INNOVATIVE REUSE AND BENEFICIAL USE EVALUATION AND DEMONSTRATION PROJECT REPORT (RE02)

Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project

Project ID No. 1-18-3-21-8R

Cecil and Harford Counties, Maryland

Prepared For:

Maryland Environmental Service
259 Najoles Road
Millersville, Maryland 21108

Prepared By:

Northgate Environmental Management, Inc.
47 East All Saints Street
Frederick, Maryland 21701

December 5, 2022

Project No. 3037.02

428 13th Street, 4th Floor
Oakland, California 94612
Tel 510.839.0688

92 Argonaut, Suite 100
Aliso Viejo, California 92656
Tel 949.716.0050

47 East All Saints Street
Frederick, Maryland 21701
Tel 301.528.1500

www.ngem.com

INNOVATIVE REUSE AND BENEFICIAL USE EVALUATION AND DEMONSTRATION PROJECT REPORT

Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project

Project ID No. 1-18-3-21-8R
Cecil and Harford Counties, Maryland

December 5, 2022

Prepared For:

Maryland Environmental Service
259 Najoles Road.
Millersville, Maryland 21108

Prepared By:

Northgate Environmental Management, Inc.
47 East All Saints Street
Frederick, Maryland 21701

Deni Chambers

Deni Chambers
President

S J Bedosky

Stephen Bedosky
Principal Hydrogeologist

Samuel Merrill
Principal

C Demorest

Ana Demorest
Principal Engineer

CONTRIBUTION ACKNOWLEDGEMENTS

Northgate-Dutra Joint Venture acknowledges the following individuals for their contributions to this Innovative Reuse and Beneficial Use (IR/BU) Evaluation Report:

Matthew Rowe, Maryland Department of the Environment
Mark Mank, Maryland Department of the Environment
Jenny Herman Maryland Department of the Environment
Gary Shank, US. Geological Survey at the Chesapeake Bay Program Office
Lewis Linker, United States Environmental Protection Agency at the Chesapeake Bay Program Office
Andrea Danucalov, Constellation Energy Generation
Victor Magar, Ramboll*
Mark Rockel, Ramboll*
Kip Mumaw, Ecosystem Services*
Jeff Cornwall, University of Maryland, Center for Environmental Sciences*
Ken Staver, University of Maryland, Wye Research and Education Center*
Paulo Monteiro, University of California, Berkeley*
Kim Kurtis, Georgia Institute of Technology*
Daniel Benkeser, Georgia Institute of Technology*
Lauren Iacobucci, Tipping Point Resources Group*
Eric Stern, Tipping Point Resources Group*
Rob Miskewitz, Rutgers University*
Brendan Daly, Holcim*
Chris Clow, Holcim
Josh Fredlake, Holcim*

** Contributing authors to the Innovative Use and Beneficial Reuse Evaluation and Demonstration Project Report*
`

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS .... *v*

EXECUTIVE SUMMARY **ES-1**

Sediment Stockpile Sample Analytical Results and Impact on Potential End Uses ES-2
IR/BU Bench Scale Testing ES-3
Field Demonstration ES-5
Water Quality Impact Evaluation ES-6
Economic Evaluation of IR/BU Scenarios ES-6

1.0 INTRODUCTION **1**

1.1 Project Purpose and Objectives 1
1.2 IR/BU Evaluation Objectives 2
1.3 Site Background 2
1.4 Previous Investigations and Sediment Characterization Study Results 4
1.4.1 Historical Studies 4
1.4.2 Sediment Characterization Study 5
1.5 Overview of IR/BU Evaluation 7

2.0 SEDIMENT COLLECTION AND SAMPLING **10**

2.1 Pre-field Activities 10
2.2 Sediment Removal Operations 10
2.2.1 Mobilization and Demobilization 10
2.2.2 Dredging and Dewatering 11
2.2.3 Staging Area Construction and Off Site Transportation 12
2.3 Stockpile Screening and Sampling 13
2.3.1 Field Screening 13
2.3.2 Stockpile Sampling 13
2.3.3 Laboratory Analyses 14
2.4 Sediment Stockpile Sampling Results 16
2.4.1 Physical Analytical Results 16
2.4.2 Chemical Analytical Results 16
2.4.2.1 Nutrients 18

3.0 IR BENCH SCALE TESTING **19**

3.1 Concrete and Asphalt Manufacturing 19
3.2 Cement Clinker Manufacturing 20
3.3 Blended Soil for Highway and Horticultural Applications 20
3.3.1 Preparation and Testing of Blended Soil Products 21
3.3.2 Soil Fertility Testing 22

3.4 Supplemental Cementitious Material 23
3.4.1 Sample Preparation 24
3.4.2 Testing for Pozzolanic Elements 24
3.4.3 Calcination Temperature Optimization 24
3.4.4 Final Product 26
3.4.5 Summary 27
3.5 Sediment Stabilization 27
3.5.1 Assessment of Coal Content 28
3.5.2 Material Characterization & Evaluation of Stabilized Sediment 29
3.5.3 Evaluation of Impacts of Moisture Content on Stabilized Sediment 30
3.5.4 Summary 31
3.6 Bricks and Pavers 31
4.0 WATER QUALITY IMPACT EVALUATION 32
4.1 Data Evaluation and Synthesis 32
4.1.1 Background 32
4.1.2 Summary of Sediment and Nutrient Modeling 34
4.2 Linear Regression Model 35
4.2.1 Purpose 35
4.2.2 Model Development 36
4.2.3 Scenario Results and Considerations 38
4.3 Strategic Dredging Plan 39
4.3.1 Location 39
4.3.2 Time of Year 43
4.3.3 Volume 43
4.3.4 Depth and Spatial Extent 43
4.4 Summary and Implications for Further Investigation 44
5.0 ECONOMIC ANALYSIS 45
5.1 Introduction 45
5.2 Regulatory Context 45
5.3 Market Trends and Attractiveness 46
5.3.1 Concrete Sand 46
5.3.2 Asphalt Sand 47
5.3.3 Cement Clinker 48
5.3.4 Supplementary Cementitious Material 48
5.3.5 Blended Soil for Highway and Horticultural Uses 49
5.3.6 Stabilized Sediment 51
5.3.6.1 Potential Constraints 54
5.3.6.2 Summary 55
5.3.7 Sediment for In-water Applications 55

5.4 Economic Analysis 56
5.4.1 Market Absorption Potentials and Cost Efficiency Inputs 56
5.4.1.1 Concrete Sand 57
5.4.1.2 Asphalt Sand 58
5.4.1.3 Cement Clinker 58
5.4.1.4 Supplementary Cementitious Material 59
5.4.1.5 Blended Soil for Highway and Horticultural Use 59
5.4.1.6 Stabilized Sediment 60
5.4.1.7 Sediment for In-water Beneficial Uses 61
5.4.2 Dredging Scenario Modeling 63
5.4.2.1 Project Assumptions 63
5.4.2.2 Economic Scenarios 65
5.5 Cost-Benefit and Willingness-to-Pay Analysis 68
5.6 Economic Evaluation Summary 73

6.0 CONCLUSIONS AND RECOMMENDATIONS 76

7.0 REFERENCES 80

TABLES

1. List of Susquehanna River Flood Events at Conowingo, MD: 1993 – 2018
2. Laboratory Analytical Results – Metals, TOC, % Moisture, Grain Size
3. Laboratory Analytical Results – VOCs
4. Laboratory Analytical Results – SVOCs
5. Laboratory Analytical Results – PCBs
6. Laboratory Analytical Results – Organochlorine Pesticides
7. Laboratory Analytical Results – Dioxins and Furans
8. Laboratory Analytical Results – Total Petroleum Hydrocarbons
9. Laboratory Analytical Results – Nutrients and Salts
10. IR/BU Stockpile Sampling Analytical Methods Summary
11. Infill Volume and Associated Loading for Infill States
12. Sample Calculator Results and Annotation
13. Conowingo Reservoir Sediment Fraction Use Potentials
14. Combined Potential State Revenue Calculations on IR/BU Component Sales, Per Year
15. Willingness to Pay Results
16. Phosphorus Reduction relative to Conowingo Watershed Implementation Plan

FIGURES

1. Project Location
2. Susquehanna River Watershed
3. Core Locations - As Built
4. Conowingo IR/BU Evaluation – Material Management Approach
5. Relative Strength of Raw and Calcined Sediments (Temperature Optimization)
6. Total Organic Carbon Content vs. Fines Content
7. Unconfined Compressive Strength vs Curing Time
8. Chesapeake Bay Modeling Process
9. Phosphorus and Nitrogen Loading vs. Infill Volume
10. Change in Depth to Bottom Surface by Transect in Conowingo Reservoir, 1993 to 2008
11. Bathymetric Survey Transects Surveyed in Conowingo Reservoir
12. Areas of Consistent Deposition in the Conowingo Reservoir
13. Estimated Annual Gross Domestic Product for Maryland: Cement and Concrete Manufacturers
14. Landfill and Mine Sites in Proximity of Conowingo Dam
15. State and Federally Identified Brownfield Sites in Proximity of Conowingo Dam
16. Willingness to Pay Survey Questionnaire

APPENDICES

A Stockpile PID Readings
B Chain of Custody Form
C Eurofins Laboratory – Quality Assurance Manual
D Data Validation Reports
E Eurofins - Analytical Report
F Holcim Concrete/Asphalt Bench Scale Testing Results
G Holcim Cement Clinker Bench Scale Testing Results
H Stancills Inc. Bench Scale Testing Results
I Supplemental Cementitious Material Bench Scale Testing Results
J Stabilization and Solidification Bench Scale Testing Results
K Soil Fertility Testing Results

ACRONYMS AND ABBREVIATIONS

AdH	Adaptive Hydraulics
Al_2O_3	aluminum oxide
ATC	Anticipated Typical Concentration
BMPs	Best Management Practices
BTV	background threshold values
Calculator	Water Quality Impact Calculator
CBEMP	Chesapeake Bay Environmental Modeling Package
cfs	cubic feet per second
CLSM	Controlled low strength material
CO2	Carbon dioxide
COC	chain-of-custody
Constellation	Constellation Energy Generation, LLC (formerly Exelon Generation, LLC)
COPC	Constituent of Potential Concern
CPMBM	Conowingo Pond Mass Balance Model
CWIP	Conowingo Watershed Implementation Plan
CWP	Center for Watershed Protection
cy	cubic yards
cy/yr	cubic yards/year
Dam	Conowingo Dam
DCE	Discreet Choice Experiment
DGA	Data Gap Analysis Report
Exelon	Exelon Generation, LLC (now Constellation Energy Generation, LLC)
ft	foot or feet
FOB	Free on Board
HDR	HDR, Inc.
Holcim	Lafarge Holcim
IR	Innovative Reuse
IR/BU	Innovative Reuse and Beneficial Use
IR/BU Guidance	MDE, 2019 Innovative Reuse and Beneficial Use Guidance Document
K_2O	potassium oxide
LOI	Loss on Ignition
LRP	Land Restoration Program

LSRWA	Lower Susquehanna River Watershed Assessment
mcy	million cubic yards
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MECs	munitions and explosives of concern
MES	Maryland Environmental Service
mlb	million pounds
MPA	Maryland Port Administration
mt	million tons
MWG	Modeling Working Group
µm	micrometer
mg/kg	milligrams per kilogram
mm	millimeter
Na2O	sodium oxide
Northgate-Dutra JV	Northgate-Dutra Joint Venture
NTUs	nephelometric turbidity units
OCPs	organochlorine pesticides
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
Pilot Dredging Area	Dredging Area Designated by MES in Request for Proposals
PID	Photoionization Detector
ppm	parts per million
Project	Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project
Project Area	The portion of the Conowingo Reservoir between the MD/PA State line and the Conowingo Dam
psi	pounds per square inch
Reservoir	Conowingo Reservoir
RIA	Regulatory Impact Analysis
SCM	Supplemental Cementitious Materials
SCR	Sediment Characterization Study Report
SEM	Scanning Electron Microscopy
SGA	Sales, General and Administrative Overhead Costs
SHA	State Highway Administration
SiO_2	silicon dioxide
SRBC	Susquehanna River Basin Commission

STAC	Chesapeake Bay Program's Scientific and Technical Advisory Committee
Staging Area	Contained area at Peach Bottom Landing where sediment was offloaded from material barge
Stancills	Stancills, Inc.
State	State of Maryland
State Line	Maryland/Pennsylvania State border
SVOCs	semi-volatile organic compounds
Tipping Point	Tipping Point Resources Group LLC
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TPH	total petroleum hydrocarbons
UC Berkeley	University of California Berkeley
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Service
VOCs	volatile organic compounds
WREC	Wye Research and Education Center, University of Maryland
WTP	willingness to pay

EXECUTIVE SUMMARY

The Maryland Environmental Service (MES) retained the Northgate-Dutra Joint Venture (Northgate-Dutra JV) to conduct the Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use (IR/BU) Pilot Project (Project). The Project contains two main components: 1) the Sediment Characterization Study of the Conowingo Reservoir (Reservoir), and 2) the Innovative Reuse and Beneficial Use Evaluation and Demonstration Project (herein designated IR/BU Evaluation). The IR/BU Evaluation includes bench-scale testing of multiple innovative reuse options, an economic evaluation of IR/BU options, and a field demonstration of a select reuse option (Field Demonstration).

This report summarizes the IR/BU Evaluation activities and presents the results including findings from the sediment stockpile sampling, IR bench-scale testing, water quality impact modeling, and a market and economic market analysis of IR/BU options. A Field Demonstration of a select reuse option is ongoing and will be documented in an addendum to this report when complete. Findings from the Sediment Characterization Study were presented in a report dated May 28, 2021 (Northgate, 2021) and are summarized below in Section 1.4.2.

The objectives of the IR/BU Evaluation included the following:

- Assess the physical and chemical characteristics of dredged sediment from a specific dredging area (Pilot Dredging Area) identified for bench-scale testing and the Field Demonstration;
- Assess the suitability of the dredged sediment, and/or sediment from cores collected as part of the Sediment Characterization Study, for various potential IR/BU end uses based on laboratory and bench-scale testing;
- Demonstrate the feasibility of using sediment from the Reservoir in the implementation of field-scale test for a selected end use;
- Evaluate the regulatory, logistic, and economic considerations of implementing a large-scale sediment IR/BU program; and
- Provide data and analysis that supports future predictive modeling used to inform decision making regarding future sediment removal and management.

Findings of the IR/BU Evaluation were used to evaluate the effectiveness of various sediment removal/reuse scenarios from a cost perspective and will inform future decisions on sediment management in the Reservoir. Removal of sediment from the Reservoir is anticipated to mitigate downstream flux of nutrients and sediment.

Sediment Stockpile Sample Analytical Results and Impact on Potential End Uses

In 2019, the IR/BU Evaluation approach was presented in the IR/BU Materials Management Plan (Northgate, 2019b) and approved by MES and Maryland Department of the Environment (MDE). In October 2021, approximately 1,000 cubic yards (cy) of sediment were mechanically dredged from the Pilot Dredging Area which was located near the Maryland/Pennsylvania state line (the State Line). The sediment was dewatered, stockpiled, and transported to Stancills, Inc. (Stancills) in Perryville, MD for reuse. The dredged sediment stockpile was sampled, analyzed, and categorized in accordance with MDE IR/BU Guidance Document (IR/BU Guidance, (MDE, 2019). Samples of sediment from the stockpile and from sediment cores collected during the Sediment Characterization Study were sent to Northgate-Dutra JV partners for bench-scale testing to assess the suitability of the material for potential end uses. In addition, stockpile sediment will be used in a Field Demonstration for a selected end use. This Field Demonstration is ongoing and will be documented in an addendum to this report when complete.

Samples collected from the sediment stockpile in November 2021 were analyzed for a broad panel of physical and chemical constituents. Physical analyses included grain size distribution, percent moisture, and total organic carbon (TOC). Chemical analyses included priority pollutant metals, hexavalent chromium, total and free cyanide, semi-volatile organic compounds (SVOCs), organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), dioxins and furans, total petroleum hydrocarbons (TPH), sulfide, sulfate, and total nitrogen. Laboratory analytical results from the sediment stockpile samples indicate the following:

- ***Lithology*****:** Grain size distribution analysis indicated the sediment stockpile consisted of silty sand with visible coal granules, which is consistent with sediment found in core samples collected in the Pilot Dredging Area during the Sediment Characterization Study. There is a general trend of coarser grained sediment being located in the northern portion of the Reservoir while increasing percentages of silt and clay were present in sediment core samples collected closer to the Conowingo Dam (the Dam).
- ***Presence of Coal*****:** Loss on ignition (LOI) testing was performed on the sediment stockpile samples to assess the relative percent of organic matter contained in the samples. This testing was conducted because granular coal and coal dust were previously reported and observed in sediment cores collected during the Sediment Characterization Study. All four samples contained sediment with TOC concentrations ranging from 13.8 – 20.7%, which is consistent with 19.0% measured in a shallow core sample collected during the Sediment Characterization Study within the Pilot Dredging Area.

- ***Chemical Analytical Results*****:** To evaluate sediment quality, sediment stockpile results were compared to the Maryland Innovative Reuse (IR) screening criteria from the IR/BU Guidance including Category 1- Residential Unrestricted Use Soil for Fill Material (the most restrictive category) and Category 2 - Non-Residential Restricted Use Soil and Fill Material. The results of metals analyses were also compared to the Central Maryland Anticipated Typical Concentration (ATC) and background threshold values (BTVs) for New York and Pennsylvania (when available).

  All analytes, including SVOCs, PCBs, OCPs, dioxins and furans, petroleum hydrocarbons, and metals were detected in samples at concentrations below Category 1 thresholds with the exception of select metals.

  Arsenic, manganese, thallium were detected in stockpile samples at concentrations above Category 1 thresholds. Arsenic also exceeded Category 2 thresholds. However, metal results in stockpile samples were generally at or below both their respective Central Maryland ATCs and available New York and Pennsylvania BTVs. Arsenic concentrations detected in core samples ranged from 1.5 to 20 mg/kg, with an average of approximately 12.5 mg/kg, while arsenic concentrations detected in stockpile samples ranged from 4.7 to 5.0 mg/kg. The arsenic results in the stockpile samples are generally consistent with arsenic results observed in Core C1 (collected in Pilot Dredging Area) which ranged from 4.6 to 8.2 mg/kg. It should be noted that the stockpile samples represent homogenized material while the core samples are discrete. Variability in arsenic concentrations may become a consideration when evaluating end uses. The exceedance of IR/BU Guidance Category 1 and 2 was further considered during bench-scale testing.

IR/BU Bench Scale Testing

As described in the IR/BU Materials Management Plan sediment from the Sediment Characterization Study cores and sediment from the dredging stockpile were provided to IR end-users on the Northgate-Dutra JV team for bench-scale testing. The objective of the bench-scale testing was to assess the physical and chemical properties of the material to determine if it is suitable for manufacturing a variety of products. The bench-scale methods and findings are summarized below.

- ***Concrete and Asphalt Manufacturing:*** Sediment stockpile samples were sent to Lafarge Holcim (Holcim) and tested according to ASTM C117/C136 and C128 to determine if the coarse fraction in the material was suitable for concrete and asphalt manufacturing. ASTM C-33 sand is used in concrete and asphalt manufacturing and testing was conducted to assess if stockpile sediment possessed the desired physical properties to potentially replace C-33 sand. The testing indicated that the unsorted sediment did not have a grain size distribution, specific gravity, or absorption characteristics suitable for use as concrete or asphalt sand. Holcim performed further testing to determine if material separation/amendment would improve the suitability of the material. This additional testing indicated that both separation of the sand fraction and amendment with coarser material would be required to produce materials meeting concrete/asphalt sand specifications. Holcim indicated it would not be economically justifiable for them to undertake material separation and amendment. If material separation occurs during full-scale dredging, blending of the sand fraction can be further evaluated for potential use in concrete and asphalt.

- ***Cement Clinker Manufacturing:*** Cement clinker is one of the ingredients, along with gypsum and limestone, used to manufacture Portland cement. Typically, fine-grained material (predominantly silt, clay, and shale) is used as source material during the manufacturing process. Sediment samples collected from Sediment Characterization Study cores were sent to Holcim for testing. Samples were analyzed for mineral composition, moisture content, and LOI. Based on the testing results, it appears that the sediment can be used as an alternative raw material in the manufacture of cement clinker. The sediment has concentrations of aluminum oxide (Al2O3) and silicon dioxide (SiO2) similar to that in Hagerstown Shale, which is currently being used as a source of these two minerals for cement manufacture. Holcim concluded that Conowingo sediment can be used successfully as an alternative raw material in cement manufacturing through proper preprocessing and/or co-processing.

- ***Blended Soil for Highway and Horticultural Applications:*** The bench-scale testing for blended soils included two elements: 1) testing of blended materials to determine if they met specification requirements for the State Highway Administration (SHA) Bioretention Soil, SHA Topsoil, MDE Bioretention Soil, and topsoil specified for commercial applications; and 2) fertility testing of the sediment.

  Soil Blending: Manufactured soil blends are typically produced with sand, silt, clay, and organic material. Specifications from the Maryland SHA as well as private construction companies dictate ingredient ratios in the blends to achieve desired performance requirements for infiltration, permeability, and erosion resistance, in addition to supporting plant growth. Stancills conducted bench-scale testing on a series of soil blends using sediment from the dredging stockpile. Their findings indicate that blends using up to 35% Reservoir sediment can be amended with sand and organic matter to produce mixes that meet specifications for SHA Bioretention soil and SHA Topsoil. A sample of the SHA Bioretention soil was sent to the SHA Quality Control laboratory and has been approved for potential use in an SHA project.

  Soil Fertility: A germination study was conducted by the University of Maryland Wye Research and Education Center (WREC) to assess the fertility of Reservoir sediment. Planting mixes were prepared using raw sediment from the stockpile, sediment amended with Leafgro, sediment amended with mushroom compost, and sediment amended with poultry litter. These mixes were planted with corn, soybean, wheat, and red fescue. Plant growth was monitored for approximately one month in a greenhouse setting. The germination study indicated that the three amended sediment mixes supported vigorous plant growth. Reservoir sediment amended with nutrients and organic matter can be used for farm field spreading or soil blending.

- ***Supplemental Cementitious Material:*** Supplemental Cementitious Materials (SCM) are alternative ingredients used in concrete manufacturing to improve material properties and reduce dependence on Portland cement. SCMs are typically byproducts from other industries that possess cementitious and/or pozzolanic properties, with fly ash and steel slag being the most common. Experts from the University of California Berkeley (UC Berkeley) and Georgia Institute of Technology (Georgia Tech) performed bench-scale tests of sediment from Sediment Characterization Study cores to determine if it could be processed into an SCM. Their testing indicated that the sediment possesses several potential sources of pozzolanic reactivity (diatoms and several types of clay) that can show pozzolanic reactivity upon calcination making the Reservoir sediment a good source material for producing SCM. Optimizing calcinations temperatures at industrial scale is recommended to refine manufacturing parameters and further assess durability of products manufactured with Reservoir sediment.
- ***Sediment Stabilization:*** Sediment stabilized with cement or other binders has been shown to improve the strength properties of the material to allow use as stabilized fill. Reservoir sediment samples from Sediment Characterization Study cores were tested by Tipping Point Resources Group LLC (Tipping Point) and associates at Rutgers University. The sediment was tested with a variety of binders including Portland cement, blast furnace slag, and Green cement. Compressive strength testing was conducted at intervals up to 28 days. Test results indicate that the stabilized sediment could be used for flowable backfill, Type A Controlled Low Strength Material, landfill caps/fills, and brownfield caps/fills.

Field Demonstration

Field Demonstration is intended to include the use of processed Reservoir sediment into a manufactured product and used in a real-world application. The Field Demonstration of a select reuse option is ongoing and will be documented in an addendum to this report when complete. As part of the soil blending bench-scale test, a soil blend was developed that meets specifications for use as a SHA bioretention soil. A potential project has been identified for the Field Demonstration using the blended material; once implemented, details on the demonstration will be provided in the addendum.

Water Quality Impact Evaluation

The purpose of the water quality impact evaluation was to provide information that can be used in the development of a strategic dredging plan for the Reservoir. The scope of the evaluation included 1) evaluating and synthesizing data; 2) developing a linear regression water quality model (Water Quality Impact Calculator); and 3) identifying best practices to be included/evaluated as part of the development of a strategic dredging plan to maximize nutrient reduction resulting from dredging.

1. ***Data Evaluation and Synthesis:*** Evaluating and synthesizing data included researching site and regulatory history as well as studies and models of the Reservoir. The data synthesis is presented in Section 4.1.
2. ***Water Quality Impact Calculator:*** The Water Quality Impact Calculator (the Calculator) is a planning-level screening tool developed to approximate the effect of different sediment removal quantities on sediment and nutrient loading and impact towards the needed Conowingo Watershed Implementation Plan reductions. The Water Quality Impact Calculator evaluates different quantities of sediment removal and estimates the associated total nitrogen and total phosphorus reductions. These removal scenarios, and the associated nutrient reductions, provide information necessary to develop a dredging strategy that will effectively improve water quality.
3. ***Strategic Dredging Plan:*** Best practices focus on aligning a strategic dredging scenario with characteristics that will increase trapping efficiency and have the best chance of reducing pollutant transport to the Chesapeake Bay. Several best practices, including location, time of year, volume, depth and spatial extent, and time interval of dredging have been identified and are discussed in Section 4.3.

Economic Evaluation of IR/BU Scenarios

The IR/BU Evaluation includes an economic analysis of potential markets for and revenues from IR/BU products that could be created with Reservoir sediment. Products evaluated include concrete, asphalt, cement clinker, supplemental cementitious material, blended soil, stabilized sediment for engineered fill, brick and paver manufacturing, and material for shoreline protection/restoration efforts.

As part of the economic analysis, an evaluation of various scenarios was conducted to assess the cost of dredging/processing versus offsetting revenue from the sale of IR/BU material and nutrient credit trading. Results indicate that dredging the Reservoir can be economically feasible. In combination, the evaluated IR/BUs represent a means for the State to find end destinations for the dredged material. Cost efficiency of evaluated scenarios indicates that dredging cost is not likely to be fully offset by revenue when trucking is the transportation mode from separation site to vendor site. However, when barging is the transportation mode, dredging cost can be offset depending on distance to the IR/BU project.

Cost ranges depend on the volume dredged and whether the State is responsible for 1) dredging and pumping slurry to a processing site; and 2) separating the sediment fractions. These responsibilities depend on the extent to which the State partners with groups involved in innovative financing of the dredging itself. For example, results from the Calculator indicated that under a 3 mcy/yr dredging scenario, 743,044 lbs/yr of nitrogen would be removed. In the economic scenarios evaluated, each with different costing inputs, this translates to a cost to the State of $359/lb of nitrogen removed (Scenario 1, in which all costs are borne by the State) and $73/lb of nitrogen removed (Scenario 2, in which some costs are borne by project partners), when trucking is the method of sediment transport. (Note that as detailed in Section 5, cost estimates for the State exclude some costs of a possible dredging program such as land acquisition and large-scale sediment conveyance infrastructure, which may or may not be significant costs for the State. In any event, costs would be site-specific and beyond the scope of this study to evaluate.) The State would need to view remaining costs, which would also include agency staffing, program management, the excluded costs outlined in Section 5.4.2, and other elements, as the price of helping meet downstream water quality, economic, and other goals discussed in this report.

Allocating public funds on an ongoing basis for these costs is supported by a willingness to pay (WTP) analysis, presented in Section 5.5 of this report. It found that the public would be willing to pay $20.3 million/year to accomplish the identified water quality objectives. Depending on the scenario, and in combination with revenues from an IR/BU program and possible coordination with coal and water quality credit sales activities, this could offset a majority of the future costs of a dredging program.

To further evaluate the feasibility of full-scale dredging, several next steps are recommended, including screening-level modeling to identify preferred dredge locations; project development including site evaluations, sediment transfer infrastructure costing, and dredging method evaluation; and scoping the extent of required permitting activities for a full dredge program.

1.0 INTRODUCTION

MES retained the Northgate-Dutra JV to conduct the Conowingo Sediment Characterization and IR/BU Pilot Project. The Project contains two main components: 1) the Sediment Characterization Study of the Reservoir; and 2) the IR/BU Evaluation. Findings from the Sediment Characterization Study were presented in a report dated May 28, 2021 (Northgate, 2021). The Project Area is comprised of the Conowingo Reservoir (Reservoir) between the State Line and the Dam as shown on Figure 1.

The scope of the IR/BU Evaluation includes sediment stockpile sampling, IR bench-scale testing, the Field Demonstration of a select reuse option, water quality impact evaluation, and market and economic market analysis of reuse options. The tasks performed as part of the IR/BU Evaluation were performed in general accordance with the IR/BU Materials Management Plan.

1.1 Project Purpose and Objectives

The Project is a key step in the State's initiative to reduce sediment and nutrient loads released from the Susquehanna River watershed (Figure 2) including from the Reservoir to the Chesapeake Bay. The Conowingo Watershed Implementation Plan (CWIP) includes nutrient reductions targeted to be complete by 2025, including 6,000,000 pounds of nitrogen reduction and 260,000 pounds of phosphorus reduction per year for the Susquehanna River (CWP, 2021). When coupled with Best Management Practices (BMPs) and other nutrient management strategies, sediment removal from the Reservoir is one component of a multifaceted approach to improve water quality in the Chesapeake Bay. The ultimate goal is to meet the United States Environmental Protection Agency's (USEPA) Total Maximum Daily Load (TMDL) requirements for the Chesapeake Bay (USEPA, 2010). Studies performed by the United States Geological Survey (USGS; USGS, 2012) and Gomez and Sullivan (2012) indicate the Reservoir has reached dynamic equilibrium and has minimal capacity to impound additional sediment. During high-flow and wet-weather events this condition results in intermittent significant releases of scoured sediments and nutrients into the Chesapeake Bay. Contingent on the period between scour events and amount scoured (capacity increase), there are periods of less significant yet continual releases of suspended sediment and dissolved nutrients.

The objectives of the Project are to identify solutions for reducing nitrogen, phosphorus, and sediment loads from the Reservoir into the Chesapeake Bay and to determine feasibility of using dredged sediment for IR/BU purposes. The objective of the Sediment Characterization Study was to supplement existing Reservoir sediment data to support development of a long-term sediment and nutrient management strategy.

