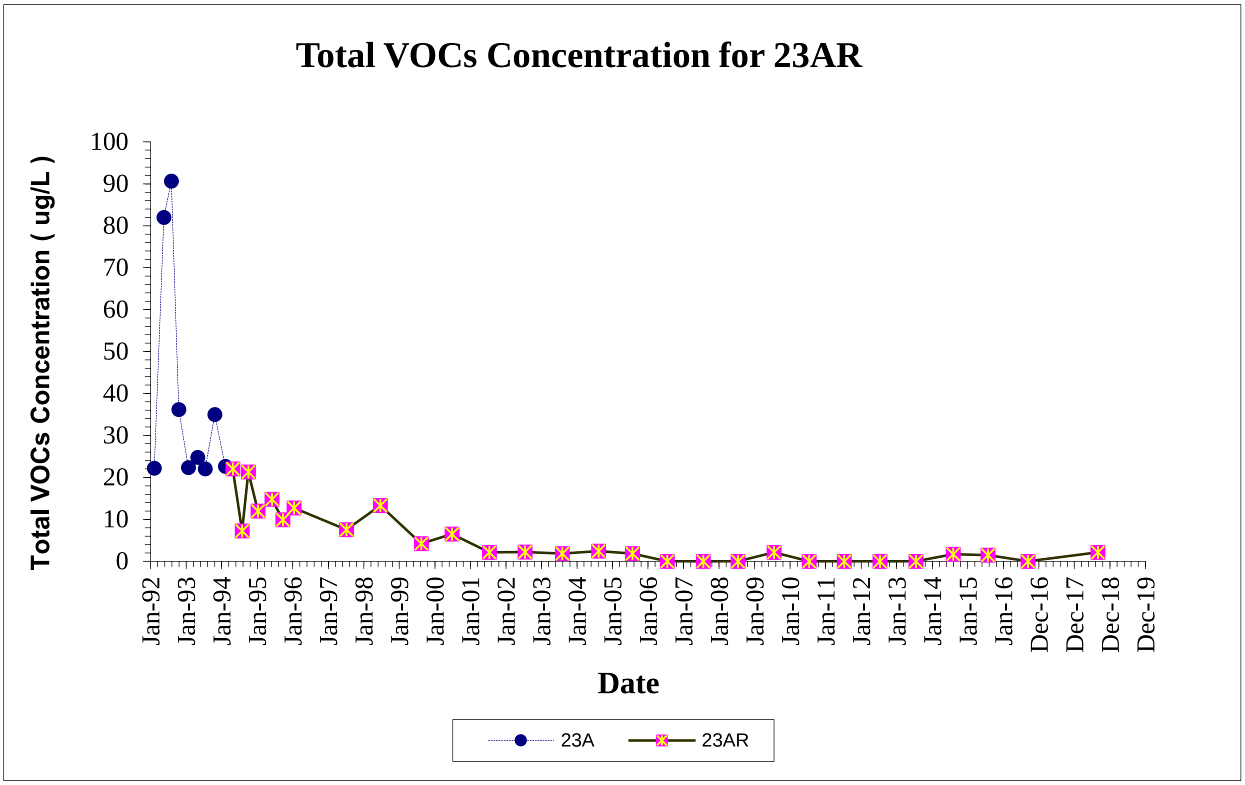
Note: Semi-log scale to distinguish changes at lower range of concentrations.
Nondetect values for 2010 and 2018 represented as 1.0 ug/L.

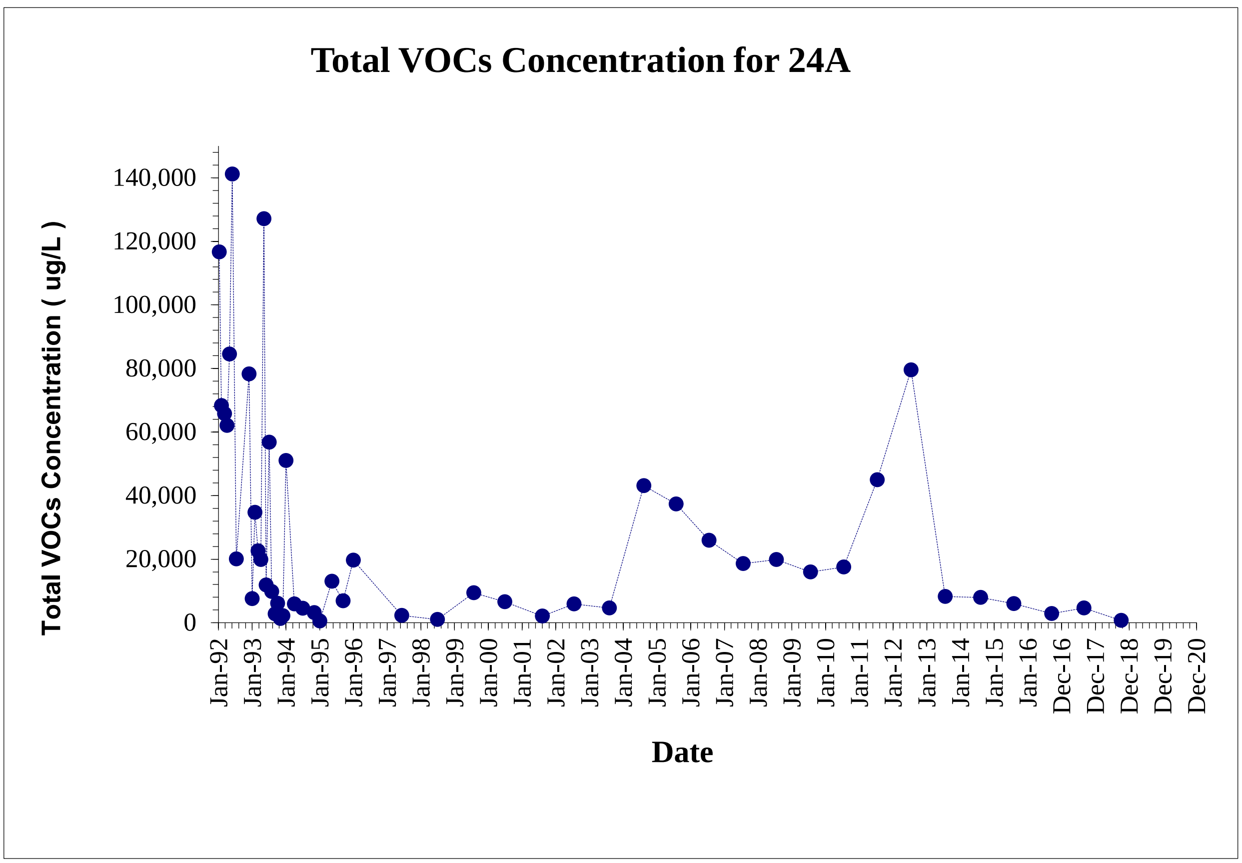


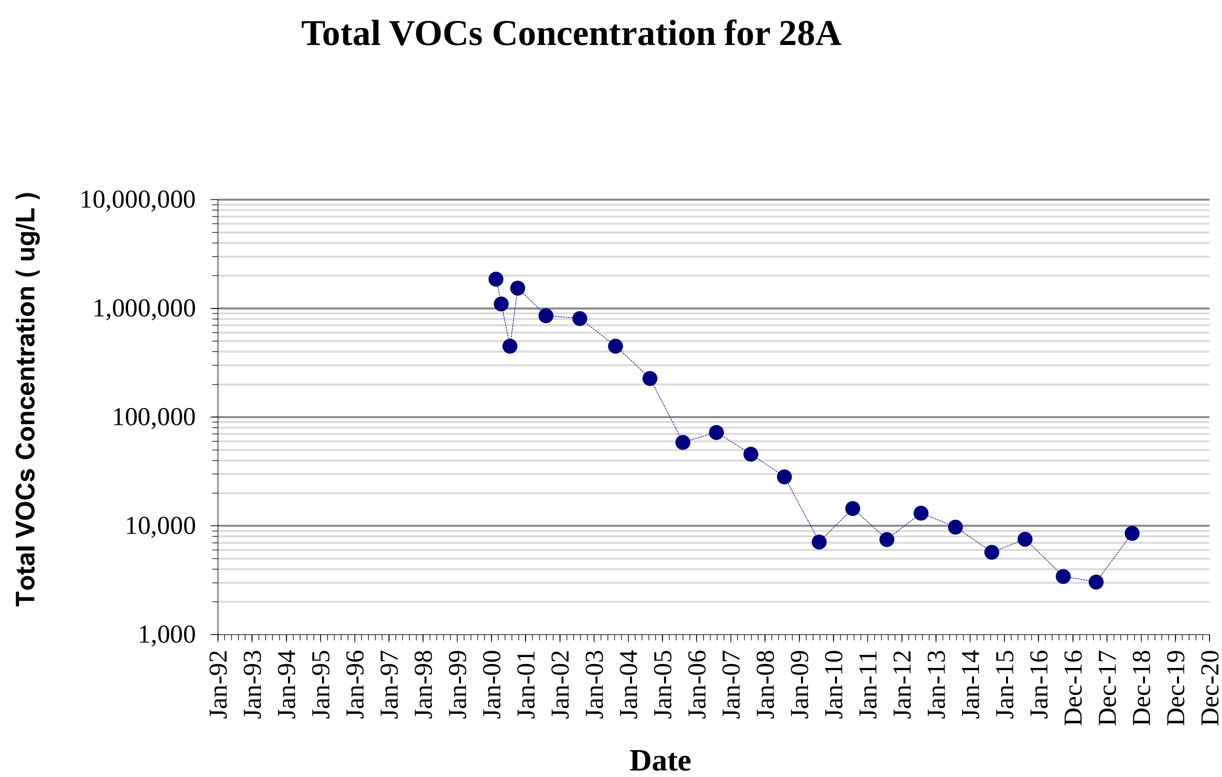
Note: Well has been dry since 1994.



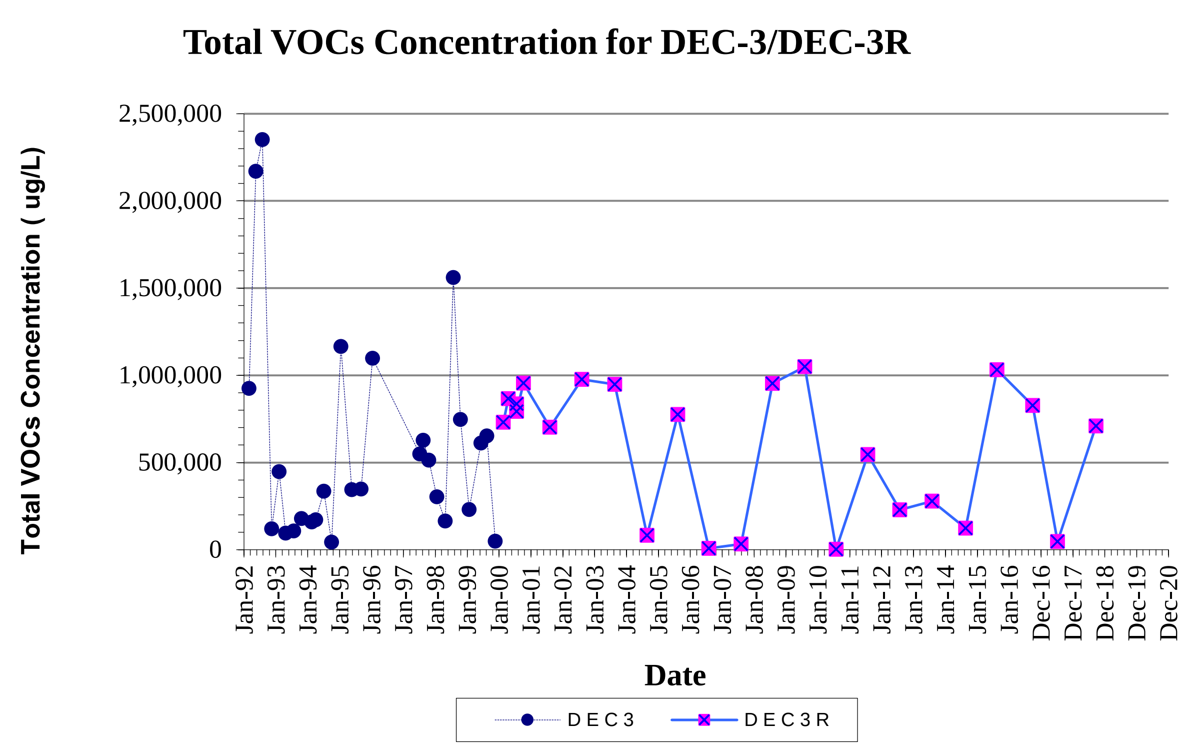
Note: Semi-log scale to distinguish changes at lower range of concentrations.

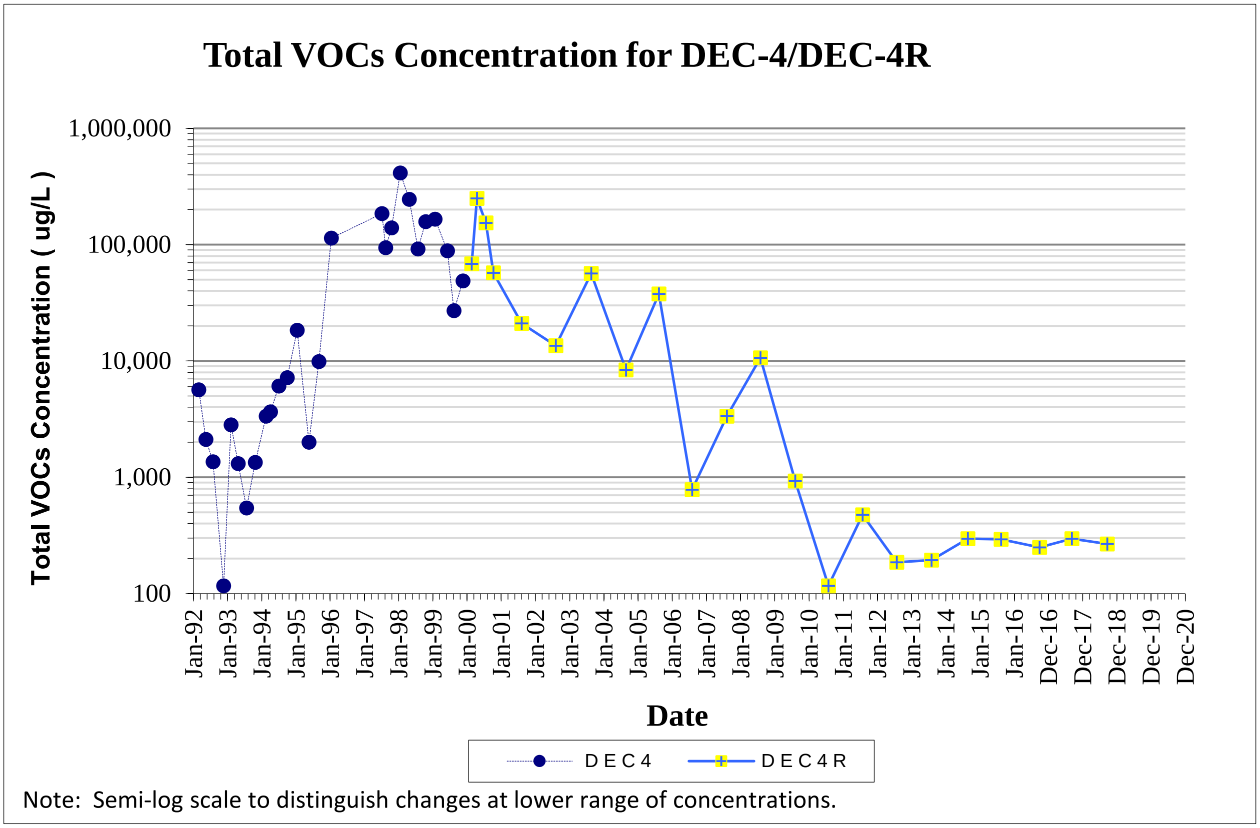

Total VOCs Concentration for 23AR
Total VOCs Concentration (ug/L)
100
90
80
70
60
50
40
30
20
10
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date
23A
23AR

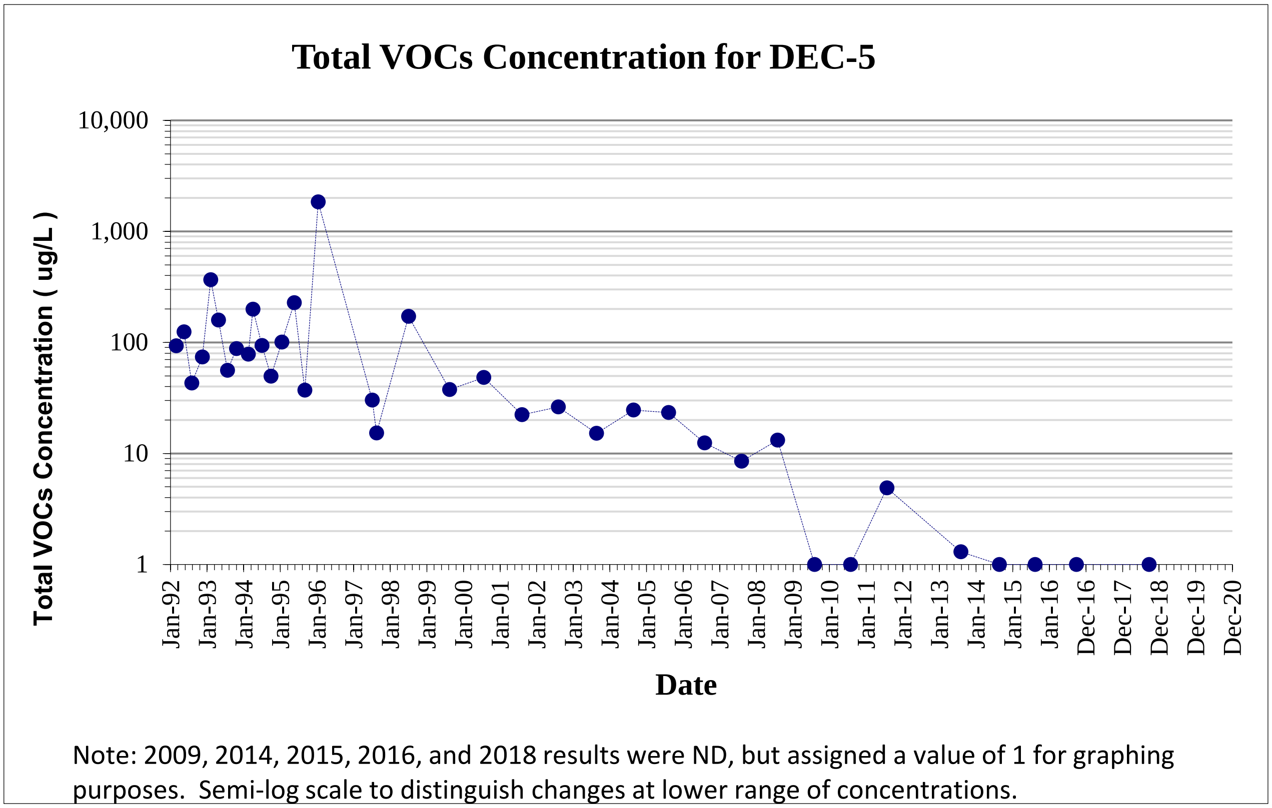

Total VOCs Concentration for 24A
Total VOCs Concentration (ug/L)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

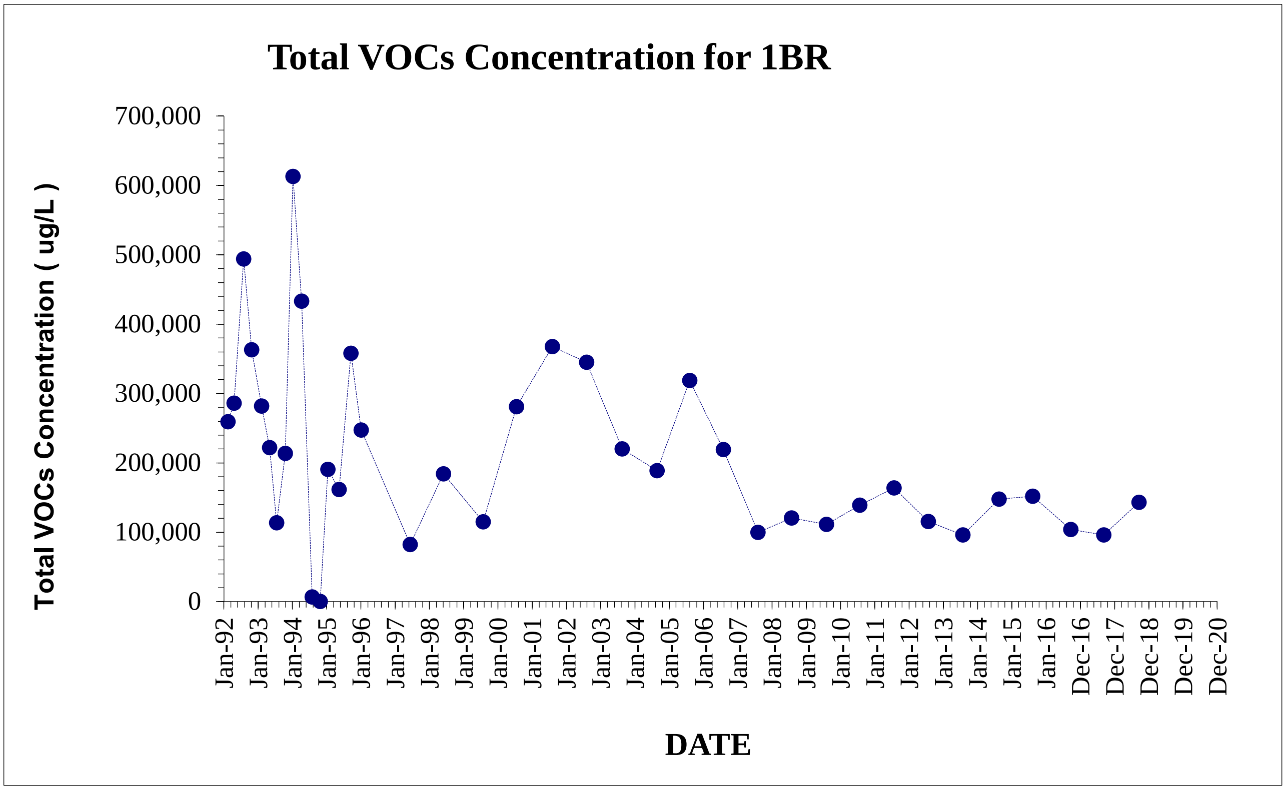


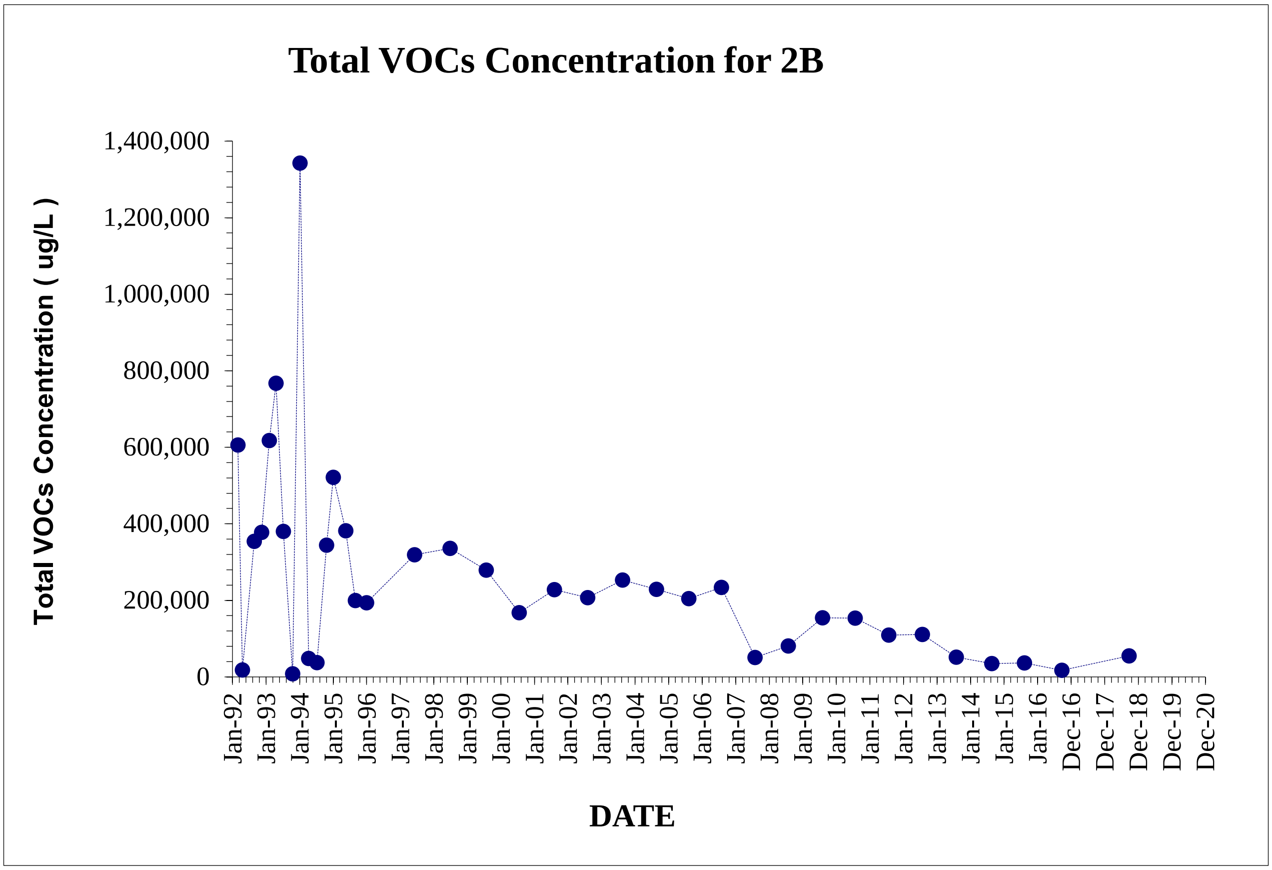
Note: Semi-log scale to distinguish changes at lower range of concentrations.

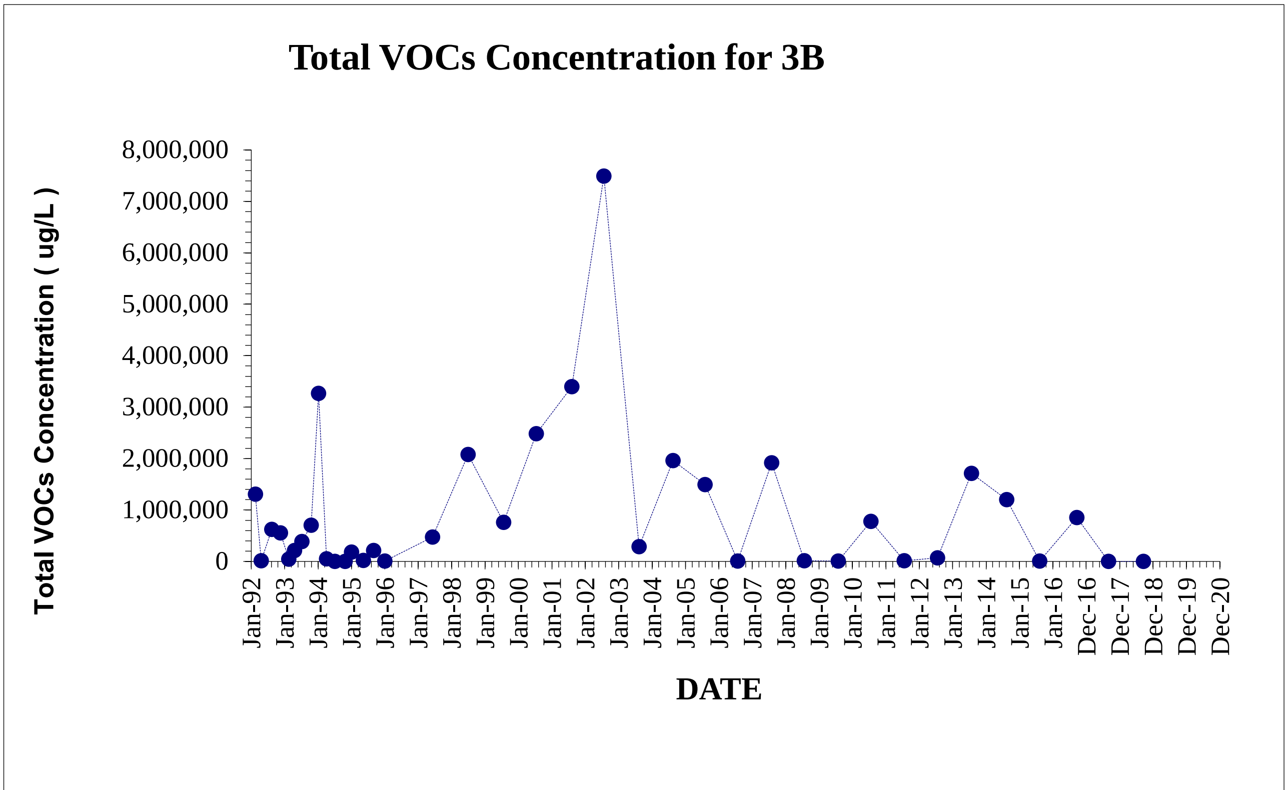


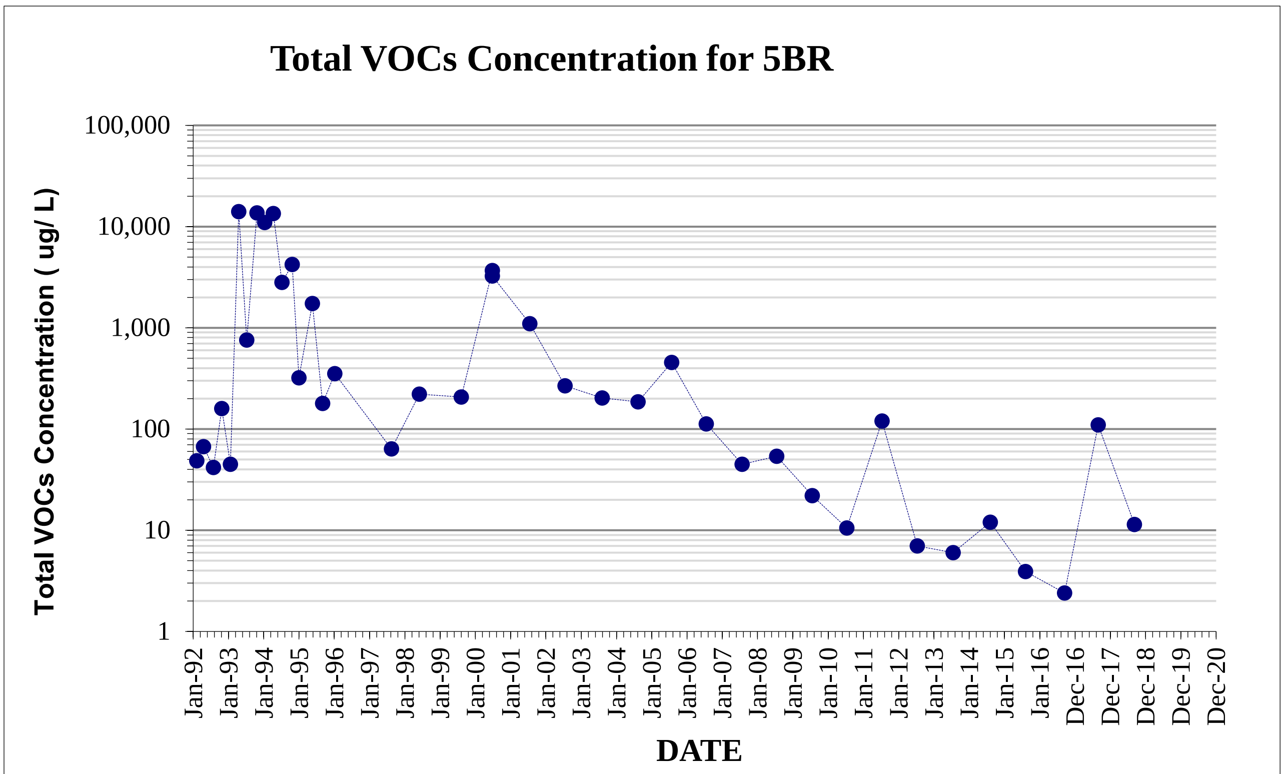

Total VOCs Concentration for DEC-4/DEC-4R
Total VOCs Concentration (ug/L)
1,000,000
100,000
10,000
1,000
100
Date
DEC4
DEC4R
Note: Semi-log scale to distinguish changes at lower range of concentrations.


Total VOCs Concentration for DEC-5
Total VOCs Concentration (ug/L)
10,000
1,000
100
10
1
Date
Note: 2009, 2014, 2015, 2016, and 2018 results were ND, but assigned a value of 1 for graphing purposes. Semi-log scale to distinguish changes at lower range of concentrations.

