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Claremont Polychemical Corporation Site

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Treatability Work Plan

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1. Site Background

The Claremont Polychemical Corporation site (NYSDEC Site Number: 130015 and USEPA ID # NYD002044584) is located in a commercial and industrial area of the Town of Oyster Bay, County of Nassau. The original groundwater treatment plant (GWTP) and former facility structure (razed) are located on the east side of Winding Road, approximately 0.33 miles south of Bethpage Sweet Hollow Road. Adjoining the site property to the west and north are commercial properties including a trucking company and a commercial distributer. Open space, owned by SUNY Farmingdale, lies to the east of the site and the Bethpage State Park lies to the south. The Old Bethpage Solid Waste Transfer Facility is located on the west side of Winding Road approximately 0.15 miles to the west and the Nassau County Fire Training Center is located approximately 0.35 miles to the southwest. The site was divided by the EPA into six (6) operable units.

This work assignment is associated with Operable Unit 5 (OU-5), which is the treatment of off-site VOC impacted groundwater using an extraction and treatment system owned by the Town of Oyster Bay and associated with the Old Bethpage Landfill. OU-5 is operated by Ramboll's subcontractor, Groundwater and Environmental Services, Inc. (GES).

Treatability testing will be conducted to evaluate options for removal of identified emerging contaminants (ECs) being discharged from the OU-5 Groundwater Treatment Plant. The ECs are understood to include PFAS and 1,4-Dioxane (1,4-D). For the purpose of this evaluation, the treatment objectives will be to observe and assess what degree of removal can be attained for each of the ECs and whether the treatment targets identified in Section 2 can be met.

2. Objective

The objective of the treatability test, after treatment of VOCs by the existing air stripper, is to conduct screening tests for the additional future treatment of:

- 1,4-Dioxane (1,4-D) treatment of the air stripper effluent.
- Per- and poly- fluorinated substances (PFAS) treatment of the air stripper effluent.

The treatability testing is divided into the following tasks:

Task 1 – Water sample Collection and Characterization
Task 2 - Treatability Testing

- Advanced Oxidation Process (AOP) testing
- Adsorption testing

Task 3 Report

2.1 Task 1 Water sample Collection and Characterization

Prior to commencing treatability testing, samples will be collected from the three on-line recovery wells and from the combined air stripper influent and effluent, with discrete parameters from each well and flow proportioned composites (of all three recovery wells (RW) on-line). The following samples will be collected for characterization:

- RW-3
- RW-4

- RW-5
- Flow weighted average composite from RW-3, RW-4, and RW-5 (laboratory composite)
- Combined air stripper influent
- Combined air stripper effluent

Each sample will be quantified for following parameters:
- Total alkalinity, carbonate (CO3) and bicarbonate (HCO3) (Method 2320B)
- Methylene blue active substances (MBAS) (Method SM 5540C)
- Sulfate (SO4) (Method 9056A)
- Chlorides (Cl) (Method 9056A)
- Chemical oxygen demand (COD) (Method 410.4)
- Volatile organic compounds (VOCs) (Method 5021)
- Semi volatile organic compounds (SVOCs), including 1,4-D (Method USEPA 8270 and 8270 SIM)
- Total suspended solids (TSS) (Method 2540D)
- Total organic carbon (TOC) (Method SM 5310C)
- Total dissolved solids (TDS) (Method 2540C)
- Calcium carbonate (hardness as CaCO3) (Method SM 2340C)
- Total- and dissolved- (lab filtered) calcium- (Ca), iron (Fe), manganese (Mn) magnesium (Mg), and Total calcium (Ca), iron (Fe), manganese (Mn) magnesium (Mg), and arsenic (As) (Method 6020B)
- Five-day biochemical oxygen demand (BOD5) (Method SM 5210B)
- Total phosphorus (TP) (Method 365.1)
- Total nitrite/nitrate nitrogen (NO¬2/NO3) (Method 353.2)
- Ammonia nitrogen (Method SM 4500-NH3 B/C modified)
- Total Kjeldahl nitrogen (TKN) (Method 351.2)
- Bromide (Br) (Method 9056A)
- Fluoride (F) (Method 9056A)
- PFAS (Method 1633)
- Oxidation reduction potential (ORP) (field measured)
- Field chemistry parameters (conductivity, temperature, turbidity, pH)
- Biological Activity Reaction Test (BART) – Lab completed by Ramboll.
- Langelier saturation index (corrosivity) – Calculations to be performed by Ramboll upon receipt of the analytical data.

It is assumed that the water samples will be collected by the OU-5 operators. Ramboll will coordinate with the OU-5 operator regarding suitable sample containers and shipment of water samples. The anticipated volumes of site water required for treatability testing are shown in Table 1.

