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ENVIRONMENT

Subject:
2018 Annual Summary Report - Operation, Maintenance, and Monitoring Report for the Bethpage Park Groundwater Containment System (BPGWCS), Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York, NYSDEC Site #1-30-003A.

Date:
March 29, 2019

Contact:
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Our ref:
NYNG2019.32TM.RPTI4

Dear Jason:

Enclosed is one electronic PDF copy of the 2018 Annual Summary Report for the BPGWCS, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. Additionally, the enclosed summarizes the operation, maintenance and monitoring activities performed during the 2018 reporting period (i.e., January 1 through December 31, 2018). As we have transitioned to electronic submittals (via PDF) in line with NYSDEC's paper reduction program, hard copies of the report can be provided on request.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Arcadis of New York, Inc.

Christopher D. Engler

Christopher Engler, PE
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Vice President

Enclosure

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Northrop Grumman Systems Corporation

2018 ANNUAL OPERATION, MAINTENANCE AND MONITORING REPORT

Operable Unit 3 - Groundwater

Bethpage, New York

NYSDEC ID # 1-30-003A

March 29, 2019

2018 ANNUAL OPERATION, MAINTENANCE AND MONITORING REPORT

Operable Unit 3 - Groundwater Containment System Bethpage, New York
NYSDEC ID # 1-30-003A

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1 INTRODUCTION

Pursuant to the Administrative Order on Consent (AOC) Index #W1-0018-04-01 (New York State Department of Environmental Conservation [NYSDEC] 2005) and the Operable Unit 3 (OU3) Record of Decision (NYSDEC 2013), Arcadis of New York, Inc. (Arcadis), on behalf of Northrop Grumman Systems Corporation (Northrop Grumman), has prepared this OU3 Bethpage Park Groundwater Containment System (BPGWCS) Annual Summary Report for submittal to the NYSDEC. The present-day Bethpage Community Park property (Park), the McKay Field, and Plant 24 Access Road, which the NYSDEC has termed the "Former Grumman Settling Ponds Area" and designated as OU3, are referred to herein as the Site Area. Figure 1 provides a Site Area location map.

The BPGWCS (previously referred to as the Groundwater Interim Remedial Measure) has been operational since July 21, 2009. The operation, maintenance, and monitoring (OM&M) activities performed during 2018 (i.e., January 1 through December 31, 2018 [the "annual reporting period"]) are summarized in this Annual Summary Report. This report also describes the Operation, Maintenance, and Monitoring (OM&M) activities performed during the Fourth Quarter of 2018 (i.e., October 1 through December 31, 2018 [the "Fourth Quarter"]). Data summaries for the previous three 2018 quarterly operational periods are available in the following letter reports:

- Results of First Quarter 2018 System Operation and Monitoring for the Bethpage Park Groundwater Containment System, May 2018 (Arcadis 2018a)
- Results of Second Quarter 2018 System Operation and Monitoring for the Bethpage Park Groundwater Containment System, August 2018 (Arcadis 2018b)
- Results of Third Quarter 2018 System Operation and Monitoring for the Bethpage Park Groundwater Containment System, November 2018 (Arcadis 2018c)

During the annual reporting period, the BPGWCS Remedial System and Environmental Effectiveness Monitoring Programs were conducted in accordance with the OU3 Groundwater Interim Operation, Maintenance, and Monitoring Manual (OM&M Manual; Arcadis 2016).

As discussed in the OU3 Site Area Remedial Investigation Report (Site Area RI) (Arcadis 2011), Northrop Grumman does not take responsibility for certain compounds (e.g., Freon 12 and Freon 22) present in Site Area groundwater. Throughout this Annual Report, a distinction is made between "Project" and "Non-Project" volatile organic compounds (VOCs), defined as follows:

- Project VOCs: VOCs that may be related to former Northrop Grumman historical activities. For this OM&M Report, Project VOCs include 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethylene (TCE); vinyl chloride (VC); cis-1,2-dichloroethene (cis-1,2-DCE); trans-1,2-dichloroethene (trans-1,2-DCE); benzene; toluene; xylene-O, and xylenes-M,P.
- Non-Project VOCs: VOCs, such as Freon 12 and Freon 22, that are understood to be unrelated to former Northrop Grumman activities but have been detected in Site Area groundwater. As noted in the Site Area RI (Arcadis 2011), a sub-plume of Freon 22 has been identified originating from the area of the Town of Oyster Bay's (Town's) former ice rink (shown on Figure 2). Based on Town information (Zervos 2007), Freon 22 was used by the Town and released to the environment.

2 BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM OBJECTIVES

Remedial action objectives (RAOs) for the BPGWCS are as follows:

- Mitigate the off-site migration of dissolved-phase VOCs. Specifically, the BPGWCS addresses:
  - Groundwater that has total VOC concentrations greater than 5 micrograms per liter (µg/L) in the upper 20 feet of the surficial aquifer across the 1,200-foot-wide lateral extent of the Site Area southern boundary.
  - Groundwater below the upper 20 feet of the surficial aquifer that has total VOC concentrations greater than 50 µg/L across the 1,200-foot-wide lateral extent of the Site Area southern boundary.
- Comply with applicable NYSDEC standards, criteria, and guidance values (SCGs) for treated water and air emissions.

A secondary benefit of the BPGWCS is the creation of a clean-water front atop downgradient groundwater, which minimizes the potential for vapor intrusion downgradient of the Site Area.

3 BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM DESCRIPTION

The BPGWCS consists of:

- A pump-and-treat system where groundwater is:
  - Extracted along the Plant 24 Access Road via four remedial wells.
  - Conveyed to a treatment plant at McKay Field via four underground pipelines.
  - Treated via air stripping to reduce concentrations of Project and Non-Project VOCs to comply with applicable NYSDEC SCGs for treated water.
  - Filtered to remove oxidized metals to comply with applicable NYSDEC SCGs for treated water.
  - Returned to the aquifer via a discharge pipeline routed to a recharge basin located on the adjacent former Bethpage Navy Weapons Industrial Reserve Plant property.
- A vapor-phase treatment system that reduces concentrations of Project VOCs in the air stripper off-gas prior to discharge to the atmosphere.
- A groundwater monitoring network periodically monitored to assess environmental effectiveness of the BPGWCS.

Major components of the BPGWCS are as follows:

- Four remedial wells (RW-1, RW-2, RW-3, and RW-4) with design pumping rates of 30 gallons per minute (gpm), 75 gpm, 75 gpm, and 30 gpm, respectively; for a total design influent flow rate of 210 gpm.
- One low-profile air stripper to remove VOCs from extracted groundwater prior to discharge to the recharge basins.
- Two bag filter units configured so that one is operational and the other is in standby mode. The system control logic automatically switches from the operational filter unit to the standby filter unit when the bag filter is full to prevent a system shutdown and the spent filters are then replaced.
- Four emission control units, two containing vapor-phase granular-activated carbon and two containing potassium permanganate-impregnated zeolite, to treat Project VOCs in the air stripper off-gas.
- A groundwater monitoring network, consisting of 35 monitoring locations, including 17 groundwater monitoring wells, four remedial wells, and 14 piezometers.

The OM&M Manual (Arcadis 2016) provides additional information on the BPGWCS. Figure 2 shows the layout of the BPGWCS, and Figure 3 provides a schematic drawing. Figure 4 shows groundwater sampling locations that form the groundwater monitoring network. Appendix A provides construction details for the monitoring wells and piezometers.

4 OPERATION AND MAINTENANCE ACTIVITIES

4.1 Annual System Performance and Alarm Summary

The 2018 system operational up-time is provided on Table 1 and summarized below. System shutdowns that occurred in 2018 are summarized below.

In 2018:

- The system operated 348 out of 365 days (95% uptime), down from 97% runtime observed in 2017.
- The remedial wells operated at reduced flow rates during portions of the year due to pump wear, which is attributed to iron build-up in the pumps, influent pipelines and valves. The reduced flow rates were corrected by adjusting the manifold globe valves or through the performance of periodic system maintenance (i.e. pulling and replacing the remedial well pumps and valve cleaning).
- There were fifty-three (53) routine system shutdowns (less than 12 hours each) due to alarm conditions encountered during normal operation of the system. Alarms in this category were responded to and troubleshooting was completed to restart the system within the same day (less than 12 hours).
- The following seven (7) non-routine system shutdowns resulted in downtime for greater than 12 hours each, of which:

- One (1) shutdown was due to internet failure causing loss in connectivity. The internet connection was restored on April 14, 2018.
- One (1) shutdown was required to accommodate PSEG switchgear changeout.
- One (1) shutdown was due to PLC failure. The PLC was replaced on June 22, 2018 and the system was brought back online.
- One (1) shutdown was due to a RW-3 pump motor overload condition. The system was restarted at a reduced flowrate and the pump motor was replaced on July 5, 2018.
- One (1) shutdown was due to electrical issues while installing new blower differential pressure switches.
- One (1) shutdown was due to alarm conditions encountered during the normal operation of the system:
    - The alarm condition was due to a sump overflow caused by heavy rainfall.
- One (1) shutdown was due to a RW-2 pump motor overload condition. The system was restarted operating at a reduced flowrate.

There were approximately 17 days of reduced flow, which was due to unforeseen RW-2 motor and pump overload conditions associated with iron build-up. Generally, the system was restarted without incident the same day or the day following routine alarms. OM&M activities were conducted in accordance with the OU3 Groundwater Interim OM&M Manual.

5 SYSTEM MONITORING ACTIVITIES

5.1 2018 System Monitoring Activities

The following compliance and performance monitoring activities were conducted during the annual reporting period (see Appendix B, Appendix B-1 for a summary of the compliance and performance monitoring program requirements):

- Twelve (12) sampling events to collect twelve (12) required water samples and four (4) air samples;
- Forty-eight (48) weekly site visits to monitor and record key system operational parameters.

System O&M results for the annual reporting period are summarized in the following tables and figures:

- Operational Summary, including monitoring events, system operational days, and noteworthy site activities (Table 1);
- Summary of Influent and Effluent Water Sample Analytical Results (Tables 2 and 3, respectively) - Table 3 also provides the BPGWCS treatment system removal efficiency;
- Summary of Influent and Effluent Vapor Sample Analytical Results and Summary of Effluent Vapor Tentatively Identified Compounds (Tables 4, 5 and 6, respectively) - Table 5 also provides the BPGWCS treatment system removal efficiency;
- Summary of System Parameters, including flow rates, line pressures, and temperatures (Table 7);

- Summary of Groundwater Recovered, VOC Mass Recovered, and VOC Mass Recovery Rates (Table 8) - Table 8 provides a breakdown of these parameters by Remedial Well and System and breaks down the VOC mass recovered and VOC recovery rates into Project, Non-Project, and total VOCs;
- Cumulative Total, Project, and Non-Project VOC Mass Removed (Figure 5);
- Remedial Well Total, Project, and Non-Project VOC Concentrations (Figures 6A, 6B, and 6C, respectively);
- Influent Total, Project, and Non-Project VOC Concentrations (Figure 7); and,
- Total, Project, and Non-Project VOC Mass Recovery Rates (Figures 8A, 8B, and 8C, respectively).

5.2 Summary of Monitoring Results and Conclusions

5.2.1 System Operation and Effectiveness

Annual BPGWCS monitoring results and conclusions are summarized below:

- Total volume of groundwater recovered and treated (Table 8):
  - 2018 Annual Total: 100 million gallons
  - Cumulative total since system startup: 968 million gallons
- Total VOC mass recovered (Table 8 and Figure 8A):
  - 2018 Annual Total: 15.2 lbs of VOCs
  - Cumulative total since system startup: 2,187 lbs of VOCs
- VOC mass recovered and mass removal rates (Table 8 and Figures 8A, 8B, and 8C):
  - The majority of VOCs recovered during the annual reporting period were Project VOCs (93 percent or 14.2 lbs).
  - Majority of Project VOCs are recovered by RW-2 (95 percent or 13.5 lbs) and RW-3 (5 percent or 0.70 lbs)
  - Majority of Non-Project VOCs are recovered by RW-4 (54 percent or 0.52 lbs), RW-2 (28 percent or 0.27 lbs), and RW-3 (20 percent or 0.19 lbs)
- Treatment system influent concentrations (Tables 2 and 11, and Figures 6A, 6B, 6C, and 7):
  - Project VOC influent concentrations, which ranged from 1.9 µg/L to 7.5 µg/L during the annual reporting period, is consistent with historical values. Project VOC influent concentrations are generally stable over the annual reporting period. These concentrations are below the peak concentration observed in 2014 (105 µg/L) and lower than the lowest concentrations observed in 2016 (27 µg/L in August and December). Project VOC influent concentrations have generally decreased since 2010.
  - Non-Project VOC influent concentrations, which ranged from 0.47 µg/L to 0.54 µg/L during the annual reporting period, is consistent with historical values. Non-Project VOC influent

concentrations generally decreased over the annual reporting period. These concentrations are below the peak concentration observed in 2014 (55 µg/L). Non-Project VOC influent concentrations have generally decreased since 2010.

- Total iron (166 µg/L) and dissolved iron (108 µg/L) were detected during the annual reporting period, which is consistent with historical values.
- Total chromium (10.5 µg/L) and dissolved chromium (10.2 µg/L) were detected in the Third Quarter influent samples, which is consistent with historical values.
- Mercury has not been detected in any influent or effluent sample since system startup.

- Project VOCs in Remedial Well, RW-1 (Table 10) were not detected during the annual reporting period.
  - In RW-2, several Project VOCs (cis-1,2-DCE, TCE, and VC) continue to be detected above applicable SCGs, but the detections remained stable or have decreased in concentration during the annual reporting period.
  - In RW-4, some Project VOCs (DCE, TCE, and VC) were detected in the first and second quarter, but the detections were below the applicable SCGs and were none detect during the third and fourth quarter.
  - RW-2 Project VOCs have decreased from the peak total concentration observed at system startup in July 2009 (3858 µg/L) to the most recent low of 38.1 µg/L in August 2018.
  - Similar to total influent concentrations, Project VOC remedial well concentrations have generally decreased since 2010, with Project VOCs not detected above applicable SCGs in Remedial Well RW-3 since November 2013, and no detections in RW-1 since system startup.
- Non-Project VOCs in Remedial Wells RW-1, RW-2, RW-3 and RW-4 (Table 10) were not detected above applicable SCGs during the Fourth Quarter. Similar to total influent concentrations, Non-Project VOC remedial well concentrations have generally decreased during the annual reporting period and since 2010, with Non-Project VOCs not detected above applicable SCGs in Remedial Wells RW-1, RW-2, or RW-4 since system startup. Only two detections of Non-Project VOCs have been above applicable SCGs in RW-3 since system startup.
- Metals concentrations in remedial wells during the annual reporting period (Table 11) are consistent with historical metals concentrations.
- The air stripper, air stripper off-gas treatment system, and bag filter system performed within acceptable operating ranges during the annual reporting period, as indicated by:
  - The air stripper VOC removal efficiency was greater than 99.9 percent for Project and Non-Project VOCs (Table 3).
  - Reduced air flow (monthly average flow rate of 1,733 scfm) was observed during the annual reporting period (Table 7), which is likely due to iron build up on the lower tray of the air stripper tower. During the annual reporting period, it was observed the air flow meter required replacement. Upon replacement, design air flow was achieved.

- Both water and air discharges complied with applicable SCGs and discharge limits (Tables 3, and 9).

5.2.2 Regulatory Status of Discharges

5.2.2.1 Air Discharge

Influent concentrations for the annual reporting period were compared to 6NYCRR III A Part 212-2.3(b) (Rule 212), Table 4 - Degree of Air Cleaning Required for Non-Criteria Air Contaminants. Concentrations of all effluent compounds detected during the Fourth Quarter were less than 15,141 µg/m^3 (concentration equivalent to 0.1 pounds per hour at a flow rate of 1,767 standard cubic feet per minute), as shown in Table 9 of this report. Therefore, in accordance with the requirements of Table 4 of the NYSDEC regulations, air dispersion modeling was performed to demonstrate that the maximum off-site air concentration is less than the NYSDEC Division of Air Resources (DAR-1) Annual Guidance Concentrations (AGCs) on a 12-month rolling average and Short-term Guidance Concentrations (SGCs), issued August 10, 2016 (NYSDEC 2016).

Effluent concentrations for the annual period are provided on Table 5. The U.S. Environmental Protection Agency (USEPA) air quality dispersion model AERMOD was executed to estimate the highest ambient air concentration of the compounds on Table 5. AERMOD is the USEPA's recommended best state-of-the-art practice Gaussian plume dispersion model. Gaussian models are the most widely used techniques for estimating the impact of non-reactive pollutants, per Appendix W of Title 40 Code of Federal Regulations (CFR) 51 – Guideline of Air Quality Models.

The following parameters were used for the AERMOD model analysis:

- Urban dispersion coefficients
- AERMAP base and terrain elevations, processed using National Elevation Dataset (NED) digitized terrain data
- Surface and upper air observations measured at the Nation Weather Service stations located at Farmingdale and Brookhaven airports for calendar years 2011-2015, in accordance with NYSDEC's DAR-1 Air Dispersion Modeling Guidance Document. This longer period of time was reviewed for the model run, to provide a conservative estimate of atmospheric impacts on the off-site concentrations.
- Discrete receptor grids, per the following methodology:
  - Receptors were located along the property boundary at distances not exceeding 25 meters;
  - A 1.5 km x 1.5 km Cartesian grid receptors with distances of 50 meters between the receptors; and
  - A 3.0 km x 3.0 km Cartesian grid receptors with distances of 100 meters between the receptors.
- Emission rate: 1 gram per second (g/s).

Table 9 provides the compound specific scaled hourly ambient air impact and the scaled annual ambient air impact for the Fourth Quarter sampling event. Based on the model, the maximum one-hour ambient air impact was 3,153.03 [µg/m^3]/[g/s] and the maximum annual ambient air impact was 96.49 [µg/m^3]/[g/s]. As shown, the scaled ambient air impacts for the BPGWCS are below the corresponding SGCs and AGCs, which is consistent with the previous quarterly results during the annual reporting period.

Based on the ambient modeling analysis, the BPGWCS effluent air discharge for the annual reporting period meets the requirements for DAR-1 and is below the Rule 212 requirements.

5.2.2.2 Water Discharge

The BPGWCS-treated water effluent met NYSDEC regulatory requirements during the annual reporting period (Table 3 and Appendix B), as noted below:

- The measured concentration of individual VOCs in the treated water effluent were below applicable discharge limits, per the interim State Pollutant Discharge Elimination System (SPDES) equivalency permit.
- The measured concentration of total and dissolved iron in the treated water effluent were below applicable SPDES discharge limits.
- Dissolved cadmium was undetected in the effluent samples for this reporting period.
- Total and dissolved chromium continued to be non-detect during the annual reporting period and have only been detected once in effluent samples in February 2015.
- Total cadmium and total mercury continue to be non-detect and have not been detected in effluent samples since system startup.

6 ENVIRONMENTAL EFFECTIVENESS MONITORING

The OU3 BPGWCS System environmental effectiveness (i.e., hydraulic monitoring and groundwater quality monitoring) activities and results for the annual reporting period are discussed below.

6.1 Hydraulic Monitoring

6.1.1 Activities

In accordance with OM&M Manual requirements and methodologies (Arcadis 2016), groundwater hydraulic monitoring was performed quarterly during the annual reporting period. Specifically, depth-to-water measurements were completed on March 16, June 12, September 28 and December 7, 2018, at the 43 locations forming the approved monitoring well network (Figure 4). Table 12 summarizes results of depth-to-water measurements to date.

6.1.2 Results

Figure 9 provides the configuration of the shallow potentiometric surface and the inferred horizontal groundwater flow directions on September 28, 2018 at the Site Area. Comparing third quarter water-level elevations from 2018 to those from 2017 reveal that the water table was approximately six-feet higher at the time water level elevations were recorded in 2018 as compared to 2017.

As Figure 9 shows, the regional groundwater flow in the area is generally toward the south/south east. The BPGWCS system is capturing groundwater flow from the Bethpage Community Park. The southern edge of the capture zone extends to just north of Monitoring Well MW-204-1 and south of Monitoring Wells MW-201-1 thru MW-203-1. The groundwater divide is slightly south of Sycamore Avenue, north of MW-207A-1R/MW-207B-1R and MW-208-1.

Figure 10 provides a cross-sectional view of vertical groundwater flow (based on groundwater levels measured on September 28, 2018), and Project VOC concentrations in groundwater (based on results from the July-August 2018 groundwater sampling round [3rd Quarter]). Figure 10 indicates groundwater containing Project VOCs is being captured and removed by remedial wells RW-1 through RW-4, which is consistent with the intended purpose of the OU3 BPGWCS System.

Figure 9 in combination with Figure 10 indicate that the OU 3 BPGWCS System provides effective vertical and horizontal hydraulic control of groundwater containing Project VOCs and prevents its movement offsite.

6.2 Groundwater Quality Monitoring

6.2.1 Activities

An annual groundwater sampling round was performed in July and August 2018 as part of site-wide sampling activity. Groundwater samples were collected from 13 monitoring wells that are specified for sampling in the OU3 OM&M Manual (Arcadis 2016).