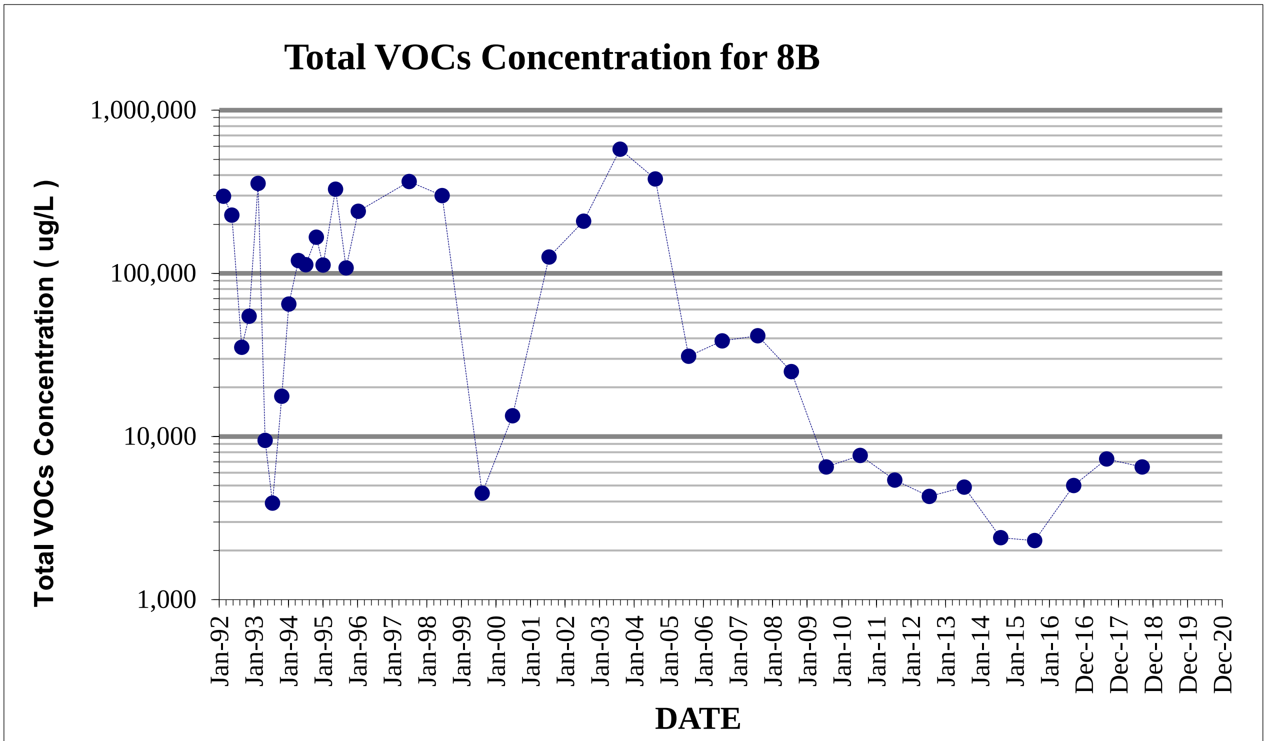

Total VOCs Concentration for 1BR
Total VOCs Concentration (ug/L)
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
DATE


Total VOCs Concentration for 2B
Total VOCs Concentration (ug/L)
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
DATE

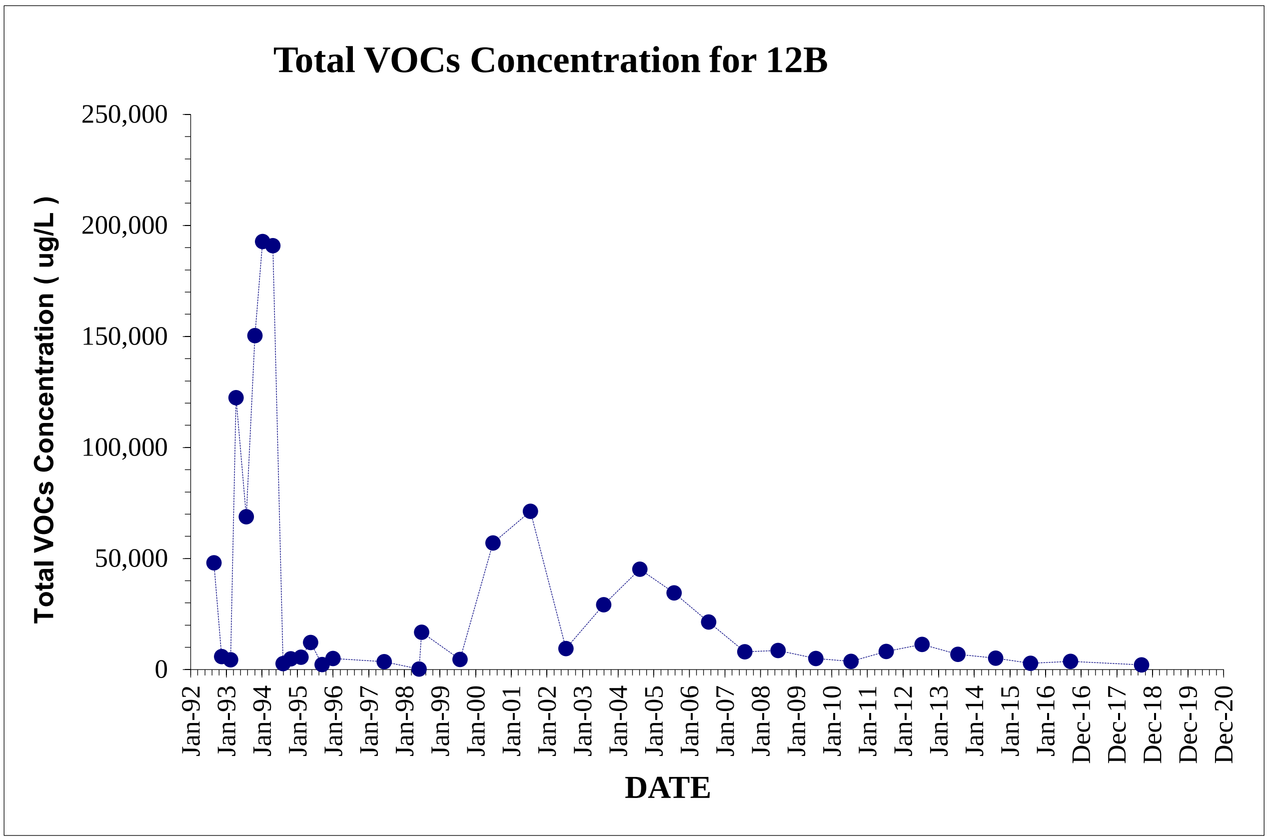


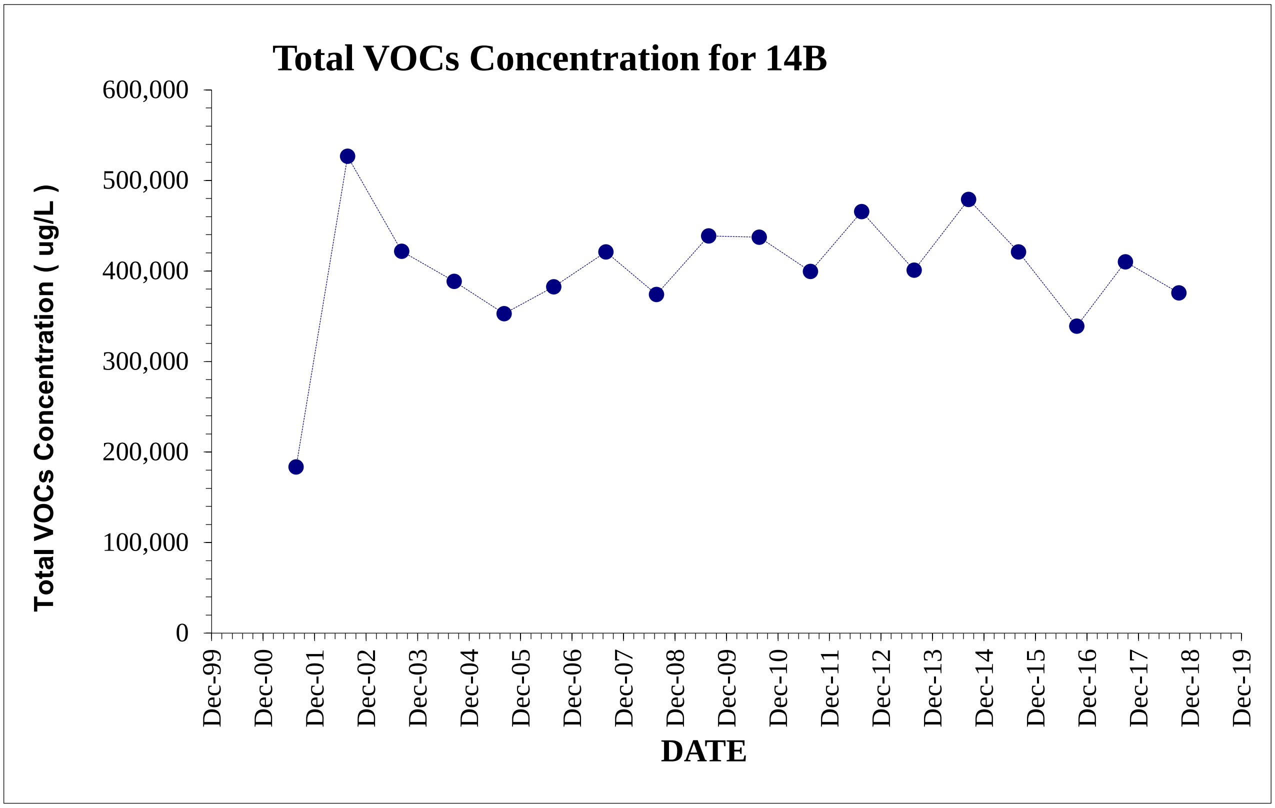


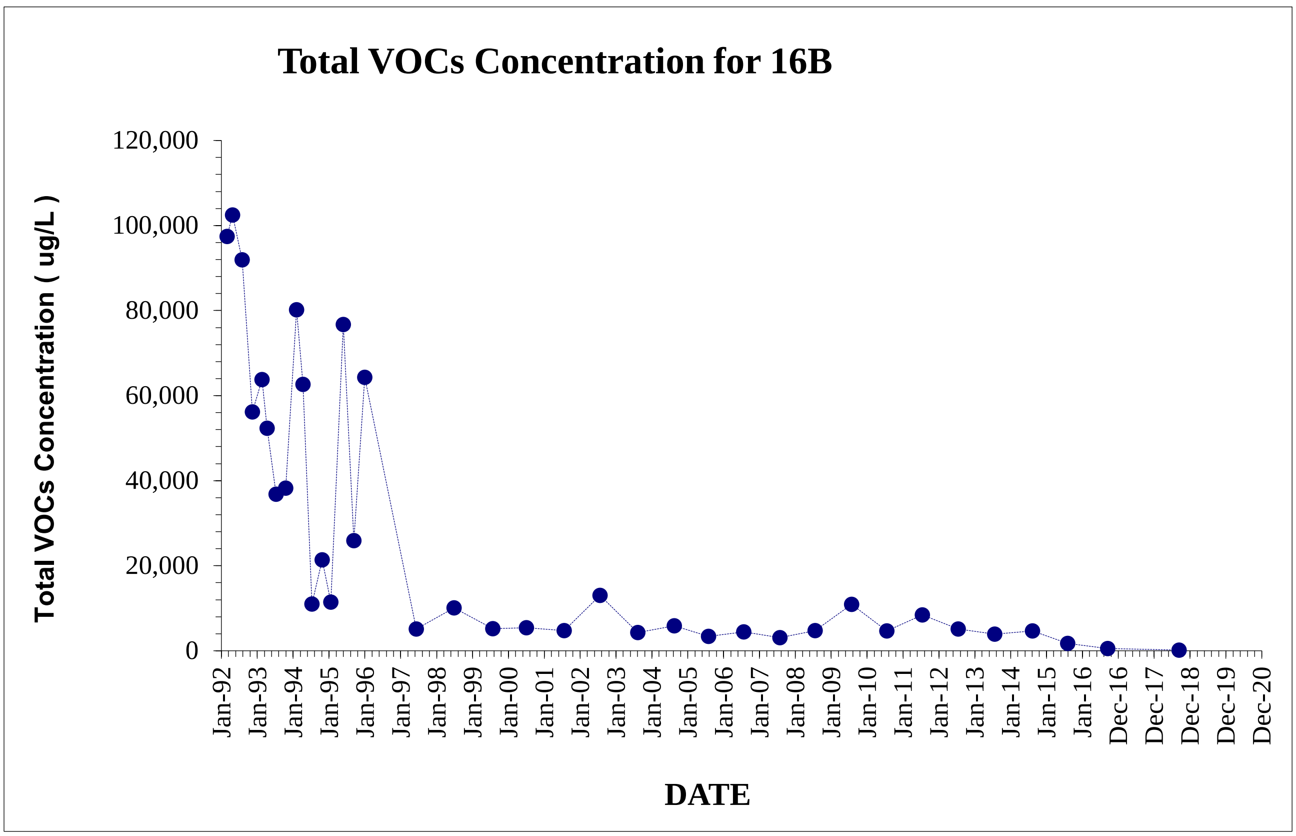
Note: Semi-log scale to distinguish changes at lower range of concentrations.

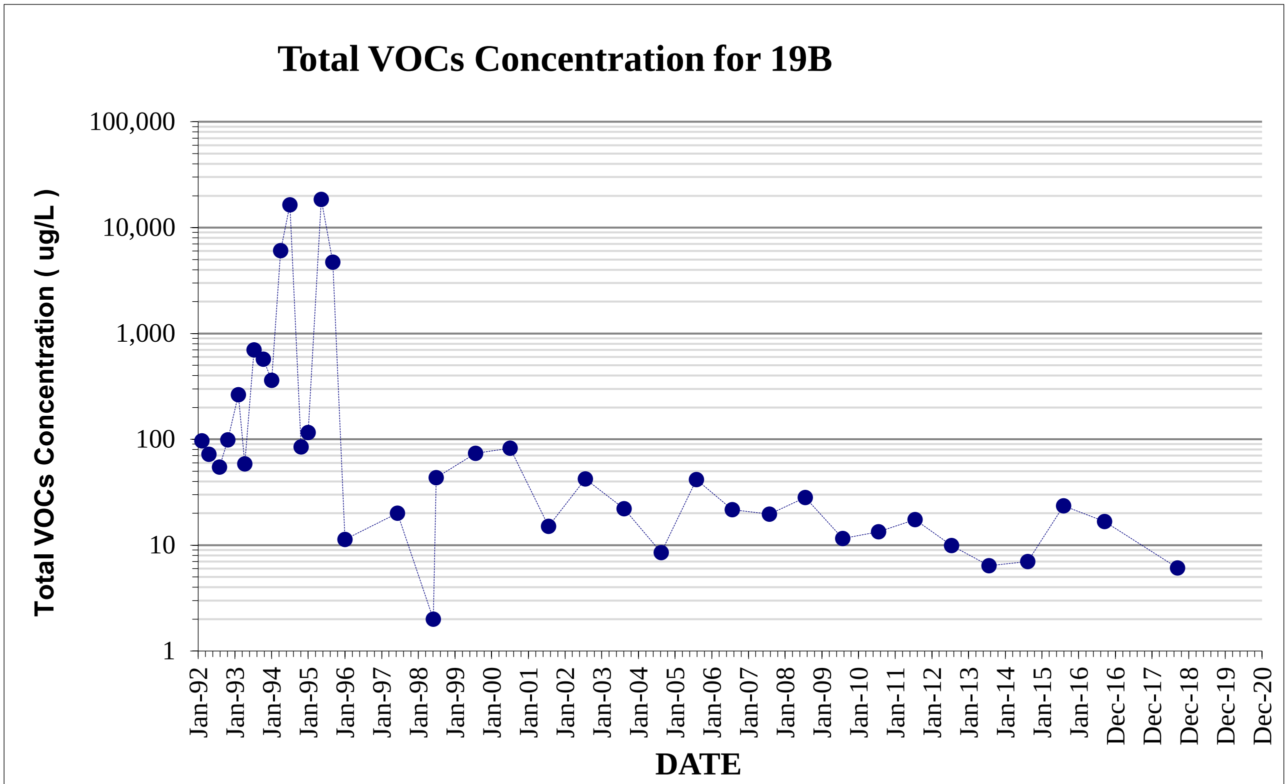


Note: Semi-log scale to distinguish changes at lower range of concentrations. THT is only VOC.

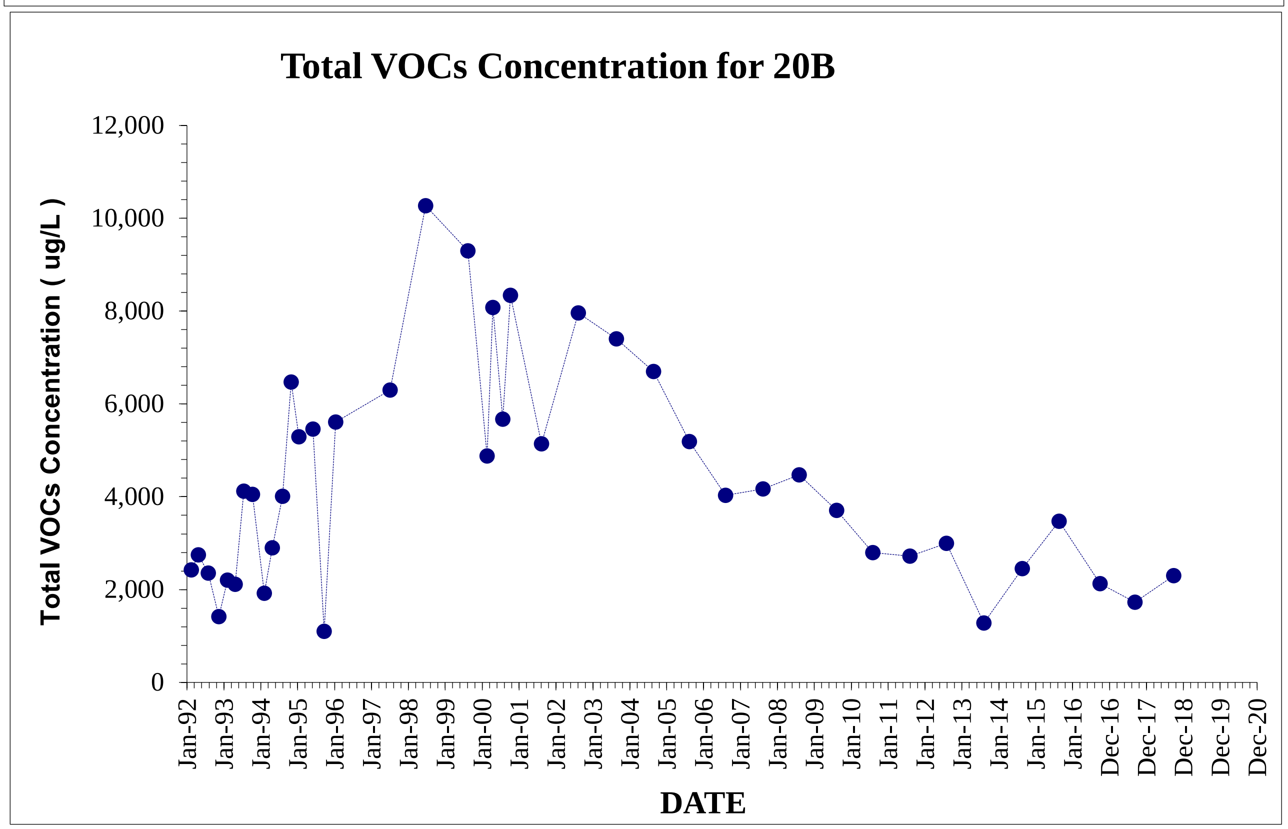


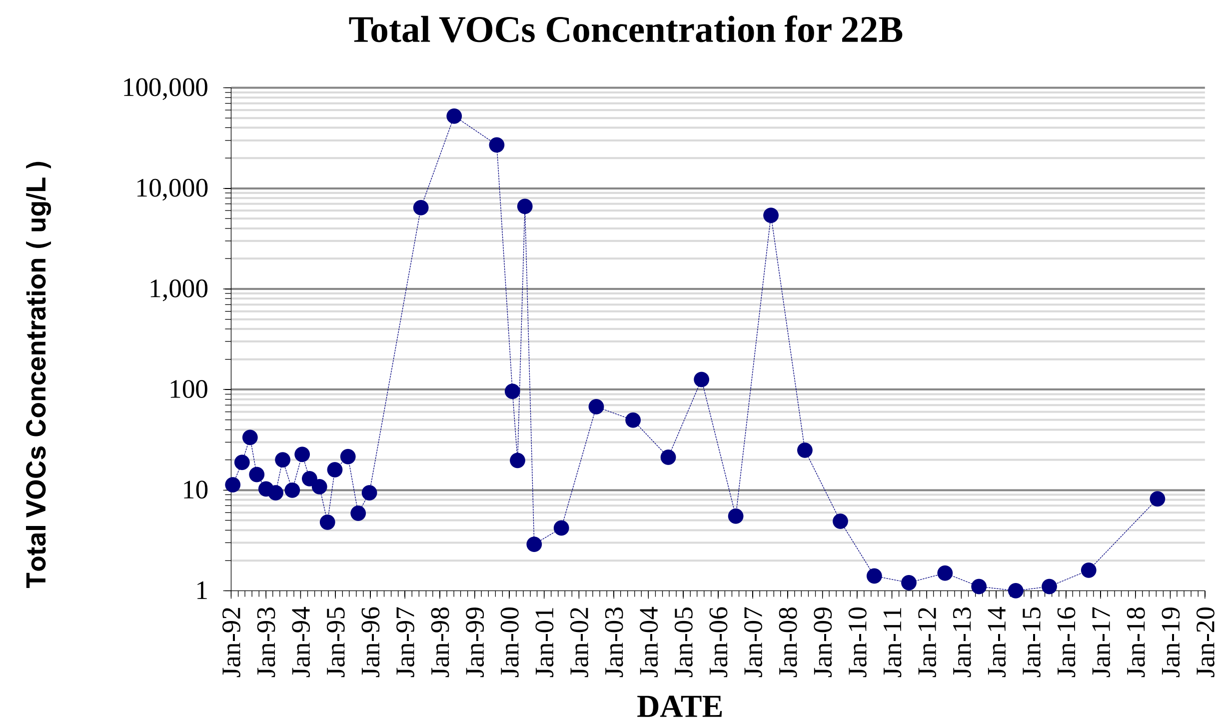

Total VOCs Concentration for 14B
Total VOCs Concentration (ug/L)
600,000
500,000
400,000
300,000
200,000
100,000
0
Dec-99
Dec-00
Dec-01
Dec-02
Dec-03
Dec-04
Dec-05
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
Dec-14
Dec-15
Dec-16
Dec-17
Dec-18
Dec-19
DATE


Total VOCs Concentration for 16B
Total VOCs Concentration (ug/L)
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
DATE

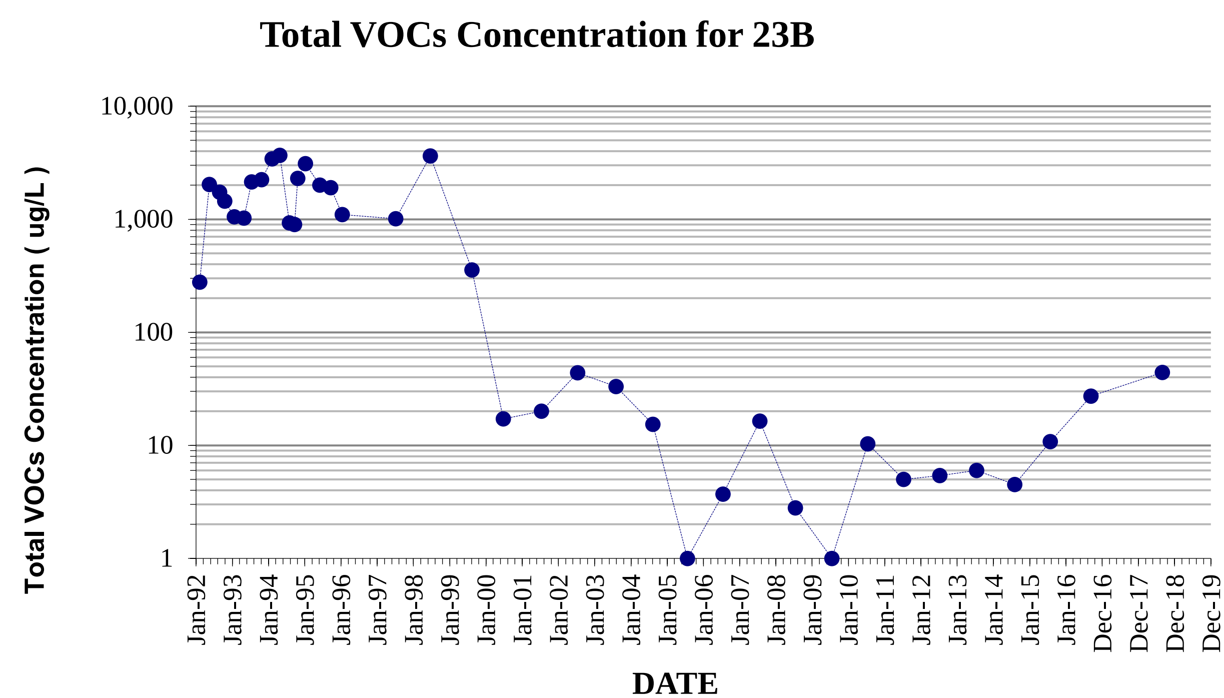


Note: Semi-log scale to distinguish changes at lower range of concentrations.

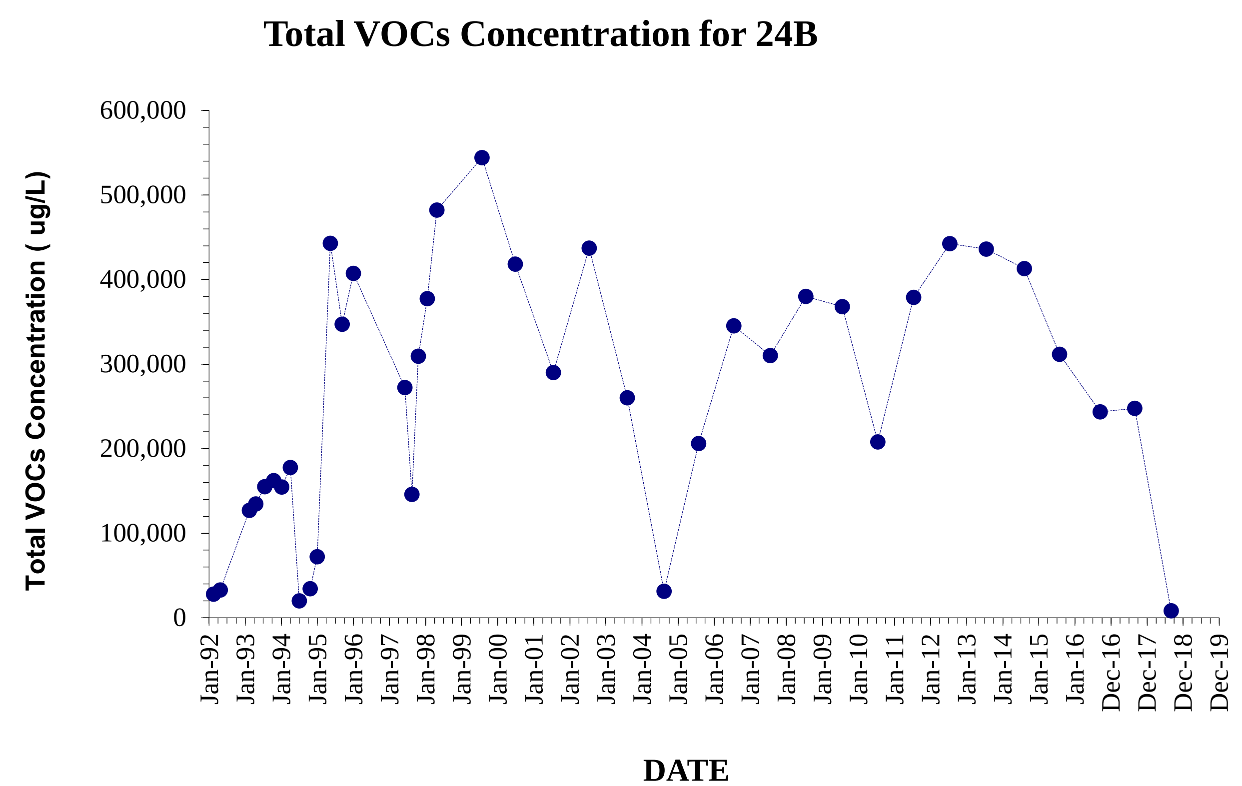


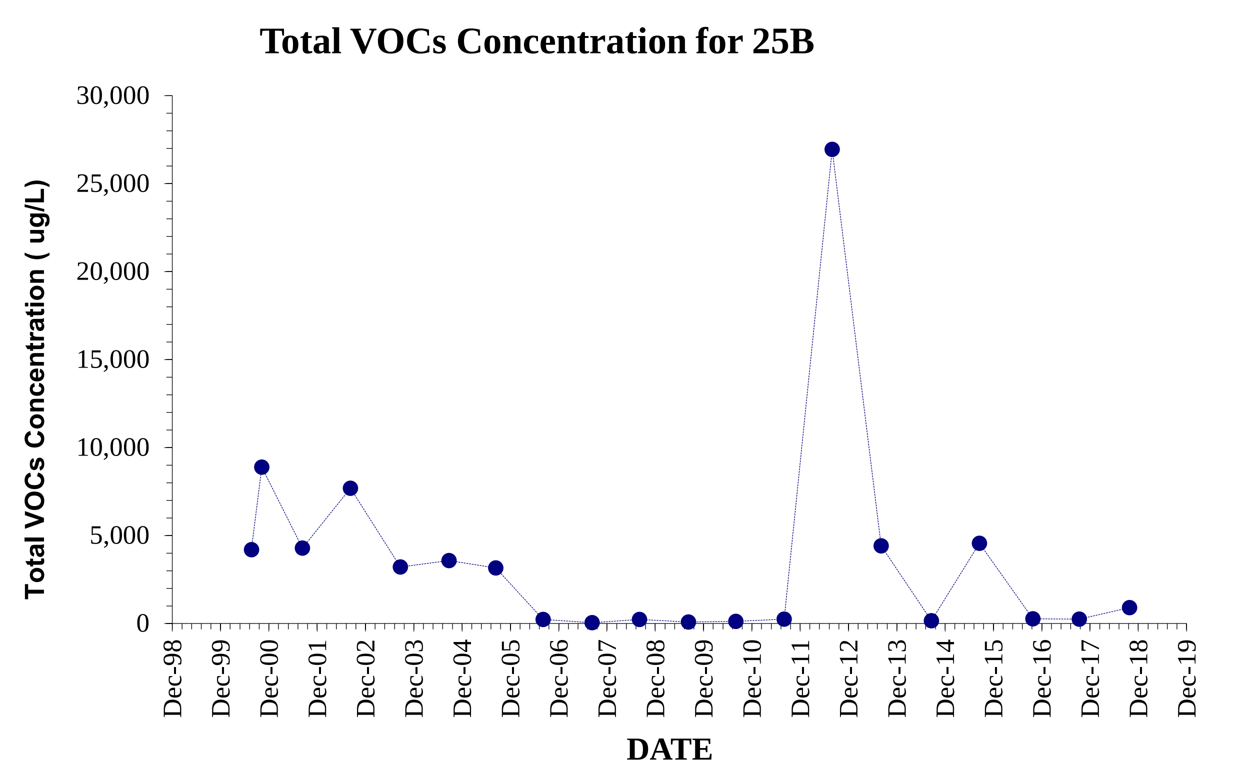


Note: Semi-log scale to distinguish changes at lower range of concentrations. 2014 VOC results were all ND, a value of 1 ug/L was given for graphing purposes.

