Appendix **A**

Groundwater Model Results

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Study Area Feasibility Study

Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York
NYSDEC Site # 1-30-003A

November 10, 2010

Appendix A

Groundwater Model Results (Simulation of Groundwater Flow and Contaminant Transport)

Operable Unit 3 (Former Grumman Settling Ponds),
Bethpage, New York
NYSDEC Site # 1-30-003A

ARCADIS

Robert Porsche
Senior Hydrogeologist

Douglas Smolensky
Technical Expert

Appendix A
Groundwater Model Results

(Simulation of Groundwater Flow and Contaminant Transport)

Prepared for:
Northrop Grumman Systems Corporation

Prepared by:
ARCADIS of New York, Inc.
Two Huntington Quadrangle
Suite 1S10
Melville
New York 11747
Tel 631.249.7600
Fax 631.249.7610

Our Ref.:
NY001496.0811.MODB7

ARCADIS

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1. Introduction

The purpose of this report is to document the methods and results of groundwater modeling using the Northrop Grumman Regional Groundwater Flow and Transport Model (Model) to evaluate remedial alternatives for the Operable Unit 3 (OU3) Study Area Feasibility Study (FS).

The modeling effort consisted of the following tasks:

1. The existing model was updated with current data for pumpage and discharge rates and total volatile organic compound (TVOC) distribution. The model was also updated to reflect dual domain advection-diffusion TVOC mass transport.

2. Particle tracking (advective transport) analysis was conducted to identify public supply and remedial wells potentially impacted by TVOCs in the Study Area and to evaluate various remedial alternatives designs.

3. Solute transport modeling was conducted to predict TVOC mass loading and peak concentrations at potentially impacted wells and proposed remedial (extraction) wells under different remedial alternatives and to evaluate changes over time in the extent of the TVOC-impacted groundwater.

2. Model Description

The groundwater flow model developed by ARCADIS for Northrop Grumman Systems Corporation (Northrop Grumman) was constructed to include the area consisting of the Northrop Grumman, Naval Weapons Industrial Reserve Plant (NWIRP), and Occidental Chemical Corporation/RUCO Polymer facilities (termed in this FS as the regional area of TVOC-impacted groundwater) and the surrounding areas. The model was used to evaluate groundwater flow patterns in the Bethpage, New York area and evaluate the movement of volatile organic compound (VOC)-impacted groundwater present beneath and downgradient of the industrial areas described above. The United States Geological Survey (USGS) Modular Three-Dimensional Groundwater Flow Model (MODFLOW) (McDonald and Harbaugh, 1988) was used to simulate the groundwater system in terms of head distribution and groundwater flow. The areal extent of the flow model domain is presented in **Figure A-1**. The current model consists of 351 Rows, 328 Columns, and 12 Layers, for a total of 1,381,526 model cells. **Figure A-2** shows the model layer configuration. **Figure A-3** depicts the maximum current extent of regional TVOC-impacted groundwater.

The model, originally constructed in 1995, underwent several revisions. A complete description of the original model's construction, calibration, sensitivity analysis and revisions through April 2003 is provided in a separate report entitled, "Comprehensive Groundwater Model Report, U.S. Naval Weapons Industrial Reserve Plant/Northrop Grumman, Bethpage, New York." (ARCADIS G&M, Inc. 2003). The 2003 model report describes how hydrologic stresses, induced by industrial pumpage and discharge of water to recharge basins created complex three-dimensional flow patterns that altered the movement of groundwater. The 2003 model report also documents the use of the model for specific contaminant transport modeling efforts. The New York State Department of Environmental Conservation (NYSDEC) has accepted the model to support the development of remedial scenarios associated with the regional TVOC plume.

2. Modeling Approach

2.1 Model Updates

The model was updated in 2008/2009 using current data for pumping and discharge rates and TVOC distribution. The model was also updated to reflect dual domain advection-diffusion mass transport. Revisions to the model grid (i.e., number of layers, number of cells, or grid cell size) were not required for the model update. A continuing source of TVOCs to groundwater was not represented in the model because the source was assumed to be remediated as part of baseline conditions and the Groundwater Interim Remedial Measure (IRM) (also referred to as the Site IRM on figures in this appendix and the Study Area FS) is actively preventing migration of VOC-impacted groundwater from the Park to the Study Area.

2.1.1 Pumping and Recharge Rates

During the model update process, the simulated rates for pumpage and recharge by currently operating remedial systems were confirmed, based on data provided by Northrop Grumman and the Navy. Current remedial systems consist of pump-and-treat systems for the Northrop Grumman Main Facility (Main Facility), the Navy GM-38 Area, and Northrop Grumman's OU3 Groundwater IRM, including discharge of treated water to recharge basins and one injection well. Current remedial well pumpage and recharge rates are summarized in **Table A-1**. In addition to confirming proper representation of pumping stresses associated with active remedial systems, average pumping rates were computed for each of the public water supply wells represented in the model for the period of 2004-2007.

2.1.2 Contaminant Mass Distribution

The regional area of TVOC-impacted groundwater represented in the model was updated using water quality data from vertical profile borings (VPBs) completed during the Site Area and Study Area remedial investigations (RIs), and average water quality data for the 2004-2007 period for groundwater monitoring wells (or more recent data for wells installed after 2007), public supply wells, and remedial wells. Data from VPBs installed by the Navy from 1999 through 2003 were also used. The density of data used to define the TVOC distribution in the model was evaluated and determined to be appropriate to evaluate the remedial alternatives.

Based on the current understanding of the area of regional TVOC-impacted groundwater (i.e., initial conditions), the estimated VOC mass in groundwater is approximately 147,000 pounds (lbs).

2.1.3 Dual Domain Mass Transport

Based on review and evaluation of existing data collected from monitoring and remedial wells throughout the region, it was evident that dual domain processes were a significant factor in solute transport within the aquifer system. The solute transport model used for this modeling effort was therefore updated to simulate dual domain mass transport. The solute transport model used is an ARCADIS-modified version of MT3DMS, a multi-species version of the MT3D software that accommodates dual-domain advection-diffusion mass transport.

Dual domain mass transport refers to a method of modeling solute transport that represents two domains of solute mass: the mobile and immobile domains. Under dual domain conditions within an aquifer system, as contaminant mass flows through mobile pore spaces, a portion of the contaminant mass partitions due to concentration gradients from the mobile groundwater (contained within coarser grained, more permeable sediments) into the immobile groundwater (contained within finer grained, less permeable sediments). This partitioning of mass between pore spaces occurs through diffusion driven by concentration gradients between sediments of higher and lower permeability. As a contaminant plume continues to migrate through the aquifer and mobile phase concentrations begin to decline, mass partitions back into the mobile phase from the immobile phase, resulting in greater plume persistence over time compared to the single domain condition. A dual-domain representation of the aquifer system offers the benefit of a more realistic mass transport simulation, in that the “storage” of contaminant mass in the immobile pore space within the aquifer can be

represented and simulated, resulting in a higher degree of confidence in the prediction of concentration trends in wells over time.

The model requires three input parameters to simulate dual domain conditions:

- The *mobile porosity* is a parameter that represents the porosity of aquifer zones of high hydraulic conductivity filled with mobile water (mobile domain) through which the majority of mass transport takes place via advection. For this evaluation, the mobile porosity assigned was 7.5% and remained unchanged following the sensitivity analysis discussed below.
- The *immobile porosity* is a parameter that represents the porosity of aquifer zones of low hydraulic conductivity filled with immobile or relatively stagnant water (immobile domain) through which the majority of the mass transport takes place via diffusion. For this evaluation, the immobile porosity assigned was 25% and remained unchanged following the sensitivity analysis discussed below.
- The *mass transfer coefficient* regulates the diffusion based rate of mass transfer between the immobile and mobile phases. For this evaluation, the mass transfer coefficient assigned was $1e^{-3}$ and remained unchanged following the sensitivity analysis discussed below. No other transport parameters were employed (e.g., retardation, chemical decay, etc.) in the simulations conducted for the Study Area FS.

A range for each input parameter value was selected based on literature values judged appropriate for the local hydrogeologic conditions and the ranges were evaluated using a sensitivity analysis to select final representative values for solute transport simulations (Payne 2008; Watson 2010).

The transport model's sensitivity to a range of transport parameter values was evaluated by completing a series of model runs. For the evaluation, a series of 30-year transport simulations were conducted, as follows:

- Mobile porosity increased from 7.5% to 10% (total porosity held constant at 32.5% [for this simulation immobile porosity was set to 22.5%]),
- Mobile porosity decreased from 7.5% to 5% (total porosity held constant at 32.5% [for this simulation immobile porosity was set to 27.5%]),
- Mass transfer coefficient increased from $1e^{-3}$ to $1e^{-2}$, and

- Mass transfer coefficient decreased from $1e^{-3}$ to $1e^{-4}$. Note that none of the simulations were run with more than one variable.

In general, the model is insensitive to changes in the mass transfer coefficient or adjustments to the mobile to immobile porosity ratio over the ranges described above. Therefore, slight differences between the model input values and actual field data, if any, would only slightly change the overall model results and not affect the conclusions reached in the FS.

2.2 Particle Tracking Analysis

Particle tracking analysis (also referred to as advective transport modeling in this report) was undertaken to evaluate the advective movement (i.e., the bulk movement of a contaminant particle at a velocity equal to the mean flow velocity in the aquifer) of TVOC-impacted groundwater. The particle tracking analyses were performed using a three-dimensional particle tracking code called MODPATH (Pollock 1989). MODPATH, was developed by the USGS and was designed to use output generated directly from MODFLOW. MODPATH computes the paths for imaginary "particles" of water moving through the simulated groundwater system until the particles reach a boundary, a sink, or satisfies some other termination criterion.

Particle tracking analysis was conducted for two purposes:

- To identify wells that are potentially impacted by Study Area TVOC-impacted groundwater; and
- To evaluate and assist in the design of remedial alternatives (e.g., remedial well locations, pumping rates, and current and predicted capture zones).

2.2.1 Potentially Impacted Wells

Based on the findings of the RI, remedial wells and public supply wells were the only potential exposure points identified. The analysis of wells potentially impacted by Study Area TVOC-impacted groundwater was conducted under baseline groundwater flow-field conditions (i.e., with all groundwater remedial systems operating at their designed rates and all public supply wells operating at their average rates). All particles were released within the TVOC-impacted groundwater in the Study Area over all layers of the groundwater model, except Layer 12 (the deepest layer, where no contamination has been detected). All particles were then permitted to move under the influence of the current groundwater flow-field to their respective endpoints (such as pumping wells

or the limits of the model domain), with no time limit placed on their migration. A given well was characterized as potentially impacted if the model-predicted particle flow path(s) reached that well. Computer-generated particle tracking figures are difficult to interpret visually; therefore, a simplified representation of the particle tracking results is presented in **Figure A-4**. Results of the baseline particle tracking concluded:

- Particles from the Study Area TVOC-impacted groundwater did not migrate beyond the most downgradient Bethpage Water District (BWD) well (i.e., Plant 5).

- The following wells are potentially impacted from TVOCs in Study Area groundwater: BWD Wells 4-1, 4-2, 5-1, and 6-2; Main Facility remedial system Wells 17 18, and 19; and the GM-38 Area remedial wells.

Main Facility remedial system Wells 17 and18, the GM-38 Area wells, and BWD Well 6-2 were not retained for further evaluation because these wells are addressed under the Operable Unit 2 (OU2) record of decision (ROD), which provides for the protection of public health and the environment and because the wells are relatively distant from or shallow relative to VOCs in the Study Area. Although the OU2 ROD also addresses Well 19, this well was retained for further evaluation because it is a key component of the remedial alternatives evaluated in this FS, given the extent of its zone of capture into the Study Area.

2.2.2 Remedial Alternatives Analysis

Development of the remedial alternatives evaluated for this FS involved modifying the existing groundwater flow field through the addition of one or more wells (remedial [extraction] wells and, for some alternatives, injection wells). The alternatives were developed to maintain and achieve the Study Area remedial action objectives (RAOs), which are:

- Prevent exposure to Site-Area related VOCs in groundwater within the Study Area (Off-Site) and Reduce VOC mass in Study Area groundwater to the extent feasible.

The methodology used for the remedial alternatives analyses is as follows:

- Review the Study Area VOC-impacted groundwater distribution and place a new remedial well(s) in locations of highest known VOC concentrations,

- Review available land and property ownership to identify reasonably accessible well locations and adjust well locations, as needed,
- Utilize particle tracking in an iterative manner to optimize the groundwater removal and recharge locations, and
- Following optimization, perform solute transport simulations to quantify time vs. concentration trends and VOC mass removal at the remedial well(s) and potentially impacted wells (see Section 2.3 for details).

Each of the remedial alternatives evaluated for this FS involved modifying the existing groundwater flow field through the addition of one or more remedial wells and reduction of the pumping rate of existing Remedial Well 19 under Remedial Alternatives 3 through 5 (see **Table A-1** for details).

Under all remedial alternatives evaluated, the capture zones (developed based on the particle tracking for each alternative) of the Groundwater IRM and Main Facility remedial system were maintained.

2.3 Solute Transport

As a final step in the modeling effort, solute transport analysis was undertaken to evaluate contaminant mass removal and future concentrations under each alternative. The MT3D computer code (Zheng and Wang 1999) updated to MT3DMS and modified further by ARCADIS (to account for dual domain conditions – see above) was selected for solute-transport modeling. MT3DMS was chosen for this modeling application because it provides a means to simulate the transport processes that occur within the Long Island aquifer system and because it was designed to be used in conjunction with MODFLOW.

The purpose of the solute transport modeling was to evaluate:

- TVOC mass loadings at potentially impacted wells and proposed remedial wells,
- peak TVOC concentrations at potentially impacted wells and proposed remedial wells, and
- changes over time in the extent of the Study Area TVOC-impacted groundwater,

Once the initial conditions were established, the solute transport model was run for a period of 30 years for each remedial alternative. The output was processed and graphics were developed to depict the results of the model runs.

3. Simulation of Remedial Alternatives

Groundwater flow, particle tracking, and contaminant transport modeling were used to evaluate potential remedial alternatives for addressing TVOC-impacted groundwater in the Study Area. Five alternatives were retained for detailed modeling evaluation:

1. Alternative 2 – Baseline/Continued Action - Source removal at Site Area, maintain operation of existing groundwater remediation systems (Groundwater IRM, OU2 systems, and GM-38 Area), and BWD wellhead protection

2. Alternative 3 – Alternative 2, plus install one new remedial well (Well RW-21); send treated discharge back to the Main Facility, to Northrop Grumman's South Basins.

3. Alternative 4 – Alternative 2, plus install two new remedial wells (Wells RW-20 and RW-21), send treated discharge back to the Main Facility to Northrop Grumman's South Basins.

4. Alternative 5 – Alternative 2, plus operate BWD Plant 4 wells (BWD Wells 4-1 and 4-2) as remedial wells (and replace Plant 4 capacity) and install one new remedial well (Well RW-20); send treated discharge back to the Main Facility, to Northrop Grumman's South Basins, Arthur Avenue recharge basin, and new shallow injection wells.

5. Alternative 6 – Alternative 2, plus install five new remedial wells (Wells RW-22 through RW-26) and seven pairs of injection wells; send treated discharge to the seven pairs of new injection wells.

The remedial alternatives listed above are focused on addressing the Study Area TVOC-impacted groundwater. The configuration of the remedial alternatives evaluated is summarized in **Table A-1,** and shown on **Figures A-19 through A-23**, which are also presented in the main section of this FS and are provided in this appendix for completeness. Alternative 1, No Action, was not modeled because it assumes that the currently operating groundwater remedies are shut down, including public supply

wellhead treatment. Alternative 2 was modeled and presents baseline conditions, as described above, for comparison to the other alternatives developed.

4. Modeling Results

The results of modeling are illustrated by the following three types of figures:

- **Figures A-5 through A-10**, which are maps showing the maximum extent and concentration of TVOCs (regardless of depth) in the Study Area for initial conditions and at the end of the 30 year simulation for each remedial alternative.
- **Figures A-11 through A-15**, which are time versus concentration graphs for the proposed remedial wells and existing Remedial Well 19 for each remedial alternative.
- **Figures A-16 through A-18**, which are time versus concentration graphs for BWD Wells 4-1, 4-2, and 5-1 depicting the effect of each remedial alternative in reducing TVOC concentrations in the wells.

Please realize that the vertical scale of TVOC concentrations shown on each graph varies by well.

4.1 Alternative 2 – Baseline/Continued Action

The results of the modeling of the baseline scenario are depicted on **Figures A-5, A-6, A-11, and A-16 through A-18.** The baseline scenario simulates the operation of the existing Main Facility Groundwater Remedial System, the GM-38 Area Remedial System, the Groundwater IRM, and public supply wells within the model domain. Of the 147,000 pounds (lbs) of TVOCs estimated to be present in the regional area of TVOC-impacted groundwater, the model predicts that approximately 100,000 lbs are extracted under this alternative after 30 years (**Table A-2)**.

Relative to the starting distribution of TVOCs in the Study Area (**Figure A-5**), while the general overall extent of the TVOCs remains relatively unchanged after 30 years, TVOCs in the Study Area have migrated slightly to the south. The model-predicted TVOC concentrations after 30 years under Alternative 2 are reduced from greater than 10,000 µg/L to below 3,000 µg/L in the core of the impacted area (**Figure A-6**).

The model-predicted TVOC concentrations at Main Facility Remedial Well 19 are shown on **Figure A-11** and indicate that the well reaches a peak TVOC concentration

of nearly 500 µg/L within 10 years, and declines to less than 300 µg/L after about 25 years.

Model-predicted TVOC concentrations at BWD Wells 4-1, 4-2 and 5-1, are shown on **Figures A-16 through A-18**, respectively, under baseline conditions and indicate peak TVOC concentrations at Wells 4-1, 4-2 and 5-1 of approximately 400 µg/L, 130 µg/L, and 180 µg/L, respectively.

4.2 Alternative 3 – Alternative 2, Plus One New Remedial Well.

The results of the modeling of Alternative 3 are depicted on **Figures A-7, A-12, and A-16 through A-18.** For this alternative, proposed Remedial Well RW-21 is pumping at 1,000 gpm (**Table A-1**) (see **Table A-3** for details for the proposed remedial wells). At the conclusion of the 30-year transport simulation, approximately 104,000 lbs of TVOCs will be extracted under this alternative **(Table A-2)**.

Figure A-7 shows the maximum extent of TVOCs in groundwater under Alternative 3 after 30 years. Relative to the starting distribution of TVOCs in the Study Area, based on model predictions, Alternative 3 results in the elimination of TVOCs in excess of 500 µg/L from migrating south of Well RW-21. The model-predicted TVOC concentrations have been reduced from greater than 10,000 µg/L to below 3,000 µg/L in the core of the impacted area.

The model-predicted TVOC concentrations at the Main Facility Well 19 (and RW-21) under Alternative 3 are shown on **Figure A-12**. The graph suggests that the peak TVOC concentration at proposed Remedial Well RW-21 will be approximately 10,000 µg/L at startup, will be below 2,000 µg/L within two years, and may approach asymptotic levels in about 20 years.

Model-predicted TVOC concentrations at BWD Wells 4-1, 4-2 and 5-1, are shown on **Figures A-16 through A-18**, respectively. The model-predicted peak TVOC concentrations under Alternative 3 at Wells 4-1, 4-2 and 5-1 are approximately 275 µg/L, 75 µg/L, and 15 µg/L, respectively. These peak values are reduced in all three wells compared to the baseline scenario by approximately 30, 40, and 90 percent, respectively.

4.3 Alternative 4 – Alternative 2, Plus Two New Remedial Wells.

The results of the modeling of Alternative 4 are depicted on **Figures A-8**, **A-13**, and **A-16 through A-18**.

For this alternative, proposed Remedial Wells RW-20 and RW-21 are pumping (**Table A-1**). At the conclusion of the 30-year transport simulation, approximately 111,500 lbs of TVOCs will be extracted under this alternative **(Table A2)**.

Figure A-8 shows the maximum extent of TVOCs in groundwater under Alternative 4 after 30 years. Relative to the starting distribution of TVOCs in the Study Area, based on model predictions, Alternative 4 results in the elimination of TVOCs in excess of 500 µg/L from migrating south of Well RW-21. The model-predicted TVOC concentrations have been reduced from greater than 10,000 µg/L to below 3,000 µg/L in the core of the impacted area.

The model-predicted TVOC concentrations at Well 19 and proposed Remedial Wells RW-20 and RW-21 under Alternative 4 are shown on **Figure A-13**. The graph suggests that the peak TVOC concentrations at Wells RW-20 and RW-21 will be approximately 7,500 and 10,000 µg/L, respectively. Wells RW-20 and RW-21 may approach asymptotic levels in about 20 years.

Model-predicted TVOC concentrations at BWD Wells 4-1, 4-2 and 5-1, are shown on **Figures A-16 to A-18**, respectively. The model-predicted peak TVOC concentrations under Alternative 4 at Wells 4-1, 4-2 and 5-1 are approximately 320 µg/L, 82 µg/L, and 12 µg/L, respectively. These peak values are reduced in all three wells compared to the baseline scenario by approximately 20, 40, and 90 percent, respectively.

4.4 Alternative 5 – Alternative 2, Plus Operate BWD Plant 4 as Remediation System, plus One New Remedial Well (RW-20).

The results of the modeling of Alternative 5 are depicted on **Figures A-9, A-14,** and **A-18**.

For this alternative, new Remedial Well RW-20 and the BWD Plant 4 well field operate as remedial wells. For this alternative, BWD Wells 4-1 and 4-2 are re-purposed as remedial wells. As shown in **Table A-2**, at the conclusion of the 30-year transport simulation, the model predicts that approximately 112,000 lbs of TVOCs will be extracted under this alternative.

Figure A-9 shows the maximum extent of TVOCs in groundwater under Alternative 5 after 30 years. A comparison to initial conditions shows that the overall extent of the TVOCs are similar, albeit slightly further south, and the extent of TVOC-impacted groundwater at concentrations greater than 500 µg/L has been significantly reduced. Also, the model predicted TVOC concentrations have been reduced from greater than 10,000 µg/L to below 3,000 µg/L in the core of the impacted area.

The model-predicted TVOC concentrations at Well RW-20 are shown on **Figure A-14**. The model-predicted peak TVOC concentration under Alternative 5 at Well RW-20 is approximately 7,500 µg/L. Well RW-20 and BWD Well 4-2 may approach an asymptote at approximately 20 years. BWD Well 4-1 does not appear to reach asymptotic levels in the 30-year modeling timeframe (**Figure A-14**).

The model-predicted TVOC concentrations at BWD Well 5-1 under Alternative 5 are shown on **Figure A-18**. The model-predicted peak TVOC concentration under Alternative 5 at BWD Well 5-1 is approximately 17 µg/L, which is reduced compared to the baseline scenario by approximately 90 percent.

4.5 Alternative 6 – Alternative 2, Plus Five New Remedial Wells

The results of the modeling of Alternative 6 are depicted on **Figures A-10,** and **A-15** through **A-18.**

For this alternative, proposed Remedial Wells RW-22, -23, -24, -25 and -26 are pumping. At the conclusion of the 30-year transport simulation, the model predicts that approximately 139,000 pounds of TVOCs will be extracted (**Table A-2**).

Figure A-10 shows the maximum extent of TVOCs in groundwater under Alternative 6 after 30 years. A comparison to initial conditions shows that based on model predictions, Alternative 6 would result in a substantial reduction in the overall extent of the TVOC plume and the maximum TVOC concentration remaining in the aquifer after 30 years; peak TVOC concentrations remaining in the aquifer are less than 50 µg/L.

The model-predicted TVOC concentrations at Well 19 and RW-22 through RW-26 under Alternative 6 are shown on **Figure A-15**. The graph suggests that the peak TVOC concentrations at proposed Remedial Wells RW-22 through RW-26 range from 3,800 to 8,600 µg/L. Collectively, Wells RW-22 through RW-26 appear to reach Standards, Criteria, and Guidance values (SCGs) at an average time of approximately 20 years.