A Initial Hydraulic Effectiveness Evaluation (HEE) of the OU3 BPGWCS System was performed in 2014-2015 (ERM 2015). As part of this HEE, a total of 6 monitoring wells and 6 piezometers were installed. Groundwater samples were also collected during this annual round from 4 of the monitoring wells installed during the Initial HEE (i.e., MW-204-1, MW-205-1, MW-206-1 and MW-208-1). Monitoring Wells MW-207A and MW-207B, installed during the Initial HEE, were assessed and found to be unusable in 2017. Therefore, monitoring wells MW-207A and MW-207B were replaced by MW-207A-1R and MW-207B-1R in 2018 as part of a Supplemental HEE conducted in 2018. Sampling results are presented in the Supplemental HEE report (EMAGIN 2018).

6.2.2 Results

Groundwater samples collected from the 17 monitoring wells were analyzed for Target Compound List (TCL) VOCs, plus Freon 12 and Freon 22, using USEPA Method 8260C, 1,4-Dioxane using USEPA Method 8270D SIM and total (unfiltered) and dissolved (filtered) metals (cadmium and chromium) using USEPA Method 6010.

Groundwater quality data, including historical results to date, are summarized in Table 13 (for VOCs and 1,4-Dioxane) and Table 14 (for metals).

6.3 Environmental Effectiveness Monitoring Conclusions

As discussed above, Figures 9 and 10 indicate that the OU3 BPGWCS System is operating as designed, that the expected associated capture zone has developed, and that off-site migration of groundwater containing Project VOCs is being prevented.

The Initial Hydraulic Effective Evaluation (HEE) performed by ERM in 2014-2015 concluded that the OU3 BPGWCS System is effectively controlling VOCs in groundwater to an approximate depth of 175 feet below land surface (ft bls) (ERM 2015). The Initial HEE also identified toluene present at concentrations above 5 ug/L at depths below 175ft (e.g., 130 µg/L at 360 ft bls in VP-300 and 87 µg/L at 280 ft bls in VP-301).

As a result, a Supplemental HEE evaluation was performed by EMAGIN per NYSDEC approved work plan (EMAGIN 2016) in 2018. One of the objectives was to investigate presence of toluene identified during the Initial HEE at depths deeper than 175 ft bls. VP-300 and VP-301 were drilled next to the two VPBs drilled by ERM in 2014-2015 and groundwater samples were collected at the same depth as in 2014-2015. All VOC screening results were less than the applicable New York Water Quality Standards (Class GA) for Groundwater (6NYCRR Part 703) (EMAGIN 2018). The maximum toluene concentration detected in any VPB sample was 2.5µg/L in VPB-300 at 375 ft bls. Two monitoring wells were also installed at the VP-300 and VP-301 following completion of VPB sampling. The monitoring wells are screened at the depths of the highest previously reported toluene concentrations in the deep aquifer (353-363 ft bls for MW-300 and 275-285 ft bls for MW-301). Groundwater samples were collected. Results show that all VOCs were detected at concentrations less than the applicable New York Water Quality Standards (Class GA) for Groundwater (6NYCRR Part 703) (EMAGIN 2018).

The results of the Supplemental HEE did not indicate the presence of toluene, other VOCs, or 1,4-dioxane at concentrations above the applicable groundwater quality criteria in deep groundwater samples (deeper than 175ft bls) and support the conclusion that the OU3 BPGWCS System is effectively controlling VOCs in groundwater to an approximate depth of 175 ft bls (EMAGIN 2018).

NYSDEC Technical Memorandum (November 28, 2018) requested Toluene be analyzed for in all groundwater samples. As shown in Table 13, Toluene has not been identified at concentrations above detection limits (i.e. 1.0 ppb).

In summary, the Initial and Supplemental HEEs collectively confirmed the effectiveness of the OU3 BPGWCS System in preventing VOC impacted groundwater from migrating offsite. Groundwater monitoring results presented in Figure 9 and Figure 10 also confirm that the OU3 BPGWCS System is effectively controlling shallow Project VOCs in groundwater.

7 SUGGESTIONS

- Based on the results of the Initial and Supplemental HEEs and the groundwater analytical results collected during the annual reporting period, Arcadis suggests continued operation of the OU3 BPGWCS System as is.

8 REFERENCES

Arcadis of New York, Inc. (Arcadis). 2016. DRAFT Operation, Maintenance, and Monitoring Manual, Bethpage Park Groundwater Containment System, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York. March 2016.

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TABLES

Table 1
Operational Summary
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

MONTH	DAY																															Days Operational [1]
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
2009 Total																																160
2010 Total																																352
2011 Total																																351
2012 Total																																353
2013 Total																																354
2014 Total																																349
2015 Total																																348
2016 Total																																351
2017 Total																																354
1Q 2018																																90
2Q 2018																																81
3Q 2018																																88
Oct 2018																																31
Nov 2018																																30
Dec 2018																				19												28
4Q 2018																																89
2018 total																																348
TOTAL																																**3320**

Legend:

- Indicates system online the majority or all of the day.
- Indicates system operated with reduced flow rates.
- Indicates system off-line the majority or all of the day.

Abbreviations, Notes, and Units on last page.

Table 1
Operational Summary
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

Notes:

1. Days the system was operational for the majority of the day are counted as one day.

Fourth Quarter 2018

2. RW-2 pump failed on December 20, 2018 and system was brought back online operating at a reduced flowrate.

Abbreviations/Units:

1Q	First Quarter
2Q	Second Quarter
3Q	Third Quarter
4Q	Fourth Quarter
RW	Recovery Well
gpm	gallons per minute

Table 2
Summary of Influent Water Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound	02/01/18 (µg/L)	04/04/18 (µg/L)	08/07/18 (µg/L)	11/08/18 (µg/L)
Project VOCs				
1,1,1 - Trichloroethane	< 1.0	< 0.50	< 1.0	< 1.0
1,1 - Dichloroethane	< 1.0	< 1.0	< 1.0	< 1.0
1,2 - Dichloroethane	< 1.0	< 1.0	< 1.0	< 1.0
1,1 - Dichloroethene	< 1.0	< 0.50	< 1.0	< 1.0
Tetrachloroethene	< 1.0	< 0.50	< 1.0	< 1.0
Trichloroethene	**2.8**	**2.9**	**2.6**	**2.6**
Vinyl Chloride	**3.0**	**6.3**	**2.7**	**1.9**
cis 1,2-Dichloroethene	**6.5**	**7.5**	**5.3**	**6.8**
trans 1,2-Dichloroethene	< 1.0	< 0.50	< 1.0	< 1.0
Benzene	< 0.50	< 0.50	< 0.50	< 0.50
Toluene	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	< 1.0	< 1.0	< 1.0	< 1.0
Subtotal Project VOCs	**12.3**	**16.7**	**10.6**	**11.3**
Non-Project VOCs				
1,1,2,2-Tetrachloroethane	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Butanone	< 5.0	< 5.0	< 5.0	--
2-Butanone	< 10	< 10	< 10	< 10
4-Methyl-2-Pentanone	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	< 10	< 10	< 10	< 10
Bromodichloromethane	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifluoromethane (Freon 22)	< 5.0	< 5.0	< 5.0	--
Chloroethane	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	**0.47 J**	**0.54**	< 1.0	< 1.0
Chloromethane	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,3-Dichloropropene	< 1.0	< 1.0	< 1.0	< 1.0

Abbreviations, Notes, Qualifers, and Units on last page.

Table 2
Summary of Influent Water Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound	02/01/18 (µg/L)	04/04/18 (µg/L)	08/07/18 (µg/L)	11/08/18 (µg/L)
Non-Project VOCs				
Dichlorodifluoromethane (Freon 12)	< 2.0	< 2.0	< 2.0	--
Dichloromethane	< 2.0	< 0.50	< 2.0	< 2.0
Ethylbenzene	< 1.0	< 1.0	< 1.0	< 1.0
Methyl N-Butyl Ketone	< 5.0	< 5.0	< 5.0	< 5.0
Methyl Tert-Butyl Ether	< 1.0	< 1.0	< 1.0	--
Styrene (Monomer)	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-Dichloropropene	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane (Freon 11)	< 2.0	< 2.0	< 2.0	--
Trichlorotrifluoroethane (Freon 113)	< 5.0	< 0.50	< 5.0	< 5.0
1-Chloro-1,1-difluoroethane (Freon 142b)	< 5.0	< 5.0	< 5.0	--
Subtotal Non-Project VOCs	**0.47**	**0.54**	0	0
Total VOCs[1]	**13**	**17**	**11**	**11**
1,4-Dioxane[2]	**0.910**	**1.08**	**0.52**	**0.59**
Compound	**02/01/18 (µg/L)**	**04/04/18 (µg/L)**	**08/07/18 (µg/L)**	**11/08/18 (µg/L)**
Inorganics				
Dissolved Cadmium	--	--	< 3.0	--
Total Cadmium	--	--	< 3.0	--
Dissolved Chromium	--	--	**10.2**	--
Total Chromium	--	--	**10.5**	--
Dissolved Iron	--	--	**108**	--
Total Iron	--	--	**166**	--
Total Manganese	--	--	--	--
pH[3]	5.6	5.7	5.8	5.7

Abbreviations, Notes, Qualifiers, and Units:

-- Not Analyzed
USEPA United States Environmental Protection Agency
VOC Volatile Organic Compound

1. "Total VOCs" represents the sum of individual concentrations of the compounds detected. The values used in calculations referenced in this report have been rounded to the nearest whole number.

2. Samples collected prior to July 11, 2018 were analyzed for 1,4-Dioxane using USEPA Method 522-SIM. Samples collected are analyzed for 1,4-Dioxane using USEPA Method 8270D-SIM-CLLE.

3. Influent pH samples collected and measured in the field by Arcadis personnel on the dates listed using a field calibrated pH/conductivity meter. pH units are standard units.

2.8 Bold value indicates a detection.
y Compound not detected at or above the laboratory quantification limit.
J Result is estimated.

µg/L micrograms per liter

Table 3
Summary of Effluent Water Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound	Discharge Limit[1] (µg/L)	01/11/18 (µg/L)	02/01/18 (µg/L)	03/01/18 (µg/L)	04/04/18 (µg/L)	05/11/18 (µg/L)	06/07/18 (µg/L)	07/11/18 (µg/L)	08/07/18 (µg/L)	09/05/18 (µg/L)	10/10/18 (µg/L)	11/08/18 (µg/L)	12/06/18 (µg/L)
Project VOCs													
1,1,1-Trichloroethane	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
1,1-Dichloroethene	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Tetrachloroethene	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Trichloroethene	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Vinyl Chloride	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
cis 1,2-Dichloroethene	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
trans 1,2-Dichloroethene	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Subtotal Project VOCs		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Compound	Discharge Limit[1] (µg/L)	01/11/18 (µg/L)	02/01/18 (µg/L)	03/01/18 (µg/L)	04/04/18 (µg/L)	05/11/18 (µg/L)	06/07/18 (µg/L)	07/11/18 (µg/L)	08/07/18 (µg/L)	09/05/18 (µg/L)	10/10/18 (µg/L)	11/08/18 (µg/L)	12/06/18 (µg/L)
Non-Project VOCs													
Chloroform	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Dichloromethane	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 1.0	< 0.50
Trichlorotrifluoroethane (Freon 113)	5[2]	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50
Subtotal Non-Project VOCs		0	0	0	0	0	0	0	0	0	0	0	0
Total VOCs[3]		0	0	0	0	0	0	0	0	0	0	0	0
Treatment Efficiency[4]		> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%	> 99.9%

Compound	Discharge Limit[1] (µg/L)	01/11/18 (µg/L)	02/01/18 (µg/L)	03/01/18 (µg/L)	04/04/18 (µg/L)	05/11/18 (µg/L)	06/07/18 (µg/L)	07/11/18 (µg/L)	08/07/18 (µg/L)	09/05/18 (µg/L)	10/10/18 (µg/L)	11/08/18 (µg/L)	12/06/18 (µg/L)
Inorganics													
Dissolved Cadmium	5	--	< 3.0	--	< 3.0	--	--	--	< 3.0	--	--	--	--
Total Cadmium	5	--	< 3.0	--	< 3.0	--	--	--	< 3.0	--	--	--	--
Dissolved Chromium	50	--	< 10	--	< 10	--	--	--	< 10	--	--	--	--
Total Chromium	50	--	< 10	--	< 10	--	--	--	< 10	--	--	--	--
Dissolved Iron	600	**150**	**116**	**181**	**172**	**158**	< 100	**141**	< 100	--	--	--	--
Total Iron	600	**204**	**183**	**229**	**218**	**106**	< 100	**168**	**138 J**	< 100	**145**	**142**	**144**
Total Mercury	250	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	--	--	--	--
Total Manganese	600	--	--	--	--	--	--	--	**50.2**	**46.2**	**47.3**	**50.6**	**48.8**
Nitrate and Nitrite	10,000	**2,800**	**3,200**	**2,800**	**2,800**	**2,800**	**2,900**	**2,500**	**2,800**	**2,900**	**2,600**	**2,600**	**2,800**
Toal Kjeldahl Nitrogen	10,000	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Total Nitrogen	10,000	**3,000**	**3,200**	**2,800**	**2,800**	**2,800**	**2,900**	**2,500**	**2,800**	**2,900**	**2,600.0**	**2,600.0**	**2.8**
1,4-Dioxane[5]	NE	**0.819**	**0.997**	**1.45**	**0.997**	**0.984**	**0.646**	**0.71**	**0.52**	**0.45**	0.57	**0.49**	0.78
pH[6]	5.5-8.5	6.8	6.6	6.7	6.6	6.9	7.0	6.5	7.0	6.5	6.5	6.8	6.8

Abbreviations, Notes, Qualifers, and Units on last page.

Abbreviations, Notes, Qualifiers, and Units:

--	Not Analyzed
NE	Not Established
NYSDEC	New York State Department of Environmental Conservation
SPDES	State Pollutant Discharge Elimination System
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1. Discharge limits per the interim SPDES equivalency program or Division of Water Technical and Operational Guidance Series (TOGS 1.1.1) Quality Standards and Guidance Values and Groundwater Effluent Limitations, if the compound is not part of the SPDES Permit Equivalency.
2. As of September 2017, the 10 SPDES VOCs discharge limits are per Site Number 1-30-003A Operable Unit 3 SPDES Permit Equivalency.
3. "Total VOCs" represents the sum of individual concentrations of compounds detected. The values used in calculations referenced in this report have been rounded to the nearest whole number.
4. Treatment efficiency was calculated by dividing the difference between the influent and effluent total VOC concentrations by the influent total VOC concentration.
5. Samples collected prior to July 11, 2018 were analyzed for 1,4-Dioxane using USEPA Method 522-SIM. Samples collected are analyzed for 1,4-Dioxane using USEPA Method 8270D-SIM-CLLE.
6. Effluent pH measured on site using a handheld pH meter. pH units are standard units.

150	Bold value indicates a detection.
< 0.50	Compound not detected above the laboratory quantification limit.
J	Result is estimated.
µg/L	micrograms per liter

Table 4
Influent Vapor Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound[1]	02/01/18 (µg/m³)	04/05/18 (µg/m³)	08/07/18 (µg/m³)	11/08/18 (µg/m³)
Project VOCs				
1,1,1 - Trichloroethane	**0.46**	**0.87**	**0.71**	**0.76**
1,1 - Dichloroethane	**2.8**	**4.9**	**3.8**	**3.6**
1,2 - Dichloroethane	< 0.65	**0.45 J**	< 0.65	< 0.65
1,1 - Dichloroethene	**1.2**	**1.7**	**1.2**	**1.2**
Tetrachloroethene	**2.4**	**3.0**	**2.9**	**4.1**
Trichloroethene	**47**	**73.1**	**53.7**	**45**
Vinyl Chloride	**48.6**	**81.8**	**47.8**	**29.1**
cis 1,2-Dichloroethene	**105**	**137**	**99.5**	**120**
trans 1,2-Dichloroethene	**0.28 J**	**0.44 J**	< 0.63	< 0.63
Benzene	**0.45 J**	**0.61**	**0.77**	**0.64**
Toluene	**0.94**	**3.6**	**0.64**	**0.41 J**
o-Xylene	< 0.69	**0.74**	< 0.69	< 0.69
m,p-Xylene	**0.48 J**	**1.1**	< 0.69	< 0.69
Subtotal Project VOCs	**210**	**309**	**211**	**205**
Non-Project VOCs				
1,1,2,2-Tetrachloroethane	< 0.55	< 0.55	< 0.55	< 0.55
1,1,2-Trichloroethane	< 0.44	< 0.44	< 0.44	< 0.44
1,2-Dichloropropane	**0.25 J**	**0.45 J**	< 0.74	< 0.74
1,3-Butadiene	< 0.35	< 0.35	< 0.35	< 0.35
2-Butanone	**0.41 J**	**4.7**	**0.86**	**0.74**
4-Methyl-2-Pentanone	< 0.66	< 0.66	< 0.66	< 0.66
Acetone	**4.0**	**22**	**7.6**	**5.2**
Bromodichloromethane	< 0.54	< 0.54	< 0.54	< 0.54
Bromoform	< 0.33	< 0.33	< 0.33	< 0.33
Bromomethane	< 0.62	< 0.62	< 0.62	< 0.62
Carbon Disulfide	< 0.50	**7.5**	< 0.50	< 0.50
Carbon Tetrachloride	**0.47**	**0.62**	**0.59**	**0.48**
Chlorobenzene	< 0.74	< 0.74	< 0.74	< 0.74
Chlorodibromomethane	< 0.68	< 0.68	< 0.68	< 0.68
Chlorodifluoromethane (Freon 22)	**14**	**14**	**15**	**12**
Chloroethane	< 0.42	< 0.42	< 0.42	< 0.42
Chloroform	**8.8**	**11**	**8.8**	**7.8**
Chloromethane	**1.3**	**1.2**	**1.8**	**1.3**
cis-1,3-Dichloropropene	< 0.73	< 0.73	< 0.73	< 0.73
Dichlorodifluoromethane (Freon 12)	**2.4**	**2.5**	**2.4**	**2.4**
Dichloromethane	**0.97**	< 0.56	**2.8**	< 0.56
Ethylbenzene	**0.37 J**	**1.1**	< 0.69	< 0.69
Methyl N-Butyl Ketone	< 0.65	< 0.65	< 0.65	< 0.65
Methyl Tert-Butyl Ether	**0.36 J**	**0.43 J**	< 0.58	**0.47 J**
Styrene (Monomer)	< 0.68	< 0.68	< 0.68	< 0.68
trans-1,3-Dichloropropene	< 0.73	< 0.73	< 0.73	< 0.73
Trichlorofluoromethane (Freon 11)	**1.7**	**1.9**	**1.7**	**1.9**
Trichlorotrifluoroethane (Freon 113)	**2.0**	**2.1**	**2.3**	**2.1**
1-Chloro-1,1-difluoroethane (Freon 142b)	**0.32 J**	< 0.66	**0.45 J**	< 0.66
Subtotal Non-Project VOCs	**37**	**70**	**44**	**34**
Total VOCs[2]	**247**	**379**	**255**	**239**

Abbreviations, Notes, Qualifiers, and Units on last page.

Table 4
Influent Vapor Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

Abbreviations, Notes, Qualifiers, and Units:

ELAP	Environmental Laboratory Approval Program
NYSDOH	New York State Department of Health
OM&M	Operation, Maintenance, and Monitoring
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1. Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15. A VOC analyte list is provided in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (Arcadis 2016). Influent samples were collected at Vapor Sampling Port-1 (VSP-1); refer to Figure 3 of this OM&M Report for the location of VSP-1.

2. "Total VOCs" represents the sum of individual concentrations of compounds detected. The values used in calculations referenced in this report have been rounded to the nearest whole number.