1.2 IR/BU Evaluation Objectives

The objective of the IR/BU Evaluation is to assess suitability of sediment in the Reservoir for potential innovative reuse options to support development of a long-term sediment and nutrient management strategy. Specific objectives include the following:

- Assess the physical and chemical characteristics of dredged sediment from the Pilot Dredging Area;
- Assess the suitability of the sediment for various potential IR/BU end uses based on laboratory and bench-scale testing;
- Demonstrate the feasibility of use of sediment from the Reservoir in the implementation of a selected end use;
- Evaluate the regulatory, logistic, and economic considerations of implementing a large-scale sediment IR/BU program; and
- Provide data and analysis that supports future predictive modeling used to inform decision making regarding future sediment removal and management.

1.3 Site Background

The Conowingo Dam was built from 1926 –1928, resulting in the largest reservoir on the Susquehanna River. The Dam was constructed by the Philadelphia Electric Company. It is operated by Constellation Energy Generation, LLC (formerly Exelon Generation, LLC; herein designated Constellation) to control floods and provide a source of hydroelectric power. Prior to late 2021, previous project documents and submittals refer to Exelon as the owner and operator of the Dam. Over time, sediment from the Susquehanna River watershed (Figure 2) deposited behind the Dam, filling the Reservoir. During storms, high water flows result in additional scoured sediment being transported into the Chesapeake Bay. Table 1 presents a summary of flood events from 1993 – 2018. During that period, eight flood events exceeded the scour threshold of 400,000 cubic feet per second (cfs).

Table 1. List of Susquehanna River Flood Events at Conowingo, MD: 1993 - 2018

Date of Flood	Crest (ft)	Streamflow (cfs)	Category	Above Scour Threshold (400k cfs)*
4/2/1993	28.06	500,000	Moderate	YES
3/23/1994	26.16	403,000	Moderate	YES
1/20/1996	34.18	909,000	Major	YES
11/11/1996	24.04	303,000	Minor	NO
1/10/1998	25.55	372,000	Moderate	NO

Date of Flood	Crest (ft)	Streamflow (cfs)	Category	Above Scour Threshold (400k cfs)*
3/22/2003	24.15	308,000	Minor	NO
1/16/2004	23.88	Not Available	Minor	Not Available
9/19/2004	30.07	620,000	Major	YES
4/4/2005	26.70	430,000	Moderate	YES
6/29/2006	27.31	461,000	Moderate	YES
3/6/2008	25.64	379,000	Moderate	NO
1/27/2010	24.37	325,000	Minor	NO
3/8/2011	24.17	317,000	Minor	NO
3/12/2011	27.79	487,000	Moderate	YES
4/29/2011	25.06	354,000	Moderate	NO
9/9/2011	32.41	778,000	Major	YES
7/26/2018	NA	353,000	Moderate	NO

Source: National Weather Service: https://www.weather.gov/media/marfc/FloodClimo/MSL/Conowingo.pdf
Approximate flow at which sediment is known to be mobilized from the lower Susquehanna River reservoirs (Lang, 1982; Reed and Hoffman, 1997)

ft	*feet*
cfs	*cubic feet per second*

Several studies of sedimentation and scour within the Reservoir have been conducted over the past 25 years or more (USGS, 1995, 1996, 1997, 2009, 2012; USACE, 2015; and Gomez and Sullivan, 2012). These studies indicate that the Reservoir now has minimal capacity to impound additional sediment. The combination of reduced sediment trapping capacity with high water flow events is resulting in increased transport of sediment and nutrients from the Reservoir to the upper Chesapeake Bay.

Transport of nutrients from the Susquehanna River to the upper Chesapeake Bay has contributed to eutrophication in the Chesapeake Bay (USACE, 2015). There are multiple effects of eutrophication, including excessive algal growth, loss of submerged aquatic grasses, and bottom water hypoxia/anoxia (Kemp et al., 2005). Chesapeake Bay eutrophication is due to the input of nitrogen and phosphorus from point and non-point sources, with inputs of both freshwater and nutrients. The Susquehanna River drainage dominates the input of nutrients and freshwater and has the largest influence on the biogeochemistry of the mid-Chesapeake Bay region.

1.4 Previous Investigations and Sediment Characterization Study Results

1.4.1 Historical Studies

Previous studies were reviewed and a data gap analysis was performed as described in the Data Gap Analysis Report (DGA Report, Northgate, 2019a). These previous investigations of sediment characteristics and bathymetry for the Reservoir are limited. Sediment characterization studies are limited to approximately five sampling events where sediment core data were collected. Data from shallow cores collected in 2000 and reported by the Watershed Assessment and Protection Program (Edwards, 2006), helped guide the identification of target analytes and provided a greater understanding of the distribution of coal layers throughout the Reservoir. However, five major flood events (Table 1) have resulted in scour since those cores were collected, reducing spatial and temporal confidence in those data. Two core sampling events conducted by the Maryland Geologic Survey in 2017 (Van Ryswick et. al., 2017a, 2017b) were conducted to specifically support the solicitation for this Project but were limited to two localized areas of the Reservoir.

Key observations from the DGA Report include:

- ***Limited Core Depth****:* Most of the cores previously collected were shallow surface cores that penetrated the sediment to a depth of an average of 3 feet below the sediment surface. The deepest available core was collected from approximately 11 feet below the sediment surface.
- ***Temporal Variation:*** Previous sample collection occurred over the span of three decades. During that time, the Reservoir was transitioning into a state of dynamic equilibrium; therefore, data from shallow sample cores collected in one decade cannot easily be compared with data from cores collected during a different decade.
- ***Varied Analytical Suites:*** Previous investigations were performed with varying objectives resulting in varied analytical suites.
- ***Dynamic Bathymetry:*** Comparison of bathymetry data collected over the last 30 years indicates episodes of scour followed by temporary localized deposition. One consistent trend is the deep channel along the western side of the Reservoir leading to the power plant.
- ***Exceedances of Regulatory Thresholds:*** Several of the previous investigations included extensive chemical analysis with only limited findings of constituents above screening criteria from the IR/BU Guidance. Constituents exceeding screening levels include metals (arsenic, manganese, and thallium), SVOCs (benzo(a)pyrene, benzo(a)anthracene, benzo(a)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene, TPH in the diesel range.

- ***Coal:*** Granular coal was found in sample cores in the form of discrete coal layers and as coal particles interspersed throughout the sediment. Previous investigators estimated the coal content of the sediment, excluding the visible coal layers, to be approximately 11% of sample volume on average.

1.4.2 Sediment Characterization Study

The Sediment Characterization Study was performed in 2020 to further characterize the sediment within the Project Area and fill identified data gaps. Sediment sample collection was conducted in December 2020 at 19 coring locations (Figure 3). One hundred fifty sediment core intervals were collected from the 19 coring locations and analyzed for a broad panel of physical and chemical constituents. All 150 core intervals were analyzed for grain size distribution, percent moisture, priority pollutant metals, and TOC. Thirty-two core intervals were analyzed for hexavalent chromium, total and free cyanide, sulfide, sulfate, TOC, volatile organic compounds (VOCs), SVOCs, organochlorine pesticides, PCBs, dioxins and furans, TPH, total nitrogen, ammonia, total phosphorus, and soluble salts. Laboratory analytical results from the Sediment Characterization Study are presented in Tables 2 through 9.

The Sediment Characterization Study results revealed the following:

- The estimated sediment volume in the Project Area is approximately 200 million cubic yards (mcy). The limited number of control points for the Reservoir bottom elevation could result in an increase or reduction in the volume calculation of up to 40 mcy.
- Grain size distribution tests indicate that the sediment is predominantly composed of silt and clay with occasional layers or lenses of coarser grained silt/sand. Coarser grain sediments are more prevalent in the central (adjacent to flow channel) and the upstream portion of the Project Area, while finer sediments are more prevalent in the downstream portion of the Project Area (closer to the Dam) and along the eastern flank of the Reservoir (lower flow velocity areas).
- All cores contained sediment with elevated TOC concentrations, indicative of the presence of coal. The highest TOC concentrations were in the upstream portion of the Project Area within the coarse-grained materials, while lower TOC concentrations were found closer to the Dam. These TOC data and visual observation of coarse-grained deposits in the upstream sediment cores indicate significant amounts of these coarse-grained sediments are comprised of coal.
- To evaluate sediment quality, laboratory analytical results were compared to the IR screening criteria from the IR/BU Guidance including Category 1- Residential Unrestricted Use Soil for Fill Material (the most restrictive category) and Category 2 - Non-Residential Restricted Use Soil and Fill Material. All analytes, including PCBs,

OCPs, dioxins and furans, petroleum hydrocarbons, and metals were detected in samples at concentrations below Category 1 thresholds with the exception select metals and SVOCs. Exceedances of screening levels include:

  - Arsenic: Concentrations generally exceeded both Category 1 and Category 2 screening levels.
  - Manganese: Concentrations generally exceeded Category 1 screening levels, with some exceedances of Category 2 screening levels.
  - Thallium: Concentrations generally exceeded Category 1 screening levels but below Category 2 screening levels.
  - SVOCs: Detected SVOCs included (benzo(a)anthracene, dibenzo(a,h)anthracene, and benzo(a)pyrene), all of which exceeded the Category 1 threshold; no SVOCs exceeded the Category 2 threshold. The detected SVOCs are likely due to the presence of coal in the samples (USEPA, 2017a).

- The results of metals analyses were also compared to the Central Maryland ATC and arsenic BTVs for Maryland, New York, and Pennsylvania. The ATC represents the mean concentration plus one standard deviation. ATC values were developed based on the background soil concentration data collected from environmental investigations overseen by the MDE (MDE, 2018). Additionally, the watershed draining to the Reservoir is located almost entirely in the states of Pennsylvania and New York. Based on an arsenic background study performed in 2010 (Volnakis et al, 2010), BTVs for arsenic in the states of New York and Pennsylvania in surface soils are 22.8 and 23.7 milligrams per kilogram (mg/kg) respectively. New York and Pennsylvania area BTVs considering all soils are 24.2 and 23.4 mg/kg, respectively. A BTV is defined as "a concentration in soil that is representative of the sample results and may be used to describe the background conditions for a particular area or geologic characteristics" (Volnakis et al, 2010). The following presents a comparison of metals exceeding Category 1 and/or Category 2 screening levels to BTV and ATC values:
  - Arsenic: Concentrations generally exceeded the Central Maryland ATC value of 4.9 mg/kg. Additionally, all sample results are at or below BTVs for New York and Pennsylvania, the predominant source of the sediment. This indicates that the observed arsenic concentrations are likely to be naturally occurring and not from anthropogenic sources.
  - Manganese: Close to half of the manganese detections were at or below the ATC value of 1,400 mg/kg, with the average manganese concentration being 1,433 mg/kg.
  - Thallium: All detections were below the ATC value.

1.5 Overview of IR/BU Evaluation

The IR/BU Evaluation considers the presence of coal, chemicals, and nutrients, and how these constituents influence potential reuse performance and marketplace potential. The influence of coal on different reuse alternatives was factored into the performance evaluation of each respective technology. The Sediment Characterization Study Report (SCR) recommended that further work be conducted, outside the scope of the Project, on solid separation technologies to evaluate reuse opportunities for both the coal and separated coarse and fine-grained sediment.

The IR/BU Evaluation included the following activities:

- Sediment Collection and Sampling
- Bench-Scale Testing
- Field Demonstration
- Water Quality Impact Assessment
- Economic Analyses

Sediment Collection and Sampling: Sediment used in the IR/BU Evaluation was obtained from both the sediment dredged from the Pilot Dredging Area (stockpile) and from cores collected as part of the Sediment Characterization Study. Sediment from the stockpile will also be used in the Field Demonstration. All sediment was sampled and analyzed for physical and chemical characteristics.

IR Bench-Scale Testing: Bench scale testing was performed to assess suitability of the dredged material for potential end uses. End uses evaluated include concrete, asphalt, cement clinker, blended soil for horticultural use, stabilized sediment, and supplemental cementitious material. An evaluation of sediment use in bricks and pavers was planned; however, the facility was no longer operating during the bench-scale test timeframe. Bench scale tests were also performed to develop potential design mixes for products produced from stabilized sediment.

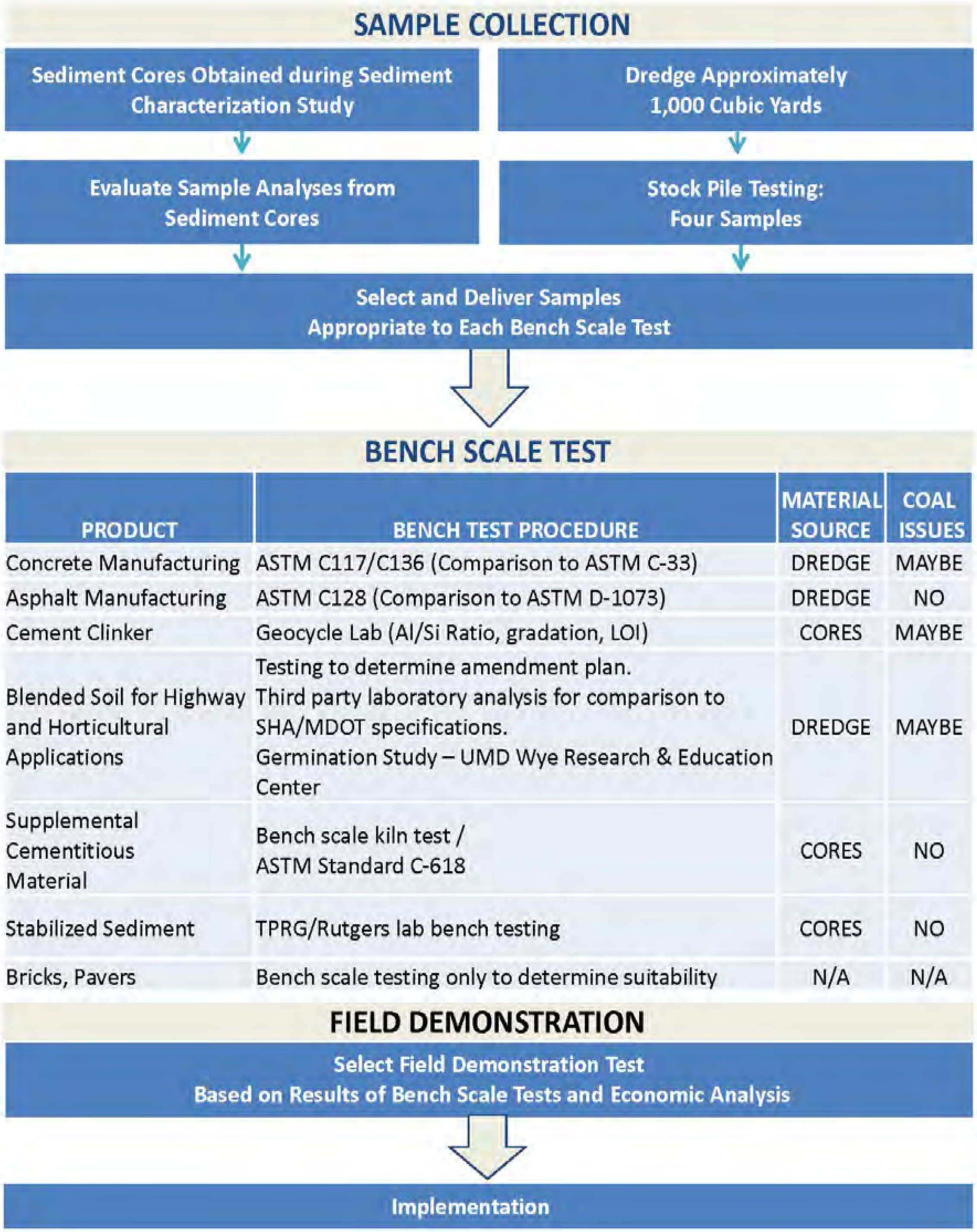
Field Demonstration: The Field Demonstration is intended to include the use of processed Reservoir sediment into a manufactured product and used in a real world application. The Field Demonstration of a select reuse option is ongoing and will be documented in an addendum to this report when complete. As part of the soil blending bench-scale test, a soil blend was developed that meets specifications for use as a SHA bioretention soil. A potential project has been identified for the Field Demonstration using the blended material. Once implemented, details on the Field Demonstration will be provided in the addendum.

Water Quality Impact Assessment: Available publications, modeling, and insights gained through the Sediment Characterization Study results were utilized to develop a planning-level screening tool (Water Quality Impact Calculator) to approximate the effect of different sediment removal quantities on sediment and nutrient loading and impact towards the needed Chesapeake Bay TMDL reductions.

Economic Analysis: An economic analysis was performed to evaluate the market for a range of IR/BU products, including the degree to which local markets could absorb each product, and to present a comparison of potential costs and revenues associated with a particular scenario for dredging and initial processing of Reservoir sediment. Although not included in the scope of the bench-scale testing, the economic analysis also included in-water Beneficial Uses for shoreline protection and restoration projects because they potentially comprise one of the most significant end use categories by volume.

The flow chart below (Figure 4) depicts a graphical overview of the Project’s materials management approach. Detailed description of each of the IR/BU Evaluation tasks is presented in Sections 2 and 3.

Figure 4. Conowingo IR/BU Evaluation – Materials Management Approach



SAMPLE COLLECTION

Sediment Cores Obtained during Sediment Characterization Study → Evaluate Sample Analyses from Sediment Cores

Dredge Approximately 1,000 Cubic Yards → Stock Pile Testing: Four Samples

Select and Deliver Samples Appropriate to Each Bench Scale Test

BENCH SCALE TEST

PRODUCT	BENCH TEST PROCEDURE	MATERIAL SOURCE	COAL ISSUES
Concrete Manufacturing	ASTM C117/C136 (Comparison to ASTM C-33)	DREDGE	MAYBE
Asphalt Manufacturing	ASTM C128 (Comparison to ASTM D-1073)	DREDGE	NO
Cement Clinker	Geocycle Lab (Al/Si Ratio, gradation, LOI)	CORES	MAYBE
Blended Soil for Highway and Horticultural Applications	Testing to determine amendment plan. Third party laboratory analysis for comparison to SHA/MDOT specifications. Germination Study – UMD Wye Research & Education Center	DREDGE	MAYBE
Supplemental Cementitious Material	Bench scale kiln test / ASTM Standard C-618	CORES	NO
Stabilized Sediment	TPRG/Rutgers lab bench testing	CORES	NO
Bricks, Pavers	Bench scale testing only to determine suitability	N/A	N/A

FIELD DEMONSTRATION

Select Field Demonstration Test Based on Results of Bench Scale Tests and Economic Analysis

Implementation

2.0 SEDIMENT COLLECTION AND SAMPLING

Sediment used in the IR/BU Evaluation was obtained from two sources depending on use:
1) sediment obtained from cores collected during the Sediment Characterization Study; and
2) sediment dredged from the Pilot Dredging Area. The Pilot Dredging area comprises roughly 225,625 square feet (475 feet by 475 feet) near the Maryland/Pennsylvania border (Figure 1) near sediment core location C-1. Figure 4 shows the sediment source for each bench-scale test and the Field Demonstration. Collection and analyses of sediment core samples used in the IR/BU bench-scale testing are described in the SCR. Sediment from the Pilot Dredging Area was collected, sampled, and analyzed for physical and chemical characteristics as described below.

2.1 Pre-field Activities

As part of pre-field planning, the Northgate-Dutra JV prepared a series of plans in accordance with the Project's Technical Specifications. The Submittal Register Number is included with each plan referenced below. These plans were reviewed and approved by MES. In addition, a Right of Entry Agreement was executed to allow the Northgate-Dutra JV to access to the Reservoir which is controlled by Constellation under license from the Federal Energy Regulatory Commission.

Prior to intrusive activities, utility clearances were obtained by contacting Maryland Miss Utility, as well as through onsite meetings with representatives from pertinent utility companies with utility crossings or water intakes in the vicinity of Project activities. On September 7, 2021, representatives from Constellation conducted a preconstruction safety meeting with the Northgate-Dutra JV field team at the mobilization and offloading sites.

2.2 Sediment Removal Operations

2.2.1 Mobilization and Demobilization

Equipment was mobilized/demobilized at the Dorsey Park Boat Launch (Figure 1) adjacent to the Peach Bottom Atomic Power Plant according to the Mobilization and Demobilization Plan developed for the project (Submittal No. 8). Equipment included sectional barges, multiple cranes, an excavator, support boats, welding equipment, generators, a skid-steer loader, a mobile office, and restroom facilities. The sectional barges were assembled at Dorsey Park Boat Launch and mobilized to the Pilot Dredging Area using support boats. Two barges were employed for this project; one contained the excavator and ancillary equipment and the other contained excavated material for transport and offloading. Equipment refueling was performed as required in accordance with procedures outlined in the Spill Prevention Plan (Submittal No. 11). Barge assembly and positioning of equipment was initiated on September 22, 2021. The excavator barge and material barges were positioned at the Pilot Dredging Area on October 8, 2021. After dredging activities were completed on October 21, 2021, all equipment was demobilized by October 31, 2021.

2.2.2 Dredging and Dewatering

Dredging commenced on October 9, 2021. Approximately 1,000 cy of sediment were dredged using a long-reach mechanical excavator according to the Dredging and Dewatering Plan (Submittal No. 1). Dredging extended to approximately 3 ft below the sediment-water interface within the Pilot Dredging Area. When dredging commenced, the material was placed on the adjacent material barge. The material barge contained a K-rail perimeter lined with geosynthetic fabric that was protected with crane mats. Water from the material passed through the filter fabric and drained back into the Reservoir. A turbidity curtain was placed around the two barges to contain suspended sediment during dredging operations.

The material barge was designed to contain up to 300 cy of material. However, due to low water levels in the Reservoir, only 100 to 150 cy could be loaded to avoid grounding the barge at the Staging Area. Loading and offloading was conducted from October 10, 2021 to October 22, 2021. The material was offloaded using a long-reach excavator and placed in a 30-foot by 90-foot lined Staging Area prior to off-site transport. Additional dewatering occurred at the Staging Area prior to transport.

Turbidity monitoring was conducted according to requirements outlined in the final regulatory permits and the Dredging and Dewatering Plan. Turbidity measurements were collected using a YSI Pro DSS Sonde. Before and during use, the sonde calibration was checked with a 24.0 nephelometric turbidity units (NTUs) standard solution and a 0.0 NTU distilled water standard. Samples were taken generally twice per loading episode. Water samples were taken at 12 inches below the surface approximately 150 feet upstream and approximately 300 feet downstream of the excavator barge approximately. All results were between 12 – 30 NTUs with the difference from background and downstream +/- 2 NTUs. No exceedances of the 150 NTU instantaneous threshold or the 50 NTU monthly average threshold were observed. These thresholds were defined in the Dredging and Dewatering Plan approved by MES.

Dredging crews were trained to recognize munitions and explosives of concern (MECs). A MEC Safety and Management Procedures Plan (Submittal No. 12) was kept on board during dredging operations.

2.2.3 Staging Area Construction and Off Site Transportation

Prior to transport from the Reservoir, dredged material was contained in a Staging Area located at Peach Bottom Landing (Figure 1). The Staging Area, which was designed to contain approximately 500 cy of dredge material, was constructed as described in the Construction Facilities Layout Plan (Submittal No. 17) and the Site Preparation Work Plan (Submittal No. 9). The perimeter of the Staging Area was established using K-Rail lined with a geotextile fabric. Straw wattle was placed around the perimeter of the K-Rail to provide further containment. A silt fence was placed around the Staging Area as described in the Erosion and Sediment Control Plan (Submittal No. 15). Dredged material was covered with plastic sheeting overnight and in anticipation of rain in accordance with the Stormwater Management Plan (Submittal No. 14). Dewatered material was then loaded into trucks for off-site transport using a rubber tire loader.

Images: Sediment Off-Loading at Staging Area

Material was transported off-site during dredging activities to maintain sufficient storage space at the Staging Area. Material was transported via sealed bed tri-axle trucks to Stancills in Perryville, MD. Sealed bed trucks were used to eliminate the potential for sediment leakage during transport. Traffic control measures were implemented for both Peach Bottom Landing and Dorsey Park Boat Launch according to the Traffic Control Plan (Submittal No. 13). Once operations were complete, the Staging Area was restored in accordance with the Site Restoration Work Plan (Submittal No. 19). Constellation conducted post-construction site inspections at Peach Bottom Landing and Dorsey Park on November 3, 2021. Punch list items were identified and addressed during the following two weeks to the satisfaction of Constellation.

2.3 Stockpile Screening and Sampling

As described in the IR/BU Materials Management Plan, sediment stockpile sampling included field screening for VOCs and sampling of the sediment stockpile for selected analytes in accordance with the IR/BU Guidance.

2.3.1 Field Screening

Sediment samples were collected from both the material barge and Staging Area and screened for VOCs using a photoionization detector (PID). Material was placed in a 1-quart zip-lock bag (approximately ½ quart of sediment per 1-quart bag) and allowed to equilibrate for five minutes. Care was taken to fill each bag with the same volume of material each time to make the headspace volume as reproducible as possible. The PID probe was placed in the head space of each bag to obtain PID readings. PID readings, presented in Appendix A, ranged from 0.8 – 2.0 parts per million (ppm) with background readings of ambient air ranging from 0.2 – 0.5 ppm. Stockpile PID results were found to be consistent with the results from the Sediment Characterization Study.

2.3.2 Stockpile Sampling

Sediment was sampled from the stockpile at Stancills as described in the IR/BU Materials Management Plan. The approximately 1,000 cy stockpile was divided into four equal-sized quadrants and a five-point composite sample was collected from each quadrant. Each composite sample consisted of five aliquots collected from various locations within the quadrant. The sample locations were marked with flags to approximate equal spacing between locations. Aliquots were composited in the field in clean stainless-steel mixing bowls using stainless steel spoons to form four composite samples for analysis. The composite samples were placed in glass jars and stored in coolers with ice to temperatures of 6º C or below. Samples were transported to the laboratory under standard chain-of-custody (COC) protocols within 24 hours to ensure holding times were met (Appendix B).

Sediment collected from the stockpiles was described by a field geologist in accordance with ASTM 2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). Upon receipt of laboratory data, the sediment descriptions were updated as appropriate in accordance with ASTM 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

2.3.3 Laboratory Analyses

Chemical and physical testing of the sediment samples was performed by Eurofins of Pittsburgh Pennsylvania, a Maryland State Certified Water Quality Laboratory (Appendix C). Table 10 provides detailed information on the suite of physical and chemical analyses that were run on the stockpile samples. In consultation with MDE, VOC analyses were not deemed necessary for the stockpile samples based on the VOC screening and the results of the Sediment Characterization Study analyses. Field quality control, laboratory quality control, and data management procedures are described in the IR/BU Materials Management Plan. Data Validation Reports are presented in Appendix D.

Table 10. IR/BU Stockpile Sampling Analytical Methods Summary

	Physical Geotech		**Metals and Inorganics**							**Organics**								**Nutrients**			
IR/BU Analyses (1,000 cy stockpile)	Grain Size Distribution (ASTM D422)	Percent Coal - Loss on Ignition Method (ASTM 2974)	Percent Moisture (SM 2540G)	Priority Pollutant Metals + Hg (EPA 6020B & 7471B)	Hexavalent Chromium (EPA 7196A)	Cyanide , Total (EPA 9014)	Cyanide , Free (EPA 9016)	Sulfate (EPA 300.0)	Sulfide, Total (SM 4500 S2)	Total Organic Carbon - (EPA 9060)	Volatile Organic Compounds (EPA 8260C)	Semi-Volatile Organic Compounds (EPA 8270D)	Organochlorine Pesticides (EPA 8081B)	PCBs Aroclors (EPA 8082A)	Dioxins / Furans (EPA 8290A / 1631)	Total Petroleum Hydrocarbons - DRO (EPA 8015D)	Total Petroleum Hydrocarbons - GRO (EPA 8015C/5035 prep)	Total Kjeldahl Nitrogen (EPA 351.2)	Ammonia, Nitrogen (SM4500-NH3B or F/EPA 350.1)	Total Phosphorus (EPA 365.3 / 365.4)	Soluble Salts EC - : 2 (V:V) (Lab SOP)
# Samples	4	4	4	4	--	4	4	4	4	4	--	4	5*	5*	5*	4	--	4	--	--	--

Note: This matrix includes analyses of samples collected from the stockpile. End users performed additional physical/geotechnical and nutrient testing as needed.

* = One stockpile composite sample comprised of the four quadrant composite samples and 4 quadrant composite samples each comprised of five aliquots from their respective quadrant of the stockpile .

4 = Four quadrant composite samples, each comprised of five aliquots from their respective quadrant of the stockpile.

-- = Not analyzed.

2.4 Sediment Stockpile Sampling Results

The results of the stockpile sampling are presented below and summarized in Tables 2 through 9. To facilitate comparison of results, analytical results from the sediment stockpile Samples collected as part of the IR/BU Evaluation have been added to the bottom of the tables previously presented as part of the Sediment Characterization Study.

2.4.1 Physical Analytical Results

The results of the physical analysis conducted by Eurofins are summarized in Table 2; more detailed information is presented in the laboratory data sheets and included in Appendix E. Grain size distribution is presented in Table 2 as percent sand and percent fines (silt and clay). As described in the SCR, the Pilot Dredging Area was designated by MES during the bid solicitation process. Variations in the chemical and physical composition of the sediment throughout the Project Area have been described in the SCR. Implications of these physical and chemical variations are described below in Section 3.0 – IR Bench Scale Testing.

Sediment collected from the stockpile consisted of a silty sand with visible coal granules. This sediment is generally consistent with sediment found in samples collected from coring location C1, which is located in the Pilot Dredging Area; however, the stockpile samples do not reflect the grain size distribution for the reservoir downgradient of the dredge area. Results from the sieve analysis are presented as percent sand and percent fines (silt/clay) in Table 2.

Given the importance of identifying and quantifying the presence of coal, Eurofins performed an LOI test (ASTM D2974) to assess the relative percent of organic matter contained in the samples. The TOC results from the LOI test are used as a surrogate for coal content for the evaluations performed as part of the Project. All four samples contained sediment with elevated TOC concentrations ranging from 13.8 – 20.7%. This is consistent with 19.0% measured in Core C1 which was collected from shallow sediment (24.7- to 25.5-foot interval measured from waterline) within the Pilot Dredging Area. It should be noted that in deeper samples collected from Core C-1, TOC concentrations were much higher, ranging from 56.8 – 70.5%. As was concluded in the SCR, the presence of coal granules and coal dust is an important factor when assessing potential end uses for the sediment.