Table 1: Anticipated volumes required for testing.

Sample Event	**Volume**	**Location**
UV/TiO_2 Screening	5 gallons	London Ontario
UV/H_2O_2 & O_3/H_2O_2	10 gallons	Liverpool NY
Vender optimization	10 gallons	TBD by screening step
Bulk AOP (To support isotherm and RSSCT)	325 gallons	Liverpool NY

Sampling events performed for Task 1 and Task 2 of the treatability study will be performed in compliance with the Quality Assurance Project Plan with respect to sample collection, handling, preservation, and transportation.

2.1.1 Quality Assurance Project Plan

To ensure the data quality of water samples collected at OU-5 for the purposes of treatability testing, the established Quality Assurance Project Plan (QAPP) will be referenced. The principal purpose of the QAPP is to specify quality assurance/quality control (QA/QC) procedures for the collection, analysis, and evaluation of data that will be legally and scientifically defensible. A site-specific QAPP Addendum is provided as an appendix to each site-specific Work Plan and specifically supplements the QAPP. The QAPP can be found as Appendix E of the Site Management Plan (SMP).

Included in the QAPP is an addendum (Revised in August 2023) which adds components to the QAPP that include low-flow groundwater sampling for perfluorinated compounds (PFCs, specifically PFOS/PFOA) and 1,4-Dioxane. Sections 3.4.3, 4.1.2, and 6.2 of the Program QAPP have been revised to address specific procedures for the groundwater sampling related to 1,4-Dioxane and PFOS/PFOA groundwater sampling.

To the extent necessary to ensure the quality of samples and analytical results, sampling procedures used in this treatability program will follow the Program QAPP.

2.2 Task 2 – Treatability Testing

The objective of treatability testing is to screen the efficacy of advanced oxidation processes (AOP) to destroy 1,4-dioxane and to evaluate the adsorption for PFAS from the AOP-treated air stripper effluent to meet the following treatment targets:

- 1,4-dioxane: 0.35 micrograms/liter (ug/L)
- Perfluorooctane sulfonic acid (PFOS): 0.0027 ug/L
- Perfluorooctanoic acid (PFOA): 0.0067 ug/L

Treatment objectives with respect to 1,4-dioxane, PFOS, and PFOA concentration are based on NYDEC 2023 addendum to technical operational guidance series (TOGS) 1.1.1 for 1,4-dioxane, PFOS, and PFOA (-6 CRR-NY Part 703 surface water and groundwater quality standards and groundwater effluent limitations).

The treatability testing will comprise:

- AOP testing for 1,4-dioxane treatment.
- Adsorption testing for PFAS treatment.

2.3 AOP tests for 1,4-dioxane treatment

The AOP testing will comprise of four primary evaluations: Tests 1a, 1b, 1c, and 1d.

2.3.1 Test 1a: AOP Screening testing for 1,4-dioxane treatment

Test 1a: Bench-scale screening tests using AOP.

- Ultraviolet (UV)/hydrogen peroxide (H_2O_2)
- H_2O_2/ozone (O_3)

The UV/H_2O_2 and the H_2O_2/O_3 screening tests will be conducted at Ramboll's Applied Technology Development Laboratory (ATDL) in Liverpool, NY. For each screening test performed, a bench-

scale AOP reactor will be utilized. The AOP equipment consists of a 5-liter water sample reservoir with ports for oxidant addition and UV lamp insert, a recirculation pump, an ozone eductor, a flowmeter, and an in-line static mixer. Water will be continuously pumped from the reservoir through the system with the recycle pump. Hydrogen peroxide (or other oxidants) can be added to the reactor via a port on top. Ozone can be introduced to the water stream via the eductor. The mixture then flows through an in-line static mixer and is recycled back to the reservoir.
It is proposed that the AOP screening be conducted based on COD concentration in the air stripper effluent. Three tests will be conducted at the Oxidant: COD ratios of 0.5x, 1X, and 5x. The screening step acts as a decision gate to assess the feasibility of an AOP treatment method. Because of this, limited analytical testing will be performed on the treated sample, as the primary objective of the screening steps is to identify the best technology for 1,4-Dioxane treatment only. Therefore, the screening test samples will include, an AOP "influent" sample, as well as the "effluent" from each bench test, control samples.