Model-predicted TVOC concentrations at BWD Wells 4-1, 4-2 and 5-1, are shown on **Figures A-16 to A-18**, respectively. The model-predicted peak TVOC concentrations under Alternative 6 at Wells 4-1, 4-2 and 5-1 are approximately 285 µg/L, 80 µg/L, and 5 µg/L, respectively. These peak values are reduced in all three wells compared to the baseline scenario by approximately 30, 40, and 98 percent, respectively.

5. References

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Table A-1. Comparison of Remedial Well Pumpage/Recharge by Alternative, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Basin/ Well ID	Alternative 2/Baseline Pumping Rate (gpm)	Alternative 3 (1) Pumping Rate (gpm)	Alternative 4 (1) Pumping Rate (gpm)	Alternative 5 (1)(2) Pumping Rate (gpm)	Alternative 6 (3) Pumping Rate (gpm)
Northrop Grumman Main Facility Remedial Wells/Systems					
Tower 96	-1540	-1540	-1540	-1540	-1540
Well 17	-1003	-1003	-1003	-1003	-1003
Well 18	-603	-603	-603	-603	-603
Well 19	-700	-200	-200	-200	-700
Plant 5 Recharge Basins	511	511	511	511	511
South Recharge Basins	2929	3430	3430	2929	2929
Groundwater IRM Wells					
RW-1	-30	-30	-30	-30	-30
RW-2	-75	-75	-75	-75	-75
RW-3	-75	-75	-75	-75	-75
RW-4	-30	-30	-30	-30	-30
Former Plant 3 Recharge Basin	210	210	210	210	210
GM-38 Area Remedial Wells					
GM38 RW-1	-800	-800	-800	-800	-800
GM38 RW-3	-300	-300	-300	-300	-300
Injection Well IW-1	300	300	300	300	300
Arthur Avenue Recharge Basin	800	800	800	800	800
Proposed Wells/Existing Basins					
Remedial Well RW-20	--	--	-500	-500	--
Remedial Well RW-21	--	-1000	-500	--	--
South Basins	--	1000 (4)	1000 (4)	500 (4)	--
Re-purposed BWD 4-1	--	--	--	-1550	--
Re-purposed BWD 4-2	--	--	--	-1150	--
Arthur Ave Basin/Injection Wells	--	--	--	2700	--
Remedial Well RW-22	--	--	--	--	-300
Injection Well IN-22-1	--	--	--	--	150
Injection Well IN-22-2	--	--	--	--	150
Remedial Well RW-23	--	--	--	--	-800
Injection Well IN-23-1	--	--	--	--	400
Injection Well IN-23-2	--	--	--	--	400
Remedial Well RW-24	--	--	--	--	-1140
Injection Well IN-24	--	--	--	--	1140
Remedial Well RW-25	--	--	--	--	-900
Injection Well IN-25	--	--	--	--	900
Remedial Well RW-26	--	--	--	--	-900
Injection Well IN-26	--	--	--	--	900

Notes:

Pumping rates are negative for remedial wells and positive for injection wells.

"--" means the remedial well is not operating under that alternative.

(1) Water from new remedial wells RW-20 and RW-21 is conveyed to Northrop Grumman's Main facility Tower 102 System for treatment and returned to the aquifer via the South Recharge Basins.

(2) Water from BWD Plant 4 is discharged to the Arthur Ave Basin and shallow injection wells.

(3) Water from the new remedial wells is treated via local remedial systems and returned to aquifer via local pairs of injection wells.

(4) This rate is already included in the rate to the South Recharge Basins under the Northrop Grumman Main Facility Remedial Wells/Systems heading.

(5) Approximately 400 gpm of pumped water treated by Tower 96 is supplied to Calpine and not recharged to the on-site recharge basins.

Table A-2. Summary of Model-Predicted TVOC Mass Removed from Groundwater at the End of the 30 Year Period of Operation, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remedial Alternative No.	Remedial Alternative Description	TVOC Mass Removed (lbs)
2	Baseline/Continued Action	100,000
3	Alternative 2, plus RW-21	104,000
4	Alternative 2, plus RW-20 and RW-21	111,500
5	Alternative 2, plus RW-20 and BWD Plant 4	112,000
6	Alternative 2, plus Return to Pre-Disposal Conditions	139,000

Notes: Mass removal values rounded down to the nearest 500 pounds.

Definitions:

BWD Bethpage Water District

TVOC Total Volatile Organic Compounds

Table A-3. Proposed Remedial Well Details, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

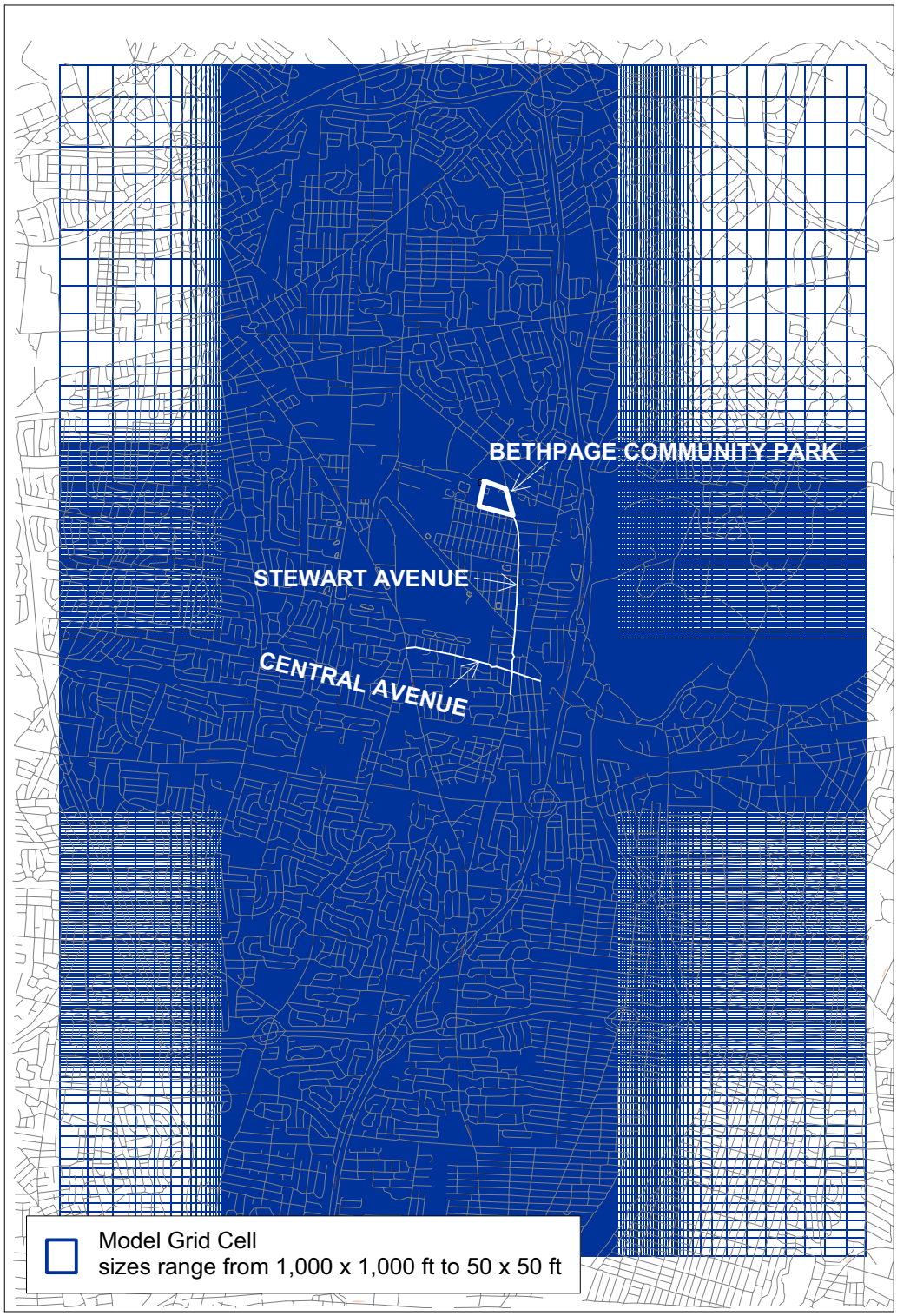
Remedial Well ID	Model Layer	Estimated Land Surface Elevation (msl) [1]	Elevation of Well Bottom (ft msl)	Depth to Bottom of Well (ft bls)
RW-20	8	100	-415	515
RW-21	9	95	-520	615
RW-22	2, 3, and 4	118	-91	209
RW-23	4, 5, and 6	115	-233	348
RW-24	6, 7, and 8	109	-409	518
RW-25	7, 8, and 9	109	-488	597
RW-26	9 and 10	95	-560	655

Note:

(1) Land surface elevations estimated from USGS Topographic Quadrangle maps (Levittown, Huntington, Freeport, Amityville).

Definitions:

RW: Remedial Well
ft bls: Feet below land surface
ft msl: feet relative to mean sea level
USGS United States geological Survey



N

Scale in feet

0 6,000 12,000 18,000 24,000

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GROUNDWATER MODEL DOMAIN
STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

PROJECT MANAGER	DEPARTMENT MANAGER
MFW	DAS
DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
NY001496.1110 .00001	A-1

Model Layer	Elevation (ft msl)	Depth Below Land Surface (ft)	Aquifer
Land Surface	115	0	
1			Upper Glacial
	20	95	
2			Upper Magothy Transition Zone
	-11	126	
3			
	-42	157	
4			
	-91	206	
5			
	-145	260	
6			
	-228	343	
7			Middle Magothy
	-319	434	
8			
	-398	513	
9			
	-476	591	
10			
	-519	634	
11			Basal Magothy
	-563	678	
12			
	-669	784	
Raritan Confining Unit			

Notes:

1. Layer elevation/thickness are specific to a location immediately south of Bethpage Community Park.
2. Layers slope and some layers thicken to south/southeast

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

MODEL LAYERS

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FIGURE
A-2

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Melville-NY\ACTIVE\01496\0811\F\00D41\00006\A-2 Model Layer.dwg LAYOUT: A-2 SAVED: 2/24/2011 4:41 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 4/6/2011 5:50 PM BY: SANCHEZ, ADRIAN
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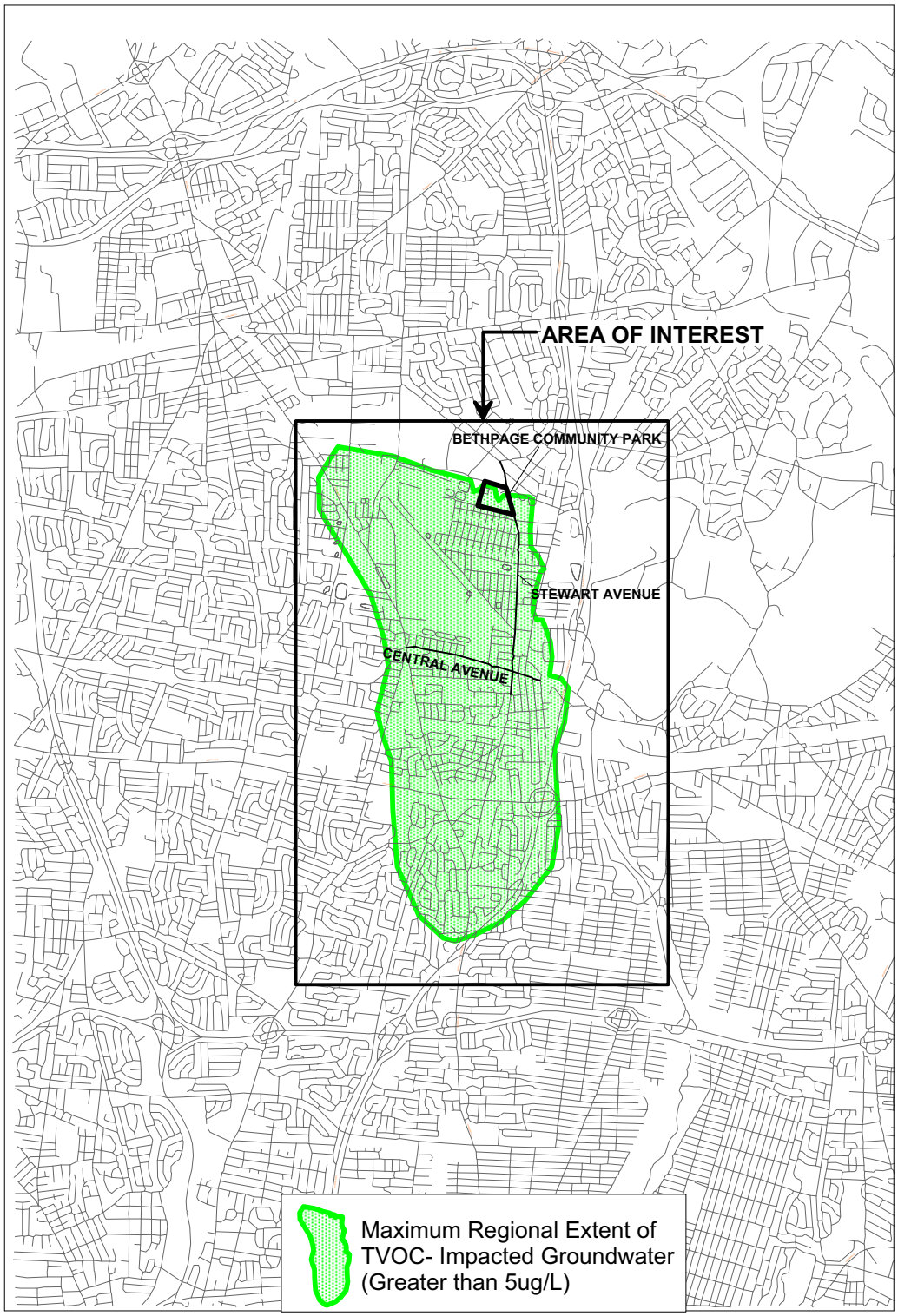

Scale in feet

0 6,000 12,000 18,000 24,000

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CURRENT EXTENT OF REGIONAL TVOC PLUME AND AREA OF INTEREST

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BETHPAGE, NEW YORK

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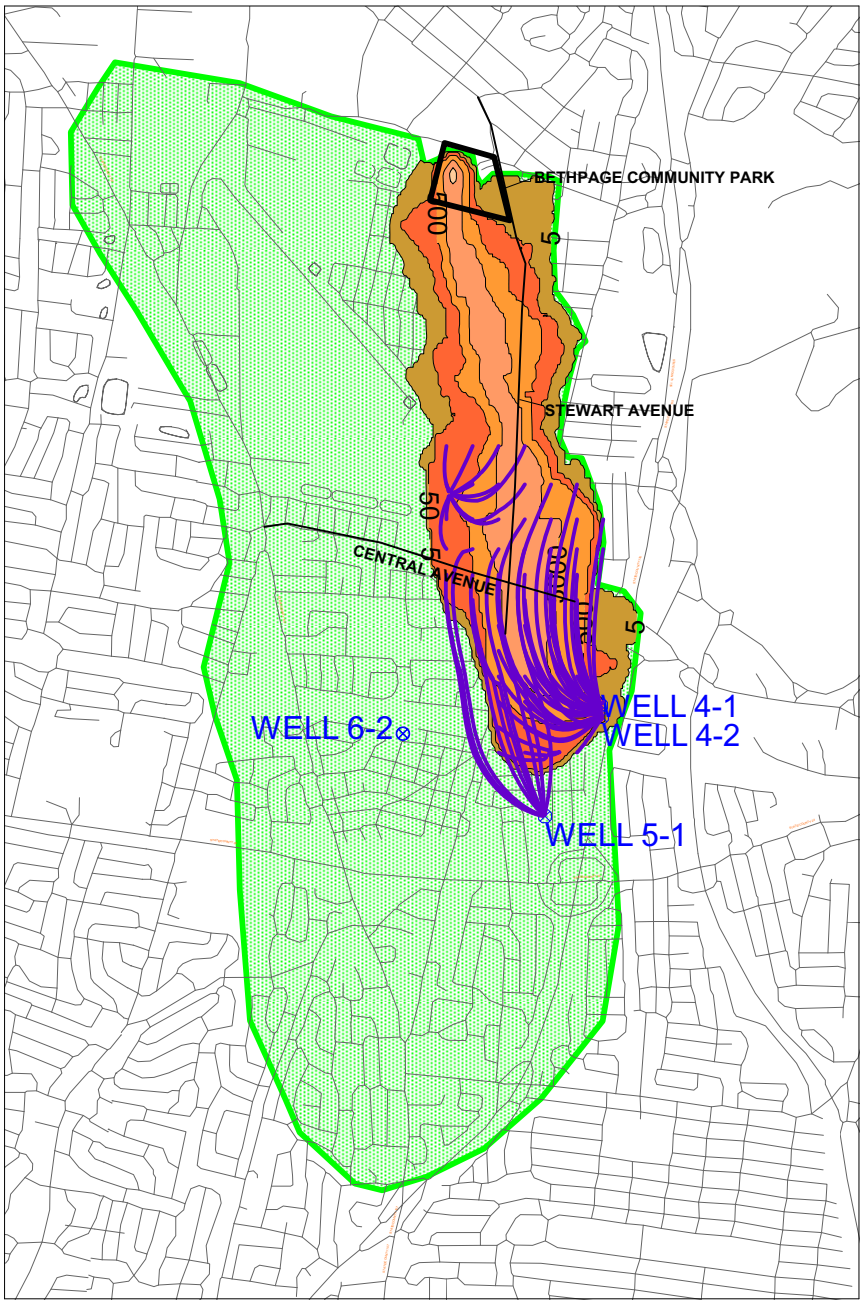
DRAFTER RP	CHECKED DAS
PROJECT NUMBER NY001496.1110 .00001	DRAWING NUMBER A-3



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Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

⊗ Well Location

STUDY AREA

- 5 ug/L
- 50 ug/L
- 500 ug/L
- 5,000 ug/L
- 50,000 ug/L

Particle Track

Particles Started Throughout Study Area
TVOC - Impacted Groundwater Model Layer 9
and Allowed to Migrate Under Baseline Conditions

TVOC - Total Volatile Organic Compounds

Scale in feet

0 3,000 6,000

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PARTICLE TRACKING
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PROJECT MANAGER	DEPARTMENT MANAGER
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DRAFTER	CHECKED
RP	DAS
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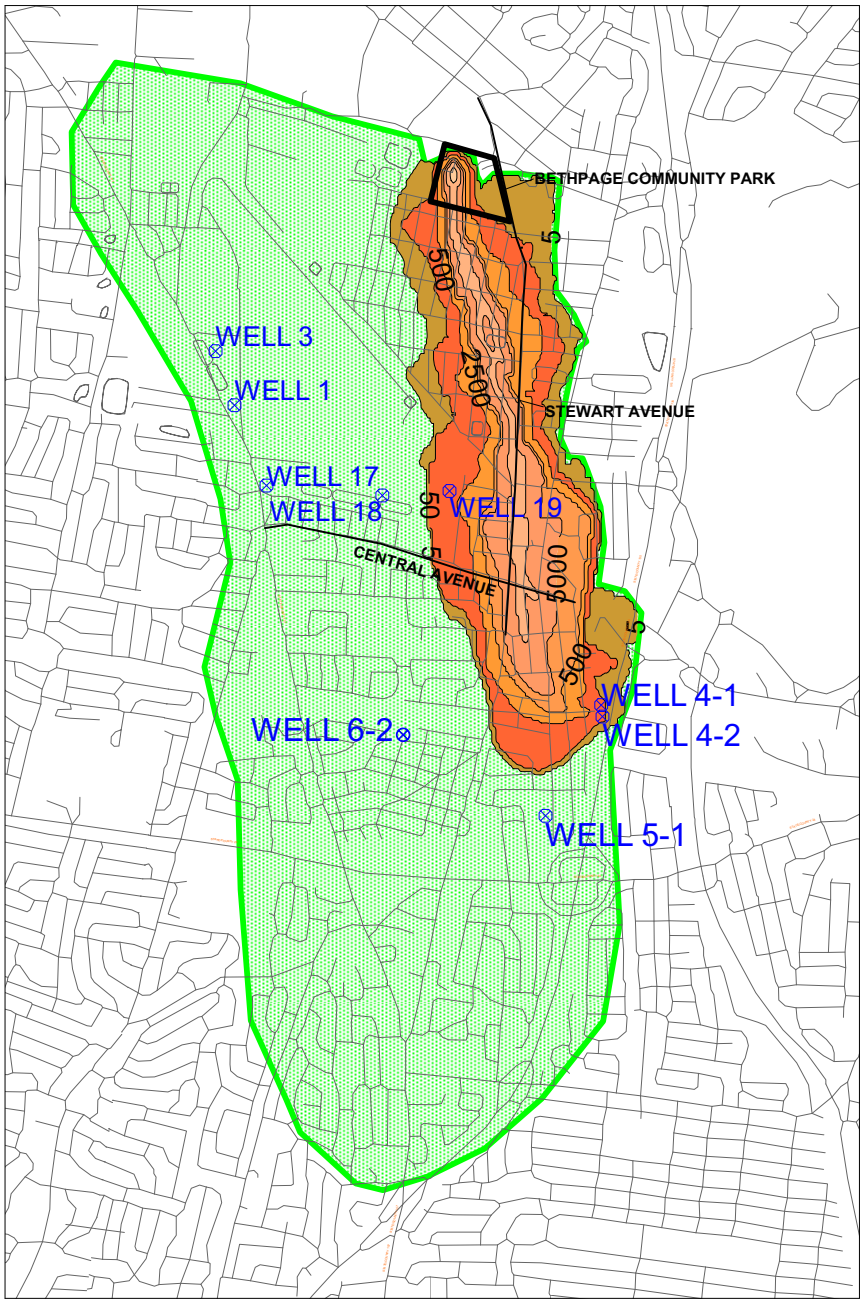

STUDY AREA

5 ug/L
50 ug/L
500 ug/L
2,500 ug/L
5,000 ug/L
10,000 ug/L
50,000 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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MAXIMUM CURRENT EXTENT OF TVOCS IN STUDY AREA GROUNDWATER – INITIAL CONDITIONS
STUDY AREA FEASIBILITY STUDY
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BETHPAGE, NEW YORK