2.4.2 Chemical Analytical Results

Laboratory analytical results are described in the following subsection and are summarized in Tables 2 through 9. The complete Eurofins laboratory analytical report for chemical analyses is presented in Appendix E. To evaluate sediment quality, sediment stockpile results were compared to the Maryland IR screening criteria from the IR/BU Guidance including Category 1-

Residential Unrestricted Use Soil for Fill Material (the most restrictive category) and Category 2 - Non-Residential Restricted Use Soil and Fill Material. The results of metals analyses were also compared to the Central Maryland ATCs and New York and Pennsylvania BTVs. The New York and Pennsylvania BTVs for arsenic (all soils) are 24.2 and 23.4 mg/kg respectively. ATC and BTV values are discussed in Section 1.4.2.

All analytes, including PCBs, OCPs, dioxins and furans, petroleum hydrocarbons, and metals were detected in samples at concentrations below Category 1 thresholds with the exception of select metals and SVOCs. VOC analyses were not performed on stockpile samples based on the results of the soil screening and SCR analytical results. Exceedances of screening levels include:

Metals: Laboratory analytical results for metals are presented in Table 2 and summarized below.

- ***Arsenic:*** Concentrations in all stockpile samples ranged from 4.7 - 5.0 mg/kg and exceeded both IR Category 1 and Category 2 thresholds; one stockpile sample (5.0 mg/kg) exceeded the Central Maryland ATC value of 4.9 mg/kg; however, the average concentration from the stockpile (4.8 mg/kg) is below the ATC. All arsenic concentrations are below BTVs for New York and Pennsylvania (i.e., naturally occurring), the predominant source of the sediment. It should be noted that the arsenic concentrations in the stockpile samples were generally lower than those observed in sediment core samples (average 12.5 mg/kg). The variability in arsenic concentrations observed throughout the Reservoir will need to be considered when end uses are evaluated in full-scale operations. In addition, end product ingredient testing will be required to ensure compliance with regulatory requirements.
- ***Manganese:*** Concentrations in stockpile samples ranged from 450 - 510 mg/kg and exceed the IR Category 1 threshold of 180 mg/kg. However, all detections were below the IR Category 2 threshold of 2,560 mg/kg and the ATC value of 1,400 mg/kg. This is consisted with manganese concentrations detected in the shallow intervals of core C1, which was in the Pilot Dredging Area. The average manganese concentration detected during the Sediment Characterization Study was 1,436 mg/kg, which is consistent with the ATC for manganese and is below the IR Category 2 threshold. Manganese is found naturally-occurring in minerals in the region and it does not appear that the detected concentrations of manganese are anthropogenic.
- ***Thallium:*** Concentrations in stockpile samples ranged from 0.12 - 0.13 mg/kg and exceed IR Category 1 threshold of 0.078 mg/kg. However, all detections were below IR Category 2 threshold of 1.2 mg/kg and the ATC value of 1.5 mg/kg. Samples collected during the Sediment Characterization Study exhibited a mean concentration of 0.32 mg/kg. These levels are consistent with the Central Maryland ATC, indicating that thallium is naturally occurring.

Semi-volatile Organic Compounds: Laboratory analytical results for SVOCs are presented in Table 4. None of the SVOC results for the stockpile samples exceeded IR Category 1 screening levels. During the Sediment Characterization Study, two polycyclic aromatic hydrocarbons (PAHs) slightly exceeded Category 1 screening levels in one sample each: benzo(a)anthracene and dibenz(a,h)anthracene. A third, benzo(a)pyrene, exceeded Category 1 screening levels in approximately a third of the samples. Detected concentrations of these three PAH compounds are likely associated with the coal particles present in the sediment (USEPA, 2017).

2.4.2.1 Nutrients

Nutrient analytical results from the stockpile samples are consistent with results from the Sediment Characterization Study and are presented in Table 9. Nutrient results were assessed during evaluation of each IR/BU end use and found to be beneficial for select IRs. While the results reported in Table 9 are appropriate for IR/BU evaluations, they are not interchangeable with data from previous studies which were undertaken for different purposes.

3.0 IR BENCH SCALE TESTING

The objective of the bench-scale testing was to assess the physical and chemical properties of the material to determine if it is suitable for manufacturing a variety of products. As described in the IR/BU Materials Management Plan, sediment from the Reservoir was provided to IR end-users on the Northgate-Dutra JV team for bench-scale testing. Sediment provided to the end users included material from both the Sediment Characterization Study and stockpile sediment as shown on Figure 4. The bench-scale methods and findings are presented below.

3.1 Concrete and Asphalt Manufacturing

Concrete is formed from a mixture of Portland cement, sand, aggregate, and water. Amendments and other additives are included in the mixture to meet different product specifications. Asphalt is made from a mixture of aggregates and bitumen, a petroleum product that can be found in natural beds or as a byproduct of petroleum distillation. The purpose of the concrete and asphalt bench-scale tests was to evaluate whether the sediment from the Pilot Dredging Area, which is predominantly coarse-grained, could be used as a sand source for concrete and asphalt.

Sediment to be evaluated for asphalt and concrete were collected from the Pilot Dredging Area stockpile. Four 5-gallon buckets of material were transported to the Holcim testing laboratory in Beltsville MD. Prior to testing, the sample was homogenized and processed. Based on visual observation, the fines content was determined to be too high to meet specifications; therefore, the sediment was wet sieved to separate the sand fraction from the silt/clay fraction. The resulting sand fraction material was given the designation AG-0278. Sample AG-0278 was analyzed for grain size per ASTM C117/C136 as well as specific gravity and absorption per ASTM C128. The results of these analyses are presented in Appendix F.

The results of the grain size analyses were compared the Standard Specification for Concrete Aggregates (ASTM C-33) and the Standard Specification for Fine Aggregate for Bituminous Paving Mixture (ASTM D-1073) to determine if the material gradation was within specification. Results of the grain size analyses indicated that the processed sediment sample did not have the specified grain size distribution for manufacturing concrete or asphalt. For both materials, the sand was too poorly graded (well sorted), with the particle sizes within the sand range generally finer than specified. Results of the specific gravity testing and absorption testing were compared to typical values presented in ACI Education Bulletin E1-07, printed in 2007 by the American Concrete Institute. Both the specific gravity and absorption were well outside of typical ranges. One potential reason for the low specific gravity and high absorption is the presence of coal in the sediment.

Based on the results of the testing, the sediment does not appear to be feasible for use in concrete and asphalt applications as presented. To potentially utilize the material, the sediment would need to be screened to remove fines and coal then mixed with coarser grained sand to meet the specified grain size distribution, specific gravity, and absorption requirements. The additional work required to process the sediment for use likely renders it economically infeasible. However, if sand separation occurs as part of dewatering during future dredging operations, further consideration of that material is warranted.

3.2 Cement Clinker Manufacturing

The purpose of the cement clinker bench-scale testing was to evaluate whether the predominantly fine-grained sediment collected during the Sediment Characterization Study could be used as a raw material in the cement manufacturing process. Portland cement is manufactured by heating limestone and clay or other silicate mixtures at high temperatures. The resulting clinker, when cooled, is crushed and mixed with gypsum (calcium sulfate) and other ingredients and ground to a highly uniform fine powder.

Based on the results of the grain size distribution testing performed as part of the Sediment Characterization Study, samples were selected from cores that contained predominantly fine-grained material and shipped to the Holcim cement plant in Holly Hill, SC. Fine-grained material (predominantly clay and silt) is preferred for cement clinker manufacturing. Prior to testing, the sample was homogenized and sieved to separate the sand from the fine-grained (silt/clay) materials. Samples were analyzed for mineral composition, moisture content, and LOI. The results of the testing were compared with the same analytical testing results for shale and coal ash, which are both commonly used in the cement manufacturing process. The bench-scale testing report is presented in Appendix G.

Based on the testing results, it appears that the sediment can be used as an alternative raw material in the manufacture of cement clinker. The sediment has concentrations of aluminum oxide (Al_2O_3) and silicon dioxide (SiO_2) similar to that found in Hagerstown Shale, which is currently being used as a source of these two minerals for cement manufacture. Additionally, concentrations of sodium oxide (Na_2O) and potassium oxide (K_2O), both of which are deleterious in the manufacture of cement, are lower in the sediment than in the Hagerstown shale. The challenge with using the sediment for cement manufacture is the high moisture content, which may require that the material be dried before use.

3.3 Blended Soil for Highway and Horticultural Applications

Manufactured soil blends are typically produced with sand, silt, clay, and organic material. Specifications from the Maryland SHA as well as private construction companies dictate ingredient ratios in the blends to achieve desired performance requirements for infiltration, permeability, and erosion resistance, in addition to supporting plant growth. Stancills conducted bench-scale testing on a series of soil blends to determine if they met specification requirements for a range of blended soil applications. These included:

- ***SHA Bioretention Soil:*** This material is typically used in interstate highway medians. It is used as a soil top layer applied over gravel layers laced with drainage piping. The blend is specifically developed to promote filtration along with sufficient permeability to avoid ponding of stormwater in grassy highway medians.
- ***SHA Topsoil:*** This material is used as a topsoil in roadway construction. As with bioretention soil, desired characteristics include permeability to promote drainage, sufficient grain size gradation to help prevent erosion, and sufficient organic matter content to support plant growth (typically grass).
- ***MDE Bioretention Soil:*** This material is typically used on commercial and residential sites for bioretention ponds, swales, and raingardens. It is intended to provide water quality management by filtering storm water runoff. The material has a lower permeability rate and higher organic percentage compared to SHA Bioretention soil.
- ***Topsoil***: This material is for general use on commercial and residential sites for vegetative growth. The material is often custom blended to meet specifications and requirements of the customer.

Bench scale testing for blended soils included two elements: 1) preparation and testing of blended soil products; and 2) fertility testing of the Reservoir sediment used as an ingredient in the blended soils.

3.3.1 Preparation and Testing of Blended Soil Products

Soil blends were prepared using varying amounts of stockpiled dredge material, concrete sand, hardwood mulch, and proprietary amendments. Appendix H presents ratios of each ingredient added to the blends. Samples from each blend were sent to Geo-Technology Associates, Inc. geotechnical laboratory in Abingdon, MD. Results are summarized in Appendix H and indicate that the material is suitable for manufacturing SHA Bioretention soil and SHA Topsoil using blends that include up to 35% of Reservoir sediment. In addition, nearly all blends prepared for potential commercial topsoil application were within required specifications. Samples of SHA Bioretention soil and SHA Topsoil were sent to the SHA project coordinator for testing conformation and approval for use on an SHA project. The SHA testing indicated that the SHA Bioretention Soil met the specification and the SHA Topsoil exceeded the organic matter and soluble salt criteria.

The blend ratios of the SHA Topsoil can be amended and retested if a project requiring SHA Topsoil is identified. Given the presence of arsenic at concentrations above the IR/BU Guidance Category 1 and Category 2 thresholds, testing of the SHA Bioretention soil ingredients as well as the final soil blend were conducted. When available, results of this testing will be presented in the addendum describing the Field Demonstration project.

3.3.2 Soil Fertility Testing

A germination study was conducted by the University of Maryland Wye Research and Education Center (WREC) to assess the fertility of Reservoir sediment (Appendix K). Twelve 5-gallon buckets of sediment from the sediment stockpile were delivered to WREC. The following three blends were created using an electric mixer:

- Reservoir sediment + Leafgro at 20% of sediment weight (7% water content)
- Reservoir sediment + mushroom compost at 20% of sediment weight (7% water content)
- Reservoir sediment + poultry litter at 3% of sediment weight (7% water content)

In addition to these three mixes, germination also was evaluated in unamended Reservoir sediment and a commercial peat-based growing mix that served as a seed germination control treatment. On April 11, 2022, the five growing substrates were placed in a pot matrix on a greenhouse bench to evaluate emergence and early growth of corn (*Zea maize*), soybean (*Glycine max*), wheat (*Triticum aestivum*), the three primary agricultural crops in Maryland, and red fescue (*Festuca rubra*), a small seeded grass used in conservation reclamation projects. A one month trial was conducted and biomass was harvested on May 11, 2022 to determine total growth and tissue nutrient concentrations.

There were some minor delays in emergence in the poultry litter mix and soil crusting temporarily hindered soybean emergence, but eventually total emergence in all treatments was as high or higher than in the potting mix control treatments. Final corn and wheat height and biomass were greatest in the poultry litter amended mixture. Plant appearance and tissue nitrogen concentrations suggested that higher nitrogen availability was the factor leading to the higher growth. Overall, final biomass in the unamended reservoir treatment tended to be lower than in all the mixtures for all four species tested. Tissue concentrations and testing of nutrient availability in all the treatments suggested that low potassium, and possibly phosphorus, was the factor likely to have limited growth. All three of the amendments used in this study appeared to have potential to mitigate any nutrient deficiencies of Reservoir sediment and to improve overall suitability for plant growth.

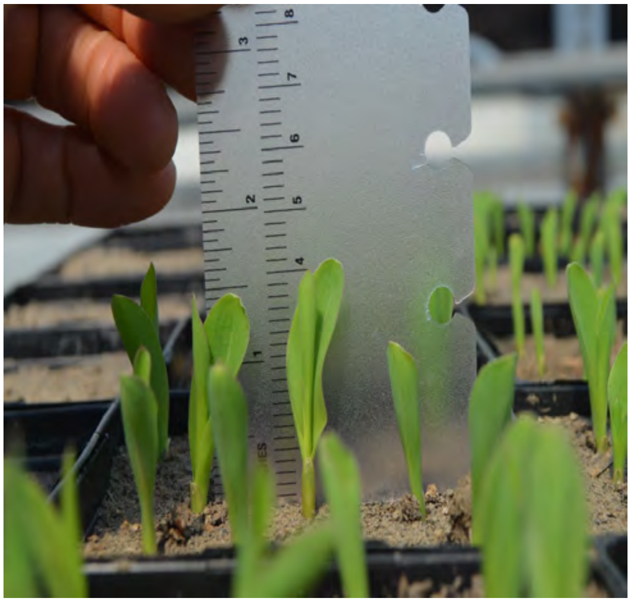


Image: Measuring Plant height in corn, 8 days after planting.

Image: Full trial matrix, 16 days after planting.

3.4 Supplemental Cementitious Material

The purpose of the SCM bench-scale testing was to evaluate whether the predominantly fine-grained sediment collected during the Sediment Characterization Study could be processed into SCM. SCM can be used to partially replace cement in concrete. SCM is produced by the calcination of high-quality clays, mainly kaolin, at elevated temperatures in the range of 600-900 ºC. SCM bench-scale testing was performed by staff from the UC Berkeley and Georgia Tech to test for pozzolanic elements and to provide information for determining the potential for SCM creation. The SCM bench-scale testing included four elements:

- Sample Preparation
- Testing for Pozzolanic Elements
- Calcination Temperature Optimization
- Final Product Testing

The procedures and findings of the SCM bench-scale test are summarized below; a report detailing the bench-scale testing is presented in Appendix I.

3.4.1 Sample Preparation

Two 5-gallon buckets of material collected from the Sediment Characterization Study were transported to Georgia Tech. Once received, the samples were thoroughly dried, crushed, and passed through a 90-µm (No. 170) sieve to separate the fine-grained material from the coarse fraction. This sediment was collected from multiple cores, potentially leading to variation in phase composition. These two buckets were subsequently labeled by Georgia Tech as samples S6 and S7.

Prior to testing, portions of samples S6 and S7 were each divided into six sub-samples for testing; the remainder of S6 and S7 were held for final product testing. Each subsample was also incorporated into a unique cement paste and mortar mix. For the both the cement paste and mortar mixes, 20% (by weight) of the cement was replaced by the raw or calcined sediment. The mortar mix also included natural sand. The details of the paste and mortar preparation are included in Appendix I.

3.4.2 Testing for Pozzolanic Elements

Potentially pozzolanic elements were identified in the raw and calcined sediments utilizing scanning electron microscopy (SEM) and X-Ray diffraction (XRD) analysis. For each primary sample, five of the subsamples were heat-treated (calcined) in a muffle furnace at temperatures between 500 and 900 degrees Celsius (ºC) at 100 degree intervals); the remaining subsample (raw) was not heat-treated.

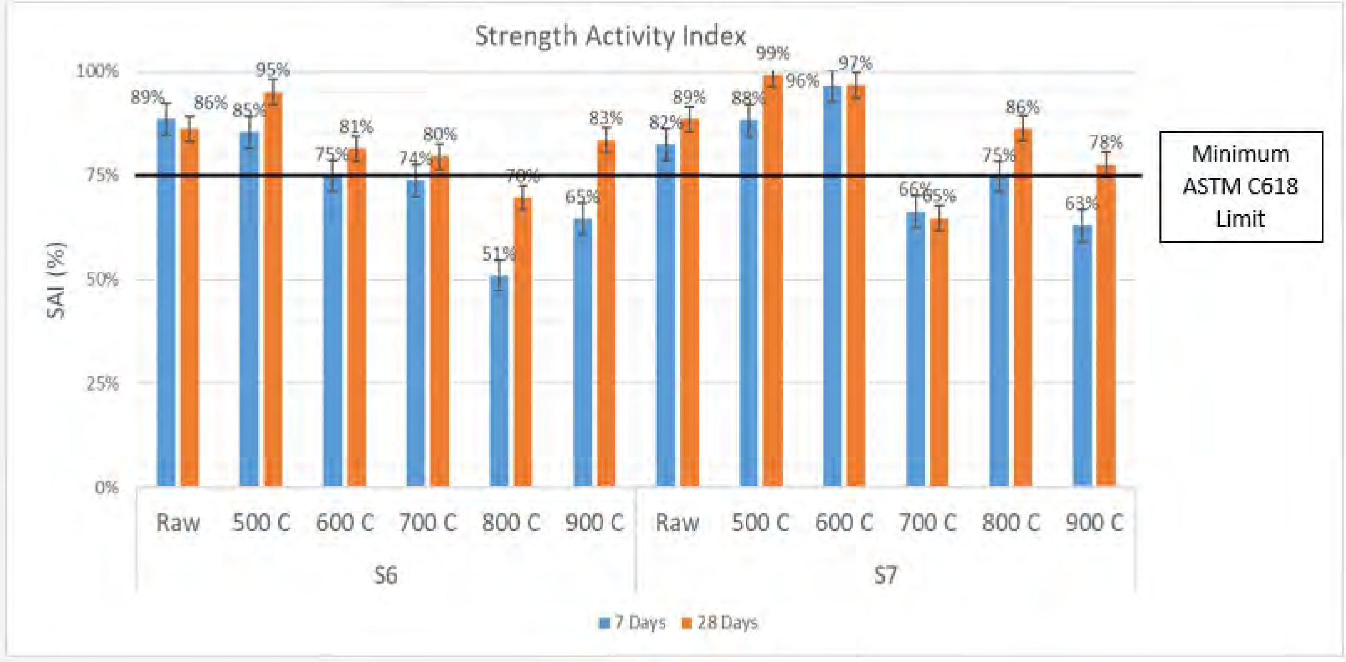
3.4.3 Calcination Temperature Optimization

Calcination temperature optimization testing included particle distribution and compressive strength.

Particle Distribution: Particle distribution testing was performed on the raw and calcined sediment samples. Post heat-treatment grain size analysis indicated that the average particle size distribution of both the raw and calcined sediments ranges between 15 – 20 µm. This particle size distribution is generally similar to and coarser than the ASTM Type I/II Portland cement which limits the sediment's potential for particle packing and nucleating effects. Higher temperatures generally led to a coarser particle size distribution, likely due to the agglomeration and subsequent sintering of clay particles. The only exceptions to this finding were samples S6 and S7 at 500 °C which decreased in average particle size.

Strength Testing: Strength testing was performed on 2-inch mortar cubes cast from the mortar mixes created for each of the raw and calcined sediment samples. Compressive strength testing was performed in accordance with ASTM C305 and ASTM C109. The relative strength (in reference to 100% ordinary Portland Cement) of each raw and calcined sediment sample is shown in Figure 5. The minimum relative strength at 7 or 28 days (ASTM C618) for Class N Pozzolans is reported as a black line at 75% relative strength.

Figure 5. Relative Strength of Raw and Calcined Sediments (Temperature Optimization)



As shown in Figure 5, there is a large variation in the relative compressive strength of the sediments with calcination temperature. In general, the relative strength of the sediments decreases with higher temperatures. This is primarily due to the sintering and subsequent agglomeration of the heat-treated particles but may also be due to potential variability between the subsamples. Based on these results, the greatest relative compressive strength level was achieved at 500 °C for both samples S6 and S7 (95% and 99% at 28 days), which may be due, in part to, the larger particle size resulting from the calcination at higher temperatures.

As a follow-up to the initial strength testing, additional testing on samples was performed on samples calcined at 700 °C with two changes to the process: the sediment was held at the target calcination temperature for two hours instead of one and the sediment was sieved through the No. 170 sieve a second time prior to casting the mortar cubes in order to remove the coarser agglomerated elements. Results indicated an increase in 28-day strength, with both samples above the threshold of 75% relative strength.

3.4.4 Final Product

Based on the results of the calcination temperature optimization, sediments calcined at 500 ^{o}C were selected as the final product for further testing. Cement pastes and mortar mixes were developed from the calcined sediments as described above. Testing of these final products included minerology (by x-ray diffraction), isothermal calorimetry, thermogravimetric analysis, compressive strength, and alkali-silica reaction. These tests are described below.

X-ray Diffraction: Two subsamples each of samples S6 and S7 were heat-treated at 500 °C; one subsample was treated for 1 hour and the other for 2 hours. The calcined samples were then tested using x-ray diffraction to evaluate the presence of pozzolanic elements within the treated sediment.

Isothermal Calorimetry: Isothermal Calorimetry is a tool used to evaluate the hydration process of cement. The shape of the heat flow versus time curve reflects the hydration processes and the effect of an admixture is reflected in a change to the hydration curve. Isothermal calorimetry tests were performed on the cement pastes using both raw and calcined sediment and compared to both Portland cement and quartz.

Thermogravimetric Analysis: Thermogravimetric analysis was performed on cement pastes using both the raw and calcined sediment to determine the calcium hydroxide content of the cement pastes. The amount of calcium hydroxide increases over time for normal cement pastes because it is a product of the cement reaction with water. However, when pozzolanic materials are incorporated into the mixture, the amount of calcium hydroxide decreases because it reacts with the pozzolan and generates cementitious products. Test results indicated that while there is a net drop in calcium hydroxide between the raw and calcined sediments, which would indicate a stronger pozzolanic reaction, this change is not significant. The results indicate that the reactivity of the calcined sediment is not fully activated by heat treatment at 500 °C, suggesting that a higher degree of calcination is needed to increase the potential of the pozzolanic material further.

Compressive Strength: In order to test the efficacy of the new calcination process at a longer time frame, additional mortar cubes were mixed and tested with the same method discussed with the temperature optimization section. Four mortar cubes were tested including one cast with raw sediment and one with sediment calcined at 500 °C for both S6 and S7 sediments. Results indicated a steady rise in relative strength over time, which is an indication of the pozzolanic reaction. The results for both heat-treated cubes were above the 75% threshold for relative strength.

Alkali Silica Reaction: Calcined Reservoir sediment was mixed and set into mortar bars for the accelerated mortar bar test (ASTM C1567). Samples tested included mortar mixes utilizing raw sediment, sediment calcined at 500 °C, and sediment calcined at 600 °C, for both S6 and S7 sediments. Results were compared to mortar made with Portland cement, Class F fly ash, or metakaolin for comparison. All of the calcined Reservoir sediments were prepared using the final calcination process. Based on the previous testing, a 500 °C calcination temperature only provided marginal benefits to pozzolanic reactivity. Therefore, the sediment calcined at 600 °C was added to the testing regime to determine if it would provide a significant difference in the mitigation of the alkali-silica reaction. None of these calcined samples passed the 14-day expansion limit, indicating a lack of pozzolanic reactivity even when calcined at a higher temperature.

3.4.5 Summary

Scanning electron microscopy and x-ray diffraction studies confirmed that the sediment possesses several potential sources of pozzolanic reactivity. The calcining temperature of 500°C optimized compressive strength, but further detailed analysis, including x-ray diffraction, isothermal calorimetry, and thermogravimetric analysis, indicated that the calcined temperature was not high enough to fully activate the pozzolanic potential of the sediment. Consequently, the calcined sediment could not prevent the alkali-aggregate reaction in concrete even when calcined at a temperature of 600 °C. Considering the economic potential of the calcined sediment, it is recommended the following actions be taken: a) increase the calcining temperature, b) induce a fast-cooling rate to avoid any recrystallization, c) grind the calcined sediment to reduce the average particle size and to increase reactivity, d) homogenize dredged sediment to reduce variability within the product. Ideally, these tests should be done on an industrial scale.

3.5 Sediment Stabilization

Stabilized sediment can be used as fill material in a wide variety of commercial and industrial setting. Often specified as controlled low strength material (CLSM), flowable fill can be used for excavation backfill as well as other applications that do not require high compressive strength. Bench-scale testing for sediment stabilization was performed by Tipping Point in combination with staff at Rutgers Center for Advanced Infrastructure and Transportation. The bench-scale tests were performed to assess the suitability of the material for stabilization. In addition, the bench-scale testing evaluated the suitability of the Reservoir sediment for use in Tipping Point's Pneumatic Flow Tube Mixing technology (PFTM). The PFTM is a sediment and sludge stabilization process that entrains air, cement, and sediment inside of a flow-through tube, as shown in image below. The air injection causes the sediment and binders to tumble through the tube which results in mixing that produces a stabilized flowable material that can be pumped for several miles.

Images: Tipping Point Pneumatic Flow Tube Mixing Apparatus Producing Flowable Fill

It is anticipated that a future full-scale hydraulic dredging project would incorporate a dewatering process that facilitates material separation into coarse and fine exit streams. To mimic the effect of the dewatering process, samples used for the stabilization study were selected from cores that were predominantly fine grained.

The sediment stabilization bench-scale testing was conducted in three phases:

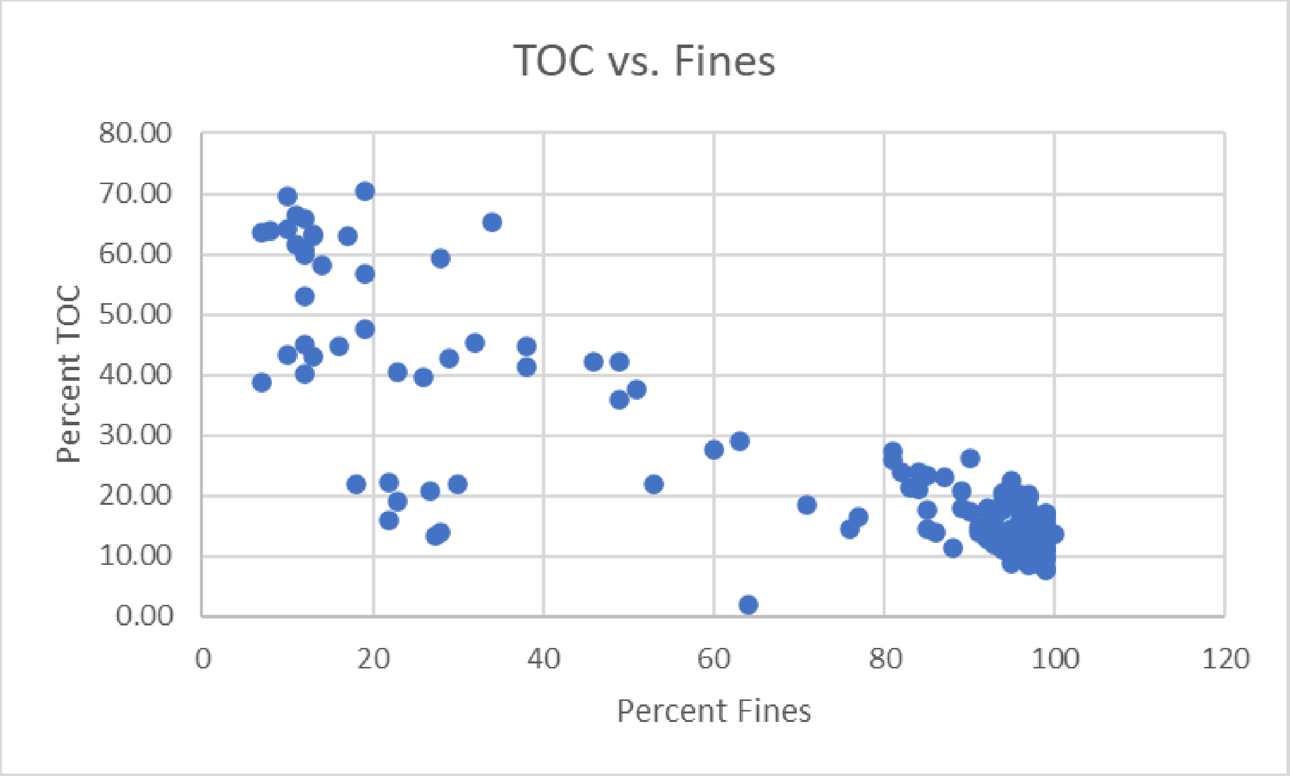
1. Assessment of Coal Content
2. Material Characterization & Evaluation of Stabilized Sediment
3. Evaluation of Stabilized Sediment

The procedures and findings of the sediment stabilization bench-scale test are summarized below; a report detailing the bench-scale testing is presented in Appendix J.

3.5.1 Assessment of Coal Content

High organic carbon has been shown to interfere with the stabilization binders and may have an adverse effect on the strength characteristics of stabilized sediment. In order to determine the amount of coal in the sample, the coal and other organic content was determined via the LOI test (ASTM D2974) at Rutgers University during the Sediment Characterization Study. The LOI results are presented in Table 2. The results of the LOI indicated that sediment core samples had TOC content ranging from less than 1% to approximately 74%. Additionally, the percentage of coal generally had an inverse relationship with the percentage of fines in the sample (Figure 6). This is likely due to granular coal being present in the coarse grains sediment while coal dust is present in the fine-grained sediment.

Figure 6. Total Organic Content versus Fines Content



3.5.2 Material Characterization & Evaluation of Stabilized Sediment

A composite sample was created from sediment from cores that were observed by field geologists to include finer grained material. The sediment was delivered to Rutgers in 5-gallon buckets. Sediment from all of the buckets was homogenized in the laboratory to yield a single sample that was then used for all subsequent testing.