0.46	Bold value indicates a detection.
< 0.65	Compound not detected above the laboratory quantification limit.
J	Result is estimated.
$\mu g/m^3$	micrograms per cubic meter

Table 5
Summary of Effluent Vapor Sample Analytical Results
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound[1]	02/01/18 (µg/m³)	04/05/18 (µg/m³)	08/07/18 (µg/m³)	11/08/18 (µg/m³)
Project VOCs				
1,1,1 - Trichloroethane	< 0.44	**0.60**	**0.50**	< 0.44
1,1 - Dichloroethane	**3.6**	**4.5**	**3.0**	**3.7**
1,2 - Dichloroethane	**0.32 J**	**0.36 J**	< 0.65	< 0.65
1,1 - Dichloroethene	**1.1**	**1.3**	**0.79**	**0.99**
Tetrachloroethene	**0.68**	**1.7**	**1.3**	**1.8**
Trichloroethene	**4.0**	**32**	**16**	**19**
Vinyl Chloride	**16**	**51.1**	**14.0**	**14.0**
cis 1,2-Dichloroethene	**51.9**	**100**	**43.2**	**67.4**
trans 1,2-Dichloroethene	< 0.63	< 0.63	< 0.63	< 0.63
Benzene	**1.5**	**1.1**	**1.7**	< 0.51
Toluene	**0.60**	**5.7**	**5.3**	**1.5**
o-Xylene	< 0.69	**0.34 J**	**0.34 J**	< 0.69
m,p-Xylene	**0.40 J**	**0.69**	**0.56 J**	< 0.69
Subtotal Project VOCs	**80**	**199**	**87**	**109**
Non-Project VOCs				
1,1,2,2-Tetrachloroethane	< 0.55	< 0.55	< 0.55	< 0.55
1,1,2-Trichloroethane	< 0.44	< 0.44	< 0.44	< 0.44
1,2-Dichloropropane	< 0.74	< 0.74	< 0.74	< 0.74
1,3-Butadiene	< 0.35	< 0.35	< 0.35	< 0.35
2-Butanone	**5.0**	**5.6**	**43.1**	**20**
4-Methyl-2-Pentanone	< 0.66	< 0.66	< 0.66	< 0.66
Acetone	**82.7**	**23**	**238**	**122**
Bromodichloromethane	< 0.54	< 0.54	< 0.54	< 0.54
Bromoform	< 0.33	< 0.33	< 0.33	< 0.33
Bromomethane	< 0.62	< 0.62	< 0.62	< 0.62
Carbon Disulfide	**17**	< 0.50	**0.26 J**	< 0.50
Carbon Tetrachloride	< 0.20	**0.45**	**0.46**	< 0.20
Chlorobenzene	< 0.74	< 0.74	< 0.74	< 0.74
Chlorodibromomethane	< 0.68	< 0.68	< 0.68	< 0.68
Chlorodifluoromethane (Freon 22)	**15**	< 0.56	**11**	**11**
Chloroethane	< 0.42	< 0.42	< 0.42	< 0.42
Chloroform	**18**	**13**	**9.3**	**10.0**
Chloromethane	**1.8**	**1.1**	**2.3**	**0.97**
cis-1,3-Dichloropropene	< 0.73	< 0.73	< 0.73	< 0.73
Dichlorodifluoromethane (Freon 12)	**2.4**	**2.5**	**2.3**	**2.5**
Dichloromethane	**0.76**	< 0.56	**1.3**	< 0.56
Ethylbenzene	< 0.69	**0.43 J**	< 0.69	< 0.69
Methyl N-Butyl Ketone	< 0.65	< 0.65	< 0.65	< 0.65
Methyl Tert-Butyl Ether	< 0.58	< 0.58	< 0.58	**0.29 J**
Styrene (Monomer)	< 0.68	< 0.68	< 0.68	< 0.68
trans-1,3-Dichloropropene	< 0.73	< 0.73	< 0.73	< 0.73
Trichlorofluoromethane (Freon 11)	**1.9**	**1.9**	**2.1**	**1.8**
Trichlorotrifluoroethane (Freon 113)	**2.6**	**2.3**	**2.1**	**2.3**
1-Chloro-1,1-difluoroethane (Freon 142b)	**0.36 J**	< 0.66	**0.36 J**	< 0.66
Subtotal Non-Project VOCs	**148**	**50**	**313**	**171**
Total VOCs[2]	**228**	**250**	**399**	**280**

Abbreviations, Notes, Qualifiers, and Units on last page.

Abbreviations, Notes, Qualifiers, and Units:

ELAP	Environmental Laboratory Approval Program
NYSDOH	New York State Department of Health
OM&M	Operation, Maintenance, and Monitoring
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1. Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15. A VOC analyte list is provided in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (Arcadis 2016). Effluent samples were collected at Vapor Sampling Port-5 (VSP-5); refer to Figure 3 of this OM&M Report for the location of VSP-5.

2. "Total VOCs" represents the sum of individual concentrations of all compounds detected. The values used in calculations referenced in this report have been rounded to the nearest whole number.

3.6	Bold value indicates a detection.
< 0.44	Compound not detected above the laboratory quantification limit.
J	Result is estimated.
$\mu g/m^3$	micrograms per cubic meter

Table 6
Summary of Effluent Vapor Tentatively Identified Compounds
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound[1,2,3]	02/01/18 (ppbv)	04/05/18 (ppbv)	08/07/18 (ppbv)	11/08/18 (ppbv)
Tentatively Identified Compounds				
2-Methyl-1,3-Dioxolane	ND	ND	**5.6 JN**	ND
2-Phenyl-2-propanol	ND	ND	**5.5 JN**	ND
3-Methyl-Furan	ND	ND	**2.6 JN**	ND
Acetophenone	ND	ND	**8.0 JN**	ND
Carbon Dioxide	**270 JNB**	ND	**210 JNB**	**16 JNB**
Dimethyl ether	ND	**290 JNB**	ND	ND
Ethanol	ND	ND	**2.6 JN**	ND
Isopropylbenzene	ND	**19 JN**	**16 JN**	ND
Pentyl-Cyclohexane	ND	ND	ND	ND
trans-2-methyl decalin	ND	ND	ND	ND
Unknown	ND	ND	**1.5 J**	ND
Total VOC TICs	0	19 J	41.8 J	0

Abbreviations, Notes, Qualifiers, and Units:

ELAP	Environmental Laboratory Approval Program
NYSDOH	New York State Department of Health
OM&M	Operation, Maintenance, and Monitoring
TIC	Tentatively Identified Compound
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1. Vapor samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per Modified USEPA Method TO-15. A VOC analyte list is provided in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (Arcadis 2016). Effluent samples were collected at Vapor Sampling Port-5 (VSP-5); refer to Figure 3 of this OM&M Report for the location of VSP-5.

2. The ECUs were placed in a parallel configuration on 3/1/2018 to test for performance gain.

3. VSP-5 sample location moved to location parallel ECUs near effluent stack.

270	Bold value indicates a detection.
ND	TIC were not detected.
B	TIC was detected in the associated field blank.
J	Result is estimated.
N	Indicates presumptive evidence of a compound.
ppbv	parts per billion by volume

Table 7
Summary of System Parameters
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Date [1]	Water Flow Rates						Water Pressures [3]					Air Flow Rate [2]	Air Pressures [5]					Air Temp. [1]
	Remedial Well [2]				Combined Influent [2]	Effluent [2]	Remedial Well Effluent [4]				Effluent	Effluent	ECU Influents				Effluent	Effluent
	RW-1	RW-2	RW-3	RW-4			RW-1	RW-2	RW-3	RW-4			GAC-501	GAC-502	PPZ-501	PPZ-502		
	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(gpm)	(psi)	(psi)	(psi)	(psi)	(psi)	(scfm)	(iwc)	(iwc)	(iwc)	(iwc)	(iwc)	(°R)
01/11/18	31.0	78.8	63.6	30.0	203	231	54	53	45	54	20	1,591	5.5	2.5	0.5	1.5	0.0	528
02/01/18	30.9	61.5	69.8	29.5	192	224	54	11	23	55	17	1,563	5.9	2.5	0.5	1.5	0.0	530
03/01/18	30.5	97.0 [6]	60.0	29.4	217 [8]	248	55	7	52	55	19	1,555	0.6 [7]	0.0 [7]	0.2 [7]	0.0 [7]	0.2	532
04/04/18	30.4	88.5	59.7	29.8	208	239	55	6	51	55	23	1,522	0.5	0.0	0.0	0.0	0.0	532
05/11/18	30.1	80.4	76.0	30.3	217	219	54	6	7	54	20	1,888	0.0	0.0	0.0	0.0	0.0	531
06/07/18	30.1	60.0	75.6	30.0	196	201	54	5	6	55	13	1,859	0.0	0.0	0.0	0.0	0.0	535
07/11/18	30.2	95.5	81.5	30.7	238	241	52	8 [(9)]	32 [(9)]	53	15	1,817	0.0	0.0	0.0	0.0	0.0	545
08/07/18	30.7	77.8	80.7	30.7	220	227	53	6 [(9)]	32 [(9)]	54	15	1,827	0.0	0.0	0.0	0.0	0.0	540
09/05/18	30.6	62.7	81.0	30.9	205	208	53	5 [(9)]	35 [(9)]	53	9	1,841	0.0	0.0	0.0	0.0	0.0	542
10/10/18	30.7	77.8	80.7	30.7	220	227	53	66	33	54	14	1,827	0.0	0.0	0.0	0.0	0.0	540
11/08/18	30.9	70.6	80.8	30.8	213	229	53	12	32	54	19	1,789	0.0	0.0	0.0	0.0	0.0	538
12/06/18	31.3	60.5	80.5	30.3	203	213	53	10	32	55	15	1,720	0.0	0.0	0.0	0.0	0.0	535

Abbreviations, Notes, and Units on last page.

Table 7
Summary of System Parameters
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

Abbreviations, Notes, and Units:

ECU	Emission Control Unit
GAC	Granular Activated Carbon
HMI	Human-Machine Interface
PPZ	Potassium Permanganate-impregnated Zeolite
RW	Remedial Well
SCADA	Supervisory Control and Data Acquisition
Temp	Temperature

1. Operational data collected by Arcadis on days noted. Parameters listed were typically recorded during compliance monitoring events. Data in this table correspond to approximately the past year of system operation.
2. Instantaneous parameters obtained from the SCADA HMI: Water Flow Rate, Water Pressure, Air Flow Rate.
3. Combined influent water-flow rate is the sum of individual well flow rates via the SCADA System.
4. Remedial Well effluent pressure readings measured at the influent manifold within the treatment system building.
5. Instantaneous values recorded from field-mounted instruments during weekly site visits.
6. RW-2 flow rate was increased on 2/15/2018 to test for performance and life cycle gains.
7. The ECUs were placed in a parallel configuration on 3/1/2018 for performance gain.
8. Combined influent on 3/01/2018 was erroneously reported as 120 gpm in the 1Q OMM Report.
9. Previously reported remedial well effluent pressures were erroneously reported.

gpm	gallons per minute
iwc	inches of water column
psi	pounds per square inch
^{o}R	degrees Rankine
scfm	standard cubic feet per minute

Table 8
Summary of Groundwater Recovered, VOC Mass Recovered, and VOC Mass Recovery Rates
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Operating Period[1]	Volume of Groundwater Recovered (to the gal)[2]					VOC Mass Recovered (lbs)[3]															VOC Mass Recovery Rate (lbs/day)[4]													
						Total VOCs[5]					Project VOCs[6]					Non-Project VOCs[7]					Total VOCs					Project VOCs					Non-Project VOCs[7]				
	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total	RW-1	RW-2	RW-3	RW-4	Total
System Pilot Test, Shakedown and Startup Totals[8]	137	270	251	150	808	NA	NA	NA	NA	1.1	NA	NA	NA	NA	1.0	NA	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010 Totals	15,726	35,127	38,160	15,689	104,702	0.56	172	412	89	672	0.56	171	28	0.10	200	< 0.01	0.17	383	89	469	< 0.01	0.46	1.1	0.24	1.8	< 0.01	0.46	0.075	< 0.01	0.54	< 0.01	< 0.01	1.0	0.24	1.3
2011 Totals	15,218	36,570	37,682	15,196	104,666	0.36	167	271	78	516	0.36	167	35	0.090	203	< 0.01	1.1	236	78	314	< 0.01	0.45	0.73	0.21	1.4	< 0.01	0.45	0.095	< 0.01	0.55	< 0.01	< 0.01	0.64	0.21	0.85
2012 Totals	15,260	35,178	36,111	15,336	101,885	0.28	114	113	40	267	0.25	113	12	0.39	126	< 0.01	1.5	101	40	141	< 0.01	0.31	0.31	0.11	0.73	< 0.01	0.31	0.032	< 0.01	0.35	< 0.01	< 0.01	0.28	0.11	0.39
2013 Totals	15,968	37,514	36,622	16,036	106,140	0.14	111	41	18	171	0.14	110	4.3	0.36	113	< 0.01	1.6	37	18	57	< 0.01	0.30	0.11	0.050	0.47	< 0.01	0.30	0.012	< 0.01	0.31	< 0.01	< 0.01	0.10	0.049	0.16
2014 Totals	15,690	33,222	31,199	15,691	95,802	0.063	67	9.9	8.1	85	0.063	65	2.0	0.20	67	< 0.01	1.5	8.1	7.9	17	< 0.01	0.19	0.028	0.023	0.24	< 0.01	0.18	< 0.01	< 0.01	0.19	< 0.01	< 0.01	0.023	0.022	0.047
2015 Totals	15,859	38,082	34,961	14,755	103,657	0.028	47	7.1	4.5	57	0.021	45	1.5	0.20	45	<0.01	1.7	5.6	4.2	12	<0.01	0.13	0.019	0.012	0.16	<0.01	0.12	<0.01	<0.01	0.12	<0.01	<0.01	0.015	0.012	0.032
2016 Totals	15,826	34,539	39,349	15,826	105,540	<0.01	38	3.2	2.2	44	<0.01	37	1.4	0.20	39	<0.01	1.5	1.7	2.0	5.2	<0.01	0.10	<0.01	<0.01	0.12	<0.01	0.10	<0.01	<0.01	0.11	<0.01	<0.01	<0.01	<0.01	0.014
2017 Totals	16,005	31,600	37,614	15,965	101,184	< 0.01	13	2.2	1.2	17	< 0.01	13	1.1	0.16	14	< 0.01	0.56	1.1	1.1	2.7	< 0.01	0.037	< 0.01	< 0.01	0.046	< 0.01	0.035	< 0.01	< 0.01	0.038	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
January 2018 through March 2018 Totals																																		
01/01/18 - 02/01/18	1,368	3,184	1,951	1,324	7,828	< 0.01	1.5	0.053	0.067	1.6	< 0.01	1.5	0.042	< 0.01	1.5	< 0.01	0.029	0.011	0.058	0.098	< 0.01	0.048	< 0.01	< 0.01	0.052	< 0.01	0.048	< 0.01	< 0.01	0.050	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
02/01/18 - 03/01/18	1,192	2,913	1,207	1,159	6,471	< 0.01	1.4	0.033	0.059	1.5	< 0.01	1.3	0.026	< 0.01	1.3	< 0.01	0.027	<0.01	0.051	0.078	< 0.01	0.049	< 0.01	< 0.01	0.052	< 0.01	0.046	< 0.01	< 0.01	0.048	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
03/01/18 - 04/01/18	1,343	4,300	1,828	1,322	8,794	< 0.01	2.0	0.050	0.067	2.1	< 0.01	2.0	0.040	< 0.01	2.0	< 0.01	0.039	0.010	0.058	0.11	< 0.01	0.065	< 0.01	< 0.01	0.068	< 0.01	0.065	< 0.01	< 0.01	0.066	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Subtotal Jan - Mar 2018[9]	3,904	10,397	4,986	3,806	23,093	< 0.01	4.9	0.14	0.19	5.2	< 0.01	4.8	0.11	< 0.01	4.9	< 0.01	0.10	0.021	0.17	0.28	< 0.01	0.054	< 0.01	< 0.01	0.058	< 0.01	0.053	< 0.01	< 0.01	0.055	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
April 2018 through June 2018 Totals																																		
04/01/18 - 05/01/18	1,132	3,140	2,376	1,105	7,754	< 0.01	1.5	0.059	0.057	1.6	< 0.01	1.5	0.044	< 0.01	1.5	< 0.01	0.026	0.015	0.052	0.09	< 0.01	0.050	< 0.01	< 0.01	0.054	< 0.01	0.049	< 0.01	< 0.01	0.051	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
05/01/18 - 06/01/18	1,168	2,864	2,910	1,169	8,111	< 0.01	1.4	0.073	0.061	1.5	< 0.01	1.3	0.054	< 0.01	1.4	< 0.01	0.024	0.019	0.055	0.097	< 0.01	0.044	< 0.01	< 0.01	0.048	< 0.01	0.043	< 0.01	< 0.01	0.045	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
06/01/18 - 07/01/18	1,128	2,762	2,233	1,105	7,228	< 0.01	1.3	0.056	0.057	1.4	< 0.01	1.3	0.041	< 0.01	1.3	< 0.01	0.023	0.014	0.052	0.09	< 0.01	0.044	< 0.01	< 0.01	0.048	< 0.01	0.043	< 0.01	< 0.01	0.045	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Subtotal Apr - Jun 2018[10]	3,429	8,765	7,519	3,379	23,092	< 0.01	4.2	0.19	0.18	4.5	< 0.01	4.1	0.14	< 0.01	4.2	< 0.01	0.073	0.048	0.16	0.28	< 0.01	0.046	< 0.01	< 0.01	0.050	< 0.01	0.045	< 0.01	< 0.01	0.047	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
July 2018 through September 2018 Totals																																		
07/01/18 - 08/01/18	1,264	3,773	2,790	1,257	9,084	< 0.01	0.6	0.083	0.062	0.8	< 0.01	0.6	0.067	< 0.01	0.7	< 0.01	0.024	0.016	0.062	0.10	< 0.01	0.021	< 0.01	< 0.01	0.025	< 0.01	0.020	< 0.01	< 0.01	0.022	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
08/01/18 - 09/01/18	1,299	3,134	3,391	1,321	9,145	< 0.01	0.5	0.10	0.065	0.7	< 0.01	0.5	0.082	< 0.01	0.6	< 0.01	0.020	0.019	0.065	0.10	< 0.01	0.017	< 0.01	< 0.01	0.023	< 0.01	0.017	< 0.01	< 0.01	0.019	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
09/01/18 - 10/01/18	1,306	3,552	3,479	1,302	9,639	< 0.01	0.6	0.10	0.064	0.8	< 0.01	0.6	0.084	< 0.01	0.7	< 0.01	0.022	0.020	0.064	0.11	< 0.01	0.020	< 0.01	< 0.01	0.026	< 0.01	0.019	< 0.01	< 0.01	0.022	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Subtotal July - Sept 2018[11]	3,869	10,459	9,660	3,880	27,868	< 0.01	1.8	0.29	0.19	2.3	< 0.01	1.7	0.23	< 0.01	1.9	< 0.01	0.065	0.055	0.19	0.31	< 0.01	0.019	< 0.01	< 0.01	0.024	< 0.01	0.019	< 0.01	< 0.01	0.021	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
October 2018 through December 2018 Totals																																		
10/01/18 - 11/01/18	1,380	3,415	3,620	1,353	9,768	< 0.01	1.2	0.10	< 0.01	1.3	< 0.01	1.2	0.078	< 0.01	1.3	< 0.01	0.015	0.022	< 0.01	0.04	< 0.01	0.039	< 0.01	< 0.01	0.043	< 0.01	0.039	< 0.01	< 0.01	0.041	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
11/01/18 - 12/01/18	1,331	2,957	3,467	1,298	9,054	< 0.01	1.1	0.10	< 0.01	1.2	< 0.01	1.0	0.075	< 0.01	1.1	< 0.01	0.013	0.021	< 0.01	0.03	< 0.01	0.035	< 0.01	< 0.01	0.038	< 0.01	0.035	< 0.01	< 0.01	0.037	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
12/01/18 - 01/01/19	1,231	1,718	3,221	1,201	7,372	< 0.01	0.61	0.09	< 0.01	0.70	< 0.01	0.61	0.070	< 0.01	0.68	< 0.01	0.007	0.020	< 0.01	0.03	< 0.01	0.020	< 0.01	< 0.01	0.023	< 0.01	0.020	< 0.01	< 0.01	0.022	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Subtotal Oct - Dec 2018[12]	3,943	8,090	10,308	3,852	26,194	< 0.01	2.89	0.29	< 0.01	3.2	< 0.01	2.9	0.22	< 0.01	3.1	< 0.01	0.034	0.063	< 0.01	0.10	< 0.01	0.031	< 0.01	< 0.01	0.035	< 0.01	0.031	< 0.01	< 0.01	0.033	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2018 Totals	15,145	37,712	32,473	14,917	100,247	< 0.01	13.71	0.90	0.56	15.2	< 0.01	13.5	0.70	< 0.01	14.2	< 0.01	0.27	0.19	0.52	0.97	< 0.01	0.038	< 0.01	< 0.01	0.042	< 0.01	0.037	< 0.01	< 0.01	0.039	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total[13]	147,426	333,652	340,867	146,135	968,080	1.6	1,018	914	256	2,187	2	1,007	105	2	1,116	< 0.01	10	809	254	1,066	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Abbreviations, Notes, Qualifiers, and Units:

NA Not Applicable
VOC Volatile Organic Compound.

1. Represents operating period between consecutive monitoring events.
2. Volume of groundwater recovered is based on individual local well totalized flow readings. Listed value is the difference between totalized flow values recorded between consecutive monitoring events. The total groundwater recovered during a given operating period is the sum of the individual well flow totals. Values shown are rounded to the nearest gallon, but should only be considered accurate to two significant figures to account for error associated with field measurements.

3. Mass recovered per well was calculated by multiplying the Total VOC concentration from the most recent sampling event by the number of gallons extracted during the reporting period. The total amount recovered during a given operating period is the sum of masses recovered from each of the individual wells. Values less than ten pounds are presented using two significant figures and values greater than ten pounds have been rounded to the nearest whole number; however, these values should only be considered accurate to two significant figures to account for error associated with field measurements and analytical data.

4. Mass recovery rates were calculated by dividing the total mass recovered for each well and for the system by the number of days in the respective operating period. Values are presented using two significant figures.
5. "Total VOCs" represents the sum of individual concentrations of the VOCs detected.
6. "Project VOCs" represents the sum of individual compound concentrations of 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethelyene; vinyl chloride; cis-1,2-dichloroethene; trans-1,2-dichloroethene; benzene; toluene; and xylenes-o,m, p.
7. "Non-Project VOCs" represents the difference between Total VOCs and Project VOCs.
8. Values based on operational data recorded prior to system startup on July 21, 2009.
9. The volume of groundwater recovered and mass recovered calculations represent the operational period between January 1, 2018 and April 1, 2018.
10. The volume of groundwater recovered and mass recovered calculations represent the operational period between April 1, 2018 and July 1, 2018.
11. The volume of groundwater recovered and mass recovered calculations represent the operational period between July 1, 2018 and October 1, 2018.
12. The volume of groundwater recovered and mass recovered calculations represent the operational period between October 1, 2018 and Janurary 1, 2019.
13. "Total" refers to the amounts removed by the Operable Unit 3 Bethpage Park Groundwater Containment System.