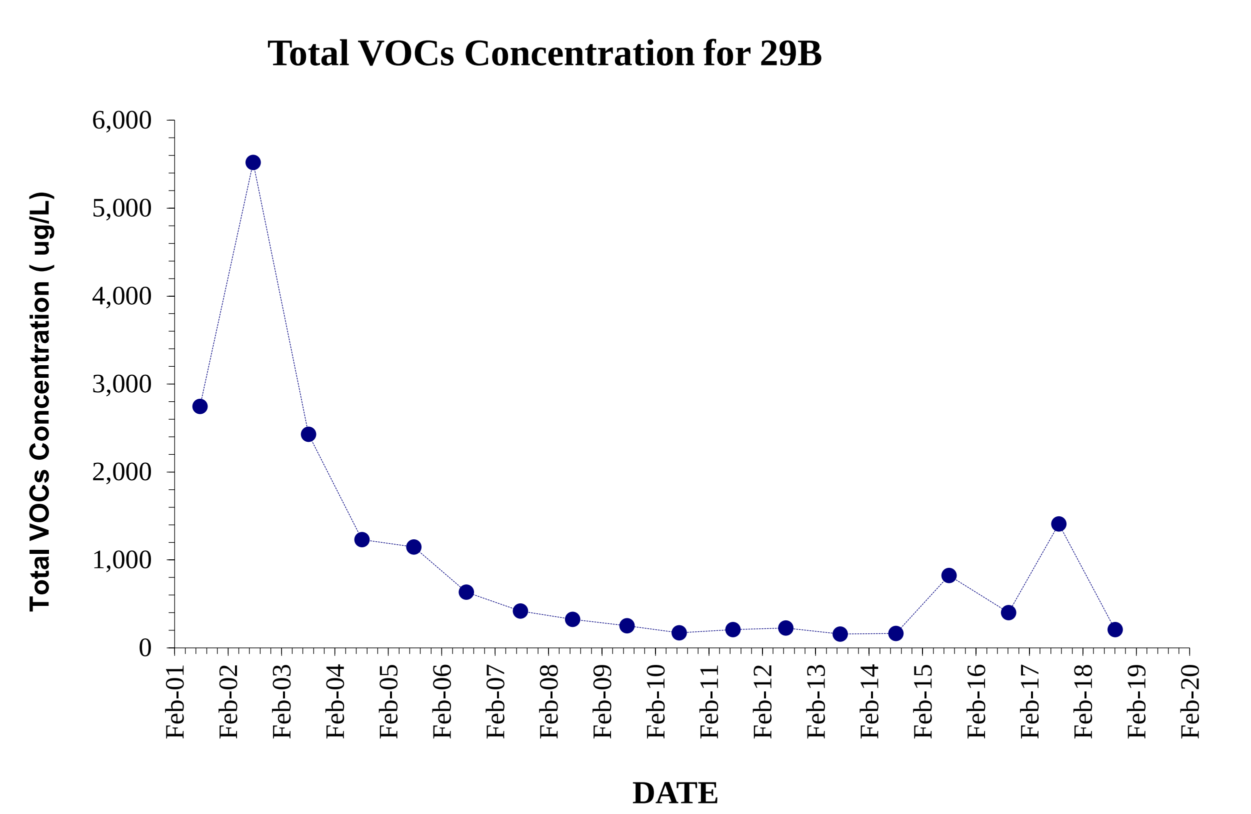


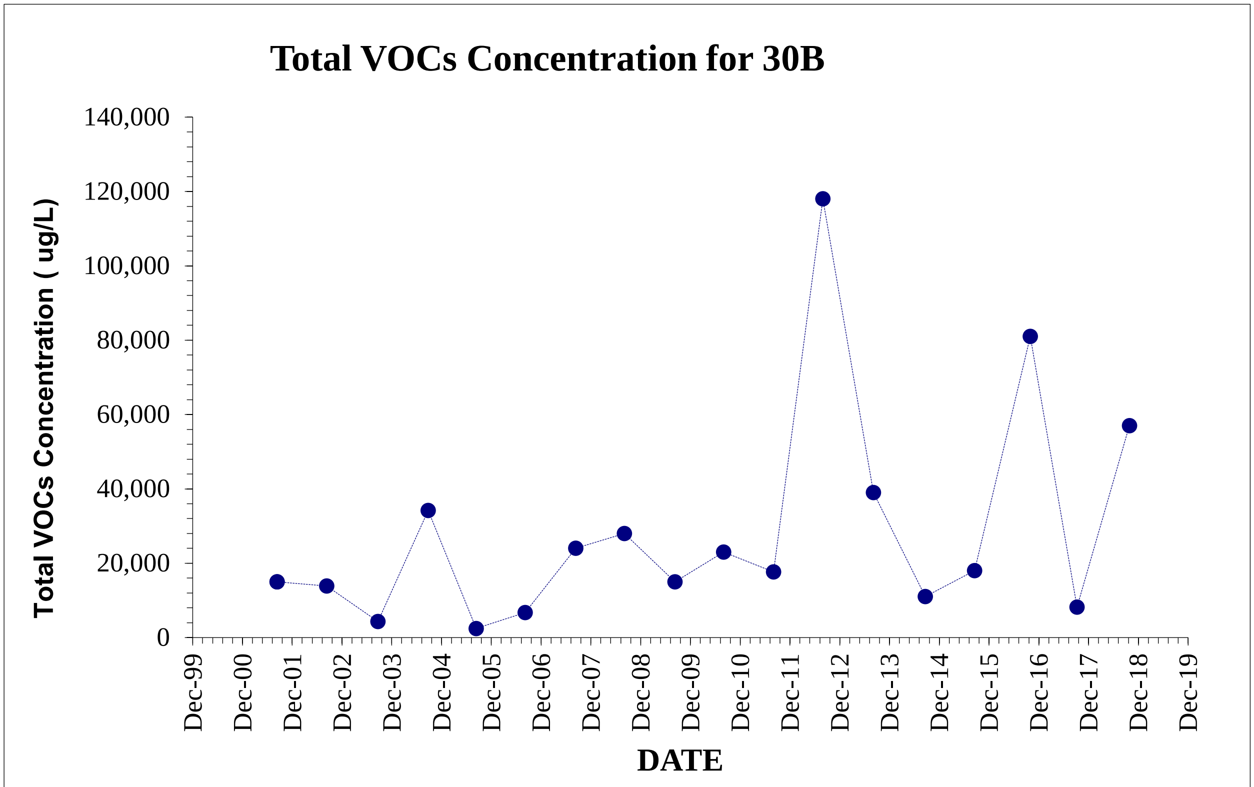
Note: Semi-log scale to distinguish changes at lower range of concentrations. 2009 VOC results were all ND, a value of 1 ug/L was given for graphing purposes



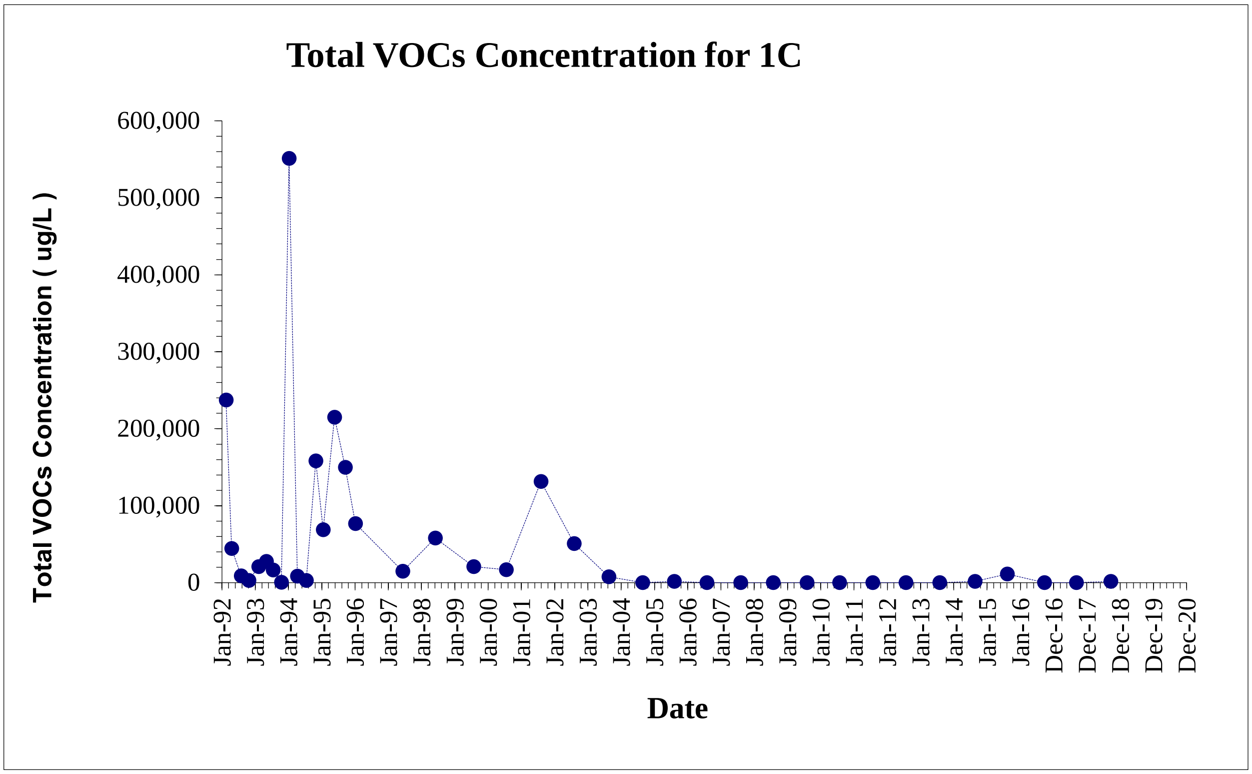


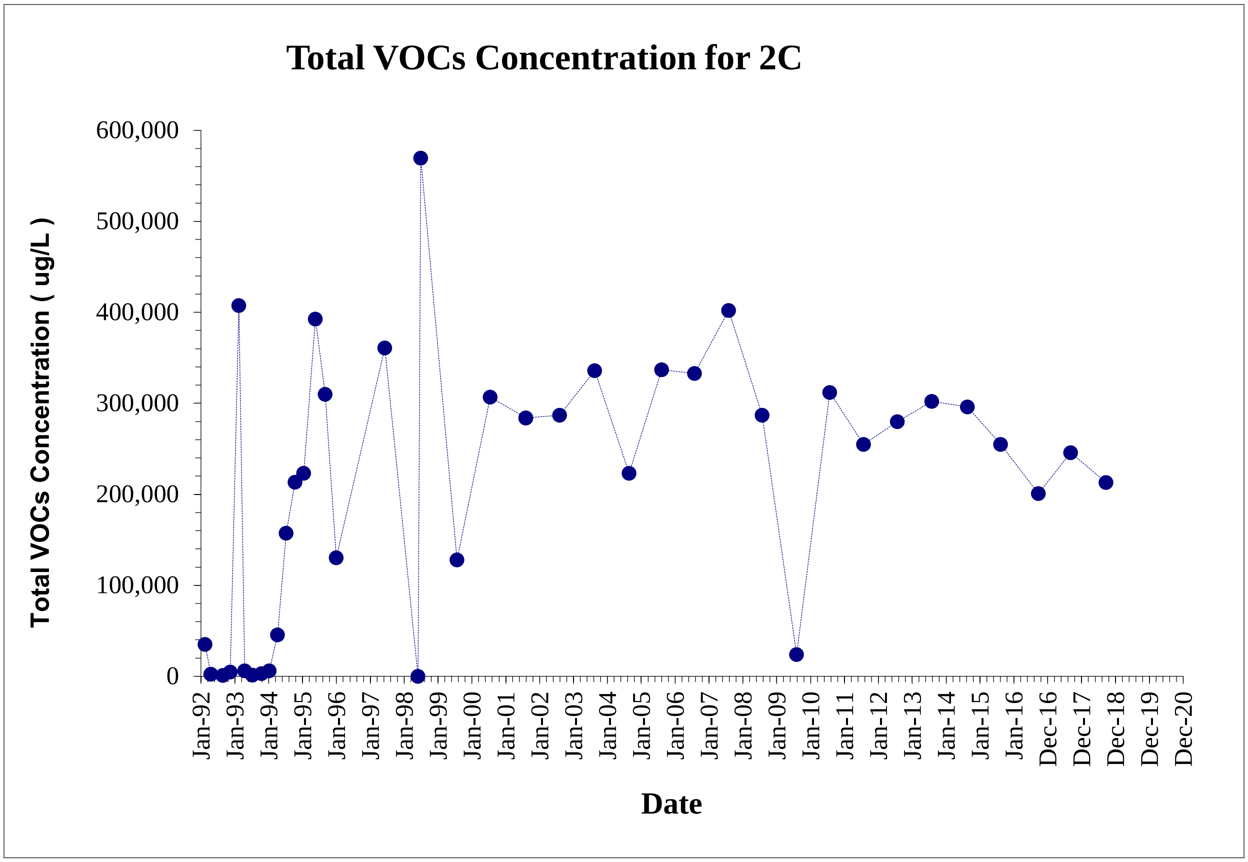
VOCs are predominantly chlorobenzene, THT, 1,2-dichlorobenzene, and 1,4-dichlorobenzene.

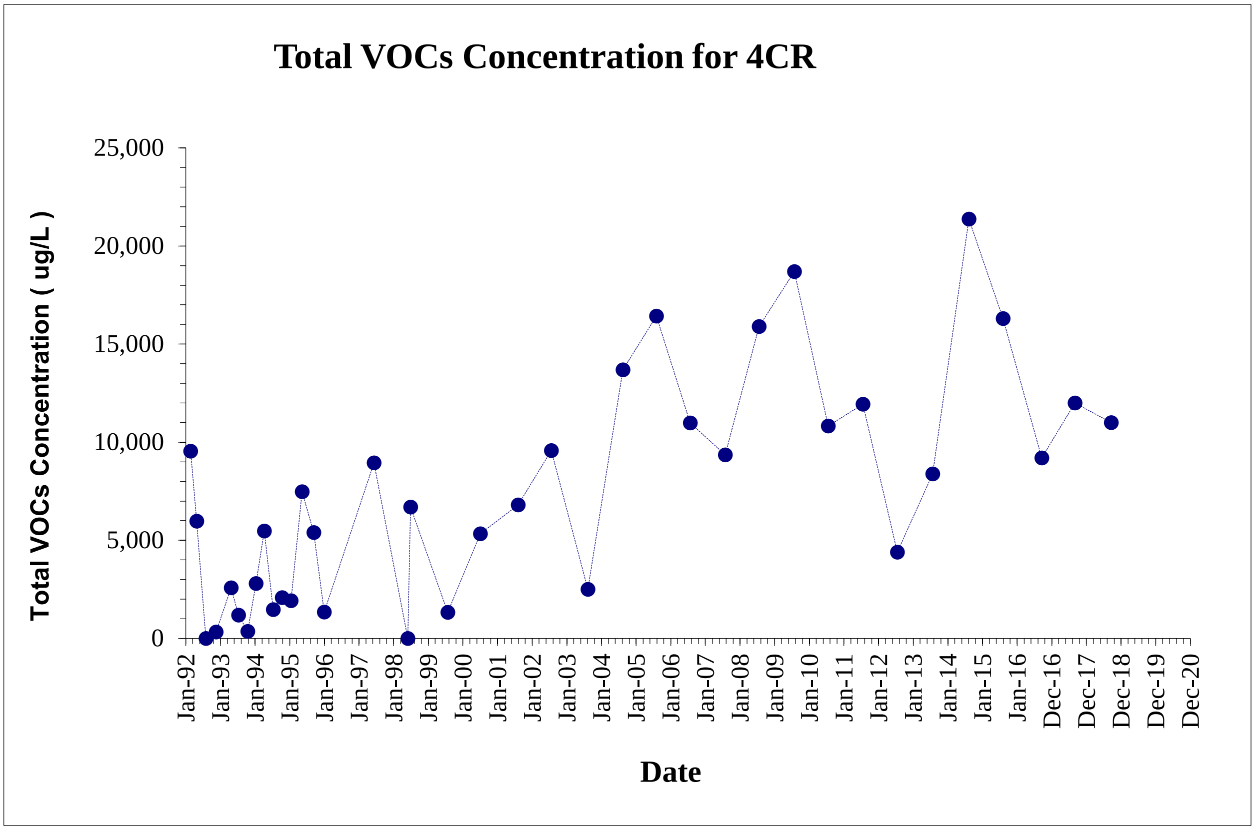


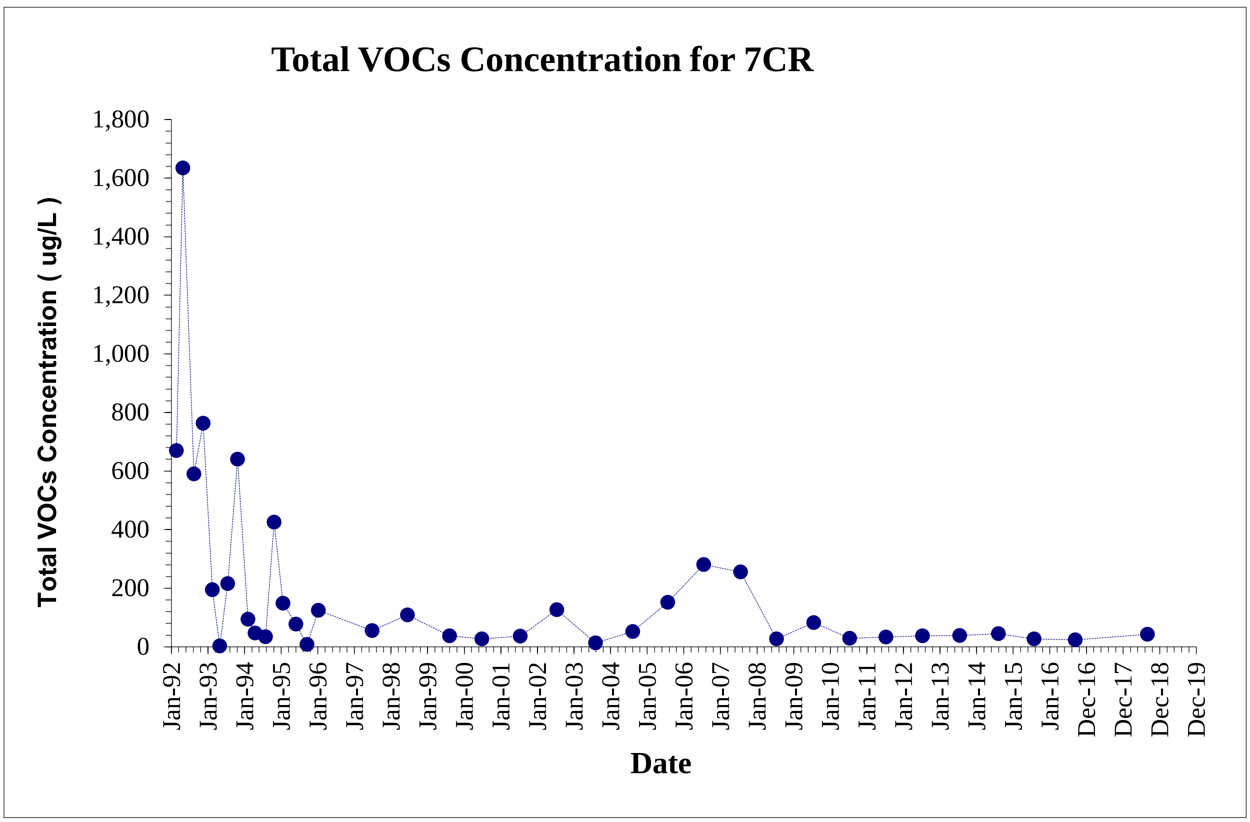


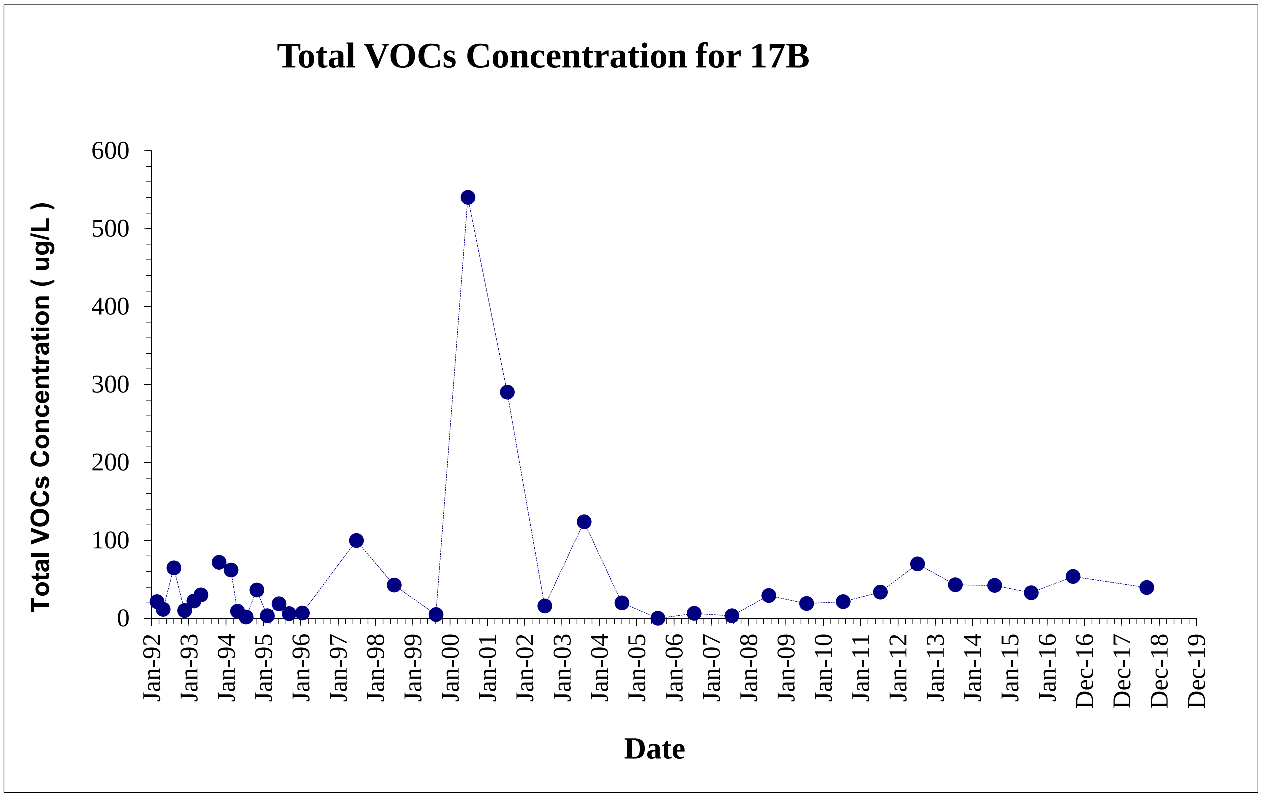
Note: VOCs are THT only.

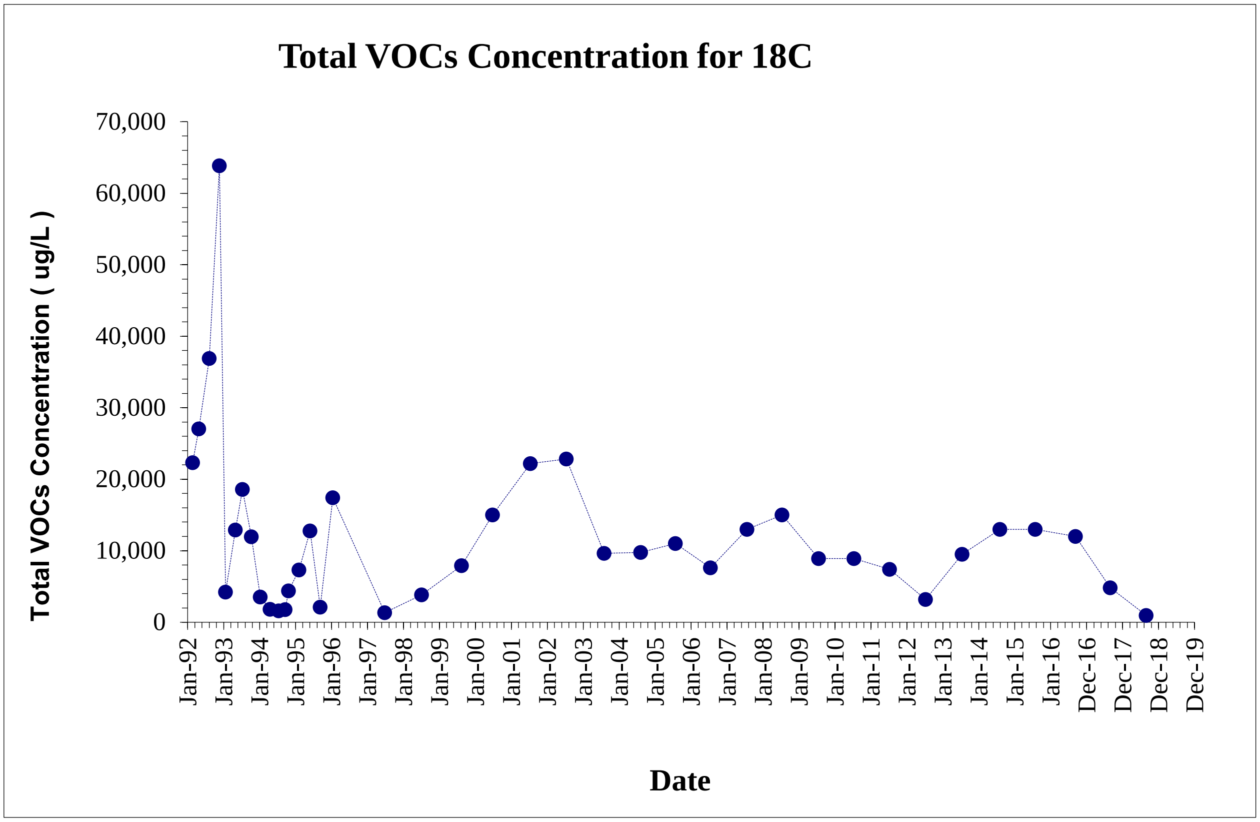

Total VOCs Concentration for 1C
Total VOCs Concentration (ug/L)
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

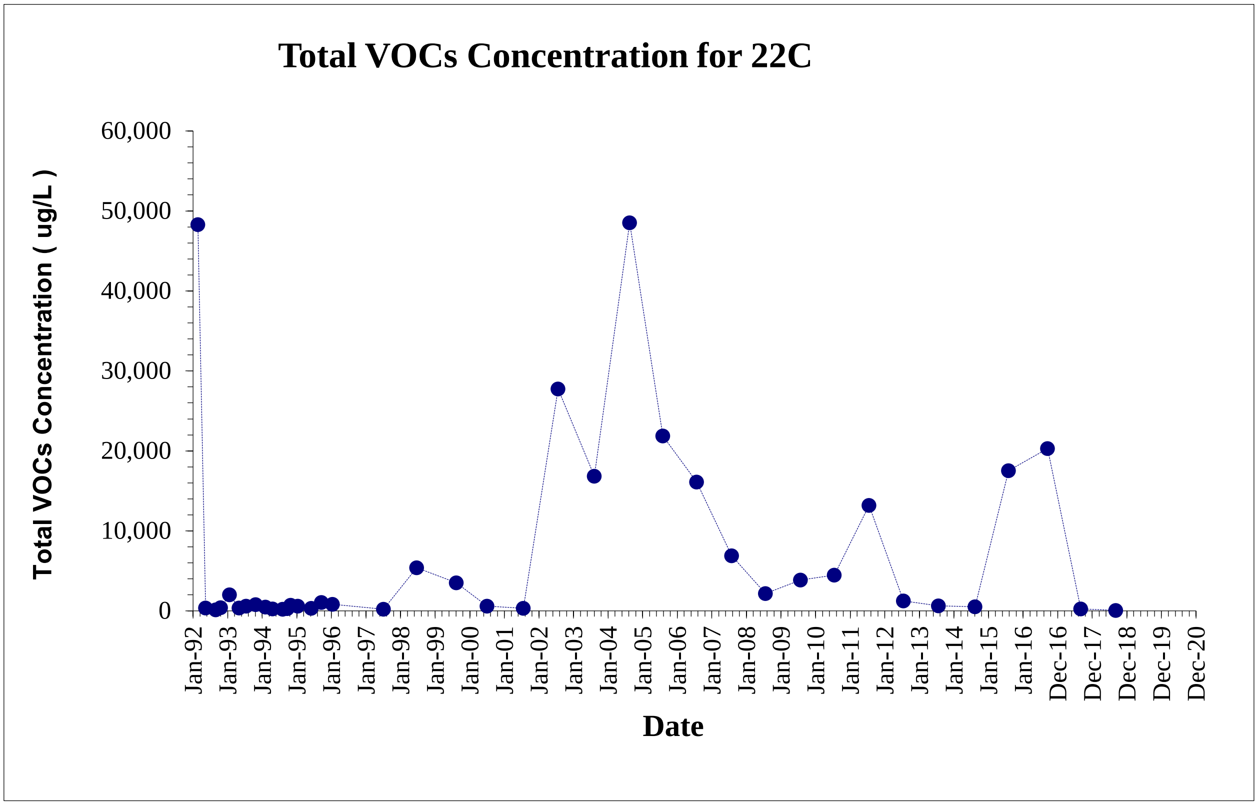

Total VOCs Concentration for 2C
Total VOCs Concentration (ug/L)
600,000
500,000
400,000
300,000
200,000
100,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

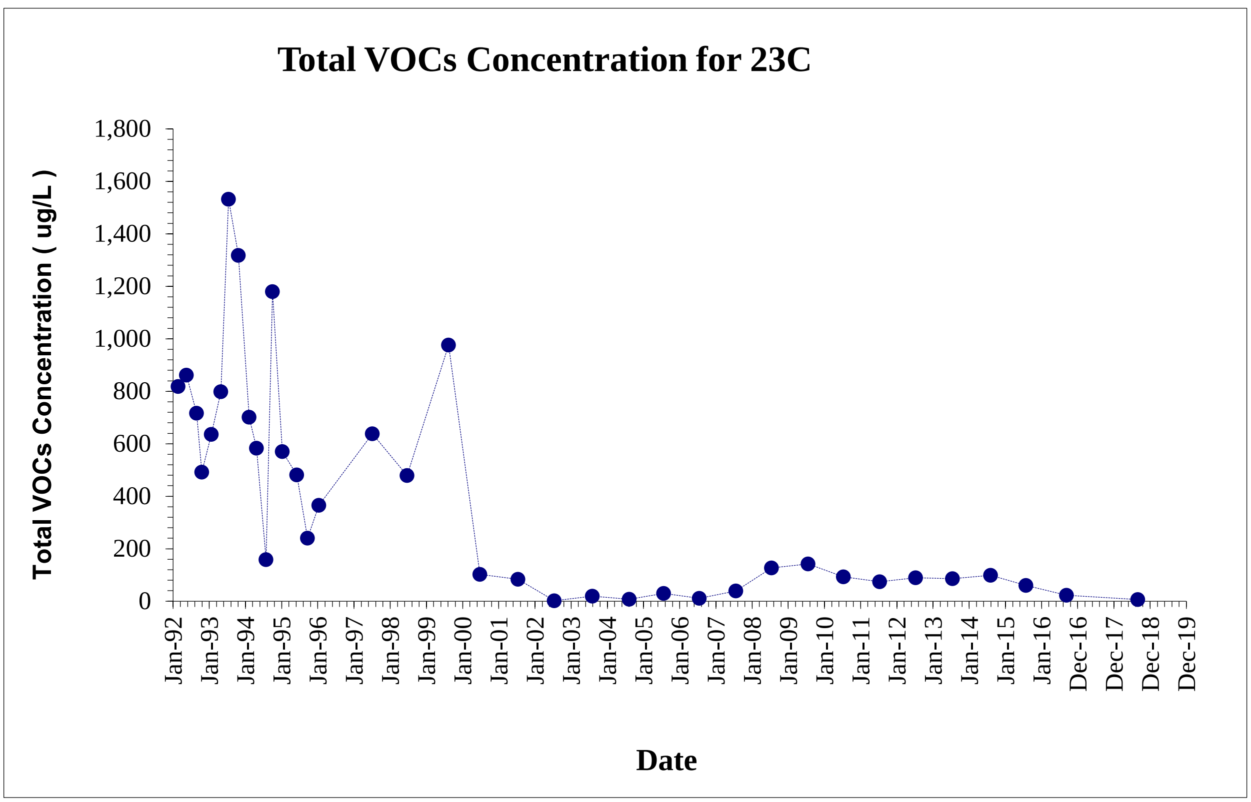

Total VOCs Concentration for 4CR
Total VOCs Concentration (ug/L)
25,000
20,000
15,000
10,000
5,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

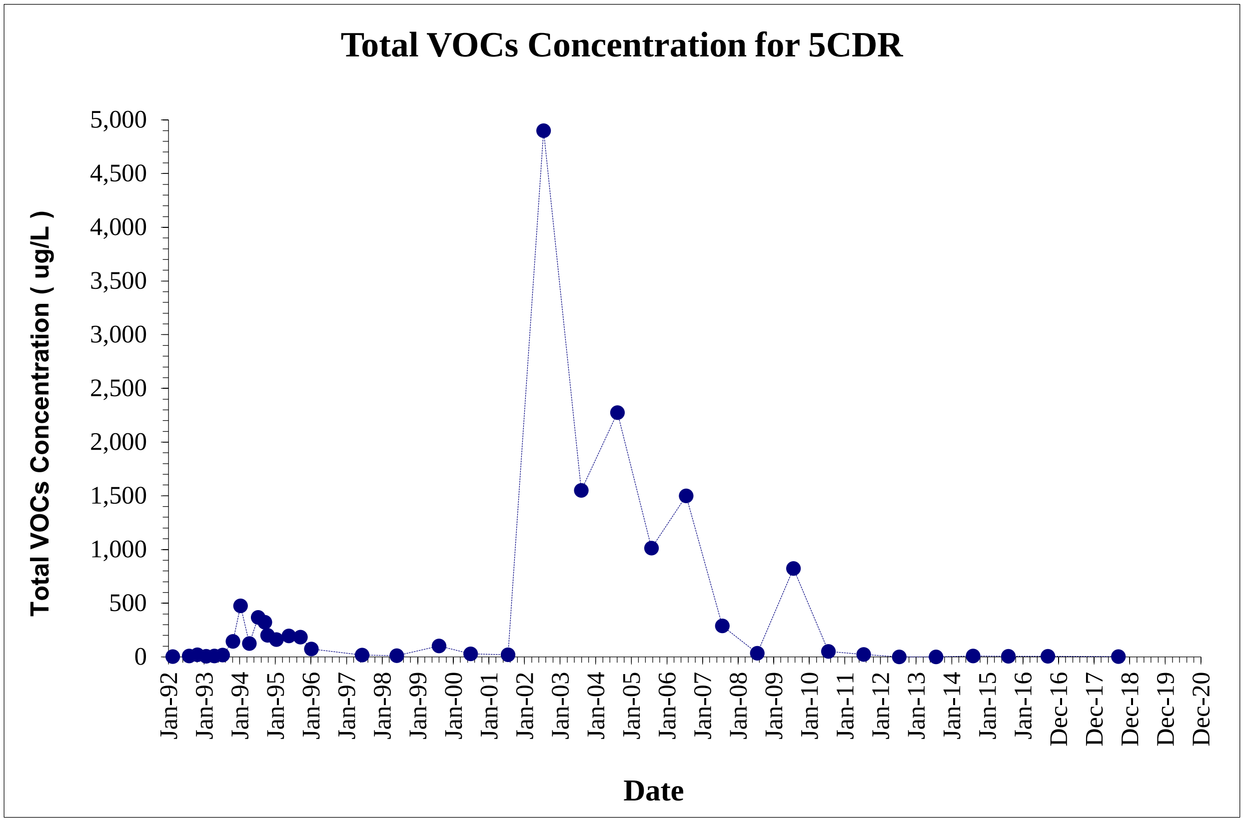

Total VOCs Concentration for 7CR
Total VOCs Concentration (ug/L)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date

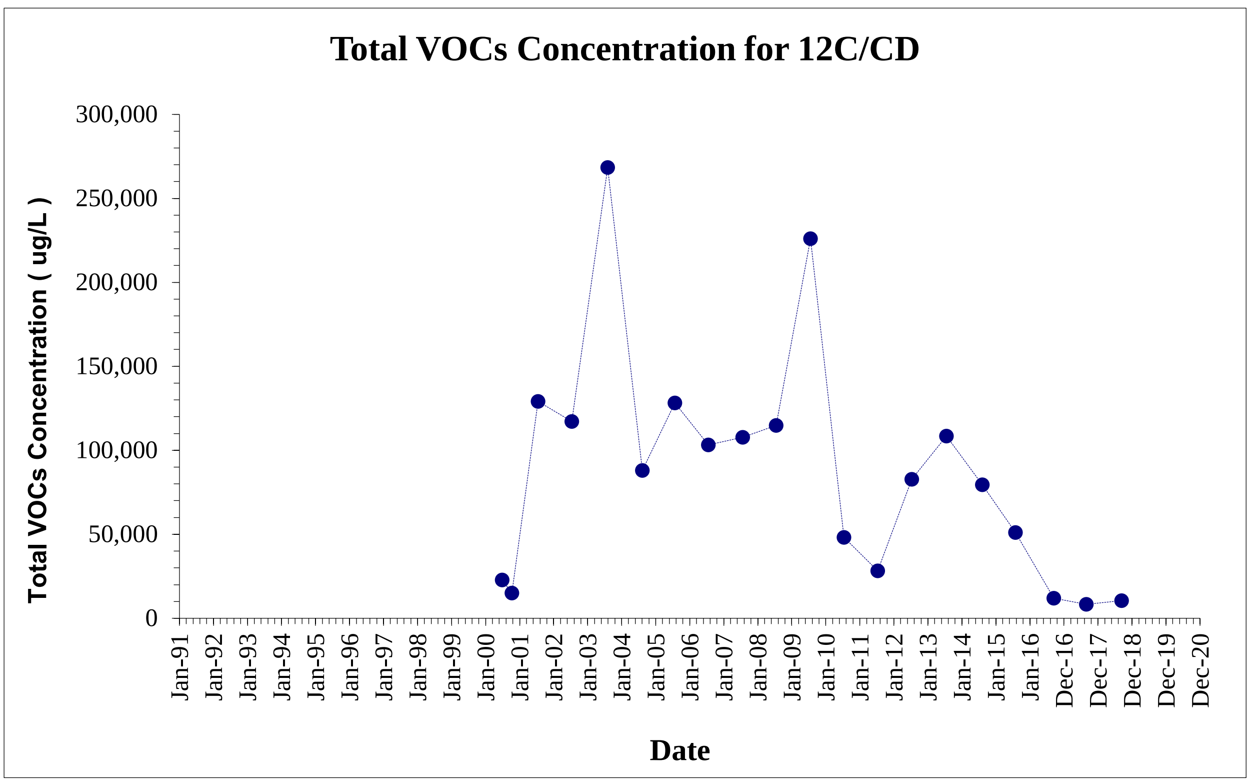

Total VOCs Concentration for 17B
Total VOCs Concentration (ug/L)
600
500
400
300
200
100
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date