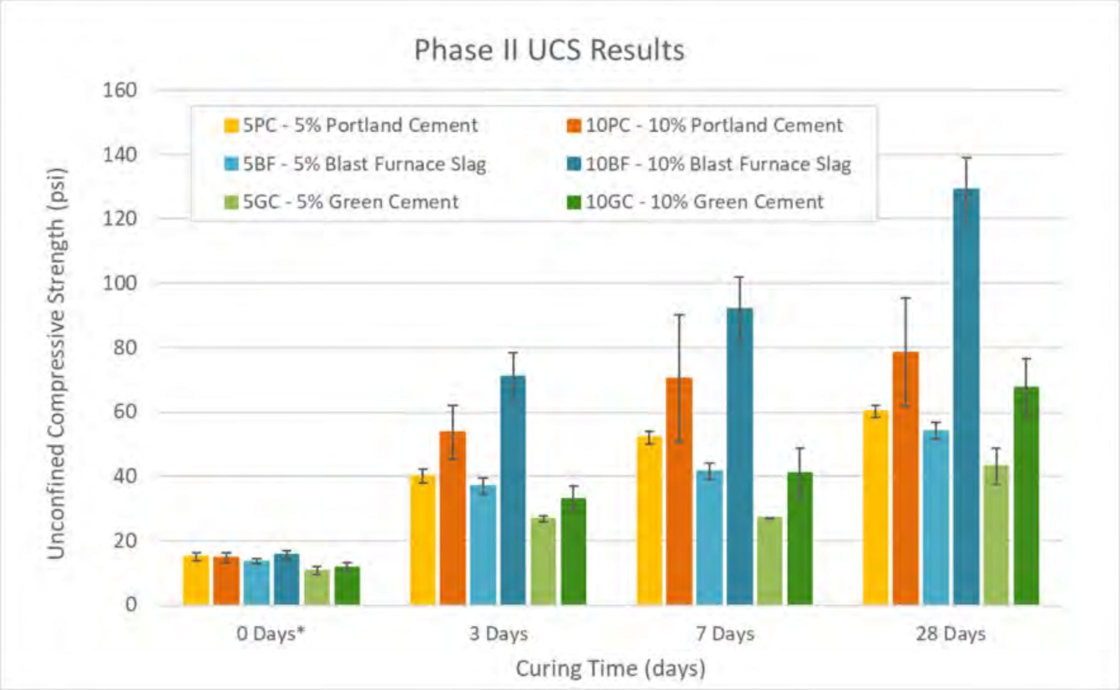
Index properties including water content, TOC, Atterberg Limits, and grain size analyses were performed on the homogenized sample, and the sediment was classified in accordance with the Unified Soil Classification System (USCS). The results of the index property testing are as follows:

- Natural Water Content: 63%
- TOC: 36%
- Grain Size: 0% gravel, 68% sand, and 32% silt/clay
- Soil Classification: Silty Sand with Organics (SM)

In preparation for the bench-scale testing, the sediment was hydrated and then stabilized with three binders: ordinary Portland cement, green cement (sourced from Holcim), and a 70:30 blend of Portland cement with blast furnace slag. Mixtures were prepared using each binder at 5% and

10% dosage rates for a total of six unique mixtures. Subsamples were cured for 0, 3, 7, and 28 days post-compaction and tested for Unconfined Compressive Strength (UCS) and moisture content (Figure 7).

Figure 7. Unconfined Compressive Strength vs. Curing Time



Results indicate that all three binders would produce stabilized material that achieves a minimum required strength for a variety of applications. Material strength specifications will vary with site-specific use and market applications, but results indicate that the tested mix designs would be appropriate for one or more of the following structural IR/BU applications based on Maryland Department of Transportation (MDOT) requirements:

- Controlled Low Strength Material (Type A – minimum 28-day UCS of 50 to 200 psi)
- Flowable Backfill (minimum 28-day UCS of 100 psi)

Additional potential end uses may include landfill and brownfield caps and fills (Maher et al, 2013).

3.5.3 Evaluation of Impacts of Moisture Content on Stabilized Sediment

In Phase III, the composite sediment was dried, then rehydrated at five moisture contents (15%, 30%, 40%, 50%, and 65%) and stabilized with 5% and 10% Portland cement to create a total of 10 unique mixtures. Triplicate samples were cured for 7 days post-compaction and tested for UCS and moisture content.

The results of the moisture content evaluation indicate that the optimum moisture content for stabilization/solidification of Reservoir sediment is around 40%. Mixtures that had a moisture content of 30% or less (consisting of both 5% and 10% Portland cement) were unable to be compacted into self-supporting cores at the time of compaction, resulting in 7-day UCS values of 0 psi. The UCS results for mixtures that had moisture contents above 30% follow the pattern typically observed for Proctor compaction and are informative for use in construction and design.

3.5.4 Summary

The sediment stabilization/solidification bench-scale testing showed favorable results. Addition of pozzolanic binder can stabilize the material to sufficient UCS to support a variety of potential IR applications including flowable fill.

3.6 Bricks and Pavers

During the development the IR/BU Materials Management Plan, Northgate-Dutra JV coordinated with the Beldin Brick Company of Canton, Ohio to assess Reservoir sediment for possible use in brick and paver manufacturing. The material was to be sent to the Belden plant located in Rocky Ridge, MD. When the material was available in the fall of 2021, the Northgate-Dutra JV contacted Belden and learned that the Rocky Ridge plant had been closed and the property had been redeveloped. Hence, brick manufacturing bench-scale testing was not performed, and this end use was not included in the economic evaluation. However, incorporation of fine-grained dredge material into brick and pavers has been demonstrated to be a potential IR option and should be reviewed when a full-scale dredging program is implemented.

4.0 WATER QUALITY IMPACT EVALUATION

The objective of this water quality impact evaluation was to provide information that can be used in the development of a strategic dredging plan for the Reservoir. The scope of the evaluation included the following:

- ***Data Evaluation and Synthesis:*** Reviewing and synthesizing available publications and modeling information to understand the current state of sediment and nutrient modeling.
- ***Linear Regression Model:*** Developing a linear regression water quality model (Water Quality Impact Calculator) as a planning-level screening tool to approximate the effect of different sediment removal quantities on sediment and nutrient loading and impact towards the needed TMDL reductions.
- ***Strategic Dredging Plan:*** Identifying best practices to be included/evaluated as part of the development of a strategic dredging plan to maximize nutrient reduction resulting from dredging.

It should be noted that development of novel numerical models or research is beyond the scope of this task. There are many well established models and a growing body of research investigating specific aspects of sediment and nutrient dynamics within the Lower Susquehanna River, Conowingo Reservoir, and Chesapeake Bay.

4.1 Data Evaluation and Synthesis

4.1.1 Background

In 2010, the Chesapeake Bay TMDL defined numerical reduction targets for sediment, phosphorus, and nitrogen with the goal of meeting these targets by 2025 (USEPA, 2010). The TMDL, and the associated modeling that informed the sediment and nutrient reduction targets, assumed that the Reservoir would continue to trap sediment and nutrients through 2025. Since that time, and due in large part to ongoing monitoring, considerable advancements have taken place in our understanding of the water quality of the Bay, its connection to various upstream sources of sediment and nutrients, and the delivery of sediment and nutrients throughout the 64,000 square mile watershed. The Chesapeake Bay TMDL included a progress review, known as the Mid-Point Assessment, which provided an opportunity to review the targeted load reductions and account for new understandings. A preponderance of evidence including bathymetric surveys, mass balance using upstream and downstream monitoring data, and modeling analyses resulted in general agreement among stakeholders that the Reservoir is currently in dynamic equilibrium (Zhang et al., 2016). This has been defined as a state associated with equal input and output of materials averaged over long time-periods which has been exhibited in the Reservoir since approximately the early 2010s. These findings were integrated into the 2017 Mid-Point Assessment and resulted in the annual addition of 0.26 million pounds per year (0.26-mlb/yr) of phosphorus and 6 million pounds per year (6-mlb/yr) of nitrogen. This precipitated the development of a CWIP, which was finalized July 31, 2021, and outlines the best management practices and strategies to address the increased reductions required to meet the TMDL targets. While the CWIP does not specifically include dredging as a management strategy, it notes that sediment removal needed to be explored further.

Strategic dredging of infill sediments in the Reservoir has been considered as a potential sediment and nutrient management strategy since at least 2015 when it was evaluated within the Lower Susquehanna River Watershed Assessment (USACE, 2015). Dredging and other Reservoir sediment management strategies are targeted because of the large contribution of sediment and associated nutrients that are delivered to the Bay during high-flow events. This has motivated researchers and others to understand the specific contribution that infill sediments play in non-attainment of water quality standards

While much of the early research focused on the sediment and nutrient contribution associated with scour events, typically defined as flows that exceed approximately 400,000 cfs, recent research has concluded that these large flow events are not necessarily *directly* responsible for degraded water quality in the Bay. These scour events tend to be relatively infrequent and when they do occur the nutrient and sediment dynamics in the upper Bay tend to trap scoured suspended sediment (Palinkas, 2019 and USACE, 2015). However, if viewed holistically, infill sediments likely influence the timing of both scour-derived and watershed-derived loading to the Bay. As pointed out in Palinkas et al. (2019), a decrease in deposition of watershed sediments within the Reservoir, due to diminished trapping efficiency related to available sediment capacity and particularly with higher energy during flow events, would allow the sediments to remain in suspension and transport downstream to the Bay. That study also showed a greater than four-fold decrease in reactivity in surface sediment nitrogen release relative to the reactivity in suspended sediments. In addition, nitrogen remineralization from suspended materials directly provides reactive nitrogen for algal growth, whereas nitrogen remineralization from sediment deposits allows a large part of the nitrogen to be rendered unreactive through microbial denitrification (Cornwell et al. 2017).

The Chesapeake Bay Program's Scientific and Technical Advisory Committee (STAC) identified a similar finding that "net sediment and particulate nutrient deposition behind the Dam are decreasing over a wide range of flows, including flows well below levels typically viewed as scour events" (Linker et al., 2016a). Ongoing research will help determine whether infill- or scour-derived load is contributing to non-attainment of water quality standards in the Bay and at what timescale these impacts take place; however, the conclusion remains that management of infill sediment is an opportunity for intervention.

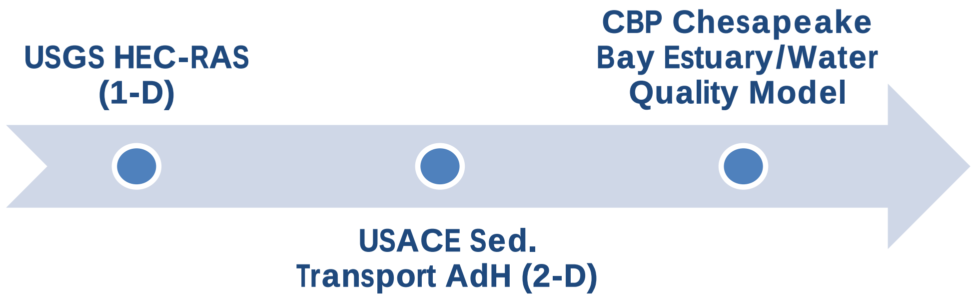
4.1.2 *Summary of Sediment and Nutrient Modeling*

The establishment of numerical TMDLs and sound planning for implementation of sediment and nutrient reduction measures requires that models are used to predict water quality conditions. As mentioned above, the 2010 TMDL relied upon modeling to develop the required reductions. The model used is referred to as the Chesapeake Bay Environmental Modeling Package (CBEMP). It consists of an Airshed Model, Land Use Change Model, Watershed Model (currently in Phase 7), and Estuary Model. These models are informed by decades of monitoring data resulting in improvements to our understanding of the mechanisms and dynamics associated with sediment and nutrient processes.

In May of 2015, the US Army Corps of Engineers, Baltimore District (USACE) and the MDE published the Lower Susquehanna River Watershed Assessment (LSRWA). The LSRWA advanced our understanding of the lower Susquehanna River sediment and nutrient dynamics and their consequences. This work included development of two new models: a hydraulic and sediment transport model of the river corridor from Lake Clarke to the Conowingo Reservoir using HEC-RAS and an Adaptive Hydraulics (AdH) model to simulate hydrodynamics and sediment transport of the Reservoir to the Susquehanna Flats, the area below the Conowingo Dam. The AdH model scenarios included 1996, 2008, and 2011 Reservoir bathymetries to evaluate different infill conditions and their effect on transport. Both models used the flow period from 2008 to 2011.

The HEC-RAS model is a 1-dimensional model that is effective at simulating scour and deposition within a river corridor over time. This model provided input information for the AdH model including flow and sediment inflows. The AdH model is a more complex 2-dimensional model that can simulate scour and deposition of bed sediment layers where these patterns may not be uniform across the flow path. The AdH model in turn provided inputs to the CBEMP to understand the downstream impacts of different conditions (Figure 8).

Figure 8. Chesapeake Bay Modeling Process



The LSRWA states that the HEC-RAS model uncertainty is primarily associated with its limited capability to simulate transport of cohesive silt and clay soils. The potential outcome of this could be underestimation of both deposition and scour under some circumstances. Stated uncertainties associated with the AdH model include simulating flocculated sediment coming into the Reservoir, simulating scour of larger compacted sediment aggregates, and the ability to simulate dam operations (USACE, 2015).

To address some of the uncertainties associated with the USACE produced HEC-RAS model documented in the LSRWA, in 2016 a new HEC-RAS model was developed by WEST Consultants and funded by Constellation. This model utilized gage data from 2008 to 2015 and also provided particle size class inputs to the Reservoir.

In June 2017, Constellation published the Conowingo Pond Mass Balance Model (CPMBM) documentation (Fitzpatrick, 2017). This work sought to answer questions related to the reactivity of scoured and deposited sediment, their chemical changes, and their transport. The CPMBM includes a hydrodynamic and sediment transport model known as ECOMSED and a water quality model developed by HDR, Inc. (HDR), known as RCA. These models improved upon the previous modeling framework by addressing previous model uncertainties associated with diagenesis, hydrodynamics, transport, and dam operations.

The HEC-RAS model of the lower Susquehanna River and the CPMBM were subsequently reviewed and incorporated into the 2017 Mid-Point Assessment and represented enhancements to the CBEMP that were used to inform the CWIP.

4.2 Linear Regression Model

4.2.1 Purpose

The Water Quality Impact Calculator (the Calculator), developed by the Northgate-Dutra JV, is a linear regression model that has been used to estimate the impact of sediment volume changes such as dredging and ongoing deposition on yearly nutrient and sediment export and TMDL allocations. The assumption inherent in the additional reduction requirements identified in the TMDL Mid-Point Assessment is that if infill volume were returned to quantities associated with a state of non-dynamic equilibrium (e.g., with remaining trapping capacity) then the required reductions or a portion thereof would be accomplished. While the reality of achieving water quality standards and the conditions that bring them about are more complicated, and thus have greater associated uncertainty, the underlying relationship between lower sediment volume behind the Dam and improved downstream water quality is evaluated at a screening level by the Calculator.

4.2.2 Model Development

The Calculator utilizes the relationship between sediment volume behind the Dam (infill) and nutrient loading to evaluate the relative impact of different dredging scenarios on water quality.

Infill: To understand the infill condition of the Reservoir, the bathymetry or capacity at different points in time must be known or calculated. The Reservoir bottom-surface profile was surveyed in 1959/60, 1990, 1993, 1996/7, 2008, 2011, and 2014 (Langland, 2009; and Langland, 2015). This record provides a robust understanding of infill conditions and patterns. This information in combination with depositional rates from long-term monitoring provides the potential for approximating infill conditions for intervening years to be interpolated while understanding that scour/depositional processes are highly variable depending on flow events.

Nutrient Loading: During the Mid-Point Assessment, the Modeling Working Group (MWG) used the CBEMP to run two scenarios to determine the effect of infill conditions on nutrient loading to the Bay. They used 1995 conditions to represent infill volume that held the previous assumption of remaining capacity and 2010 conditions to represent infill volume at dynamic equilibrium (MWG, 2017). The difference between these two scenarios represents the loading contribution due to infill volume at dynamic equilibrium. It was noted that although scour increases the delivery of particulate nutrients, many of these nutrients are not bioavailable and only reach the Bay during high, infrequent flow events. For this reason, only a portion of these nutrients, those more associated with watershed derived sediments, were assumed to impact water quality and to be relevant to the TMDL.

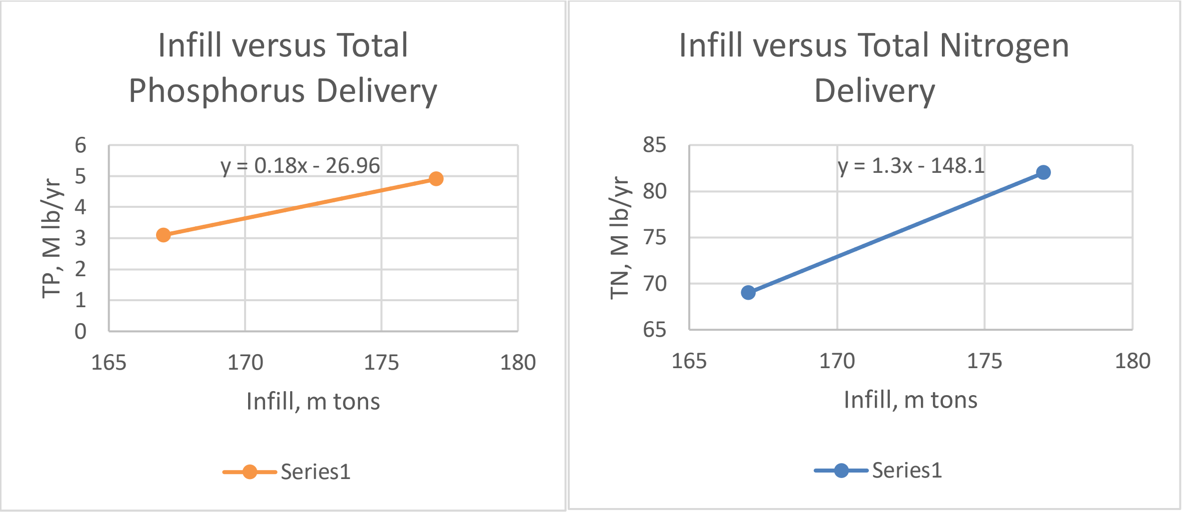
The Calculator was developed to approximate the effect of different infill volumes on downstream water quality (Table 11) based on the bathymetric and depositional information and the delivered nutrient rates calculated through the MWG efforts. While it is not certain that this relationship is linear, given the nonlinearity of sediment concentrations to flow-events among other uncertainties inherent in a stochastic system, the connection to the CWIP TMDL reductions given the two points of analysis makes this relationship a useful planning level tool to evaluate how infill volume relates to downstream water quality.

Table 11. Infill Volume and Associated Loading for Infill States

Year	***Infill (m tons)***	***Delivered Load***			***TMDL***	
		TP (mlb/yr)	***TN (mlb/yr)***	***TSS (mlb/yr)***	***TP (mlb/yr)***	***TN (mlb/yr)***
1995	167	3.1	69	1863	0	0
2010	177	4.9	82	3217	0.26	6

This relationship is defined in Figure 9 for nutrient delivery rates for the portion of that delivered load that impacts nonattainment of water quality standards and has been incorporated into the TMDL calculations.

Figure 9. Phosphorus and Nitrogen Loading vs. Infill Volume



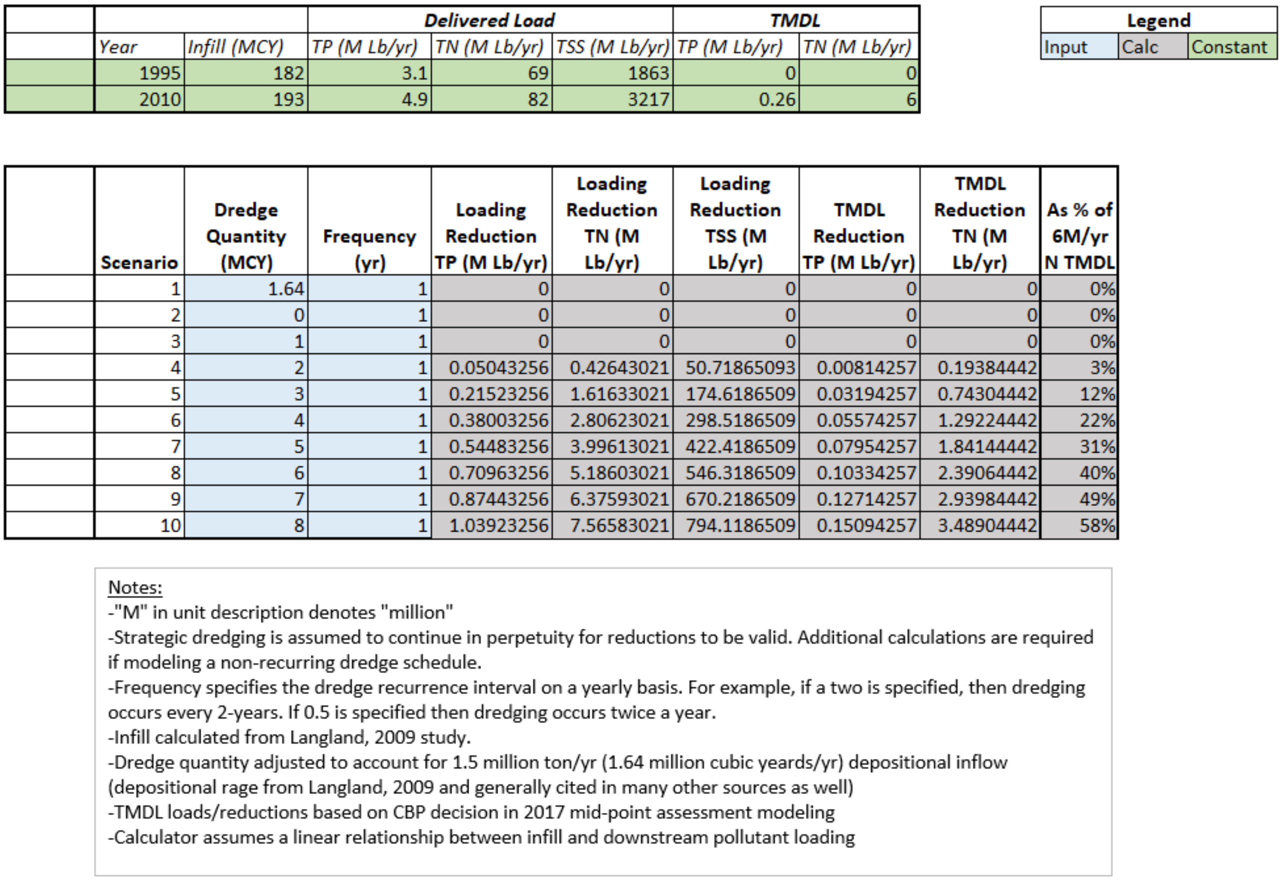
(TP = Total Phosphorus; TN = Total Nitrogen; m = million)

The Calculator is designed with tabs that allow dredge quantities to be input in either mcy or million tons (mt). This work relied on infill densities as reported and used in previous studies (Langland, 2009) for consistency; however, actual soil densities may vary. Estimates produced by the Calculator are intended as a planning or screening level assessment to understand the potential relative impact of sediment removal. The Calculator does not take into consideration resuspension during dredging or the hydrodynamic impacts of altered bed bathymetry among other characteristics that affect fate and transport of sediment and nutrients within the Reservoir. More sophisticated modeling will be necessary to produce more accurate estimates of the effect of dredging.

4.2.3 Scenario Results and Considerations

Table 12 below is from the Calculator and shows results of different dredging quantities and their impact on downstream water quality and specifically their impact on the TMDL allocations outlined in the CWIP.

Table 12. Sample Calculator Results and Annotation



			Delivered Load			TMDL	
	Year	*Infill (MCY)*	*TP (M Lb/yr)*	*TN (M Lb/yr)*	*TSS (M Lb/yr)*	*TP (M Lb/yr)*	*TN (M Lb/yr)*
	1995	182	3.1	69	1863	0	0
	2010	193	4.9	82	3217	0.26	6

Legend		
Input	Calc	Constant

	Scenario	Dredge Quantity (MCY)	Frequency (yr)	Loading Reduction TP (M Lb/yr)	Loading Reduction TN (M Lb/yr)	Loading Reduction TSS (M Lb/yr)	TMDL Reduction TP (M Lb/yr)	TMDL Reduction TN (M Lb/yr)	As % of 6M/yr N TMDL
	1	1.64	1	0	0	0	0	0	0%
	2	0	1	0	0	0	0	0	0%
	3	1	1	0	0	0	0	0	0%
	4	2	1	0.05043256	0.42643021	50.71865093	0.00814257	0.19384442	3%
	5	3	1	0.21523256	1.61633021	174.6186509	0.03194257	0.74304442	12%
	6	4	1	0.38003256	2.80623021	298.5186509	0.05574257	1.29224442	22%
	7	5	1	0.54483256	3.99613021	422.4186509	0.07954257	1.84144442	31%
	8	6	1	0.70963256	5.18603021	546.3186509	0.10334257	2.39064442	40%
	9	7	1	0.87443256	6.37593021	670.2186509	0.12714257	2.93984442	49%
	10	8	1	1.03923256	7.56583021	794.1186509	0.15094257	3.48904442	58%

Notes:
-"M" in unit description denotes "million"
-Strategic dredging is assumed to continue in perpetuity for reductions to be valid. Additional calculations are required if modeling a non-recurring dredge schedule.
-Frequency specifies the dredge recurrence interval on a yearly basis. For example, if a two is specified, then dredging occurs every 2-years. If 0.5 is specified then dredging occurs twice a year.
-Infill calculated from Langland, 2009 study.
-Dredge quantity adjusted to account for 1.5 million ton/yr (1.64 million cubic yeards/yr) depositional inflow (depositional rage from Langland, 2009 and generally cited in many other sources as well)
-TMDL loads/reductions based on CBP decision in 2017 mid-point assessment modeling
-Calculator assumes a linear relationship between infill and downstream pollutant loading

Dredging of the Reservoir has been described in the LSRWA and the CWIP as a potential solution to be paired with watershed BMPs that will reduce pollutant inflow to the Reservoir. These results support that conclusion by showing that increased dredging of the Reservoir above the rate of depositional inflow is expected to reduce downstream sediment and nutrient loading. Economic implications of the reduced loading are discussed in Section 5.

4.3 Strategic Dredging Plan

Strategic dredging is the most direct method to regain the trapping efficiency and associated transport reduction benefits associated with less Reservoir sediment infill. Strategic dredging of infill sediments in the Reservoir should be considered as part of a comprehensive sediment and nutrient management strategy. Strategic dredging has many potential benefits that will help reduce sediment nutrient flux to the upper Chesapeake Bay including:

- Physical removal of sediment and attendant nutrients
- Increase in Reservoir storage-capacity
- Decrease in flow velocity
- Increase in particle settling rates
- Increase in sediment deposition
- Decrease of shear stress
- Increase in scour threshold
- Decrease of scour induced transport of sediment and nutrients downstream
- Decrease of suspended load transport of sediment and nutrients downstream
- Increase of sediment trap efficiency

A dredging strategy should consider the conditions needed to achieve these benefits to derive the greatest reduction in nutrient and sediment flux. Key elements of a dredging management strategy include location, time of year, volume, and dredge geometry.

4.3.1 Location

Locations within the Reservoir where dredging is to occur and the sequence of multi-year dredging locations could focus on areas where deposition has occurred in recent decades (Figures 10 and 11). They could also focus on recent depositional areas (Figure 12). Areas identified as A and B in Figure 12 represent areas of consistent deposition and in the case of Area B, scour during high-flow events. Area A is likely also susceptible to high and moderate flow events due to the narrowing of the Reservoir in this location, which increases velocity and lowers the scour threshold.