< Less than

gal Gallons
lbs Pounds
lbs/day Pounds per day

Table 9
Summary of Air Quality Impact Analysis
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Toxic Air Contaminant	VSP-05 Vapor Effluent (µg/m³)	Emission Rate[1]			Scaled Impact - Hourly[2] (µg/m³)	Scaled Impact - Annual[2] (µg/m³)	SGC[3] (µg/m³)	AGC[3] (µg/m³)	% of SGC	% of AGC
	11/8/2018	lb/yr	lb/hr	g/s						
Project VOCs										
1,1-Dichloroethane	3.7	0.21	2.44E-05	3.1E-06	9.7E-03	3.0E-04	--	0.63	--	0.0%
1,1-Dichloroethene	0.99	0.06	6.54E-06	8.24E-07	2.60E-03	7.9E-05	--	200	--	0.0%
cis-1,2-Dichloroethene	67.4	3.90	4.45E-04	5.6E-05	1.8E-01	5.4E-03	--	63	--	0.0%
Tetrachloroethene	1.8	0.10	1.19E-05	1.5E-06	4.7E-03	1.4E-04	300	4	0.0%	0.0%
Toluene	1.5	0.09	9.91E-06	1.2E-06	3.9E-03	1.2E-04	37,000	5,000	0.0%	0.0%
Trichloroethene	19	1.10	1.25E-04	1.6E-05	5.0E-02	1.5E-03	20	0.20	0.2%	0.8%
Vinyl Chloride	14	0.81	9.25E-05	1.2E-05	3.7E-02	1.1E-03	180,000	0.11	0.0%	1.0%
Non-Project VOCs										
2-Butanone	20	1.16	1.32E-04	1.7E-05	5.2E-02	1.6E-03	13,000	5,000	0.0%	0.0%
Acetone	122	7.06	8.06E-04	1.0E-04	3.2E-01	9.8E-03	180,000	30,000	0.0%	0.0%
Chlorodifluoromethane (Freon 22)	11	0.64	7.27E-05	9.2E-06	2.9E-02	8.8E-04	--	50,000	--	0.0%
Chloroform	10	0.58	6.60E-05	8.3E-06	2.6E-02	8.0E-04	150	15	0.0%	0.0%
Chloromethane	0.97	0.06	6.41E-06	8.1E-07	2.5E-03	7.8E-05	22,000	90	0.0%	0.0%
Dichlorodifluoromethane (Freon 12)	2.5	0.14	1.65E-05	2.1E-06	6.6E-03	2.0E-04	--	12,000	--	0.0%
Methyl-Tert-Butylether	0.29	0.02	1.92E-06	2.41E-07	7.61E-04	2.3E-05	--	3.8	--	0.0%
Trichlorofluoromethane (Freon 11)	1.8	0.10	1.19E-05	1.5E-06	4.7E-03	1.4E-04	9,000	5,000	0.0%	0.0%
Trichlorotrifluoroethane (Freon 113)	2.3	0.13	1.52E-05	1.9E-06	6.0E-03	1.8E-04	960,000	180,000	0.0%	0.0%

Abbreviations, Notes, and Units on last page.

Table 9
Summary of Air Quality Impact Analysis
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Abbreviations, Notes, and Units:

AGC	Annual Guideline Concentration
CAS#	Chemical Abstracts Service Registry Number
DAR-1	Division of Air Resources-1
--	None Specified
NYSDEC	New York State Department of Environmental Conservation
SGC	Short-term Guideline Concentration
VSP	Vapor Sampling Point

1. Emission rate calculated based on VSP-05 effluent concentration and a daily average exit air flow rate of 1,767 ft^3/min for 11/8/2018.
   1,1,1-Trichloroethane (lb/hr) = TCE [µg/m^3] x Air Flow Rate [ft^3/min] x (1 m^3/35.3147 ft^3) x (60 min/hr) x (0.000001 g/1 µg) x (0.0022 lb/g)
   lb/yr = lb/hr x 8,760 hrs/yr
   g/s = lb/hr x hr/3,600 sec x 453.59 g/lb
2. Ambient impact based on AERMOD modeling using normalized rate of 1 g/s is scaled to the actual emission rate of the pollutant. Modeling was performed using the representative meteorological data from the nearest station (Brookhaven/Farmingdale) for the years 2011 through 2015. The maximum impact from all the years was used for the calculations.
   Scaled hourly impact (µg/m^3) = AERMOD predicted hourly ambient impact at 1 g/s ([µg/m^3]/[g/s]) x Actual emission rate (g/s)
   Scaled annual impact (µg/m^3) = AERMOD predicted annual ambient impact at 1 g/s ([µg/m^3]/[g/s]) x Actual emission rate (g/s)

AERMOD Normalized Ambient Impact at 1 g/s	
Hourly ([µg/m³]/[g/s])	Annual ([µg/m³]/[g/s])
3,153.03	96.49

3. Short-term and annual guideline concentrations specified in the NYSDEC DAR-1 AGC/SGC tables revised August 10, 2016.
4. Compounds not detected above the laboratory reporting limit are excluded from the air quality impact analysis summary.

cfm	cubic feet per minute
g/s	grams per second
lb/hr	pounds per hour
lb/yr	pounds per year
µg/m^3	micrograms per cubic meter

Table 10
Summary of Remedial Well Groundwater Sample Analytical Results - VOCs
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Compound[1] (µg/L)	Sample Location: Sample Date: NYSDEC SCGs	RW-1 2/1/2018	RW-1 4/4/2018	RW-1 8/7/2018	RW-1 11/8/2018	RW-2 2/1/2018	RW-2 4/4/2018	RW-2 8/7/2018	RW-2 11/8/2018	RW-3 2/1/2018	RW-3 4/4/2018	RW-3 8/7/2018	RW-3 11/8/2018	RW-4 2/1/2018	RW-4 4/4/2018	RW-4 8/7/2018	RW-4 11/8/2018
Project VOCs																	
1,1,1-Trichloroethane	5	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
1,1-Dichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	**0.52 J**	**0.65 J**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**0.29 J**	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	0.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	5	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
Tetrachloroethene	5	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	**0.33 J**	< 1.0	< 1.0
Trichloroethylene	5	< 1.0	< 0.50	< 1.0	< 1.0	**11.3**	**8.9**	**7.8**	**8.2**	**1.6**	**1.3**	**1.5**	**1.6**	**0.51 J**	**0.30 J**	< 1.0	< 1.0
Vinyl Chloride	2	< 1.0	< 0.50	< 1.0	< 1.0	**13.6**	**20.5**	**11.8**	**7.6**	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
cis-1,2-dichloroethene	5	< 1.0	< 0.50	< 1.0	< 1.0	**29.6**	**25.8**	**18.5**	**26.6**	**1.0**	**0.92**	**1.4**	**1.0**	< 1.0	< 0.50	< 1.0	< 1.0
trans-1,2-dichloroethene	5	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
Benzene	1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Toluene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**0.41 J**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Xylene-o	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Xylenes-m,p	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Subtotal Project VOCs		0	0	0	0	55.02	56.26	38.1	42.4	2.6	2.22	2.9	2.6	0.8	0.63	0	0
Non-Project VOCs																	
1,1,2,2-Tetrachloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,3-Butadiene	0.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
2-Butanone	NE	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
4-methyl-2-pentanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	NE	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Bromodichloromethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	60	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon tetrachloride	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifluoromethane (Freon 22)	NE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	**5.3**	**5.6**	**5.9**	**3.8**
Chloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	7	< 1.0	< 0.50	< 1.0	< 1.0	**1.1**	**1.0**	**0.75 J**	**0.51 J**	**0.66 J**	**0.77**	**0.68 J**	**0.73 J**	< 1.0	< 0.50	< 1.0	< 1.0
Chloromethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,3-dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dichlorodifluoromethane (Freon 12)	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Dichloromethane	5	< 2.0	< 0.50	< 2.0	< 2.0	< 2.0	< 0.50	< 2.0	< 2.0	< 2.0	< 0.50	< 2.0	< 2.0	< 2.0	< 0.50	< 2.0	< 2.0
Ethylbenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl N-Butyl Ketone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methyl tert-Butyl Ether	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Styrene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorofluoromethane (Freon 11)	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Trichlorotrifluoroethane (Freon 113)	5	< 5.0	< 0.50	< 5.0	< 5.0	< 5.0	< 0.50	< 5.0	< 5.0	< 5.0	< 0.50	< 5.0	< 5.0	< 5.0	< 0.50	< 5.0	< 5.0
1-Chloro-1,1-difluoroethane (Freon 142b)	NE	< 5.0	< 5.0	< 5.0	NA	< 5.0	< 5.0	< 5.0	NA	< 5.0	< 5.0	< 5.0	NA	< 5.0	< 5.0	< 5.0	NA
Subtotal Non-Project VOCs		0	0	0	0	1.1	1.0	0.75	0.51	0.66	0.77	0.68	0.73	5.3	5.6	5.9	0
Total VOCs[2]		0	0	0	0	56.12	57.26	38.85	42.91	3.26	2.99	3.58	3.33	6.10	6.23	5.90	0
1,4-Dioxane[3]		0.726	0.750	0.43	0.46	1.71	1.76	0.82	0.87	0.503	0.512	0.33	0.29	0.259	0.223	0.15 J	0.13 J

Notes and abbreviations on last page.

Abbreviations, Notes, Qualifiers, and Units:

ASP	Analytical Services Protocol
ELAP	Environmental Laboratory Approval Program
NA	Not Analyzed
NE	Not Established
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OLM	Ozone Limited Method
OM&M	Operation, Maintenance, and Monitoring
SCGs	Standards, Criteria, and Guidance values
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1. Water samples collected by Arcadis on the dates shown and submitted to a NYSDOH ELAP certified laboratory for VOC analyses per NYSDEC ASP 2005, Method OLM 4.3 (prior to September 1, 2014) and per EPA Method 8260C (after September 1, 2014). Results validated following protocols specified in Sampling and Analysis Plan in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (Arcadis 2016). See previous quarterly reports for historical analytical results.

2. "Total VOCs" represents the sum of individual concentrations of the VOCs detected.

3. Samples collected prior to July 11, 2018 were analyzed for 1,4-Dioxane using USEPA Method 522-SIM. Samples collected after are analyzed for 1,4-Dioxane using USEPA Method 8270D-SIM-CLLE.

	Bold cell outline indicates an exceedance of an SCG
0.52	Bold data indicates a detection
< 1	Compound not detected above its laboratory quantification limit
J	Compound detected below its reporting limit; value is estimated
µg/L	micrograms per liter

Table 11
Summary of Remedial Well Groundwater Sample Analytical Results - Metals
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

COMPOUND[1,3] (µg/L)	NYSDEC SCGs	RW-1[2] 8/7/2018	RW-2[2] 8/7/2018	RW-3[2] 8/7/2018	RW-4[2] 8/7/2018
Total Cadmium	5	< 3.0	< 3.0	< 3.0	< 3.0
Dissolved Cadmium	5	< 3.0	< 3.0	< 3.0	< 3.0
Total Chromium	50	**30.9**	< 10	< 10	< 10
Dissolved Chromium	50	**31.1**	< 10	< 10	< 10
Total Iron	600	< 100	**505**	< 100	< 100
Dissolved Iron	600	< 100	**424**	< 100	< 100

Abbreviations, Notes, Qualifiers, and Units:

ELAP	Environmental Laboratory Approval Program
NS	Not Specified
NYSDEC	New York State Department of Environmental Conservation.
NYSDOH	New York State Department of Health
SCGs	Standards, Criteria, and Guidance values
USEPA	United States Environmental Protection Agency

1. Water samples collected by Arcadis on the dates shown and submitted to a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified laboratory for metals analysis using USEPA Method 6010. Results validated following protocols specified in Sampling and Analysis Plan in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (Arcadis 2016).

2. Beginning August 2017, metals analyses for recovery wells RW-1 through RW-4 are included with annual recovery well sampling performed in the third quarter of each year.

3. Total refers to an unfiltered sample and dissolved refers to a filtered sample.

	Indicates an exceedance of an SCG.
30.9	Bold data indicates that the analyte was detected at or above its reporting limit.
< 3	Compound not detected above its laboratory quantification limit.
µg/L	micrograms per liter

Table 12
Summary of Water-Level Elevations
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Well Identification	Well Casing Elevation (ft msl)	Event Date	Baseline [3] 5/8/2009 (ft msl)	1Q 2018 3/16/2018 (ft msl)	2Q 2018 6/12/2018 (ft msl)	3 Q 2018 9/20/2018 (ft msl)	4 Q 2018 12/7/2018 (ft msl)
Recovery Wells							
RW-1	125.18		69.75	65.03	66.83	65.83	67.02
RW-2	124.48		72.27	54.33	60.45	55.53	59.78
RW-3	122.84		69.40	62.41	63.34	62.12	63.35
RW-4	121.24		69.25	64.37	65.83	65.02	66.24
Monitoring Wells							
B24MW-2	126.96		74.31	68.94	70.41	69.90	70.86
B24MW-3	127.11		72.63	62.16	69.61	68.94	70.24
B30MW-1	128.33		73.55	67.53	71.92	68.04	69.33
BCPMW-1	125.73		73.16	NM [4]	NM [4]	68.20	NM [4]
BCPMW-2	126.39		72.55	NM [4]	NM [4]	67.38	68.48
BCPMW-3	124.94		72.46	66.14	NM [4]	66.95	68.13
BCPMW-4-1	128.71		72.30	65.82	67.51	66.57	67.92
BCPMW-4-2	129.33		72.58	66.10	67.78	66.84	68.19
BCPMW-4-3	129.20		72.32	66.08	67.60	66.77	68.10
BCPMW-5-1	129.37		72.79	66.46	68.13	67.31	NM [4]
BCPMW-6-1	126.01		72.12	65.62	67.16	66.26	67.57
BCPMW-6-2	125.16		71.74	65.36	66.81	65.98	67.32
BCPMW-7-1	124.81		72.00	65.59	67.19	66.29	67.52
MW-200-1	123.49		72.16	65.98	67.57	66.75	67.94
MW-201-1	121.69		72.04	65.64	67.22	66.32	67.63
MW-202-1	119.27		71.90	65.57	67.12	66.29	67.53
MW-203-1	118.25		71.83	65.46	67.00	66.20	67.37
MW-204-1 [2]	124.95		--	65.93	57.50	66.68	67.95
MW-205-1 [2]	123.47		--	65.38	67.11	66.21	67.55
MW-206-1 [2]	120.80		--	65.59	67.11	66.25	67.52
MW-207A-1R [3]	120.38		--	65.28	NM [4]	66.12	67.23
MW-207B-1R [3]	120.48		--	65.88	NM [4]	66.28	67.47
MW-208-1 [2]	118.56		--	65.55	66.71	66.16	67.27
Piezometers							
PZ-1a	128.82		72.56	65.03	66.92	66.04	67.41
PZ-1b	128.92		72.47	65.57	67.32	66.37	67.78
PZ-1c	128.96		72.47	66.01	67.54	66.71	68.02
PZ-2a	128.36		72.47	65.53	67.22	66.31	67.67
PZ-2b	128.37		72.43	65.52	67.22	67.27	67.61
PZ-2c	128.55		72.41	65.75	67.40	66.60	67.90
PZ-3	124.99		72.52	65.43	NM [5]	66.19	NM [5]
PZ-4	125.31		72.50	65.55	NM [5]	66.33	NM [5]
PZ-5a	129.07		72.50	66.66	68.02	67.32	68.53
PZ-5b	129.06		72.50	66.65	67.91	67.25	68.49
PZ-5c [2]	128.84		--	66.44	67.84	67.23	68.43
PZ-6a	125.67		72.50	65.47	66.98	66.03	67.31
PZ-6b	125.74		72.50	65.22	66.91	66.97	67.28
PZ-7a	125.10		72.50	65.65	67.25	66.35	67.49
PZ-7b	125.06		72.50	65.52	67.06	66.14	67.57
PZ-8a [2]	127.63		--	65.33	66.93	66.01	67.36
PZ-8b [2]	127.54		--	NM [5]	66.03	66.14	67.43
PZ-8c [2]	127.57		--	65.82	67.27	66.43	67.43
PZ-9a [2]	125.30		--	67.33	68.69	67.89	NM [4]
PZ-10a [2]	125.27		--	66.62	68.12	67.19	68.51

Notes and abbreviations on last page.

Notes and Abbreviations:

(1) Baseline readings were taken prior to system startup, which occurred on July 21, 2009.

(2) Wells installed by ERM in 2015.

(3) MW-207-1a and MW-207-1b were replaced by MW-207A-1R and MW-208A-1R by EMAGIN in March/April 2018.

(4) Not Measured due to no access.

(5) Measurement collected is believed to be anomalous.

Well measuring point elevation is surveyed to NAVD88.

ft msl feet relative to mean sea level

Table 13
Concentrations of Volatile Organic Compounds and 1,4-Dioxane
in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constituents [1,2,3] (units in µg/L)	Sample Location: Sample Date:	B24MW-2 8/9/2018	B24MW-3 8/9/2018	B30MW-1 8/9/2018	BCPMW-4-1 7/24/2018	BCPMW-4-2 7/24/2018
	NYSDEC SCGs					
1,1,1-Trichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	5	< 1.0	< 1.0	< 1.0	**0.87 J**	**0.87 J**
1,1-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	0.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Butanone	NE	< 10	< 10	< 10	< 10	< 10
2-Hexanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-Methyl-2-Pentanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	NE	< 10	< 10	< 10	< 10	< 10
Benzene	1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Bromodichloromethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	60	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifloromethane (Freon 22)	NE	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	7	< 1.0	< 1.0	< 1.0	< 1.0	**1.3**
Chloromethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene	5	< 1.0	< 1.0	< 1.0	**30.7**	**58.1**
cis-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dichlorodifloromethane (Freon 12)	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl-Tert-Butylether	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methylene Chloride	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Styrene (Monomer)	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	5	**2.5**	< 1.0	< 1.0	**13.5**	**61.5**
Trichlorotrifloroethane (Freon 113)	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total VOCs [4]		**2.5**	0	0	**45**	**120**
Project VOCs [4]		**2.5**	0	0	**45**	**120**
1,4-Dioxane		**0.16 J**	**0.11 J**	< 0.24	**0.68**	**2.4**

See Notes and Abbreviations on Last Page

Table 13
Concentrations of Volatile Organic Compounds and 1,4-Dioxane
in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constituents [1,2,3] (units in µg/L)	Sample Location: Sample Date:	BCPMW-4-3 8/8/2018	BCPMW-6-1 8/6/2018	BCPMW-6-2 8/6/2018	BCPMW-7-1 8/3/2018 [5]	BCPMW-7-1 8/5/2018 [5]
	NYSDEC SCGs					
1,1,1-Trichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	0.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Butanone	NE	< 10	< 10	< 10	< 10	< 10
2-Hexanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-Methyl-2-Pentanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	NE	< 10	< 10	< 10	< 10	< 10
Benzene	1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Bromodichloromethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	60	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifloromethane (Freon 22)	NE	< 5.0	**3.7 J**	< 5.0	< 5.0	< 5.0
Chloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	7	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloromethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene	5	< 1.0	< 1.0	**0.97 J**	< 1.0	< 1.0
cis-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dichlorodifloromethane (Freon 12)	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl-Tert-Butylether	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methylene Chloride	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Styrene (Monomer)	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichlorotrifloroethane (Freon 113)	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total VOCs [4]		0	**3.7**	**0.97**	0	0
Project VOCs [4]		0	0	**0.97**	0	0
1,4-Dioxane		**0.43**	< 0.24	**0.092 J**	--	< 0.24

See Notes and Abbreviations on Last Page

Table 13
Concentrations of Volatile Organic Compounds and 1,4-Dioxane
in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constituents [1,2,3] (units in µg/L)	Sample Location: Sample Date:	MW-200-1 7/30/2018	MW-201-1 8/1/2018	MW-202-1 7/31/2018	MW-203-1 8/2/2018	MW-204-1 7/30/2018
	NYSDEC SCGs					
1,1,1-Trichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	5	< 1.0 J	< 1.0	< 1.0	< 1.0	< 1.0 J
1,2-Dichloroethane	0.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
2-Butanone	NE	< 10	< 10	< 10	< 10	< 10
2-Hexanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
4-Methyl-2-Pentanone	50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	NE	< 10	< 10	< 10	< 10	< 10
Benzene	1	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Bromodichloromethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	60	< 2.0 J	< 2.0	< 2.0	< 2.0	< 2.0 J
Carbon Tetrachloride	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifloromethane (Freon 22)	NE	< 5.0 J	< 5.0	< 5.0	< 5.0	< 5.0 J
Chloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	7	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chloromethane	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene	5	< 1.0	**0.87 J**	< 1.0	< 1.0	< 1.0
cis-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	50	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Dichlorodifloromethane (Freon 12)	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl-Tert-Butylether	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methylene Chloride	5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Styrene (Monomer)	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	5	< 1.0	< 1.0	**1.1**	< 1.0	< 1.0
Toluene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	5	< 1.0	**0.90 J**	**0.70 J**	**2.6**	**0.63 J**
Trichlorotrifloroethane (Freon 113)	5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total VOCs [4]		0	1.8	1.8	2.6	0.63
Project VOCs [4]		0	1.8	1.8	2.6	0.63
1,4-Dioxane		0.40	0.40	0.30	0.19 J	0.25 J

See Notes and Abbreviations on Last Page

Table 13
Concentrations of Volatile Organic Compounds and 1,4-Dioxane
in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constituents [1,2,3] (units in µg/L)	Sample Location: Sample Date:	MW-206-1 8/1/2018	MW-206-1 7/31/2018	MW-206-1 8/2/2018	MW-206-1 (REP) 8/2/2018
	NYSDEC SCGs				
1,1,1-Trichloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2,2-Tetrachloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	1	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	5	< 1.0	**0.96 J**	**0.61 J**	< 1.0
1,1-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	0.6	< 1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	1	< 1.0	< 1.0	< 1.0	< 1.0
2-Butanone	NE	< 10	< 10	< 10	< 10
2-Hexanone	50	< 5.0	< 5.0	< 5.0	< 5.0
4-Methyl-2-Pentanone	50	< 5.0	< 5.0	< 5.0	< 5.0
Acetone	NE	< 10	< 10	< 10	< 10
Benzene	1	< 0.50	< 0.50	< 0.50	< 0.50
Bromodichloromethane	50	< 1.0	< 1.0	< 1.0	< 1.0
Bromoform	50	< 1.0	< 1.0	< 1.0	< 1.0
Bromomethane	5	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Disulfide	60	< 2.0	< 2.0	< 2.0	< 2.0
Carbon Tetrachloride	5	< 1.0	< 1.0	< 1.0	< 1.0
Chlorobenzene	5	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodifloromethane (Freon 22)	NE	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	5	< 1.0	< 1.0	< 1.0	< 1.0
Chloroform	7	< 1.0	< 1.0	**0.75 J**	**0.71 J**
Chloromethane	5	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene	5	**0.76 J**	**0.56 J**	**129**	**135**
cis-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0
Chlorodibromomethane	50	< 1.0	< 1.0	< 1.0	< 1.0
Dichlorodifloromethane (Freon 12)	5	< 2.0	< 2.0	< 2.0	< 2.0
Ethylbenzene	5	< 1.0	< 1.0	< 1.0	< 1.0
Methyl-Tert-Butylether	5	< 1.0	< 1.0	< 1.0	< 1.0
Methylene Chloride	5	< 2.0	< 2.0	< 2.0	< 2.0
Styrene (Monomer)	5	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	5	< 1.0	**1.4**	< 1.0	< 1.0
Toluene	5	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene	5	< 1.0	< 1.0	< 1.0	< 1.0
trans-1,3-Dichloropropene	0.4	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	5	< 1.0	**0.79 J**	**11.7**	**11.4**
Trichlorotrifloroethane (Freon 113)	5	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	2	< 1.0	< 1.0	**1.1**	**0.98 J**
o-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	5	< 1.0	< 1.0	< 1.0	< 1.0
Total VOCs [4]		**0.76**	**3.7**	**140**	**150**
Project VOCs [4]		**0.76**	**3.7**	**140**	**150**
1,4-Dioxane		**0.40**	**0.34**	**0.51**	**0.35**

See Notes and Abbreviations on Last Page

Notes and Abbreviations:

(1) Results are validated at 20% frequency, per protocols specified in Sampling and Analysis Plan in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (ARCADIS 2016).