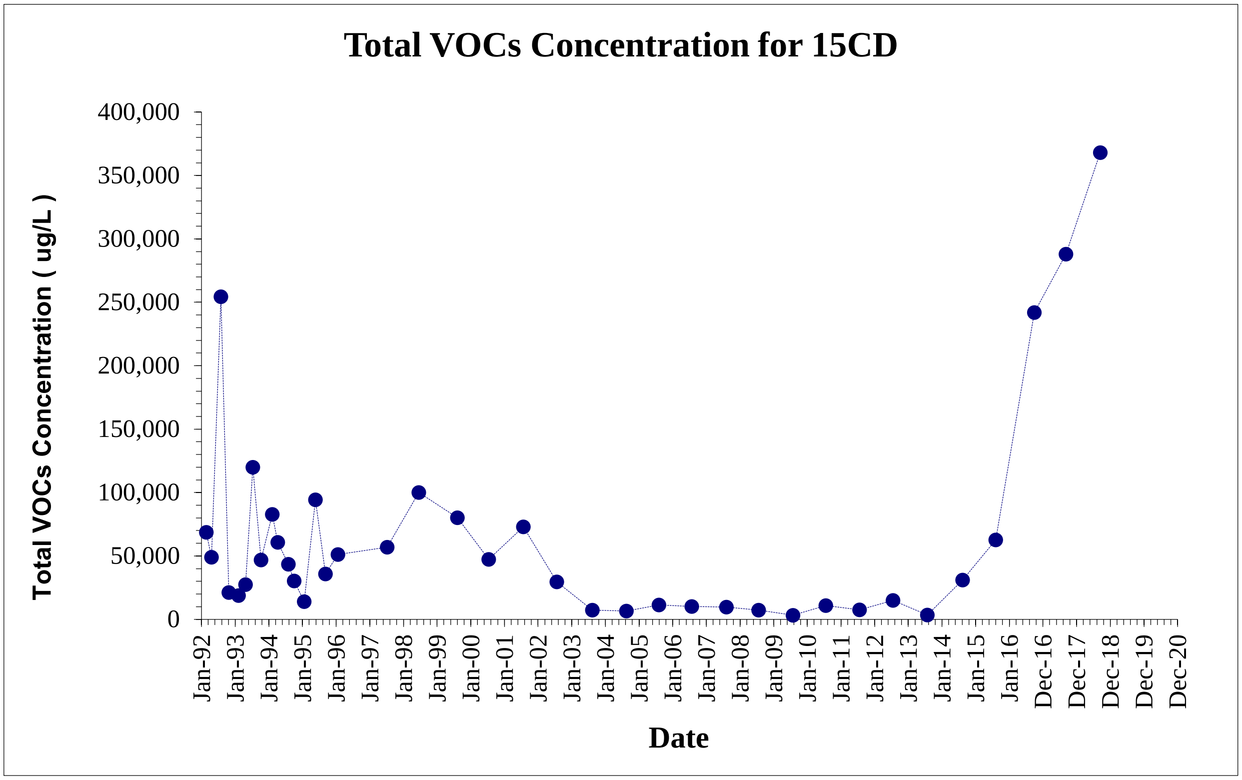

Total VOCs Concentration for 18C
Total VOCs Concentration (ug/L)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date

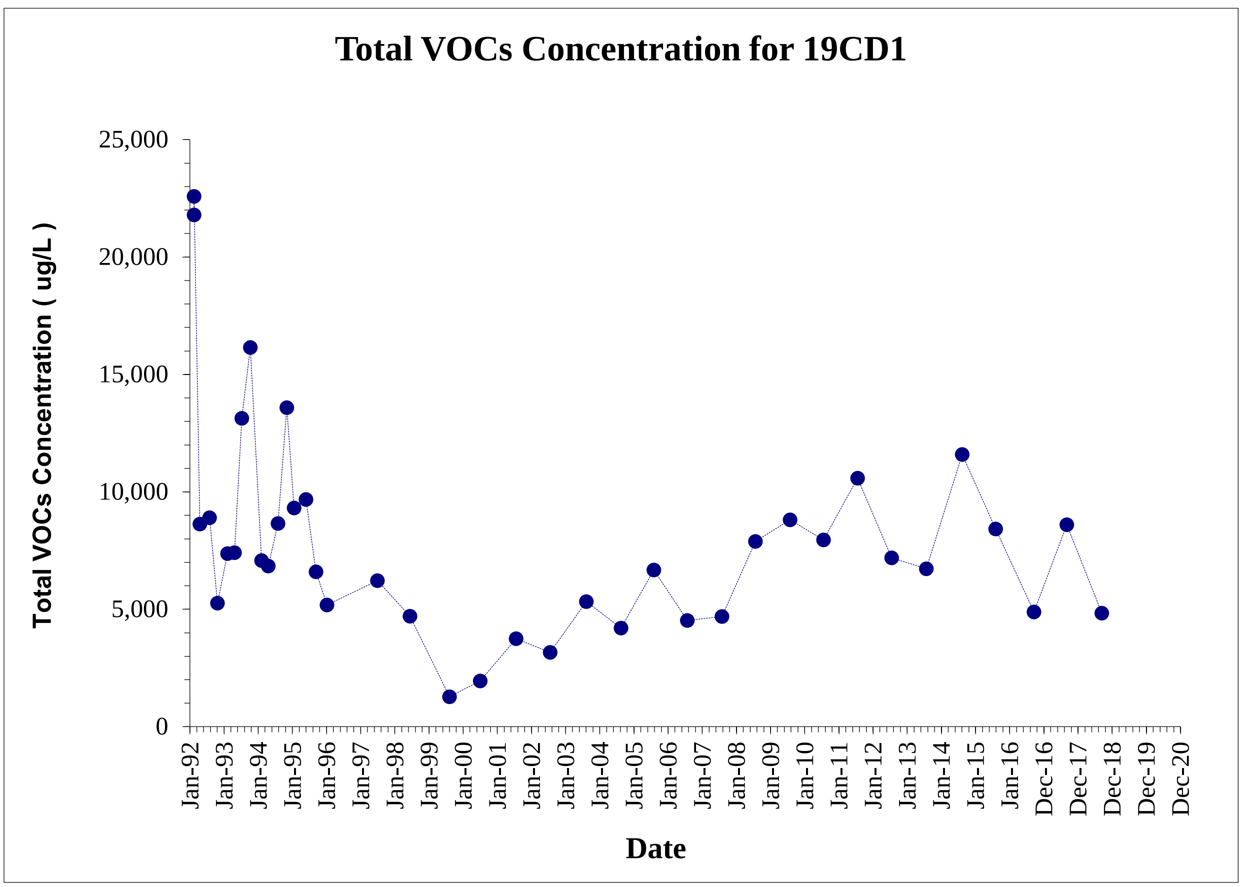

Total VOCs Concentration for 22C
Total VOCs Concentration (ug/L)
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

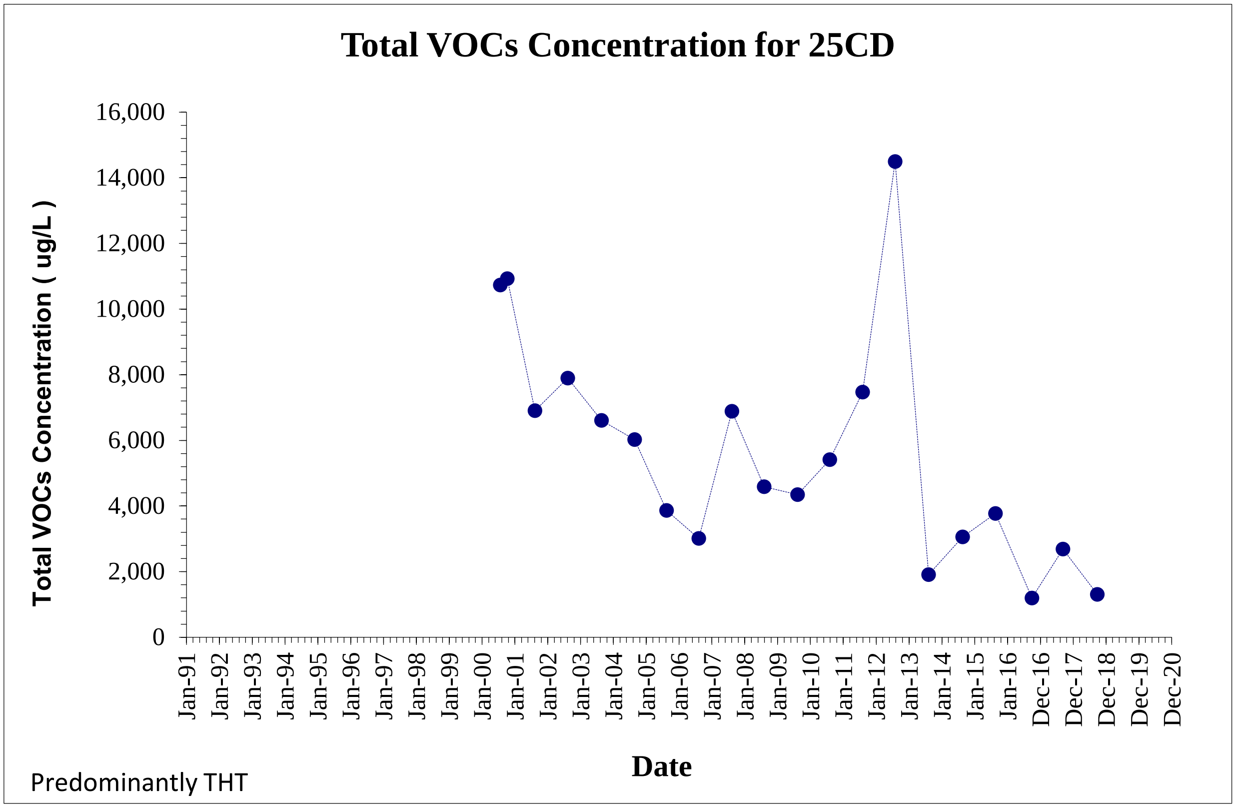

Total VOCs Concentration for 23C
Total VOCs Concentration (ug/L)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date

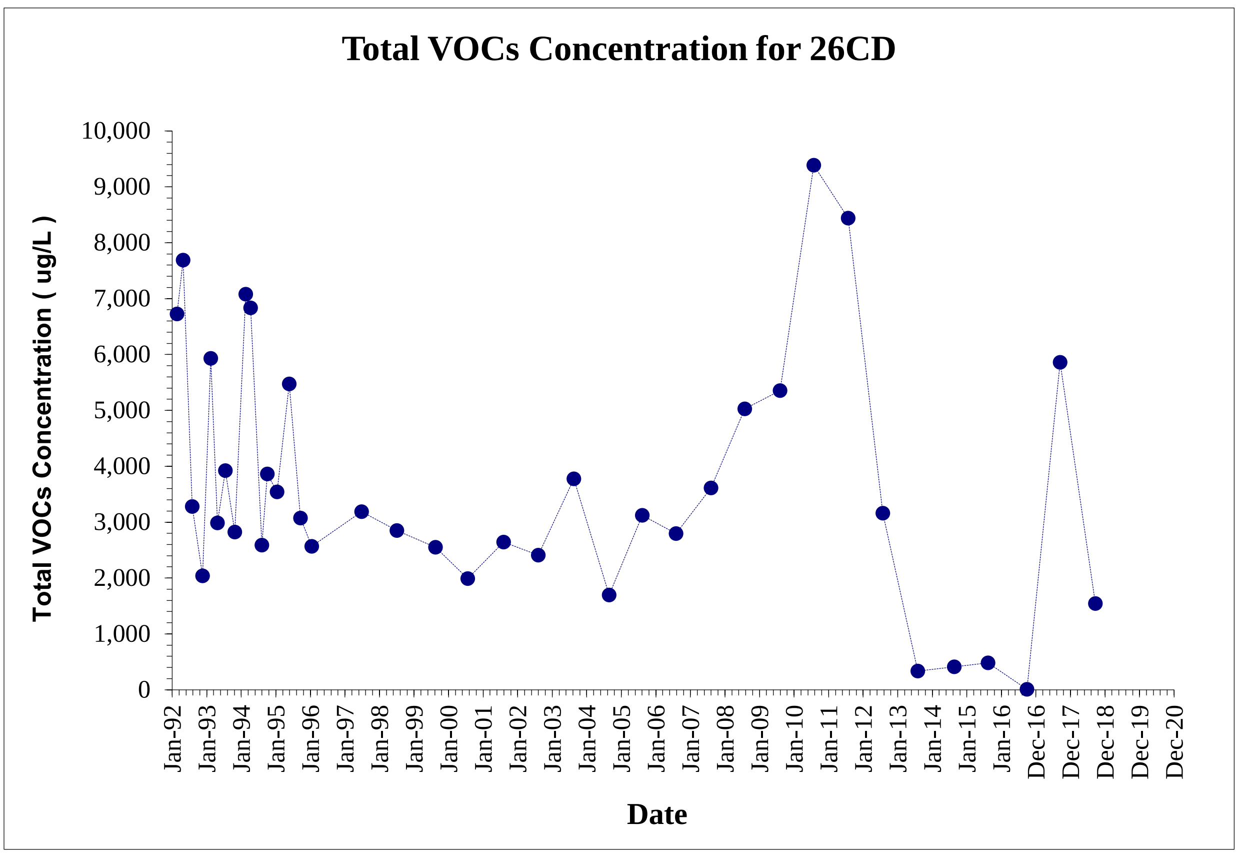

Total VOCs Concentration for 5CDR
Total VOCs Concentration (ug/L)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date


Total VOCs Concentration for 12C/CD
Total VOCs Concentration (ug/L)
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

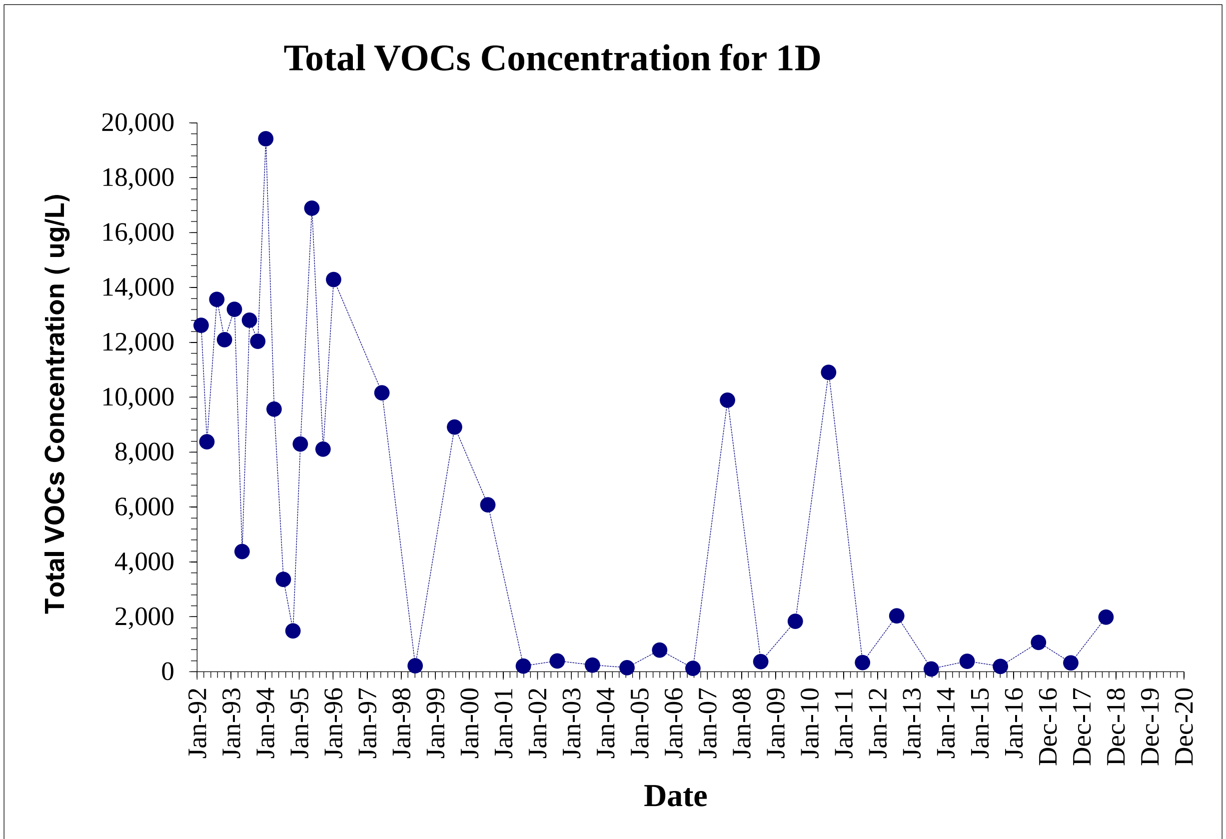

Total VOCs Concentration for 15CD
Total VOCs Concentration (ug/L)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date

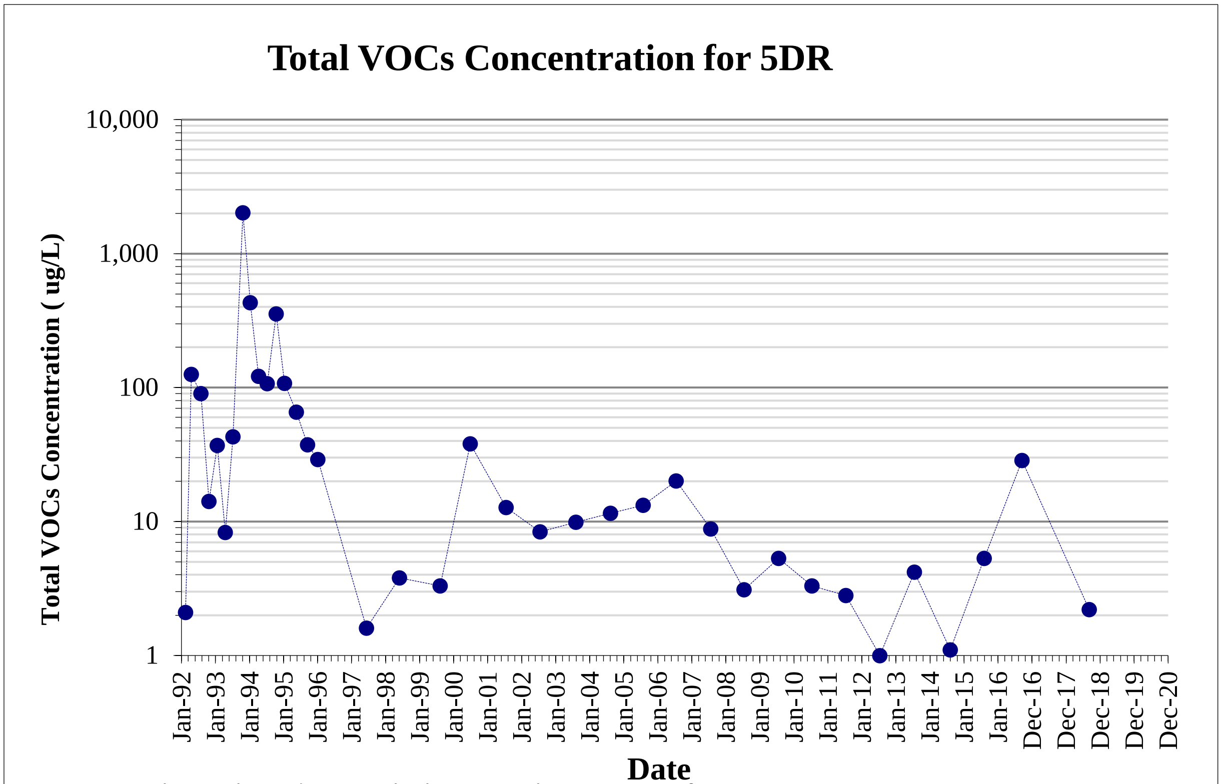

Total VOCs Concentration for 19CD1
Total VOCs Concentration (ug/L)
25,000
20,000
15,000
10,000
5,000
0
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date


Total VOCs Concentration for 25CD
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Total VOCs Concentration (ug/L)
Jan-91 Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date
Predominantly THT


Total VOCs Concentration for 26CD
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Total VOCs Concentration (ug/L)
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date

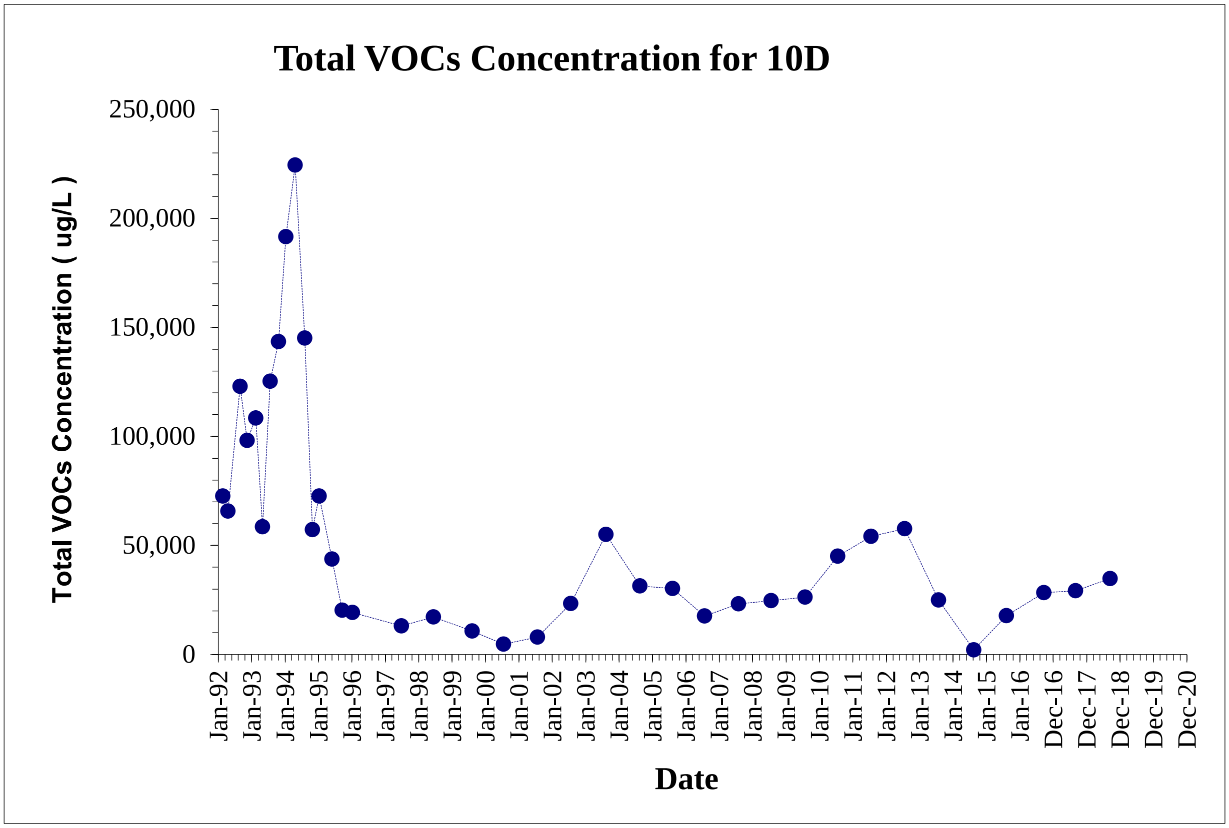
Appendix B
D-Zone TVOC Graphs

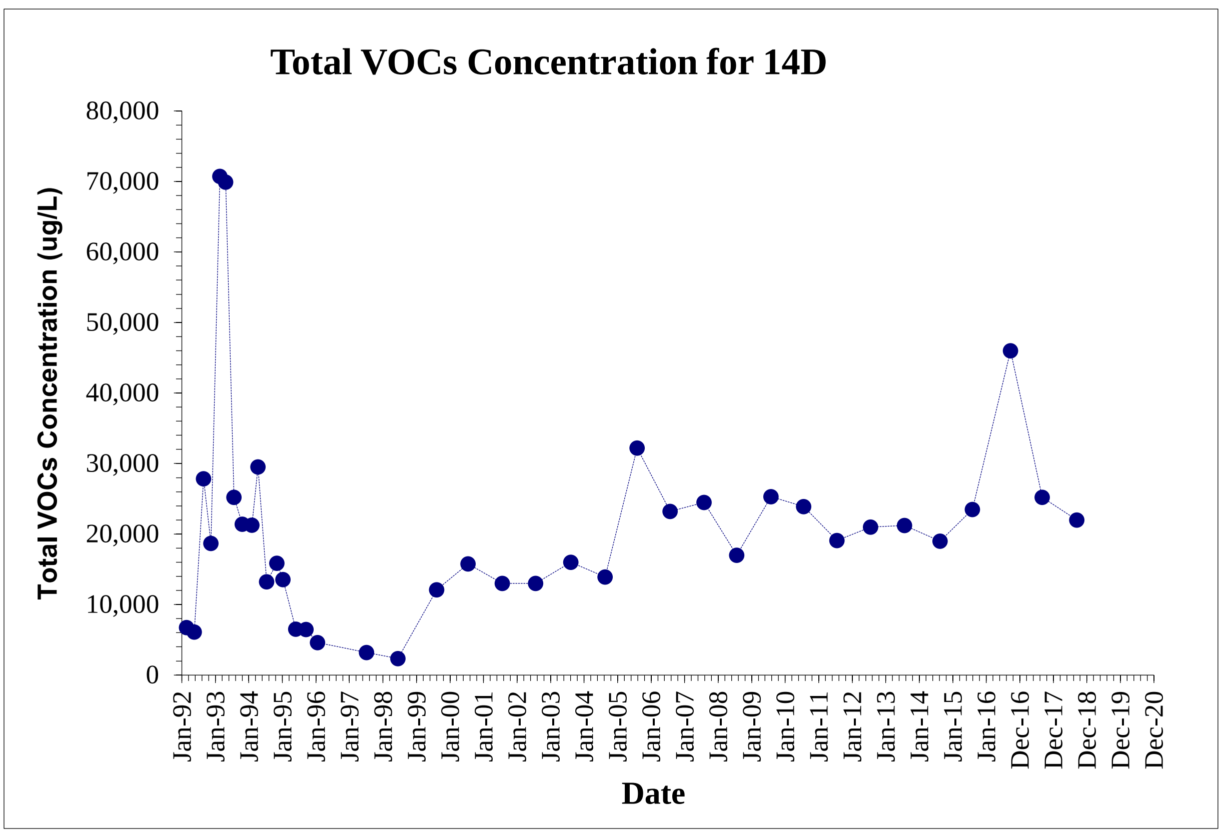


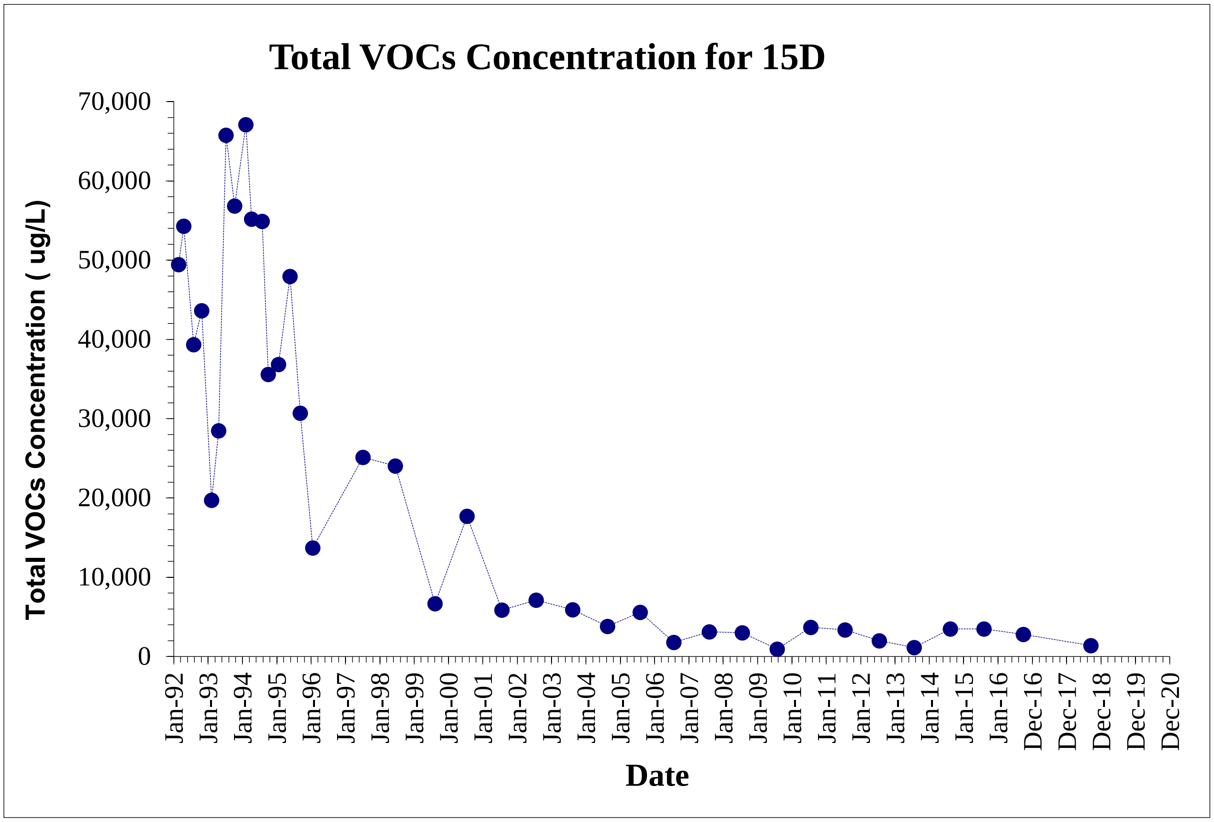


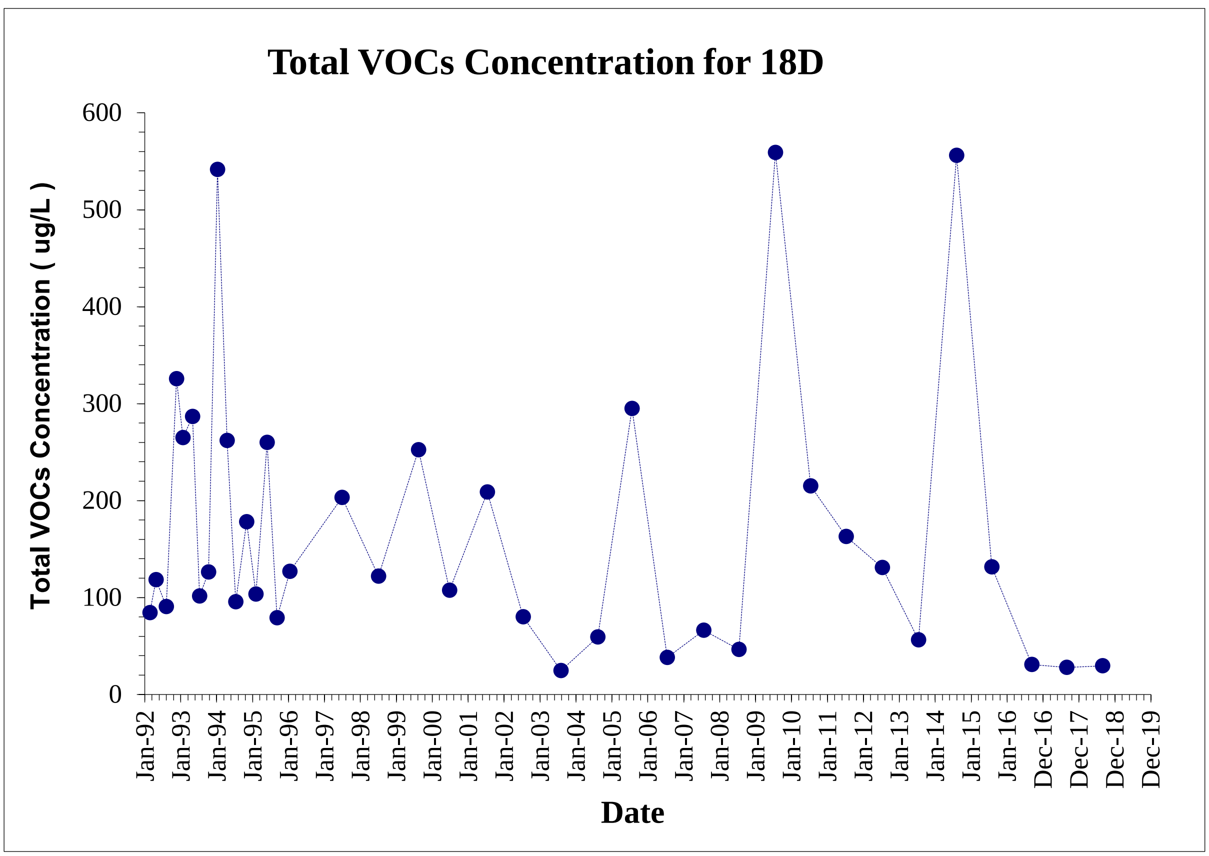
Note: Semi-log scale to distinguish changes at lower range of concentrations.
Nondetected value for 2012 represented as 1.0 ug/L.