Figure 10. Change in Depth to Bottom Surface by Transect in Conowingo Reservoir, 1993 to 2008

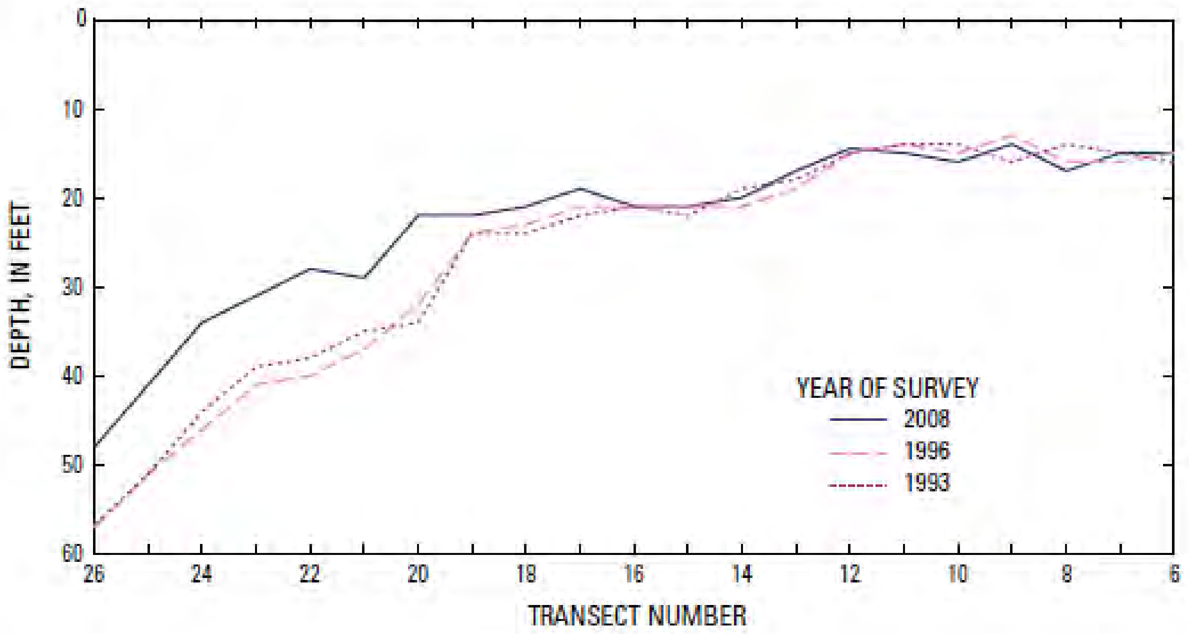
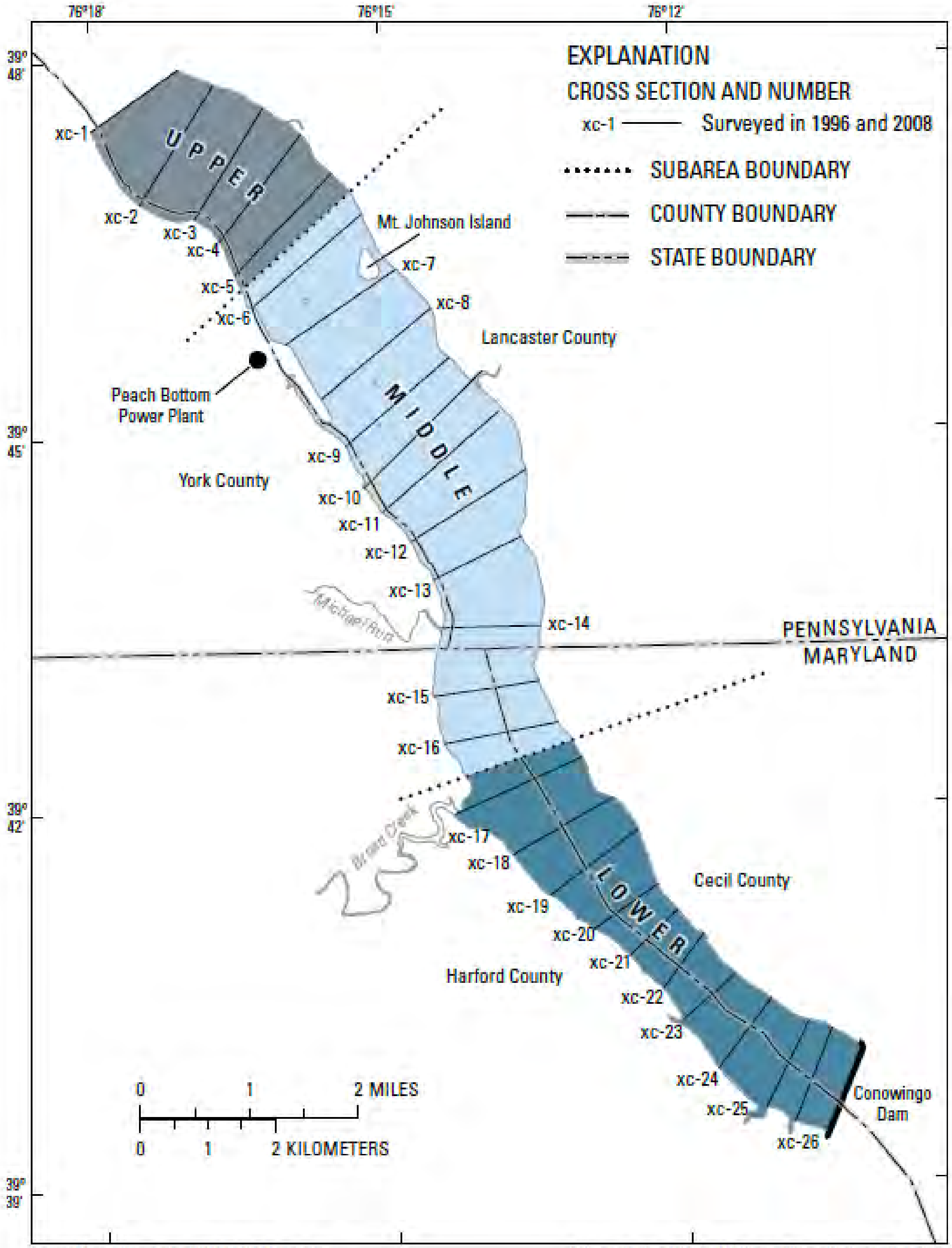


Figure 11. Bathymetric Survey Transects surveyed in Conowingo Reservoir

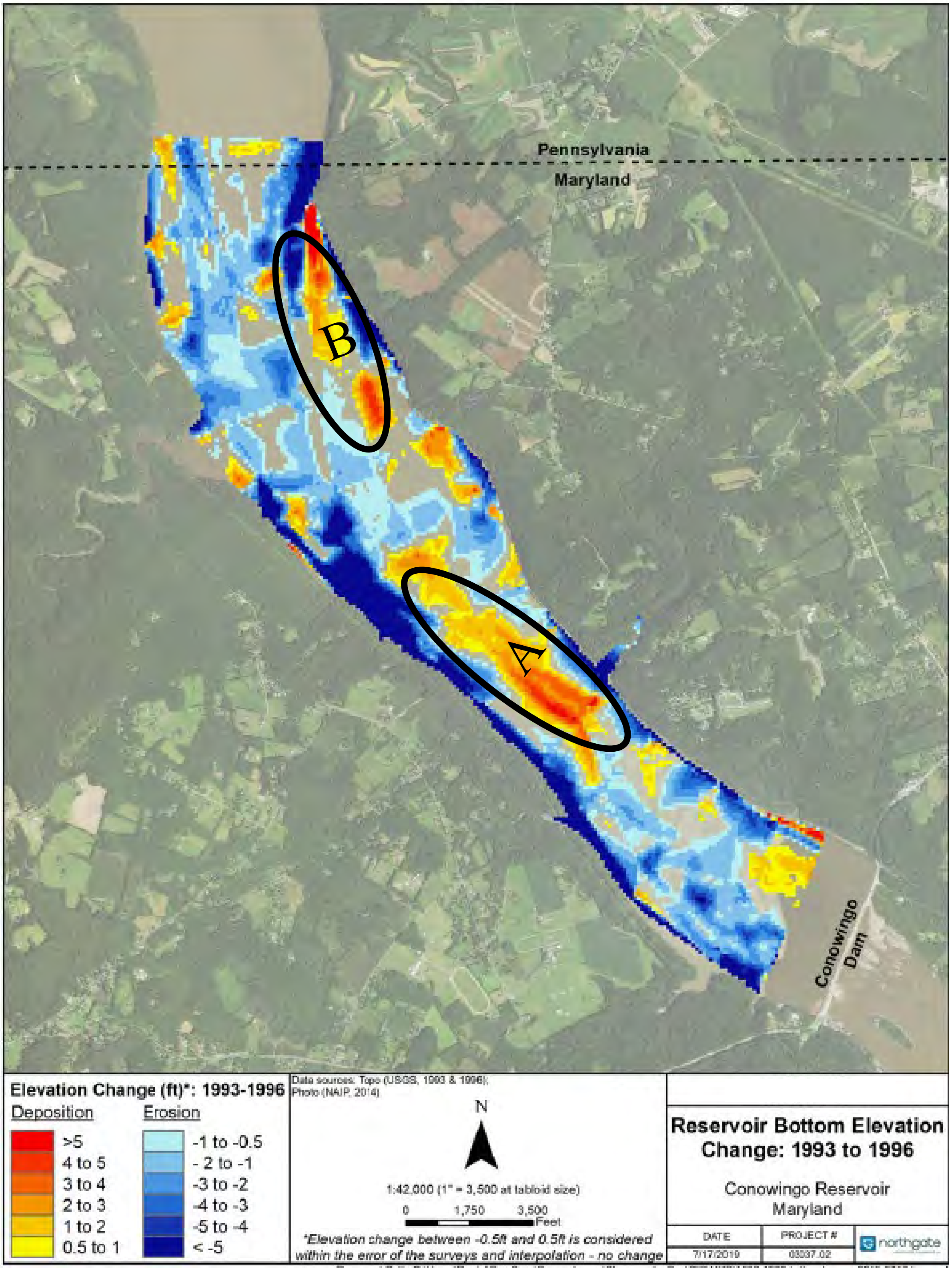
Bathymetry and Sediment-Storage Capacity Change from 1996 to 2008 15



State and County Boundaries: USGS 1:100,000-scale data,
Universal Transverse Mercator Projection: Zone 18, NAD 1983

Hydrography data: USGS, 1:24,000-scale National Hydrography Dataset

Figure 12. Areas of Consistent Deposition in the Conowingo Reservoir



4.3.2 Time of Year

Moderate flow-events, those capable of moving suspended sediment downstream of the Dam, occur most frequently during the spring due to snow melt and moderate to heavy rains associated with the freshet. Higher flow-events occur in the late summer or early fall associated with the Mid-Atlantic hurricane season. Aligning dredging scenarios prior to these events would increase the depositional opportunities resulting from these events and potentially reduce the susceptibility of newly deposited sediments to scour. However, other factors such as fisheries restrictions, permit limitations, and property access requirements will also influence timing of dredging events.

4.3.3 Volume

To achieve the goal of providing trapping capacity that can capture net volumes of sediment and nutrients that flow downstream, dredge volumes in any year need to be greater than the annual sediment deposition rate of 1.5 mt (1.64 mcy). Results from the Calculator above indicate that if 3 mcy/yr are dredged in a given year, total nitrogen delivered to the Bay will be reduced by 1.616 mlb/yr. Note though that this total nitrogen estimate is not the same as the TMDL reduction that would be observed for total nitrogen (0.743 mlb/yr). This TMDL reduction would be 12.4% of the EPA’s 6 mlb/yr target.[1] Because of the annual deposition rate, doubling sediment removal to 6 mcy/yr would more than double this percentage; the percentage would jump to 40%. Volumes removed annually could be structured in reference to nutrient reductions from a more refined version of the calculator presented here, recognizing practical limitations on maximum potential volume based on a 6-month window.

4.3.4 Depth and Spatial Extent

The profile of Reservoir bed sediments is commonly organized by reactivity and referred to as G1, labile; G2, refractory; and G3, inert. The layer of sediment closer to the surface has the greatest bioavailability and thus the greatest impact on downstream water quality. Strategic dredging that focuses on removing a wide rather than deep cross section of sediment would thereby likely have the greatest impact by removing the most reactive (labile) layer. Further modeling should take these parameters into account.

---

[1] This is because “delivered load” reflects nutrients that reach the Bay, whereas TMDL reductions are calculated based on amounts of nutrients considered to be bioavailable after passing through tidal regimes, submerged aquatic beds, and biogeochemical conversions that render some nutrients unavailable.

4.4 Summary and Implications for Further Investigation

This work provides planning or screening level estimates of the potential impact of a dredging management strategy. For example, screening level results indicate that dredging 3 mcy/yr is conservatively expected to provide a TMDL reduction for total nitrogen of 12% of the EPA-stated annual need to reduce 6 mlb/yr, and dredging 6 mcy/yr is expected to raise this contribution to 40% TMDL reduction. However, it is expected that more precise measurements of pollutant reduction would be needed prior to implementation of a full-scale dredging approach. Currently, and as described in Section 4.2, the Chesapeake Bay Program has used the CPMBM, developed by HDR and funded by Constellation, to produce input into the CBEMP. It is recommended that a modified modeling approach be used to generate more precise pollutant reduction quantities. It is also expected that more focused modeling may show a greater TMDL reduction than calculated in this study because dredge activities would be tailored to 1) locations where deposition is most likely to occur and 2) times of year when resuspension would be minimized. To model changes that dredging would cause, Reservoir bathymetry would need to be modified in the dredging locations and updated at the frequency outlined in the dredging scenario. G-fraction reactivity differences should also be incorporated as described above. Such a modeling effort should be conducted in a manner consistent with CPMBM and able to be incorporated into forecasting models using CBEMP.

An important drawback with regard to the CPMBM is that it has no feedback between changes in bathymetry resulting from sediment deposition/erosion and Reservoir hydrodynamics. Therefore, it would be unable to represent the process by which dredged areas of different dimensions fill with sediment over multi-year simulations, during which the depth of the dredged area is decreased and sediment trapping efficiency is gradually reduced. Further, the CPMBM model will need further development to address wind-wave resuspension, which is important because sediment seasonally deposited at the upper end of the Reservoir is redistributed into deeper parts of the Reservoir during high flow events. Future comparisons of Reservoir dynamics under different dredging scenarios should take this resuspension into account. A modeling effort that addresses these issues could produce more refined results than this project; results may include slightly different TMDL implications from those found here.

5.0 ECONOMIC ANALYSIS

5.1 Introduction

The objectives of the economic analysis include:

- Evaluate market trends and attractiveness for a range of IR/BU products;
- Evaluate the degree to which local markets could absorb each product;
- Provide cost details of a particular scenario for dredging and initial processing of Reservoir sediment;
- Compare costs of generating IR/BU products from Reservoir sediment while considering both the market value of those products and ability of the respective markets to absorb them; and
- Provide a cost-benefit and WTP analysis for potential water quality improvements that would result from dredging the Reservoir at the identified levels.

The overall goal of the economic analysis is to provide an economic model the State can use to optimize sediment removal and reuse, considering a range of reuse alternatives. Because no single reuse alternative is likely able to absorb the entire sediment volume targeted for removal, different reuse alternatives represent greater or lesser potential value.

The working assumption is that a full range of reuse options may need to be combined to both handle the large volume in consideration and produce an overall approach that is financially sound. The need for a range of reuse options is increased by the highly variable timeframes for commercialization of each product. For example, while the sand fraction of dredged material could be used as raw material for beneficial use applications in a relatively short amount of time, calcining dredged material to make pozzolans can have a much longer implementation time yet have a higher aggregate value.

The Northgate-Dutra JV derived inputs for the economic analysis from our technical team, Moody’s Analytics economic demand forecasts, and partner contributions including Holcim, Geocycle, Stancills, Ramboll International, Georgia Institute of Technology, UC Berkeley, and Tipping Point.

5.2 Regulatory Context

The current regulatory context in Maryland provides support for market trends described in this report. For example, Governor Hogan’s Resource Recovery Plan for Maryland (Executive Order 01.01.2017.13) directs State agencies to “consider innovative reuse and beneficial uses of dredged material when economically feasible,” and by adopting a Sustainable Materials

Management policy, aims to “capture and make optimal use of recovered resources, including raw materials, water, energy, and nutrients.” Steps taken by Maryland State agencies to implement this Executive Order are enhancing the opportunity for the reuses evaluated in this report to be successful.

Similarly, the IR/BU Guidance helps enable many of the uses considered in this report, including screening thresholds per contaminant in a Category 1 – 4 system for IRs (upland) and regulations and permitting requirements for BUs (in-water) including beach nourishment and marsh creation. For other BUs, the IR/BU Guidance also provides a case-by-case and risk-based framework that incorporates chemical concentrations, exposed populations, exposure duration, and pathway(s) for which regulation and permitting requirements are less prescriptive. Regulatory issues confronting individual sediment reuse alternatives are referenced in sections below where appropriate.

5.3 Market Trends and Attractiveness

Market dynamics, size, outlook, and attractiveness are particular to each reuse evaluated. Observations of key trends and drivers in the US and the mid-Atlantic are presented to help understand opportunities in each reuse market. Estimates of current market volumes are provided along with considerations about growth potential. Because prospective dredging activities would not likely begin for three to five years, demand estimations developed for each IR/BU market are based on estimated market conditions in the year 2026.

5.3.1 Concrete Sand

Over the five years from 2016 to 2021, estimated industry revenue in North America increased at an annualized rate of 3.4% to $66.6 billion, including an expected increase of 3.4% in 2022[2]. In May 2021, total shipments of Portland and blended cement were up 5.6% from May 2020 (some of this may be related to the pandemic). There are 55,816 concrete contractors in the US as of 2021, an increase of 1.8% from 2020[3]. The increase in cement usage can be assumed to be analogous to an increase in all the concrete ingredients including C-33 concrete sand.

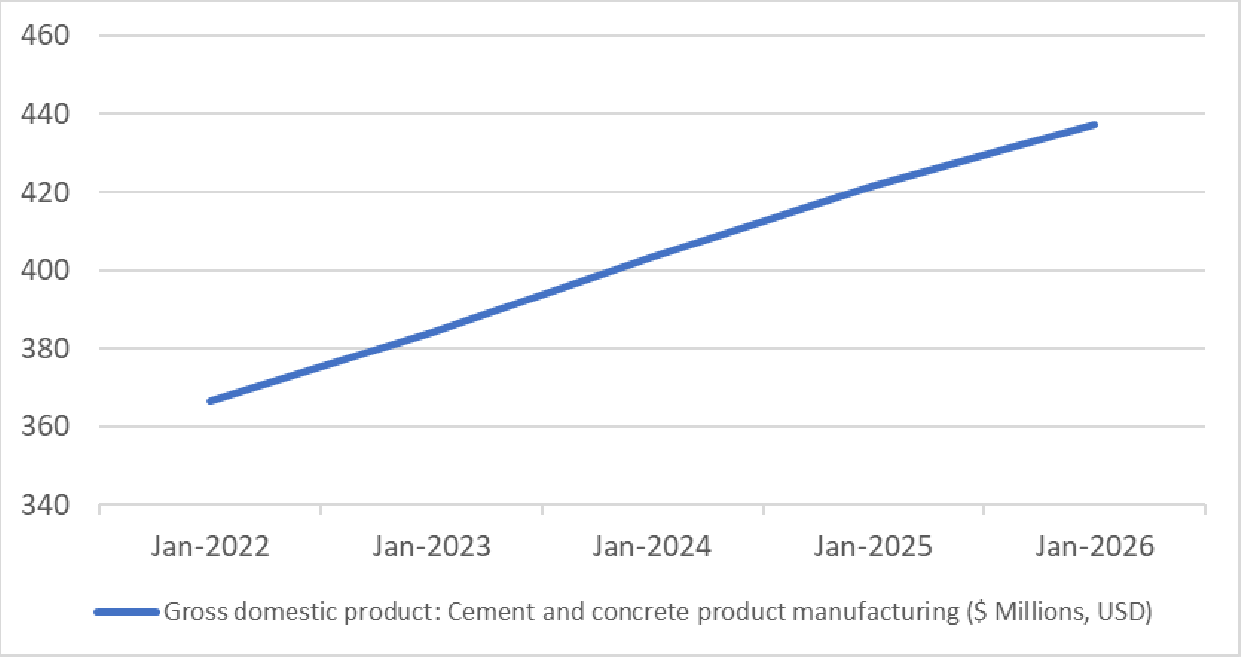
Forecasts for cement and concrete markets in Maryland reinforce these national observations. The 4.2%/yr increase (Figure 13) is partly related to expected recovery from a recent pandemic-driven lull in the construction industry. It is also reasonable to expect that as native resources for concrete sand are depleted, there should be an increasing demand for alternative sources of C-33 concrete sand over time. Demand is also influenced by recent economic stimulus measures

---

[2] https://www.ibisworld.com/industry-statistics/market-size/concrete-contractors-united-states/
[3] https://www.usgs.gov/centers/nmic/cement-statistics-and-information

enacted by the current political administration in the US. About 2 trillion dollars have been earmarked specifically for infrastructure stimulus, which will involve repairs and construction of new roads, bridges, and other concrete and asphalt constructions.

Figure 13. Estimated Annual Gross Domestic Product for Maryland: Cement and Concrete Manufacturers



5.3.2 *Asphalt Sand*

As with concrete, the demand for asphalt puts substantial demand on other resources, including sand. Although asphalt manufacturing growth projections through 2021 have been at 3% since 2017, the market contracted slightly in 2020 due to the pandemic, and recovery in 2021 was expected to produce growth of just 2.1%; demand for street/highway pavement will be the leading cause of this increase. Expected spending on roads, highways, and bridges through the new infrastructure stimulus funding at the national level should enhance this trend. Asphalt is the primary product used for road construction in the United States, and often the most cost-effective end use for asphalt products will be developed near both the material source and the intended use location. The current annual US market is $27.2 billion, growing an average of 2.2% over the last five years. Local market predictions for asphalt demand are similar to those for concrete.

5.3.3 Cement Clinker

Cement clinker is an ingredient used to produce cement, which is, in turn, the active binder ingredient in concrete. As described in Section 5.3.1, demand for cement is increasing. Based on USGS data, the yearly production of Portland cement for the last five years was 84 (2016), 86 (2017), 86 (2018), 88 (2019), and 89 (2020) mt/y[4]. Many of the American cement plants are old and under-utilized (the 2019 utilization rate was only 70%[5]), creating an opportunity for cheaper foreign cements to enter the market. During the last five years, consumption of Portland cement has been 95 (2016), 98 (2017), 99 (2018), 103 (2019), and 103 (2020) mt/y. Because of this expanding market and the ability to use 60% of the full profile of Reservoir sediment in clinker production, this IR merits attention.

Demand for cement clinker and other pozzolanic substitutes within 100 miles of the Conowingo Dam is estimated at roughly 6 – 7 mt/year[6]. This market has the potential grow up to 5% per year, but in 2 – 3 years at that rate, is expected to reach a point where domestic production capacity is fully utilized, after which imported clinker will likely satisfy new demand. That is, numerous groups may want to add fly ash, supplemental cementitious material (discussed below), and other domestic materials such as the cement clinker bench-scale tested on this project to make up the difference. The 2026 estimate for local market demand is thus 6.5 mt/year plus two years of 5% growth, or 7.17 mt/year (10.03 mcy).

5.3.4 Supplementary Cementitious Material

SCMs are pozzolanic minerals that can be used as an alternative to cement in the manufacture of concrete. While cement is a key component of concrete manufacturing, it comes with a high environmental cost related to high energy cost for operating kilns along with high carbon dioxide CO2 emissions.[7] Manufacturing of Portland cement occurs at high temperatures (about 1,450º C) and together with the calcination of limestone produces about 1 ton of CO2 per ton of cement (Mehta and Monteiro, 2014). Modern facilities can reduce this ratio to about 0.8 but still, the manufacturing of cement worldwide is responsible for 8% of the total production of CO2 (Mehta and Monteiro, 2014). For this reason among others, concrete companies are increasingly reducing the proportion of cement used in concrete mixes with industrial byproducts like slag from steel manufacturing and fly ash from coal-fired power plants. For example, fly ash, a by-product from coal combustion, has been widely used in the construction industry, replacing 15 – 50% of Portland cement. A typical range is 15 – 25% replacement (Holcim replaces 27% of its

---

[4] US Geological Survey, Mineral Commodity Summaries, January 2016 – 2020.
[5] Post-Covid Trends in Cement Production | Specify Concrete
[6] Geocyle (Holcim) mid-Atlantic region market estimate.
[7] Cement_Report_Ex_Summary.pdf (rackcdn.com)

global concrete production with cement alternatives such as slag, fly ash and other types of waste, depending upon geographic availability[8]). At the same time, the global transition away from fossil fuels means that many of these byproducts are themselves becoming less available, increasing demand for new substitutes. As an example, the major sources of fly ash are decreasing because of both the success of shale replacing coal and increased governmental regulations causing many obsolete coal plants to close. Reports from the American Coal Ash Association confirm that consumption of fly ash for concrete declined from 15.7 mt/y in 2016 to 12.6 mt/y in 2019.[9] This decreasing trend is likely to continue over time. Use of alternative pozzolanic materials as a cement replacement is thus expected to increase as cement and concrete companies seek to lower their CO2 emissions.[10]

SCMs originate in nature as pozzolanic minerals or are produced industrially, more commonly as by-products of industrial processes. The calcination of high-quality clays, mainly kaolin, at elevated temperatures in the range of 600-900ºC can produce excellent SCM. This calcination temperature, while high, is lower than the temperature required to produce Portland cement clinker and primarily releases water vapor instead of carbon dioxide like in cement clinker production. As a result, reducing the carbon footprint of Portland cement is a significant benefit of the use of SCMs, which has led to this solution gaining significant traction, mainly in Europe.

The high demand for alternative supplementary pozzolans creates a unique opportunity for calcining the clay portion of the Reservoir sediment to produce pozzolanic material suitable for incorporation into cement binders. The bench-scale testing conducted at Georgia Tech (Section 3.4) confirms that the calcined material exhibits desirable pozzolanic properties and, if industrial tests additionally confirm, could be available for the market in a relatively short period. Use of calcined clays in association with fine limestone has been heavily studied in Europe and India, so this knowledge can be easily incorporated to develop protocols for use of the calcined clay portion of Reservoir sediments. As detailed in the cement clinker section above, local demand for SCMs in 2026 is expected to reflect the growth margin of cement clinker each year beyond 2024, or roughly 500,000 cy/year (5% of 10.03 mcy).

5.3.5 Blended Soil for Highway and Horticultural Uses

Custom blended soil can be manufactured for a wide variety of applications. Some applications such as green roof-top gardens, sporting fields, or equestrian footing can require specific and precise addition of amendments to meet narrow product specification requirements. While these types of specialty products may have high implementation costs, total volume of repeated market

---

[8] BNEF Newsletter Template (Grid) (ctfassets.net)
[9] Production & Use Reports – ACAA (acaa-usa.org)
[10] BNEF Newletter Template (Grid) (ctfassets.net)

demand is limited. Other applications such as blended topsoil and bioretention soil have higher market demand relating to ongoing highway and development projects. For the purposes of this economic evaluation, market analysis of blended topsoil and bioretention soil will be considered given the larger market demand. Demand for engineered soils in each of these applications can generally be high-volume, on the order of hundreds of thousands of cubic yards (100,000+ cy) per application in large highway construction projects. Smaller construction projects typically require less than 5,000 cy. However, due to transportation costs and local competition, it is unlikely that demand for soil blends made with Reservoir sediment material will extend beyond Cecil, Harford, and northern Baltimore counties in Maryland. Discussion of opportunities and constraints of various end-uses is presented below.

- ***SHA and MDE Bioretention Soil:*** Bioretention soil is used in a wide variety of applications to control infiltration of stormwater to reduce potential pollutant infiltration and runoff. Stormwater retention ponds are included in new development plans in both residential and commercial settings. In addition, bioretention soil is used in highway medians and associated highway stormwater control features. Local, state, and federal projects drive demand and timelines for roadway construction. In addition, growth in the Mid-Atlantic region is occurring in areas between larger cities (Cecil and Harford counties are located on the 1-95 corridor between Baltimore and Philadelphia). Ongoing conversion from rural to residential and commercial land uses will continue in the region and will drive demand for blended soil products. Annual demand for bioretention soil in Cecil, Harford, and northern Baltimore counties ranges from 10,000 – 15,000 cy/year.[11]
- ***Topsoil:*** Topsoil is specified for use in a wide variety of applications including:
  - Roadway construction
  - Commercial development
  - Airport and supporting aviation facilities
  - Large residential developments
  - Retail development

Demand for topsoil in northeast MD will be affected by the same factors mentioned above as rural areas are converted to commercial and residential areas. Annual demand for topsoil in Cecil, Harford, and northern Baltimore counties is generally less than 10,000 cy/year.[12]

Given that only 30 – 40% of a soil blend will be comprised of Reservoir sediment, this end use is relatively small compared to some of the others discussed in this economic evaluation.

---

[11] Stancills, Inc. Economic Analysis Interview, 2022

[12] Stancills, Inc. Economic Analysis Interview, 2022

5.3.6 Stabilized Sediment

Annual demand for stabilized sediment in Maryland, including the material tested as part of the bench-scale testing, comes from various end-use applications that include:

- utility and pipe trench backfill
- brownfield and waterfront site capping, and elevation increase
- landfill, quarry, or mine site reclamation (capping or infill)
- construction site grading and stabilization
- landscape contouring to support redevelopment and recreational opportunities

Project types in addition to these end uses include:

- brownfield and waterfront site redevelopment for economic revitalization
- roadway construction and transportation infrastructure rehabilitation
- waterfront infrastructure protection and resilience projects
- Port expansion projects

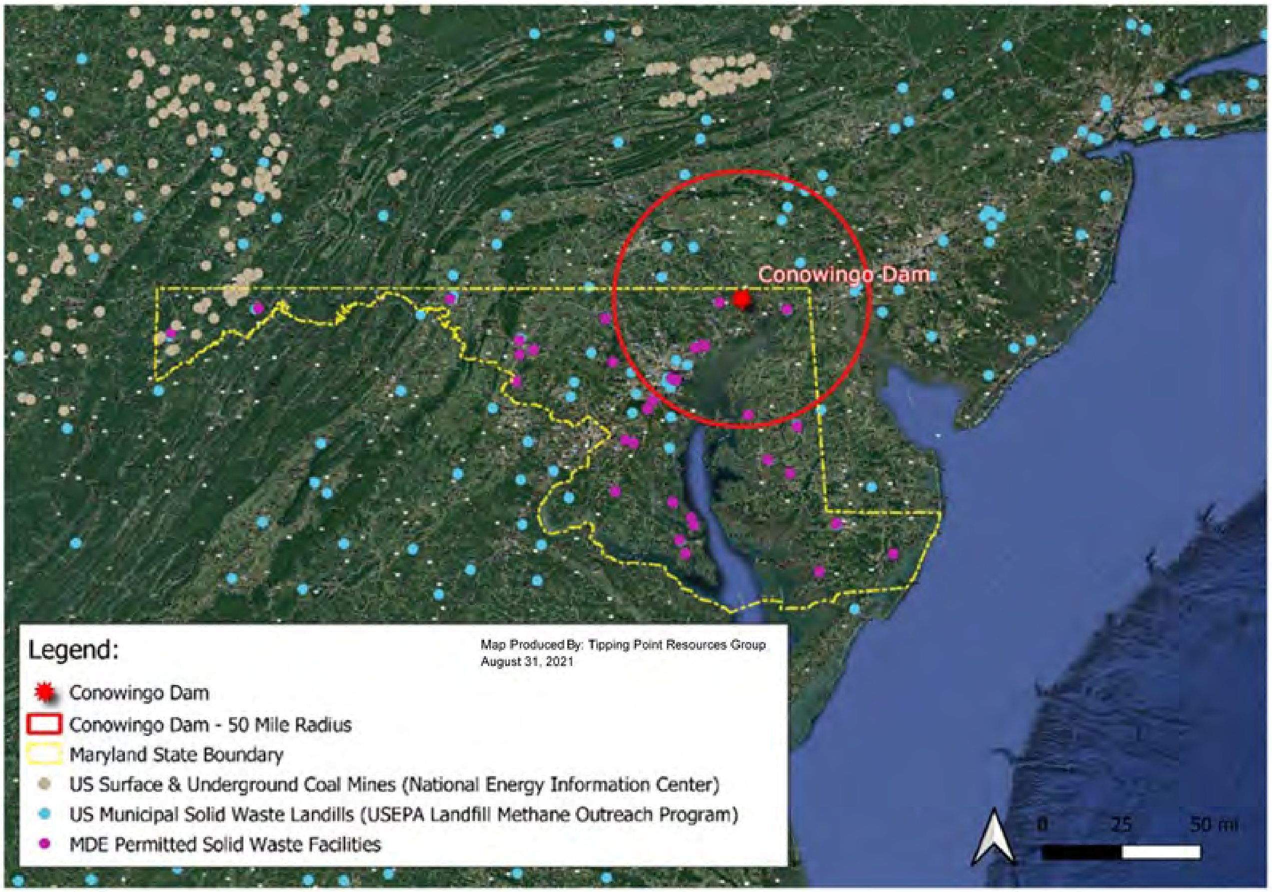
Demand for fill in each of these applications can generally be high-volume, on the order of hundreds of thousands of cubic yards (100,000+ cy) per application. Discussion of opportunities and constraints of various end-uses is presented below.