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DRAFTER	CHECKED
RP	DAS
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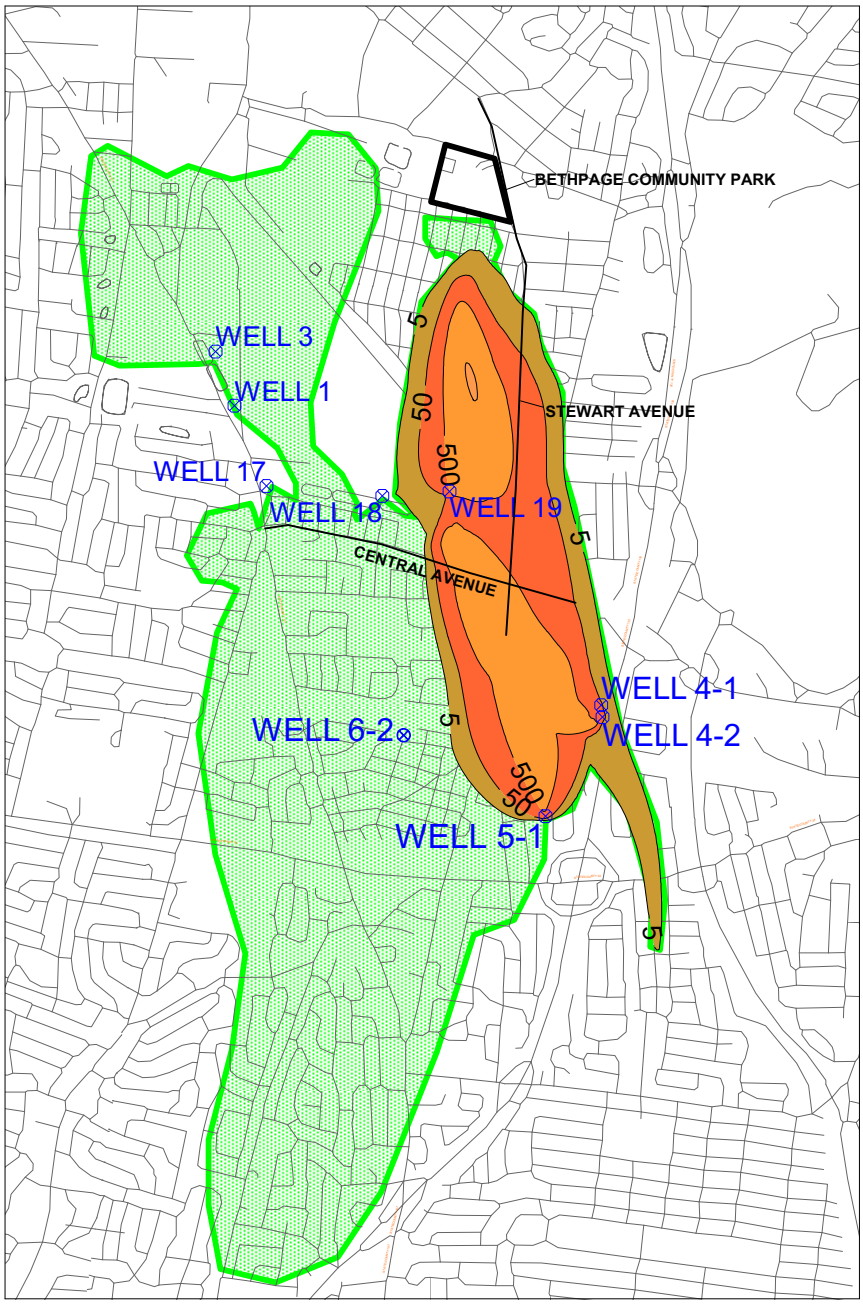

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STUDY AREA

5 ug/L

50 ug/L

500 ug/L

2,500 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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ALTERNATIVE 2 – BASELINE/CONTINUED ACTION
MAXIMUM EXTENT OF TVOCS IN STUDY AREA
GROUNDWATER AFTER 30 YEARS
STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION, OPERABLE UNIT 3
(FORMER GRUMMAN SETTLING PONDS), BETHPAGE, NEW YORK

PROJECT MANAGER	DEPARTMENT MANAGER
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DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
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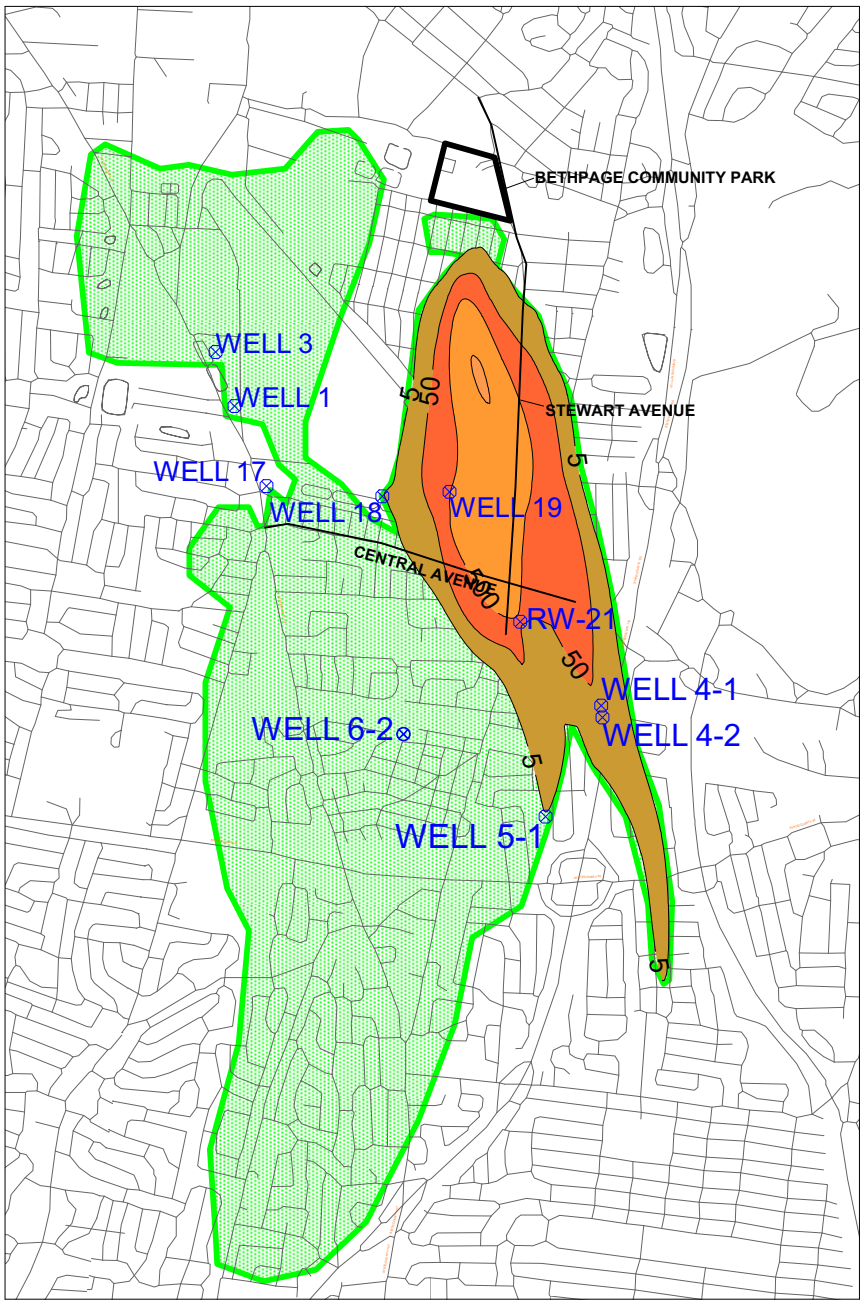

N

STUDY AREA

5 ug/L

50 ug/L

500 ug/L

2,500 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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ALTERNATIVE 3 – MAXIMUM EXTENT OF TVOCS IN STUDY AREA GROUNDWATER AFTER 30 YEARS
STUDY AREA FEASIBILITY STUDY
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PROJECT MANAGER	DEPARTMENT MANAGER
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DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
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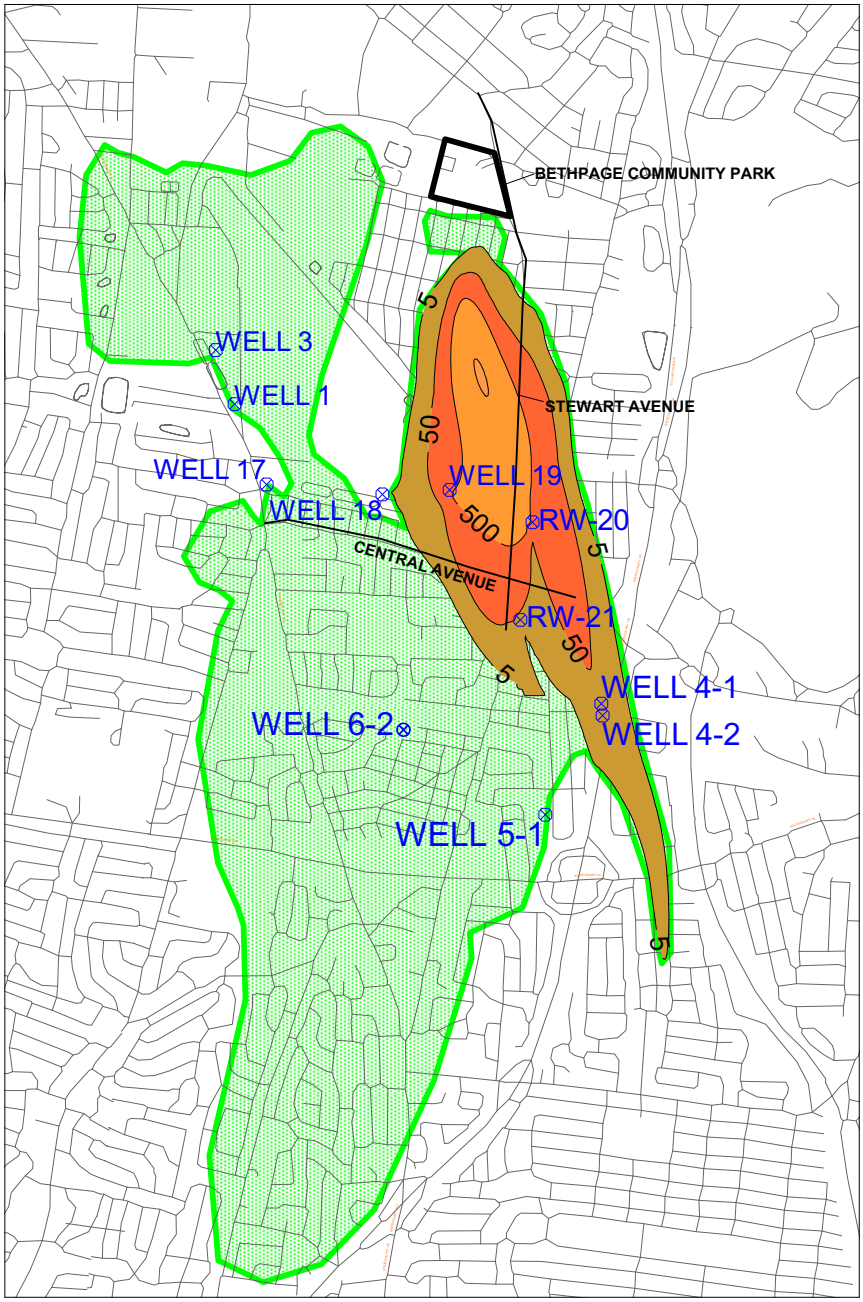

N

STUDY AREA

5 ug/L

50 ug/L

500 ug/L

2,500 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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ALTERNATIVE 4 – MAXIMUM EXTENT OF TVOCS IN STUDY AREA GROUNDWATER AFTER 30 YEARS
STUDY AREA FEASIBILITY STUDY
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BETHPAGE, NEW YORK

PROJECT MANAGER	DEPARTMENT MANAGER
MFW	DAS
DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
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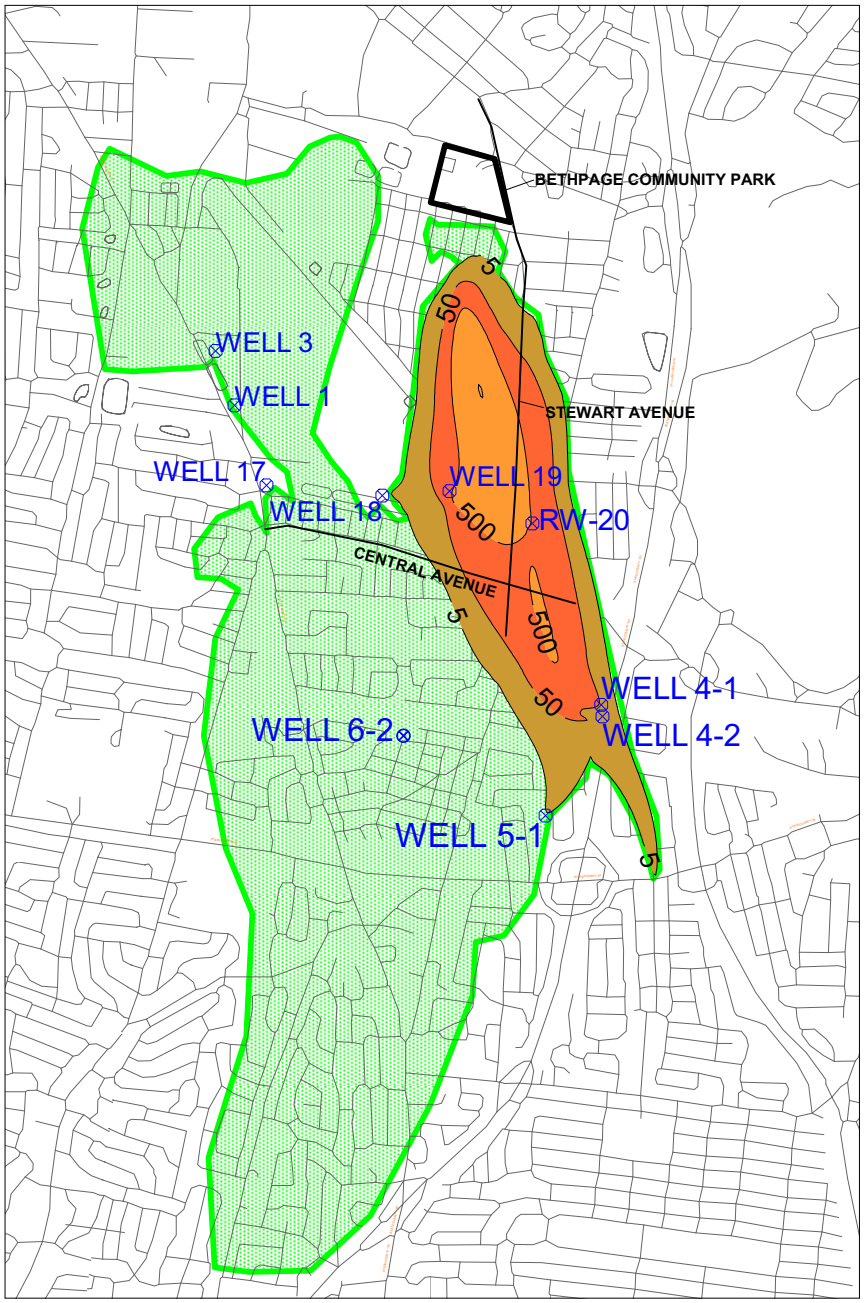

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STUDY AREA

5 ug/L

50 ug/L

500 ug/L

2,500 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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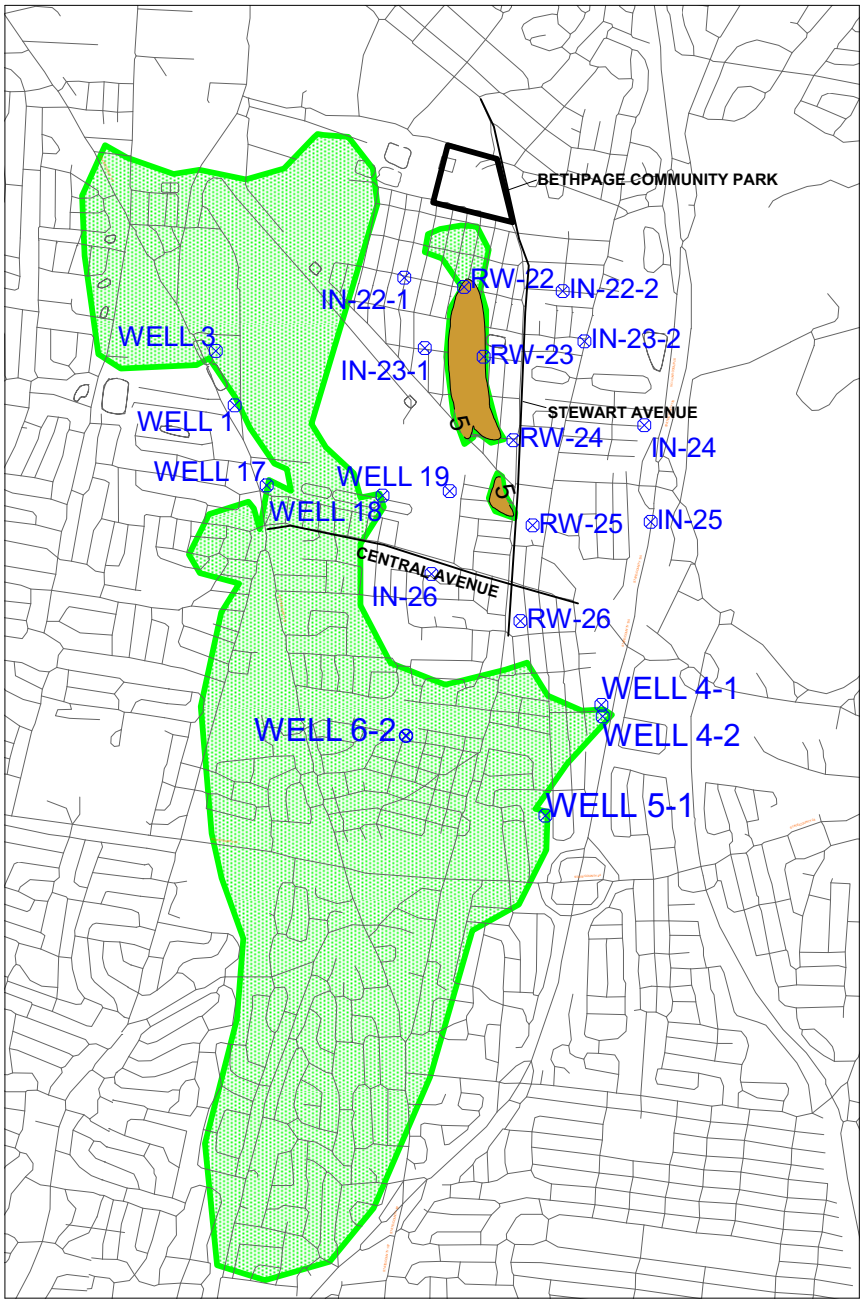
ALTERNATIVE 5 – MAXIMUM EXTENT OF TVOCS IN STUDY AREA GROUNDWATER AFTER 30 YEARS

STUDY AREA FEASBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

PROJECT MANAGER	DEPARTMENT MANAGER
MFW	DAS
DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
NY001496.1110 .00001	A-9



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STUDY AREA

5 ug/L

Maximum Regional Extent of TVOC - Impacted Groundwater (Greater than 5ug/L)

Scale in feet

0 3,000 6,000

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ALTERNATIVE 6 – MAXIMUM EXTENT OF TVOCS IN STUDY AREA GROUNDATER AFTER 30 YEARS
STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

PROJECT MANAGER	DEPARTMENT MANAGER
MFW	DAS
DRAFTER	CHECKED
RP	DAS
PROJECT NUMBER	DRAWING NUMBER
NY001496.1110 .00001	A-10

Figure A-11.Model-Predicted TVOC Concentrations in Existing Northrop Grumman Remedial Well under Alternative 2,
Study Area Feasibility Study,Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.

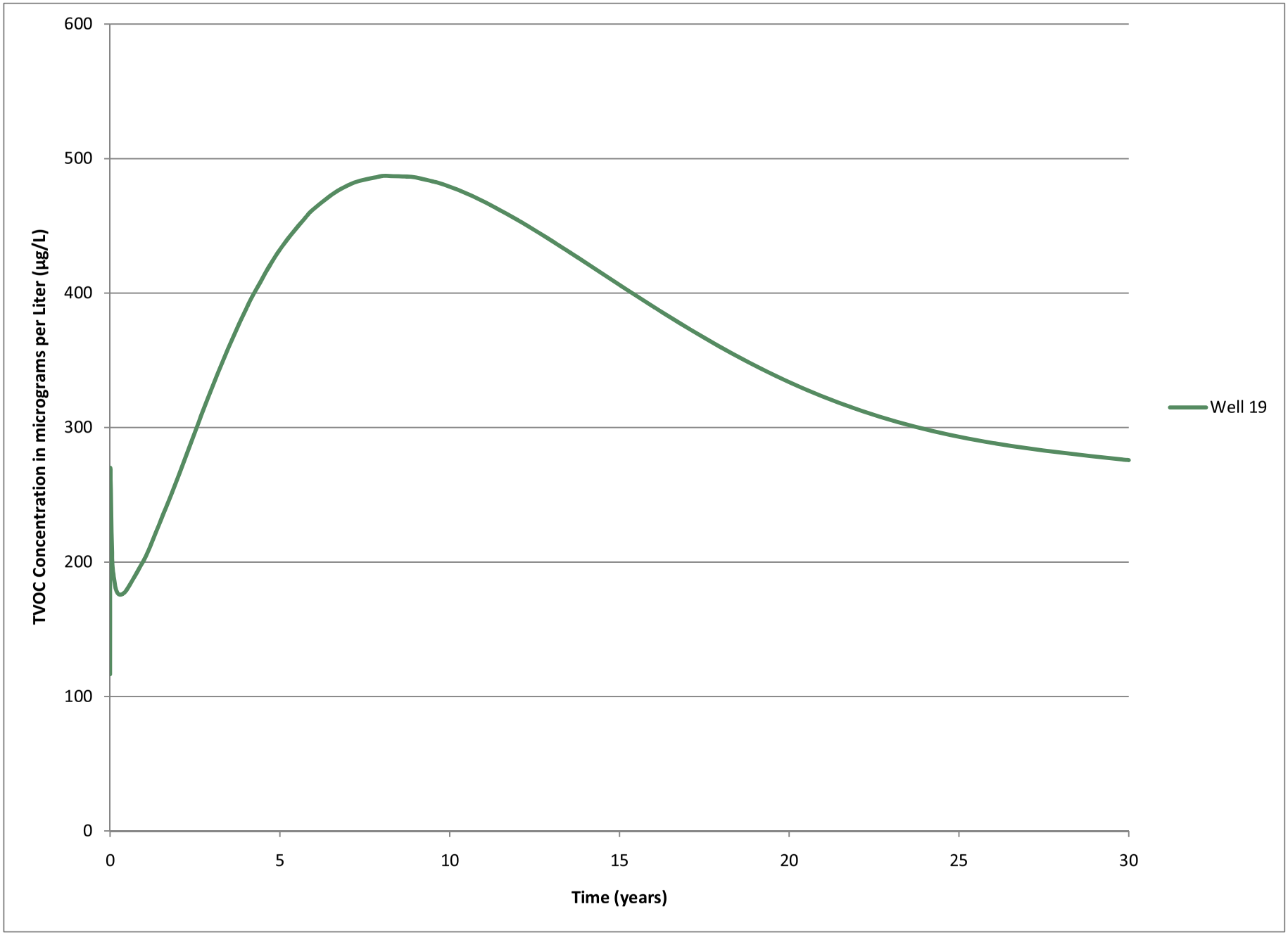

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Figure A-12.Model-Predicted TVOC Conc. in Existing and Proposed Northrop Grumman Remedial Wells under Alternative 3,
Study Area Feasibility Study,Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.