2.3.2 UV/H_2O_2 Screening

Following addition of the untreated water sample and the oxidant to the reactor, the mixture will be allowed to mix with the recirculation pump for 5 minutes to ensure that the oxidant is mixed with the water. Power will be supplied to the UV-bulb, and UV light will be irradiated through the sample. The water sample will be allowed to mix for 15 minutes with exposure to constant UV light. At the end of the mixing period, the treated sample will be quenched with sodium metabisulfite to remove excess oxidant. Treated samples from each test run will be collected for 1,4-dioxane, PFAS, and TDS analysis by an outside laboratory with an expedited turn-around time. Table 2 outlines the testing parameters for the UV/H_2O_2 screening.

Table 2: UV/H_2O_2 screening test matrix

Sample	**Oxidant Dose (H_2O_2)**	**UV light Exposure (minutes)**
Screen 1 (low dose)	COD (mg/L) x 0.5	15
Screen 2 (middle dose)	COD (mg/L) x 1.0	15
Screen 3 (high dose)	COD (mg/L) x 5.0	15

The oxidant dose, as described in Table 2, is subject to change after review of the Task 1 characterization data. The UV light exposure time will remain equal for each oxidant dose tested. During the first screening test, COD will be measured before and after the 15-minute reaction period. If insignificant changes in COD concentration are observed, the test will be repeated with additional UV light exposure.

After each screening test, the pH of the treated sample and any physical observations (color change, solids formation, etc.) will be recorded. The residual peroxide in the treated sample will be measured and recorded.

2.3.3 H_2O_2/O_3 Screening

Similar to the UV/H_2O_2 testing, the H_2O_2/O_3 will be conducted at oxidant: COD mass ratios of 0.5X, 1X, and 5X (pending Task 1 results). The H_2O_2/O_3 addition will be conducted at 1:2 molar ratio.

For each H_2O_2/ O_3 screening test, the AOP reactor's sample reservoir will be filled with the site water, then the hydrogen peroxide will be added, followed by five minutes of mixing to ensure that the hydrogen peroxide is fully homogenized with the water, then the ozone will be sparged to the water sample via the eductor. Ozone will continue to be added until the total ozone added reaches the target mass, followed by an additional mixing period of 15 minutes. The treated sample then will be quenched with sodium metabisulfite to remove residual oxidants. Treated samples from each test run will be collected for 1,4-dioxane, PFAS, and TDS analysis by an outside laboratory with an expedited turn-around time. The H_2O_2/ O_3 screening test matrix is summarized in Table 3.

Table 3: H_2O_2/O_3 screening test matrix

Sample	Oxidant Dose ($H_2O_2+O_3$)	H_2O_2/O_3 Molar Ratio
Screen 1 (low dose)	COD (mg/L) x 0.5	1:2
Screen 2 (middle dose)	COD (mg/L) x 1.0	1:2
Screen 3 (high dose)	COD (mg/L) x 5.0	1:2

After each screening test, the pH of the treated sample and any physical observations (color change, solids formation, etc.) will be recorded. The residual peroxide in the treated sample will be measured and recorded.

2.3.4 Test 1b: Photocatalytic oxidation UV/TiO_2 tests

Historically, photocatalytic oxidation (UV/TiO_2) has been used successfully for 1,4-dioxane treatment of contaminated groundwater. Testing will be conducted by Purifics Water Inc. of London, Ontario, Canada. Three tests using three different electric energy dosages (EED) of increasing kWh/m3 will be conducted. Ramboll will consult with Purifics to select the EEDs to be used for the screening tests based on the results of Task 1, and Purifics' experience with treating 1,4-dioxane in similar aqueous matrix.

After each screening test, the pH of the treated sample and any physical observations (color change, solids formation, etc.) will be recorded. The AOP treated samples from each test run will be collected for 1,4-dioxane, PFAS, and TDS analysis by an outside laboratory with an expedited turn-around time.

2.3.5 Test 1c: Optimization testing for 1,4-dioxane treatment

Following the review of the AOP results from Tests 1a and 1b, Ramboll will identify the most successful treatment technology for the removal of 1,4-dioxane. Confirmation testing will be conducted by a selected AOP equipment vendor to better understand the oxidant dosages required, reaction kinetics, and to optimize the AOP system. The data from the optimization tests performed by the vendor will be collected and used for the basis of design of the full-scale AOP treatment system.

Ramboll will coordinate with the AOP vendor regarding the sample volume required for the optimization testing, and with the OU-5 operators to assist with the collection and shipment of samples. In addition, Ramboll will coordinate a bulk shipment of water with the treatment vendor that will be selected using the optimized treatment parameters.

If NYSDEC desires to have optimization testing performed amongst multiple bidding vendors to avoid sole-sourcing a particular treatment technology, Ramboll will revise the work plan and identify the estimated additional costs for NYSDEC approval prior to proceeding.