(2) Samples analyzed for the TCL VOCs using USEPA Method 8260C and 1,4-Dioxane using USEPA Method 8270D SIM.

(3) "Total VOCs" represents the sum of individual concentrations of the VOCs detected. TVOCs were rounded to two significant figures.

(4) "Project VOCs" represents the sum of individual concentrations of 1,1,1-Trichloroethane; 1,1-Dichloroethane; 1,2-Dichloroethane; 1,1-Dichloroethene; Tetrachloroethene; Trichloroethene; Vinyl Chloride; cis-1,2-Dichloroethene; trans-1,2-Dichloroethene; Benzene; Toluene; and Xylenes-o,m, and p.

(5) 1,4-Dioxane sample collected on 8/3/2018 arrived the laboratory at temperature above QC requirement. Well was re-sampled on 8/8/2019 for all analytes (i.e. VOCs, 1,4-Dioxane and metals) for contemporaneousness.

Bolded outline indicates an exceedance of an SCG.
Bold value indicates a detection.

BPGWCS	Bethpage Groundwater Containment System
OU3	Operable Unit 3
J	Value is estimated.
< 5	Compound not detected above its laboratory quantification limit.
µg/L	Micrograms per liter.
NE	Not established.
NYSDEC	New York State Department of Environmental Conservation.
REP	Field replicate QA/QC sample
SCGs	Standards, criteria, and guidance values.
SIM	Selective Ion Monitoring
TCL	Target compound list.
USEPA	United State Environmental Protection Agency.
VOC	Volatile Organic Compound.

Table 14
Concentrations of Metals in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constitents [1,2,3] (units in ug/L)	Sample Location: Sample Date:	B24MW-2 8/9/2018	B24MW-3 8/9/2018	B30MW-1 8/9/2018	BCPMW-4-1 7/24/2018	BCPMW-4-2 7/24/2018	BCPMW-4-3 8/8/2018	BCPMW-6-1 8/6/2018
	NYSDEC SCGs							
Total Cadmim	5	< 6.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Dissolved Cadmim	5	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Total Chromim	50	**153**	**12.5**	< 10	< 10	< 10	< 10	< 10
Dissolved Chromim	50	< 10	< 10	< 10	< 10	< 10	< 10	< 10

Notes and Abbreviations on Last Page

Table 14
Concentrations of Metals in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

Constitents [1,2,3] (units in ug/L)	Sample Location: Sample Date:	BCPMW-6-2 8/6/2018	BCPMW-7-1 8/3/2018 [4]	BCPMW-7-1 8/8/2018 [4]	MW-200-1 7/30/2018	MW-201-1 8/1/2018	MW-202-1 7/31/2018
	NYSDEC SCGs						
Total Cadmim	5	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Dissolved Cadmim	5	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Total Chromim	50	< 10	< 10	< 10	**12.4**	< 10	**21.4**
Dissolved Chromim	50	< 10	< 10	< 10	< 10	< 10	< 10

Notes and Abbreviations on Last Page

Table 14
Concentrations of Metals in Groundwater Samples Collected from Monitoring Wells
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

ARCADIS Design & Consultancy for natural and built assets

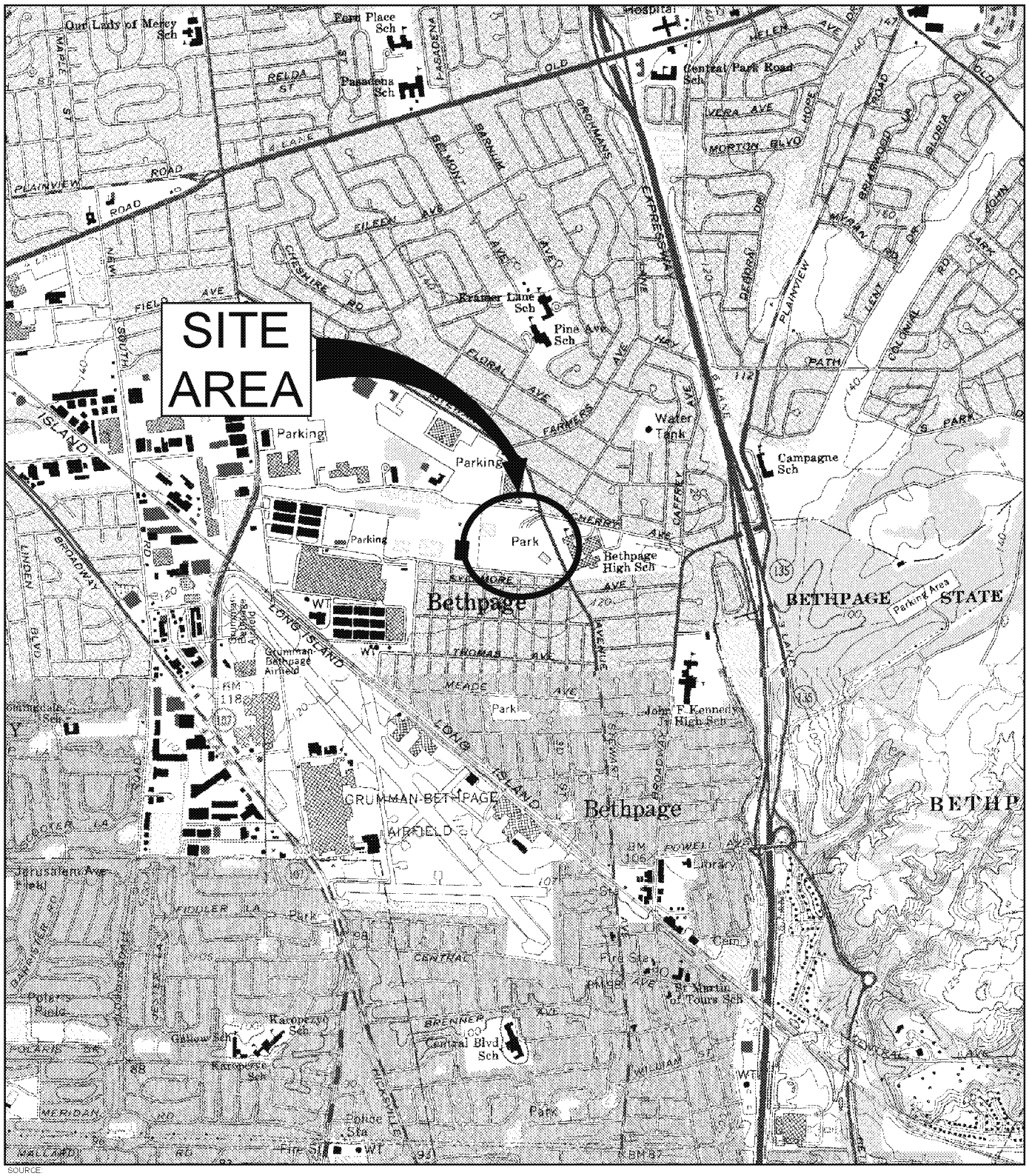
Constitents [1,2,3] (units in ug/L)	Sample Location: Sample Date:	MW-203-1 8/2/2018	MW-204-1 7/30/2018	MW-205-1 8/1/2018	MW-206-1 7/31/2018	MW-208-1 8/2/2018	MW-208-1 (REP) 8/2/2018
	NYSDEC SCGs						
Total Cadmim	5	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Dissolved Cadmim	5	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Total Chromim	50	**22.7**	**239**	**88.7**	**13.6**	< 10	< 10
Dissolved Chromim	50	< 10	**89.1**	**23.7**	< 10	< 10	< 10

Notes and Abbreviations on Last Page

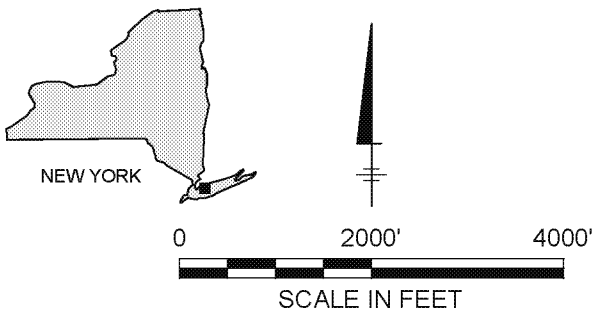
Notes and Abbreviations:

(1)	Results are validated at 20% frequency, per protocols specified in Sampling and Analysis Plan in the DRAFT Bethpage Park Groundwater Containment System OM&M Manual (ARCADIS 2016).
(2)	Samples analyzed for metals using USEPA Method 6010.
(3)	Total means unfiltered; dissolved means filtered.
(4)	1,4-Dioxane sample collected on 8/3/2018 arrived the laboratory at temperature above QC requirement. Well was re-sampled on 8/8/2019 for all analytes (i.e. VOCs, 1,4-Dioxane and metals) for contemporaneousness.
OU3	Operable Unit 3
BPGWCS	Bethpage Groundwater Containment System
	Indicates an exceedance of an SCG
20.5	Bold indicates a detection
NYSDEC	New York State Department of Environmental Conservation
SCGs	Standards, Criteria, and Guidance values
USEPA	United State Environmental Protection Agency
ug/L	Micrograms per liter
< 5	Compound not detected above its laboratory quantification limit

FIGURES



SOURCE:
USGS 7.5 MIN. AMITYVILLE QUADRANGLE, AMITYVILLE, N.Y., 1994, FREEPORT QUADRANGLE, FREEPORT, N.Y., 1994, HICKSVILLE QUADRANGLE, HICKSVILLE, N.Y., 1967, PHOTOREVISED 1979, HUNTINGTON, N.Y., 1967, PHOTOREVISED 1979



BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

SITE LOCATION

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

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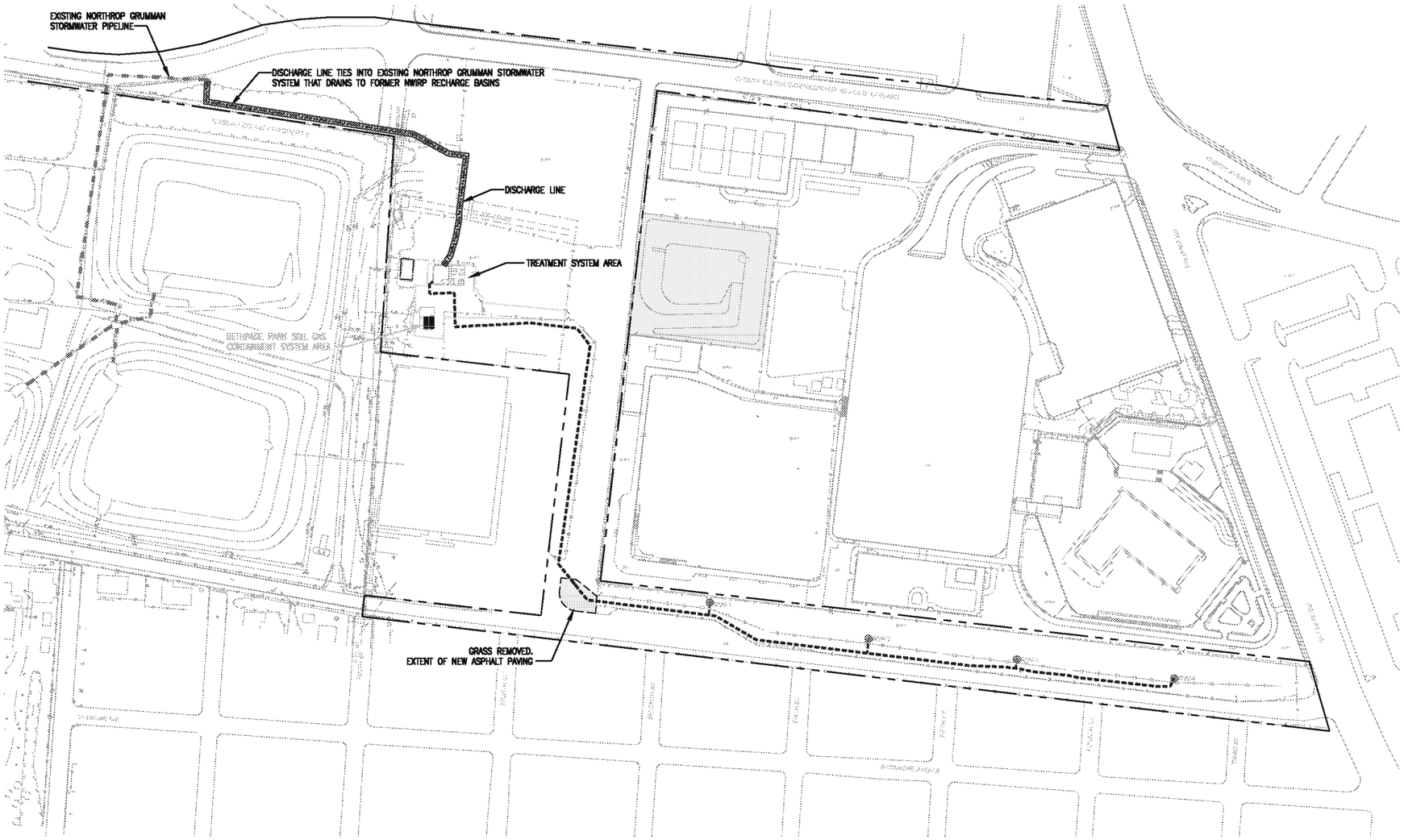
AMITYVILLE.TIF
FREEPORT.TIF
HICKSVILLE.TIF
HUNTINGTON.TIF



LEGEND:

- NORTHROP GRUMMAN PROPERTY LINE
- FENCE
- BITUMINOUS PAVEMENT
- INFLUENT PIPELINE AND ELECTRICAL CONDUITS
- EFFLUENT PIPELINE
- EXISTING NORTHROP GRUMMAN STORMWATER PIPELINE
- REMEDIAL WELL
- NWIRP — NAVAL WEAPONS INDUSTRIAL RESERVE PLANT (NOW OWNED BY NASSAU COUNTY)

0 200' 400'

SCALE IN FEET

BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

SITE AND GROUNDWATER CONTAINMENT SYSTEM

ARCADIS Design & Consultancy for natural and built assets

FIGURE **2**

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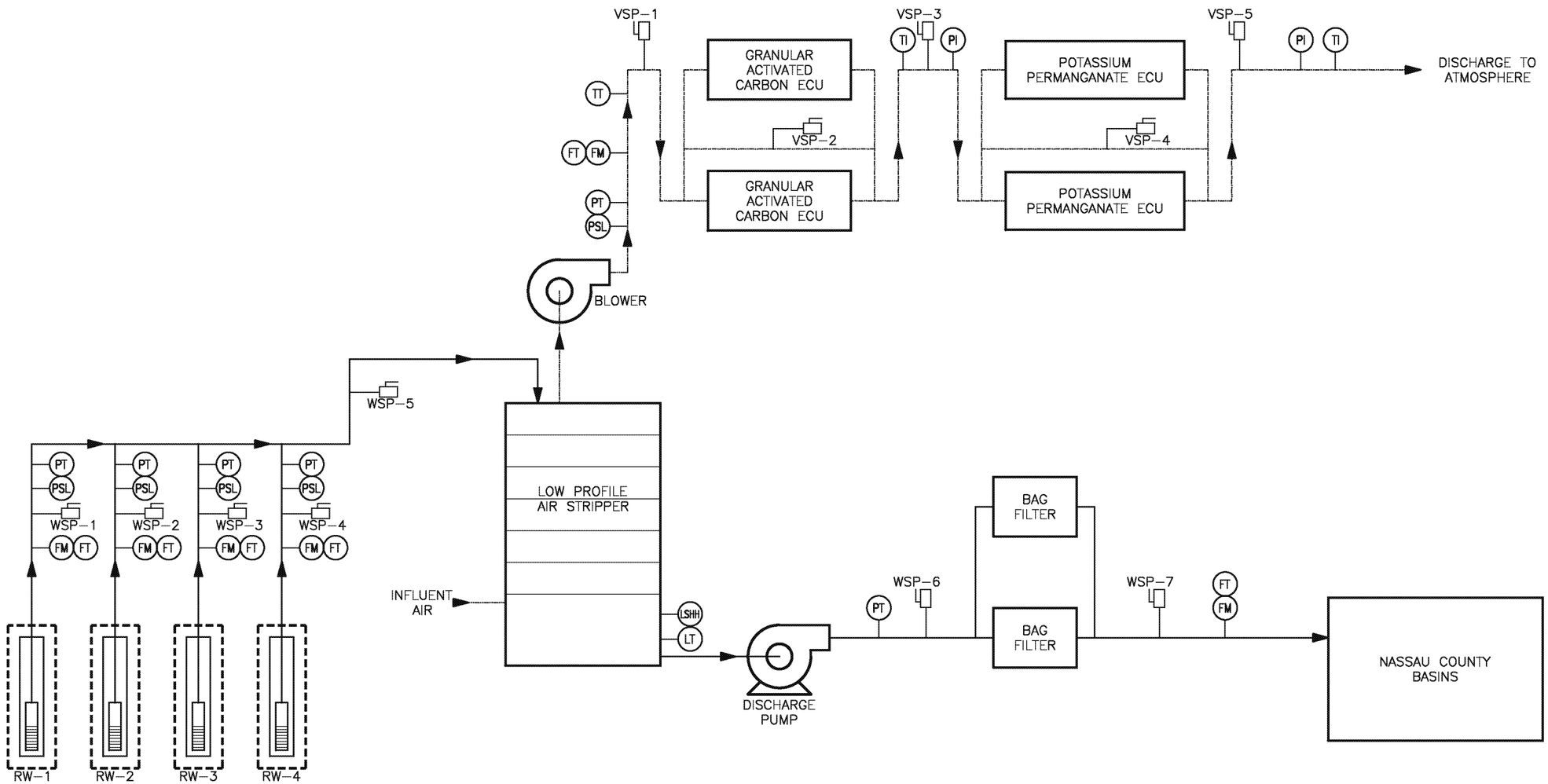
XREFS: IMAGES: PROJECTNAME: ----
Xr1496X00
X-ONSITE-BASE SITE



LEGEND:

	PROCESS WATER
	PROCESS AIR
FM	INSTRUMENT
	SAMPLE PORT
	FLOW DIRECTION
FM	FLOW METER
FT	FLOW RATE TRANSMITTER
PSL	PRESSURE VACUUM LOW
PT	PRESSURE TRANSMITTER
PI	PRESSURE INDICATOR
LSHH	LEVEL SWITCH HIGH HIGH
LT	LEVEL TRANSMITTER
TT	TEMPERATURE TRANSMITTER
TI	TEMPERATURE INDICATOR
WSP	WATER SAMPLE PORT
VSP	VAPOR SAMPLE PORT
ECU	EMISSION CONTROL UNIT

BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

GROUNDWATER TREATMENT SYSTEM PROCESS SCHEMATIC AND MONITORING LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE 3

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:AS PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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XREFS: IMAGES: PROJECTNAME: ----
XI1496X00

EXPLANATION:

- NORTHROP GRUMMAN PROPERTY LINE
- FENCE
- BASIN
- bit. BITUMINOUS PAVEMENT
- MW-200-1 MONITORING WELL
- RW-2 REMEDIAL WELL
- PZ-2C PIEZOMETER

NOTES:

1. MONITORING WELLS, REMEDIAL WELLS, AND PIEZOMETERS SURVEYED TO NORTH AMERICAN DATUM (NAD) 83.
2. PARK FEATURES SHOWN WERE PRESENT PRIOR TO TOWN OF OYSTER BAY REDEVELOPMENT IN 2005.