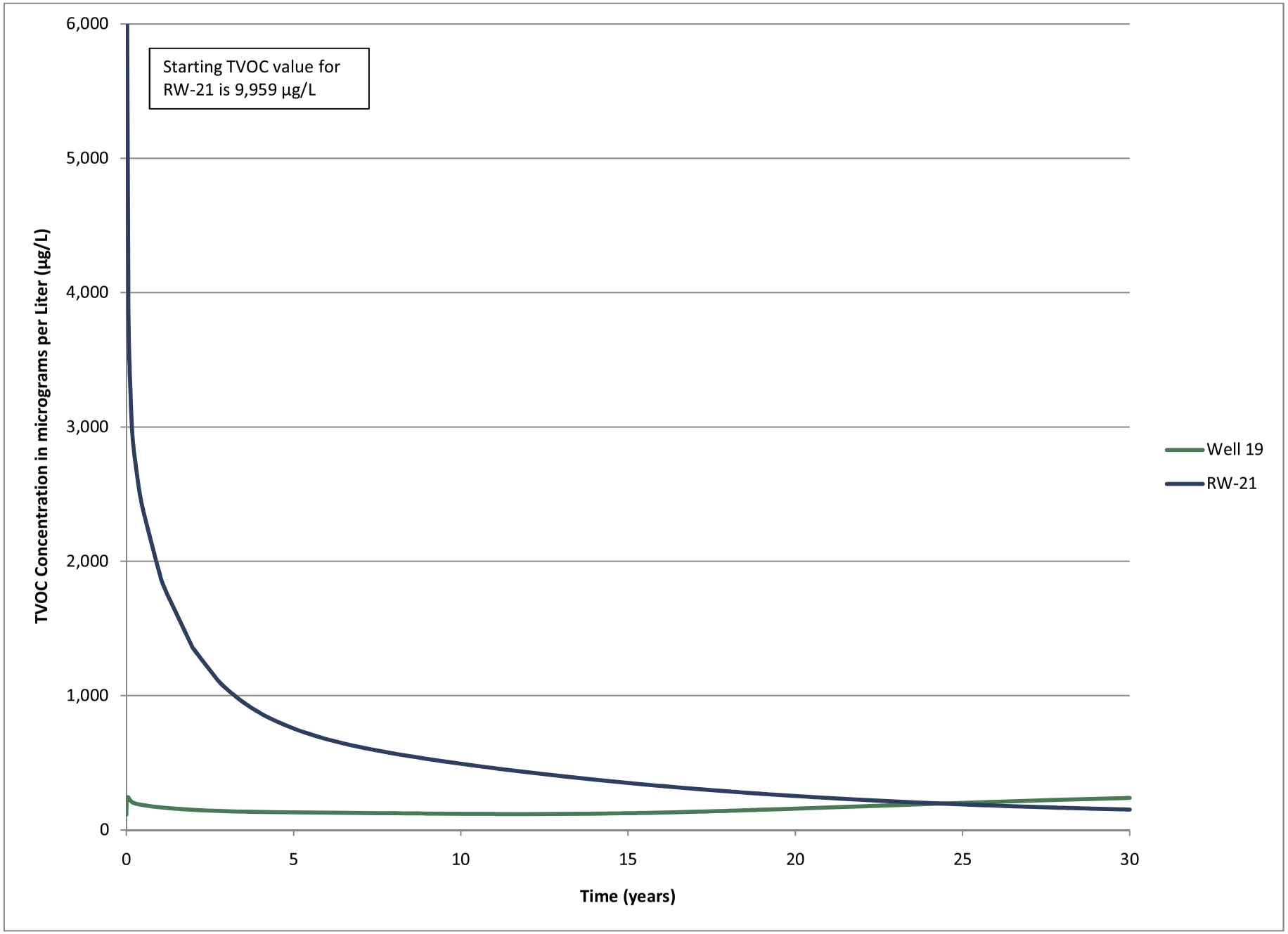

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Figure A-13.Model-Predicted TVOC Conc. in Existing and Proposed Northrop Grumman Remedial Wells under Alternative 4,
Study Area Feasibility Study,Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.

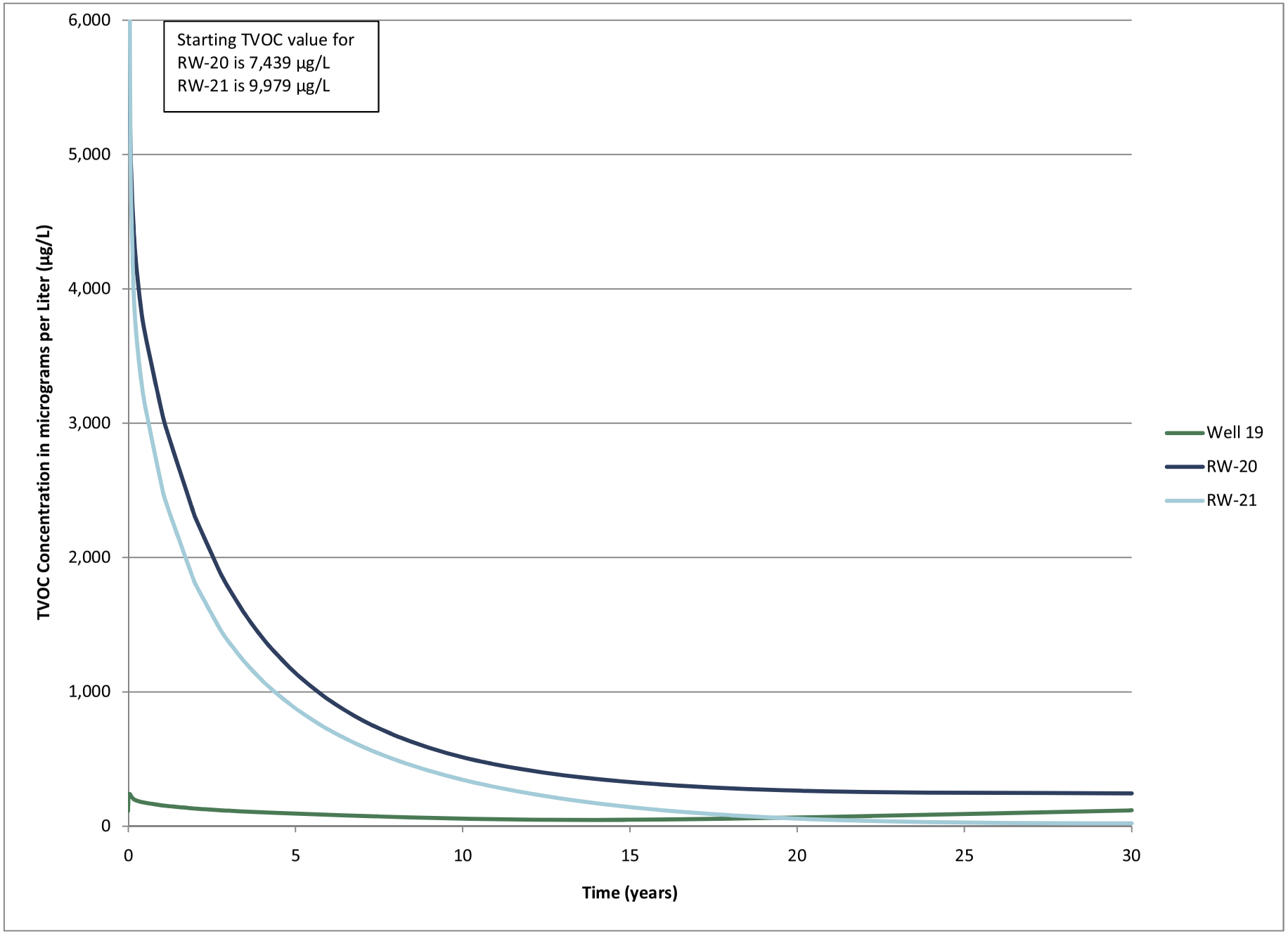

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Figure A-14.Model-Predicted TVOC Conc. in Existing and Proposed Northrop Grumman Remedial Wells under Alternative 5,
Study Area Feasibility Study,Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.

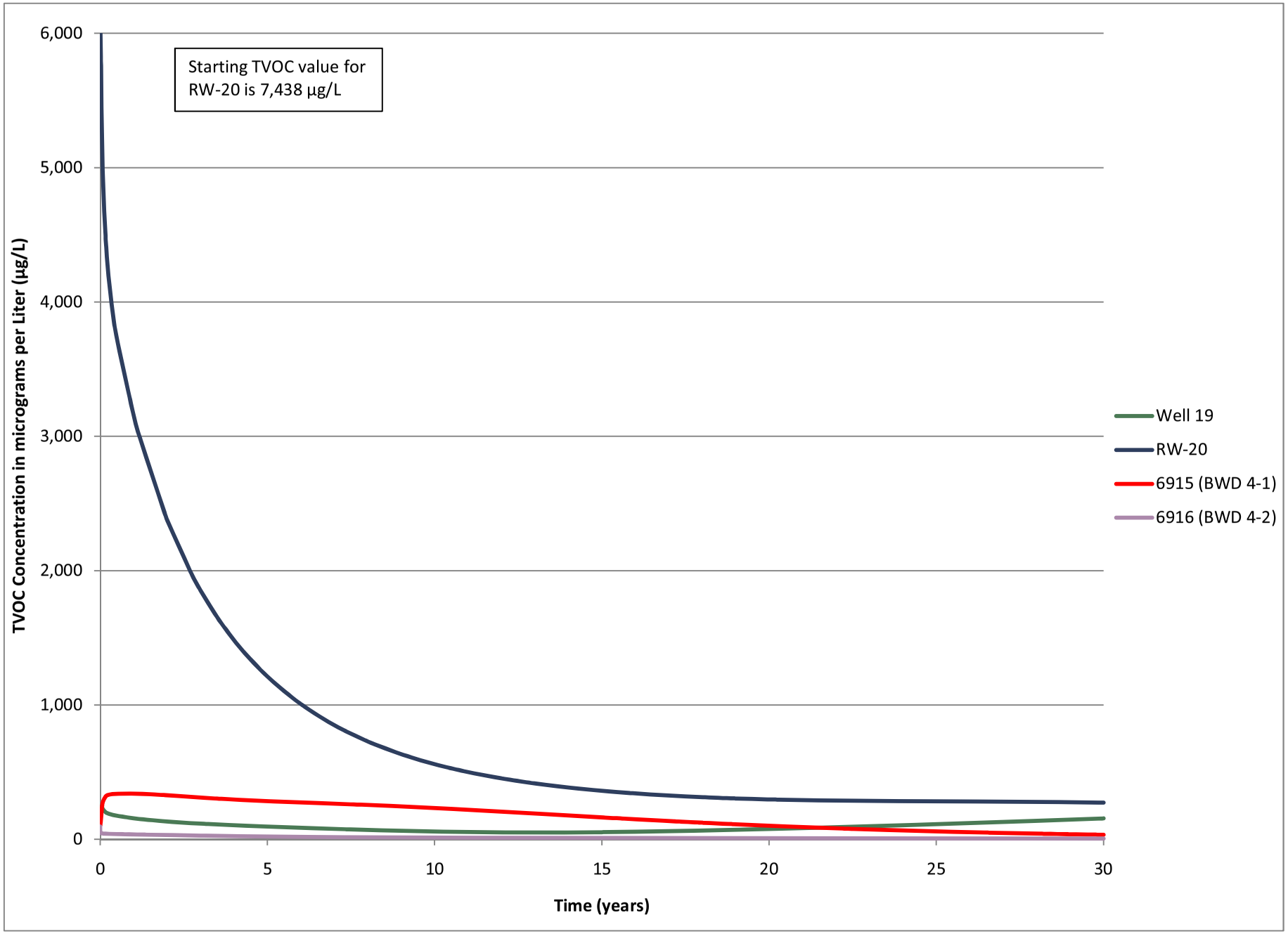

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Figure A-15.Model-Predicted TVOC Conc. in Existing and Proposed Northrop Grumman Remedial Wells under Alternative 6,
Study Area Feasibility Study,Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.

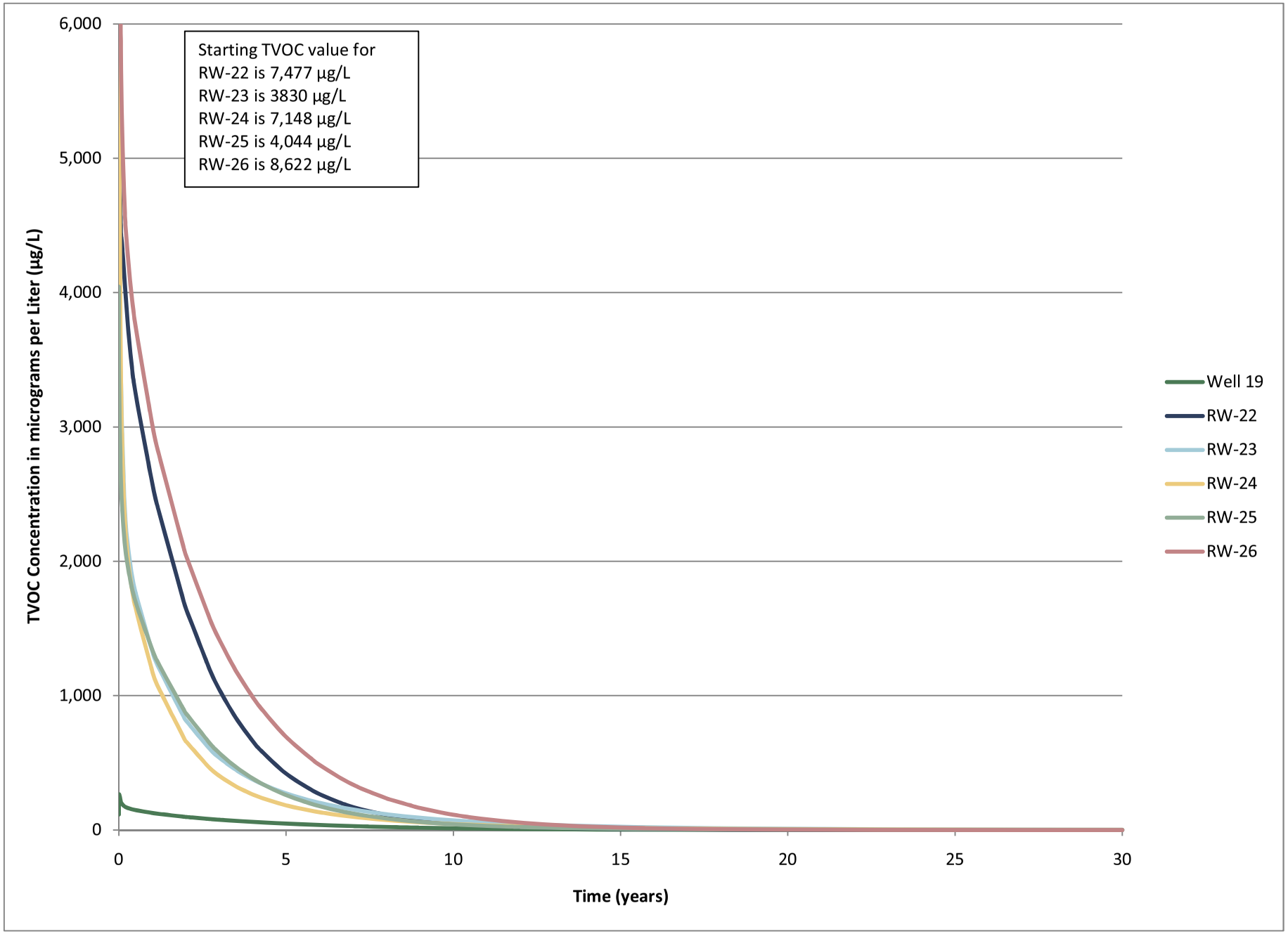

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Figure A-16.Comparison of Model-Predicted TVOC Concentrations at BWD Well 4-1 by Remedial Alternative,
Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3(Former Grumman Settling Ponds), Bethpage, New York.

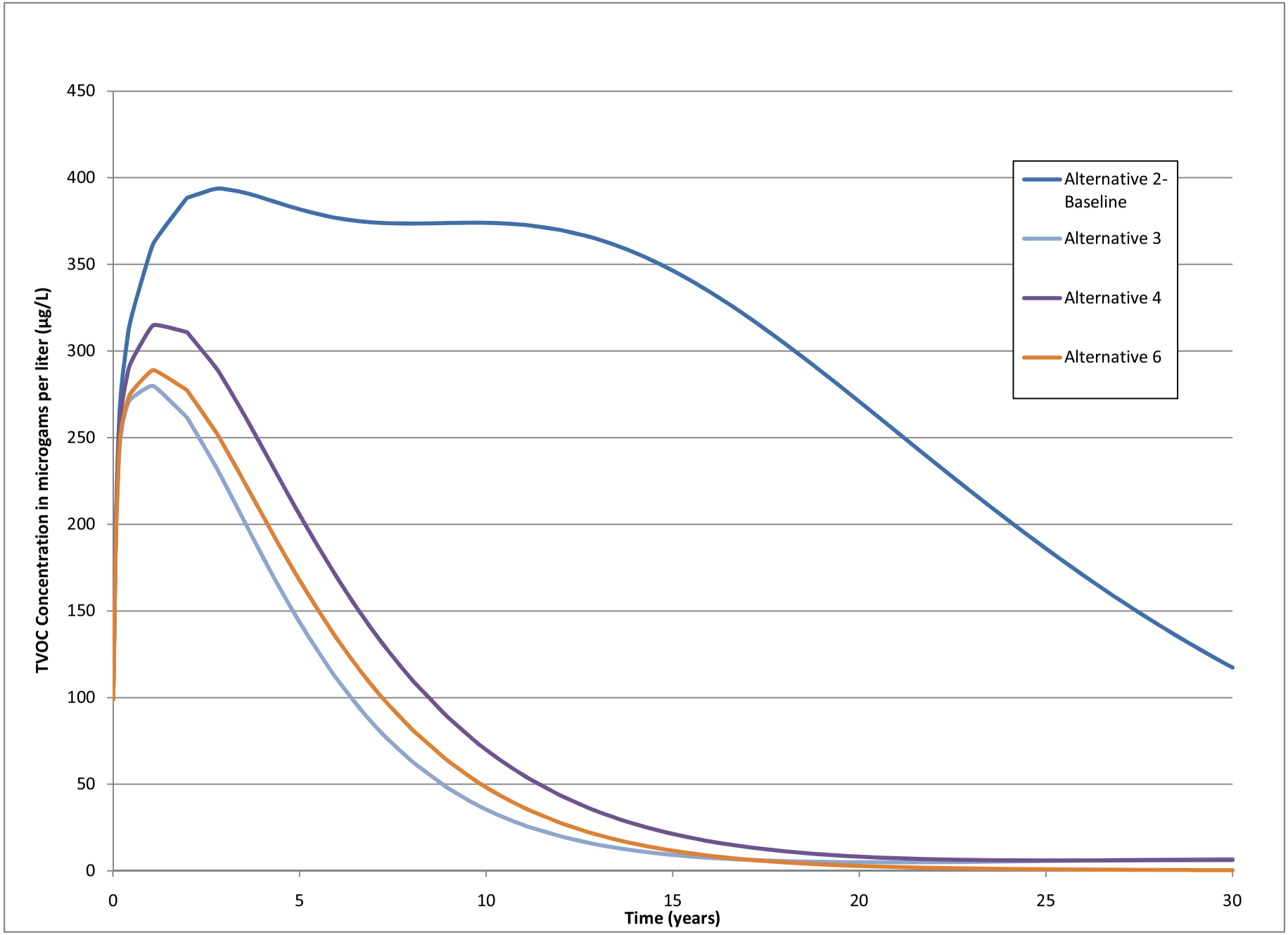

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Figure A-17. Comparison of Model-Predicted TVOC Concentrations at BWD Well 4-2 by Remedial Alternative,
Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3(Former Grumman Settling Ponds), Bethpage, New York.

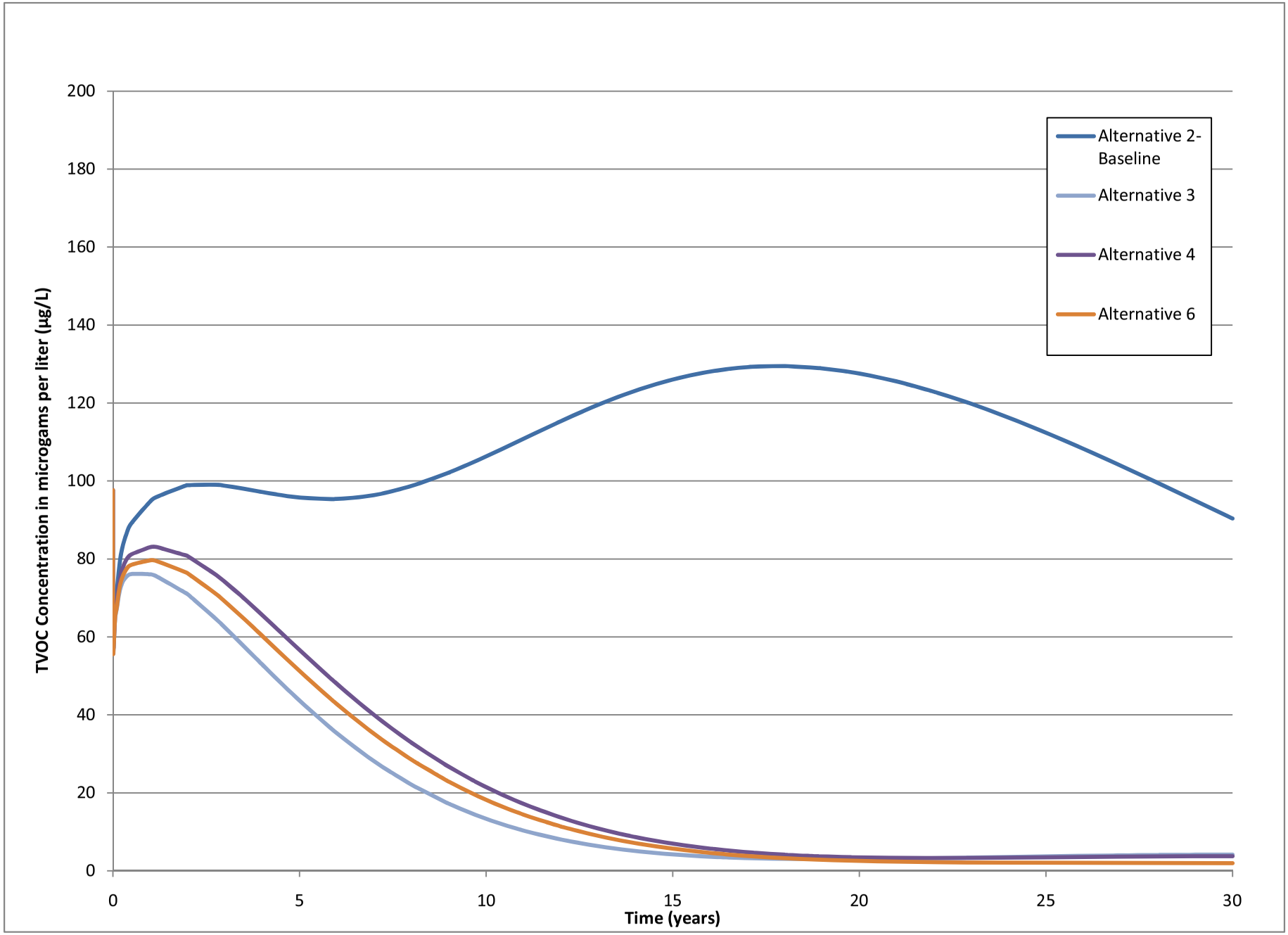

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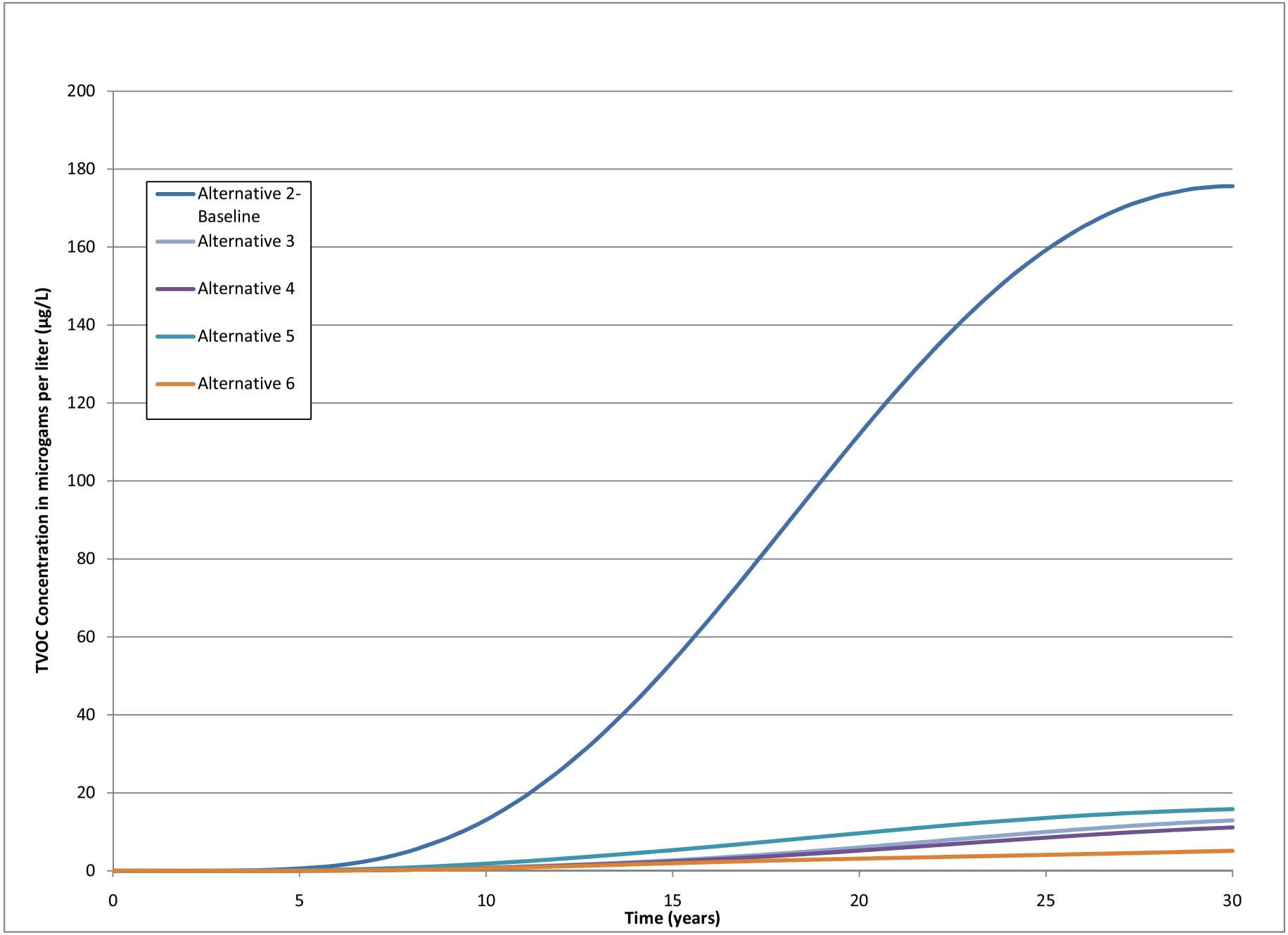
Figure A-18. Comparions of Model-Predicted TVOC Concentrations at BWD Well 5-1 by Remedial Alternative,
Study Area Feasibility Study, Northrop Grumman Systems Corporation,Operable Unit 3(Former Grumman Settling Ponds),Bethpage,New York.