2.3.6 Test 1d: Bulk AOP treatment of site water

Upon completion of Test 1c, the selected vendor will treat a bulk sample of the site water using the optimized treatment conditions identified in Test 1c. The vendor will collect the treated bulk sample and ship one aliquot to an outside analytical lab for characterization, and the remaining sample to Ramboll's ATDL. Quenching of residual oxidant prior to shipment of samples will be performed as needed. The sample generated during Test 1d will be used to complete the subsequent adsorption testing. It is anticipated that approximately 325 gallons of AOP pretreated water will be required for the subsequent Task 2.

2.4 Adsorption Testing for PFAS Treatment

Bench-scale adsorption tests will be conducted to evaluate the capability of several adsorption media to effectively remove the PFAS from the AOP-treated effluent stream. The adsorption tests will be conducted following the completion of the AOP screening, optimization, and bulk treatment. The bulk AOP treated sample will be used for the adsorption testing since the adsorption treatment units will be downstream of the AOP treatment units in the full-scale system.

The adsorption tests will comprise two parts:

Part 1 Adsorption isotherm tests
Part 2 Rapid small-scale column tests (RSSCT)

2.4.1 Part 1: Adsorption isotherm tests

The isotherm tests will be used to screen the effectiveness of adsorption media (adsorbents) in removing of the PFAS compounds. Up to eight adsorption media will be selected for isotherm testing. Media will consist of various activated carbon and ion exchange resins.

For each media, five, 1-liter volumes of AOP treated site water will be mixed with pre-selected doses of adsorbent for a period of 24 hours. For activated carbon (AC), the adsorbent doses to be used will be dependent on the measured starting TOC concentrations, with a basis that carbon will adsorb 200mg TOC/g AC. Resin dosages will be based on the exchange capacity of the individual resins, and anion concentrations in the pretreated site water.

Upon completion of the mixing period, the adsorbent will be separated from the treated water by filtering each isotherm with a 0.45-µm filter. The filtrate will be collected and analyzed for PFAS and TOC. The objectives of this test are to identify the adsorption capacity and adsorption intensity of the adsorbents for PFAS. These parameters will be calculated by modeling the isotherm data; the models that will be used include the Langmuir and Freundlich isotherm.
The preliminary adsorption media selection matrix, based on previous PFAS remediation experience, is shown in Table 4.

Table 4: Adsorption Isotherm Media Matrix.

Vendor	Calgon	Evoqua	Cabot	Dupont	Lanxess	Purolite
GAC	Filtrasorb 400	Ultracarb 1240LD	Hydrodarco 4000	-	-	-
Resin	Calres 2301	-	-	Dowex PSR2+	Lewatit TP106	PFA694E
	Calres 2304	-	-	-	-	-

The most effective GAC and resin media from Part 1 (isotherms) will be used to perform RSSCT (Part 2).

2.4.2 Part 2: RSSCT

RSSCT will be performed to assess how long a full-scale contactor filled with the most successful media for PFAS removal will last before breakthrough of PFAS above the treatment goal is observed. Column testing will be performed by Ramboll. In total, two columns will be tested. One column will be packed with the most effective GAC media, and one column will be packed with the most effective resin media. Both PFAS and TOC will be monitored from the effluent of the column to assess breakthrough.

RSSCT column design and media preparation will be performed following the ASTM 6586 method "Standard Practice for the Prediction of Contaminant Adsorption on GAC in Aqueous Systems Using Rapid Small-Scale Column Tests".

2.5 Task 3 – Report

Upon completion of the testing, receipt of all submitted analytical sample data, and finalized vendor reports, Ramboll will prepare a treatability study report. The report will include a narrative of the study accompanied by the collected data, vendor recommendations, pertinent photography, and Ramboll's interpretation of the data as well as conclusions and recommendations.

A draft report will be submitted to NYSDEC for review. A final report will be issued to address NYSDEC comments.

3. Schedule

The following schedule (tasks are sequential, not parallel) is proposed for this scope of treatability testing:

Task	Schedule
1 - Source Characterization	6-8 weeks pending analytical TAT
2.3.1 - AOP Screening	3-4 weeks assuming 2-week TAT for non-PFAS analytes
2.3.5 - Vendor AOP optimization	3-4 weeks assuming 2-week TAT for non-PFAS analytes
2.3.6 - Vendor Bulk AOP Treatment	1-2 weeks
2.4.1 - Adsorption Isotherms	6-8 weeks
2.4.2 - RSSCT	9-10 weeks
3 - Draft Report	Within 3-weeks of receiving final analytical data from RSSCT
3 - Final Report	Within 3-weeks of receiving NYSDEC comments on Draft Report

*Based on analytical turnaround times of 6-8 weeks for PFAS