Appendix B
D-Zone TVOC Graphs

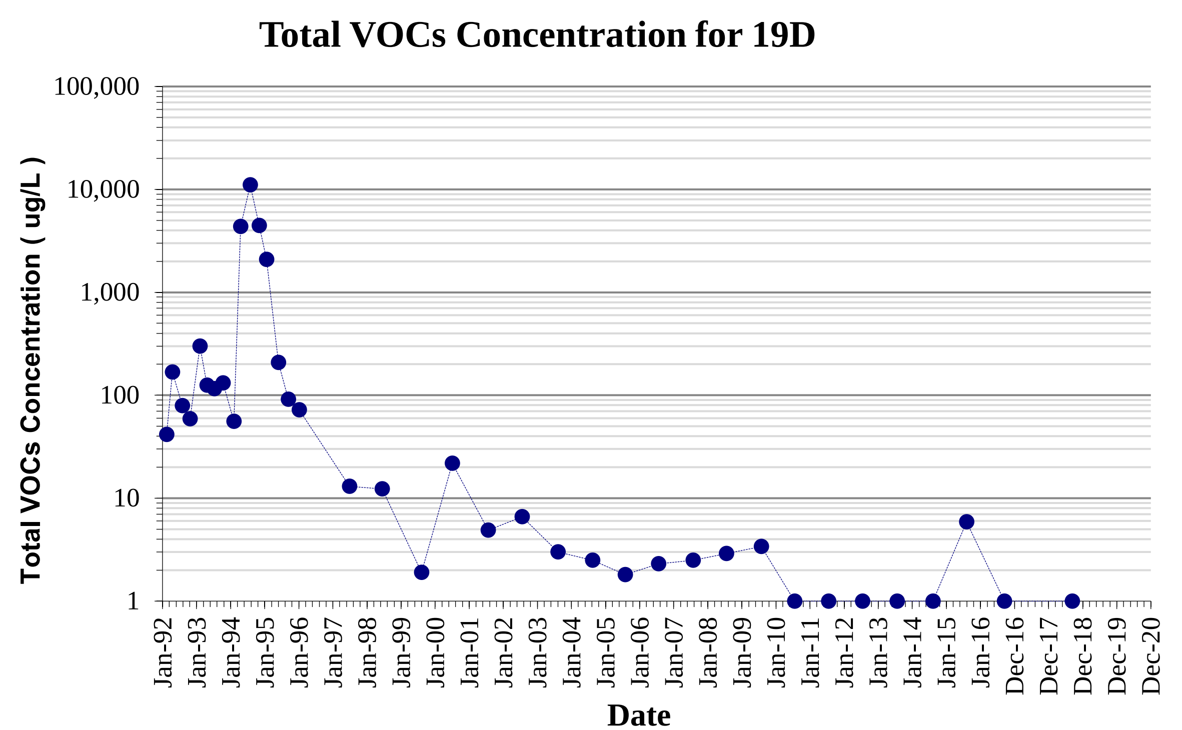




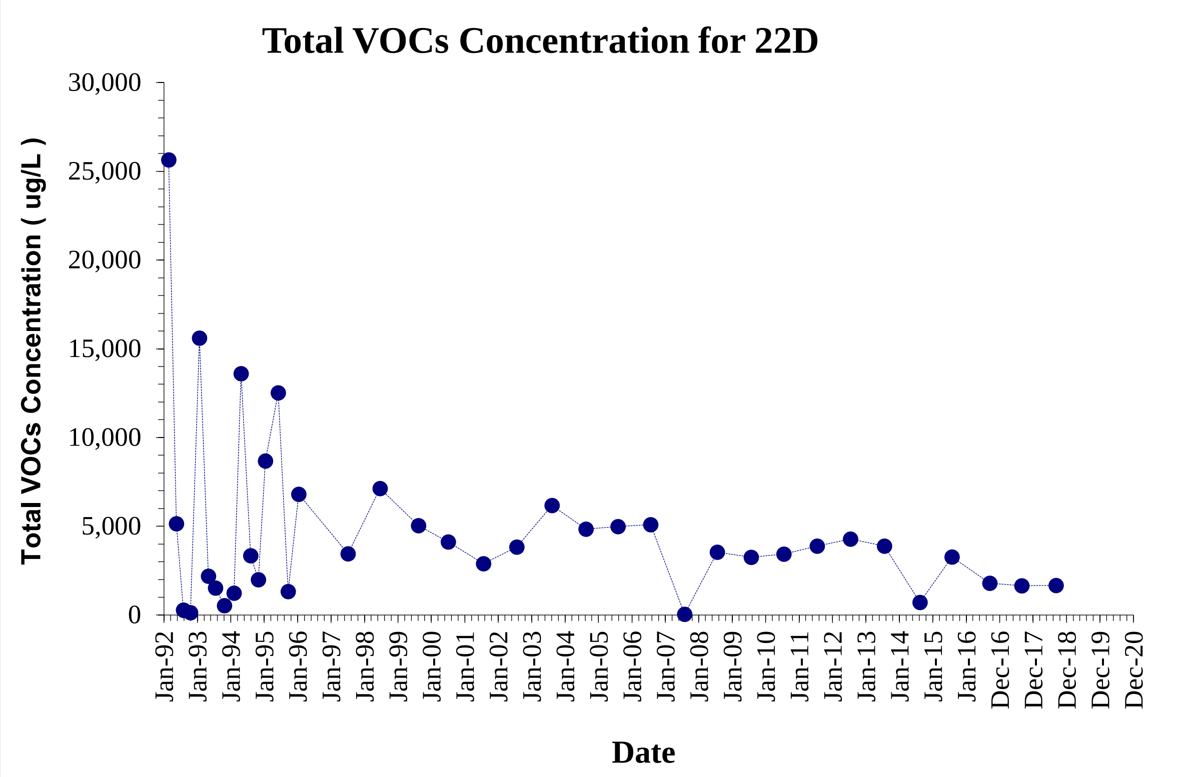

Total VOCs Concentration for 15D
Total VOCs Concentration (ug/L)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date


Total VOCs Concentration for 18D
Total VOCs Concentration (ug/L)
600
500
400
300
200
100
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date

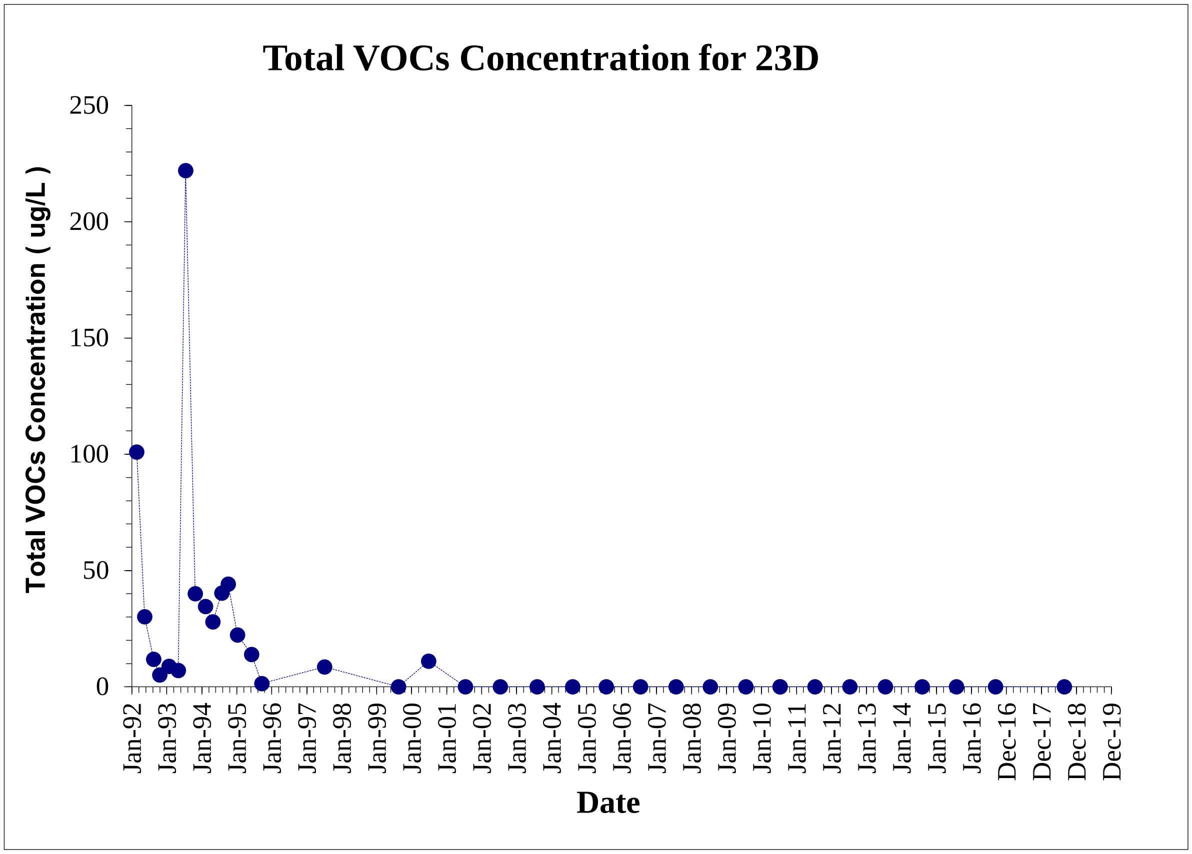
Appendix B
D-Zone TVOC Graphs

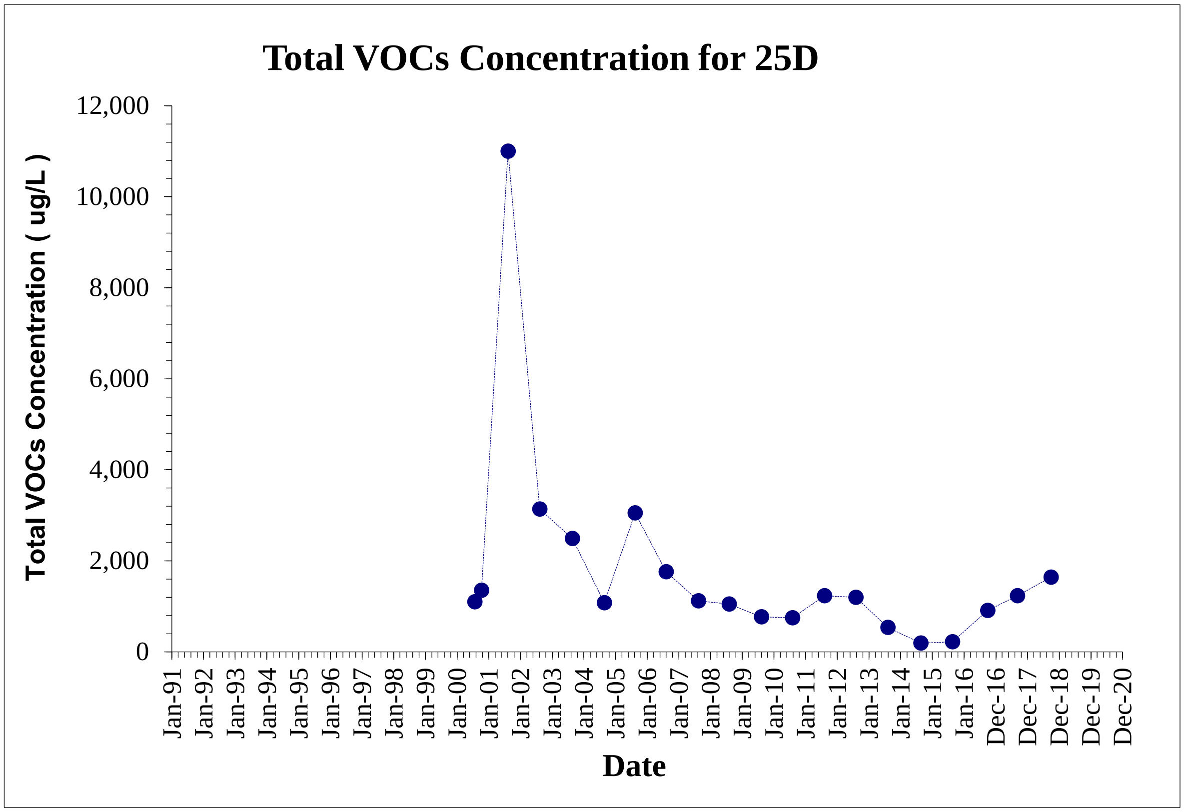


Note: Semi-log scale to distinguish changes at lower range of concentrations.
Nondetected values for 2010, 2011, 2012, 2013, 2014, and 2016 represented as 1.0 ug/L.

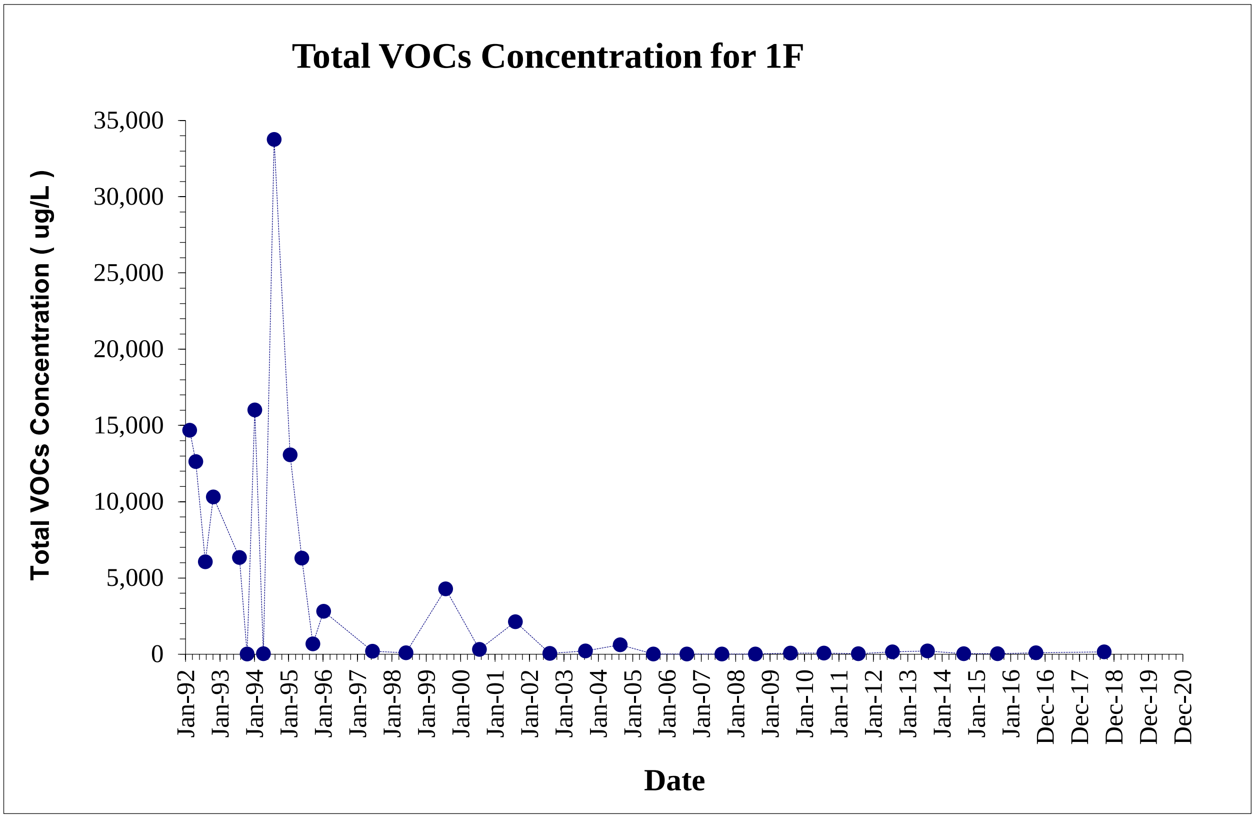


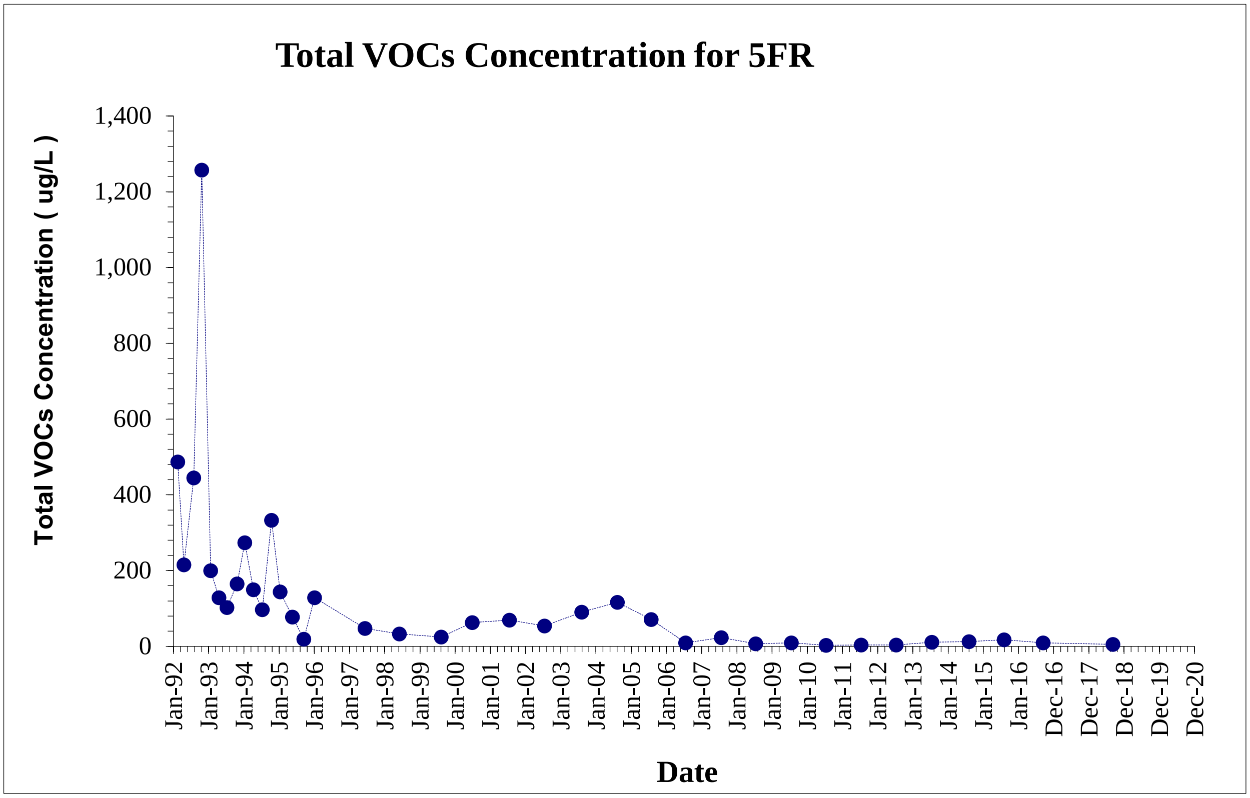
Appendix B
D-Zone TVOC Graphs

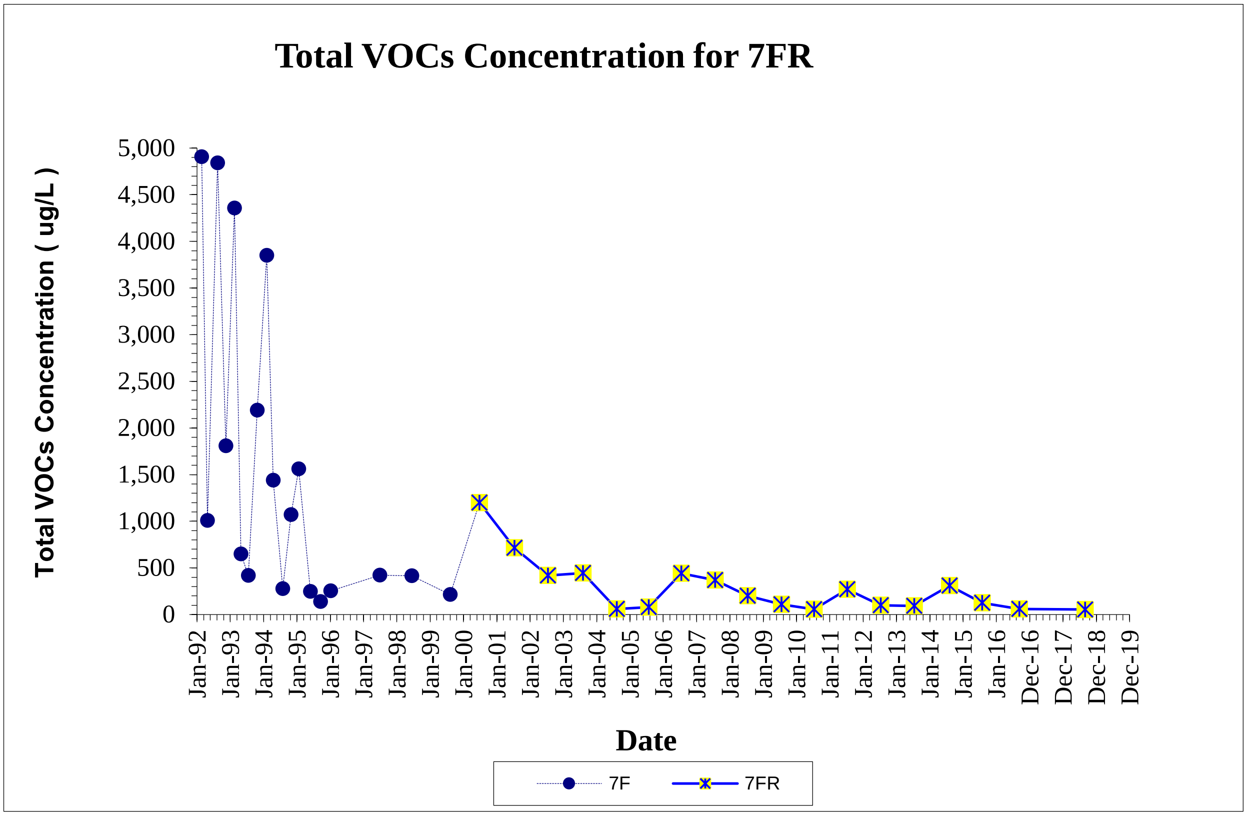


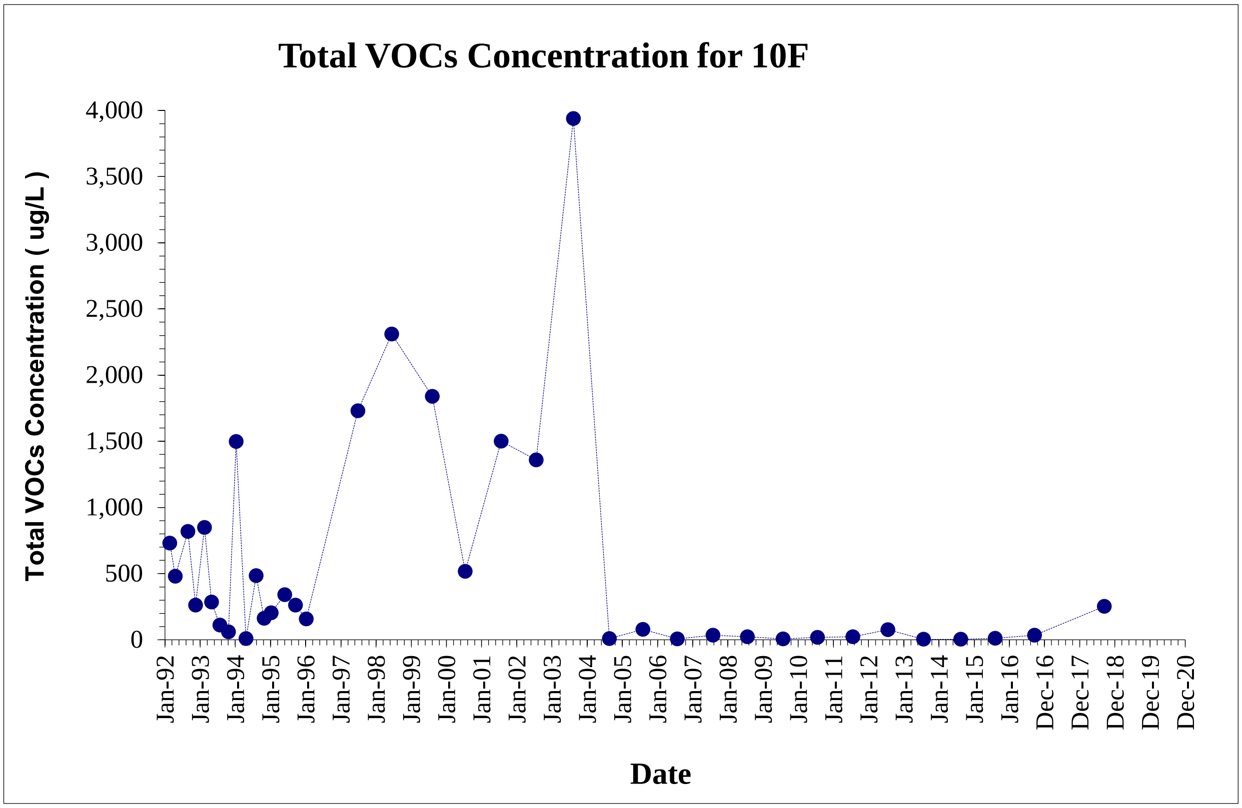


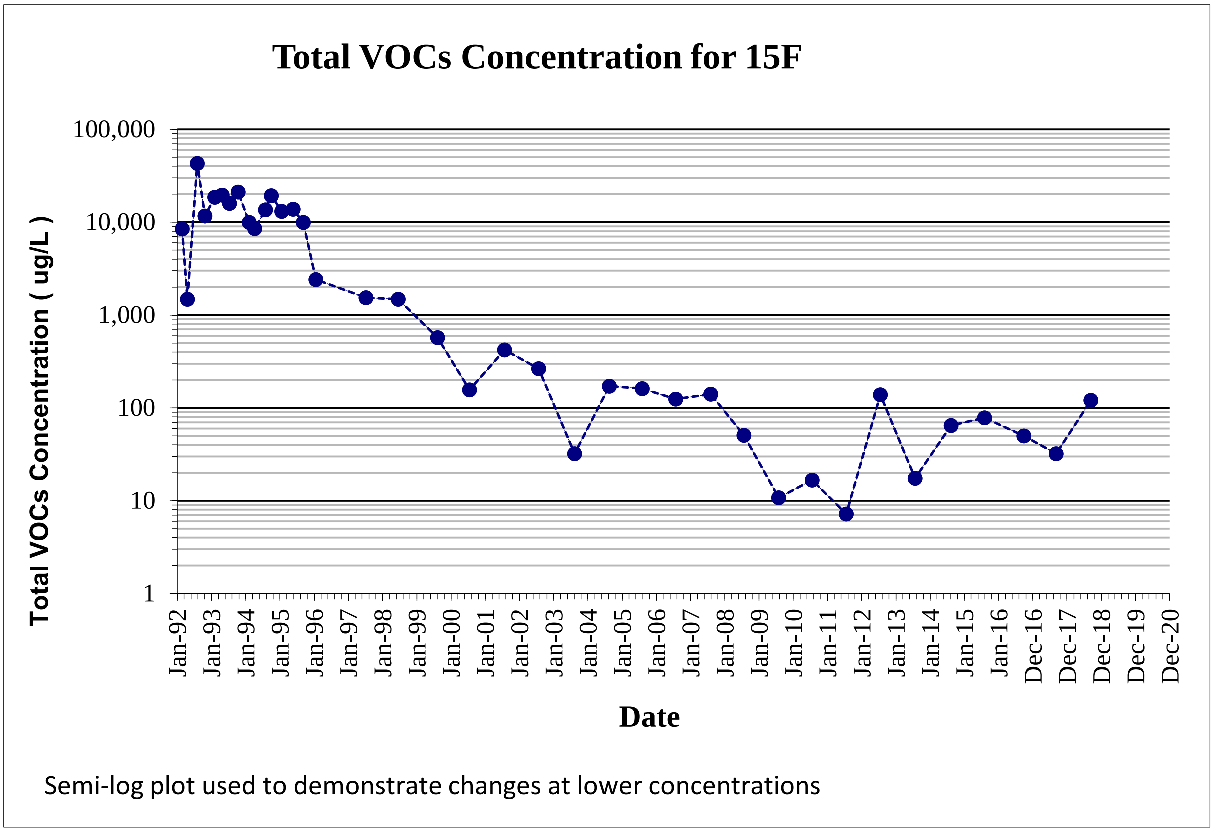
Appendix B
F-Zone TVOC Graphs

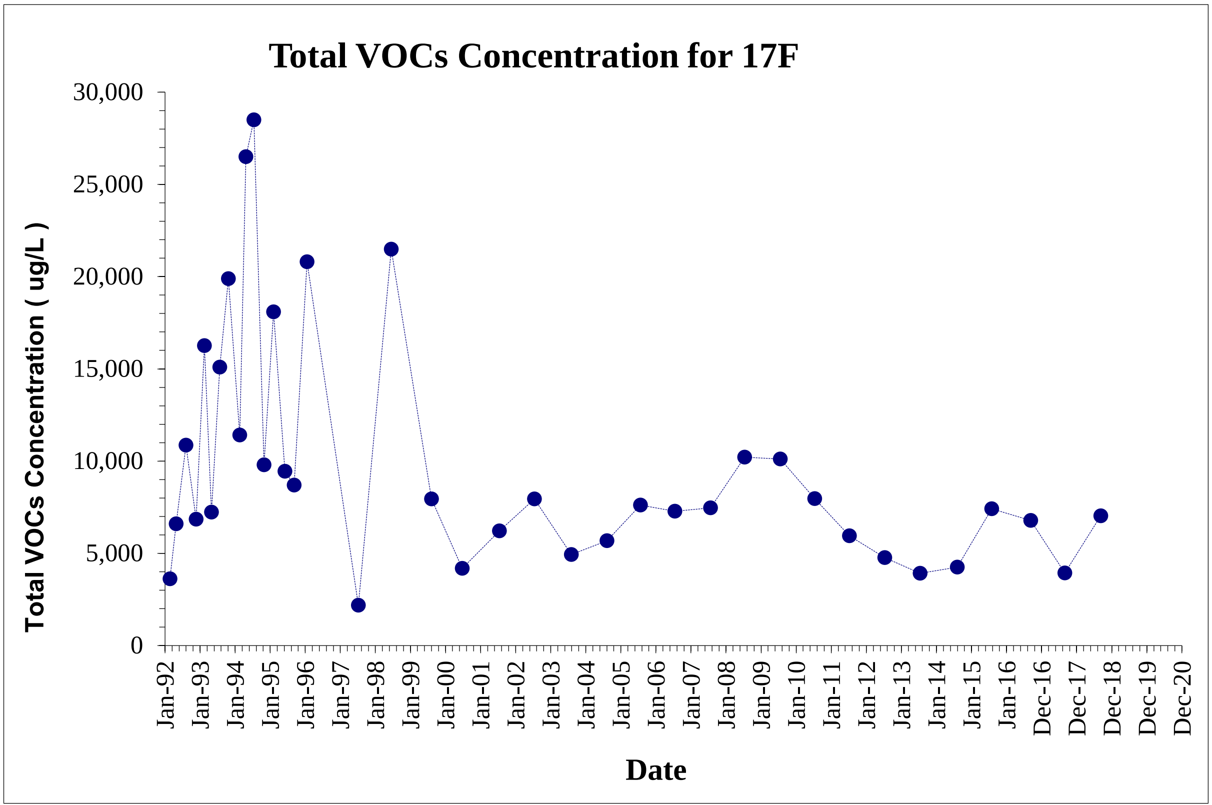


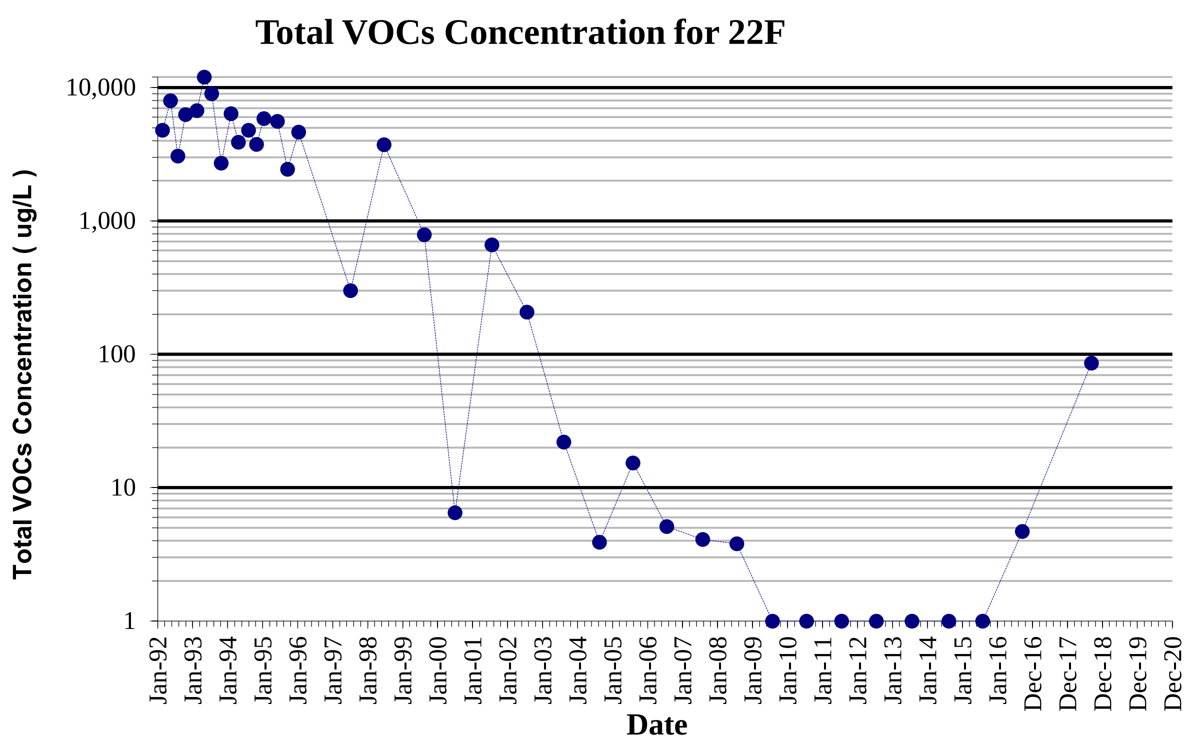



Total VOCs Concentration for 7FR
Total VOCs Concentration (ug/L)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Date
7F
7FR