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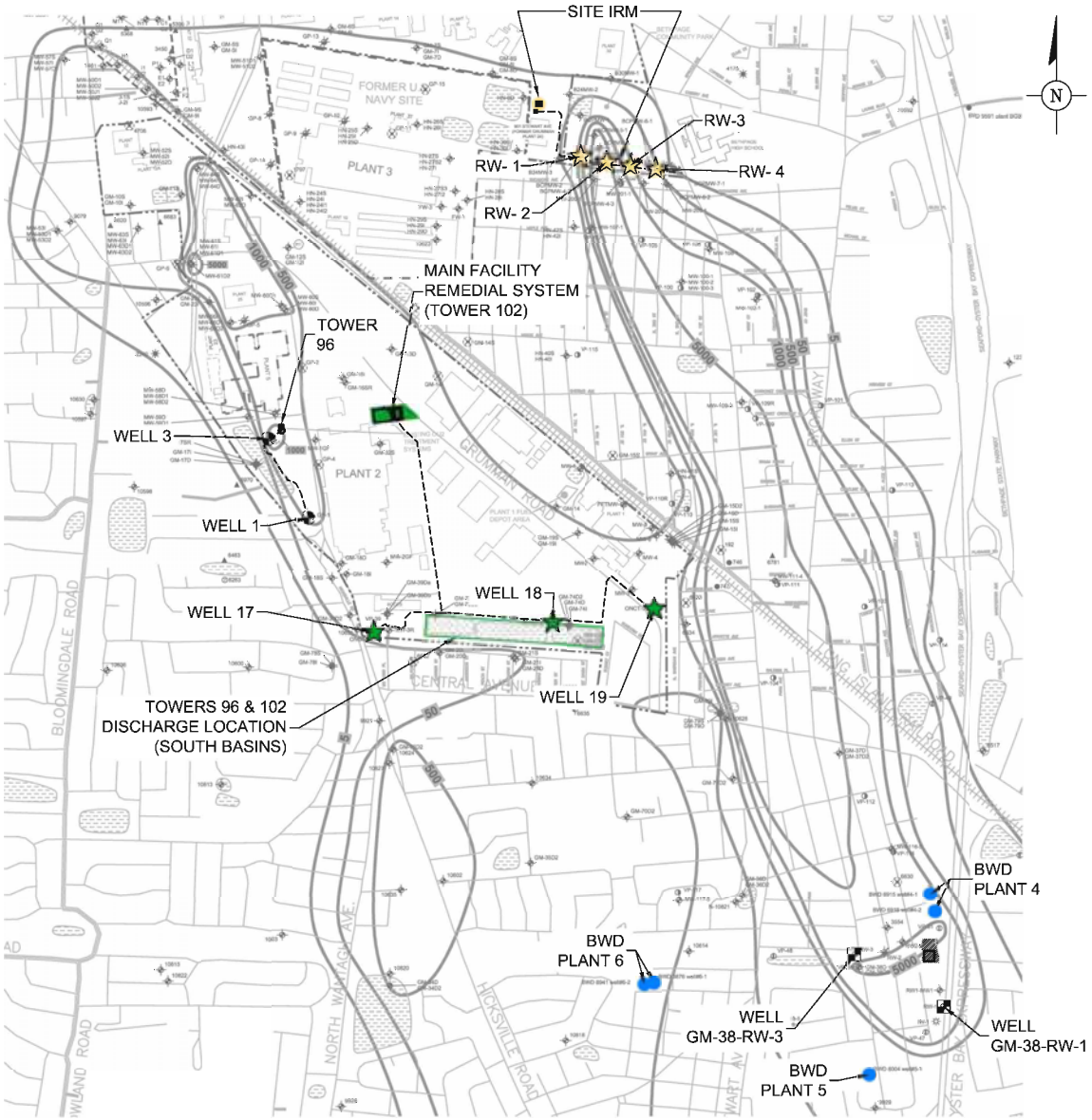

LEGEND:

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- PROPERTY BOUNDARY OF THE FORMER U.S. NAVY SITE
- PROPERTY BOUNDARY OF THE FORMER OCC SITE
- LONG ISLAND RAILROAD
- RECHARGE BASIN
- TVOC ISO-CONCENTRATION CONTOUR IN MICROGRAMS PER LITER (µg/L)
- PUBLIC SUPPLY WELL
- EXISTING MAIN FACILITY REMEDIAL WELL (TOWER 96)
- STUDY AREA PUBLIC SUPPLY WELL
- EXISTING THIRD PARTY REMEDIAL WELL (GM-38 AREA)
- EXISTING THIRD PARTY REMEDIAL TREATMENT SYSTEM (GM-38 AREA)
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- EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM (TOWER 102)
- EXISTING SITE IRM REMEDIAL WELL
- EXISTING SITE IRM GROUNDWATER TREATMENT SYSTEM
- EXISTING SYSTEM INFLUENT PIPELINE

BWD BETHPAGE WATER DISTRICT
TVOC TOTAL VOLATILE ORGANIC COMPOUND
GPM GALLONS PER MINUTE
IRM INTERIM REMEDIAL MEASURE

NOTE:

1. BASELINE CONDITIONS/CONTINUED ACTION, PLUS SOURCE AREA REMOVAL AT SITE AREA. CONTINUE TO OPERATE SITE IRM, MAIN FACILITY, AND GM-38 REMEDIAL TREATMENT SYSTEMS. OPERATE EXISTING BWD WELL HEAD PROTECTION SYSTEMS.

0 600' 1200'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

ALTERNATIVE 2 - BASELINE
CONTINUED ACTION
CONCEPTUAL SITE LAYOUT

ARCADIS

FIGURE
A-19

CITY (Reqd) DIV/GROUP (Reqd) DB (Reqd) LE (Cut) PIC (Opt) TM (Reqd) TM (Cut) LYR (Cut/ON=*;OFF=*REF*
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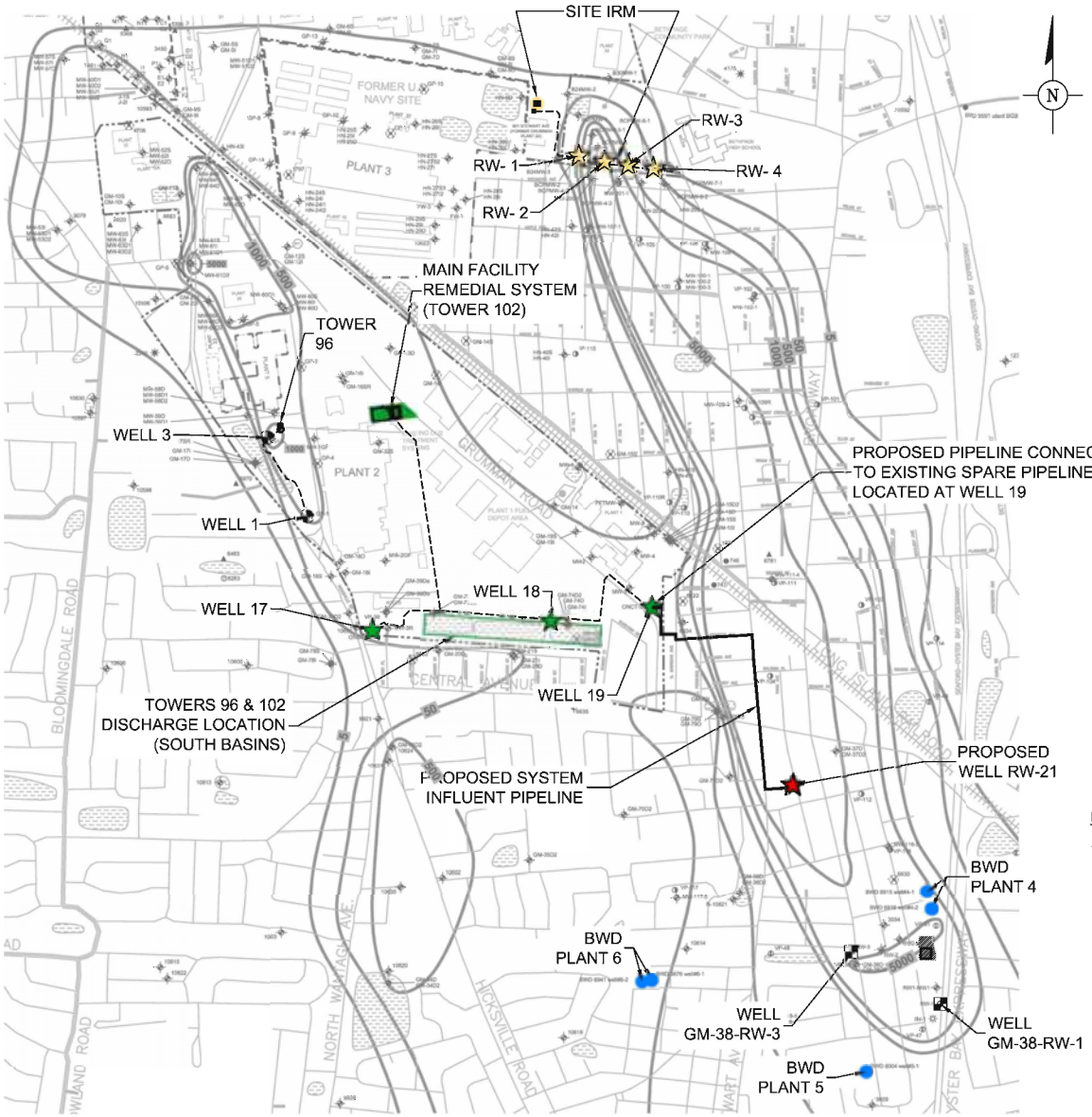

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- EXISTING SITE IRM REMEDIAL WELL
- EXISTING SITE IRM GROUNDWATER TREATMENT SYSTEM
- EXISTING SYSTEM INFLUENT PIPELINE
- PROPOSED REMEDIAL WELL
- PROPOSED SYSTEM INFLUENT PIPELINE

BWD BETHPAGE WATER DISTRICT
TVOC TOTAL VOLATILE ORGANIC COMPOUND
GPM GALLONS PER MINUTE
IRM INTERIM REMEDIAL MEASURE

NOTE:

1. ALTERNATIVE 2 PLUS NEW REMEDIAL WELL RW-21 PUMPING AT 1,000 GPM TO REDUCE VOC MASS IN STUDY AREA GROUNDWATER. EXTRACTED GROUNDWATER WILL BE TREATED AT THE EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM.

0 600' 1200'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

ALTERNATIVE 3 - ALTERNATIVE 2 PLUS
ONE NEW REMEDIAL WELL
CONCEPTUAL SITE LAYOUT

ARCADIS

FIGURE
A-20

CITY (Req'd): DIV/GROUP: (Req'd): DB: (Req'd): LE: (Cut): PIC: (Cpy): TM: (Red): TM: (Ord): LYR: (Cut/ON=*;OFF=*REF*
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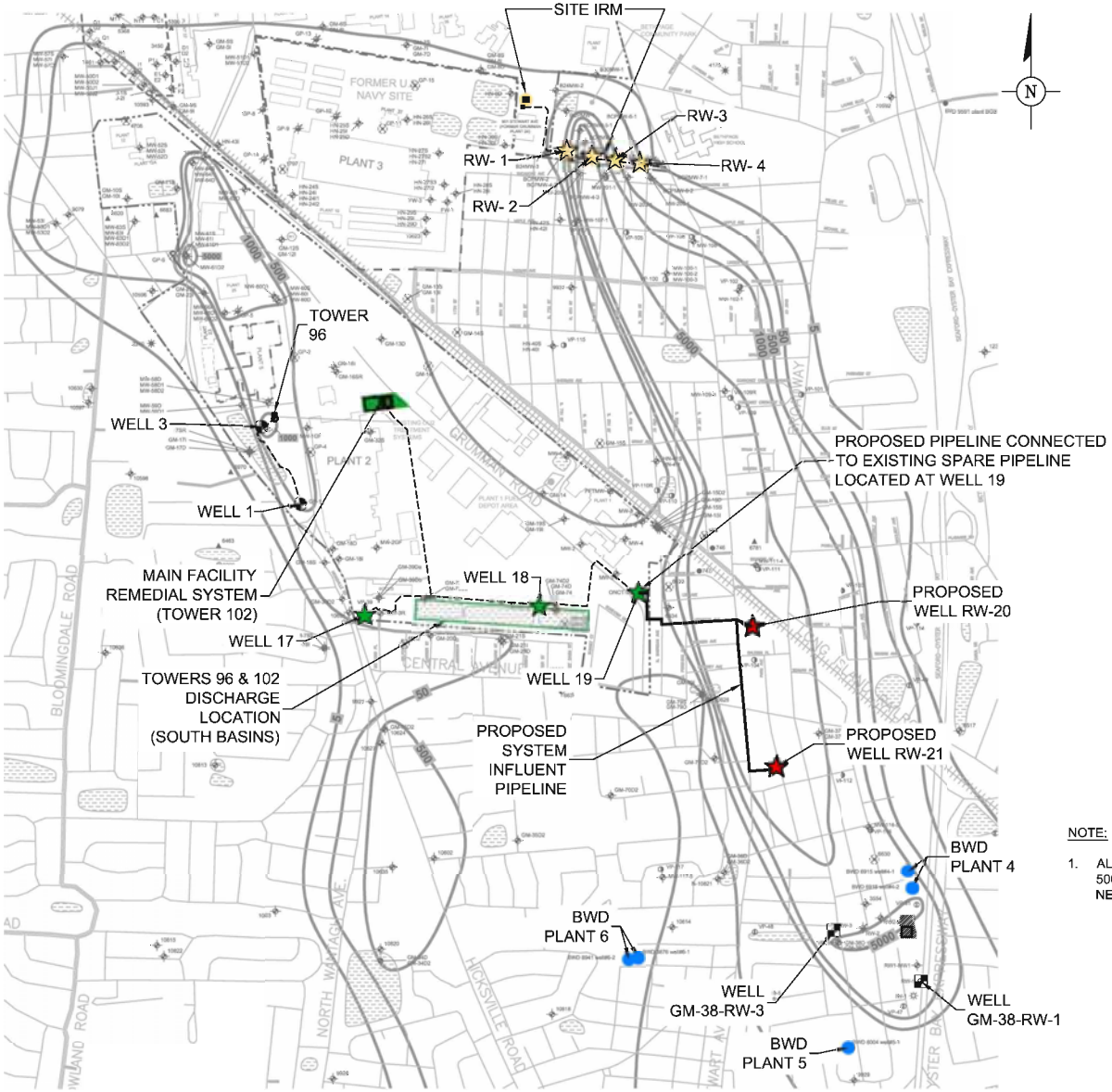

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- EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM (TOWER 102)
- EXISTING SITE IRM REMEDIAL WELL
- EXISTING SITE IRM GROUNDWATER TREATMENT SYSTEM
- EXISTING SYSTEM INFLUENT PIPELINE
- PROPOSED REMEDIAL WELL
- PROPOSED SYSTEM INFLUENT PIPELINE

BWD BETHPAGE WATER DISTRICT
TVOC TOTAL VOLATILE ORGANIC COMPOUND
GPM GALLONS PER MINUTE
IRM INTERIM REMEDIAL MEASURE

NOTE:

1. ALTERNATIVE 2 PLUS TWO (2) NEW REMEDIAL WELLS: WELL RW-20 AND WELL RW-21 EACH PUMPING AT 500 GPM, TO REDUCE VOC MASS IN STUDY AREA GROUNDWATER. EXTRACTED GROUNDWATER FROM NEW WELLS WILL BE TREATED AT THE EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM.

0 600' 1200'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

ALTERNATIVE 4 - ALTERNATIVE 2 PLUS TWO NEW REMEDIAL WELLS CONCEPTUAL SITE LAYOUT

ARCADIS

FIGURE
A-21

CITY (Req'd) DIV/GROUP (Req'd) DB (Req'd) LE (Cut) PIC (Cpy) TM (Red) TM (Ctrl) LYR (On/Off=*OFF=*REF*
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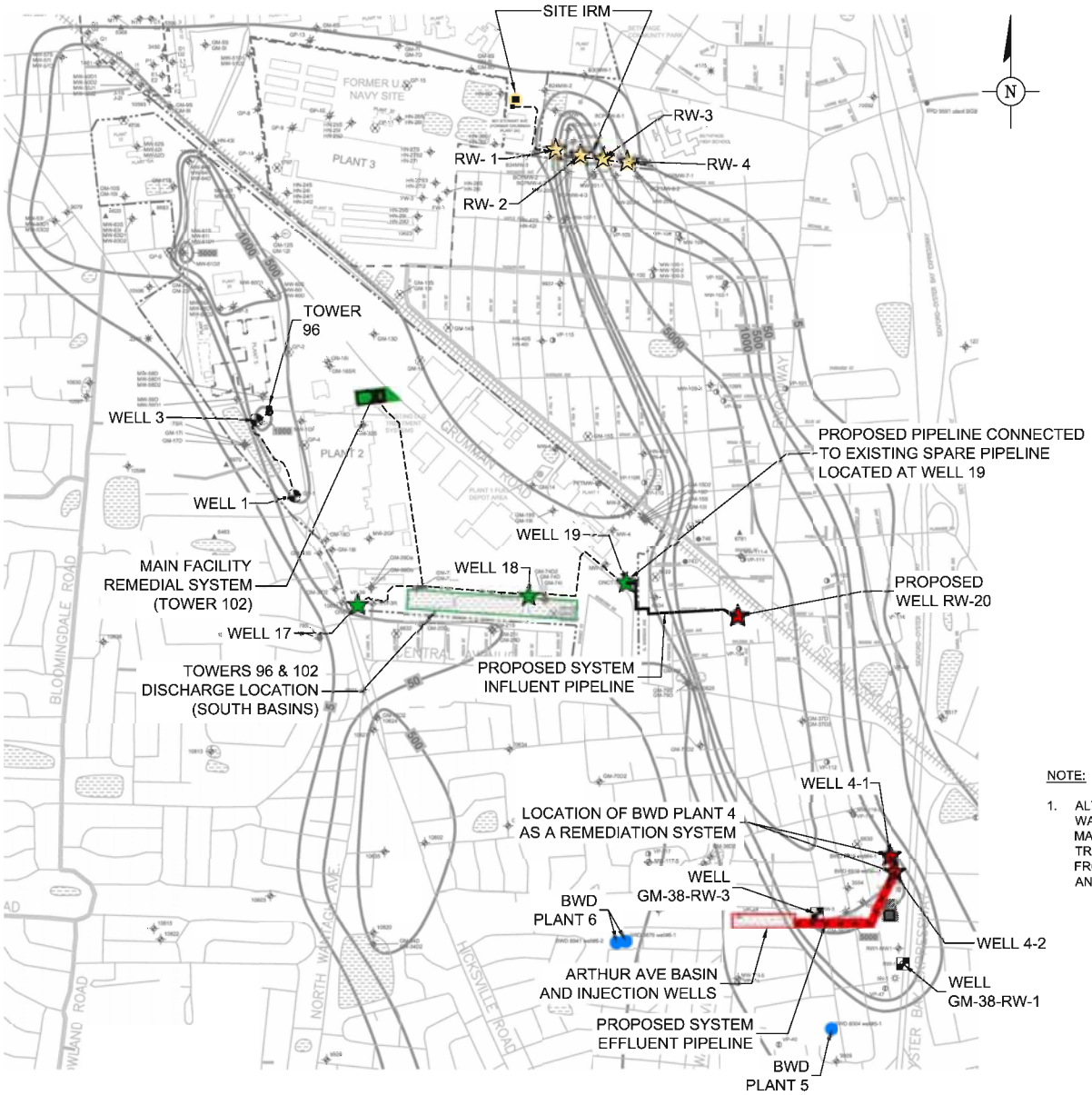

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- EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM (TOWER 102)
- EXISTING SITE IRM REMEDIAL WELL
- EXISTING SITE IRM GROUNDWATER TREATMENT SYSTEM
- EXISTING SYSTEM INFLUENT PIPELINE
- PROPOSED REMEDIAL WELL
- PROPOSED SYSTEM INFLUENT PIPELINE
- PROPOSED SYSTEM EFFLUENT PIPELINE

BWD BETHPAGE WATER DISTRICT
TVOC TOTAL VOLATILE ORGANIC COMPOUND
GPM GALLONS PER MINUTE
IRM INTERIM REMEDIAL MEASURE

NOTE:

1. ALTERNATIVE 2 PLUS NEW REMEDIAL WELL RW-20 PUMPING AT 500 GPM, AND THE TWO (2) BETHPAGE WATER DISTRICT (BWD) PLANT 4 WELLS PUMPING AT A COMBINED RATE OF 2,700 GPM TO REDUCE VOC MASS IN STUDY AREA GROUNDWATER. EXTRACTED GROUNDWATER FROM NEW WELL WILL BE TREATED AT THE EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM. TREATED GROUNDWATER FROM BWD PLANT 4 WELLS WILL BE DISCHARGED TO A COMBINATION OF EXISTING RECHARGE BASIN AND SHALLOW INJECTION WELLS LOCATED AT ARTHUR AVE. REPLACE BWD PLANT 4 CAPACITY.