Environmental Remediation and Landfills: Backfilling and environmental capping of landfills (including daily cover) or other sites under state or federal remediation programs could alone require over 300,000 to 1,000,000 cy per application.[13] There are currently 35 municipal, industrial, rubble (construction and demolition), and land-clearing debris landfills permitted by the MDE Solid Waste Program. Nine of these landfills are within a 50-mile radius of the Conowingo Dam (Figure 14). Several other landfills, quarries, and mine sites are located farther (within Maryland, Pennsylvania, and West Virginia) for which this stabilized sediment product may apply.

---

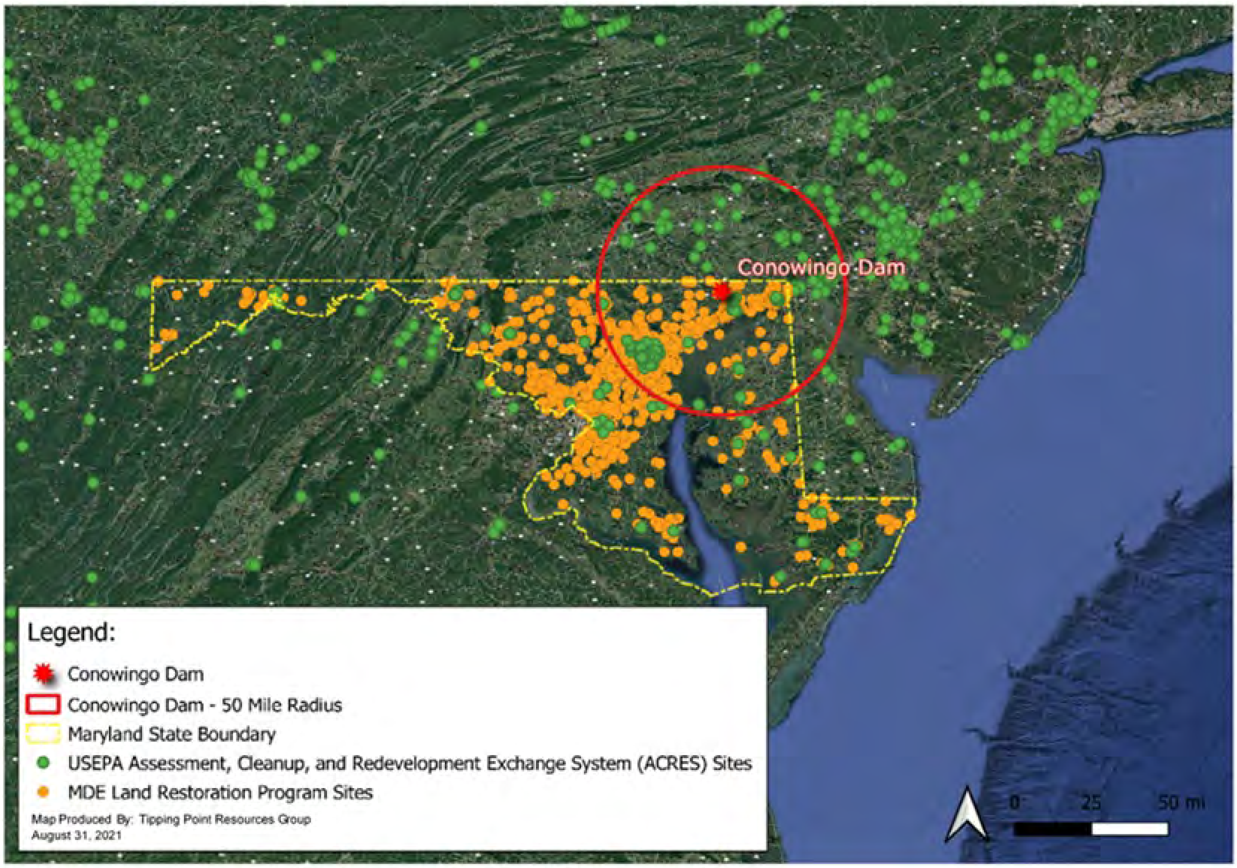
[13] Maher, A., Douglas, W. S., Jafari, F., & Pecchioli, J. (2013). *The Processing and Beneficial Use of Fine-Grained Dredged Material: A Manual for Engineers.* Available online at: https://cait.rutgers.edu/wp-content/uploads/2018/05/193-ru2763_1.pdf

Figure 14. Landfill and Mine Sites in Proximity of the Conowingo Dam



Local, state, and federal programs drive demand and timelines for upland sites undergoing remediation activities as part of consent orders. Within Maryland, over 200 sites have been identified by the USEPA as *USEPA Assessment, Cleanup and Redevelopment Exchange System Brownfields Project Location* (Figure 15). Additionally, the State's *Land Restoration Program* (LRP), which incentivizes the revitalization of brownfields in industrial and commercial areas, lists over 2,000 LRP sites that qualify for assessment and/or redevelopment (approximately 90 of which are active brownfields).

Figure 15. State and Federally Identified Brownfield Sites in Proximity of the Conowingo Dam



Shoreline Resiliency and Recreation: Stabilized sediment products may be used to increase shoreline property elevations as a response to flooding vulnerability. Estimates indicate that more than 16.1 million properties across the United States are already at "substantial risk" of flooding in 2021 (having at least a 1% chance of flood water reaching the building or center of a lot), and approximately 145,100 of those properties are located in Maryland. Similarly, over 90,000 properties in the State have been assessed to have "Severe" or "Extreme" comprehensive flood risk, indicating a high likelihood and/or depth of flooding over the next 30 years (First Street Foundation Flood Factor Tool, 2021). Coastal flooding is of concern both in the long-term, relating to sea level rise, and the short-term, relating to high-energy weather events. This is particularly important for coastal brownfields or environmentally impacted sites with high flood risk – stabilized sediment may serve a dual purpose as material for both capping and elevation increase.

Stabilized sediment may also be used as a foundational component of coastal resilience and shoreline protection infrastructure. This includes both the construction of "gray" engineered solutions (providing backfill behind/beneath bulkheads, seawalls, and breakwaters) and support of “green” techniques such as land reclamation for restored islands and habitat creation, as well as construction of living shorelines. Similarly, these projects are expected to begin at 50,000 cy per application but could exceed hundreds of thousands of cubic yards per application, given proper site conditions. Stabilized sediment may also be used as supporting earthworks material for landscape contouring with respect to residential/commercial/industrial construction and the development of recreational areas (including parks, bike paths, and hiking trails).

Transportation: Port expansion to support commerce activities (i.e., additional container storage and berthing areas) could alone require 150,000 cy or more. Port development related to offshore wind farm equipment fabrication is also a high-level priority for Ports along the east coast of the US. There are several Port facilities within a 50-mile radius of the Conowingo Dam (MD and DE), and others slightly farther (VA) for which stabilized sediment products may apply. At the same time, local Port demand estimates should be conservative. For example, the Maryland Port Administration (MPA) is actively pursuing new means of using sediment dredged from the Bay and may not need additional material from the Reservoir.

Similarly, the MDOT Consolidated Transportation Program indicates that 47.5% of planned capital expenditures for Fiscal Years 2021-2026 will be allocated to Roads and Bridges, and 7.0% to Maritime Infrastructure. This is from a total $15.2 billion project capital expenditures budget. It is anticipated that stabilized sediment products could be utilized to replace non-renewable imported resources for roadway capital improvement projects throughout the State. As an example, significant additional volumes of amended dredged material could be deployed in associated embankments and access points (e.g., on/off ramps), with potential applications of hundreds of thousands of cubic yards.

5.3.6.1 Potential Constraints

One constraint on the use of stabilized sediment as an innovative reuse product would be State permitting, both in terms of material processing and each specific end-use site. In Maryland, a Beneficial Use Determination authorization would be required from the State for use of the stabilized sediment for a variety of potential uses. This may have significant implications in terms of project construction timelines and, as a result, on the sale or delivery of the innovative reuse product. Missed opportunities often result from misaligned construction, permitting, and processing/delivery schedules, as well as dynamic market drivers. Another constraint would involve public perception and industry acceptance of a stabilized sediment, particularly for large-scale construction applications. The overall “branding” and go-to-market strategy should consider education of consumers as well as public stakeholders and provide transparency in product properties and uses.

Finally, interstate regulatory issues require careful attention. Decades of work have been spent in neighboring states on the use of stabilized amended dredged material for many purposes. In the Port of NY/NJ alone, over 30 million cy of amended dredged material have been used upland for brownfield development, sub-base for shopping malls, construction of golf courses and landfill capping in-state and out-of-state (Maher et al., 2013). However, the translation of this work into other regions has been somewhat limited. To address the significant sediment load in the Reservoir, there is a need for integration with adjoining States and regulatory agencies that share the commonality of sediment transport to/from the Susquehanna River and its impacts on the Reservoir. Multi-state collaboration for acceptance of the use of stabilized sediment should be encouraged to sustain this innovative reuse program and identify appropriate market outlets.

5.3.6.2 Summary

Ultimately, success of this innovative reuse product is not a question of volume. Rather, the limitation is on regulatory and program evolution and efficiency to accept the use of stabilized dredged material. Changes in this direction will create many more opportunities to advance cleanup goals; cap or reclaim landfills, quarries, and mines; support general construction needs (including utility installation and habitat restoration); and address urgent flood resilience and transportation infrastructure needs.

Some limitations may exist with respect to the physical and/or chemical composition of the sediment in relation to environmental standards for a given end-use. Nevertheless, it is expected that there will be a gradual increase in market capacity/demand of roughly 10% per year as consumer confidence develops. An expansion in several of the end-use application markets can also be expected, such as land elevation increase to address coastal flooding hazards and landfill/remediation site capping and closure.

5.3.7 Sediment for In-water Applications

Although in-water uses of the Reservoir sediment were not included in the bench-scale testing for this IR/BU Evaluation, it may represent the largest potential use category by volume. Therefore, we have included this end use in the economic analysis. Shoreline protection has been addressed in Section 5.3.6; however, additional in-water restoration beneficial uses include potential wetland restoration/creation, living shoreline applications of numerous types, and island-building/restoration. Much work of this type using dredged material has been underway for decades to address the thousands of miles of shoreline and islands in Maryland and the upper Chesapeake Bay. This has included recent efforts led by the Maryland Department of Natural Resources and others at Ferry Point Park (living shorelines), Blackwater National Wildlife Refuge (thin-layer placement), Skimmer Island (island restoration), and Eastern Neck National

Wildlife Refuge (beach nourishment).[14] Similarly, larger scale island-building efforts at Hart-Miller Island,[15] Poplar Island,[16] and the Mid-Chesapeake Bay Island Project[17] represent use of well over 100 mcy of dredged sediment. Among the primary reasons this category is promising for Reservoir sediment is that dredged material can be directly placed at restoration sites, reducing processing and transportation costs.

Of course, in-water use of Reservoir sediment must be done carefully to ensure all environmental thresholds are met. While this Project was not structured to conduct chemical evaluations that would test whether large-scale beneficial uses of the sediment are possible, the project's SCR helps frame the issues that need to be evaluated for these purposes, including questions about leachability and bioavailability of constituents of potential concern (COPCs) in the sediment given higher than expected percentages of coal in the sediments. Research on these questions is underway. Importantly, it has been demonstrated via many case studies in Europe and the United States that large-scale beneficial use applications exist for clean sediment as well as for sediment that has low levels of COPCs.[18] By combining current research with both 1) in situ risk assessments for particular COPCs, organisms, and prospective habitat types and project locations and 2) case study knowledge of how to use sediments of diverse quality in large-scale BU applications, the State will be in a good position to maximize use of this important resource.

5.4 Economic Analysis

The economic analysis involved two components: 1) evaluating the potential of local markets to absorb each IR/BU product and 2) evaluating the cost efficiency of developing and bringing those products to market. In combination they provide an economic model for the State to use in making decisions about whether and how to pursue IR/BU market development using dredged Reservoir sediment.

5.4.1 Market Absorption Potentials and Cost Efficiency Inputs

The market absorption potential for the evaluated IRs, as well as unprocessed sediment for in-water applications are described below. The market absorption potential has been compared against three annual dredging volume scenarios: 1 mcy/yr, 3 mcy/yr, and 5 mcy/yr. The results of the absorption potential analysis are presented in Table 13.

---

[14] BeneficialUseof-DredgedMaterial101619.pdf (maryland.gov)
[15] Hart-Miller Island | Maryland Port Administration (maryland-dmmp.com)
[16] PoplarFactSheetFinal.pdf (maryland.gov)
[17] MDOTMPAMidBayFACTSHEET.pdf (maryland.gov)
[18] 2019-05-bus-ip.pdf (dredging.org)

5.4.1.1 Concrete Sand

Bench scale testing of material dredged in Fall 2021 indicated that for both physical (grain size distribution) and chemical reasons, high volumes of coal in the sediment's sand fraction may render concrete a nonviable commercial end use due to the significant processing required. However, concrete sand has been included as a potential end use because sand from the Reservoir sediment could potentially be used as a source for a blended concrete sand. Cost efficiency comparisons below assume coal separation would be integrated into the sediment separation process. As below, the estimated sales price has been reduced to reflect the lower value of the product because blending will be required, however detailed cost estimation for such activities is beyond the scope of this project.

For concrete that uses C-33 grade sand in the 100-mile vicinity of the Conowingo Dam (concrete sand can travel 100 miles one way by truck and still remain economical to use), transportation costs for obtaining and transporting the sand are approximately 7 – $28/cy by truck and 4 – $11/cy by barge. Remaining costs to produce concrete are approximately 6 – $11/cy, exclusive of royalty or other fees due for the raw material itself, fixed costs, overhead, or costs to extract the usable C-33 sand from the sediment stream. With these inputs, a maximum sale price for sand from Reservoir sediment for C-33 concrete sand production is reasonably estimated at 14 – $21/cy FOB (Free on Board; i.e., seller is responsible for shipping costs), with a midpoint of $17.50/cy. As above, this price has been reduced to $8/cy to reflect needed blending.

Across sediment cores collected on this project, sand usable for concrete (if it were successfully separated from coal, as above) is estimated to be 15% of total sediment volume, with the medium and fine sand fractions usable for this purpose at an estimated 5% and 10% of total volume, respectively. For the 1, 3, and 5 mcy scenarios, this translates to 150,000, 450,000, and 750,000 cy/yr of saleable product volume. In the 100-mile radius of the Conowingo Dam, approximately 4 – 5 mcy of concrete are produced and sold annually; this requires approximately 1.79 mcy of C-33 concrete sand per year.

Using the Moody's 5-year forecast above for gross product in cement and concrete markets (4.2%/yr expected increase), local demand for this product is expected to be an estimated 2.11 mcy/yr by 2026. Based on this demand, local concrete markets alone could absorb the entire sand fraction from dredged Reservoir sediment even accounting for 50% blending. The above saleable product volumes and mid-range product sale price ($17.50/cy, reduced to an estimated $8/cy) also imply that the sand fraction blended into a C-33 sand could potentially generate $1.2 m, $3.6 m, and $6.0 m/yr in gross revenue, for dredge rates of 1, 3, and 5 mcy, respectively.

5.4.1.2 Asphalt Sand

Similar to concrete, the gradation of the sand appears to render asphalt a nonviable commercial application; however, sand could be blended as described above for concrete. Using the Moody's 5-year forecast above for gross product in cement and concrete markets (4.2%/yr expected increase) as a proxy, local demand for this product is expected to be an estimated 2.11 mcy/year by 2026. That is, at dredging rates of 1, 3, and 5 mcy/year, local demand for asphalt sand in 2026 is reasonably expected to be 14.1x (2.11 mcy/0.15 mcy), 4.7x (2.11 mcy/.45 mcy), and 2.8x (2.11 mcy/0.75 mcy) the volume that would be produced. The above saleable product volumes and mid-range product sale price ($17.50/cy, reduced to an estimated $8/cy as for concrete) also imply that similar to concrete, in the three dredged volume scenarios, ASTM D-1073 sand for asphalt could potentially generate $1.2 m, $3.6 m, and $6.0 m/yr in gross revenue, respectively. Nevertheless, the analysis assumes the sand fraction will have been consumed by the concrete market and will be unavailable for sale.

5.4.1.3 Cement Clinker

Manufacturers of cement clinker can be expected to pay roughly 14 – $21/cy for the silt and clay fraction needed to produce clinker in the manner evaluated for this project with FOB to a local processing site.[19] Current clinker mix designs include roughly 7 – 12% of clay/silt. After processing (including machinery, energy, labor, and SGA), vendor costs incurred for creating final clinker product are variable depending on plant design, type of kiln, additional labor costs, etc., but can be expected to range from $56 – $84/cy with clinker sold as raw feed or as a pozzolanic amendment. Vendors of cement clinker will then structure innovative arrangements with wholesalers to arrange acceptable margins.

In the 1, 3, and 5 mcy scenarios, local demand for clinker in 2026 is reasonably expected to be 16.7x (10.03 mcy/0.60 mcy), 5.6x (10.03 mcy/1.80 mcy), and 3.3x (10.03 mcy/3.00 mcy) the volume that would be produced under the dredging scenario detailed here. Taking the average value of the clay/silt fraction to be $17.50/cy, gross local market value the State could expect for cement clinker absorption in the three volume scenarios is estimated at $10.5 m, $31.5 m, and $52.5m/yr, respectively. This also assumes that like concrete sand, the clay/silt fractions will be transported not more than 100 miles. Note also that LOI tests during bench-scale testing on this project confirmed that presence of coal dust in the clay/silt fraction is not an issue for production of cement clinker.

---

[19] Northgate-Dutra JV team experience

5.4.1.4 Supplementary Cementitious Material

For some products, SCM included, representatives of cement and concrete industries are understandably cautious about sharing information about costs for raw materials and manufacturing. Without this information, it becomes risky to estimate how much the industry would be willing to pay for sediment to produce calcined SCM. An upper bound could be the cost of impure kaolin clays, but such comparison lacks the environmental benefit of using sediment. Having said that, and using the available volumes of 150,000, 450,000, and 750,000 cy/yr for sand in the three scenarios as above and assuming that for a typical concrete, the mass of sand is twice that of cement (the range is typically 1.7 – 2.3x the mass of cement), market consumption of cement will therefore be 75,000, 225,000, and 375,000 cy/yr. Taking 3.10 and 2.45 as the specific gravity for cement (cem) and calcined clay (cc), respectively, and assuming 20% replacement by mass (see the Market Trends and Attractiveness section for this IR):

$$V(cc) = (Mcc)/(SGcc) = (0.20*Mcem)/(SGcc) = 0.20*[(3.10*Vcem)/(2.45)] = 0.20*(1.26*Vcem)$$

That is, for given volumes of cement of 75,000 cy, 225,000 cy, and 375,000 cy in the three volume scenarios, volumes of calcined clay that could be absorbed will be an estimated 18,900 cy, 56,700 cy, and 94,500 cy. Taking the value of the calcined clay to be similar to an estimated $40/cy for fly ash (an assumed average, as density of fly ash can be highly variable), and reducing this by $9/cy for the calcining process that a purchaser would undertake (costs can be expected to roughly match costs to produce cement clinker), gross local market value for the SCM product is estimated at $585,900, $1,757,700, and $2,929,500/yr. This also assumes that like concrete sand, the calcined sediments will be transported not more than 100 miles. Note also that presence of coal dust in the clays used to produce this product is not an issue for production of SCM; rather, this dust is combusted during the calcining process and contributes to product formation.

5.4.1.5 Blended Soil for Highway and Horticultural Use

Manufacturers of blended soil can be expected to pay roughly $25 – 35/cy for the sand, silt, clay, and organic amendments needed to produce soil to specification. Processing (including machinery, energy, labor, and SGA) and vendor costs incurred for creating final soil products are variable depending on client specifications, screening requirements, availability of biosolids, additional labor costs, etc., but can be expected to range from $6 – $8/cy. Soil blenders will then structure innovative arrangements with wholesalers to arrange acceptable margins. In the 1, 3, and 5 mcy scenarios, and combining demand from bioretention soil and topsoil (Section 5.3.5), local demand for engineered soil in 2026 is reasonably expected to be 2.0% (20,000 cy/1.0 mcy), 0.7% (20,000 cy/3.0 mcy), and 0.4% (20,000 cy/5.0 mcy) of the volume that would be produced under the dredging scenario detailed here. Taking the average sale price of the profile to be $50/cy, gross local market value the State could expect for blended fill absorption in the three volume scenarios is estimated at $1,000,000/yr. This also assumes that like concrete sand, the sediment will be transported not more than 50 miles. Volumes of Reservoir sediment potentially consumed by soil blending are compared to other end use options in Table 13.

5.4.1.6 Stabilized Sediment

Absent State regulations or subsidies to the end user, initial discounting is expected to be large enough that end users may need to be provided the material along with a "placement" payment (or "fee") exercised by the ultimate landowner or user of the product (perhaps on the order of $3/cy to $10/cy (negative revenue)). It is possible that as demand and industry/consumer confidence grows, particularly alongside increasing cost or scarcity of imported construction fill, the stabilized sediment may begin to be viewed as a commodity, in which case a reduction in placement fees could be expected (with an estimated inflection of $0/cy in year 5), followed by a gradual increase to positive gross revenue. For these reasons an average sale price of $0/cy is used in this analysis.

The financial benefit of generating stabilized material is not necessarily in the sale of material; rather, it is to avoid the ultimate cost of disposal while providing a significant source of material to replace non-renewable resources (i.e. mined/quarried and imported fill). Often, the benefits of introducing a more sustainable product to the market are not entirely reflected in market costs. The consumption of resources such as energy, water, and land area/habitat should be considered in any economic assessment that compares the current state of practice to a more innovative/sustainable approach.

When considering the innovative reuse of stabilized sediment, it is important to understand that the current state of practice for dredging entails significant resource consumption, including both off-site transportation and disposal of dredged material and off-site mining/production and import of non-renewable construction fill. That is, even without complete quantification, this analysis additionally suggests a qualitative assertion that stabilized sediment from dredged Reservoir sediment would likely require consumption of fewer resources than the current state of practice.

Stabilized sediment can use the full clay and silt fraction of Reservoir sediment, representing roughly 70% of available sediment volume. In the three volume scenarios this equals 0.7 mcy, 2.1 mcy, and 3.5 mcy, respectively. Potential supply of stabilized sediment is therefore expected to exceed market demand. Net revenue estimates incorporate product transportation and other costs and assumptions and are encompassed in the below cost efficiency scenarios.

Finally, note that while the bench-scale testing indicated that stabilization/solidification of Reservoir sediment with a pozzolanic binder (i.e., ordinary Portland cement) can achieve the material strength performance specifications for a variety of IR/BU applications, additional focused treatability analyses may be required to identify the appropriate amendment mix designs for the specific end-uses discussed in this section. These studies may also identify opportunities to offset the Portland cement volume required for stabilization with industrial byproducts or additives such as green cement, blast furnace slag, and cement kiln dust.

5.4.1.7 Sediment for In-water Beneficial Uses

Although forecasting demand for BU efforts in the upper Chesapeake Bay can be ambiguous, trends identified in this analysis can help. For example, it is reasonable to assume that between the numerous small- and large-scale habitat restoration projects expected to continue to emerge in the Bay, as in the Market Analysis section above, this category would be able to absorb large volumes of Reservoir sediment if it is not consumed by other markets – possibly all of it. For example, just the Mid-Chesapeake Bay Island projects underway at James and Barren Islands are utilizing 90 – 95 mcy of dredged sediment[20] (and Hart-Miller Island, Poplar Island, and other projects have used smaller but substantial volumes, sometimes on an ongoing basis) - whereas the dredging scenarios in the economic analysis presented here assume a total of 30 mcy will be produced; therefore, 100% of potential volume is reflected, in the event that the State may decide to pursue these types of BU efforts to the exclusion of other efforts detailed here or elsewhere.

Developing detailed cost inputs for specific in-water projects is beyond the scope of this Project which focuses on upland IRs. In general, transportation costs for sediment on BU projects range from 0.37 – $0.60/cy per mile for projects in Baltimore and engineers' estimates range from 0.83 – $0.96/cy per mile.[21] The midpoint of these ranges ($0.59) is used for an estimated average 25 miles of transport to potential BU projects ($14.75/cy). Note that the generic BU project considered here is large-scale island- or habitat-creation where 1) barge costs at $8/cy are selected with the assumption of this mode of transport for a large project, and 2) dewatering and separation costs are assumed to be zero because natural dewatering is assumed to occur on the site, as has occurred with Poplar Island.

On a BU project-specific basis, the implementing agency and partners would need to arrange adequate funds to bring Reservoir sediment from the post-dredging transfer point to their BU location. Engineering design, permitting, sediment placement/berm creation, environmental studies, and other cost categories would need to be addressed for each project. For these reasons,

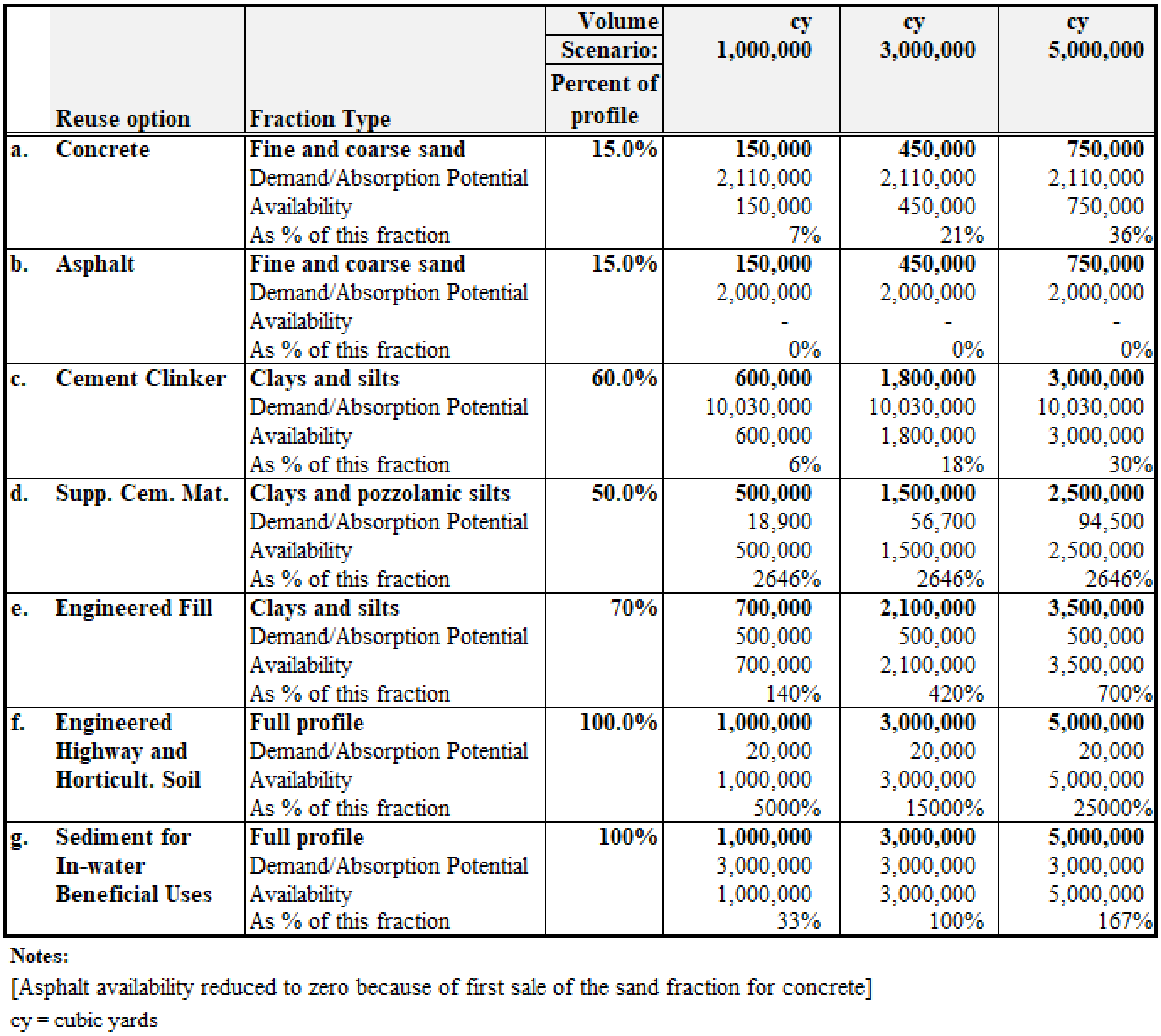
---

[20] Mid-Chesapeake Bay Islands Ecosystem Restoration Project at Barren Island, Dorchester County, Maryland > Baltimore District > Public Notice View (army.mil)

[21] Northgate-Dutra JV team experience

the accompanying tables indicate that final sale price/cy, gross revenue/yr, total costs/yr, and net revenue/yr as “project-specific.” Additional factors to consider for further cost refinements include region and urban density; union labor requirements; volume and corresponding efficiencies (smaller volumes are more expensive than larger volumes, per cy); and distances (shorter distances are more expensive than longer distances, per cy).