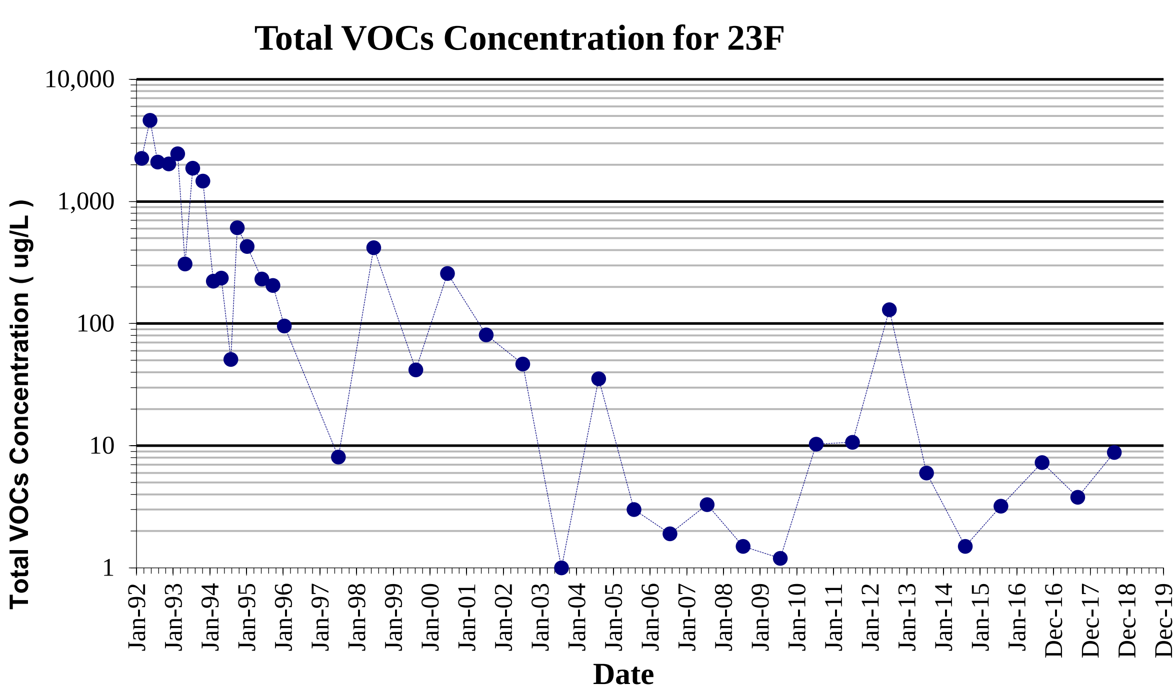

Total VOCs Concentration for 10F
Total VOCs Concentration (ug/L)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date


Total VOCs Concentration for 15F
100,000
10,000
1,000
100
10
1
Total VOCs Concentration (ug/L)
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date
Semi-log plot used to demonstrate changes at lower concentrations

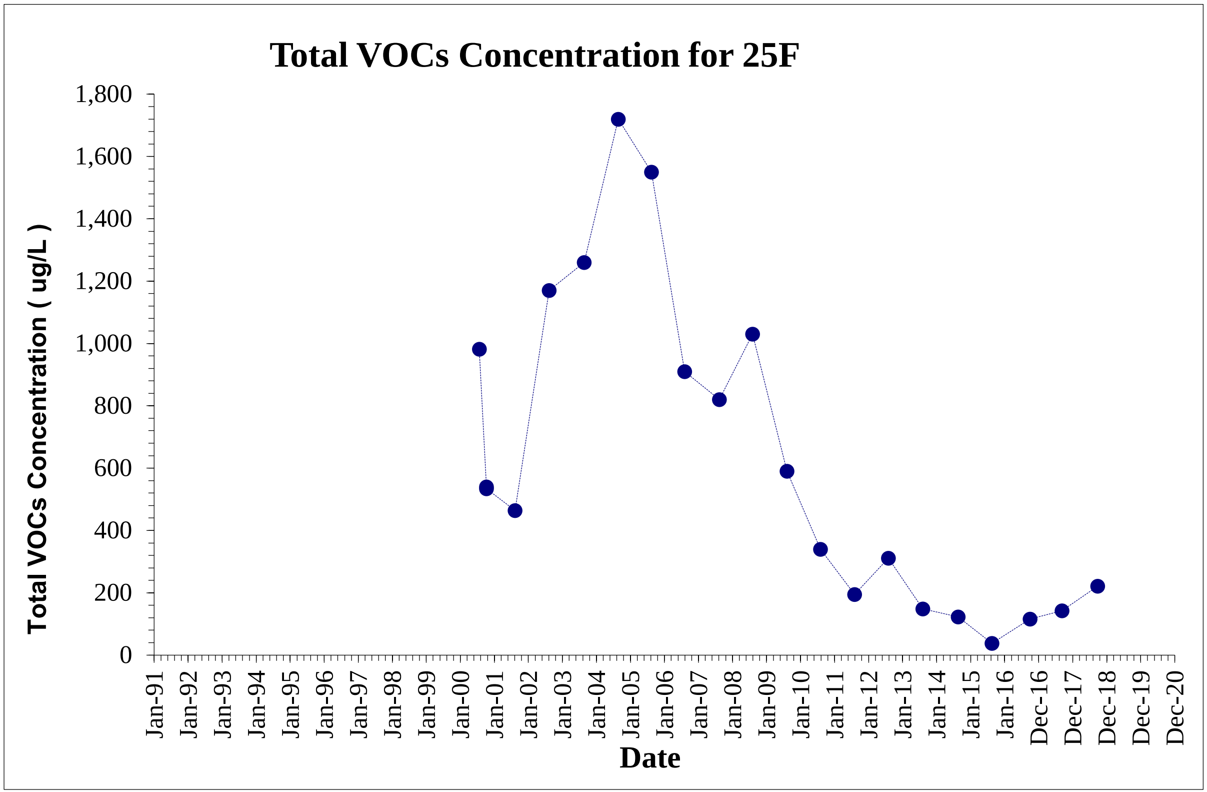

Total VOCs Concentration for 17F
30,000
25,000
20,000
15,000
10,000
5,000
0
Total VOCs Concentration (ug/L)
Jan-92 Jan-93 Jan-94 Jan-95 Jan-96 Jan-97 Jan-98 Jan-99 Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Dec-16 Dec-17 Dec-18 Dec-19 Dec-20
Date



Semi-log plot used to demonstrate changes at lower concentrations
TVOC were below detection limit 2009 through 2015, value of 1 ug/L used to plot on semi-log graph



Semi-log plot used to demonstrate changes at lower concentrations
2003 TVOCs were actually below detection limits and 1 ug/L was used for graphing purposes


Total VOCs Concentration for 25F
Total VOCs Concentration (ug/L)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Date

ANNUAL REPORT
APPENDIX C
EAST PLANT BEDROCK MNA UPDATE

APPENDIX C – NATURAL ATTENUATION
FOR CHEMOURS NIAGARA PLANT
NIAGARA FALLS, NY

TABLE OF CONTENTS

TABLES

1.0 NATURAL ATTENUATION

Biodegradation of hydrocarbons, particularly chlorinated solvents or "chlorocarbon" compounds, has been well documented in theory and practice. Natural attenuation (including intrinsic bioremediation) has been recognized by both scientists and regulatory agencies as a cost-effective method to control and mitigate subsurface contaminants in soil and groundwater. The three lines of evidence used to determine whether natural attenuation (or intrinsic bioremediation) is occurring (Weidermeier, et.al., 1996), are as follows:

- Chlorocarbon loss at field scale downgradient of the source
- Geochemical indicators of attenuation, and
- Microbial indicators of attenuation

In 2000 an initial study was conducted using the three lines of evidence approach discussed above with groundwater data from the East Plant bedrock north and east of well cluster 24. The objective of this analysis was to define the presence and extent of natural attenuation of chlorocarbon compounds in the bedrock water-bearing fracture zones. Based on this analysis, the data indicated that natural attenuation (including intrinsic bioremediation) of the chlorinated solvent plume was occurring at the site.

In 2004, a five-year review of the MNA processes demonstrated these were still active at the East Plant. Groundwater results for the 2008 and 2013 sampling events were used to provide an update on the MNA processes in the East Plant bedrock.

1.1 Natural Attenuation Background

The science and research regarding natural attenuation has been long established, to the extent that Monitored Natural Attenuation has been a recognized remedial technology for decades. Chlorocarbon biodegradation may occur via several microbial pathways including mineralization, cometabolism, or microbial reductive dehalogenation (dehalorespiration). The higher chlorocarbons (i.e., PCE) are degraded primarily via sequential anaerobic (i.e., no oxygen) reduction. During this anaerobic process, chlorinated solvents serve as electron acceptors where chloride atoms are sequentially replaced with hydrogen, eventually forming a totally non-chlorinated end product. Other organic substrates, such as indigenous or man-made hydrocarbon materials (TOC), and hydrogen serve as the electron donors required to fuel the degradation (Gossett and Zinder, 1996). An example of this microbial process is the sequential dechlorination of PCE through TCE, cDCE, and VC, to the final dehalogenated end product ethene under anerobic conditions.

Under aerobic conditions the lower chlorinated species (i.e., TCE, DCE, and VC) may be cometabolized (oxygenated) in the presence of a hydrocarbon such as methane, propane, toluene, ethene, or ethane or may be directly oxidized (DCE and VC only) to carbon dioxide and chloride ion (Davis, 1990; RTDF, 1996).

1.2 B-Zone Bedrock Biodegradation Analysis

Groundwater data from the 2018 monitoring event were analyzed using the lines of evidence approach to demonstrate continued MNA within the B-Zone. Indicators of intrinsic bioremediation and natural attenuation along the bedrock zone flow paths include loss of cVOC mass, the presence of biogenic daughter products (TCE, cDCE, VC, and ethene), elevated chloride ion, and geochemical conditions conducive to intrinsic biodegradation such as low redox potential (Eh), elevated dissolved iron, and methane.

Demonstrated Chlorocarbon Mass Loss

Total VOC data from the East Plant wells in the B-Zone are shown on Table C-1. TVOC concentrations are primarily composed of PCE, TCE and their degradation products in the southwestern portions of the East Plant (wells 12B and 24B) and tetrahydrothiophene in the eastern and northwestern portions of the East Plant (wells 8B, 25B, 29B and 30B). The B-Zone wells demonstrate generally declining concentrations with time, including well 24B which had exhibited high concentrations of cVOC ranging above 100,000 µg/L in 2013, but has decreased to 7,240 µg/L cVOC in 2018. Additionally, the TVOC concentrations downgradient from 24B at well 12B has continued to decrease significantly since 2000, dropping 96 percent. TVOC concentrations downgradient from 24B at well 29B have increased since 2013, but remain at low concentrations since 2000, dropping 90 percent. Analysis of the total chlorocarbon millimolar concentrations in wells 24B, 12B, and 29B indicated that the total molar mass decreases along the flow path and in time:

	24B	12B	29B
2000 millimoles cVOC	3.2	0.4	0.02
2004 millimoles cVOC	0.33	0.32	0.01
2008 millimoles cVOC	2.96	0.068	0.0025
2013 millimoles cVOC	3.47	0.054	0.0012
2018 millimoles cVOC	0.078	0.016	0.0017

In the east side of the east plant tetrahydrothiophene has been stable or declining. Well 8B has been declined by orders of magnitude since 2003. Concentrations in well 25B increased in 2013, but decreased in 2018, while concentrations of tetrahydrothiophene in and 30B remained variable. Farther to east TVOC in well 23B increased slightly from 6 µg/L to 44 µg/L in 2018. This location which is also predominantly tetrahydrothiophene was greater than 1000 µg/L before it started declining in 2000.

Organic Geochemical Indicators

Total volatile chlorocarbon spatial data and specific chlorocarbon isomer data at East Plant locations provide evidence that attenuation and biological degradation mechanisms are present in the investigation area. In the eastern region of the B-Zone bedrock, loss of cVOC mass along the flowpath is dramatically demonstrated by the near complete degradation of PCE and TCE from the high concentration area at 24B and downgradient along the flowpath to 12B and 29B. DCE and VC concentrations also decrease in mass with distance from the high concentration area. Evidence of sequential reductive dechlorination and degradation by-products along the flowpath is provided by the observed measurements of TCE, DCE, VC, and ethene/ethane at all three monitoring points. The molar ratios of biogenic daughter products to PCE in 2018 were calculated (or ratio to TCE, cisDCE, or VC if parent compounds were below detectable levels), and the ratios were compared to the analysis completed in 2000, 2004, 2008 and 2013. In well 12B, the ratios indicate increasing proportions of daughter products over time compared to the parent compound PCE. In wells 24B and 29B, the ratios indicate significant proportions of daughter products compared to the parent compounds cDCE and VC, respectively. Elevated chloride concentrations above backgrounds concentrations at all three monitoring points also provide further evidence for PCE dehalogenation in this fracture zone. These data indicate that the plume is actively bioattenuating and is significantly decreasing in the downgradient direction as shown below.

	PCE	TCE	CDCE	VC	Ethene
24B					
2000 Ratio to PCE	1	6.5	2.9	1.5	0.1
2004 Ratio to PCE	1	1.2	23.4	4.1	0.8
2008 Ratio to PCE	1	5.2	1.4	0.5	0.06
2013 Ratio to PCE	1	3.6	0.9	0.1	0.005
2018 Ratio to cDCE	Bdl	Bdl	1	0.15	0.18
12B					
2000 Ratio to PCE	1	1.9	0.5	0.1	0.01
2004 Ratio to PCE	1	2.3	0.6	Bdl	0.1
2008 Ratio to PCE	1	1.1	0.9	0.3	0.7
2013 Ratio to PCE	1	1.1	0.6	0.3	0.8
2018 Ratio to PCE	1	1.83	0.77	0.34	2.31
29B					
2000 Ratio to PCE	1	15.3	7.3	0.9	0.2
2004 Ratio to TCE	Bdl	1	9.4	2.2	0.2
2008 Ratio to VC	Bdl	Bdl	Bdl	1	Bdl
2013 Ratio to PCE	Bdl	Bdl	Bdl	Bdl	Bdl
2018 Ratio to VC	Bdl	Bdl	Bdl	1	8.39

Note: Bdl = Below detection limit

Ethene and ethane sampling were conducted to assess the extent of PCE/TCE reductive dechlorination due to biodegradation. Ethene (the terminal endpoint for reductive dechlorination) can be converted to ethane by some methanogenic microorganisms, therefore the combined measurement of ethene + ethane is sometimes a better measurement of the extent of PCE/TCE bioattenuation. The 2018 sampling results detected ethene and ethane concentrations in all B-Zone wells containing elevated cVOCs, suggesting that reductive dechlorination is proceeding to the terminal endpoint.

Inorganic Geochemical Indicators

Additional groundwater parameters used to monitor geochemical trends are summarized on Table C-1. Reduction-oxidation potential (redox) and the terminal electron acceptors, nitrate, iron, and sulfate are typically measured during bioattenuation investigations to evaluate which microbial metabolic processes (i.e. sulfate reduction, nitrate reduction, etc.) may be occurring within the flow fractures. Redox measurements that are below zero (negative) indicate reducing / anaerobic conditions which are consistent with iron reducing and sulfate reducing environments. It should be noted that redox measurements are highly sensitive to measurement technique, and any small, entrained air bubbles would dramatically impact the measured redox potential. These results are consistent with the past bioattenuation analyses, supporting favorable conditions for reductive dechlorination of PCE and TCE throughout the majority of the B-Zone.

Nitrate concentrations measured in 2018 were all below detection limit. Reductive dechlorination of chlorinated ethenes is uncommon under nitrate reducing conditions, therefore, the absence of nitrate is a favorable indicator for reductive dechlorination. Dissolved ferrous iron concentrations remain elevated in some location, ranging from 0.35 mg/L to 3.2 mg/L in the impacted plume regions. Ferrous iron concentrations are below detectable levels at wells 23B and 25B in the downgradient regions of the fracture zone. The measured concentrations suggest that iron reduction is occurring, indicating a reducing environment. The highest measured iron concentrations are coincident with the plume source area near 12B. It is possible that the dissolved iron concentrations in the downgradient plume areas are impacted by formation of iron sulfide precipitates due to sulfate reduction. The 2018 data are consistent with the 2000, 2004, 2008, and 2013 analyses, indicating there is sufficient iron to serve as an alternative electron acceptor to foster anaerobic microbial dechlorination activity (Lovely, et. al., 1994). Furthermore the creation of iron sulfides in a sulfate reducing area can create the appropriate biogeochemical conditions to degrade CVOCs in pathways other than sequential microbial dichlorination (AFCEE, 2008).

Methane levels were detected throughout the B-Zone groundwater at concentrations ranging from 39 µg/l to 2,600 µg/l. Slightly elevated levels are found throughout the study area indicating somewhat methanogenic conditions are apparent. Microbial dechlorination of aqueous phase chlorocarbons can be favored under both sulfate reducing and methanogenic aquifer conditions.

TOC is a measure of the non-volatile organic carbon that may be available to microbes as a carbon source. TOC concentrations measured during the 2018 sampling event ranged from 1,000 mg/L at 24B to 28,000 mg/L at 30B. The source of this TOC is believed to be anthropogenic in nature, being derived from past plant operations at the site. TOC is elevated in the source area near well 24B, where concentrations of PCE and TCE are below the detection limit, and increases in the downgradient direction at well 12B. This indicates that organic carbon substrate is found in areas coincident with elevated chlorocarbon levels and is likely being consumed by microorganisms while during the process of reductive dichlorination.

Specific conductivity, pH, and temperature are routinely measured to determine the representativeness of groundwater samples and to provide gross evaluations of aquifer homogeneity. The pH of the 2018 groundwater samples ranged from 6.5 to 7.71 SU, the temperature ranged from 17.1° C to 22.6° C. These ranges in values are favorable for growth of most microbiological communities.

1.3 C/CD-Zone Bedrock Biodegradation Analysis

Groundwater data from the 2018 monitoring event were analyzed using the lines of evidence approach to demonstrate continued MNA within the C/CD-Zone. Indicators of intrinsic bioremediation include the presence of biogenic daughter products (TCE, cDCE, VC, and ethene), chloride ion, and geochemical conditions conducive to intrinsic biodegradation such as low redox potential (Eh), elevated dissolved iron, and methane.

Demonstrated Chlorocarbon Mass Loss

Total VOC data from the East Plant wells in the C/CD-Zone are shown on Table C-2. TVOC concentrations at well locations, 25C/CD, 18C, and 17B (C well although names indicates otherwise) are primarily composed of tetrahydrothiophene; whereas, TVOC at well 12C/CD is primarily PCE biodegradation products, and well 23C contains similar amounts of both types of contamination. Well 7CR is mostly uncontaminated, with only low levels of vinyl chloride, tetrahydrothiophene, and 1,4-dichlorobutane.

Concentrations at 25C/CD, 18C, and 17B all have demonstrated slight decreases over the long term, but are generally within historical range. Well 12C/CD has decreased from the year 2000. Wells 7C/CR and 23C have shown significant decreased since the early 1990s.

Organic Geochemical Indicators

The molar ratios of biogenic daughter products to PCE were compared to the analysis completed in 2000, 2003, 2008, 2013 and 2018. The ratios remain elevated relative to the parent PCE compound and have decreased since the earlier analysis in 2003. However, the daughter product concentrations of cDCE and Ethene are present, which provides continued evidence reductive dechlorination. In particular, elevated chloride concentrations above backgrounds concentrations continue to be observed at well 12C/CD, indicating significant dechlorination activity.

MW 12C/CD	PCE	TCE	CDCE	VC	Ethene
2000 Ratio to PCE	1	3.9	1.9	1.0	0.15
2003 Ratio to PCE	1	8.3	29.4	1.2	0.8
2008 Ratio to PCE	1	2.2	0.86	0.2	0.1
2013 Ratio to PCE	1	2.3	1.8	0.1	0.1
2018 Ratio to PCE	1	Bdl	2.78	Bdl	0.25

Note: Bdl = Below detection limit

The 2018 sampling results detected ethene and ethane concentrations throughout the C/CD-Zone where cVOCs are elevated, suggesting that reductive dechlorination is proceeding to the terminal endpoint. Ethene is generally enriched in the presence of elevated chlorocarbon compounds and occurs at 170 μg/l in the vicinity of well 12C/CD, which also contains biogenic daughter products of PCE biodegradation, particularly cDCE. Ethene, a light gas for which there is no groundwater standard, is rapidly metabolized by indigenous microbes in the ambient subsurface environment and does not tend to accumulate.

Inorganic Geochemical Indicators

Additional groundwater parameters used to monitor geochemical trends are summarized on Table C-2. Wells 18C and 23C had negative redox measurements which support favorable conditions for reductive dichlorination. Other locations had slightly aerobic condition which is contradicting by the elevated methane and other light gases (ethene and ethane) as well as the depleted nitrate and iron, indicating the redox samples may have been biased high.

Nitrate concentrations measured in 2018 are all below the detection limit, consistent with the previous years. Dissolved ferrous iron concentrations remain elevated in the PCE plume area, at 7.2 mg/L and 3.7 mg/L in wells 12C/CD and 25C/CD, respectively. Ferrous iron concentrations are below detectable levels at wells 7CR, 17B, and 18C. These measured concentrations suggest that iron reduction is occurring, indicating anoxic subsurface conditions.

Sulfate concentration are relatively high in most of the C wells, with the exception of 12C/CD, which is below the detection limit. This is likely the result of sulfate reduction in this area of the east plant.

Methane levels were detected at concentrations ranging from 11 μg/L to 1,100 μg/L throughout the east plant C/CD-Zone indicating that methanogenic conditions are occurring. Microbial dechlorination of aqueous phase chlorocarbons can be favored under both sulfate reducing and methanogenic conditions.

TOC concentrations measured during the 2018 sampling event ranged from undetected at 1,000 mg/L (MW-7CR) to 6,900 mg/L (MW-17B).

Specific conductivity, pH, and temperature are routinely measured to determine the representativeness of groundwater samples and to provide gross evaluations of aquifer homogeneity. The pH of the 2018 groundwater samples ranged from 6.62 to 7.96, which is favorable for growth of most microbiological communities. The exception is MW-7CR which had a pH of 5.82. However, this well is mostly uncontaminated. The temperature of the 2018 groundwater samples ranged from 16° C to 18.7° C. These ranges in values are favorable for growth of most microbiological communities.

1.4 D-Zone Bedrock Biodegradation Analysis

Groundwater data from the 2018 monitoring event were analyzed using the lines of evidence approach to demonstrate continued MNA within the D-Zone, in a similar fashion as above.

Demonstrated Chlorocarbon Mass Loss

Total VOC data from the East Plant wells in the D-Zone are shown on Table C-3. Wells All four wells indicate TVOC trends that have generally been declining or stable since 2000, with slight TVOC increases 2013 in wells 10D and 25D. Consistent with the 2004, 2008, and 2013 observations, well 23D, a peripheral D-Zone well, indicated no detectable TVOCs in 2018. This well decreased to low concentrations during the early-1990's from as high as approximately 220 μg/L and has remained low since the mid-1990s. PCE is below detectable levels in wells 10D, 18D, 23D, and 35D, while TCE is below detectable levels all wells except 10D (9,700 μg/L in 2018). TVOC in wells 18D and 25D are composed solely of cDCE and VC, biodegradation daughter products of PCE and TCE. TVOC in well 10D is composed of TCE, cDCE, and VC.

Organic Geochemical Indicators

In the eastern region of the D-Zone, loss of cVOC mass is very dramatically demonstrated by the complete degradation of PCE throughout the bedrock fracture zone. While well 10D still contains the highest level of cVOCs, specifically the PCE biogenic daughter products TCE, cDCE, VC, and ethene, the TVOC level has remained appreciably decreased from the levels in the early 1990s.

The molar ratios of the PCE biogenic daughter products were calculated relative to TCE concentrations, because current PCE levels were below detectable levels, and CDCE, as a comparison to the 2008 and 2013 ratios to CDCE. The ratios were compared to the analyses completed in 2000, 2004, 2008 and 2013. The ratios are low, and the VC/DCE ratio is slightly lower in 2018 than 2013 and 2008. The change in ratio calculation from comparison to PCE in 2000, TCE in 2004, then CDCE in 2008 and 2013were caused by the decreases in primary coupled PCE and TCE, substantiating the observation that natural attenuation is occurring. While an increase in TCE is seen in 2018, high ratios of CDCE by comparison indicate that the plume is actively bioattenuating and is removing significant PCE and TCE mass in the D-Zone bedrock.

MW 10D	PCE	TCE	CDCE	VC	Ethene
2000 Ratio to PCE	1	26.8	5.9	2.2	3.3
2004 Ratio to TCE	~	1	59.5	2.8	1.2
2004 Ratio to CDCE	~	~	1	0.05	0.02
2008 Ratio to CDCE	~	~	1	0.1	0.03
2013 Ratio to CDCE	~	~	1	0.4	0.01
2018 Ratio to TCE	~	1	3.35	0.24	0.01
2018 Ratio to CDCE	~	~	1	0.07	0.03

Ethene and ethane are present in the study area and are generally enriched in the presence of elevated chlorocarbon compounds. Ethene occurs at 200 μg/l in the vicinity of well 10D, which also shows all of the biogenic daughter products of PCE biodegradation. Ethene is also present at 7.3 μg/l in well 25D. Ethene is rapidly metabolized by indigenous microbes in the ambient subsurface environment, which explains lower levels in the 10D area, relative to the concentrations of the higher chlorinated ethenes. The persistence of ethene and ethane demonstrated the continued microbial dechlorination activity caused by MNA.

Inorganic Geochemical Indicators

Additional groundwater parameters used to monitor geochemical trends are summarized on Table C-3.

Redox measurements for wells 10D, 18D, and 25D are 26 mV, -110 mV, and 52 mV (respectively). This indicates that the conditions are aerobic to slightly anaerobic. While decreased ORP values are desirable, this is only one indication of the MNA.

Nitrate concentrations measured in 2018 remained below detection (less than 0.5 mg/L), and ferrous iron concentrations measured in 2018 ranged from below detection limits of 0.2 mg/L to 2.1 mg/L in 10D. Depletion of these ions indicated groundwater is in a state of sulfate reduction, which is an anaerobic state. Due to high naturally occurring sulfate the depletion of sulfate is unclear in the D zone. It is possible that the deleted dissolved iron concentrations in the region may have formed iron sulfide precipitates due to the sulfate reduction in the fracture zone. The formation of iron sulfates may cause a higher rate of degradation through biogeochemical processes.

Methane detections ranged from a high of 220 μg/l in well 10D to below the detection limit of 1 μg/l in well 18D farther to the northeast. Monitoring well 23D methane was measured at 7.1 μg/l in 2018. Under such conditions, microbial dechlorination of aqueous phase chlorocarbons is favored.

PH, and temperature are routinely measured to determine the representativeness of groundwater samples and to provide gross evaluations of aquifer homogeneity. The pH of the 2018 groundwater samples ranged from 7.09 to 8.89, the temperature ranged from 16.8° C to 20.3° C. TOC concentrations measured during the 2018 sampling event were below detection except for 1,600 mg/L in 10D.

In general the 2018 data are consistent with the previous analyses, indicating geochemical conditions compatible with anaerobic microbial dechlorination activity, especially in the higher concentrations areas onsite, such as 10D. As expected where the concentrations of CVOCs are low the MNA is less robust.

1.5 F-Zone Bedrock Biodegradation Analysis

Groundwater data from the 2018 annual monitoring events were analyzed using the lines of evidence approach to demonstrate continued MNA within the F-Zone bedrock, as was above.

Demonstrated Chlorocarbon Mass Loss

As with the other bedrock zones, several key wells in the F-Zone (10F, 7FR, 23F, and 25F) display reduced TVOC levels compared to historical values. The TVOC levels in these wells remained low and similar to the values seen in previous years.

Organic Geochemical Indicators

Total VOC data from the East Plant wells in the F-Zone is shown in Table C-4. Overall, there are relatively low levels of cVOCs scattered throughout the F-Zone area, which have decreased over time. For example wells 7FR 10F, 23F and 25F originally had TVOC concentrations in the range of 1,000 to 5,000 μg/L (year 2004 and earlier), meanwhile in 2018 TVOCs were 253 µg/L and less at each of these locations. This is demonstrated by clear downward trends of concentrations overtime which indicating mass is being reduced. At location 17F the concentrations have remain elevated (7,030 µg/L in 2018), but are moderately reduced from the high concentrations of greater than 10,000 µg/L. Well 17F contains the highest concentrations of TVOCs, primarily chlorobenzenes and benzene (total aromatics: 6,230 µg/L), but also includes cDCE (150 µg/l) and VC (650 µg/l). The chlorobenzenes can be dechlorinated through reductive dechlorination, resulting in accumulation of benzene, which does not degrade anaerobically. The data in well 17F show accumulation of both ethane and benzene dechlorination end-products.

At well 10F, detections of VOCs included tetrahydrothiophene and 1,4-dichlorobutane, along with PCE (50 µg/L in 2018) and TCE (48 µg/L in 2018), with PCE daughter-products below detection limits. At well 23Fdetections of VOCs included tetrahydrothiophene (6.4 µg/L in 2018), and PCE daughter-products TCE (3.2 µg/L), cDCE (1.2 µg/L), tDCE (1.4 µg/L), and VC (3 µg/L). TVOC concentrations at well 25F were primarily chlorinated ethene degradation products cDCE and VC (31 and 190 µg/L, respectively). At well 7FR the only VOC detected was tetrahydrothiophene at 45 µg/L.

Elevated chloride concentrations above background concentrations continue to be observed within the F-Zone wells, in particular at wells 17F and 25F where primarily chlorinated ethenes are predominately degradation products cDCE and VC. These data are consistent with results reported in previous years and provides further indication that the microbial dechlorination of aqueous phase chlorocarbons is favored and occurring in the F-Zone near wells 10F, 17F, 23F and 25F.

With the exception of 17F, ethene is present at low levels in the study area and is generally enriched in the presence of elevated chlorocarbon compounds. Ethene occurs at 220 µg/l in the vicinity of well 17F, which also shows the biogenic daughter products of cDCE and VC. Ethane is also present throughout much of the study area, but at very low levels, ranging from 5.9 µg/L in 10F to 25 µg/L in 25F in 2018. This is reasonable in view of the low levels of cVOCs. The presence of ethene at such levels indicates sustained microbial dechlorination activity.

Inorganic Geochemical Indicators

Redox measurements for F-Zone wells ranged from -92 to 93 mV, indicating mixed results. The only negative OPR result (-92 mV in 23F) indicate anaerobic conditions, while the positive OPR results (wells 10F, 17F, 25F, and 7FR) are inconsistent with other observations (low nitrate, contaminants, etc). Redox measurements are highly sensitive to measurement technique, and any small, entrained air bubbles would dramatically impact the measured redox potential.

Nitrate concentrations measured in 2018 were non-detect. Dissolved ferrous iron concentrations were elevated in well 17F at 3.5 mg/L. These levels are strong indicators of active anaerobic activity and highly reducing conditions. The presence of reduced species ferrous iron and sulfate suggests that iron and sulfate reduction are occurring, indicating highly reducing conditions. It is possible that the dissolved iron concentrations in the region near well 10F are being impacted by formation of iron sulfide precipitates due to the sulfate reduction in the fracture zone. Elevated methane (73 – 890 µg/L) concentrations were detected in all F-Zone wells. The 2018 data are consistent with the previous analyses, indicating geochemical conditions compatible with anaerobic microbial dechlorination activity.

Specific conductivity, pH, and temperature are routinely measured to determine the representativeness of groundwater samples and to provide gross evaluations of aquifer homogeneity. The pH of the 2018 groundwater samples ranged from 5.39 to 8.63, the temperature ranged from 18.4° C to 20.3° C. Although the 5.39 value is at the lower range of pH levels for anerobic biological dechlorination, the values suggest favorable conditions for growth of most microbiological communities. TOC concentrations were mostly non-detect during the 2018 sampling event except for well 10F (7,700 mg/L).

1.6 Microbial Evidence for Intrinsic Bioattenuation

The original 2000 natural attenuation analysis used genetic identification (16S rRNA genetic probes) of microbial communities in the East Plant groundwater monitoring wells to confirm the presence of *Dehalococcoides* family microbes in key site wells. This microbe has been shown in the literature to reductively dehalogenate PCE and other related chlorinated solvents to ethene. Positive results were found in numerous wells, including wells 24B and 8B, 17CR and 18C, 18D, and 17F indicating the presence of the dehalogenating microbes within the fractured bedrock groundwater flow regime. Results of the sampling were presented in the 2000 Annual Report (DuPont, 2000). Repeating these tests during the 2008, 2013, and 2018 MNA review was not required to further establish microbial evidence for intrinsic bioremediation in the various bedrock zones beneath the East Plant area.

2.0 MNA CONCLUSIONS

The original 2000 evaluation provided strong evidence that natural attenuation and intrinsic bioremediation were occurring in the subsurface and are a primary mechanism for removal of chlorocarbon mass in the East Plant bedrock. Data was collected annually from 2001 through 2004 to monitor the progress of the MNA processes in the East Plant bedrock and to confirm continued intrinsic bioremediation of the chlorocarbon plume areas. Consistent with EPA guidance, a five-year review of the data was completed following collection of the 2004 annual data. This review confirmed that MNA processes, including intrinsic bioremediation of the chlorocarbons, is still actively removing plume mass from the fractured bedrock system. This 2018 report serves as a fourth five-year review of the MNA process.

TVOC and cVOC concentrations for most B through F-Zone bedrock wells in the East Plant area have displayed stable to decreasing concentration trends in most wells since long term groundwater monitoring was initiated in 1992 following GWRS start-up. Loss of cVOC mass is very dramatically demonstrated by the significant degradation of PCE and TCE from wells 23B, 25B, 29B, 7CR, 10D, 25D, 18D, 23F during the 2018 monitoring period compared to earlier years (2000 and 2004). Near complete attenuation of TVOCs at well clusters 23 and 7 at the eastern plume boundary indicate the plumes have further decreased over time. The presence of biogenic daughter products (TCE, cDCE, VC, ethene) and geochemical conditions indicate natural attenuation processes are degrading the PCE constituents throughout all the bedrock zones. This is confirmed by molar ratios of TCE, cDCE, VC, and ethene to PCE which show enrichment of these compounds relative to the parent PCE concentrations, indicating active biodegradation.

Finally, 16S rRNA genetic identification of in-situ microorganisms conducted during the original 2000 analysis confirmed the presence of the dehalogenating *Dehalococcoides* family microbes in key East Plant area wells. Results from these analyses provide biological evidence for intrinsic bioremediation within the East Plant bedrock fracture zones. This microbe has been shown in the literature to reductively dehalogenate PCE and other related chlorinated solvents.

Evidence complied during the past five years of the natural attenuation assessment are strongly indicative of continued constituent attenuation through biodegradation and natural dispersive mechanisms in all the East Plant bedrock water-bearing zones. Stable or declining concentrations are a clear indication that any constituent plume is either stable or is shrinking in size. Both geochemical and biological data provide sufficient evidence to support active intrinsic bioremediation in the various fracture zones.

2.1.1 Recommendations

Data from 2000 through 2018 continue to indicate that intrinsic bioremediation and natural attenuation of chlorocarbon constituents in the East Plant area are actively maintaining either stable or shrinking groundwater plumes. As there are no groundwater users in Niagara Falls located between the Plant and the presumed discharge point for any plume (Falls Street Tunnel/NYPA conduit drain) it is recommended that continued monitoring of natural attenuation in East Plant bedrock is appropriate.