0 600' 1200'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

ALTERNATIVE 5 - ALTERNATIVE 2 PLUS ONE NEW REMEDIAL WELL AND BWD PLANT 4 AS A REMEDIATION SYSTEM CONCEPTUAL SITE LAYOUT

ARCADIS

FIGURE
A-22

CITY (Req'd) DIV/GROUP (Req'd) DB (Req'd) LE (Cut) PIC (Cpy) TM (Read) TM (Out) LYR (On/Off=*OFF=*REF*)
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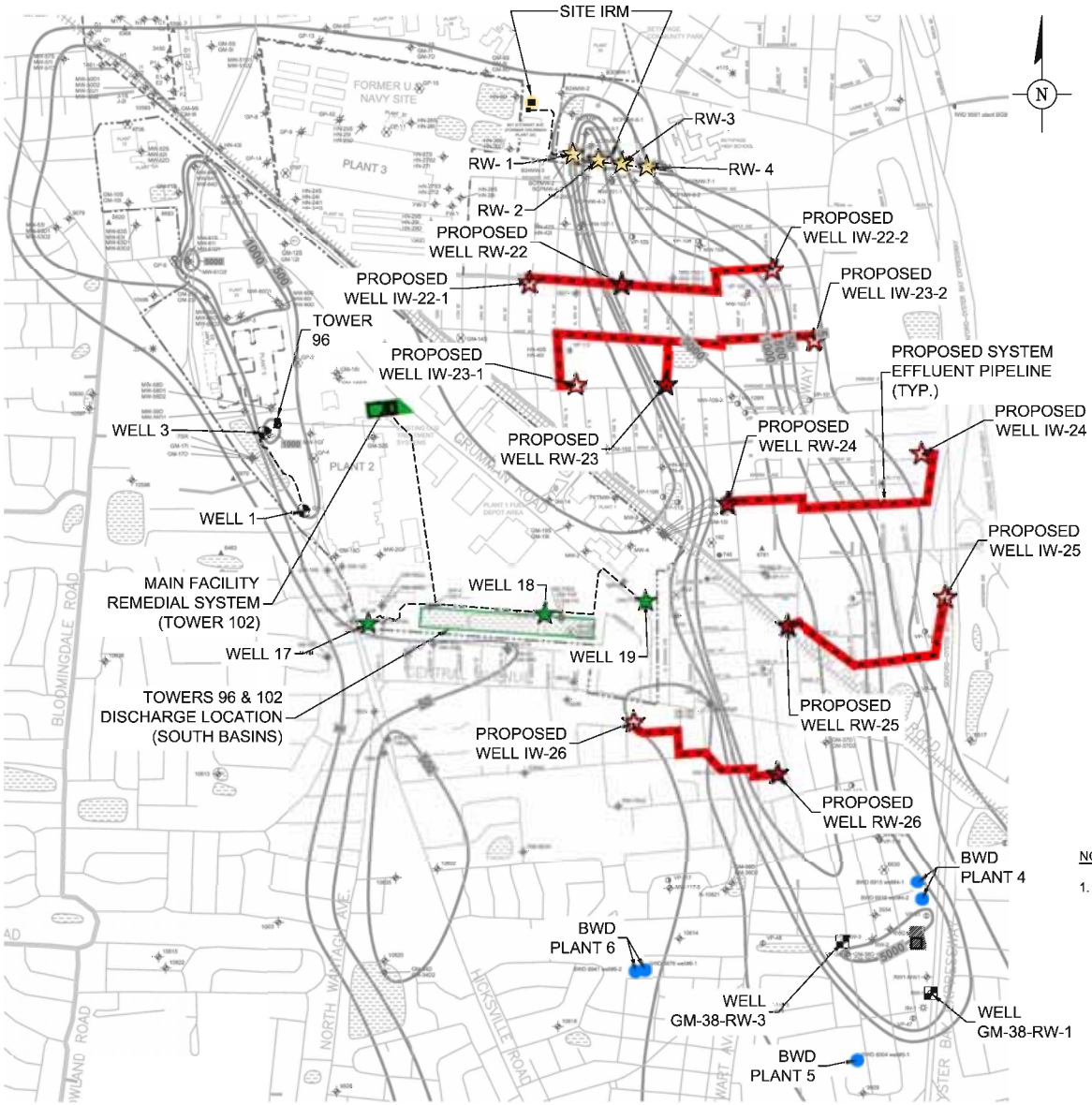

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- PUBLIC SUPPLY WELL
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- STUDY AREA PUBLIC SUPPLY WELL
- EXISTING THIRD PARTY REMEDIAL WELL (GM-38 AREA)
- EXISTING THIRD PARTY REMEDIAL TREATMENT SYSTEM (GM-38 AREA)
- EXISTING MAIN FACILITY REMEDIAL WELL (TOWER 102)
- EXISTING MAIN FACILITY REMEDIAL TREATMENT SYSTEM (TOWER 102)
- EXISTING SITE IRM REMEDIAL WELL
- EXISTING SITE IRM GROUNDWATER TREATMENT SYSTEM
- EXISTING SYSTEM INFLUENT PIPELINE
- PROPOSED REMEDIAL WELL/TREATMENT SYSTEM
- PROPOSED LOCATION OF INJECTION WELLS (ONE OPERATING/ONE BACKUP)
- PROPOSED SYSTEM EFFLUENT PIPELINE

BWD BETHPAGE WATER DISTRICT
TVOC TOTAL VOLATILE ORGANIC COMPOUND
GPM GALLONS PER MINUTE
IRM INTERIM REMEDIAL MEASURE

NOTE:

1. ALTERNATIVE 2 PLUS ATTEMPT TO RETURN STUDY AREA GROUNDWATER TO PRE-DISPOSAL CONDITIONS USING FIVE (5) NEW REMEDIAL WELLS, SEVEN (7) OPERATING (SEVEN BACKUP) INJECTION WELLS, AND FIVE (5) NEW REMEDIAL TREATMENT SYSTEMS.

0 600' 1200'
SCALE IN FEET

ALL COORDINATES REFERENCED TO NORTH AMERICAN DATUM 1983

STUDY AREA FEASIBILITY STUDY
NORTHROP GRUMMAN SYSTEMS CORPORATION
OPERABLE UNIT 3 (FORMER GRUMMAN SETTLING PONDS)
BETHPAGE, NEW YORK

ALTERNATIVE 6 -
ALTERNATIVE 2 PLUS
FIVE NEW REMEDIAL WELLS
CONCEPTUAL SITE LAYOUT

ARCADIS

FIGURE
A-23

CITY (Req'd) DIV/GROUP (Req'd) DB (Req'd) LD (Cob) PIC (Cor) TM (Req'd) TM (Cob) LYR (On/Off=*OFF*REF*)
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PROJECTNAME: ----

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Appendix **B**

Remedial Alternatives Detailed Cost Estimates

Study Area Feasibility Study
Operable Unit 3 (former Grumman Settling Ponds)
Bethpage, New York
NYSDEC Site #1-30-003A

Table of Contents

Appendix B **Remedial Alternatives Detailed Cost Estimates**

Table B-1 Summary of Systems Operation Periods, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-2 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-3 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-4 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-5 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-6 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-7 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-8 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Table B-9 Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

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Table B1. Summary of System Operational Periods, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Remedial Alternative	Remedial Wells	Active Remedial Phase (Years)	Pulsed Remedial Phase (Years)	Post System Shutdown Monitoring Phase (Years)
3	RW-21	1 to 20	21 to 25	26 to 30
4	RW-20	1 to 20	21 to 25	26 to 30
	RW-21	1 to 20	21 to 25	26 to 30
5	4-1	1 to 30	N/A	N/A
	4-2	1 to 20	21 to 25	26 to 30
	RW-20	1 to 20	21 to 25	26 to 30
6	RW-22	1 to 20	21 to 25	26 to 30
	RW-23	1 to 20	21 to 25	26 to 30
	RW-24	1 to 20	21 to 25	26 to 30
	RW-25	1 to 20	21 to 25	26 to 30
	RW-26	1 to 20	21 to 25	26 to 30

Notes:
N/A - not applicable; does not achieve shut down criteria within 30 year evaluation period.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Construction Capital Costs					
Recovery and Monitoring Wells					
Recovery Well Installation					
Recovery Well RW-21	1	ea	$700,000	$700,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Recovery Well Testing					
Recovery Well RW-21	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Monitoring Well Installation					
Monitoring Wells 150 to 250 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 250 to 350 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 350 to 450 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 450 to 550 ft bls	3	ea	$85,000	$255,000	Mud rotary, includes mobe/demobe, surface casing, and permitting.
Well Development					
Recovery Wells	1	ea	$14,000	$14,000	Subcontractor cost for well development.
Monitoring Wells	3	ea	$7,000	$21,000	Subcontractor cost for well development.
Waste Management					
Recovery Wells	1	ls	$23,000	$23,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Monitoring Wells	1	ls	$39,000	$39,000	Waste characterization, handling, and disposal for well soil cuttings and development water.
Subtotal Recovery and Monitoring Wells				**$1,072,000**	
Recovery Well RW-21 Pumping System and Tower 102 Upgrades					
Contractor mobilization/demobilization	1	ls	$150,000	$150,000	Engineering estimate for mobilization/demobilization, H&S, and client required bid, performance, and payment bonds.
Site Utility Survey	1	ls	$20,000	$20,000	One-call utility survey for public property, subcontracting utility locating firm for private property.
Site Preparation	1	ls	$311,000	$311,000	Engineering estimate for clearing, work area set up, equipment set up, traffic, E&S controls.
Wellhead Vault Structural	1	ls	$20,000	$20,000	6' x 8' precast concrete vault with penetrations for utilities including installation.

continued on following page.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
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- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Recovery Pump and In-Well Drop Pipe	1	ls	$106,000	$106,000	Includes a Grundfos 75 HP submerisble turbine pump and 6-inch diameter in-well recovery pipe to land surface.
Wellhead Vault Mechanical	1	ls	$45,000	$45,000	Includes flowmeter, pressure gauges, sample ports, in-vault piping, etc.
Wellhead Vault Electrical Supply	1	ls	$96,000	$96,000	Power supply and disconnect to recovery well vault.
Wellhead Vault Electrical Controls	1	ls	$75,000	$75,000	Local sub-control panel and remote/satellite communication system to Main Faciltiy system.
Tower 102 System Mechanical Upgrades	1	ea	$115,000	$115,000	New blower, piping, valves, sample port, upgrade to Tower 102 system.
Tower 102 System Controls and Instrumentation	1	ls	$75,000	$75,000	Remote/satellite or ethernet based control upgrades to receive feed from new recovery vaults.
Pipe Cleanouts and Air/Vacuum Release Valves	7	ea	$750	$5,250	Recovery line pipe cleanouts and air/vacuum release valves every 500 feet.
Trenching and Piping	3300	lf	$151	$496,794	10-inch diameter double-wall HDPE from recovery well to existing spare pipe adjacent to existing recovery well RW-19.
Site Restoration	1	ls	$294,000	$294,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for recovery pipe.
Contractors In-House Project Management	16	wks	$12,000	$192,000	Engineering estimate for construction contractors internal project management cost.
As-built Survey	1	ls	$20,000	$20,000	Engineering estimate for as-built utility survey and elevations.
System Startup Testing	2	wks	$15,000	$30,000	Engineering estimate includes two weeks of startup with two engineers plus management and laboratory.
Subtotal Recovery Well RW-21 Pumping System and Tower 102 Upgrades				**$2,052,000**	
Engineering/Project Management					
Engineering	10%	of	$3,124,000	$312,400	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management	12%	of	$3,124,000	$374,880	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management	12%	of	$3,124,000	$374,880	All fees associated with management of construction related aspects of the project.
Subtotal Engineering/Project Management				**$1,062,000**	
Miscellaneous Project Costs					
SMP Preparation	1	LS	$200,000	$200,000	Preparation of site management plan and related appendices (SAP, OM&M, QAPP, etc.)
Site Management Survey	1	LS	$100,000	$100,000	ALTA survey for site management plan.

continued on following page.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Administrative Controls Legal Fees	1	LS	$100,000	$100,000	Engineering allotment for legal fees associated with easement/deed restriction filing. Assumes individual property/lot deed restrictions not required.
Recovery Well and Pipe Land Acquisition Cost	1	Acre	$250,000	$250,000	Engineering estimate for land lease, and right of ways, and property owner required bonds.
Recovery Well and Pipe Land Acquisition Legal and Administrative Fees	10%	of	$250,000	$25,000	Engineering estimate for legal fees related to land lease and right-of-way recording.
Treatment Building and Discharge Land Acquisition Cost	0	Acre	$500,000	$0	No new treatment plant.
Treatment Building and Discharge Land Acquisition Legal and Administrative Fees	10%	of	$0	$0	No new treatment plant.
Subtotal Miscellaneous Project Costs				**$675,000**	
Site Closure and Demobilization					
Well Abandonment	0	ea	$0	$0	Occurs after Year 30. Not included.
Building Removal	0	ea	$0	$0	Occurs after Year 30. Not included.
Site Closure Labor	0	ea	$0	$0	Occurs after Year 30. Not included.
Project Management/Regulatory Communications/Meetings	0	ls	$0	$0	Occurs after Year 30. Not included.
Subtotal Site Closure and Demobilization				**$0**	
SUBTOTAL CAPITAL COST				**$4,861,000**	
CAPITAL COST CONTINGENCY				**$972,200**	20% contingency.
TOTAL CAPITAL COST WITH CONTINGENCY ALTERNATIVE 3				**$5,900,000**	Rounded to nearest $100,000.

continued on following page.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Annual Operation and Maintenance and Long-Term Activities					
Years 1 through 5					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$37,000	$37,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	1	well	$89,000	$89,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	1	ls	$5,000	$5,000	Replacement of valves/piping, pumps, etc.
Electric	120	hp	$1,241	$148,920	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW Basin 495.
Groundwater Plume Management Monitoring Labor	1	ls	$67,000	$67,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$19,000	$19,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$39,900	$39,900	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$475,320	$47,532	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$475,320	$47,532	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 1 through 5)				**$571,000**	
Years 6 through 10					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.

continued on following page.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$35,000	$35,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	1	well	$89,000	$89,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	1	ls	$5,000	$5,000	Replacement of valves/piping, pumps, etc.
Electric	120	hp	$1,241	$148,920	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW Basin 495.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$7,000	$7,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$10,000	$10,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$39,900	$39,900	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$447,820	$44,782	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$447,820	$44,782	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 6 through 10)				**$493,000**	
Years 11 through 15					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.
Performance Monitoring Labor	1	ls	$35,000	$35,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	1	well	$89,000	$89,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	1	ls	$5,000	$5,000	Replacement of valves/piping, pumps, etc.
Electric	120	hp	$1,241	$148,920	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$2	$0	No discharge to NCDPW Basin 495.

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Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$7,000	$7,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$9,000	$9,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$39,900	$39,900	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$429,320	$42,932	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$429,320	$42,932	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 11 through 15)				**$516,000**	
Years 16 through 20					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$35,000	$35,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	1	well	$89,000	$89,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	1	ls	$5,000	$5,000	Replacement of valves/piping, pumps, etc.
Electric	120	hp	$1,241	$148,920	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW Basin 495.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$7,000	$7,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$9,000	$9,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$39,900	$39,900	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.

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Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
PM/Local Agency Response	10%	of	$429,320	$42,932	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$429,320	$42,932	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 16 through 20)				**$516,000**	
Years 21 through 25 (Pulsed Operation)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$5,000	$5,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$17,500	$17,500	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	1	well	$44,500	$44,500	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	1	ls	$2,500	$2,500	Replacement of valves/piping, pumps, etc.
Electric	120	hp	$621	$74,460	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW Basin 495.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$7,000	$7,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$9,000	$9,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$26,600	$26,600	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$26,667	$26,667	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$258,727	$25,873	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$258,727	$25,873	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 21 through 25)				**$311,000**	

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Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-21 water (1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 26 through 30 (Monitoring Only)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	0	ls	$10,000	$0	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	0	ls	$35,000	$0	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	0	well	$133,500	$0	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW Basin 495.
Equipment Replacement	0	ls	$5,000	$0	Replacement of valves/piping, pumps, etc.
Electric	0	hp	$1,241	$0	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW Basin 495.
Groundwater Plume Management Monitoring Labor	1	ls	$19,000	$19,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$3,500	$3,500	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$4,500	$4,500	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$19,950	$19,950	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$20,000	$20,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$74,450	$7,445	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$74,450	$7,445	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 26 through 30)				**$90,000**	
PRESENT WORTH O&M AND LONG-TERM ACTIVITIES COST ALTERNATIVE 3				**$ 7,800,000**	30-year present worth value. Assumes a discount factor of 4.5 percent. See Table B3.
BASELINE COST (ALL ALTERNATIVES)				**$40,300,000**	See Notes 1 and 2 below.
TOTAL COST ALTERNATIVE 3				**$ 54,000,000**	Rounded to nearest $100,000.

See notes on the last page.

Table B2. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Notes:

1. Baseline cost is the capital and 30 year present worth cost for: OM&M of the existing Main Facility Treatment System, Site Groundwater IRM, and Plant 4 well head protection; capital cost for Site Area source reduction.
2. Capital cost for Site Area source reduction ($15.6 MM) has been previously estimated and provided in the Site Area FS. OM&M costs for the Site Groundwater IRM ($4.7 MM), Main Facility Remedial System ($19.9 MM) and Plant 4 well head treatment ($0.1 MM) have been estimated and provided by Northrop Grumman based on actual operating costs. Costs have been included herein for completeness (i.e., to include all associated cost for Study Area groundwater remediation).

Table B3. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 3 Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

NPV Operation & Maintenance Costs Escalated over a 30-Year Period
Interest Rate: 8%
Escalation Rate: 3.5%
Capital Cost Amortization Period: 5 years

Year	GW IRM O&M	Pre-Escalated Costs	Escalated Cost (FV)	PV (Cost)
1	$571,000	$ 571,000	$ 590,985	$ 547,208
2	$571,000	$ 571,000	$ 611,669	$ 524,408
3	$571,000	$ 571,000	$ 633,078	$ 502,558
4	$571,000	$ 571,000	$ 655,236	$ 481,618
5	$586,000	$ 586,000	$ 695,984	$ 473,675
6	$493,000	$ 493,000	$ 606,023	$ 381,897
7	$493,000	$ 493,000	$ 627,234	$ 365,985
8	$493,000	$ 493,000	$ 649,187	$ 350,735
9	$493,000	$ 493,000	$ 671,908	$ 336,121
10	$508,000	$ 508,000	$ 716,584	$ 331,917
11	$516,000	$ 516,000	$ 753,344	$ 323,096
12	$516,000	$ 516,000	$ 779,711	$ 309,634
13	$516,000	$ 516,000	$ 807,001	$ 296,733
14	$516,000	$ 516,000	$ 835,246	$ 284,369
15	$531,000	$ 531,000	$ 889,610	$ 280,442
16	$516,000	$ 516,000	$ 894,737	$ 261,165
17	$516,000	$ 516,000	$ 926,053	$ 250,283
18	$516,000	$ 516,000	$ 958,464	$ 239,855
19	$516,000	$ 516,000	$ 992,011	$ 229,861
20	$531,000	$ 531,000	$ 1,056,578	$ 226,687
21	$311,000	$ 311,000	$ 640,483	$ 127,236
22	$311,000	$ 311,000	$ 662,900	$ 121,934
23	$311,000	$ 311,000	$ 686,102	$ 116,854
24	$311,000	$ 311,000	$ 710,115	$ 111,985
25	$326,000	$ 326,000	$ 770,418	$ 112,495
26	$90,000	$ 90,000	$ 220,136	$ 29,763
27	$90,000	$ 90,000	$ 227,841	$ 28,523
28	$90,000	$ 90,000	$ 235,815	$ 27,334
29	$90,000	$ 90,000	$ 244,069	$ 26,195
30	$105,000	$ 105,000	$ 294,713	$ 29,288
	$ 12,575,000	$ 12,575,000	$ 20,043,237	**$ 7,800,000**

1. Recurring 5 year cost for 5 year review report preparation.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Construction Capital Costs					
Recovery and Monitoring Wells					
Recovery Well Installation					
Recovery Well RW-20	1	ea	$640,000	$640,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Recovery Well RW-21	1	ea	$700,000	$700,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Recovery Well Testing					
Recovery Well RW-20	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Recovery Well RW-21	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Monitoring Well Installation					
Monitoring Wells 150 to 250 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 250 to 350 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 350 to 450 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 450 to 550 ft bls	6	ea	$85,000	$510,000	Mud rotary, includes mobe/demobe, protective casing, and permitting.
Well Development					
Recovery Wells	2	ea	$14,000	$28,000	Subcontractor cost for well development.
Monitoring Wells	6	ea	$7,000	$42,000	Subcontractor cost for well development.
Waste Management					
Recovery Wells	1	ls	$43,000	$43,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Monitoring Wells	1	ls	$77,000	$77,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Subtotal Recovery and Monitoring Wells				**$2,080,000**	
Recovery Well RW-20 Pumping System and Tower 102 Upgrades					
Contractor mobilization/demobilization	1	ls	$150,000	$150,000	Engineering estimate for mobilization/demobilization, H&S, and client required bid, performance, and payment bc
Site Utility Survey	1	ls	$20,000	$20,000	One-call utility survey for public property, subcontracting utility locating firm for private property.

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Site Preparation	1	ls	$172,000	$172,000	Engineering estimate for clearing, work area set up, equipment set up, traffic, E&S controls.
Wellhead Vault Structural	1	ls	$20,000	$20,000	6' x 8' precast concrete vault with penetrations for utilities including installation.
Recovery Pump and In-Well Drop Pipe	1	ls	$85,000	$85,000	Includes a Grundfos 40 HP submerisble turbine pump and 6-inch diameter in-well recovery pipe to land surface.
Wellhead Vault Mechanical	1	ls	$45,000	$45,000	Includes flowmeter, pressure gauges, sample ports, in-vault piping, etc.
Wellhead Vault Electrical Supply	1	ls	$73,000	$73,000	Power supply and disconnect to recovery well vault.
Wellhead Vault Electrical Controls	1	ls	$75,000	$75,000	Remote/satellite or ethernet based controls tied into upgraded Tower 102 system.
Tower 102 System Mechanical Upgrades	1	ea	$45,000	$45,000	Piping, valves, sample port, upgrade to Tower 102 system.
Tower 102 System Controls and Instrumentation	1	ls	$85,000	$85,000	Remote/satellite or ethernet based control upgrades to receive feed from new recovery vaults.
Pipe Cleanouts and Air/Vacuum Release Valves	4	ea	$750	$3,000	Recovery line pipe cleanouts and air/vacuum release valves every 500 feet.
Trenching and Piping	1600	lf	$151	$240,870	10-inch diameter double-wall HDPE from recovery well to existing spare pipe adjacent to existing recovery well R
Site Restoration	1	ls	$158,000	$158,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for recovery pipe.
Contractors In-House Project Management	0	wks	$12,000	$0	Included in RW-21 pumping system below.
As-built Survey	1	ls	$20,000	$20,000	Engineering estimate for as-built utility survey and elevations.
System Startup Testing	2	wks	$15,000	$30,000	Engineering estimate includes two weeks of startup with two engineers plus management.
Subtotal Recovery Well RW-20 Pumping System and Tower 102 Upgrades				**$1,222,000**	
Recovery Well RW-21 Pumping System					
Contractor mobilization/demobilizationn	0	ls	$0	$0	Inlcuded in RW-20 recovery well capital line item above.
Site Utility Survey	1	ls	$20,000	$20,000	One-call utility survey for public property, subcontracting utility locating firm for private property.
Site Preparation	1	ls	$311,000	$311,000	Engineering estimate for clearing, work area set up, equipment set up, E&S controls, and bonds.
Wellhead Vault Structural	1	ls	$20,000	$20,000	6' x 8' precast concrete vault with penetrations for utilities including installation.
Recovery Pump and In-Well Drop Pipe	1	ls	$106,000	$106,000	Includes a Grundfos 40 HP submerisble turbine pump and 6-inch diameter in-well recovery pipe to land surface.
Wellhead Vault Mechanical	1	ls	$45,000	$45,000	Includes flowmeter, pressure gauges, sample ports, in-vault piping, etc.
Wellhead Vault Electrical Supply	1	ls	$96,000	$96,000	Power supply and disconnect to recovery well vault.
Wellhead Vault Electrical Controls	1	ls	$75,000	$75,000	Remote/satellite or ethernet based controls tied into upgraded Tower 102 system.