Table 13. Conowingo Reservoir Sediment Fraction Use Potentials – Annual Market Estimates as of 2026



	Reuse option	Fraction Type	Volume Scenario: Percent of profile	cy 1,000,000	cy 3,000,000	cy 5,000,000
a.	**Concrete**	**Fine and coarse sand**	**15.0%**	**150,000**	**450,000**	**750,000**
		Demand/Absorption Potential		2,110,000	2,110,000	2,110,000
		Availability		150,000	450,000	750,000
		As % of this fraction		7%	21%	36%
b.	**Asphalt**	**Fine and coarse sand**	**15.0%**	**150,000**	**450,000**	**750,000**
		Demand/Absorption Potential		2,000,000	2,000,000	2,000,000
		Availability		-	-	-
		As % of this fraction		0%	0%	0%
c.	**Cement Clinker**	**Clays and silts**	**60.0%**	**600,000**	**1,800,000**	**3,000,000**
		Demand/Absorption Potential		10,030,000	10,030,000	10,030,000
		Availability		600,000	1,800,000	3,000,000
		As % of this fraction		6%	18%	30%
d.	**Supp. Cem. Mat.**	**Clays and pozzolanic silts**	**50.0%**	**500,000**	**1,500,000**	**2,500,000**
		Demand/Absorption Potential		18,900	56,700	94,500
		Availability		500,000	1,500,000	2,500,000
		As % of this fraction		2646%	2646%	2646%
e.	**Engineered Fill**	**Clays and silts**	**70%**	**700,000**	**2,100,000**	**3,500,000**
		Demand/Absorption Potential		500,000	500,000	500,000
		Availability		700,000	2,100,000	3,500,000
		As % of this fraction		140%	420%	700%
f.	**Engineered Highway and Horticult. Soil**	**Full profile**	**100.0%**	**1,000,000**	**3,000,000**	**5,000,000**
		Demand/Absorption Potential		20,000	20,000	20,000
		Availability		1,000,000	3,000,000	5,000,000
		As % of this fraction		5000%	15000%	25000%
g.	**Sediment for In-water Beneficial Uses**	**Full profile**	**100%**	**1,000,000**	**3,000,000**	**5,000,000**
		Demand/Absorption Potential		3,000,000	3,000,000	3,000,000
		Availability		1,000,000	3,000,000	5,000,000
		As % of this fraction		33%	100%	167%

Notes:

[Asphalt availability reduced to zero because of first sale of the sand fraction for concrete]

cy = cubic yards

5.4.2 Dredging Scenario Modeling

This section represents an update to the LSRWA conclusion that the eight dredging scenarios evaluated at that time were generally cost-prohibitive. That analysis did not consider potential revenue from IR/BU products that could be created with Reservoir sediment or whether those revenues could render any dredging scenario cost efficient. The LSRWA was also conducted prior to development of potential means the State and/or others may have to help finance dredging activities such as such through the multi-state CWIP, Susquehanna River Basin Commission (SRBC), and/or involvement of private sector funds and water quality credit exchange opportunities.

This section evaluates the possibility the State has to ensure that end producers of each IR/BU product will be able to purchase source materials at competitive market rates. It therefore addresses the State's interest in identifying which IR/BU or combination may provide the best return on potential investment (recognizing that some potential costs, such as land acquisition and large-scale conveyance infrastructure, are highly site-specific and are excluded from this analysis). To do so, several principles must apply: "Cost effectiveness" of individual reuse options needs to be evaluated with careful regard to the collection of revenue generation potentials among all reuse options. In this context it also implies that some reuse options may have less revenue generation potential but are still necessary if the anticipated volumes are to find appropriate destinations. Note that because each IR/BU product development sequence evaluated has different endpoints, the analyses are not strictly lifecycle cost comparisons. Full lifecycle cost comparisons encompass costs to develop, produce, deploy, maintain, operate, and dispose components and products from a system over its entire lifespan.

Two cost efficiency scenarios are presented to accomplish this: 1) the State assumes all costs as outlined below and 2) the State partners with other groups to offset the dredging, sediment conveyance and sediment management costs. The general project assumptions, as well as assumptions included for each scenario are presented below. Based on Northgate-Dutra JV Team experience and consultation with partners, the assumed dredging inputs are considered reasonable and characteristic of a feasible dredging option.

5.4.2.1 <u>Project Assumptions</u>

Design and Permitting: Significant design will be required including the sediment conveyance system, sediment management area, and dewater management. Significant permitting efforts will also be required. *Because these costs are highly variable based on the site, sediment conveyance, and dewater options selected, they have not been included in the cost evaluation.*

Land and ROW Acquisition: The project will require acquisition of land and/or rights-of-way for both sediment management and conveyance of sediment to the management area. *Because these costs are highly variable based on the site selected, they have not been included in the cost evaluation.*

Dredging:

- ***Approach:*** The results of the LSRWA indicated that mechanical dredging was less cost efficient than hydraulic dredging; therefore, hydraulic dredging was selected for this evaluation.
- ***Annual Volumes:*** The LSRWA used three volume estimates to compare dredging alternatives: 1, 3, and 5 mcy/yr of in-place sediment; this evaluation uses the same annual volumes.
- ***Limitations:*** Dredging inputs have been developed with consideration given to calendar limitations (6 months of dredging, selected to account for calendar exclusions for wildlife and other permit requirements), typical maximum dredge volumes for individual dredges given the 1, 3, and 5 mcy scenarios, and mobilization/demobilization constraints.
- ***Dredging Costs:*** Cost to hydraulically dredge the material for 6 months/yr is estimated at $15/cy. These dredging costs are also based on size of dredge, number of dredge teams mobilized, etc.

Sediment Conveyance:

- ***Conveyance Approach:*** Transportation costs to move dredged material from the dredging location to the point of processing and stabilization is a function of the distance, route, and access between the two locations. It has been assumed that dredge slurry will be conveyed from the dredge location to the sediment management area via pipeline.
- ***Conveyance Route:*** These costs have been developed based on an assumed short distance (<1,000’) and elevation (<100’) that slurry would need to be pumped.
- ***Construction Costs:*** Cost to construct a piping system is roughly estimated at $16 m, $24 m, or $29 m depending on whether the 1 mcy, 3 mcy, or 5 mcy volume scenario is selected. Construction costs amortized over the life of the project (10 years) is expected to contribute approximately $16, $8, and $6 to the per cubic yard cost of the respective volume scenarios.
- ***Operations and Maintenance Costs:*** *Ongoing maintenance costs for this system are not included in this analysis.*

Sediment Management:

- ***Management Approach:*** It has been assumed that sediment management will include mechanical separation of sediment fractions by grain size and dewatering. Considered dewatering options include hydrocyclones and other dewatering technologies and associated costs.

- ***Sediment Processing:*** Cost for sediment processing is estimated to range from 45 – $51/cy (of in-place sediment, not slurry) depending on the volume scenario. *Costs for sediment management on the Site prior to transport have not been included in this analysis.*
- ***Dewater Management:*** *Costs for disposition of the dewater have not been included in this analysis.*

Transportation of Processed Sediment:

- ***Transportation Options:*** It is assumed that appropriate infrastructure is in place to transport the material by truck and/or barge from a separation facility to the respective IR/BU markets.
- ***Truck:*** Typically, a single load is 22 tons. Trucking costs per ton are determined by how many "turns" a truck and trucker can make in a single day. Assuming a combined truck and driver rate of $700 to $1,100/day, if the distance allows for 4 turns/day (roughly 1 – 1.5-hour drive one-way), cost will be roughly $8 – 11/ton.
- ***Barge:*** Barge costs typically range form $4 – 11/cy.

End Uses: Potential revenues developed are concept-level only; a more detailed market study specific to each candidate reuse may be required if an entity were to begin commercialization activities.

5.4.2.2 Economic Scenarios

Unlike the LSRWA, in this evaluation the variable of interest is not $/cy of the dredging option (though that cost is provided below); rather, for this analysis the variable of interest is the portion of the high volumes of sediment that can be absorbed by the market given a range of reuse options, within a single dredge volume scenario. In the absence of large-scale beneficial use, a range of innovative reuse options will need to be combined to be able to handle the large volume of material and contribute to an overall approach that is financially sound.

Two scenarios were developed for this cost efficiency evaluation. The scenarios developed do not include costs for additional maintenance dredging that may be required to ensure continued water quality benefits of dredging beyond a 10-year period.

Scenario 1:

- All costs, as outlined in Section 5.4.2.1, the responsibility of the State.
- Revenue from all end product sales is assumed to be available to offset State costs.

Scenario 2:

- Unlike Scenario 1, costs for dredging, sediment conveyance, and sediment management are covered by a third party that may be able to arrange this through public-private partnerships.
- Revenue from all end product sales is assumed to be available to offset State costs.
- It is assumed participating private partners will recoup the indicated investments in dredging, dewatering, and sediment separation through sale of water quality credits and the coal fraction.
- Evaluation of which public or private entities would engage in the potential pathways discussed is ongoing and will be determined in the future.

For both Scenarios, the degree to which the State's overall costs could be offset by sales of sediment fractions is presented as a percentage of assumed costs. The scenarios thus allow the State to evaluate IR/BUs in terms of how much they could potentially offset costs of a dredging, processing, and sale program. These offsets range from 12 – 15% when trucking is the transportation mode for processed sediment from the sediment management area to vendor site, and 65 – 137% when barging is the transportation mode. Within transportation modes, these ranges depend on the economic Scenario and assumed annual dredge volume.

Table 14. Combined Potential State Revenue Calculations on IR/BU Component Sales, Per Year

			Scenario 1			Scenario 2		
Pre-production costs:		**Volume:**	1,000,000	3,000,000	5,000,000	1,000,000	3,000,000	5,000,000
Dredging, delivering to separation point/cy			$31.00	$23.00	$21.00			
Dewatering and separation/cy			$51.00	$48.00	$45.00			
FOB Transportation/cy		truck	$18.00	$18.00	$18.00	$18.00	$18.00	$18.00
		barge	$8.00	$8.00	$8.00	$8.00	$8.00	$8.00
Pre-Production Costs Subtotal/cy		truck	$100.00	$89.00	$84.00	$18.00	$18.00	$18.00
		barge	$90.00	$79.00	$74.00	$8.00	$8.00	$8.00
Costs at volume		truck	$100,000,000	$ 267,000,000	$ 420,000,000	$ 18,000,000	$ 54,000,000	$ 90,000,000
		barge	$ 90,000,000	$ 237,000,000	$ 370,000,000	$ 8,000,000	$ 24,000,000	$ 40,000,000
Potential revenue:								
Concrete	State's sale price/cy		$8.00	$8.00	$8.00	$8.00	$8.00	$8.00
	Possible volume to sell (cy)		150,000	450,000	750,000	150,000	450,000	750,000
	Gross revenue potential		$1,200,000	$3,600,000	$6,000,000	$1,200,000	$3,600,000	$6,000,000
Asphalt	State's sale price/cy		$8.00	$8.00	$8.00	$8.00	$8.00	$8.00
	Possible volume to sell (cy)		-	-	-	-	-	-
	Gross revenue potential		$0	$0	$0	$0	$0	$0
Cement Clinker	State's sale price/cy		$17.50	$17.50	$17.50	$17.50	$17.50	$17.50
	Possible volume to sell (cy)		581,100	1,743,300	2,905,500	581,100	1,743,300	2,905,500
	Gross revenue potential		$10,169,250	$30,507,750	$50,846,250	$10,169,250	$30,507,750	$50,846,250
Supp. Cem. Mat.	State's sale price/cy		$31.00	$31.00	$31.00	$31.00	$31.00	$31.00
	Possible volume to sell (cy)		18,900	56,700	94,500	18,900	56,700	94,500
	Gross revenue potential		$585,900	$1,757,700	$2,929,500	$585,900	$1,757,700	$2,929,500
Engineered Fill	State's sale price/cy		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	Possible volume to sell (cy)		700,000	2,100,000	3,500,000	700,000	2,100,000	3,500,000
	Gross revenue potential		$0	$0	$0	$0	$0	$0
Engineered Highway and Horticultural Soil	State's sale price/cy		$50.00	$50.00	$50.00	$50.00	$50.00	$50.00
	Possible volume to sell (cy)		20,000	20,000	20,000	20,000	20,000	20,000
	Gross revenue potential		$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Sediment for In-water Beneficial Uses	State's sale price/cy		$0	$0	$0	$0	$0	$0
	Possible volume to sell (cy)		1,000,000	3,000,000	5,000,000	1,000,000	3,000,000	5,000,000
	Gross revenue potential		$0	$0	$0	$0	$0	$0
		Total	$11,755,150	$33,265,450	$54,775,750	$11,755,150	$33,265,450	$54,775,750
	As a Percentage of Pre-production costs	**truck**	12%	12%	13%	65%	62%	61%
		barge	13%	14%	15%	147%	139%	137%

Notes:

[Concrete and asphalt discounted from est. industry standard $17.50/cy sale price to reflect costs of amendments and processing due to presence of coal]
[Asphalt available to sell reduced to zero because of first sale of the sand fraction for concrete]
[Clinker available to sell reduced by the amout of silt/clay utilization (demand/absorption potential) for the SCM market]
cy = cubic yards

5.5 Cost-Benefit and Willingness-to-Pay Analysis

This section estimates the amount the public would be willing to pay to support the desired environmental outcomes; it is calculated as $20,327,359 per year. A cost-benefit analysis is the process of comparing the projected or estimated costs and benefits (or opportunities) associated with a project decision to determine whether that decision makes sense from society's perspective. The value to affected individuals is measured by assessing their willingness to pay for good things or to accept compensation for bad things. All federal agencies including USEPA and USACE are required to conduct a Regulatory Impact Analysis (RIA) of their regulations to provide both the public and the agencies with accurate information on the costs and benefits of the proposed regulations. An estimate of WTP to measure the benefits resulting from an action is the preferred metric for cost benefit analysis and RIA (See OMB Circular A-4). This analysis uses a benefit transfer method (presented in Moore, et. al., 2018) measuring the economic benefits in question to assess the potential benefits from the dredging action. Estimated values from the analysis are calibrated to reflect the potential WTP for increased water quality benefits, for users and non-users of the Bay, resulting from dredging the Reservoir.

The Moore report values water quality improvements in the Chesapeake Bay – the largest estuary in North America and the third largest in the world. The surrounding watershed encompasses 64,000 square miles in parts of six states in the eastern US and the District of Columbia, and is home to about 18 million people. The Chesapeake Bay's unique set of ecological and cultural elements has motivated efforts to preserve and restore its condition for more than 25 years, however excess nutrient and sediment pollution continues to degrade water quality and adversely affect the provision of ecosystem services including recreation, tourism, property values; food like fish, crabs, clams, and oysters; and flood protection and erosion control. The Chesapeake Bay TMDL (see Section 4) requires loadings of nitrogen, phosphorus, and sediment to be reduced by 25%, 24%, and 20%, respectively, by the year 2025. Those who live near or visit the Chesapeake Bay will benefit from improved water clarity, enhanced recreational experiences, and better conditions for aquatic wildlife resulting in improved harvests of shellfish. Estimating the total economic value of the expected improvements requires capturing non-use value as well. Non-use value accrues to people who may never visit these waterbodies but benefit from the improvements because of a sense of stewardship, a desire to preserve the resource for future generations, or other reasons. (Moore, et.al., 2018).

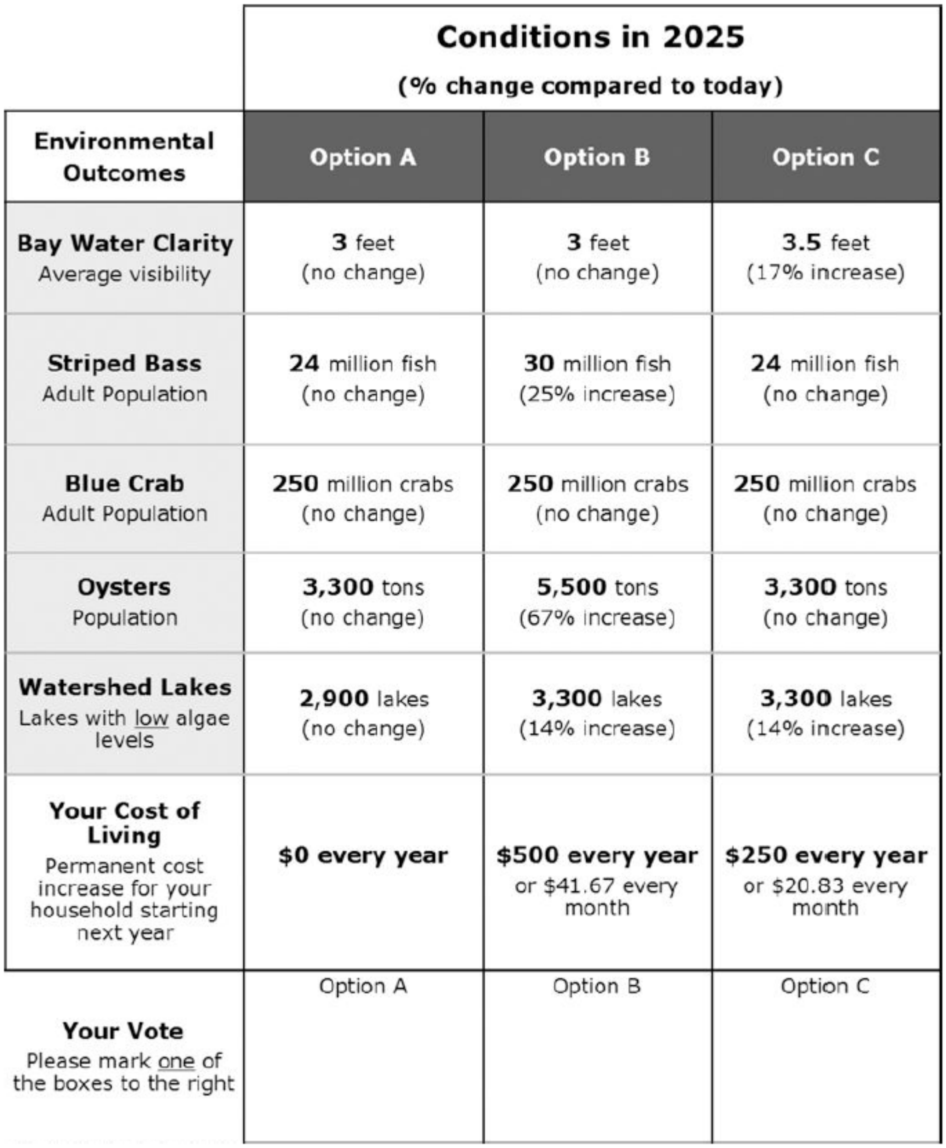
To estimate the total economic value of the benefits expected as a result of the Chesapeake Bay TMDL, Moore, et. al., conducted a stated preference survey of residents living in 17 eastern states and the District of Columbia. The survey employed a discrete choice experiment (DCE) response format to estimate WTP for improvements in five environmental attributes: water clarity; populations of three Chesapeake species (striped bass, blue crab, and eastern oysters); and the condition of freshwater lakes in the Chesapeake Bay Watershed. The DCE response format allows for the estimation of marginal WTP for each attribute, as well as total WTP for outcomes expected from the TMDL. Moore, et. al. relied on a combination of integrated hydrological and ecological modeling and expert judgement to obtain projections of the effects of the TMDL on the environmental attributes.

The survey instrument was designed through extensive focus groups held in several locations, both within and outside of the Chesapeake Bay Watershed. The foremost goals of the focus groups were: 1) to identify the environmental attributes that were the most important to respondents and that would be affected by the TMDL; and 2) to develop an information section that educates the respondent without influencing their responses and remains brief enough to prevent survey fatigue. Attributes used to describe the policy outcomes were limited to those that are likely to enter household utility functions directly, rather than inputs into an ecological production function. The survey includes three choice questions. As shown in the example survey in Figure 16 (numerous surveys were used), each question presents a status quo option with baseline attribute levels and zero cost, and two policy options with some or all of the attributes improving and positive costs. Baseline and policy attribute levels represent conditions in the year 2025 because management practices will be implemented over time and most require additional time to generate ecological or aesthetic improvements. The attribute levels are presented in both absolute terms and relative to current conditions. In the Moore, et. al. survey, respondents were asked to choose one of the three options in each choice question.

The chosen attributes and attribute levels used in the choice questions are shown in Table 15, including costs, which were presented as an increase in a household's annual cost of living resulting from higher costs to industry and government from implementation of the TMDL.

This annual household cost payment vehicle was chosen because it was germane to focus group participants inside and outside of the watershed. More typical payment vehicles such as an increase in taxes or utility bills are only feasible for households in states directly affected by the TMDL. The information treatment included a description of how costs imposed on industry within the watershed would increase prices of goods sold elsewhere, thus increasing the cost of living for households outside the watershed. The metrics describing each of the environmental attributes were chosen based on what focus group participants found to be most tangible (e.g., feet of water clarity, number of striped bass, number of crabs, etc.). To provide points of reference to which respondents could relate these levels to personal experiences, the Moore, et. al. survey briefly described the levels of each attribute historically, and within the last 20 years. Focus group participants stated that these reference levels were more salient than references to "pristine" conditions or policy goals. The attribute levels were chosen to ensure appropriate coverage for potential policy applications and were informed by consultation with the EPA's Chesapeake Bay Program Office.

Figure 16: Willingness to Pay Survey Questionnaire

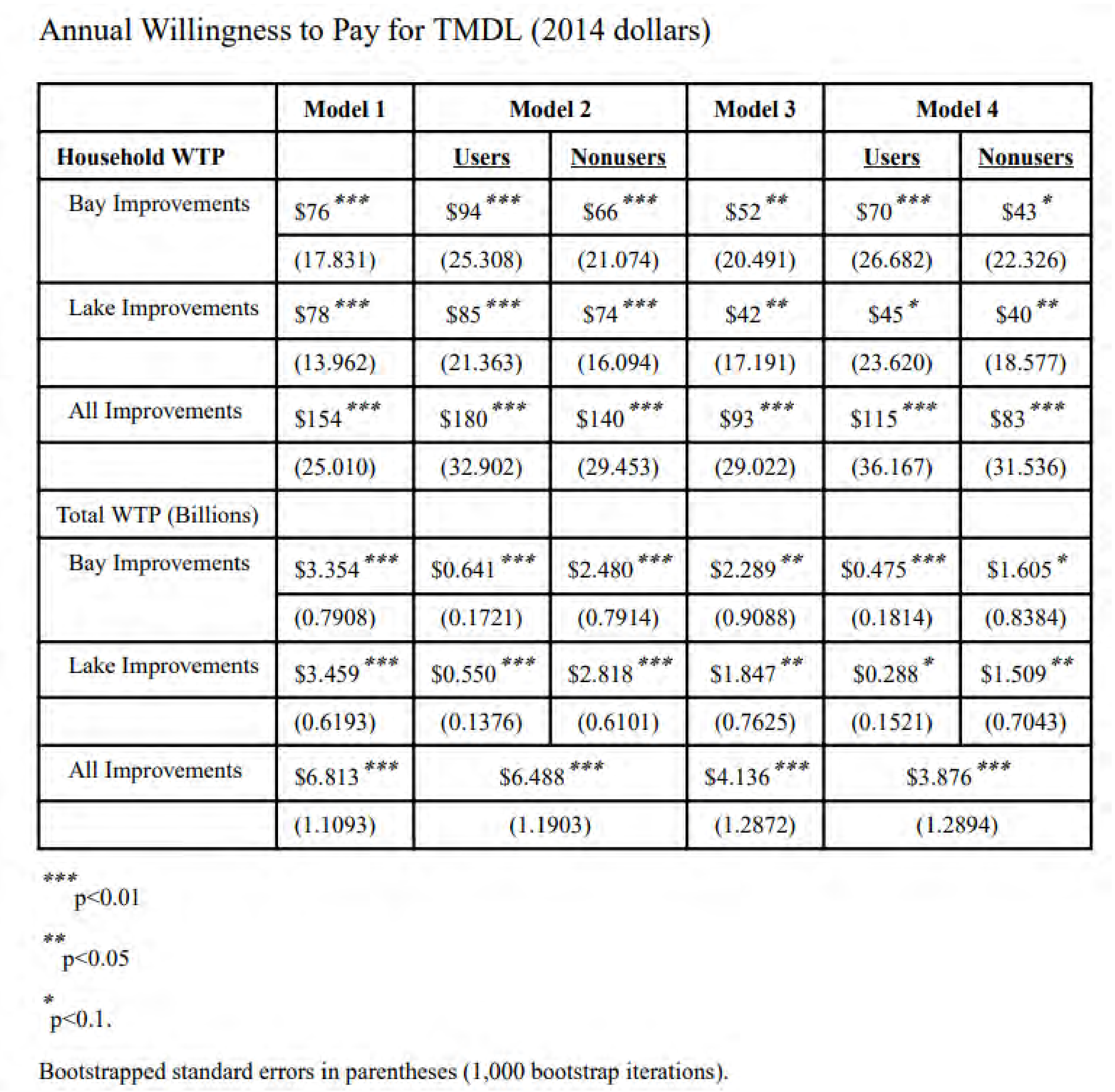


	Conditions in 2025 (% change compared to today)		
Environmental Outcomes	**Option A**	**Option B**	**Option C**
Bay Water Clarity Average visibility	**3** feet (no change)	**3** feet (no change)	**3.5** feet (17% increase)
Striped Bass Adult Population	**24** million fish (no change)	**30** million fish (25% increase)	**24** million fish (no change)
Blue Crab Adult Population	**250** million crabs (no change)	**250** million crabs (no change)	**250** million crabs (no change)
Oysters Population	**3,300** tons (no change)	**5,500** tons (67% increase)	**3,300** tons (no change)
Watershed Lakes Lakes with low algae levels	**2,900** lakes (no change)	**3,300** lakes (14% increase)	**3,300** lakes (14% increase)
Your Cost of Living Permanent cost increase for your household starting next year	**$0 every year**	**$500 every year** or $41.67 every month	**$250 every year** or $20.83 every month
Your Vote Please mark one of the boxes to the right	Option A	Option B	Option C

Note: From Moore, et. al, 2018

The authors used a random utility mixed logit model to estimate the parameters used in calculating annual WTP for households (44,353,441) in the study area. These results are shown in Table 15.

Table 15. Willingness to Pay Results



Annual Willingness to Pay for TMDL (2014 dollars)

	Model 1	Model 2		Model 3	Model 4	
Household WTP		Users	Nonusers		Users	Nonusers
Bay Improvements	$76***	$94***	$66***	$52**	$70***	$43*
	(17.831)	(25.308)	(21.074)	(20.491)	(26.682)	(22.326)
Lake Improvements	$78***	$85***	$74***	$42**	$45*	$40**
	(13.962)	(21.363)	(16.094)	(17.191)	(23.620)	(18.577)
All Improvements	$154***	$180***	$140***	$93***	$115***	$83***
	(25.010)	(32.902)	(29.453)	(29.022)	(36.167)	(31.536)
Total WTP (Billions)						
Bay Improvements	$3.354***	$0.641***	$2.480***	$2.289**	$0.475***	$1.605*
	(0.7908)	(0.1721)	(0.7914)	(0.9088)	(0.1814)	(0.8384)
Lake Improvements	$3.459***	$0.550***	$2.818***	$1.847**	$0.288*	$1.509**
	(0.6193)	(0.1376)	(0.6101)	(0.7625)	(0.1521)	(0.7043)
All Improvements	$6.813***	$6.488***		$4.136***	$3.876***	
	(1.1093)	(1.1903)		(1.2872)	(1.2894)	

***p<0.01

**p<0.05

*p<0.1.

Bootstrapped standard errors in parentheses (1,000 bootstrap iterations).

Note: From Moore, et. al, 2018

For this analysis, results from Model 1 ($154 per year per household) are used to estimate WTP as these estimates provide the best statistical fit. These results reflect the public's WTP to achieve TMDL water quality levels for the entirety of the Chesapeake Bay. The results from Model 1 indicate the 44,353,441 households in the Chesapeake study area are willing to pay $6.8 billion per year (2014 dollars) to achieve the TMDL water quality standard.

To estimate WTP for dredging the Conowingo Dam this analysis assumes the public's WTP is directly and positively correlated with the amount of phosphorus removed from the system. Generally, in these types of aquatic ecosystems, phosphorus is the limiting factor in terms of achieving water quality. That is, the amount of plant and algae growth and hence, water quality, is dictated by the amount of phosphorus available, no matter how much nitrogen is available.

For this analysis, we assume a pound of phosphorus removed anywhere within the system has the same or constant WTP as any other pound of phosphorus removed. Interestingly, Moore, et. al. did not find the effect of proximity to the Chesapeake Bay on choice behavior. Several measures of proximity were tested including linear distance, inverse distance, natural log of distance, a dummy variable denoting a respondent within 50 kilometers, a dummy variable for living inside the watershed, and categorical variables denoting the geographic sampling strata. None of the measures tested yielded statistically significant results. The lack of a WTP distance gradient has been found in other stated preference studies and is not surprising given the iconic nature of the Chesapeake Bay and the potentially large nonuse values people may hold (Moore, et.al., 2018).

The infill of the Reservoir had estimated impairments of water quality, primarily on deep-water and deep channel dissolved oxygen, because of increased discharge and transport of organic and particulate inorganic nutrients from the Reservoir (Linker, et. al. 2016b). The dissolved oxygen decline is significant, however, in view of the effort, expressed in the TMDL, to maintain a minimum of 1 g m-3 of dissolved oxygen in deep bottom water. The TMDL prohibits any decline below dissolved oxygen standards (Cerco & Noel, 2016).

The TMDL sets Bay watershed limits of 203.39 million pounds of nitrogen, 12.62 million pounds of phosphorus (Table 16), and 6,135-6,749 billion pounds of sediment per year (USEPA, 2010). For this analysis, we focus on reducing phosphorous loadings.

To estimate WTP from dredging the Reservoir we used the Water Quality Impact Calculator (Section 4.2.2) to derive estimates of phosphorus loading reductions. Table 16 indicates total phosphorus will be removed at the rate of 31,943 pounds per year.

Table 16: Phosphorus Reduction Relative to the Conowingo Watershed Implementation Plan

	TN (mlb/yr)	**TP (mlb/yr)**
2010 TMDL	203.39	12.62
Conowingo Implementation Plan	6	0.26
Total TMDL	209.39	12.88
Removed from Conowingo[1]	0.743044416	0.031942566
Reduction relative to total TMDL	0.355%	0.248%
[1] Scenario 3 from Strategic Dredge - Water Quality Impact Calculator		

This implies that Reservoir dredging will remove 0.248% of phosphorus relative to the total TMDL for phosphorus. Using the Bureau of Labor Statistics Consumer Price Index (BLS, 2022) to adjust for inflation yields a willingness to pay for improvements resulting from the TMDL of $184.80 per household per year in 2022 dollars. Multiplying this value by the number of households in the surveyed area (44,353,441) yields an annual willingness to pay for the Conowingo dredging action of $20,327,359 per year.