0 100' 200'

APPROXIMATE SCALE IN FEET

BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

GROUNDWATER MONITORING NETWORK SITE PLAN

ARCADIS Design & Consultancy for natural and built assets

FIGURE 4

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:ALS PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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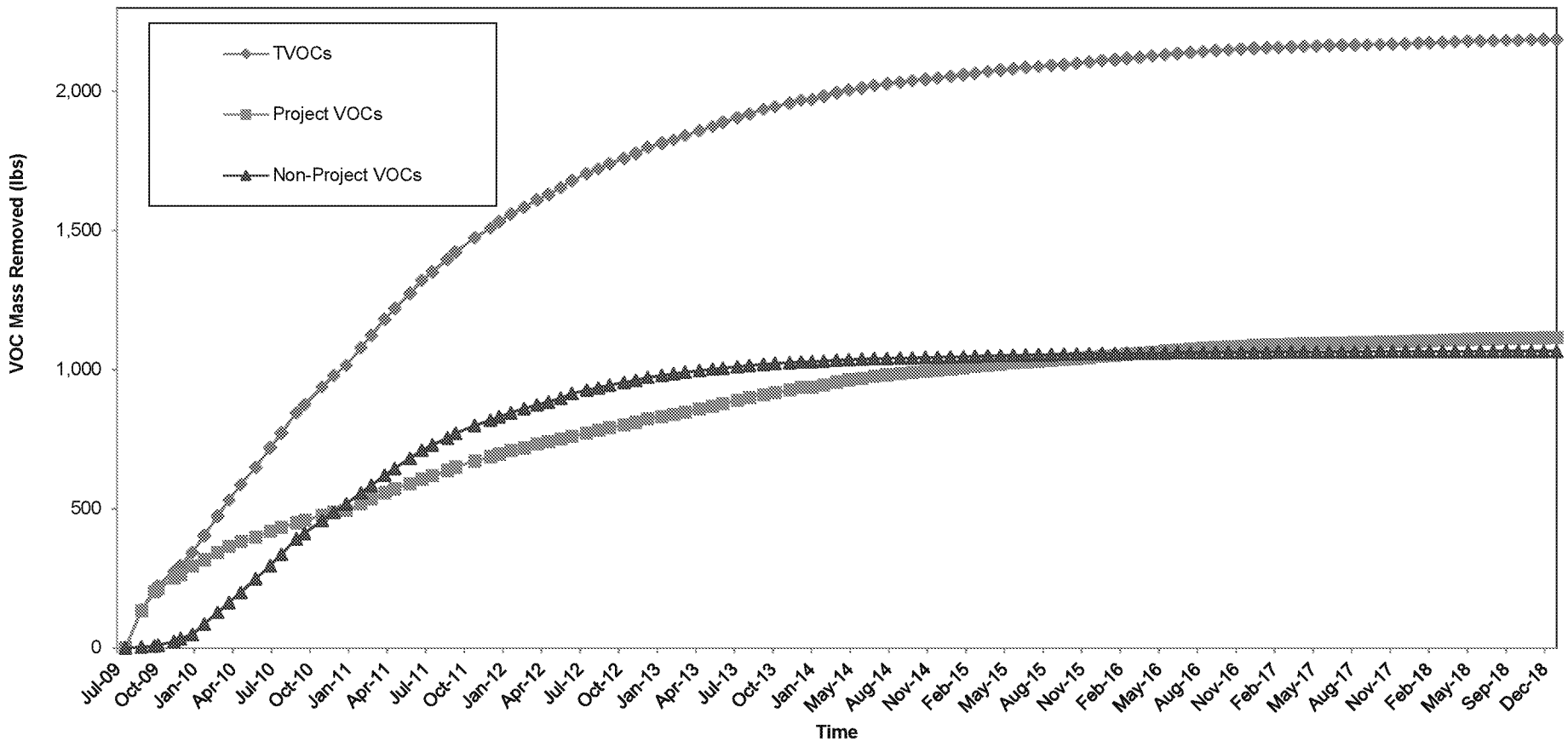
X-ONSITE-BASE SITE
XrBDR-CL
Xr1496Xsp



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected

Project VOCs = sum of 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethene; vinyl chloride; cis-1,2-dichloroethene; trans-1,2-dichloroethene; benzene; toluene; and total xylenes.
Non-Project VOCs = sum of VOCs that are not Project VOCs.

lbs = pounds

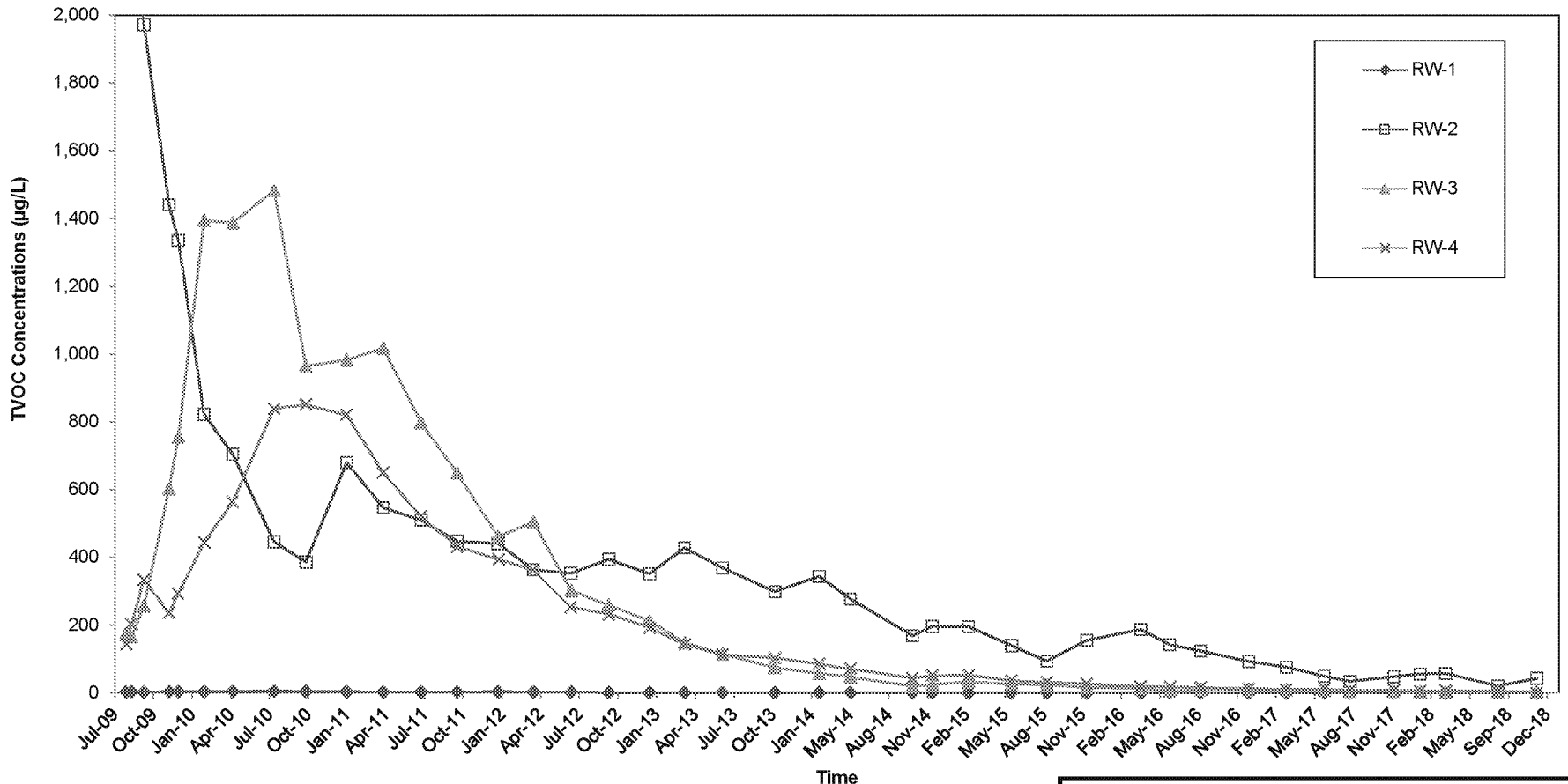
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

CUMULATIVE TOTAL, PROJECT, AND NON-PROJECT VOC MASS REMOVED

ARCADIS

FIGURE
5

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 5 TVOC Mass Graph



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected

1. Results prior to September 10, 2009 are not shown to improve figure clarity. The TVOC concentrations are greater than 2,000 µg/L. See previous reports for full data set.

µg/L = micrograms per liter

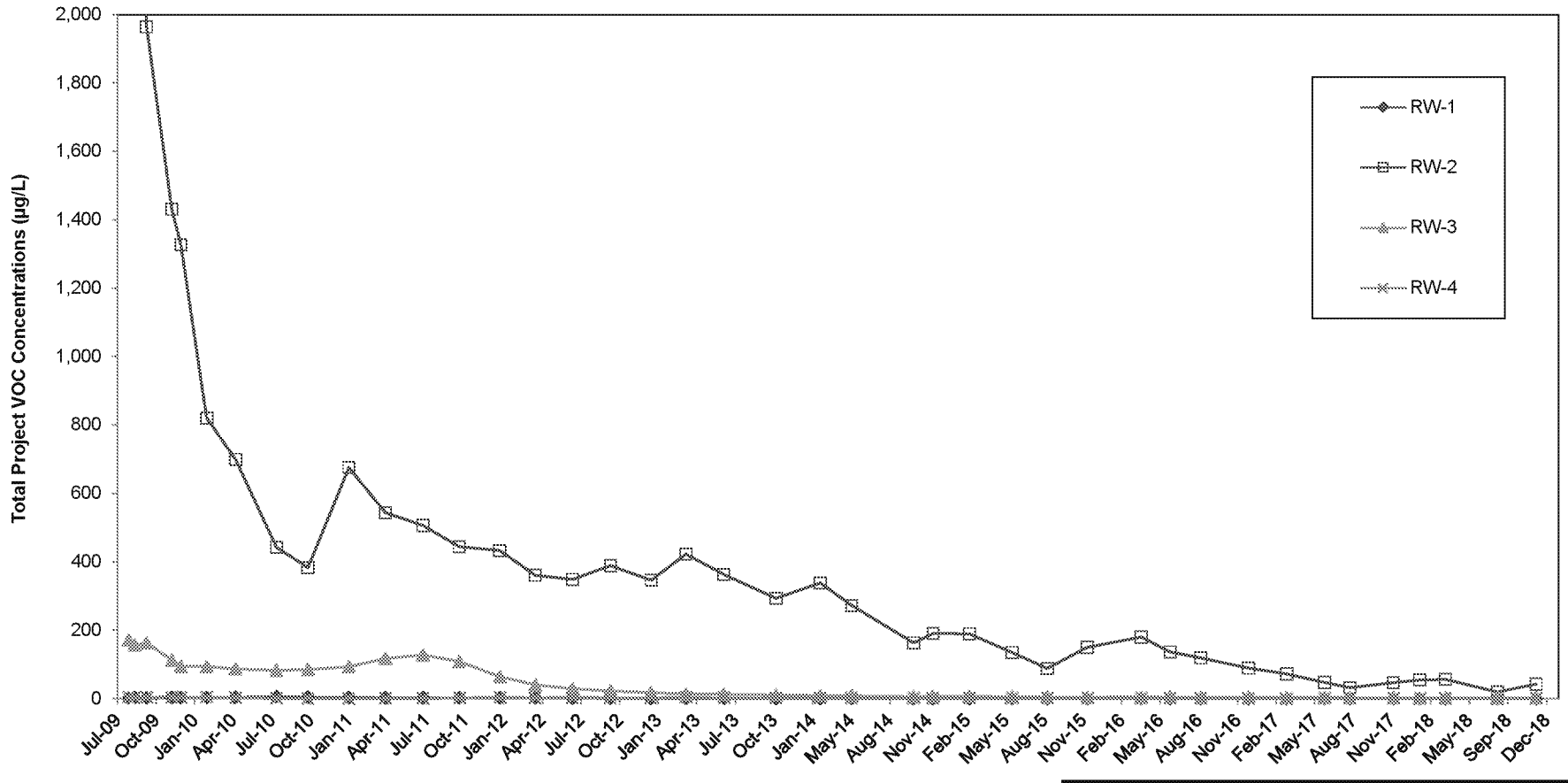
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

REMEDIAL WELL TOTAL VOC CONCENTRATIONS

ARCADIS

FIGURE
6A

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 6A RW Total VOC



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected

Project VOCs = sum of 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethene; vinyl chloride; cis-1,2-dichloroethene; trans-1,2-dichloroethene; benzene; toluene; and total xylenes.

1. Results prior to September 10, 2009 are not shown to improve figure clarity. Total Project VOC concentrations are greater than 2,000 µg/L. See previous reports for full data set.

µg/L = micrograms per liter

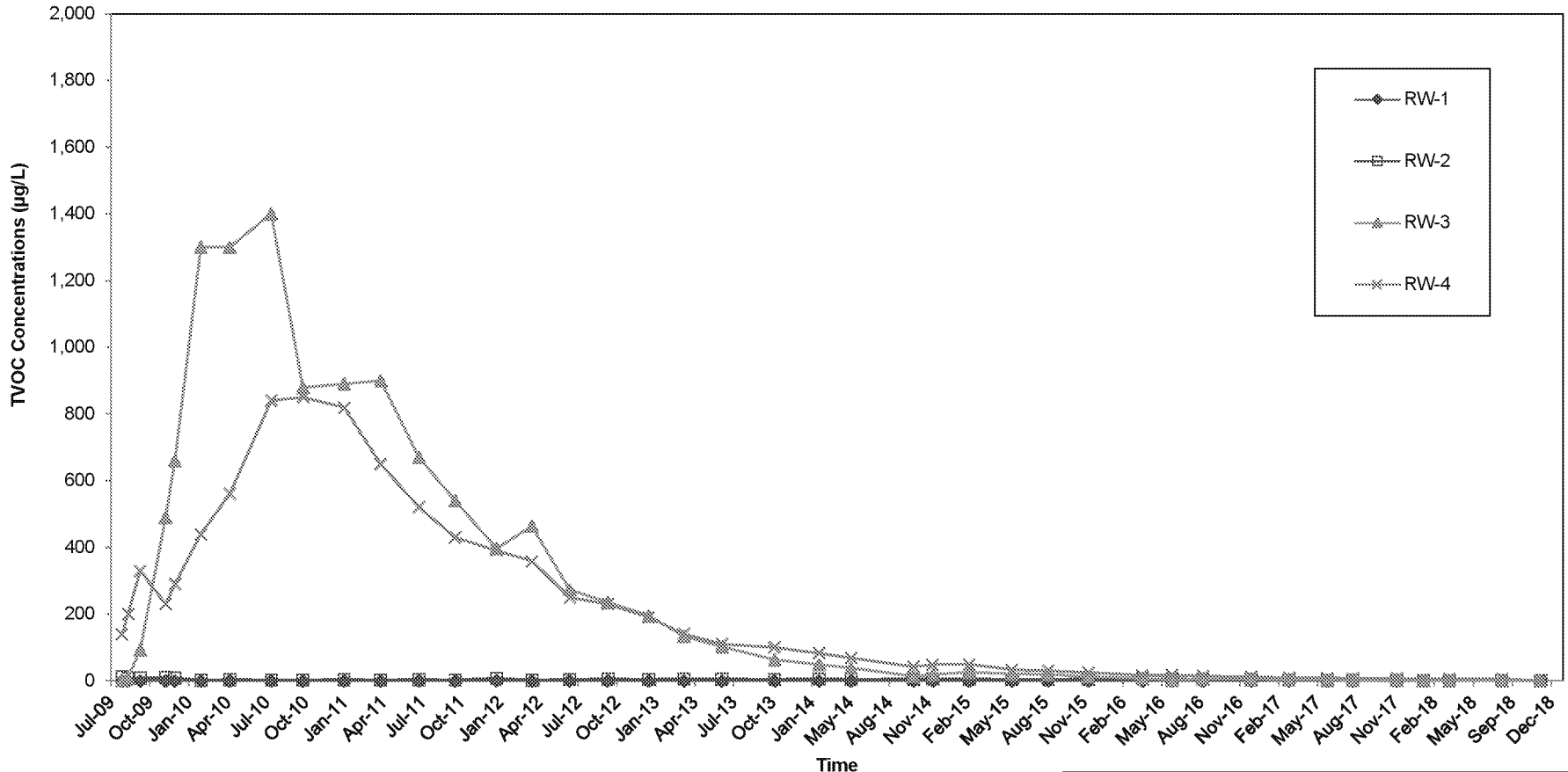
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

REMEDIAL WELL PROJECT VOC CONCENTRATIONS

ARCADIS

FIGURE
6B

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 6B RW Project VOC



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected.

Non-Project VOCs = sum of TVOCs that are not Project VOCs.

µg/L = micrograms per liter

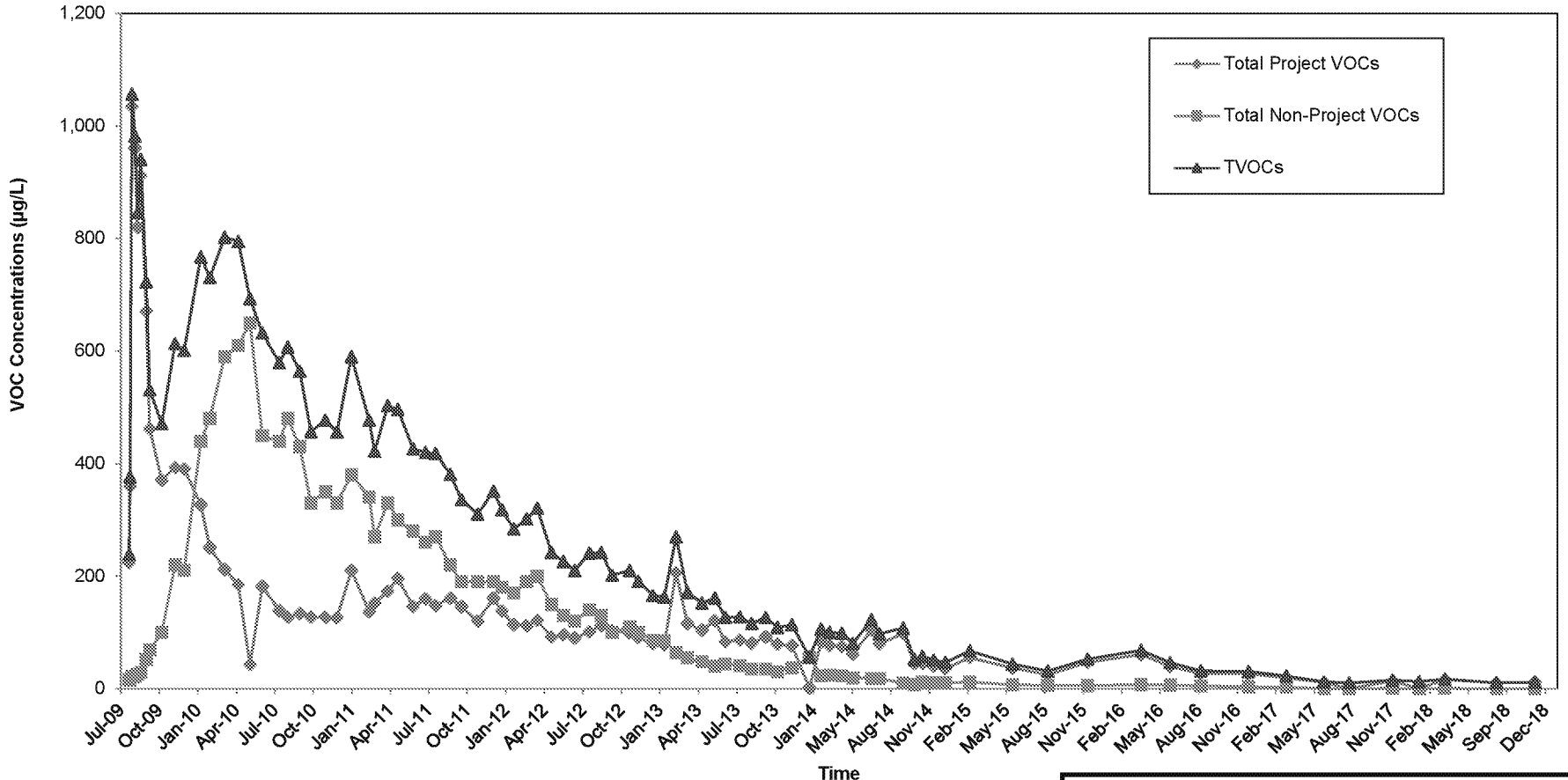
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

REMEDIAL WELL NON-PROJECT VOC CONCENTRATIONS

ARCADIS

FIGURE
6C

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 6C RW Non-Proj VOC



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected.