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Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Pipe Cleanouts and Air/Vacuum Release Valves	7	ea	$500	$3,500	Recovery line pipe cleanouts and air/vacuum release valves every 500 feet.
Trenching and Piping	3300	lf	$151	$496,794	10-inch diameter double-wall HDPE from recovery well to existing spare pipe adjacent to existing recovery well RW-19.
Site Restoration	1	ls	$294,000	$294,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for recovery pipe.
Contractors In-House Project Management	16	wks	$12,000	$192,000	Engineering estimate for construction contractors internal project management cost.
As-built Survey	1	ls	$20,000	$20,000	Engineering estimate for as-built utility survey and elevations.
System Startup Testing	0	wks	$12,000	$0	Included in RW-20 pumping system cost above.
Subtotal Recovery Well RW-21 Pumping System				**$1,680,000**	
Engineering/Project Management					
Engineering	10%	of	$4,982,000	$498,200	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management	12%	of	$4,982,000	$597,840	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management	12%	of	$4,982,000	$597,840	All fees associated with management of construction related aspects of the project.
Subtotal Engineering/Project Management				**$1,694,000**	
Miscellaneous Project Costs					
SMP Preparation	1	LS	$200,000	$200,000	Preparation of site management plan and related appendices (SAP, OM&M, QAPP, etc.)
Site Management Survey	1	LS	$100,000	$100,000	ALTA survey for site management plan.
Administrative Controls Legal Fees	1	LS	$100,000	$100,000	Engineering allotment for legal fees associated with easement/deed restriction filing. Assumes individual property/lot deed restrictions not required.
Recovery Well and Pipe Land Acquisition Cost	1.4	Acre	$250,000	$340,909	Engineering estimate for land lease, and right of ways, and property owner required bonds.
Recovery Well and Pipe Land Acquisition Legal and Administrative Fees	10%	of	$340,909	$34,091	Engineering estimate for legal fees related to land lease and right-of-way recording.

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Treatment Building and Discharge Land Acquisition Cost	0	Acre	$500,000	$0	No new treatment plant.
Treatment Building and Discharge Land Acquisition Legal and Administrative Fees	10%	of	$0	$0	No new treatment plant.
Subtotal Miscellaneous Project Costs				**$775,000**	
Site Closure and Demobilization					
Well Abandonment	0	ea	$0	$0	Occurs after Year 30. Not included.
Building Removal	0	ea	$0	$0	Occurs after Year 30. Not included.
Site Closure Labor	0	ea	$0	$0	Occurs after Year 30. Not included.
Project Management/Regulatory Communications/Meetings	0	ls	$0	$0	Occurs after Year 30. Not included.
Subtotal Site Closure and Demobilization				**$0**	
SUBTOTAL CAPITAL COST				**$7,451,000**	
CAPITAL COST CONTINGENCY				**$1,490,200**	20% contingency.
TOTAL CAPITAL COST WITH CONTINGENCY ALTERNATIVE 4				**$9,000,000**	Rounded to nearest $100,000.
Annual Operation and Maintenance and Long-Term Activities					
Years 1 through 5					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$20,000	$20,000	Includes allotment for increase in OM&M of existing treatment system.

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Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$61,000	$61,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	2	well	$89,000	$178,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	1	ls	$7,500	$7,500	Replacement of valves/piping, pumps, etc.
Electric	80	hp	$1,241	$99,280	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$67,000	$67,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$25,000	$25,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$28,000	$28,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$581,280	$58,128	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$581,280	$58,128	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 1 through 5)				**$698,000**	
Years 6 through 10					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$20,000	$20,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	2	well	$89,000	$178,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Equipment Replacement	1	ls	$7,500	$7,500	Replacement of valves/piping, pumps, etc.
Electric	80	hp	$1,241	$99,280	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$14,000	$14,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$520,280	$52,028	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$520,280	$52,028	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 6 through 10)				**$625,000**	
Years 11 through 15					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$20,000	$20,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	2	well	$89,000	$178,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$7,500	$7,500	Replacement of valves/piping, pumps, etc.
Electric	80	hp	$1,241	$99,280	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$10,000	$10,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$47,880	$47,880	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$516,160	$51,616	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$516,160	$51,616	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 11 through 15)				**$620,000**	
Years 16 through 20					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$20,000	$20,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	2	well	$89,000	$178,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	1	ls	$7,500	$7,500	Replacement of valves/piping, pumps, etc.
Electric	80	hp	$1,241	$99,280	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$10,000	$10,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$40,000	$40,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
PM/Local Agency Response	10%	of	$516,280	$51,628	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$516,280	$51,628	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 16 through 20)				**$620,000**	
Years 21 through 25 (Pulsed Operation)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$10,000	$10,000	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	1	ls	$28,000	$28,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	2	well	$44,500	$89,000	Assumes redevelopment of all recovery wells every 5-years. Redevelopment of injection wells every 5-years, if applicable.
Recharge Basin Maintenance	0	ls	$178,000	$0	No discharge to NCDPW basin.
Equipment Replacement	1	ls	$3,750	$3,750	Replacement of valves/piping, pumps, etc.
Electric	40	hp	$621	$24,820	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$10,000	$10,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$32,000	$32,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$26,667	$26,667	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$281,737	$28,174	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$281,737	$28,174	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 21 through 25)				**$339,000**	

continued on following page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of two new remedial wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Installation of new recovery well RW-21.*
- *Transfer of recovery well RW-20 and RW-21 water(1,000 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 26 through 30 (Monitoring Only)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	0	ls	$20,000	$0	Includes allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	No GAC replacement. Use of existing Main Facility regen GAC system.
Performance Monitoring Labor	0	ls	$56,000	$0	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	0	well	$89,000	$0	Assumes redevelopment of all recovery wells every 5-years. Redevelopment of injection wells every 5-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	0	ls	$7,500	$0	Replacement of valves/piping, pumps, etc.
Electric	0	hp	$1,241	$0	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$19,000	$19,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$6,000	$6,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$5,000	$5,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cy
Field Management and Data Evaluation	1	ls	$23,940	$23,940	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$20,000	$20,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$81,440	$8,144	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$81,440	$8,144	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 26 through 30)				**$98,000**	
PRESENT WORTH O&M AND LONG-TERM ACTIVITIES COST ALTERNATIVE 4				**$ 9,400,000**	30-year present worth value. Assumes a discount factor of 4.5 percent. See Table B5.
BASELINE COST (ALL ALTERNATIVES)				**$40,300,000**	See Notes 1 and 2 below.
TOTAL COST ALTERNATIVE 4				**$ 58,700,000**	Rounded to nearest $100,000.

See notes on the last page.

Table B4. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Notes:

1. Baseline cost is the capital and 30 year present worth cost for: OM&M of the existing Main Facility Treatment System, Site Groundwater IRM, and Plant 4 well head protection; capital cost for Site Area source reduction.
2. Capital cost for Site Area source reduction ($15.6 MM) has been previously estimated and provided in the Site Area FS. OM&M costs for the Site Groundwater IRM ($4.7 MM), Main Facility Remedial System ($19.9 MM) and Plant 4 well head treatment ($0.1 MM) have been estimated and provided by Northrop Grumman based on actual operating costs. Costs have been included herein for completeness (i.e., to include all associated cost for Study Area groundwater remediation).

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Table B5. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 4 Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

NPV Operation & Maintenance Costs Escalated over a 30-Year Period
Interest Rate: 8%
Escalation Rate: 3.5%
Capital Cost Amortization Period: 5 years

Year	GW IRM O&M	Pre-Escalated Costs	Escalated Cost (FV)	PV (Cost)
1	$698,000	$ 698,000	$ 722,430	$ 668,917
2	$698,000	$ 698,000	$ 747,715	$ 641,045
3	$698,000	$ 698,000	$ 773,885	$ 614,335
4	$698,000	$ 698,000	$ 800,971	$ 588,738
5	$713,000	$ 713,000	$ 846,820	$ 576,332
6	$625,000	$ 625,000	$ 768,285	$ 484,150
7	$625,000	$ 625,000	$ 795,175	$ 463,977
8	$625,000	$ 625,000	$ 823,006	$ 444,644
9	$625,000	$ 625,000	$ 851,811	$ 426,117
10	$640,000	$ 640,000	$ 902,783	$ 418,163
11	$620,000	$ 620,000	$ 905,181	$ 388,217
12	$620,000	$ 620,000	$ 936,863	$ 372,041
13	$620,000	$ 620,000	$ 969,653	$ 356,539
14	$620,000	$ 620,000	$ 1,003,591	$ 341,684
15	$635,000	$ 635,000	$ 1,063,847	$ 335,369
16	$620,000	$ 620,000	$ 1,075,071	$ 313,803
17	$620,000	$ 620,000	$ 1,112,699	$ 300,728
18	$620,000	$ 620,000	$ 1,151,643	$ 288,198
19	$620,000	$ 620,000	$ 1,191,951	$ 276,189
20	$635,000	$ 635,000	$ 1,263,516	$ 271,085
21	$339,000	$ 339,000	$ 698,147	$ 138,691
22	$339,000	$ 339,000	$ 722,582	$ 132,912
23	$339,000	$ 339,000	$ 747,873	$ 127,374
24	$339,000	$ 339,000	$ 774,048	$ 122,067
25	$354,000	$ 354,000	$ 836,589	$ 122,157
26	$98,000	$ 98,000	$ 239,704	$ 32,408
27	$98,000	$ 98,000	$ 248,094	$ 31,058
28	$98,000	$ 98,000	$ 256,777	$ 29,764
29	$98,000	$ 98,000	$ 265,764	$ 28,524
30	$113,000	$ 113,000	$ 317,168	$ 31,519
	$ 15,090,000	$ 15,090,000	$ 23,813,640	**$ 9,400,000**

1. Recurring 5 year cost for 5 year review report preparation.

Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Construction Capital Costs					
Recovery, Monitoring, and Injection Wells					
Recovery Well Installation					
Recovery Well RW-20	1	ea	$640,000	$640,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Injection Well Installation					
Injection Well IW-1	1	ea	$230,000	$230,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Injection Well IW-2	1	ea	$230,000	$230,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Injection Well IW-3	1	ea	$230,000	$230,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring and permitting.
Recovery Well Testing					
Recovery Well RW-20	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Monitoring Well Installation					
Monitoring Wells 150 to 250 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 250 to 350 ft bls	0	ea	$0	$0	None required under this alternative.
Monitoring Wells 350 to 450 ft bls	3	ea	$65,000	$195,000	Mud rotary, includes mobe/demobe, surface casing, and permitting.
Monitoring Wells 450 to 550 ft bls	3	ea	$85,000	$255,000	Mud rotary, includes mobe/demobe, surface casing, and permitting.
Well Development					
Recovery Wells	1	ea	$14,000	$14,000	Subcontractor cost for well development.
Monitoring Wells	6	ea	$7,000	$42,000	Subcontractor cost for well development.
Injection Wells	3	ea	$11,000	$33,000	Subcontractor cost for well development.
Waste Management					
Recovery Wells	1	ls	$14,000	$14,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Monitoring Wells	1	ls	$77,000	$77,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Injection Wells	1	ls	$8,000	$8,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Subtotal Recovery, Monitoring, and Injection Wells				**$1,988,000**	

continued on following page.

Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Recovery Well RW-20 Pumping System and Tower 102 Upgrades					
Contractor mobilization/demobilization	1	ls	$0	$0	Inlcuded in BWD Plant 4 capital upgrades line item below.
Site Utility Survey	1	ls	$20,000	$20,000	One-call utility survey for public property, subcontracting utility locating firm for private property.
Site Preparation	1	ls	$172,000	$172,000	Engineering estimate for clearing, work area set up, equipment set up, traffic, E&S controls.
Wellhead Vault Structural	1	ls	$20,000	$20,000	6' x 8' precast concrete vault with penetrations for utilities including installation.
Recovery Pump and In-Well Drop Pipe	1	ls	$85,000	$85,000	Includes a Grundfos 40 HP submerisble turbine pump and 6-inch diameter in-well recovery pipe to land surface.
Wellhead Vault Mechanical	1	ls	$45,000	$45,000	Includes flowmeter, pressure gauges, sample ports, in-vault piping, etc.
Wellhead Vault Electrical Supply	1	ls	$73,000	$73,000	Power supply and disconnect to recovery well vault.
Wellhead Vault Electrical Controls	1	ls	$75,000	$75,000	Remote/satellite or ethernet based controls tied into upgraded Tower 102 system.
Tower 102 System Mechanical Upgrades	1	ea	$30,000	$30,000	Piping, valves, sample port, upgrade to Tower 102 system.
Tower 102 System Controls and Instrumentation	1	ls	$85,000	$85,000	Remote/satellite or ethernet based control upgrades to receive feed from new recovery vaults.
Pipe Cleanouts and Air/Vacuum Release Valves	4	ea	$750	$3,000	Recovery line pipe cleanouts and air/vacuum release valves every 500 feet.
Trenching and Piping	1600	lf	$151	$240,870	10-inch diameter double-wall HDPE from recovery well to existing spare pipe adjacent to existing recovery well RW-19.
Site Restoration	1	ls	$158,000	$158,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for recovery pipe.
Contractors In-House Project Management	9	wks	$12,000	$108,000	Engineering estimate for construction contractors internal project management cost.
As-built Survey	1	ls	$20,000	$20,000	Engineering estimate for as-built utility survey and elevations.
System Startup Testing	0	wks	$12,000	$0	Inlcuded in BWD Plant 4 capital upgrades line item below.
Subtotal Recovery Well RW-20 Pumping System and Tower 102 Upgrades				**$1,135,000**	

continued on following page.

Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Bethpage Water District Plant 4 Capital Upgrades					
Contractor mobilization/demobilizationn	1	ls	$200,000	$200,000	Engineering estimate for mobilization/demobilization, H&S, and client required bid, performance, and payment bonds.
Site Utility Survey	1	ls	$20,000	$20,000	One-call utility survey for public property, subcontracting utility locating firm for private property.
Site Preparation	1	ls	$20,000	$20,000	Engineering estimate for clearing, work area set up, equipment set up, and E&S controls.
Structural Construction	1000	sf	$25	$25,000	1000 square foot VPGAC foundation and related site work.
Recovery Pump and Well Upgrades	0	ls	$0	$0	Assumes no additional upgrades necessary. Use of existing wells/pumps as-is.
Decommissioning of Unnecessary Components	1	ea	$100,000	$100,000	Estimated allotment for removing/decommissioning unnecessary water supply components from service and winterizing
System Mechanical Upgrades	1	ea	$100,000	$100,000	Replacement blower, ductwork for GAC, piping modifications to convert from water supply to remediation system.
System Controls and Instrumentation Upgrades	1	ls	$100,000	$100,000	Installation of new controls system and additional instrumentation upgrades including remote access system.
System Electrical Supply Upgrades	1	ls	$50,000	$50,000	Assumes no major upgrades necessary. Replacement of blower starter and misc. minor upgrades.
Major Process Equipment Items					
VPGAC	2	ea	$70,000	$140,000	Includes two 12,000 lb VPGAC units in lead/lag.
Duct Heater	1	ea	$35,000	$35,000	One electric operated duct heater to condition air before treatment.
Discharge Trenching and Piping	1600	lf	$120	$192,000	10-inch single-wall HDPE to Nassau County Basin NC-495.
Variable Orifice Valve, Drop-Pipe, Well Vault	3	ls	$135,500	$406,500	VO valve, stainless drop-pipe, centralizers, well vault, with installation.
Site Restoration	1	ls	$42,000	$42,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for recovery pipe.
Contractors In-House Project Management	0	wks	$12,000	$0	Included in RW-20 pumping system and tower 102 upgrade cost above.
As-built Survey	1	ls	$20,000	$20,000	Engineering estimate for as-built utility survey and elevations.
System Startup Testing	3	wks	$15,000	$45,000	Engineering estimate includes two weeks of startup with two engineers plus management and laboratory.
Bethpage Water District Plant 4 Capital Upgrades				**$1,496,000**	

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Engineering/Project Management					
Engineering	10%	of	$4,619,000	$461,900	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management	12%	of	$4,619,000	$554,280	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management	12%	of	$4,619,000	$554,280	All fees associated with management of construction related aspects of the project.
Subtotal Engineering/Project Management				**$1,570,000**	
Miscellaneous Project Costs					
SMP Preparation	1	LS	$250,000	$250,000	Preparation of site management plan and related appendices (SAP, OM&M, QAPP, etc.)
Site Management Survey	1	LS	$100,000	$100,000	ALTA survey for site management plan.
Administrative Controls Legal Fees	1	LS	$100,000	$100,000	Engineering allotment for legal fees associated with easement/deed restriction filing. Assumes individual property/lot deed restrictions not required.
Replacement of Lost Capacity	1	LS	$11,600,000	$11,600,000	Engineering estimate for replacement of BWD Plant 4 lost capacity provided by H2M consultants.
Replacement of Lost Capacity Legal Fees	2%	of	$11,600,000	$232,000	Engineering estimate for legal fees related to land lease, closing, and right-of-way recording.
Discharge Land Acquisition Cost	0.36	Acre	$250,000	$90,909	Engineering estimate for land lease, and right of ways, and property owner required bonds.
Discharge Land Acquisition Legal and Administrative Fees	10%	of	$90,909	$9,091	Engineering estimate for legal fees related to land purchase and right-of-way recording.
Subtotal Miscellaneous Project Costs				**$12,382,000**	
Site Closure and Demobilization					
Well Abandonment	0	ea	$0	$0	Occurs after Year 30. Not included.
Building Removal	0	ea	$0	$0	Occurs after Year 30. Not included.

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Site Closure Labor	0	ea	$0	$0	Occurs after Year 30. Not included.
Project Management/Regulatory Communications/Meetings	0	ls	$0	$0	Occurs after Year 30. Not included.
Subtotal Site Closure and Demobilization				**$0**	
SUBTOTAL CAPITAL COST				**$18,571,000**	
CAPITAL COST CONTINGENCY				**$3,714,200**	20% contingency.
TOTAL CAPITAL COST WITH CONTINGENCY ALTERNATIVE 5				**$22,300,000**	Rounded to nearest $100,000.
Annual Operation and Maintenance and Long-Term Activities					
Years 1 through 5					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$41,200	$41,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	60431	lbs	$2.54	$153,314	Replacement of VPGAC media for new treatment system. Average annual usage rate for given timeframe.
Performance Monitoring Labor	1	ls	$61,000	$61,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	5	well	$89,000	$445,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$15,000	$15,000	Replacement of valves/piping, pumps, etc.
Electric	671	hp	$1,241	$832,711	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$65,000	$65,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$25,000	$25,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$30,000	$30,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$60,000	$60,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$1,848,725	$184,873	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,848,725	$184,873	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 1 through 5)				**$2,219,000**	
Years 6 through 10					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$41,200	$41,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	52437	lbs	$2.54	$133,034	Replacement of VPGAC media for new treatment system. Average annual usage rate for given timeframe.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	5	well	$89,000	$445,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$15,000	$15,000	Replacement of valves/piping, pumps, etc.
Electric	671	hp	$1,241	$832,711	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Waste Management Costs	1	ls	$21,000	$21,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$60,000	$60,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$1,774,445	$177,444	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,774,445	$177,444	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 6 through 10)				**$2,130,000**	
Years 11 through 15					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$41,200	$41,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	25484	lbs	$2.54	$64,654	Replacement of VPGAC media for new treatment system. Average annual usage rate for given timeframe.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	5	well	$89,000	$445,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$15,000	$15,000	Replacement of valves/piping, pumps, etc.
Electric	671	hp	$1,241	$832,711	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$20,000	$20,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$48,000	$48,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$60,000	$60,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
PM/Local Agency Response	10%	of	$1,705,065	$170,507	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,705,065	$170,507	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 11 through 15)				**$2,047,000**	
Years 16 through 20					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$41,200	$41,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$56,000	$56,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	5	well	$89,000	$445,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$15,000	$15,000	Replacement of valves/piping, pumps, etc.
Electric	671	hp	$1,241	$832,711	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$20,000	$20,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$47,880	$47,880	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$60,000	$60,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$1,640,291	$164,029	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,640,291	$164,029	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 16 through 20)				**$1,969,000**	

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Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 21 through 25 (Pulsed Operation for Well 20 and Well 4-2; Well 4-1 Operating Full Time)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$36,200	$36,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$38,500	$38,500	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	4	well	$89,000	$356,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$15,000	$15,000	Replacement of valves/piping, pumps, etc.
Electric	614	hp	$1,241	$761,354	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$12,000	$12,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$20,000	$20,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$36,000	$36,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$45,000	$45,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$1,430,554	$143,055	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,430,554	$143,055	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 21 through 25)				**$1,717,000**	

continued on the following page.

Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Reduce TVOC mass and reduce impacts to BWD Plants 4 and 5 through installation of one new remedial well, operation of BWD Plant 4 as a remediation system, and replacement of water supply capacity. Includes:

- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery well RW-20.*
- *Transfer of recovery well RW-20 water (500 gpm) to the existing Main Facility Treatment System (Tower 102).*
- *Upgrade and use of BWD Plant 4 and Recovery Wells 4-1 and 4-2 as a remediation system (2,700 gpm).*
- *Replacement of lost capacity of BWD Plant 4.*
- *Discharge of 1,000 gpm from BWD Plant 4 treated effluent to Arthur Avenue Recharge Basin.*
- *Discharge of 1,700 gpm from BWD Plant 4 treated effluent to three (3) new shallow injection wells (two operating; one backup/spare).*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 26 through 30 (Wells RW-20 and 4-2 offline; Well 4-1 Operating Full Time)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	1	ls	$31,200	$31,200	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$21,000	$21,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	3	well	$89,000	$267,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	1	ls	$30,000	$30,000	Cleaning of recharge basin to restore permeability once every 5 years. Assumes cost split with third parties.
Equipment Replacement	1	ls	$10,000	$10,000	Replacement of valves/piping, pumps, etc.
Electric	556	hp	$1,241	$689,996	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	1000	gpm	$35	$35,000	Discharge fee for utilization of NCDPW basin.
Groundwater Plume Management Monitoring Labor	1	ls	$28,500	$28,500	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$9,000	$9,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$15,000	$15,000	Disposal of site refuse and incremental increase in DNAPL disposal due to increase in existing VPGAC regen cycles.
Field Management and Data Evaluation	1	ls	$36,000	$36,000	Engineers estimate for management of field staff and data evaluation.
Reporting	1	ls	$45,000	$45,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$1,225,196	$122,520	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$1,225,196	$122,520	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 26 through 30)				**$1,470,235**	
PRESENT WORTH O&M AND LONG-TERM ACTIVITIES COST ALTERNATIVE 5				**$ 33,400,000**	30-year present worth value. Assumes a discount factor of 4.5 percent. See Table B7.
BASELINE COST (ALL ALTERNATIVES)				**$40,300,000**	See Notes 1 and 2 below.
TOTAL COST ALTERNATIVE 5				**$ 96,000,000**	Rounded to nearest $100,000.

See notes on the last page.