The frequency of the monitoring for specific MNA parameters (inorganic parameters, dissolved gases, TOC, alkalinity) may remain at once every 5 years concurrent with a detailed evaluation of the data to verify conditions have not changed. VOC data and field parameters would still be collected annually to monitor plume distribution and VOC attenuation.

TABLES

Table C-1
B-Zone Natural Attenuation Evaluation
Chemours Niagara

Analyte		MW-12B 09/11/2018	MW-23B 08/28/2018	MW-24B 08/31/2018	MW-25B 9/26/2018 & 10/2/2018	MW-29B 09/27/2018	MW-30B 09/26/2018	MW-8B 9/7/2018 & 9/11/2018
Field Parameters								
COLOR	NONE	None	Clear	None	CLEAR	CLEAR	CLEAR	None
ODOR	NONE	None	None	None	SLIGHT	SLIGHT	SLIGHT	None
OXIDATION REDUCTION POTENTIAL	MV	90	-	9	6	24.5	28	23
PH	STD UNITS	7.06	-	6.5	7.7	6.68	7.1	7.71
SPECIFIC CONDUCTANCE	UMHOS/CM	50840	-	42	850	3150	2370	918
TEMPERATURE	DEGREES C	20.4	-	19.6	18.9	17.1	19.4	22.6
TURBIDITY QUALITATIVE	NTU	4.3	-	17.9	1.9	24.5	5.47	1.3
Volatile Organics								
1,1,1-TRICHLOROETHANE	UG/L	<50	<2	<200	<33	<5	<2500	<330
1,1,2,2-TETRACHLOROETHANE	UG/L	<50	<2	<200	<33	<5	<2500	<330
1,1,2-TRICHLOROETHANE	UG/L	<50	<2	<200	<33	<5	<2500	<330
1,1-DICHLOROETHANE	UG/L	<50	<2	<200	<33	<5	<2500	<330
1,1-DICHLOROETHENE	UG/L	<50	<2	<200	<33	<5	<2500	<330
1,2-DICHLOROBENZENE	UG/L	<50	<2	<200	58	7.6	<2500	<330
1,4-DICHLOROBENZENE	UG/L	<50	<2	<200	110	83	<2500	<330
1,4-DICHLOROBUTANE	UG/L	<50	<2	<200	<33	8.2	<2500	<330
BENZENE	UG/L	<50	<2	<200	<33	<5	<2500	<330
CARBON TETRACHLORIDE	UG/L	<50	<2	<200	<33	<5	<2500	<330
CHLOROBENZENE	UG/L	<50	<2	<200	540	84	<2500	<330
CHLOROFORM	UG/L	<50	<2	<200	<33	<5	<2500	<330
CIS-1,2 DICHLOROETHENE	UG/L	310	8.6	6600	<33	<5	<2500	<330
METHYL CHLORIDE	UG/L	<50	<2	<200	<33	<5	<2500	<330
METHYLENE CHLORIDE	UG/L	<250	<10	<1000	<170	<25	<13000	<1700
TETRACHLOROETHYLENE	UG/L	690	<2	<200	<33	<5	<2500	<330
TETRAHYDROTHIOPHENE	UG/L	<100	31	<400	140	19	57000	6500
TOLUENE	UG/L	<50	<2	<200	<33	<5	<2500	<330
TRANS-1,2-DICHLOROETHENE	UG/L	<50	<2	<200	<33	<5	<2500	<330
TRICHLOROETHENE	UG/L	1000	<2	<200	<33	<5	<2500	<330
VINYL CHLORIDE	UG/L	88	4.4	640	<33	5.3	<2500	<330
Inorganics / other								
ALKALINITY, TOTAL	MG/L	190000	120000	340000	110000	220000	230000	30000
TOTAL ORGANIC CARBON	MG/L	2600	1300	1000	1400	2200	28000	6300
CHLORIDE	UG/L	32000000	30000	22000000	78000	1000000	480000	240000 J
CYANIDE	UG/L	640	<10	5600	25 J	11	1400	920
IRON, DISSOLVED	UG/L	3200	<200	1900	<200	350	1100	300
NITRATE	UG/L	<1000	<100	<5000	<100	<500	<100	<100 UJ
SULFATE (2018)	UG/L	3700000	70000	1400000	110000 J	500000	470000	35000 J
SULFIDE	UG/L	<1000	<1000	4900	<1000	<1000	5500	4000
Gases								
ETHANE	UG/L	5.6	<1	12	4.6	<1	75	3
ETHENE	UG/L	270	2	350 J	<1	20	140	29
METHANE	UG/L	1000	39	150 J	110	170	2600	140
PROPANE	UG/L	<1	<1	<1	<1	<1	3.9	<1

< and ND = Non detect at stated reporting limit

Table C-2
C/CD-Zone Natural Attenuation Evaluation Data
Chemours Niagara

Analyte		MW-12C/CD **09/11/2018**	MW-17B **08/31/2018**	MW-18C **08/28/2018**	MW-23C **08/28/2018**	MW-25C/CD **09/26/2018**	MW-7CR **08/31/2018**
Field Parameters							
COLOR	NONE	None	Yellowish	CLEAR	CLEAR	CLEAR	None
ODOR	NONE	None	--	SLIGHT	SLIGHT	SLIGHT	None
OXIDATION REDUCTION POTENTIAL	MV	36	29	-81	-61	13	45
PH	STD UNITS	7.26	6.62	7.94	7.96	6.65	5.82
SPECIFIC CONDUCTANCE	UMHOS/CM	3690	1932	1342	694	4046	812
TEMPERATURE	DEGREES C	18	16	17.6	18.52	18.7	18.3
TURBIDITY QUALITATIVE	NTU	1.8	18.1	4.9	5.41	15.8	1.6
Volatile Organics							
1,1,1-TRICHLOROETHANE	UG/L	<330	<1	<50	<1	<50	<1
1,1,2,2-TETRACHLOROETHANE	UG/L	<330	<1	<50	<1	<50	<1
1,1,2-TRICHLOROETHANE	UG/L	<330	<1	<50	<1	<50	<1
1,1-DICHLOROETHANE	UG/L	<330	<1	<50	<1	<50	<1
1,1-DICHLOROETHENE	UG/L	<330	<1	<50	<1	<50	<1
1,2-DICHLOROBENZENE	UG/L	<330	<1	<50	<1	<50	<1
1,4-DICHLOROBENZENE	UG/L	<330	1.2	<50	<1	<50	<1
1,4-DICHLOROBUTANE	UG/L	<330	<1	<50	<1	<50	3.8
BENZENE	UG/L	<330	<1	<50	3.2	210	<1
CARBON TETRACHLORIDE	UG/L	<330	<1	<50	<1	<50	<1
CHLOROBENZENE	UG/L	<330	4.3	<50	<1	<50	<1
CHLOROFORM	UG/L	<330	<1	<50	<1	<50	<1
CIS-1,2 DICHLOROETHENE	UG/L	6500	<1	<50	1.1	<50	<1
METHYL CHLORIDE	UG/L	<330	<1	<50	<1	<50	<1
METHYLENE CHLORIDE	UG/L	<1700	<5	<250	<5	<250	<5
TETRACHLOROETHYLENE	UG/L	4000	<1	<50	<1	<50	<1
TETRAHYDROTHIOPHENE	UG/L	<670	34	850	2 B	1100	38
TOLUENE	UG/L	<330	<1	<50	<1	<50	<1
TRANS-1,2-DICHLOROETHENE	UG/L	<330	<1	<50	<1	<50	<1
TRICHLOROETHENE	UG/L	<330	<1	<50	<1	<50	<1
VINYL CHLORIDE	UG/L	<330	<1	110	1.7	<50	1.3
Inorganics / other							
ALKALINITY, TOTAL	MG/L	<5000	73000	13000	-	290000	9600
TOTAL ORGANIC CARBON	MG/L	2600	6900	1800	-	2500	<1000
CHLORIDE	UG/L	1500000	490000	360000	-	880000	43000
CYANIDE	UG/L	100	22	200	-	<10	
IRON, DISSOLVED	UG/L	7200	<200 UJ	<200	-	3700	<200 UJ
NITRATE	UG/L	<500	<100	<100	-	<500	<100
SULFATE	UG/L	<5000	450000	64000	-	2300000	360000
SULFIDE	UG/L	<1000	<1000	<1000	-	<1000	<1000
Gases							
ETHANE	UG/L	86	6.7	4.1	-	11	<1
ETHENE	UG/L	170	<1	45	-	280	<1
METHANE	UG/L	100	460	150	-	1100	11
PROPANE	UG/L	9.6	<1	<1	-	2.2	<1

< and ND = Non detect at stated reporting limit

Table C-3
D-Zone Natural Attenuation Evaluation Data
Chemours Niagara

Analyte		MW-10D 09/13/2018	MW-18D 08/28/2018	MW-23D 08/28/2018	MW-25D 09/26/2018
Field Parameters					
COLOR	NONE	CLEAR	CLEAR	CLEAR	CLEAR
DISSOLVED OXYGEN	MG/L	-	-	-	-
ODOR	NONE	SLIGHT	SLIGHT	NONE	SLIGHT
OXIDATION REDUCTION POTENTIAL	MV	26	-110	--	52
PH	STD UNITS	8.17	8.89	--	7.09
SPECIFIC CONDUCTANCE	UMHOS/CM	3610	270	--	769
TEMPERATURE	DEGREES C	20.3	16.8	--	19.2
TURBIDITY QUALITATIVE	NTU	16.9	4.3	--	23.5
Volatile Organics					
1,1,1-TRICHLOROETHANE	UG/L	<1000	<1.7	<1	<50
1,1,2,2-TETRACHLOROETHANE	UG/L	<1000	<1.7	<1	<50
1,1,2-TRICHLOROETHANE	UG/L	<1000	<1.7	<1	<50
1,1-DICHLOROETHANE	UG/L	<1000	<1.7	<1	<50
1,1-DICHLOROETHENE	UG/L	<1000	<1.7	<1	<50
1,2-DICHLOROBENZENE	UG/L	<1000	<1.7	<1	<50
1,4-DICHLOROBENZENE	UG/L	<1000	<1.7	<1	<50
1,4-DICHLOROBUTANE	UG/L	<1000	<1.7	<1	<50
BENZENE	UG/L	<1000	<1.7	<1	<50
CARBON TETRACHLORIDE	UG/L	<1000	<1.7	<1	<50
CHLOROBENZENE	UG/L	<1000	<1.7	<1	<50
CHLOROFORM	UG/L	<1000	<1.7	<1	<50
CIS-1,2 DICHLOROETHENE	UG/L	24000	27	<1	1400
METHYL CHLORIDE	UG/L	<1000	<1.7	<1	<50
METHYLENE CHLORIDE	UG/L	<5000	<8.4	<5	<250
TETRACHLOROETHYLENE	UG/L	<1000	<1.7	<1	<50
TETRAHYDROTHIOPHENE	UG/L	<2000	<3.3	<2	<100
TOLUENE	UG/L	<1000	<1.7	<1	<50
TRANS-1,2-DICHLOROETHENE	UG/L	<1000	<1.7	<1	<50
TRICHLOROETHENE	UG/L	9700	<1.7	<1	<50
VINYL CHLORIDE	UG/L	1100	2.6	<1	240
Inorganics / other					
ALKALINITY, TOTAL	MG/L	110000	22000	63000	17000
BARIUM, DISSOLVED	UG/L	<200	-	-	-
TOTAL ORGANIC CARBON	MG/L	1600	<1000	<1000	<1000
CHLORIDE	UG/L	1200000	28000	14000	160000
CYANIDE	UG/L	32	<10	<10	<10
IRON, DISSOLVED	UG/L	2100	<200	<200	270
NITRATE	UG/L	<500	<100	<100	<100
SULFATE	UG/L	1700000	34000	<1000	93000
SULFIDE	UG/L	<1000	<1000	<1000	<1000
Gases					
ETHANE	UG/L	190	<1	<1	9.1
ETHENE	UG/L	200	<1	<1	7.3
METHANE	UG/L	220	<1	7.1	32
PROPANE	UG/L	9.1	<1	<1	4.8

< and ND = Non detect at stated reporting limit

Table C-4
F-Zone Natural Attenuation Evaluation Data
Chemours Niagara

Analyte	Sample ID / Date	MW-10F	MW-17F	MW-23F	MW-25F	MW-7FR
		09/13/2018	9/7/2018 & 9/11/2018	08/28/2018	09/26/2018	08/31/2018
Field Parameters						
COLOR	NONE	CLEAR	None	CLEAR	None	None
DISSOLVED OXYGEN	MG/L	-	-	-	-	-
ODOR	NONE	SLIGHT	None	SLIGHT	SLIGHT	None
OXIDATION REDUCTION POTENTIAL	MV	10	32	-92	93	45
PH	STD UNITS	8.63	6.82	6.78	6.53	5.39
SPECIFIC CONDUCTANCE	UMHOS/CM	640	2504	1851	241	1289
TEMPERATURE	DEGREES C	20.3	18.6	19.3	18.4	18.7
TURBIDITY QUALITATIVE	NTU	1.3	12.4	17	10.4	5.8
Volatile Organics						
1,1,1-TRICHLOROETHANE	UG/L	<5	<100	<1	<6.7	<2
1,1,2,2-TETRACHLOROETHANE	UG/L	<5	<100	<1	<6.7	<2
1,1,2-TRICHLOROETHANE	UG/L	<5	<100	<1	<6.7	<2
1,1-DICHLOROETHANE	UG/L	<5	<100	<1	<6.7	<2
1,1-DICHLOROETHENE	UG/L	<5	<100	<1	<6.7	<2
1,2-DICHLOROBENZENE	UG/L	<5	2600	<1	<6.7	<2
1,4-DICHLOROBENZENE	UG/L	<5	1000	<1	<6.7	<2
1,4-DICHLOROBUTANE	UG/L	25	<100	<1	<6.7	<2
BENZENE	UG/L	<5	330	<1	<6.7	<2
CARBON TETRACHLORIDE	UG/L	<5	<100	<1	<6.7	<2
CHLOROBENZENE	UG/L	<5	2300	<1	<6.7	<2
CHLOROFORM	UG/L	<5	<100	<1	<6.7	<2
CIS-1,2 DICHLOROETHENE	UG/L	<5	150	1.2	31	<2
METHYL CHLORIDE	UG/L	<5	<100	<1	<6.7	<2
METHYLENE CHLORIDE	UG/L	<25	<500	<5	<33	<10
TETRACHLOROETHYLENE	UG/L	50	<100	<1	<6.7	<2
TETRAHYDROTHIOPHENE	UG/L	130	<200	6.4 B	<13	45 J
TOLUENE	UG/L	<5	<100	<1	<6.7	<2
TRANS-1,2-DICHLOROETHENE	UG/L	<5	<100	1.4	<6.7	<2
TRICHLOROETHENE	UG/L	48	<100	3.2	<6.7	<2
VINYL CHLORIDE	UG/L	<5	650	3	190	<2
Inorganics / other						
ALKALINITY, TOTAL	MG/L	71000	24000	79000	5000	<5000
BARIUM, DISSOLVED	UG/L	<200	-	-	-	-
TOTAL ORGANIC CARBON	MG/L	7700	<1000	<1000	<1000	<1000
CHLORIDE	UG/L	110000	690000	180000	770000	110000
CYANIDE	UG/L	130	<10	<10	<10	<10
IRON, DISSOLVED	UG/L	<200	35000	<200	790	2500
NITRATE	UG/L	<100	<500 UJ	<100	<100	<100
SULFATE	UG/L	71000	1500000	520000	63000	570000
SULFIDE	UG/L	<1000	<1000	<1000	<1000	<1000
Gases						
ETHANE	UG/L	<1	26	3.4	20	2
ETHENE	UG/L	5.9	220	18	25	7.2
METHANE	UG/L	52	890	73	420	110
PROPANE	UG/L	<1	<1	<1	17	<1

< and ND = Non detect at stated reporting limit

ATTACHMENT 4
FOURTH QUARTER DATA PACKAGE

GROUNDWATER REMEDIATION SYSTEM
FOURTH QUARTER 2018
GROUNDWATER MONITORING DATA PACKAGE
CHEMOURS NIAGARA PLANT
NIAGARA FALLS, NIAGARA COUNTY, NEW YORK

Prepared For:

THE CHEMOURS COMPANY FC LLC
CORPORATE REMEDIATION GROUP

Buffalo Avenue and 26th Street
Niagara Falls, New York 14302

Prepared By:

PARSONS

40 La Riviere Drive, Suite 350
Buffalo, New York 14202
Phone: (716) 541-0730

April 2019

TABLE OF CONTENTS

SECTION 1

DATA PACKAGE SUMMARY

1.1 INTRODUCTION

This data package presents a summary of operating and monitoring data collected during the fourth quarter of 2018 (4Q18) for groundwater remediation measures at the Chemours Niagara Plant (the Plant) in Niagara Falls, New York. The Niagara Plant remediation program was implemented pursuant to an Administrative Consent Order with the New York State Department of Environmental Conservation (NYSDEC), Index Number B9-0206-87-09. This Data Package also includes the Silicone Oil Remediation Fourth Quarter Progress Report.

Tables 1 through 6 provide information related to the quarterly sampling program and operational statistics. Figures 1 through 6 provide groundwater potentiometric maps. Appendix A and B provide supporting data.

1.2 OPERATIONAL SUMMARY

Pumping well uptime was 100.0 percent for the original GWRS pumping wells, 100 percent for pumping well PW-37, and 100 percent for PW-39 during 4Q18. There were no scheduled or unscheduled system shutdowns greater than 24 hours in 4Q18. Additionally, no wells were down for greater than 48 consecutive hours during the quarter. One well pump was replaced at PW-34 with the well shutdown less than 48-hours.

From an operations standpoint, the air strippers effectively remove organics from groundwater. The refined indicator parameters for process sampling are summarized in Table 1. It is estimated that 1,609 pounds of volatile organic compounds were removed from groundwater during operation of the Groundwater Remediation System (GWRS) in 4Q18 (see Tables 2 and 3). Historical organic compound removal by the GWRS is summarized in Table 4.

Olin Production Well uptime was 100.0 percent during 4Q18. Organics removal at the Olin Production Well treatment system was estimated to be 283.2 pounds for 4Q18 (see Tables 2 and 5). Estimated organic compound removal for the Olin Production Well from October 1992 through December 2018 is approximately 44,406 pounds (Table 5).

Point source contaminant loading rates are provided in Table 6. Loading to the Niagara Falls Wastewater Facility (NFWWF) from Outfall 023 is estimated to have been 0.73 pounds of organics per day during 4Q18. Since effluent discharged through this outfall is treated at the NFWWF, this represents an additional 67 pounds of organics (Table 2) that were removed and treated during 4Q18.

Groundwater elevation data collected during 4Q18 indicated that inward hydraulic gradients exist in the A-Zone throughout most plant areas while the GWRS is operating, thereby decreasing off-plant groundwater flow. Inward gradients are coincident with the southern border of the West Plant along Staub Road in both the A-Zone overburden (Figure 1) and A-Zone top-of-rock (Figure 2) and are largely attributed to pumping of the two BFBTs.

Investigation and recovery activities related to Silicone Oil Recovery have been conducted in accordance with the technical scope of work submitted on July 21, 1999 and approved by NYSDEC on August 26, 1999. During 4Q18, no silicone oil was observed in PW-20, and 1.5 gallons were recovered from PW-24. Silicone oil has never been observed at PW-22 since inspections began at this location in 3Q00. To date, 64 gallons and 1,985.5 gallons of Silicone Oil have been recovered from PW-20 and PW-24 respectively. A total of 2,049.5 gallons of silicone oil have been removed from GWRS pumping wells since recovery began in June 1999.

As noted in 2016 and 2017 Periodic Review Reports, Chemours has ceased Reactive Metals production and prepared certain areas of the site for future (undetermined) use. Meanwhile, Olin Production (on leased portion of the Site) will continue for the foreseeable future. Site groundwater remediation responsibilities related to Order on Consent No. B9-0206-87-09 will remain with Chemours without change. Current institutional and engineering controls associated with Site 932013 will remain in place and under Chemours control.

TABLES

Table 1

Refined Indicator Parameters
Chemours Niagara

Volatiles	Base/Neutrals[1]
Benzene	1,4-dichlorobutane
Carbon tetrachloride	bis(2-ethylhexyl)phthalate
Chlorobenzene	Naphthalene
Chloroform	1,2-dichlorobenzene
Chloromethane	1,4-dichlorobenzene
1,1-dichloroethane	Hexachlorobutadiene
1,1-dichloroethene	Hexachloroethane
trans-1,2-dichloroethene	**Pesticides/PCBs[1]**
cis-1,2-dichloroethene	alpha-BHC
Methylene chloride	beta-BHC
1,1,2,2-tetrachloroethane	delta-BHC
Tetrachloroethene	gamma-BHC
Tetrahydrothiophene	Total PCBs
Toluene	
1,1,1-trichloroethane	
1,1,2-trichloroethane	
Trichloroethene	
Vinyl chloride	
Inorganics and Other Parameters	
Total cyanide[1]	
Soluble barium[1]	
pH*	
Temperature*	
Specific Gravity*	
Specific Conductivity*	

[1] Analyses required once per year for these parameters on select samples.
* Field measurement

Table 2

GWRS Operations Statistics
Fourth Quarter 2018
Chemours Niagara

Treatment System Operations	
GWRS	
Original 23 Pumping Wells System Uptime	100.0%
Pumping Well 37 Uptime	100.0%
Pumping Well 39 Uptime	100.0%
Total Gallons Pumped	3,691,345
Average System Pumping Rate for Quarter (GPM)	27.9
Estimated Pounds of Organics Treated	1,609
Number of unscheduled treatment shutdowns (> 24 hours)	0
Number of scheduled treatment shutdowns (> 24 hours)	0
Olin System	
Pumping System Uptime	100.0%
Estimated Pounds of Organics Treated	283.2
Carbon vessel changes	0
Outfall 023	
Estimated Pounds of Organics Treated	67

GWRS Pumping Well Operations	
Total Pump Replacements:	1
Number of Individual Pumps down > 48 hours:	0

Table 3

Total Volatile Organic Compounds Removed by GWRS
Fourth Quarter 2018
Chemours Niagara

Quarterly Total Flow (gallons)	Influent Total VOC Concentration (µg/l)	Effluent Total VOC Concentration (µg/l)	Estimated VOC Removal (lbs.)
3,691,345	52,400	101.8	1,609

Table 4
Summary of Organic Compounds Removed by GWRS
Chemours Niagara

Time Period	**Estimated Organic Removal (lbs)[1]**	
1991[2]	4,700	
1992	10,350	
1993	7,220	
1994	7,320	
1995	7,840	
1996	9,436	
1997	6,463	
1998	7,000	
1999	3,382	
2000	3,010	
2001	3,224	
2002	3,848	
2003	2,820	
2004	2,645	
2005	2,237	
2006	11,589	
2007	8,678	
2008	7,932	
2009	12,128	
2010	7,854	
2011	9,004	
2012	8,453	
2013	9,433	
1Q14	2,224	2014 Total 8,567
2Q14	2,085	
3Q14	1,958	
4Q14	2,300	
1Q15	2,031	2015 Total 8,255
2Q15	2,215	
3Q15	1,945	
4Q15	2,064	
1Q16	1,999	2016 Total 6,629
2Q16	2,232	
3Q16	1,216	
4Q16	1,182	
1Q17	3,127	2017 Total 10,815
2Q17	2,581	
3Q17	2,930	
4Q17	2,177	
1Q18	1,454	2018 Total 5,794
2Q18	1,410	
3Q18	1,321	
4Q18	1,609	
TOTAL	**214,513**	

(1) Estimated based on influent/effluent data and daily groundwater flow rates, except as noted.

(2) Estimated based on influent/effluent data and instantaneous flow to treatment system.

Table 5
Summary of Organic Compounds Removed by Olin Production Well
Chemours Niagara

Date	Average Pumping Rate (gpm)	Influent Total VOC (µg/l)	Effluent Total VOC (µg/l)	Total VOC Removed (lbs/day)	Total VOC Removed (lbs)
1992					5,470
1993					3,580
1994					3,530
1995					2,378
1996					2,240
1997					1,887
1998					1,392
1999					1,695
2000					1,214
2001					1,185
2002					1,374
2003					1,124
2004					1,044
2005					1,066
2006	590	491	71	3.0	1,096
2007	527	514	56	2.9	1,068
2008	529	547	6.7	3.4	1,257
2009	536	534	14	3.3	1,222
2010	557	483	5	3	1,168
2011	595	546	9	4	1,386
2012	578	459	11	3	1,137
2013	541	461	24	3	1,042
2014	574	534	32	3	1,269
2015	566	511	23	3	1,197
1Q16	*562*	487	27.6	3.1	282
2Q16	*578*	501	5.5	3.4	313
3Q16	*597*	441	1	3	276
4Q16	*556*	444	10.0	2.9	266
1Q17	*550*	452	9.6	2.9	263
2Q17	*569*	430	1	3	273
3Q17	*583*	540	14.2	3.7	338
4Q17	*570*	616	17.5	4.1	377
1Q18	*550*	454	1	3	270
2Q18	*567*	299	14.6	1.9	176
3Q18	*604*	369	41.5	2.4	218
4Q18	*590*	453	18.3	3.1	283
TOTAL					**44,406**

An average analytical result is used when a field duplicate is reported.

All averages are italicized.

Annual VOCs removed is sum of quarterly VOCs removed

Table 6

Point Source Contaminant Loading Rates
Loading Indicator Organics
Fourth Quarter 2018
Chemours Niagara

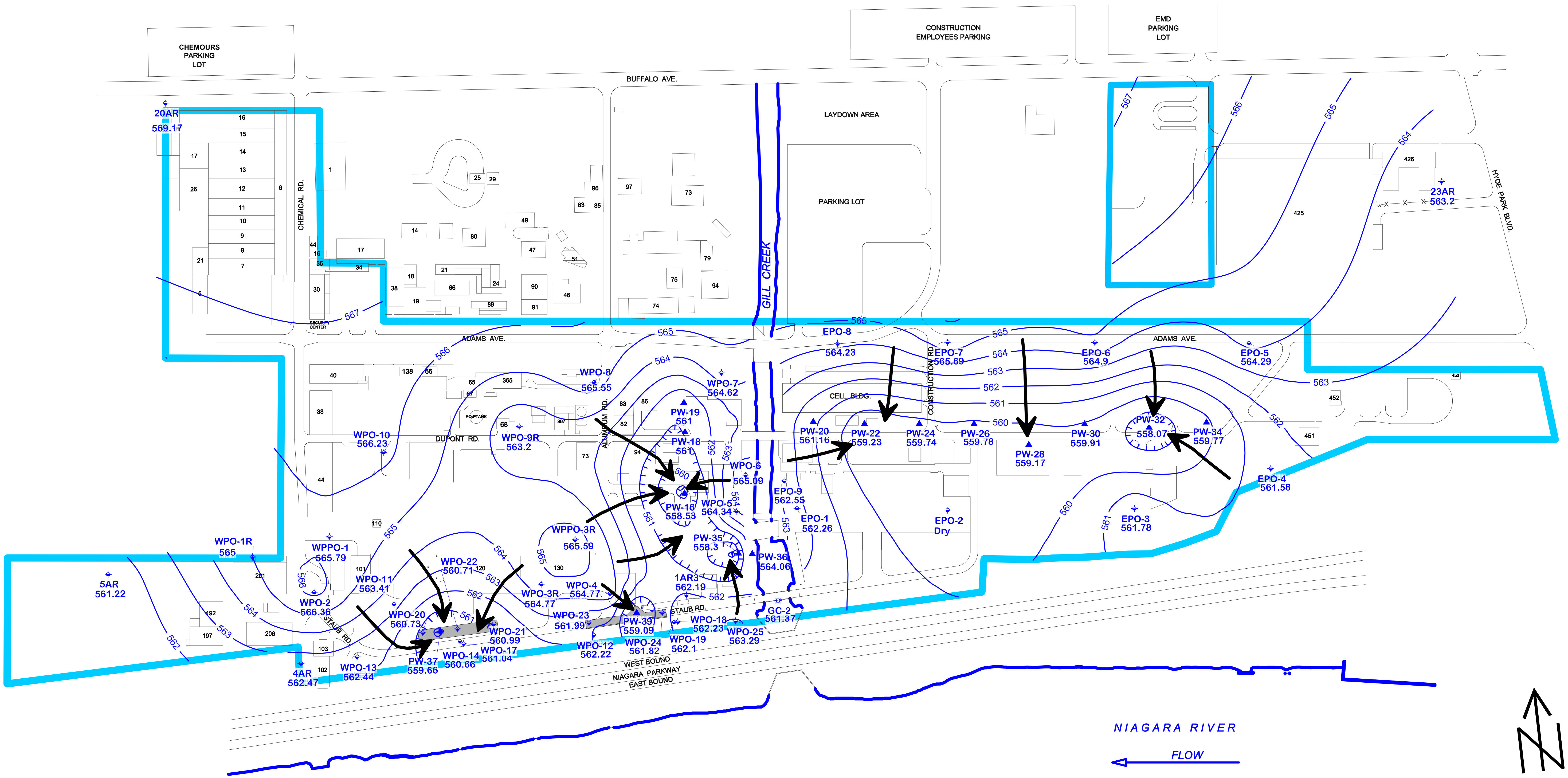
Outfall Sample Location*	Quarterly Average Flow Rate (gpm)	Total Indicator Organic Concentration (µg/l)(1)	Quarterly Average Loading Rate (lb/day)(1)
023	295	*207.5*	0.73
Olin GAC(2)	590	18.3	0.13

GAC = Granular Activated Carbon (Olin Treatment Effluent)
TIO average of field duplicate results are *italicized* .

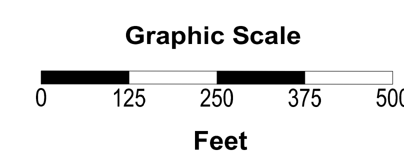
(1) Values are not adjusted to account for concentrations of loadings indicator organics which may be present in the raw intake water.

(2) Average pumping rate for Olin well through quarter.

FIGURES



Note:
Experion data recorded the groundwater elevation at PW-36 at 564.20, which confirmed the hand-measured elevation.
Average groundwater elevation for 4Q2018 at PW-36 was 562.40 according to Experion Data.



PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND

BUILDING
ROAD
CHEMOURS PROPERTY BOUNDARY
SURFACE WATER

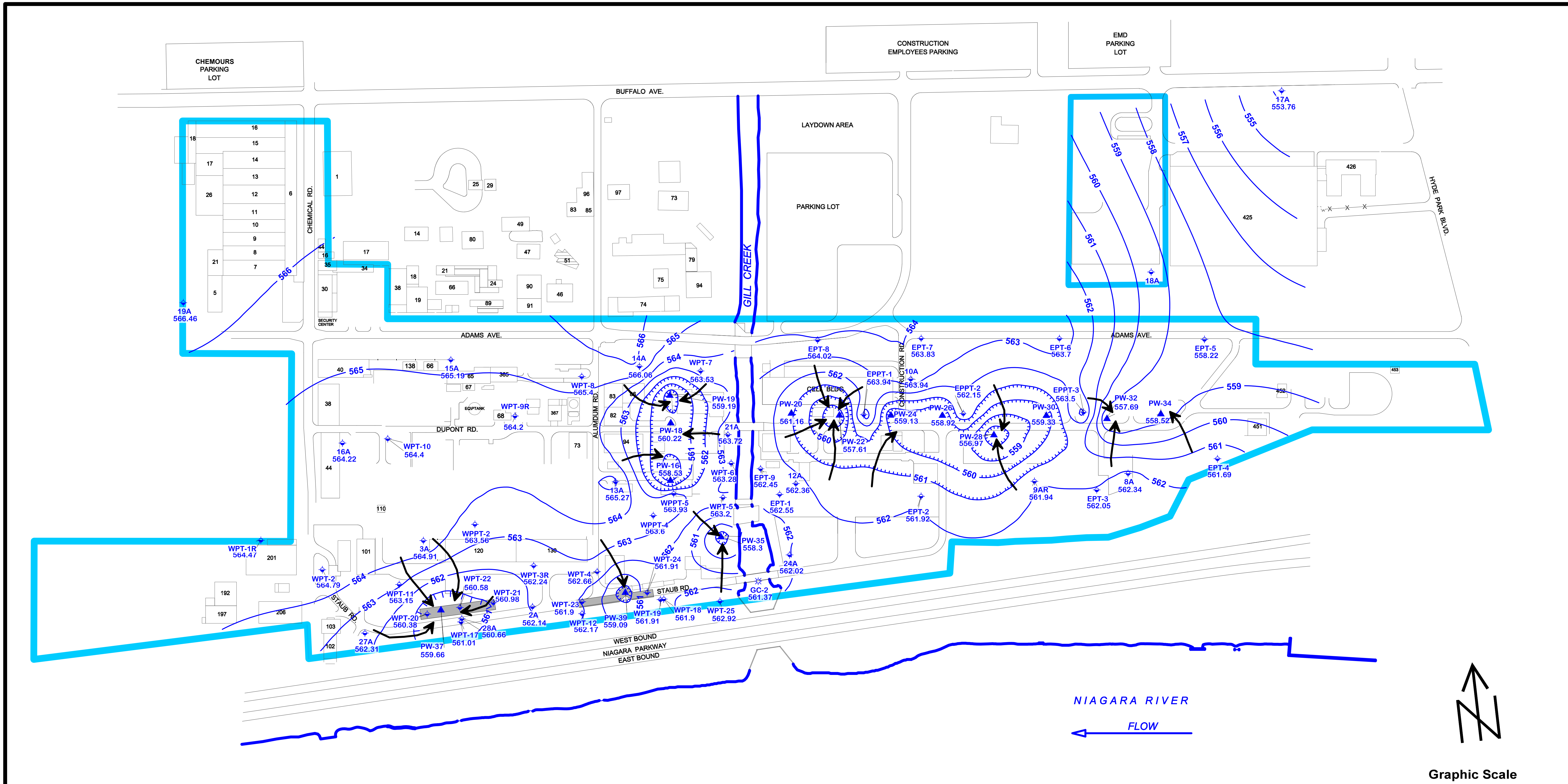
CHEMOURS WELLS

1AR3 WELL ID
PIEZOMETER
PUMPING WELL
MONITORING WELL
UNDERGROUND UTILITY WELL
GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION

BLAST FRACTURED BEDROCK TRENCH
GROUNDWATER CONTOUR
GROUNDWATER CONTOUR DEPRESSION
561 GROUNDWATER CONTOUR ELEVATION

FIGURE 1
POTENTIOMETRIC SURFACE MAP
A-ZONE OVERBURDEN - DECEMBER 4, 2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-OBPZ.srf



Note:
Well 18A was not accessible on 12/4/18. Water level measurement for this well was collected on 12/5/18, but was not used to generate the groundwater contours.