Project VOCs = sum of 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethene; vinyl chloride; cis-1,2-dichloroethene; trans-1,2-dichloroethene; benzene; toluene; and total xylenes.

Non-Project VOCs = sum of VOCs that are not Project VOCs.

µg/L = micrograms per liter

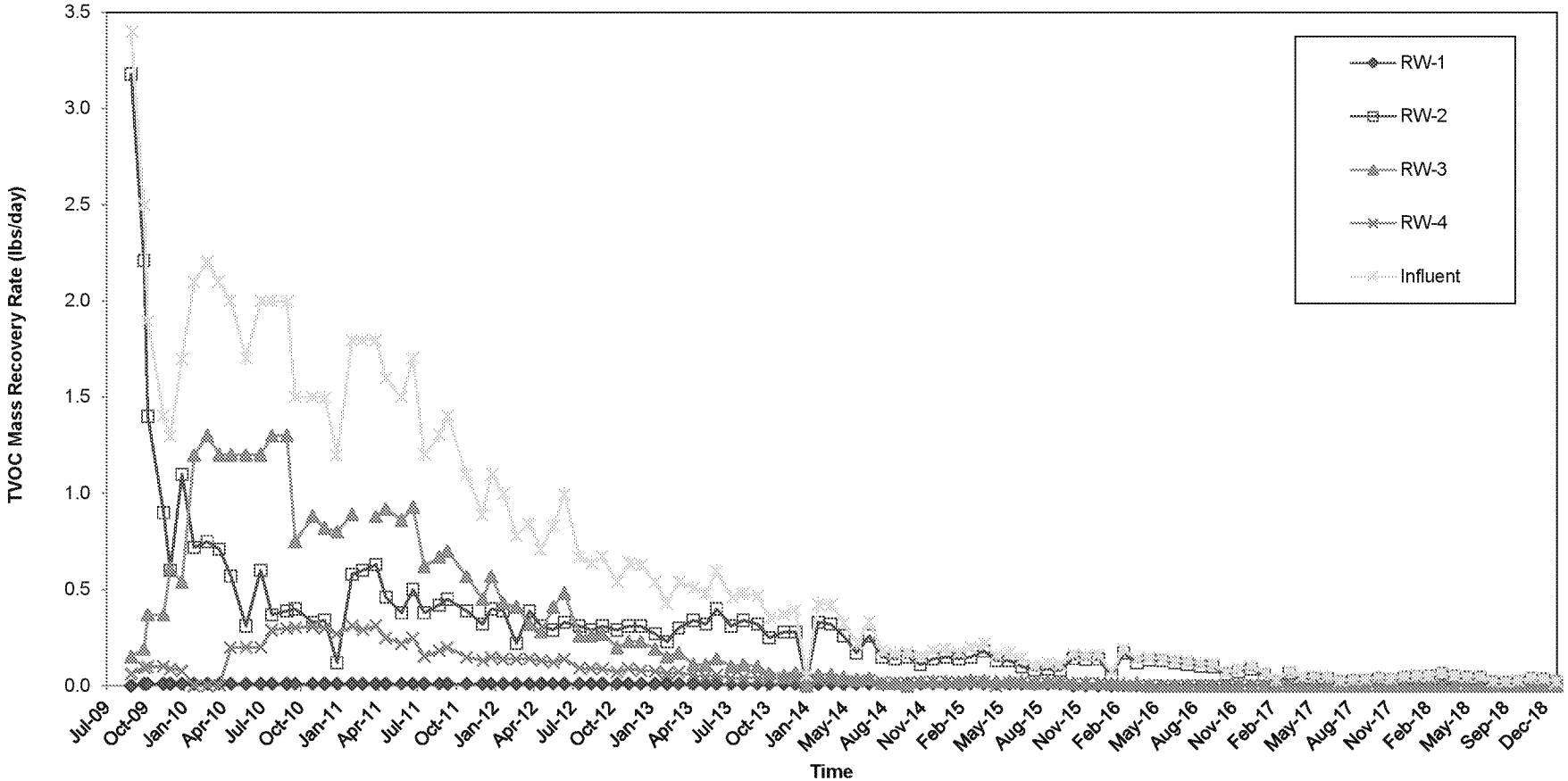
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

INFLUENT TOTAL, PROJECT AND NON-PROJECT VOC CONCENTRATIONS

ARCADIS

FIGURE
7

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 7 Comb. Inf. VOC Conc.



Abbreviation, Notes, and Units:

VOC = Volatile Organic Compound
TVOCs = Total VOCs detected

lbs/day = pounds per day

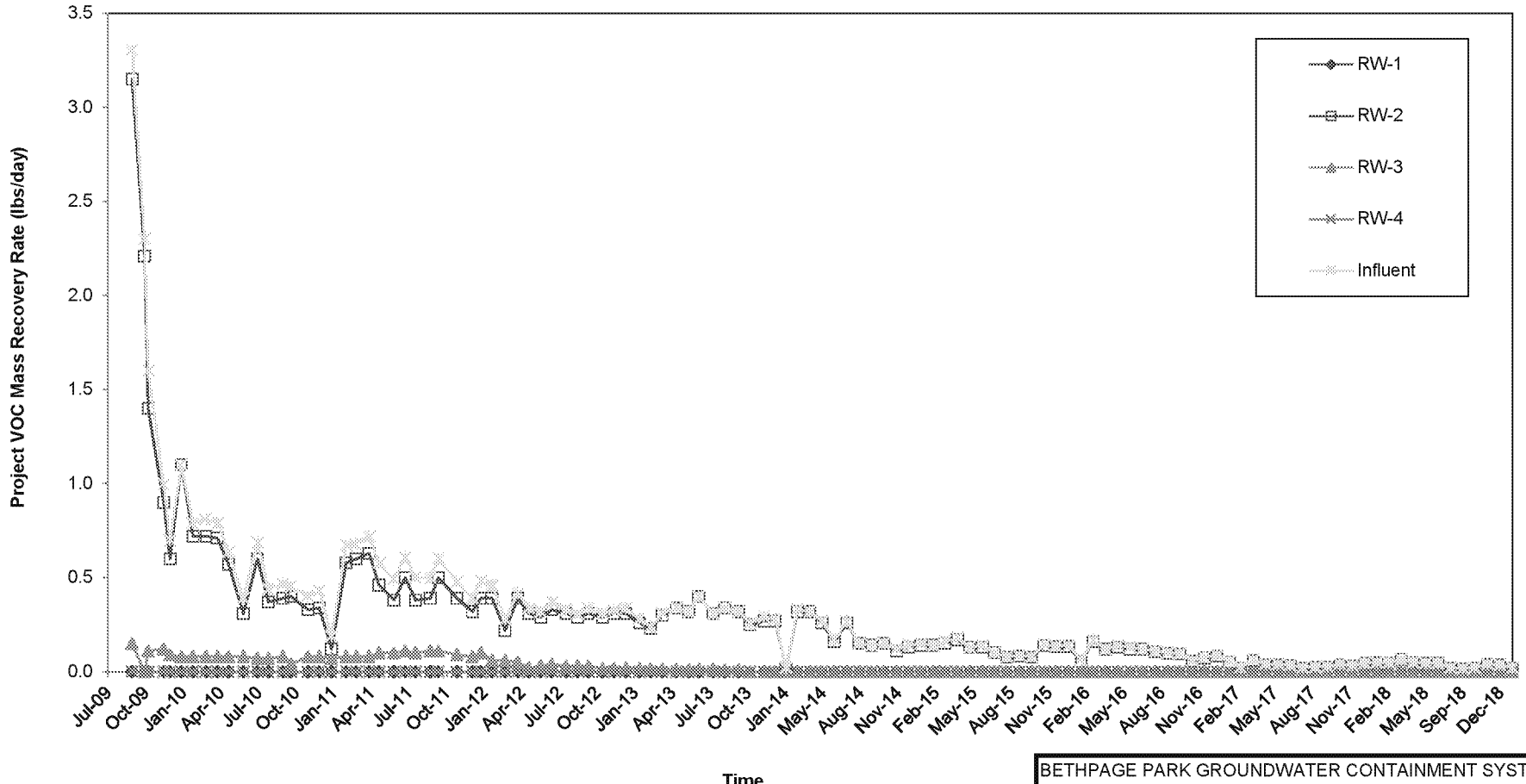
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

TOTAL VOC MASS RECOVERY RATES

ARCADIS

FIGURE
8A

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 8A VOC Recovery Rates



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound

Project VOCs = Sum of 1,1,1-trichloroethane; 1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene; tetrachloroethene; trichloroethene; vinyl chloride; cis-1,2-dichloroethene; trans-1,2-dichloroethene; benzene; toluene; and total xylenes

lbs/day = pounds per day

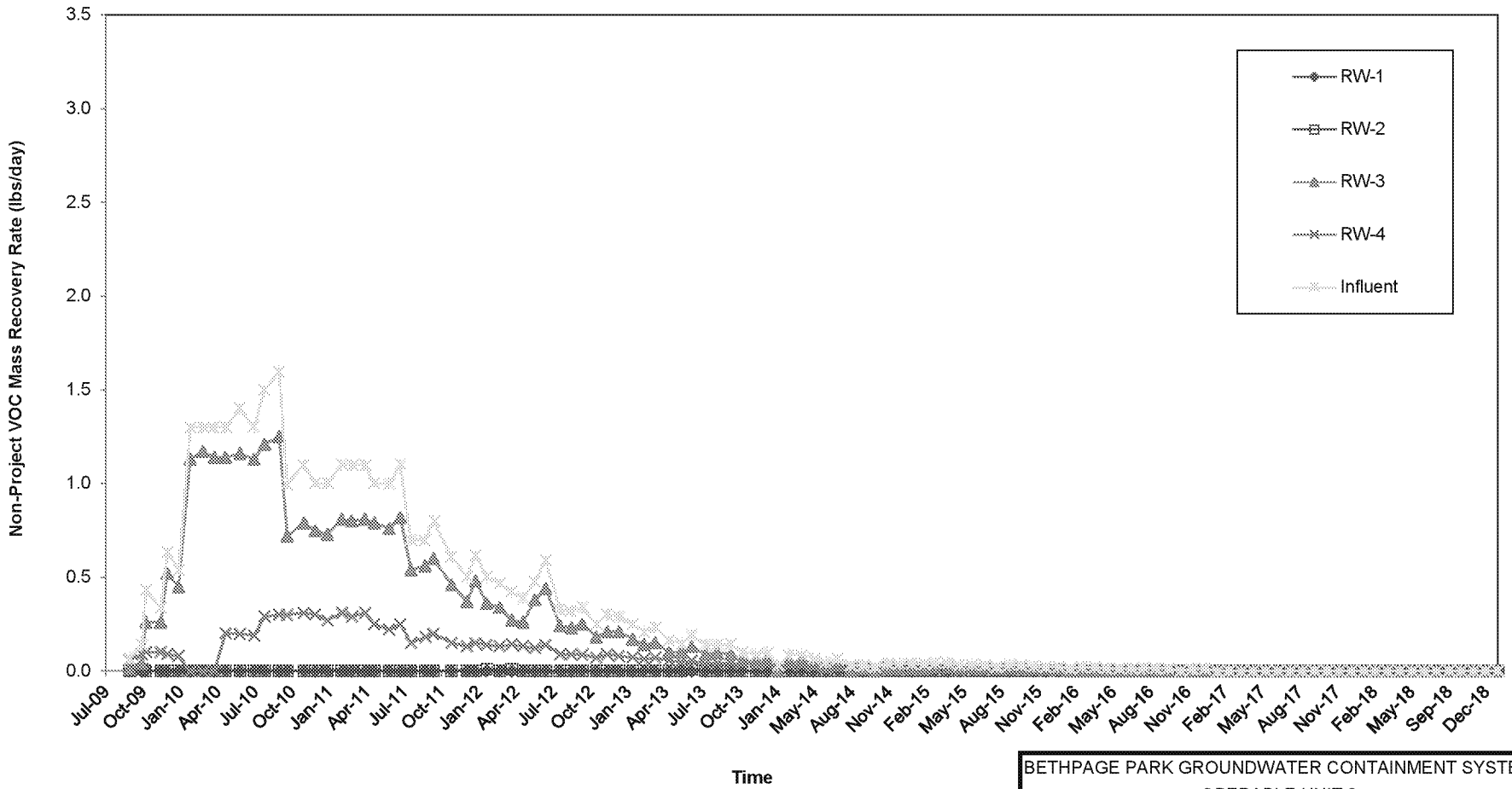
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

PROJECT VOC MASS RECOVERY RATES

ARCADIS

FIGURE
8B

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 8B VOC Recovery Rates



Abbreviations, Notes, and Units:

VOC = Volatile Organic Compound

Non-Project VOCs = sum of VOCs that are not Project VOCs.

lbs/day = pounds per day

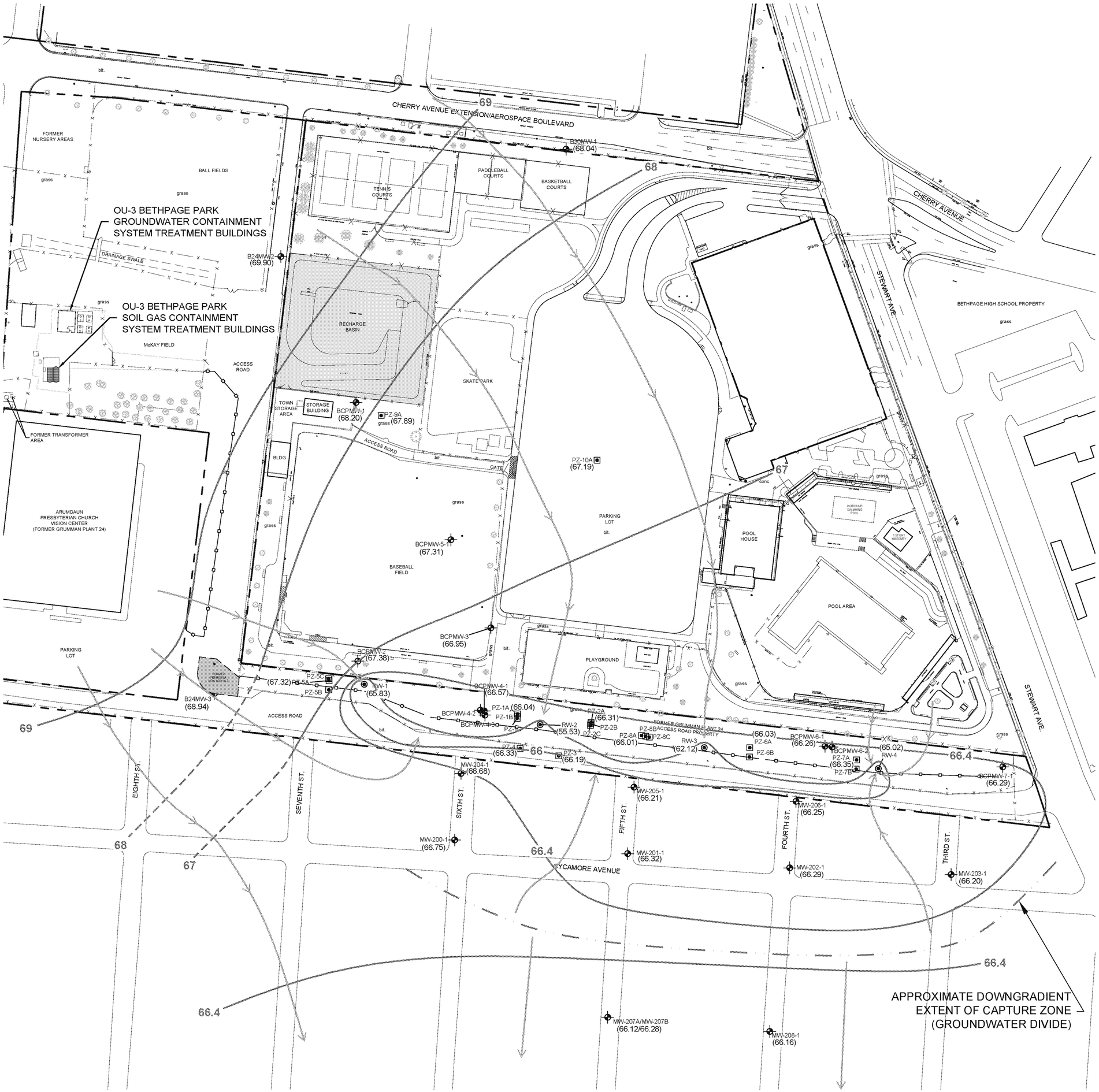
BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM
OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

NON-PROJECT VOC MASS RECOVERY RATES

ARCADIS

FIGURE
8C

G:\APROJECT\Northrop Grumman Bethpage\OU3.2 Groundwater Containment System\10 Final Reports-Presentations\OM&M Reports\2018 Q4\Tables\Q4_Table 2-8Figure 8C VOC Recovery Rates



EXPLANATION:

- NORTHROP GRUMMAN PROPERTY LINE
- FENCE
- BASIN
- bit. BITUMINOUS PAVEMENT
- MW-200-1 MONITORING WELL
- RW-2 REMEDIAL WELL
- PZ-2C PIEZOMETER
- (63.65) WATER-LEVEL ELEVATION (FEET MEAN SEA LEVEL)
- 67 GROUNDWATER ELEVATION CONTOUR IN FEET RELATIVE TO MEAN SEA LEVEL (DASHED WHERE LESS CONTROL AVAILABLE)
- DIRECTION OF THE HORIZONTAL COMPONENT OF GROUNDWATER FLOW
- GROUNDWATER DIVIDE

NOTES:

1. MONITORING WELLS, REMEDIAL WELLS, AND PIEZOMETERS SURVEYED TO NORTH AMERICAN HORIZONTAL DATUM (NAD) 83.
2. PARK FEATURES SHOWN WERE PRESENT PRIOR TO TOWN OF OYSTER BAY REDEVELOPMENT IN 2005.
3. WATER LEVEL ELEVATIONS CALCULATED FROM DATA COLLECTED ON SEPTEMBER 28, 2018.
4. REFER TO TABLE 7 FOR PUMPING RATES OF REMEDIAL WELLS.