Table B6. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Notes:

1. Baseline cost is the capital and 30 year present worth cost for: OM&M of the existing Main Facility Treatment System, Site Groundwater IRM, and Plant 4 well head protection; capital cost for Site Area source reduction.
2. Capital cost for Site Area source reduction ($15.6 MM) has been previously estimated and provided in the Site Area FS. OM&M costs for the Site Groundwater IRM ($4.7 MM), Main Facility Remedial System ($19.9 MM) and Plant 4 well head treatment ($0.1 MM) have been estimated and provided by Northrop Grumman based on actual operating costs. Costs have been included herein for completeness (i.e., to include all associated cost for Study Area groundwater remediation).

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Table B7. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 5 Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

NPV Operation & Maintenance Costs Escalated over a 30-Year Period
Interest Rate: 8%
Escalation Rate: 3.5%
Capital Cost Amortization Period: 5 years

Year	GW IRM O&M	Pre-Escalated Costs	Escalated Cost (FV)	PV (Cost)
1	$2,219,000	$ 2,219,000	$ 2,296,665	$ 2,126,542
2	$2,219,000	$ 2,219,000	$ 2,377,048	$ 2,037,936
3	$2,219,000	$ 2,219,000	$ 2,460,245	$ 1,953,022
4	$2,219,000	$ 2,219,000	$ 2,546,354	$ 1,871,646
5	$2,234,000	$ 2,234,000	$ 2,653,291	$ 1,805,785
6	$2,130,000	$ 2,130,000	$ 2,618,314	$ 1,649,982
7	$2,130,000	$ 2,130,000	$ 2,709,955	$ 1,581,233
8	$2,130,000	$ 2,130,000	$ 2,804,803	$ 1,515,348
9	$2,130,000	$ 2,130,000	$ 2,902,971	$ 1,452,208
10	$2,145,000	$ 2,145,000	$ 3,025,734	$ 1,401,500
11	$2,047,000	$ 2,047,000	$ 2,988,558	$ 1,281,741
12	$2,047,000	$ 2,047,000	$ 3,093,158	$ 1,228,335
13	$2,047,000	$ 2,047,000	$ 3,201,418	$ 1,177,155
14	$2,047,000	$ 2,047,000	$ 3,313,468	$ 1,128,107
15	$2,062,000	$ 2,062,000	$ 3,454,569	$ 1,089,024
16	$1,969,000	$ 1,969,000	$ 3,414,219	$ 996,578
17	$1,969,000	$ 1,969,000	$ 3,533,716	$ 955,054
18	$1,969,000	$ 1,969,000	$ 3,657,396	$ 915,260
19	$1,969,000	$ 1,969,000	$ 3,785,405	$ 877,124
20	$1,984,000	$ 1,984,000	$ 3,947,741	$ 846,981
21	$1,717,000	$ 1,717,000	$ 3,536,044	$ 702,455
22	$1,717,000	$ 1,717,000	$ 3,659,805	$ 673,186
23	$1,717,000	$ 1,717,000	$ 3,787,899	$ 645,137
24	$1,717,000	$ 1,717,000	$ 3,920,475	$ 618,256
25	$1,732,000	$ 1,732,000	$ 4,093,140	$ 597,672
26	$1,470,235	$ 1,470,235	$ 3,596,134	$ 486,204
27	$1,470,235	$ 1,470,235	$ 3,721,999	$ 465,945
28	$1,470,235	$ 1,470,235	$ 3,852,269	$ 446,531
29	$1,470,235	$ 1,470,235	$ 3,987,098	$ 427,925
30	$1,485,235	$ 1,485,235	$ 4,168,749	$ 414,279
	$ 57,851,176	$ 57,851,176	$ 99,108,641	**$ 33,400,000**

1. Recurring 5 year cost for 5 year review report preparation.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Construction Capital Costs					
Recovery, Monitoring, and Injection Wells					
Recovery Well Installation					
Recovery Well RW-22	1	ea	$450,000	$450,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Recovery Well RW-23	1	ea	$540,000	$540,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Recovery Well RW-24	1	ea	$640,000	$640,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Recovery Well RW-25	1	ea	$700,000	$700,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Recovery Well RW-26	1	ea	$750,000	$750,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Recovery Well Testing					
Recovery Well RW-22	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Recovery Well RW-23	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Recovery Well RW-24	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Recovery Well RW-25	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Recovery Well RW-26	1	ea	$20,000	$20,000	Subcontractor cost for 48-hour pump test.
Injection Well Installation					
Injection Well INJ-22	4	ea	$230,000	$920,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Injection Well INJ-23	4	ea	$310,000	$1,240,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Injection Well INJ-24	2	ea	$410,000	$820,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Injection Well INJ-25	2	ea	$470,000	$940,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Injection Well INJ-26	2	ea	$520,000	$1,040,000	Reverse rotary, includes mobe/demobe, surface casing, verticle profile boring, and permitting.
Monitoring Well Installation					
Monitoring Wells 0 to 125 ft bls	18	ea	$10,000	$180,000	HSA, includes mobe/demobe, protective casing, and permitting.
Monitoring Wells 126 to 250 ft bls	9	ea	$55,000	$495,000	Mud rotary, includes mobe/demobe, surface casing and permitting.
Monitoring Wells 251 to 450 ft bls	12	ea	$65,000	$780,000	Mud rotary, includes mobe/demobe, surface casing and permitting.

continued on following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Monitoring Wells 451 to 650 ft bls	12	ea	$85,000	$1,020,000	Mud rotary, includes mobe/demobe, surface casing and permitting.
Well Development					
Recovery Wells	5	ea	$14,000	$70,000	Subcontractor cost for well development.
Shallow Monitoring Wells	18	ea	$4,000	$72,000	Subcontractor cost for well development.
Deep Monitoring Wells	33	ea	$7,000	$231,000	Subcontractor cost for well development.
Injection Wells	14	ea	$11,000	$154,000	Subcontractor cost for well development.
Waste Management					
Recovery Wells	1	ls	$98,000	$98,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Monitoring Wells	1	ls	$493,000	$493,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Injection Wells	1	ls	$123,000	$123,000	Waste characterization, handling, and disposal for well soil cuttings, development water, and pump test water.
Subtotal Recovery, Monitoring, and Injection Wells				**$11,856,000**	
Recovery Well Pumping Systems (5 Systems)					
Contractor mobilization/demobilizationn	0	ls	$0	$0	Inlcuded in typical treatment system capital line item below.
Site Utility Survey	0	ls	$0	$0	Included in typical treatment system capital line item below.
Site Preparation	0	ls	$0	$0	Included in typical treatment system capital line item below.
Wellhead Shed	5	ls	$15,000	$75,000	10' x10' above grade well house with penetrations for utilities including installation.
Recovery Pump and In-Well Drop Pipe	5	ls	$85,000	$425,000	Includes a Grundfos submerisble turbine pump (various motor sizes) and 6-inch diameter in-well recovery pipe to land surface.
Wellhead Shed Mechanical	5	ls	$25,000	$125,000	Includes flowmeter, pressure gauges, sample ports, in-vault piping, etc.
Wellhead Shed Electrical Supply	5	ls	$33,500	$167,500	Power supply and disconnect to recovery well shed.
Wellhead Shed Electrical Controls	5	ls	$10,000	$50,000	Minor controls for pump protection and system protection.
Pipe Cleanouts and Air/Vacuum Release Valves	0	ea	$500	$0	Recovery line pipe cleanouts and air/vacuum release valves every 500 feet. Not necessary.
Influent Trenching and Piping	250	lf	$120	$30,000	10-inch single-wall pipe. Assumes well installed on same parcel as treatment plant.

continued on following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Site Restoration	0	ls	$0	$0	Inlcuded in typical treatment system capital line item below.
Contractors In-House Project Management	0	wks	$12,000	$0	Inlcuded in typical treatment system capital line item below.
As-built Survey	0	ls	$0	$0	Inlcuded in typical treatment system capital line item below.
System Startup Testing	0	wks	$15,000	$0	Included in typical treatment system capital line item below.
Subtotal Recovery Well Pumping Systems				**$873,000**	
Recovery Well Treatment Systems (5 Systems)					
Contractor mobilization/demobilizationn	5	ls	$150,000	$750,000	Engineering estimate for mobilization/demobilizationn for 5 new treatment plants plus bonds.
Site Utility Survey	5	ls	$20,000	$100,000	One-call utility survey for public property, subcontracting utility locating firm for private property (for 5 new treatment plants).
Site Preparation	1	ls	$753,000	$753,000	Engineering estimate for clearing, work area set up, equipment set up, traffic and E&S controls for 5 new treatment plants.
Building/Air Stripper Structural Construction	10000	sf	$25	$250,000	Includes a 30 X 30 X 16-foot building foundation plus 1000 square foot VPGAC foundation and site work for 5 new treatment plants.
Building Erection	5000	sf	$125	$625,000	Includes a 30 X 30 X 16-foot pre-engineered butler building for ea of 5 new treatment plants.
Major Process Equipment Items					
Air Stripping System	20	ea	$190,000	$3,800,000	Four Bisco/NEEP low profile air stripping skids with transfer pumps, blower, controls, piping/valves per treatment plant.
VPGAC	10	ea	$70,000	$700,000	Includes two 12,000 lb VPGAC units in lead/lag per treatment plant.
Transfer Pumps	0	ea	$0	$0	Included in air stripping skids.
Duct Heater	5	ea	$25,000	$125,000	One xx kw electric operated duct heater to condition air before treatment for ea of 5 new treatment plants.
Building Process Piping	5	ls	$100,000	$500,000	Engineering estimate for building process piping/duct work for ea of 5 new treatment plants.
Building HVAC	5	ls	$20,000	$100,000	Includes pitless adapters and oversized curb box (concrete sub-vault) for ea of 5 new treatment plants.
Building Electrical Supply	5	ls	$100,000	$500,000	Engineering estimate to supply power from utility pole to treatment building for ea of 5 new treatment plants..
Building Controls and Instrumentation	5	ls	$150,000	$750,000	Engineering estimate to supply electric, lighting, HVAC, and controls to equipment in building w/main control panel (5 plants).
Additional Utility Connections	5	ls	$125,000	$625,000	Engineering estimate for potable water supply for 5 new plants.
Building Drainage System	5	ls	$20,000	$100,000	Engineering estimate for catch basins and drywells for stormwater management plus gutters/leaders (5 plants).

continued on following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Pipe Cleanouts and Air/Vacuum Release Valves	26	ea	$750	$19,500	Discharge line pipe cleanouts and air/vacuum release valves every 500 feet for 5 plants.
Discharge Trenching and Piping	12650	lf	$120	$1,518,000	10" HDPE to individual injection wells (5 treatment plants).
Variable Orifice Valve, Drop-Pipe, Well Vault	14	ls	$135,500	$1,897,000	VO valve, stainless drop-pipe, centralizers, well vault, with installation (5 treatment plants).
Site Restoration	1	ls	$1,162,000	$1,162,000	Engineering estimate to restore all areas disturbed by work including sidewalk/road restoration for discharge pipe.
Site Security System	5	ls	$10,000	$50,000	Fencing and CCTV system w/remote monitoring access (5 treatment plants).
Contractors In-House Project Management	30	wks	$12,000	$360,000	Engineering estimate for construction contractors internal project management cost for 5 treatment plants.
As-Built Survey	5	ls	$20,000	$100,000	Engineering estimate for as-built utility survey and elevations for 5 treatment plants.
System Startup Testing	15	wks	$15,000	$225,000	Engineering estimate includes two weeks of startup per plant with two engineers plus management and laboratory.
	Subtotal Well Treatment Systems			**$15,010,000**	
Engineering/Project Management					
Engineering	10%	of	$27,739,000	$2,773,900	Design, Remedial Action Work Plan(s), construction related reporting, etc.
Construction Management	12%	of	$27,739,000	$3,328,680	Subcontractor bidding and procurement, management of field staff/construction crew, etc.
Project Management	12%	of	$27,739,000	$3,328,680	All fees associated with management of construction related aspects of the project.
	Subtotal Engineering/Project Management			**$9,431,000**	
Miscellaneous Project Costs					
SMP Preparation	1	LS	$600,000	$600,000	Preparation of site management plan and related appendices (SAP, OM&M, QAPP, etc.) for 5 treatment plants.
Site Management Survey	1	LS	$100,000	$100,000	ALTA survey for site management plan.
Administrative Controls Legal Fees	1	LS	$100,000	$100,000	Engineering allotment for legal fees associated with easement/deed restriction filing. Assumes individual property/lot deed restrictions not required.

continued on following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Injection Well and Pipe Land Acquisition Cost	2.88	Acre	$250,000	$718,750	Engineering estimate for land lease, and right of ways, and property owner required bonds.
Injection Well and Pipe Land Acquisition Legal and Administrative Fees	10%	of	$718,750	$71,875	Engineering estimate for legal fees related to land lease and right-of-way recording.
Treatment Building and Discharge Land Acquisition Cost	5	Acre	$500,000	$2,500,000	Engineering estimate for land purchase.
Treatment Building and Discharge Land Acquisition Legal and Administrative Fees	10%	of	$2,500,000	$250,000	Engineering estimate for legal fees related to land purchase and right-of-way recording.
Subtotal Miscellaneous Project Costs				**$4,341,000**	
Site Closure and Demobilization					
Well Abandonment	0	ea	$0	$0	Occurs after Year 30. Not included.
Building Removal	0	ea	$0	$0	Occurs after Year 30. Not included.
Site Closure Labor	0	ea	$0	$0	Occurs after Year 30. Not included.
Project Management/Regulatory Communications/Meetings	0	ls	$0	$0	Occurs after Year 30. Not included.
Subtotal Site Closure and Demobilization				**$0**	
SUBTOTAL CAPITAL COST				**$41,511,000**	
CAPITAL COST CONTINGENCY				**$8,302,200**	20% contingency.
TOTAL CAPITAL COST WITH CONTINGENCY ALTERNATIVE 6				**$49,900,000**	Rounded to nearest $100,000.

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Annual Operation and Maintenance and Long-Term Activities					
Years 1 through 5					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	5	ls	$41,200	$206,000	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	707428	lbs	$2.54	$1,794,746	Replacement of VPGAC media for all new treatment systems. Average annual usage rate for given timeframe.
Performance Monitoring Labor	1	ls	$206,000	$206,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	12	well	$89,000	$1,068,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	5	ls	$15,000	$75,000	Replacement of valves/piping, pumps, etc.
Electric	2023	hp	$1,241	$2,509,923	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$65,000	$65,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$87,000	$87,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$67,000	$67,000	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$63,840	$63,840	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$60,000	$300,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$6,450,008	$645,001	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$6,450,008	$645,001	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 1 through 5)				**$7,741,000**	

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 6 through 10					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	5	ls	$41,200	$206,000	Assumes 5-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	3635	lbs	$2.54	$9,223	Replacement of VPGAC media for all new treatment systems. Average annual usage rate for given timeframe.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Performance Monitoring Labor	1	ls	$172,000	$172,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	12	well	$89,000	$1,068,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	5	ls	$15,000	$75,000	Replacement of valves/piping, pumps, etc.
Electric	2023	hp	$1,241	$2,509,923	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$49,000	$49,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$67,000	$67,000	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$63,840	$63,840	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$60,000	$300,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$4,565,486	$456,549	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$4,565,486	$456,549	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Year 6 through 10)				**$5,479,000**	

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 11 through 15					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	5	ls	$41,200	$206,000	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$151,000	$151,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	12	well	$89,000	$1,068,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	5	ls	$15,000	$75,000	Replacement of valves/piping, pumps, etc.
Electric	2023	hp	$1,241	$2,509,923	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$46,000	$46,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$67,000	$67,000	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$63,840	$63,840	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$60,000	$300,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$4,532,263	$453,226	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$4,532,263	$453,226	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 11 through 15)				**$5,439,000**	

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 16 through 20					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	5	ls	$41,200	$206,000	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$131,000	$131,000	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	12	well	$89,000	$1,068,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	5	ls	$15,000	$75,000	Replacement of valves/piping, pumps, etc.
Electric	2023	hp	$1,241	$2,509,923	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$41,000	$41,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$67,000	$67,000	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$63,840	$63,840	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$60,000	$300,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$4,507,263	$450,726	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$4,507,263	$450,726	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 16 through 20)				**$5,409,000**	

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 21 through 25 (Pulsed Operation)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	5	ls	$20,600	$103,000	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	1	ls	$65,500	$65,500	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	12	well	$44,500	$534,000	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	5	ls	$7,500	$37,500	Replacement of valves/piping, pumps, etc.
Electric	2023	hp	$621	$1,254,961	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$38,000	$38,000	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$41,000	$41,000	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$67,000	$67,000	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$42,560	$42,560	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$40,000	$200,000	Engineers estimate for quarterly interim monitoring reports and annual reporting.
PM/Local Agency Response	10%	of	$2,391,021	$239,102	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$2,391,021	$239,102	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 21 through 25)				**$2,870,000**	

continued on the following page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Restore Aquifer to Pre-Disposal Conditions through groundwater pump-and-treat with enhanced recharge via injection wells.
Includes:
- *Park source remediation and continued operation of existing remedial systems and wellhead protection (i.e., baseline conditions).*
- *Installation of new recovery wells RW-22, RW-23, RW-24, RW-25, and RW-26.*
- *Treatment of recovered groundwater through 5 new treatment plants.*
- *For estimating purposes, ea treatment plant design/cost assumed to be equivalent.*
- *Recharge of groundwater through 7 new groundwater Injection wells plus installation of 7 spare/backup wells.*
- *Proposed remedial measures shutdown as described in Table B1.*

Description	Quantity	Units	Unit Cost ($)	Total Cost ($)	Comments
Years 26 through 30 (Monitoring Only)					
Site Management Plan Implementation	1	ls	$7,500	$7,500	Annual site verification inspections and reporting by NYS PE.
System Operator Labor	0	ls	$41,200	$0	Assumes 3-days per month for a site operator to perform OM&M of new treatment plant plus allotment for increase in OM&M of existing treatment system.
Media Replacement	0	lbs	$2.54	$0	GAC no longer required to meet air discharge regulations based on modeled influent groundwater concentration.
Performance Monitoring Labor	0	ls	$131,000	$0	Water-levels and influent and effluent sampling to monitor system performance.
Well Redevelopment	0	well	$89,000	$0	Assumes redevelopment of all recovery wells every 3-years. Redevelopment of injection wells every 3-years, if applicable.
Recharge Basin Maintenance	0	ls	$30,000	$0	No discharge to NCDPW basin.
Equipment Replacement	0	ls	$15,000	$0	Replacement of valves/piping, pumps, etc.
Electric	0	hp	$1,241	$0	$0.17/kwh. Includes recovery well pumps, air stripper blower, building HVAC, transfer pumps, and duct heater.
NCDPW Discharge Fee	0	gpm	$35	$0	No discharge to NCDPW basin.
Groundwater Plume Management					
Monitoring Labor	1	ls	$12,667	$12,667	Monitoring labor for system effectiveness and plume management monitoring.
Laboratory Analytical	1	ls	$13,667	$13,667	Laboratory analytical for groundwater samples and system performance samples (i.e., system air and water samples).
Waste Management Costs	1	ls	$22,333	$22,333	Disposal of site refuse and groundwater monitoring wastes.
Field Management and Data Evaluation	1	ls	$21,280	$21,280	Engineers estimate for management of field staff and data evaluation.
Reporting	5	ls	$20,000	$100,000	Plume management monitoring reporting only. Systems shut down.
PM/Local Agency Response	10%	of	$177,447	$17,745	Financial management, regulatory and internal/client communications, public relations.
Contingency	10%	of	$177,447	$17,745	Contingency for OM&M.
Subtotal Annual O&M and Long-Term Activities (Years 26 through 30)				**$213,000**	
PRESENT WORTH O&M AND LONG-TERM ACTIVITIES COST ALTERNATIVE 6				**$ 87,700,000**	30-year present worth value. Assumes a discount factor of 4.5 percent. See Table B9.
BASELINE COST (ALL ALTERNATIVES)				**$40,300,000**	See Notes 1 and 2 below.
TOTAL COST ALTERNATIVE 6				**$ 177,900,000**	Rounded to nearest $100,000.

See notes on the last page.

Table B8. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

Notes:

1. Baseline cost is the capital and 30 year present worth cost for: OM&M of the existing Main Facility Treatment System, Site Groundwater IRM, and Plant 4 well head protection; capital cost for Site Area source reduction.
2. Capital cost for Site Area source reduction ($15.6 MM) has been previously estimated and provided in the Site Area FS. OM&M costs for the Site Groundwater IRM ($4.7 MM), Main Facility Remedial System ($19.9 MM) and Plant 4 well head treatment ($0.1 MM) have been estimated and provided by Northrop Grumman based on actual operating costs. Costs have been included herein for completeness (i.e., to include all associated cost for Study Area groundwater remediation).

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Table B9. Detailed Costs of Remedial Alternatives: Study Area Groundwater Alternative 6 Present Worth Calculations, Study Area Feasibility Study, Northrop Grumman Systems Corporation, Operable Unit 3 (Former Grumman Settling Ponds), Bethpage, New York.

NPV Operation & Maintenance Costs Escalated over a 30-Year Period
Interest Rate: 8%
Escalation Rate: 3.5%
Capital Cost Amortization Period: 5 years

Year	GW IRM O&M	Pre-Escalated Costs	Escalated Cost (FV)	PV (Cost)
1	$7,741,000	$ 7,741,000	$ 8,011,935	$ 7,418,458
2	$7,741,000	$ 7,741,000	$ 8,292,353	$ 7,109,356
3	$7,741,000	$ 7,741,000	$ 8,582,585	$ 6,813,133
4	$7,741,000	$ 7,741,000	$ 8,882,976	$ 6,529,252
5	$7,756,000	$ 7,756,000	$ 9,211,695	$ 6,269,325
6	$5,479,000	$ 5,479,000	$ 6,735,090	$ 4,244,249
7	$5,479,000	$ 5,479,000	$ 6,970,818	$ 4,067,405
8	$5,479,000	$ 5,479,000	$ 7,214,797	$ 3,897,930
9	$5,479,000	$ 5,479,000	$ 7,467,315	$ 3,735,516
10	$5,494,000	$ 5,494,000	$ 7,749,830	$ 3,589,671
11	$5,439,000	$ 5,439,000	$ 7,940,775	$ 3,405,662
12	$5,439,000	$ 5,439,000	$ 8,218,702	$ 3,263,760
13	$5,439,000	$ 5,439,000	$ 8,506,357	$ 3,127,770
14	$5,439,000	$ 5,439,000	$ 8,804,080	$ 2,997,446
15	$5,454,000	$ 5,454,000	$ 9,137,353	$ 2,880,475
16	$5,409,000	$ 5,409,000	$ 9,379,130	$ 2,737,679
17	$5,409,000	$ 5,409,000	$ 9,707,400	$ 2,623,609
18	$5,409,000	$ 5,409,000	$ 10,047,159	$ 2,514,292
19	$5,409,000	$ 5,409,000	$ 10,398,810	$ 2,409,530
20	$5,424,000	$ 5,424,000	$ 10,792,615	$ 2,315,536
21	$2,870,000	$ 2,870,000	$ 5,910,568	$ 1,174,168
22	$2,870,000	$ 2,870,000	$ 6,117,438	$ 1,125,245
23	$2,870,000	$ 2,870,000	$ 6,331,549	$ 1,078,359
24	$2,870,000	$ 2,870,000	$ 6,553,153	$ 1,033,428
25	$2,885,000	$ 2,885,000	$ 6,817,962	$ 995,544
26	$213,000	$ 213,000	$ 520,989	$ 70,439
27	$213,000	$ 213,000	$ 539,224	$ 67,504
28	$213,000	$ 213,000	$ 558,097	$ 64,691
29	$213,000	$ 213,000	$ 577,630	$ 61,996
30	$228,000	$ 228,000	$ 639,949	$ 63,596
	$ 135,845,000	$ 135,845,000	$ 206,618,331	**$ 87,700,000**

1. Recurring 5 year cost for 5 year review report preparation.