Graphic Scale

0 125 250 375 500

Feet

PARSONS

40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND

BUILDING

ROAD

CHEMOURS PROPERTY BOUNDARY

SURFACE WATER

CHEMOURS WELLS

1AR3 WELL ID

PIEZOMETER

PUMPING WELL

MONITORING WELL

UNDERGROUND UTILITY WELL

GILL CREEK SURFACE WELL or WATER SAMPLE LOCATION

BLAST FRACTURED BEDROCK TRENCH

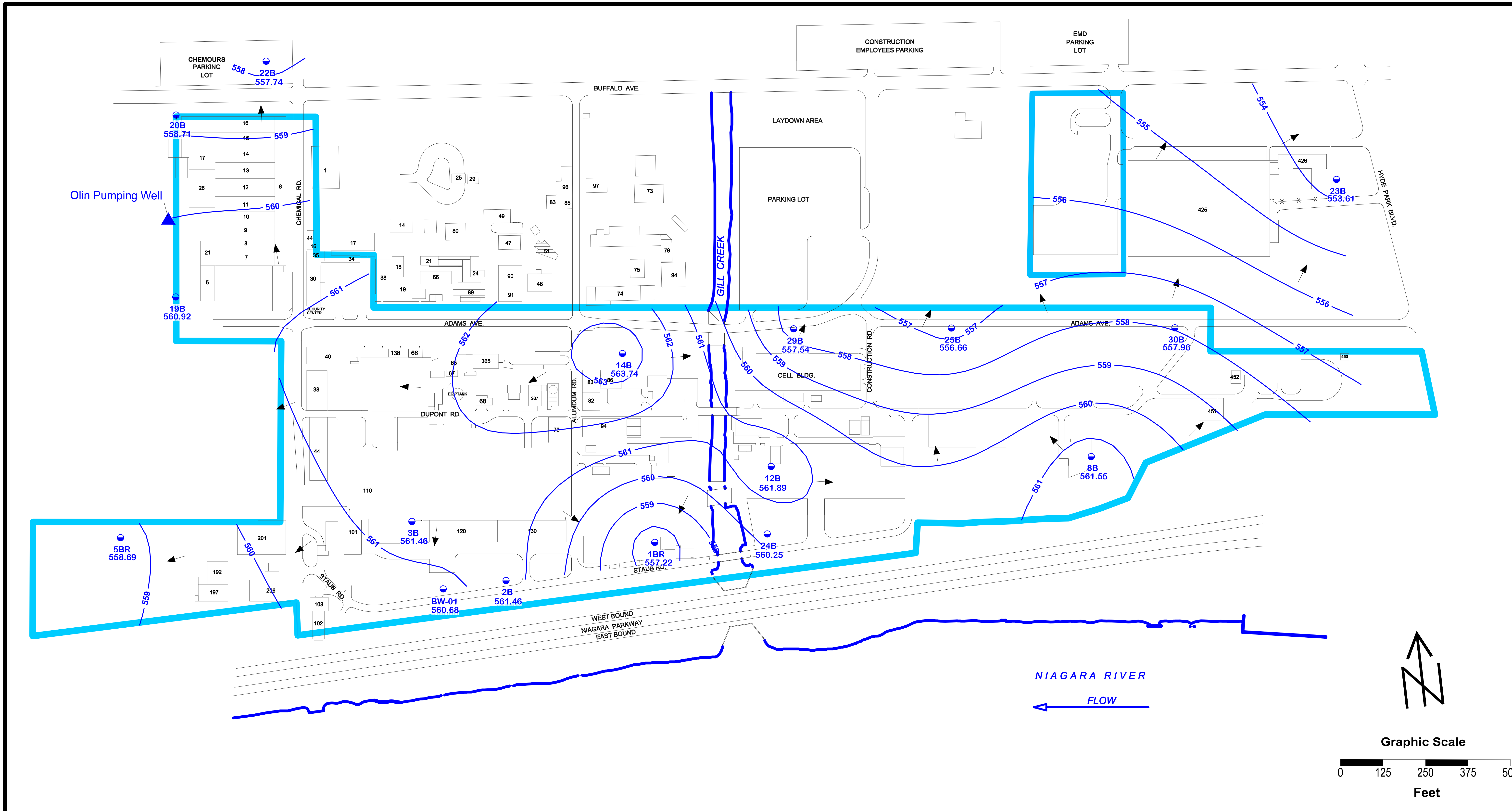
GROUNDWATER CONTOUR

GROUNDWATER CONTOUR DEPRESSION

561 GROUNDWATER CONTOUR ELEVATION

FIGURE 2
POTENTIOMETRIC SURFACE MAP
A-ZONE BEDROCK - DECEMBER 4, 2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-BRPZ.srf



PARSONS

40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND

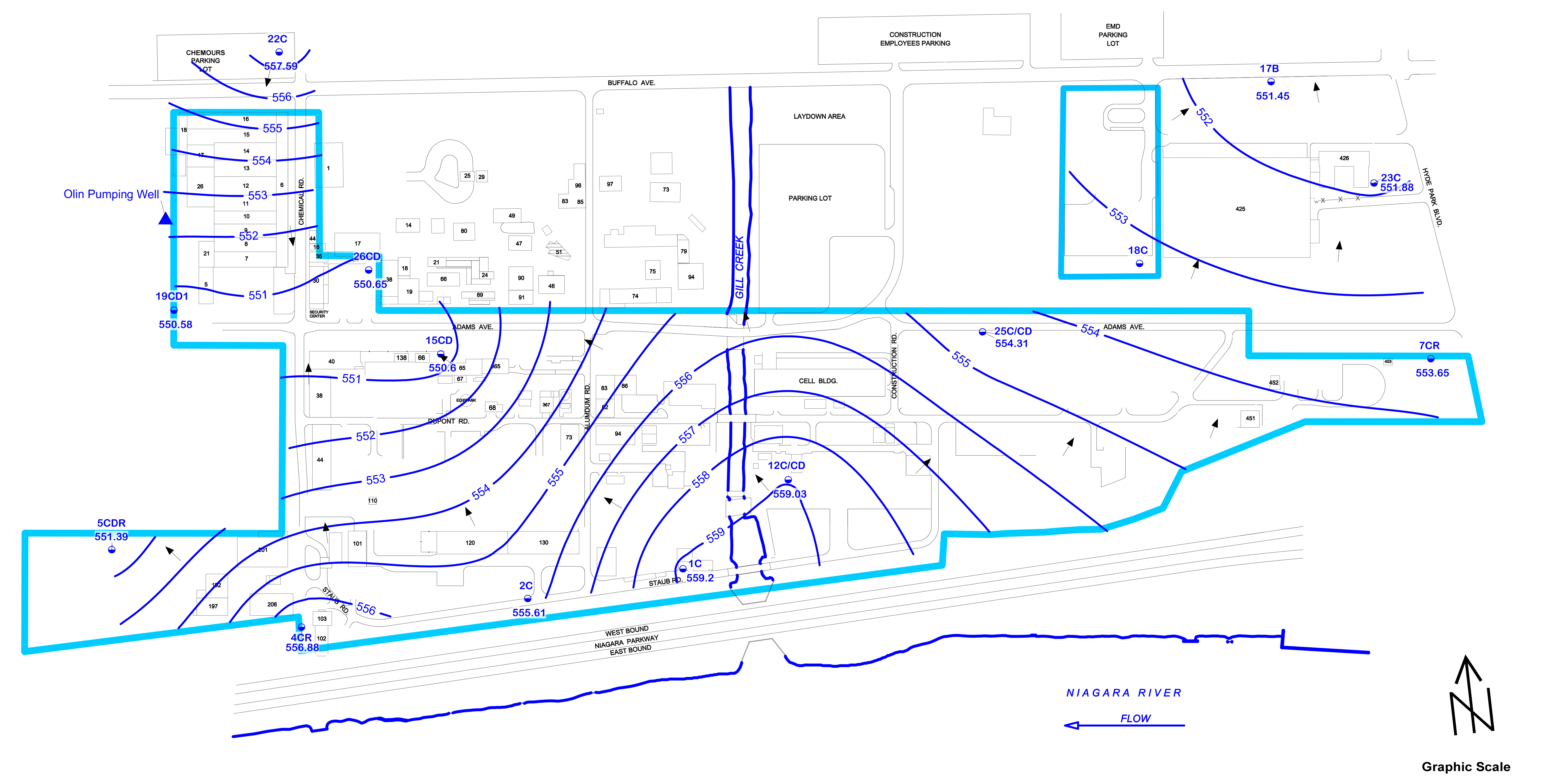
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1BR — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- UNDERGROUND UTILITY WELL
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 561 — GROUNDWATER CONTOUR ELEVATION

FIGURE 3
POTENTIOMETRIC SURFACE MAP
B-ZONE BEDROCK - DECEMBER 4, 2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-BZPZ.srf



Note:
Well 18C was not accessible on 12/4/18. Water level measurement for this well was collected on 12/5/18, but was not used to generate the groundwater contours.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND

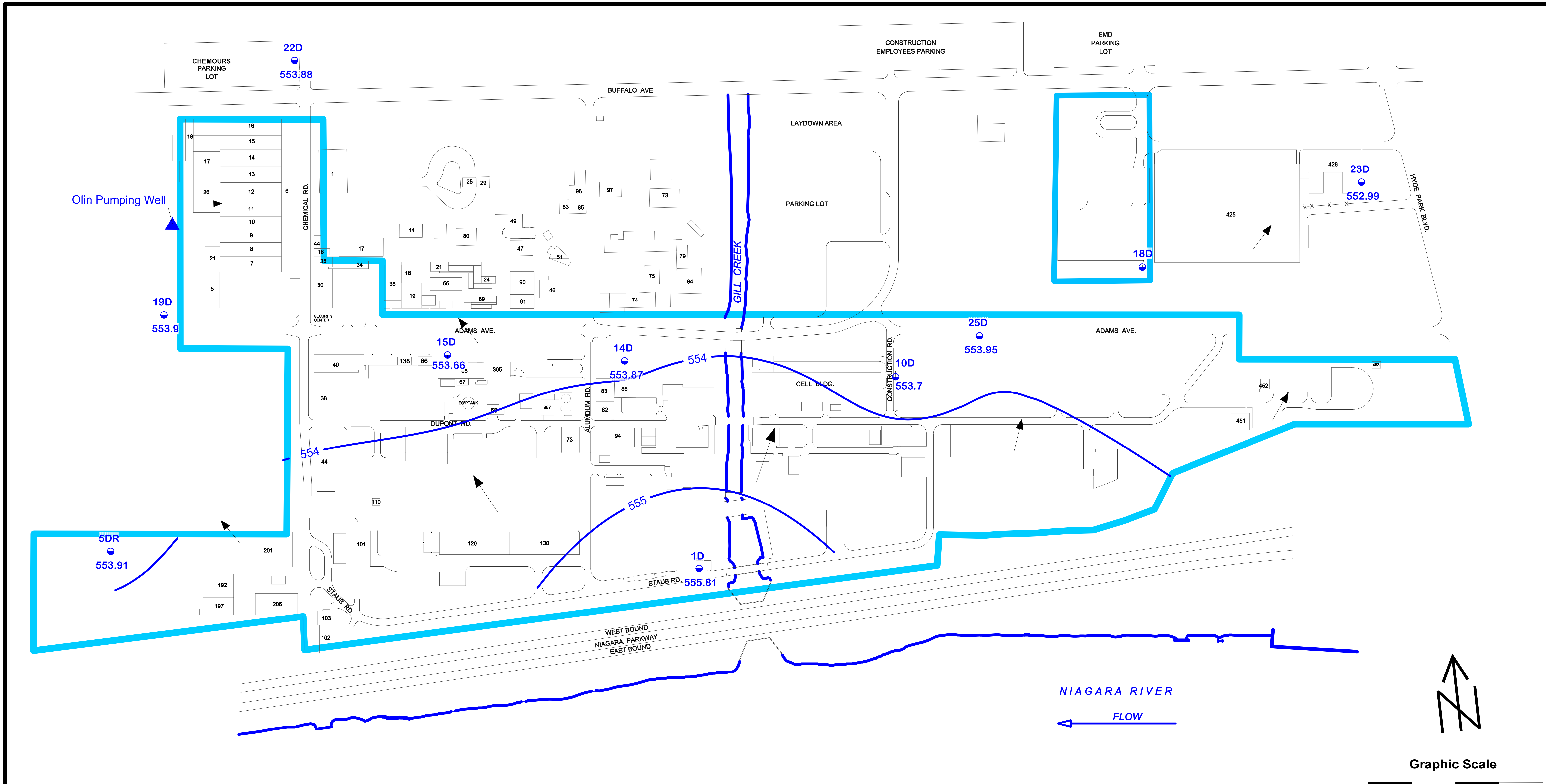
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS

- 1C — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL
- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 558 — GROUNDWATER CONTOUR ELEVATION

FIGURE 4
POTENTIOMETRIC SURFACE MAP
C/CD-ZONE BEDROCK - DECEMBER 4, 2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-CZPZ.srf



Note:
Well 18D was not accessible on 12/4/18. Water level measurement for this well was collected on 12/5/18, but was not used to generate the groundwater contours.

PARSONS
40 La Riviere Dr, Suite 350
Buffalo, NY 14202
(716) 541-0730

Created by: RBP	Date: 1/11/19
Checked by: JWS	Date: 1/16/19
Project Manager: EAF	Date: 1/16/19
Job number: 451477.02024	

LEGEND
- BUILDING
- ROAD
- CHEMOURS PROPERTY BOUNDARY
- SURFACE WATER

CHEMOURS WELLS
- 1D — WELL ID
- PIEZOMETER
- PUMPING WELL
- MONITORING WELL

- GROUNDWATER CONTOUR
- GROUNDWATER CONTOUR DEPRESSION
- 557 — GROUNDWATER CONTOUR ELEVATION

FIGURE 5
POTENTIOMETRIC SURFACE MAP
D-ZONE BEDROCK - DECEMBER 4, 2018
CHEMOURS NIAGARA PLANT, NIAGARA FALLS, NY

\\NYBUF03FS01\Dupont$\Niagara\NiaPlant\Hydrogeo\Hydro\GW_contours\2018-12-04 NIA Contour Tool\2018-12-04-DZPZ.srf

APPENDIX A

CHEMOURS NIAGARA PLANT
GROUNDWATER ELEVATION DATA
FOURTH QUARTER 2018

APPENDIX A

GROUNDWATER ELEVATION DATA - FOURTH QUARTER 2018

CHEMOURS NIAGARA PLANT

SAMPLE POINT	DATE	DEPTH TO WATER (FT)	CASING ELEVATION (FT AMSL)	GW ELEVATION (FT AMSL)	TIME	Groundwater Level Comments
BW-01	12/04/2018	10.85	571.53	560.68	10:57	
DEC-3R	12/04/2018	12.53	574.39	561.86	10:50	
DEC-4R	12/04/2018	14.28	575.81	561.53	10:51	
DEC-5	12/04/2018	20.89	582.13	561.24	10:51	
EPO-1	12/04/2018	10.41	572.67	562.26	10:58	
EPO-2	12/04/2018	-	572.31	-	12:20	Dry
EPO-3	12/04/2018	10.89	572.67	561.78	11:35	
EPO-4	12/04/2018	9.17	570.75	561.58	11:31	
EPO-5	12/04/2018	6.06	570.35	564.29	11:30	
EPO-6	12/04/2018	5.56	570.46	564.90	11:30	
EPO-7	12/04/2018	5.02	570.71	565.69	11:56	
EPO-8	12/04/2018	6.46	570.69	564.23	11:57	
EPO-9	12/04/2018	9.81	572.36	562.55	11:02	
EPPT-1	12/04/2018	5.02	568.96	563.94	12:15	
EPPT-2	12/04/2018	10.26	572.41	562.15	11:22	
EPPT-3	12/04/2018	8.55	572.05	563.50	11:57	
EPT-1	12/04/2018	10.31	572.86	562.55	10:58	
EPT-2	12/04/2018	10.30	572.22	561.92	12:21	
EPT-3	12/04/2018	10.46	572.51	562.05	11:35	
EPT-4	12/04/2018	9.34	571.03	561.69	11:31	
EPT-5	12/04/2018	12.06	570.28	558.22	11:30	
EPT-6	12/04/2018	6.82	570.52	563.70	11:30	
EPT-7	12/04/2018	6.70	570.53	563.83	11:56	
EPT-8	12/04/2018	6.64	570.66	564.02	11:57	
EPT-9	12/04/2018	9.34	571.79	562.45	11:03	
GC-1	12/04/2018	11.03	572.71	561.68	11:04	
GC-2	12/04/2018	11.42	572.79	561.37	10:41	
MW-10A	12/04/2018	8.19	572.13	563.94	12:01	
MW-10C	12/04/2018	11.50	568.10	556.60	12:00	
MW-10D	12/04/2018	14.79	568.49	553.70	12:00	
MW-12A	12/04/2018	10.20	572.56	562.36	11:00	
MW-12B	12/04/2018	10.25	572.14	561.89	11:01	
MW-12C/CD	12/04/2018	13.74	572.77	559.03	11:00	
MW-13A	12/04/2018	7.86	573.13	565.27	11:09	
MW-14A	12/04/2018	6.24	572.30	566.06	11:12	
MW-14B	12/04/2018	8.55	572.29	563.74	11:13	
MW-14C	12/04/2018	16.95	572.10	555.15	11:12	
MW-14D	12/04/2018	18.81	572.68	553.87	11:12	
MW-15A	12/04/2018	3.42	568.61	565.19	10:10	
MW-15C	12/04/2018	16.79	568.52	551.73	10:23	
MW-15CD	12/04/2018	17.95	568.55	550.60	10:12	
MW-15D	12/04/2018	14.91	568.57	553.66	10:24	
MW-16A	12/04/2018	8.11	572.33	564.22	12:27	
MW-16B	12/04/2018	10.15	572.96	562.81	12:28	
MW-17A	12/04/2018	18.22	571.98	553.76	11:12	
MW-17B	12/04/2018	20.49	571.94	551.45	11:12	

APPENDIX A
GROUNDWATER ELEVATION DATA - FOURTH QUARTER 2018
CHEMOURS NIAGARA PLANT

SAMPLE POINT	DATE	DEPTH TO WATER (FT)	CASING ELEVATION (FT AMSL)	GW ELEVATION (FT AMSL)	TIME	Groundwater Level Comments
MW-18A	12/05/2018	12.44	570.81	558.37	10:23	Not accessible 12/4- Collected 12/5, not used in contouring
MW-18C	12/05/2018	14.36	570.71	556.35	10:22	Not accessible 12/4- Collected 12/5, not used in contouring
MW-18D	12/05/2018	16.49	570.89	554.40	10:24	Not accessible 12/4- Collected 12/5, not used in contouring
MW-19A	12/04/2018	7.21	573.67	566.46	12:08	
MW-19B	12/04/2018	12.34	573.26	560.92	12:07	
MW-19C	12/04/2018	16.84	573.59	556.75	12:06	
MW-19CD1	12/04/2018	22.71	573.29	550.58	12:05	
MW-19D	12/04/2018	19.18	573.08	553.90	12:02	
MW-1AR3	12/04/2018	9.49	571.68	562.19	10:23	
MW-1BR	12/04/2018	14.16	571.38	557.22	10:24	
MW-1C	12/04/2018	12.18	571.38	559.20	10:25	
MW-1D	12/04/2018	16.32	572.13	555.81	10:26	
MW-20AR	12/04/2018	1.34	570.51	569.17	12:13	
MW-20B	12/04/2018	11.38	570.09	558.71	12:14	
MW-21A	12/04/2018	9.69	573.41	563.72	11:05	
MW-22B	12/04/2018	12.12	569.86	557.74	11:11	
MW-22C	12/04/2018	2.50	570.09	567.59	11:11	
MW-22D	12/04/2018	16.23	570.11	553.88	11:12	
MW-23AR	12/04/2018	10.30	573.50	563.20	11:13	
MW-23B	12/04/2018	19.09	572.70	553.61	11:13	
MW-23C	12/04/2018	20.86	572.74	551.88	11:13	
MW-23D	12/04/2018	19.82	572.81	552.99	11:14	
MW-24A	12/04/2018	10.55	572.57	562.02	10:47	
MW-24B	12/04/2018	12.44	572.69	560.25	10:46	
MW-25B	12/04/2018	13.05	569.71	556.66	11:31	
MW-25C/CD	12/04/2018	16.40	570.71	554.31	11:31	
MW-25D	12/04/2018	16.58	570.53	553.95	11:31	
MW-26C	12/04/2018	14.43	568.39	553.96	12:25	
MW-26CD	12/04/2018	18.22	568.87	550.65	12:26	
MW-27A	12/04/2018	11.29	573.60	562.31	11:35	
MW-28A	12/04/2018	9.82	570.48	560.66	11:07	
MW-29B	12/04/2018	13.99	571.53	557.54	11:57	
MW-2A	12/04/2018	9.68	571.82	562.14	11:05	
MW-2B	12/04/2018	12.09	573.55	561.46	11:03	
MW-2C	12/04/2018	16.01	571.62	555.61	11:04	
MW-30B	12/04/2018	12.87	570.83	557.96	11:29	
MW-3A	12/04/2018	7.52	572.43	564.91	10:41	
MW-3B	12/04/2018	10.79	572.25	561.46	10:41	
MW-4AR	12/04/2018	11.35	573.82	562.47	11:33	
MW-4CR	12/04/2018	12.97	569.85	556.88	11:32	
MW-5AR	12/04/2018	13.79	575.01	561.22	11:55	
MW-5BR	12/04/2018	16.24	574.93	558.69	11:54	
MW-5CDR	12/04/2018	23.61	575.00	551.39	11:53	
MW-5CR	12/04/2018	17.39	574.91	557.52	11:52	

APPENDIX A
GROUNDWATER ELEVATION DATA - FOURTH QUARTER 2018
CHEMOURS NIAGARA PLANT

SAMPLE POINT	DATE	DEPTH TO WATER (FT)	CASING ELEVATION (FT AMSL)	GW ELEVATION (FT AMSL)	TIME	Groundwater Level Comments
MW-5DR	12/04/2018	21.19	575.10	553.91	11:51	
MW-6AR	12/04/2018	7.72	576.41	568.69	11:58	
MW-7AR	12/04/2018	10.40	571.90	561.50	11:49	
MW-7CR	12/04/2018	17.95	571.60	553.65	11:46	
MW-8A	12/04/2018	9.30	571.64	562.34	11:30	
MW-8B	12/04/2018	9.88	571.43	561.55	11:29	
MW-9AR	12/04/2018	10.72	572.66	561.94	11:26	
MW-U-1	12/04/2018	14.91	573.25	558.34	12:10	
MW-U-14	12/04/2018	4.15	571.26	567.11	12:04	
MW-U-16	12/04/2018	10.94	573.78	562.84	10:52	
OBA-10A	12/04/2018	-	568.39	-	13:15	Well could not be located - not applicale to contour maps
OBA-24A	12/04/2018	5.35	568.97	563.62	12:25	
OBA-24B	12/04/2018	11.60	568.90	557.30	12:25	
OBA-25A	12/04/2018	5.18	569.10	563.92	11:58	
OBA-25B	12/04/2018	11.76	569.07	557.31	11:58	
OBA-26A	12/04/2018	5.96	569.67	563.71	11:58	
OBA-26B	12/04/2018	12.29	569.67	557.38	11:59	
PW-16	12/04/2018	14.92	573.45	558.53	11:07	
PW-18	12/04/2018	9.91	570.13	560.22	11:17	
PW-19	12/04/2018	14.11	573.30	559.19	11:16	
PW-20	12/04/2018	8.59	569.75	561.16	12:11	
PW-22	12/04/2018	11.89	569.50	557.61	12:15	
PW-24	12/04/2018	9.62	568.75	559.13	12:07	
PW-26	12/04/2018	9.48	568.40	558.92	11:58	
PW-28	12/04/2018	10.40	567.37	556.97	12:04	
PW-30	12/04/2018	9.48	568.81	559.33	11:52	
PW-32	12/04/2018	10.48	568.17	557.69	11:51	
PW-34	12/04/2018	10.40	568.92	558.52	11:50	
PW-35	12/04/2018	14.38	572.68	558.30	12:23	
PW-36	12/04/2018	5.45	569.51	564.06	10:54	
PW-37	12/04/2018	9.38	569.04	559.66	11:42	
PW-38	12/04/2018	11.41	572.07	560.66	10:59	
PW-39	12/04/2018	12.67	571.76	559.09	09:59	
TPW-01	12/04/2018	10.44	570.85	560.41	10:56	
WPO-10	12/04/2018	5.80	572.03	566.23	12:30	
WPO-11	12/04/2018	9.84	573.25	563.41	11:37	
WPO-12	12/04/2018	11.61	573.83	562.22	11:18	
WPO-13	12/04/2018	11.21	573.65	562.44	11:35	
WPO-14	12/04/2018	9.85	570.51	560.66	11:08	Cap cracked

APPENDIX A
GROUNDWATER ELEVATION DATA - FOURTH QUARTER 2018
CHEMOURS NIAGARA PLANT

SAMPLE POINT	DATE	DEPTH TO WATER (FT)	CASING ELEVATION (FT AMSL)	GW ELEVATION (FT AMSL)	TIME	Groundwater Level Comments
WPO-15	12/04/2018	14.21	575.98	561.77	10:51	
WPO-16	12/04/2018	12.46	574.84	562.38	10:50	
WPO-17	12/04/2018	9.80	570.84	561.04	11:09	
WPO-18	12/04/2018	10.15	572.38	562.23	10:20	
WPO-19	12/04/2018	10.39	572.49	562.10	10:17	
WPO-1R	12/04/2018	8.43	573.43	565.00	11:48	
WPO-2	12/04/2018	6.96	573.32	566.36	11:24	
WPO-20	12/04/2018	10.91	571.64	560.73	11:39	
WPO-21	12/04/2018	11.07	572.06	560.99	11:00	
WPO-22	12/04/2018	10.15	570.86	560.71	10:55	
WPO-23	12/04/2018	9.85	571.84	561.99	11:17	
WPO-24	12/04/2018	9.59	571.41	561.82	10:16	
WPO-25	12/04/2018	8.48	571.77	563.29	10:39	
WPO-3R	12/04/2018	8.07	572.84	564.77	11:12	
WPO-4	12/04/2018	7.61	572.38	564.77	11:15	
WPO-5	12/04/2018	8.65	572.99	564.34	10:57	
WPO-6	12/04/2018	12.64	577.73	565.09	11:06	
WPO-7	12/04/2018	6.90	571.52	564.62	11:15	
WPO-8	12/04/2018	2.79	568.34	565.55	10:29	
WPO-9R	12/04/2018	9.74	572.94	563.20	12:42	
WPPO-1	12/04/2018	2.87	568.66	565.79	11:28	
WPPO-3R	12/04/2018	6.19	571.78	565.59	10:37	
WPPT-2	12/04/2018	8.59	572.15	563.56	10:39	
WPPT-4	12/04/2018	8.70	572.30	563.60	10:36	
WPPT-5	12/04/2018	12.72	576.65	563.93	11:08	
WPT-10	12/04/2018	7.75	572.15	564.40	12:31	
WPT-11	12/04/2018	10.11	573.26	563.15	11:38	
WPT-12	12/04/2018	11.24	573.41	562.17	11:19	
WPT-17	12/04/2018	9.80	570.81	561.01	11:09	
WPT-18	12/04/2018	11.05	572.95	561.90	10:21	
WPT-19	12/04/2018	10.82	572.73	561.91	10:18	
WPT-1R	12/04/2018	9.55	574.02	564.47	11:47	
WPT-2	12/04/2018	8.34	573.13	564.79	11:23	
WPT-20	12/04/2018	11.81	572.19	560.38	11:41	
WPT-21	12/04/2018	11.51	572.49	560.98	11:02	
WPT-22	12/04/2018	11.06	571.64	560.58	10:57	
WPT-23	12/04/2018	9.79	571.69	561.90	11:16	
WPT-24	12/04/2018	9.55	571.46	561.91	10:00	
WPT-25	12/04/2018	9.58	572.50	562.92	10:39	
WPT-3R	12/04/2018	10.74	572.98	562.24	11:12	
WPT-4	12/04/2018	9.90	572.56	562.66	11:14	
WPT-5	12/04/2018	9.31	572.51	563.20	10:57	
WPT-6	12/04/2018	14.42	577.70	563.28	11:06	
WPT-7	12/04/2018	8.05	571.58	563.53	11:15	
WPT-8	12/04/2018	3.26	568.66	565.40	10:30	
WPT-9R	12/04/2018	8.42	572.62	564.20	12:41	

APPENDIX B

CHEMOURS NIAGARA PLANT
SUMMARY OF ANALYTICAL RESULTS
FOURTH QUARTER 2018 SYSTEM MONITORING

Appendix B
Summary of Analytical Results
Chemours Niagara Plant
Fourth Quarter 2018

Method	Parameter Name	Location Date Units	GWRS-INF 12/04/2018 FS	GWRS-EFF 12/04/2018 FS	OLIN-INF 12/04/2018 FS	OLIN-EFF 12/04/2018 FS	OUTFALL-023 12/04/2018 FS	OUTFALL-023 12/04/2018 DUP	EB 12/04/2018 EB	TB 12/04/2018 TB
	Field Parameters									
	COLOR	NONE	No	No	No	No	Clear	Clear	--	--
	ODOR	NONE	No	No	No	No	None	None	--	--
	OXIDATION REDUCTION POTENTIAL	MV	148	208	39	4	120	120	--	--
	PH	STD UNITS	6.3	6.5	5.74	6.05	7.01	7.01	--	--
	SPECIFIC CONDUCTANCE	UMHOS/CM	3471	3358	459	4182	1625	1625	--	--
	TEMPERATURE	DEGREES C	15.9	22.7	10.7	11.8	18.5	18.5	--	--
	TURBIDITY QUANTITATIVE	NTU	4.6	4.2	3.5	2.7	5.11	5.11	--	--
	Volatile Organics									
8260C	1,1,1-Trichloroethane	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,1,2,2-Tetrachloroethane	UG/L	<1000	41	12	<1	9.2	11	--	<1
8260C	1,1,2-Trichloroethane	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,1-Dichloroethane	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,1-Dichloroethene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,2-Dichlorobenzene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,4-Dichlorobenzene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	1,4-Dichlorobutane	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Benzene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Carbon Tetrachloride	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Chlorobenzene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Chloroform	UG/L	25000	7.7	63	4.4	20	19	--	<1
8260C	cis-1,2 Dichloroethene	UG/L	9200	4.1	52	2.9	53	51	--	<1
8260C	Methyl Chloride	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Methylene Chloride	UG/L	<5000	<10	<50	<5	<33	<33	--	<5
8260C	Tetrachloroethene	UG/L	4200	20	110	<1	51	60	--	<1
8260C	Tetrahydrothiophene	UG/L	<2000	<4	<20	<2	<13	<13	--	<2
8260C	Toluene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	trans-1,2-Dichloroethene	UG/L	<1000	<2	<10	<1	<6.7	<6.7	--	<1
8260C	Trichloroethene	UG/L	14000	29	200	2.6	59	74	--	<1
8260C	Vinyl Chloride	UG/L	<1000	<2	16	8.4	<6.7	7.7	--	<1
	Total VOCs		52400	101.8	453	18.3	192.2	222.7	--	0
	Other Organics									
8270D	Bis(2-Ethylhexyl)Phthalate	UG/L	--	--	--	--	<5.7	<5.9	--	--
8270D	Hexachlorobutadiene	UG/L	--	--	--	--	<9.5	<9.9	--	--
8270D	Hexachloroethane	UG/L	--	--	--	--	<9.5	<9.9	--	--
8270D	Naphthalene	UG/L	--	--	--	--	<9.5	<9.9	--	--
8081B	Alpha-BHC	UG/L	--	--	--	--	0.24	0.28	--	--
8081B	beta-BHC	UG/L	--	--	--	--	<0.053	<0.051	--	--
8081B	delta-BHC	UG/L	--	--	--	--	<0.053	<0.051	--	--
8081B	Lindane	UG/L	--	--	--	--	0.13	0.15	--	--
8082A	PCB 1016	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1221	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1232	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1242	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1248	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1254	UG/L	--	--	--	--	<0.53	<0.51	--	--
8082A	PCB 1260	UG/L	--	--	--	--	<0.53	<0.51	--	--
	Inorganics									
6010C	Barium, dissolved	UG/L	--	--	--	--	<200	<200	<200	--
9012B	Cyanide, total	UG/L	--	--	--	--	200	200	--	--

< Not detected at stated reporting limit

J Estimated concentration

APPENDIX C

CHEMOURS NIAGARA PLANT
SILICONE OIL REMEDIATION

TABLE 1
Silicone Oil Recovery Summary - 4Q2018
Niagara Plant
Niagara Falls, NY

DATE	PW-20 PRODUCT THICKNESS (FT)	PW-20 AMOUNT RECOVERED (GALLONS)	PW-20 CUMULATIVE TOTAL (GALLONS)	PW-24 PRODUCT THICKNESS (FT)	PW-24 AMOUNT RECOVERED (GALLONS)	PW-24 CUMULATIVE TOTAL (GALLONS)
			64.0			1984.0
10/01/18	0.0	0.0	64.0	0.0	0.0	1,984.0
10/08/18	0.0	0.0	64.0	0.0	0.0	1,984.0
10/15/18	0.0	0.0	64.0	0.0	0.5	1,984.5
10/22/18	0.0	0.0	64.0	0.0	0.0	1,984.5
10/29/18	0.0	0.0	64.0	0.0	0.5	1,985.0
11/05/18	0.0	0.0	64.0	0.0	0.0	1,985.0
11/13/18	0.0	0.0	64.0	0.0	0.0	1,985.0
11/19/18	0.0	0.0	64.0	0.0	0.0	1,985.0
11/26/18	0.0	0.0	64.0	0.0	0.0	1,985.0
12/05/18	0.0	0.0	64.0	0.0	0.5	1,985.5
12/10/18	0.0	0.0	64.0	0.0	0.0	1,985.5
12/18/18	0.0	0.0	64.0	0.0	0.0	1,985.5
12/24/18	0.0	0.0	64.0	0.0	0.0	1,985.5
4Q18 Totals	**0.0**	**0.0**	**64.0**	**0.0**	**1.5**	**1,985.5**

TOTAL SILICONE OIL RECOVERED SINCE JUNE 1999: 2,049.5 GALLONS

comments:
12/18/2018 Changed out Drum #2018-07-25-1 containing 8.0 gals oil
12/18/2018 New drum # 2018-12-18-1