0 100' 200'
SCALE IN FEET

OPERABLE UNIT 3
ONCT SYSTEM
BETHPAGE, NEW YORK

GROUNDWATER MONITORING NETWORK AND CONFIGURATION OF THE SHALLOW POTENTIOMETRIC SURFACE AND GROUNDWATER FLOW DIRECTIONS THIRD QUARTER 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE 9

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:ALS PIC:(Opt) PM:(Req) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
CTB:(Opt)ARCADIS.CTB PAT:ISO13B3M 360 Doc:NORTHROP GRUMMAN\OU3 Regional Groundwater\2018\NY001\1468.34\NG0-DWG\NG0-OU3-3QTR-GWFLOW.dwg LAYOUT: 9 SAVED: 3/19/2019 9:45 AM ACADVER: 23.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 3/19/2019 9:46 AM
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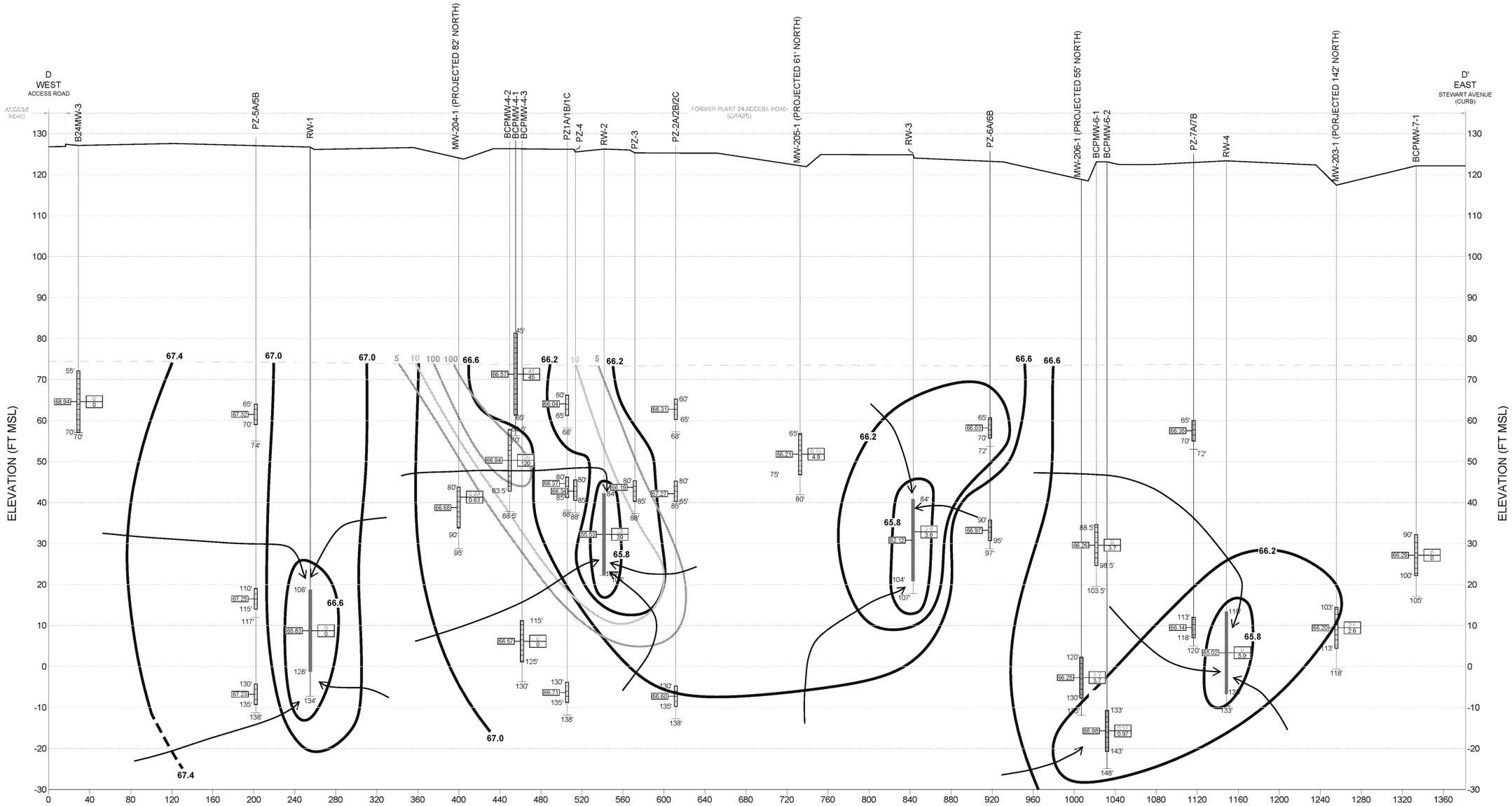
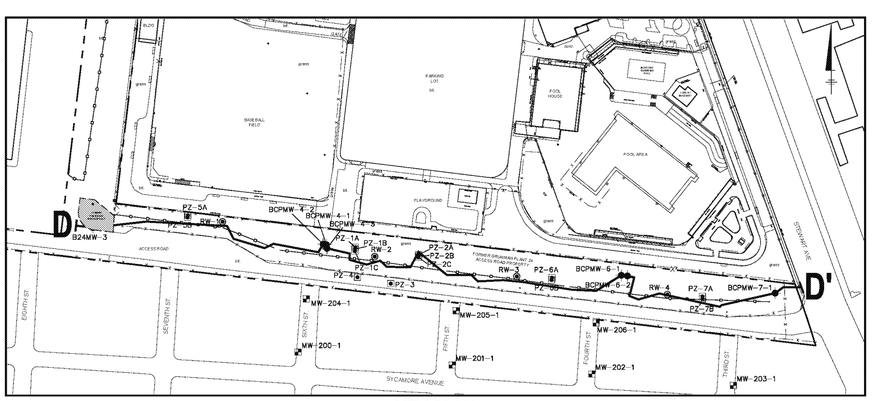
XREFS: IMAGES:
X-EDR-CL
x-onsite-base site

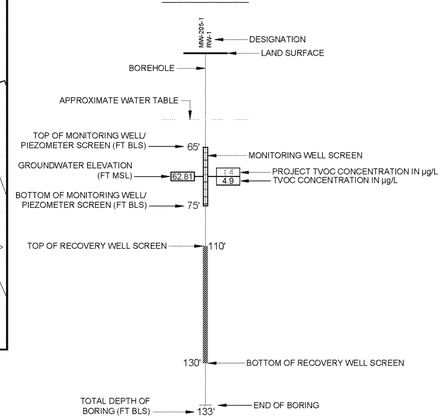




KEY PLAN
SHOWING CROSS SECTION D-D'

0 100' 200'
APPROXIMATE SCALE IN FEET

EXPLANATION



VERTICAL SCALE IN FEET
EXAGGERATION: 4x

10
0
0 40
HORIZONTAL SCALE IN FEET

DEFINITIONS:
FT - FEET
MSL - MEAN SEA LEVEL
BLS - BELOW LAND SURFACE
µg/L - MICROGRAMS PER LITER
TVOC - TOTAL VOLATILE ORGANIC COMPOUND
NM - NOT MEASURED

LEGEND:

66.2 — GROUNDWATER ELEVATION CONTOUR IN FEET RELATIVE TO MEAN SEA LEVEL, DASHED WHERE LESS CONTROL AVAILABLE

← VERTICAL DIRECTION OF GROUNDWATER FLOW

10 — PROJECT TVOC CONTOUR IN µg/L, DASHED WHERE LESS CONTROL AVAILABLE

NOTES:

1. WATER LEVEL ELEVATIONS CALCULATED FROM DATA COLLECTED ON SEPTEMBER 28, 2018.
2. WELL TVOC/PROJECT TVOC DATA FROM THE JULY-AUGUST 2018 SAMPLING ROUND. RESULT REPRESENTATIVE OF ENTIRE WELL SCREEN INTERVAL.
3. TVOC CONTOURS ARE BASED ON PROJECT TVOC DATA, SEE NOTE 2 AND 5.
4. APPROXIMATE DOWNGRADIENT EXTENT OF CAPTURE ZONE IS SOUTH OF WELLS MW-200-1, MW-201-1, MW-202-1, AND MW-203-1, SEE FIGURE 9.
5. THE BETHPAGE PARK GROUNDWATER CONTAINMENT SYSTEM HAS BEEN DESIGNED TO ADDRESS GROUNDWATER THAT HAS TVOC CONCENTRATIONS GREATER THAN 5 µg/L IN THE UPPER 20 FEET OF THE SURFICIAL AQUIFER AND GROUNDWATER BELOW THE UPPER 20 FEET OF THE SURFICIAL AQUIFER THAT HAS TVOC CONCENTRATIONS GREATER THAN 50 µg/L.
6. PROJECT VOCS ARE VOCS THAT MAY BE RELATED TO FORMER GRUMMAN HISTORICAL ACTIVITIES. NON-PROJECT VOCS ARE VOCS THAT ARE NOT RELATED TO FORMER GRUMMAN ACTIVITIES BUT HAVE BEEN DETECTED IN THE SITE AREA. PLEASE REFER TO THE REPORT TABLES FOR LISTS OF PROJECT AND NON-PROJECT VOCS.
7. REFER TO TABLE 7 FOR PUMPING RATES OF REMEDIAL WELLS.

OPERABLE UNIT 3
ONCT SYSTEM
BETHPAGE, NEW YORK

CROSS SECTION D-D' SHOWING TVOCs IN GROUNDWATER AND DIRECTION OF VERTICAL GROUNDWATER FLOW THIRD QUARTER 2018

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FIGURE
10

CITY:SYRACUSE-NY DIV/GROUP:ENV DB:A.SANCHEZ LD:ALS PIC:(Opt) PM:(Recd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
CTB:(Opt) STYLE:ARCADIS.ctb SCHD:BEM 360 Docs\NORTHROP GRUMMAN\DO 3 Regional Groundwater\20178\NT001498.34TM\01-DWG\NOC-CU3-3QTR-SECT_DD.dwg LAYOUT: 10 SAVED: 3/19/2019 9:30 AM ACADVER: 23.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 3/19/2019 9:46 AM
BY: SANCHEZ, ADRIAN PROJECTNAME: ----
XREFS: IMAGES:
X-BDR-EL
X-ONSITE-BASE SITE

APPENDIX A

Well Construction Information and Environmental Effectiveness Monitoring Program

Appendix A-1
Well Construction Information and Environmental Effectiveness Monitoring Program
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

Well ID [1,2]	Well Diameter (inches)	Depth to Screen Top (ft bls)	Depth to Screen Bottom (ft bls)	Screen Length (ft)	Well Depth (ft)	Well Materials	Water Levels [3]	Monitoring Activity: Water Quality [4] VOC	Monitoring Activity: Water Quality [4] Cd/Cr	Monitoring Activity: Water Quality [4] Fe/Mn
Monitoring Wells										
BCPMW-1	2	50	65	15	65	Sch. 40 PVC	Quarterly	Baseline	Baseline	--
BCPMW-2	2	60	75	15	75	Sch. 40 PVC	Quarterly	Baseline	Baseline	Baseline
BCPMW-3	2	59	74	15	74	Sch. 40 PVC	Quarterly	Baseline	Baseline	Baseline
BCPMW-4-1	4	45	65	20	70	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	Baseline
BCPMW-4-2	4	68.5	83.5	15	88.5	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	Baseline
BCPMW-4-3	4	115	125	10	130	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	Baseline
BCPMW-5-1	4	50	65	15	70	Sch. 80 PVC/SS	Quarterly	Baseline	Baseline	Baseline
BCPMW-6-1	4	88.5	98.5	10	103.5	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
BCPMW-6-2	4	133	143	10	148	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
BCPMW-7-1	4	90	100	10	105	Sch. 40 PVC	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
B24MW-2	2	54	74	20	74	PVC	Quarterly	Baseline/Annual	Baseline	--
B24MW-3	2	55	70	15	70	PVC	Quarterly	Baseline/Annual	Baseline	--
B30MW-1	2	57	72	15	72	PVC	Quarterly	Baseline/Annual	Baseline	--
MW-200-1	4	85	95	10	100	Sch. 40 PVC/SS	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
MW-201-1	4	70	80	10	85	Sch. 40 PVC/SS	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
MW-202-1	4	125	135	10	140	Sch. 40 PVC/SS	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
MW-203-1	4	103	113	10	118	Sch. 40 PVC/SS	Quarterly	Baseline/Semiannual [5]	Baseline/Annual	--
Remedial Wells [6]										
RW-01	8	108	128	20	134	Sch. 80 PVC/SS	Quarterly	Baseline/Quarterly	Baseline/Annual	--
RW-02	6	84	104	20	104	Steel/SS	Quarterly	Baseline/Quarterly	Baseline/Annual	--
RW-03	8	84	104	20	107	Sch. 80 PVC/SS	Quarterly	Baseline/Quarterly	Baseline/Annual	--
RW-04	8	110	130	20	133	Sch. 80 PVC/SS	Quarterly	Baseline/Quarterly	Baseline/Annual	--

Appendix A-1
Well Construction Information and Environmental Effectiveness Monitoring Program
Bethpage Park Groundwater Containment System
Operable Unit 3 (Former Grumman Settling Ponds)
Bethpage, New York

Well ID [1,2]	Well Diameter (inches)	Depth to Screen		Screen Length (ft)	Well Depth (ft)	Well Materials	Water Levels [3]	Monitoring Activity		
		Top (ft bls)	Bottom (ft bls)					Water Quality [4]		
								VOC	Cd/Cr	Fe/Mn
Piezometers										
PZ-01a	2	60	65	5	68	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-01b	1	80	85	5	88	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-01c	1	130	135	5	138	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-02a	2	60	65	5	68	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-02b	1	80	85	5	85	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-02c	1	130	135	5	138	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-03	1	80	85	5	88	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-04	1	80	85	5	88	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-05a	2	65	70	5	74	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-05b	1	110	115	5	117	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-06a	2	65	70	5	72	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-06b	1	90	95	5	97	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-07a	2	65	70	5	72	Sch. 40 PVC/SS	Quarterly	--	--	--
PZ-07b	1	113	118	5	120	Sch. 40 PVC/SS	Quarterly	--	--	--

Notes:

(1) Water samples will be collected and analyzed in accordance with the method and procedures described in the Sampling and Analysis Plan (SAP).
(2) Approximate locations of the wells and piezometers in the OU3 Bethpage Park Groundwater Containment System are shown in Figure 4.
(3) Water levels will be measured in all wells/piezometers during the baseline monitoring event. Water levels will be measured in accordance with the procedures presented in the SAP.
(4) VOC: VOC analyses per NYSDEC ASP 2005, Method OLM 4.3 (prior to September 1, 2014) and per USEPA Method 8260C (after September 1, 2014).
Cd/Cr: Cadmium and Chromium using USEPA Method 6010C.
Fe/Mn: Iron and Manganese using USEPA Method 6010C, both total and dissolved.
(5) Semiannual wells will be monitored annually after Year 1.
(6) Some of the analyses listed here are also covered in the Remedial System Sampling Program (Table B-1) and some of the analyses and/or frequencies may be modified based on review of short-term and/or long-term testing results. (e.g. the Cd/Cr sampling frequency was changed from quarterly to annually in 2011).

Abbreviations/Units:

NYSDEC	New York State Department of Enviromental Conservation	ft	Feet
--	Not applicable	ft bls	Feet below land surface
Sch. 40 PVC	Schedule 40 polyvinyl chloride	ft ms	Feet relative to mean sea level
Sch. 80 PVC	schedule 80 polyvinyl chloride		
SS	Stainless steel		
Steel	Low carbon steel		
USEPA	United States Environmental Protection Agency		
VOC	Volatile Organic Compound		

APPENDIX B

Compliance and Performance Program

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Sample Location/Instrument [1]	Parameter (Method) [2]	Frequency			
		Short-Term [3]		Long-Term [4]	SCADA Data Acquisition
		(First month)	(Five month period following first month)		
Water Samples [5]					
Remedial Well 1 (WSP-1)	VOCs (USEPA Method 8260C)	Bi-Weekly	Quarterly	Quarterly	NA
	Iron (USEPA 6010C)	Bi-Weekly	Annually	Annually	NA
	Cadmium and Chromium (USEPA 6010C)[11]				
	---		Annually	Annually	NA
	1,4-Dioxane (USEPA Method 522)[12]		Quarterly	Quarterly	NA
Remedial Well 2 (WSP-2)	VOCs (USEPA Method 8260C)	Bi-Weekly	Quarterly	Quarterly	NA
	Iron (USEPA 6010C)	Bi-Weekly	Annually	Annually	NA
	Cadmium and Chromium (USEPA 6010C)[11]				
	---		Annually	Annually	NA
	1,4-Dioxane (USEPA Method 522)[12]		Quarterly	Quarterly	NA
Remedial Well 3 (WSP-3)	VOCs (USEPA Method 8260C)	Bi-Weekly	Quarterly	Quarterly	NA
	Iron (USEPA 6010C)	Bi-Weekly	Annually	Annually	NA
	Cadmium and Chromium (USEPA 6010C)[11]				
	---		Annually	Annually	NA
	1,4-Dioxane (USEPA Method 522)		Quarterly	Quarterly	NA
Remedial Well 4 (WSP-4)	VOCs (USEPA Method 8260C)	Bi-Weekly	Quarterly	Quarterly	NA
	Iron (USEPA 6010C)	Bi-Weekly	Annually	Annually	NA
	Cadmium and Chromium (USEPA 6010C)[11]				
	---		Annually	Annually	NA
	1,4-Dioxane (USEPA Method 522)[12]		Quarterly	Quarterly	NA
Air Stripper Influent (WSP-5)	VOCs (USEPA Method 8260C)	1-hr [6]; Days 1, 3, & Weekly	Monthly	Quarterly	NA
	Iron (USEPA 6010C)	1-hr [6]; Days 1, 3, & Weekly	Monthly	Quarterly	NA
	1,4-Dioxane (USEPA Method 522)[12]		Quarterly	Quarterly	NA
Air Stripper Effluent (WSP-6)	Iron (USEPA 6010C)	1-hr [6]; As Needed	As Needed	As Needed	NA
Plant Effluent (WSP-7)	**VOCs (USEPA Method 8260C and 624)[13]**	**1-hr [6]; Days 1, 3, & Weekly**	**Monthly**	**Monthly**	NA
	Iron (USEPA 6010C)	**1-hr [6]; Days 1, 3, & Weekly**	**Monthly**	**Monthly**	NA
	Mercury (USEPA 7470A) [7]	**1-hr [6]; Days 1, 3, & Weekly**	**Monthly**	**Monthly**	NA
	1,4-Dioxane (USEPA Method 522)[12]		**Monthly**	**Monthly**	NA
	Cadmium and Chromium (USEPA 6010C)[11]				
	---		**Quarterly**	**Quarterly**	NA
	Total Nitrogen, Nitrate + Nitrite (USEPA Method 353.2)[13]		**Monthly**	**Monthly**	NA
	TKN (USEPA Method 351.2)[13]		**Monthly**	**Monthly**	NA
	pH (field) [8]	**1-hr [6]; Days 1, 3, & Weekly**	**Monthly**	**Monthly**	NA
	and		Quarterly	Quarterly	NA
Air Samples [9] [10]					
Air Stripper Effluent/ECU-1 Influent (VSP-1)	VOCs (TO-15 Modified)	Monthly	Monthly	Quarterly	NA
ECU-1 Effluent/ECU-2 Influent (VSP-2)	VOCs (TO-15 Modified)	As Needed	As Needed	As Needed	NA
ECU-2 Effluent/ECU-3 Influent (VSP-3)	VOCs (TO-15 Modified)	As Needed	As Needed	As Needed	NA
ECU-3 Effluent/ECU-4 Influent (VSP-4)	VOCs (TO-15 Modified)	As Needed	As Needed	As Needed	NA
Total Effluent (VSP-5)	**VOCs (TO-15 Modified)**	**Monthly**	**Monthly**	**Quarterly**	NA

See notes on last page.

ARCADIS Design & Consultancy for natural and built assets

Sample Location/Instrument[1,2]	Parameter (Method)[3]	Frequency			
		Short-Term[4]		Long-Term[5]	SCADA Data Acquisition
		(First month)	(Five month period following first month)		
Water Flow Measurements					
Remedial Well RW-1 (FT - 110)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-2 (FT - 120)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-3 (FT - 130)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-4 (FT - 140)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Combined Influent (FR - 200)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
System Effluent (FT-700)	Flow rate (gpm + total gal.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Air Flow Measurements					
Air Stripper Effluent (FT-500)	Flow rate (SCFM)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Water Pressure Measurements					
Remedial Well RW-1 (PT - 110)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-2 (PT - 120)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-3 (PT - 130)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Remedial Well RW-4 (PT - 140)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Air Stripper Effluent (PT-700)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Weekly	Weekly	Continuously
Air Temperature & Relatively Humidity Measurements					
Air Stripper Effluent (TT-500)	Temperature	Weekly	Weekly	Weekly	Continuously
ECU Mid-Train (TI-503)	Temperature	Weekly	Weekly	Weekly	NA
Effluent (TI-603)	Temperature	Weekly	Weekly	Weekly	NA
Air Pressure Measurements					
Air Stripper Effluent (PT-500)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	Continuously
ECU #1 Influent (PI-501)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	NA
ECU #2 Influent (PI-502)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	NA
ECU #3 Influent (PI-601)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	NA
ECU #4 Influent (PI-602)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	NA
System Effluent (PI-603)	Pressure (i.w.g.)	(Daily -1st week) Weekly	Monthly	Quarterly	NA

See notes on last page.

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Abbreviations, Notes and Units:

(1) Refer to Figure 3 of this Operation, Maintenance, & Monitoring (OM&M) Report and Appendix E of the Groundwater IRM OM&M Manual (OM&M Manual (ARCADIS 2009)) for a diagram showing referenced sample locations and measurement points.
(2) Parameters/methods may be modified based on review of short-term and/or long-term testing results. Parameters shown in **Bold** indicate parameters that require NYSDEC notification/approval prior to change in monitoring schedule.
(3) Short-term schedule is tentative. Modification may be required/recommended based on the results of start-up and performance testing.
(4) Long-term schedule is tentative. Modification may be required/recommended based on the results of short-term testing or water quality trends.
(5) Water samples will be collected in accordance with the methods described in the Sampling and Analysis Plan, which is included as Appendix A of the OM&M Manual (ARCADIS 2009). Samples will be analyzed in accordance with the methods and procedures described in the Sampling and Analysis Plan.
(6) Per NYSDEC request, a 1-hr pilot test was performed during system shake-down. The 1-hr pilot test samples were also analyzed for Mercury (Hg).
(7) Per the interim treated effluent (water) discharge criteria provided in the NYSDEC letter dated March 19, 2009, select samples were analyzed for Mercury (Hg).
(8) As authorized by the NYSDEC, the pH monitoring frequency was reduced from weekly to monthly beginning on February 8, 2010.
(9) Air samples collected and analyzed in accordance with methods described in the Sampling and Analysis Plan, which is included as Appendix A of the OM&M Manual (ARCADIS 2009).
(10) Additional air samples will be collected to help calculate media usage rates and to help determine media changeout frequencies.
(11) Cadium and Chromium analyses are part of the Environmental Effectiveness Monitoring Program (Table A-1) and the original discharge permit application. They are included here for consistency.
(12) As of July 11 2018, 1,4-Dioxane is analyzed per USEPA Method 8270-SIM-CLLE.
(13) As of November 2017, plant effluent was analyzed for permit equivalency Volatile Organic Compounds (VOCs) using USEPA Method 624; Total Nitrogen is calculated as the sum of Nitrogen, (Nitrate+Nitrite) and Total Kjeldahl Nitrogen (TKN), (CAS number: 14797-55-8, 14797-65-0, and 7727-37-9, respectively) by USEPA Methods 353.2 and 351.2, respectively; Total Iron and Manganese using USEPA Method 200.7.

ECU	Emissions Control Unit
EPA	U.S. Environmental Protection Agency
NA	Not Applicable
—	Not Required
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operation, Maintenance and Monitoring
SCADA	Supervisory Control And Data Acquisition
SPDES	State Pollutant Discharge Elimination System
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds (refer Tables D-3 and D-5 in the Quality Assurance Project Plan (QAPP) (Appendix D of the OM&M Manual (ARCADIS 2009)) for the analyte lists for aqueous and air samples, respectively)
gal	gallons
gpm	gallons per minute
i.w.g.	inches water gauge

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