5.6 Economic Evaluation Summary

Local markets for IR/BU products from Reservoir sediment are robust, although each market requires careful evaluation to ensure the State can realize revenues. Under the three volume scenarios examined, demand is substantially greater than supply for concrete, asphalt, and cement clinker. For blended soil and stabilized sediment, supply is likely greater than demand, though this could change over time as recognition grows that Reservoir sediment could be cost-effective for large-scale project delivery. For BUs, demand could also be greater than supply. That is, large-scale habitat creation or island-building projects could potentially absorb the full volume produced; assuming environmental thresholds are met in terms of leachability, bioavailability, and criteria established through site-specific risk-based assessments. In combination, the IR/BUs evaluated represent a means for the State to find end destinations for slurry dredged and pumped to a transfer location. Findings of the economic evaluation are summarized below.

The economic analysis suggests that while IR/BU processing and sales could provide substantial revenue to the State, the full suite of costs to dewater, separate, and transport sediment fractions to their relative markets will not be completely offset based solely on the sale of end products evaluated if all costs (including those excluded from this evaluation) are considered. The modeled scenarios, which as described in Section 5.4.2.2 do no not include some costs that cannot be reasonably anticipated at this time, allow the State to evaluate IR/BUs in terms of how much they could potentially offset costs of a dredging and processing program. The cost offsets range from 12 – 15% when trucking is the transportation mode from separation site to vendor site, and 65 – 137% when barging is the transportation mode. Within transportation modes, these ranges depend on the Scenario and the assumed annual dredge volume.

The shortfall resulting from costs exceeding potential revenue should not be viewed as rendering dredging an economically problematic option. The State should view remaining costs, which would also include agency staffing, program management, and other elements not detailed here, as the price of helping meet downstream water quality, economic, and other goals. For example, in comparison with other programs that have looked to achieve regional water quality goals, the expenses are not large. An example is the draft CWIP (in which EPA recently declared no confidence[22]), which estimated it would cost $53 million a year to implement plus roughly $13 million a year for additional technical and administrative support (with this support estimated in the CWIP as roughly 25% of the overall contribution). This $53 million estimate is significantly lower than other estimates in the draft CWIP that range up to $368 million/year,[23] highlighting that the potential deltas detailed in this report may be less difficult for the State to manage than available alternatives, especially through collaboration with neighboring states that stand to benefit from dredging-related water quality improvements.

In addition to revenue generation options evaluated in Scenario 1 (concrete sand, blended soils, clinker, SCM), the State could evaluate sale of coal in that scenario. In addition, large-volume versions of some IR/BUs presented here such as habitat creation or mine reclamation could consume material that has not been processed by other means and possibly generate revenue under some circumstances. Alternatively, additional scenarios could be generated from these inputs including one in which slurry is pumped by a private party, possibly working through a public-private partnership, to a location where dewatering occurs naturally and sediment separation and engagement with IR/BU markets may occur from that site or sites. Implications for the State would include 1) less or no cost to establish the programs and deploy and maintain dewatering and separation equipment; and 2) less or no revenue from IR/BU component sales.

Work by Chesapeake Bay Program modelers has clarified that while the Reservoir is now at equilibrium in terms of trapping capacity; removal of net 20 mcy of sediment is expected to return the Reservoir to roughly its 1995 trapping capacity. This value was used in creation of the dredging scenario calculator described in Section 4 of this report and helps frame the relative need for dredging 1, 3, or 5 mcy over a sustained period. By creating new trapping capacity, dredging would be associated with significant overall reductions in nutrient loads delivered to the Bay. These reductions present the opportunity for additional revenue through the sale of water quality credits under a private/public partnership. The State is currently evaluating which dredge geometries will maximize these benefits, both for an initial and larger dredging program to create trapping capacity and for less intensive maintenance dredging to ensure the benefits of this capacity will continue. Additional efforts are underway to quantify economic benefits to fisheries in the Bay in terms of damages from storm-associated nutrient surges that could be avoided by dredging.

As an update to financial observations in the LSRWA, this study concludes that dredging the Reservoir is not necessarily too expensive. Through a combination of partnerships, new financing mechanisms such as private sector engagement with the Maryland Water Quality Credit Exchange to help cover costs of dredging, and an aggressive combination of IR/BUs that

---

[22] EPA Declares 'No Confidence' In Cleanup Plan For Conowingo Dam | Annapolis, MD Patch
[23] Draft_cwip_with_appendices_03_30_2020.pdf (chesapeakebay.net)

have market potential, the State could cover a majority of the costs associated with restoring the Reservoir’s trapping capacity. Allocating public funds on an ongoing basis would also be theoretically supported by the WTP analysis in this section. If remaining costs appear too large, the State could collaborate with private partners to finance and coordinate both dredging and an IR/BU program.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions based on the IR/BU Evaluation are summarized below:

- Results of physical and chemical analysis of stockpile samples were generally consistent with the findings reported during the Sediment Characterization Study which indicated that concentrations of three metals (arsenic, manganese, and thallium) were observed above IR/BU Guidance during both sampling events.
- Arsenic, manganese, and thallium were detected in stockpile samples at concentrations exceeding MDE's more restrictive IR Categories. However, these metals are at or below Central Maryland ATCs, and/or Pennsylvania and New York BTVs which represent naturally occurring conditions.
- Arsenic concentrations in the stockpile samples (range 4.7 to 5.0 mg/kg) were consistent with core samples collected in the same area (4.6 to 8.2 mg/kg), but lower than observed in core sample data set (range average 12.5 mg/kg). These elevated concentrations may affect the material's suitability for some end uses such as soil blending and farm field spreading. Ingredients testing will be required to ensure that end products meet regulatory requirements.
- The presence of coal granules and coal dust in the Pilot Dredging Area was consistent with observations of coal during the Sediment Characterization Study. The presence of coal may have negative implications for downstream environmental health after scour events and certain sediment end uses (blended soil products, in-water applications) and will require further testing during larger scale applications. However, the presence of coal is not a deterrent for manufacturing cement clinker, SCMs, and stabilized fill material. In addition, the value of the coal may justify the cost of implementing coal separation processes during dewatering. These items should be further evaluated during development of the large-scale project.
- Bench scale testing determined that the Reservoir sediment possesses suitable grain size distribution, mineral content, and clay content for manufacturing cement clinker and SCMs. This is a favorable finding because the majority of sediment in the Project Area is fine grained and will be the largest portion of the material to place in end use options.
- The grain size distribution of the material from the Pilot Dredging Area was too fine grained to be suitable for use as concrete or asphalt sand. However, the sand may have alternative uses or contribute to concrete sand as part of a blended product, especially if separation occurs at scale.
- When properly amended, Reservoir sediment can be used in soil blending applications including bioretention soil and topsoil. However, only 30 – 35% of the blend can be comprised of Reservoir sediment thereby impacting the potential volume that could be consumed by this end use. Transportation costs and market competition are additional

factors that must be considered for large volume use of Reservoir sediment in soil blending applications.

- Soil fertility testing indicated that Reservoir sediment amended with nutrients and organic matter supported vigorous plant growth. Adding nutrient and organic matter amendments to Reservoir sediment is beneficial for farm field spreading or soil blending. Ingredients testing will be required to ensure that end products meet regulatory requirements.
- Dredging of the Reservoir has been described in the LSRWA and the CWIP as a potential solution to be paired with watershed BMPs that will reduce pollutant inflow to the Conowingo Reservoir. These results support that conclusion by showing that increased dredging of the Reservoir above the rate of depositional inflow is expected to reduce downstream sediment and nutrient loading.
- A Water Quality Impact Calculator has been developed as a useful tool to provide planning or screening level estimates of the potential benefit of a dredging management strategy. Results include that dredging 3 mcy per year could result in meeting 12% of the annual requirement to reduce 6 million pounds of nitrogen entering the Bay if TMDL goals are to be met and dredging 6 mcy per year could result in meeting 40% of this goal. Because these are conservative estimates, recommendations include conducting additional modeling to refine the estimates under varied dredging configurations and locations.
- Current understanding of nutrient and sediment dynamics suggest that strategic dredging in areas of recent deposition would have the greatest benefit to trapping efficiency and removing more reactive sediments that impact downstream water quality. A significant added benefit of dredging is that the removal of coal should significantly reduce environmental impacts on the Bay. Timing of dredging activities to be completed prior to the spring freshet would likely have the greatest benefit to reducing moderate and extreme scour events.
- Economic evaluation indicated that local markets for IR/BU products from Reservoir sediment are robust. Under three volume scenarios examined, demand is substantially greater than supply for concrete, asphalt, and cement clinker. For blended soil and stabilized sediment, supply is likely greater than demand.
- For BUs, demand could also be greater than supply. That is, large-scale habitat creation or island-building projects could potentially absorb the full volume produced; assuming environmental thresholds are met in terms of leachability, bioavailability, and criteria established through site-specific risk-based assessments.
- Having a dedicated Conowingo Reservoir Innovative Reuse/Beneficial Use Program in place prior to operational dredging could help alleviate some uncertainty. Proactivity on the part of regulatory agencies and industry stakeholders could also help grow the early market to avoid saturation and expand the number of viable opportunities.

- In combination, the IR/BUs evaluated represent a means for the State to find end destinations for dredged material. However, cost of transportation will be among the key factors determining economic efficiency.
- The WTP study indicates public willingness to support $20.3 million per year to achieve the water quality goals associated with dredging 3 mcy. In combination with sale of dredged material and possibly water quality credits, the economic analysis indicates that dredging the Reservoir is not necessarily too expensive.
- Cost efficiency of evaluated scenarios ranges from 12 – 15% when trucking is the transportation mode from separation site to vendor site, and 65 – 137% when barging is the transportation mode. Ranges depend on the volume scenario and whether the State is responsible for costs of dredging and pumping slurry to a processing site and separating the sediment fractions. For the higher end of the range (Scenario 2), it has been assumed that third party costs could be offset by commercializing the coal fraction, though this would require additional study, and the sale of water quality credits.

Recommended next steps required before full-scale implementation include the following:

Immediate Tasks

- Consider additional Pilot Project scope – Adding screening-level modeling using the HDR model would provide the foundation for further project development (planning and costing) of full-scale implementation. Various dredging scenarios could be assessed in parallel with the BMP approval process through the Exploratory Group for an Expert Panel. This would allow for overall project planning, permitting, and cost evaluation (outlined below) to proceed, giving the State a more robust and timely solution to the Conowingo dilemma.
- Proceed with project development and answer questions recently expressed by legislative leaders, including the following needs:
    - Identify opportunities and constraints for site evaluation based on biological and other permitting/NEPA considerations.
    - Develop a project description that includes:
        - Sediment management site evaluation, site selection, and conceptual design (taking into account options downgradient of the Reservoir)
        - Sediment conveyance infrastructure routing and conceptual design
        - Dredging method selection and dredging window identification
        - Identification and evaluation of additional IRs and BUs as appropriate based on results of the SCR and this IR/BU report
- Concurrently perform full-scale hydrologic and nutrient modeling to confirm nutrient reduction benefits of dredging at scale, in support of a BMP designation process.

Subsequent Tasks

- Perform additional testing and evaluation related to both new and previously identified IRs and BUs including the following:
  - Coordinate with the Maryland Department of Natural Resources to identify potential BU applications.
  - *Concrete and Asphalt Sand*: If full-scale dewatering processes results in material separation, the coarse fraction should be reanalyzed to determine if use as a concrete or asphalt sand would be economically viable if amended.
  - *Cement Clinker*: Full-scale kiln testing will need to be conducted to assess physical properties and performance characteristics of cement clinker.
  - *Soil Blending*: Continue to adjust to the material proportions used in soil blending to meet specifications for a wider variety of soil blends.
  - *SCM*: Further evaluate SCM calcine temperatures, cooling rates, and grind size to further develop the use of SCMs at full scale.
  - *Coal*: Assess impacts of coal on the Bay given selected dredging scenarios. Further consider potential end-uses of the coal fraction.
  - *Beneficial Use of unamended or stabilized sediment*: Conduct additional testing per the Maryland IR/BU Guidance regarding in-water applications such as coastal stabilization and island creation.
  - Conduct an assessment of market demand in Pennsylvania for the various IR/BU products. Evaluate regulatory and other issues to address in consideration of potential subsequent dredging in Lower Susquehanna waters above the Pennsylvania state line.

In summary, based on our findings, Conowingo Reservoir sediment can be considered a resource as opposed to a waste. Given this outcome, it is apparent that Reservoir trapping capacity can be restored with removal of existing sediment. The costs to do so can be offset, potentially significantly, depending on how much sediment is dredged each year, the sediment transportation modes employed, and the degree to which the State partners with other entities on project implementation.

7.0 REFERENCES

Bureau of Labor Statistics. 2022. Inflation Calculator. https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=1&year1=201401&year2=202201

Boicourt, W.C. 1992. Influences of circulation processes on dissolved oxygen in the Chesapeake Bay. In Oxygen dynamics in the Chesapeake Bay: A synthesis of recent research, ed. D.E. Smith et al., 7–59. College Park: Maryland Sea Grant Publication. Fennel, K., and J.M. Testa, 2018. Biogeochemical controls on coastal hypoxia. Annual Review of Marine Science 11:105-130.

Center for Watershed Protection. 2021. Conowingo Watershed Implementation Plan, July 31, 2021.

Cerco CF, Noel MR. 2018. Impact of Reservoir Sediment Scour on Water Quality in a Downstream Estuary. J Environ Qual. 2016 May;45(3):894-905. doi: 10.2134/jeq2014.10.0425. PMID: 27136156.

Cornwell, J. C., M. S. Owens, H. Perez, and Z. Vulgaropulos. 2017. The Impact of Conowingo Particulates on the Chesapeake Bay: Assessing the Biogeochemistry of Nitrogen and Phosphorus in Reservoirs and the Chesapeake Bay. Final Report to Exelon Generation and Gomez and Sullivan. UMCES Contribution TS-703-17. Cambridge, Maryland.

Edwards, Robert E. 2006. Comprehensive Analysis of the Sediments Behind Hydroelectric Dams of the Lower Susquehanna River. Watershed Assessment and Protection Program Susquehanna River Basin Commission in cooperation with the Chesapeake Bay Commission and the Pennsylvania Department of Environmental Sciences. Publication 239, 154 pp.First Street Foundation Flood Factor Tool. 2021. < https://firststreet.org/flood-factor/> Accessed 8/31/21.

Fitzpatrick, J. 2017. Conowingo Pond Mass Balance Model. Report to Exelon Generation, LLC. June 2017. HDR.

Gomez and Sullivan Engineers, P.C., (Gomez and Sullivan). 2012. Conowingo Pond Bathymetric Survey Analysis. Memorandum to Conowingo Relicensing Stakeholders.

Kemp, W. M., W. R. Boynton, J. E. Adolf, D. F. Boesch, W. C. Boicourt, G. Brush, J. C. Cornwell, T. R. Fisher, P. M. Glibert, J. D. Hagy, L. W. Harding, E. D. Houde, D. G. Kimmel, W. D. Miller, R. I. E. Newell, M. R. Roman, E. M. Smith, and J. C. Stevenson. 2005. Eutrophication of Chesapeake Bay: historical trends and ecological interactions. Marine Ecology-Progress Series 303:1-29.

Lang, D.J. 1982. Water quality of the three major tributaries to the Chesapeake Bay, The Susquehanna, Potomac, and James Rivers, January 1979 - April 1981: US Geological Survey Water-Resources Investigations 82-32, 64 p.

Langland, M.J. 2009. Bathymetry and sediment-storage capacity change in three reservoirs on the Lower Susquehanna River, 1996-2008. 2009-5110. Scientific Investigations. US Geological Survey.

Langland, M.J. 2015. Sediment transport and capacity change in three reservoirs, Lower Susquehanna River Basin, Pennsylvania and Maryland, 1900–2012: US Geological Survey Open-File Report 2014–1235, 18 p., http://dx.doi.org/10.3133/ofr20141235.

Linker, L., R. Hirsch, W. Ball, J. Testa, K. Boomer, C. Cerco, L. Sanford, J. Cornwell, L. Currey, C. Friedrichs, R. Dixon. 2016a. Conowingo Reservoir Infill and Its Influence on Chesapeake Bay Water Quality. STAC Publication Number 16-004, Edgewater, MD. 51 pp.

Linker, L., R. Batiuk, C. Cerco, G. Shenk, P. Wang, R. Tian, and G. Yactayo. 2016b. Influence of reservoir infill on coastal deep water hypoxia. J. Environ. Qual. doi:10.2134/jeq2014.11.0461

Maher, A., Douglas, W. S., Jafari, F., & Pecchioli, J. 2013. *The Processing and Beneficial Use of Fine-Grained Dredged Material: A Manual for Engineers.* Available online at: https://cait.rutgers.edu/wp-content/uploads/2018/05/193-ru2763_1.pdf

Maryland Department of the Environment (MDE). 2018. Cleanup Standards for Soil and Groundwater, Interim Final Guidance (Update No. 3). October.

MDE. 2019. Innovative Reuse and Beneficial Use of Dredged Material Guidance Document. December.

Maryland Department of Transportation State Highway Administration. 2021. *Standard Specifications for Construction and Materials.*

Moore C, Guignet D, Maguire KB, Dockins C, Simon NB. Valuing Ecological Improvements in the Chesapeake Bay and the Importance of Ancillary Benefits. J Benefit Cost Anal. 2018 Spring 9(1):1-26. doi: 10.1017/bca.2017.9. Epub 2017 Jun 15. PMID: 31080702; PMCID: PMC6510401.

Northgate Environmental Management. August 30, 2019a, Data Gap Analysis Report, Appendix A of Sampling and Analysis Plan RE003, Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project. Project ID No. 1-18-3-21-8R, Cecil and Harford Counties, Maryland.

Northgate Environmental Management. December 6, 2019b, IR/BU Materials Management Plan RE001, Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project, Project ID No. 1-18-3-21-8R, Cecil and Harford Counties, Maryland.

Northgate Environmental Management. May 28, 2021, Sediment Characterization Study Report RE01, Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use Pilot Project, Project ID No. 1-18-3-21-8R, Cecil and Harford Counties, Maryland.

Palinkas, Cindy M., Jeremy M. Testa, Jeffrey C. Cornwell, Ming Li, and Lawrence P. Sanford. 2019. Influences of a River Dam on Delivery and Fate of Sediments and Particulate Nutrients to the Adjacent Estuary: Case Study of Conowingo Dam and Chesapeake Bay. Estuaries and Coasts. Coastal and Estuarine Research Federation.

P.K. Mehta and P.J.M. Monteiro. 2014. *Concrete: Microstructure, Properties, and Materials*, McGraw-Hill, fourth edition.

Reed, L.A., and Hoffman, S.A. 1997. Sediment deposition in Lake Clarke, Lake Aldred, and Conowingo Reservoir, Pennsylvania and Maryland, 1910-93: US Geological Survey Water-Resources Investigations Report 96-4048, 14 p., 3 pls.

United States Army Corps of Engineers (USACE). 2015. Lower Susquehanna River watershed assessment report. Army Corps of Engineers, Baltimore District, Baltimore, MD.

USEPA. 1998. Region 1 EPA Compendium of Quality Assurance Project Plan Guidance. US EPA-NEW ENGLAND Region I Quality Assurance Unit Staff Office of Environmental Measurement and Evaluation. September 1998 Draft Final.

USEPA. 2017a. Toxicological Review of Benzo(a)pyrene. Integrated Risk Information System. January, 2017, [CASRN 50-3208]

USEPA. 2017b. Office of Superfund Remediation and Technology Innovation, January 2017. *National Functional Guidelines for Inorganic Superfund Methods Data Review.* OLEM 9355.0-135; EPA-540-R-2017-001; 150 pages.

USEPA. 2010. Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment. US Environmental Protection Agency Regions 2 and 3. December 29. https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document

United States Geological Survey (USGS). 1995. Deposition and Simulation of Sediment Transport in the Lower Susquehanna River System. Water Resources Investigations Report 95-4122.

USGS. 1996. Sediment Deposition in Lake Clark, Lake Alred, and Conowingo Reservoir, Pennsylvania and Maryland, 1910-93. Water Resources Investigations Report 96-4048.

USGS. 1997. Changes in Bottom-Surface Elevations in Three Reservoirs on the Lower Susquehanna River, Pennsylvania and Maryland, Following the January 1996 Flood - Implications for Nutrient and Sediment Loads to Chesapeake Bay. Water Resources Investigations Report 97-4138.

USGS. 2009. Bathymetry and Sediment Storage Capacity Change in Three Reservoirs on the Lower Susquehanna River, 1996-2008. Scientific Investigations Report 2009-5110.

USGS. 2012. Sediment Transport and Capacity Changes in Three Reservoirs, Lower Susquehanna River Basin, Pennsylvania and Maryland, 1900 - 2012. Open File Report 2014-1235.

Vosnakis, Kelly A.S.; Perry, Elizabeth; Madsen, Karen; and Bradley, Lisa J.N. 2010. "Background Versus Risk-Based Screening Levels - An Examination Of Arsenic Background Soil Concentrations In Seven States," Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy: Vol. 14 , Article 10. Available at: https://scholarworks.umass.edu/soilsproceedings/vol14/iss1/10

Zhang, Q., R.M. Hirsch, and W.P. Ball. 2016. Long-term changes in sediment and nutrient delivery from Conowingo dam to Chesapeake Bay: Effects of reservoir sedimentation. Environmental Science & Technology 50 (4): 1877-1886.

TABLES

TABLE 2
Laboratory Analytical Results - Metals, TOC, % Moisture, Grain Size
Conowingo, Maryland

Analytic Method				ASTM D422	ASTM D422	D2974-87	SM2540G	ASTM D422	SM22 2540G	SW-846 9060	ASTM D2974	SW-846 9014	9016	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 7196 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A
Units				%	%	%	%	%	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Coarse Grain	Fine Grain	Percent moisture	Percent moisture	Percent moisture	Percent moisture	Total Organic Carbon (mean)	Organic Matter	Cyanide	Cyanide, Free	Antimony	Arsenic	Beryllium	Cadmium	Chromium*	Hexavalent Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Central Maryland ATC															**4.9**			**30**				**1,400**					**1.5**	
Category 1 RSL												**23**		**3.1**	**0.68**	**16**	**7.1**	**12,000**	**0.3**	**310**	**400**	**180**	**1.1**	**150**	**39**	**39**	**0.078**	**2,300**
Category 2 RSL												**150**		**47**	**3**	**230**	**98**	**180,000**	**6.3**	**4,700**	**800**	**2,560**	**4.6**	**2,200**	**580**	**580**	**1.2**	**35,000**
Category 3 RSL Composite												**147**		**467**	**30**	**2290**	**982**	**1,750,000**	**63.3**	**46,700**	**800**	**25,600**	**46**	**22,400**	**5,840**	**5,840**	**11.7**	**350,000**
Category 3 RSL Construction												**32.6**		**136**	**142**	**618**	**277**	**509,000**	**425**	**13,600**	**800**	**5,530**	**9.49**	**5,570**	**1,700**	**1,700**	**3.39**	**102,000**
Transect 1																												
B1	36.6	38.8	ft	47	53	32.1	31.2	41.9	--	344,000	22.04	--	--	0.47 J	9.6	1.5	0.49 J	19	--	49	35	590	0.34	42	4.3	0.13 J	0.19 J	170
B1	41.2	43.8	ft	15	85	44.2	44.6	48.9	--	119,000	14.37	--	--	0.44 J	19	3.7	1.2	61	--	100	73	1500 E	0.7	94	5	0.45 J	0.4 J	440
C1	24.7	25.5	ft	77	23	31.2	31.5	38.7	--	125,000	18.99	--	--	0.56 J	8.2	1.2	0.53 J	24	--	28	20	710 E	0.12 J	49	0.95	0.16 J	0.18 J	180
C1	27.9	30.5	ft	89	11	30.0	37.3	40.2	--	654,000	66.46	--	--	0.37 J	6.2	1.6	0.66	15	--	34	31	510	0.28	37	2.5	0.33 J	<0.56	190
C1	33.3	35.5	ft	89	11	39.2	36.5	43.1	--	669,000	61.54	--	--	0.63 J	6	1.5	0.53 J	14	--	34	27	490	0.31	33	2.7	0.28 J	<0.55	140
C1	38.8	40.5	ft	81	19	32.2	31.9	46.9	--	755,000	70.48	--	--	<3.1	4.6	1.3	0.41 J	25	--	30	21	500	0.28	26	2	0.15 J	<0.62	110
C1	44.5	45.5	ft	81	19	31.5	30.0	46.1	--	530,000	56.81	--	--	0.58 J	6.6	1.8	0.59 J	61	--	41	27	680 E	0.29	40	2.9	0.28 J	<0.65	180
D1	20.8	22.7	ft	77	23	30.5	28.4	40.0	--	143,000	--	--	--	<2.9	7	1.2	0.48 J	15	--	27	21	600 E	0.11 J	45	1.5	0.25 J	<0.57	160
D1	22.7	22.7	ft	--	--	--	--	--	--	--	74.29	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D1	24.7	26.7	ft	9	91	39.6	43.1	45.2	--	105,000	14.71	--	--	0.44 J	19	3.4	3.9	60	--	85	72	2900 E	0.34	110	2.5	5	0.38 J	570
D1	26.7	27.7	ft	88	12	25.7	25.8	34.0	--	704,000	65.93	--	--	0.4 J	7.5	1.6	0.55 J	11	--	33	24	590	0.25	39	2.7	0.25 J	<0.61	150
D1	28.5	30.2	ft	7	93	44.6	44.4	33.9	--	86,300	12.16	--	--	0.52 J	19	3.5	4	97	--	90	60	1900 E	0.38	120	2.7	3.6	0.31 J	610
D1	30.2	32.7	ft	19	81	38.0	38.7	33.4	--	194,000	27.21	--	--	0.43 J	16	3.3	2.9	55	--	85	58	1700 E	0.39	97	3.4	2.3	0.29 J	530
D1	33.0	37.7	ft	12	88	42.3	45.6	70.9	--	93,700	--	--	--	<3.5	23	4.7	3.5	100	--	120	84	1700 E	0.62	120	5.3	3.7	0.41 J	790
D1	35.0	35.0	ft	--	--	--	--	--	--	--	27.27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D1	38.0	42.7	ft	5	95	42.7	42.8	61.9	--	124,000	14.49	--	--	0.56 J	19	4.7	4.2	85	--	110	84	2000 E	0.59	110	3.3	5.3	0.36 J	750
Transect 2																												
A2	7.8	12.8	ft	14	86	39.0	41.7	56.4	--	79,500	13.84	--	--	<4.2	11	2.1	1.3	34	--	44	52	2100 E	0.19	63	1.2	0.65 J	0.33 J	230
A2	13.2	16.4	ft	90	10	27.5	27.4	37.1	--	401,000	43.31	--	--	<2.8	5.1	1.1	0.29 J	9.8	--	22	18	550	0.13	27	1.7	0.11 J	<0.57	110
A2	16.4	17.8	ft	2	98	46.3	46.3	53.6	--	69,600	10.26	--	--	0.48 J	18	3.8	4.1	64	--	89	82	2600 E	0.39	100	2.1	6	0.4 J	570
A2	18.0	20.2	ft	87	13	23.2	23.2	31.1	--	358,000	43.08	--	--	<2.8	4.7	0.89	0.24 J	16	--	25	15	560 E	0.12	29	1.4	0.087 J	<0.56	100
A2	20.2	22.8	ft	5	95	43.2	43.3	40.2	--	67,300	10.06	--	--	<4	14	3.6	2.7	58	--	81	70	1700 E	0.54	79	1.8	2.1	0.35 J	540
A2	23.4	27.8	ft	3	97	38.7	38.5	61.7	--	115,000	13.59	--	--	0.3 J	17	3.4	1.7	48	--	83	70	1400 E	0.41	73	3.5	1.4	0.35 J	430
A2	28.4	32.8	ft	4	96	37.0	36.5	57.8	--	82,000	15.92	--	--	<3.7	15	2.5	0.8	39	--	62	57	1600 E	0.39	59	2.7	0.31 J	0.33 J	260
A2	33.6	35.8	ft	5	95	37.1	37.4	54.6	--	153,000	22.46	--	--	<3	13	2.7	0.76	43	--	69	60	1200 E	0.51	54	3.2	0.24 J	0.29 J	300
A2	38.0	40.0	ft	93	7	17.3	18.0	20.2	--	3,250	0.97	--	--	<2	1.5	0.23 J	0.051 J	6	--	3.7	7.2	**57**	<0.079	10	0.077 J	<0.4	<0.4	29
C2	24.5	27.3	ft	93	7	19.8	20.1	27.3	--	624,000	38.69	--	--	<2.9	4.7	0.9	2	4.9	--	19	13	260	0.099 J	23	1.8	<0.57	<0.57	87
C2	29.8	32.2	ft	5	95	44.1	42.3	42.9	--	75,000	12.10	--	--	<3.4	14	3	3.6	56	--	73	67	2300 E	0.33	83	1.8	3.7	0.33 J	450
C2	34.1	34.9	ft	24	76	39.8	41.4	67.5	--	167,000	14.50	--	--	<4.2	9.7	2.1	1.6	41	--	50	43	1400 E	0.3	56	2.2	1.2	<0.83	300
C2	35.3	37.3	ft	4	96	39.1	39.7	55.3	--	106,000	17.32	--	--	<2.9	14	3.3	2.2	48	--	76	63	1500 E	0.42	78	2.6	1.8	0.32 J	440
C2	38.4	39.3	ft	10	90	34.5	39.2	53.2	--	148,000	17.29	--	--	0.4 J	14	2.6	1	42	--	65	60	1500 E	0.35	61	3.1	0.52 J	0.33 J	250
C2	39.3	42.3	ft	66	34	29.3	31.6	26.9	--	662,000	65.32	--	--	<2.7	8.3	1.6	0.39 J	16	--	41	36	630 E	0.41	32	3.5	0.1 J	0.17 J	140
Transect 3																												
A3	24.6	26.0	ft	84	16	24.4	24.5	25.2	--	536,000	44.70	--	--	<2.9	3.6	0.86	0.22 J	7.8	--	18	15	550	0.14	21	1.2	<0.57	<0.57	71
A3	26.0	28.4	ft	23	77	34.6	36.0	45.7	--	104,000	16.47	--	--	<2.9	12	2.2	1.4	30	--	53	47	1700 E	0.3	63	2	0.83	0.24 J	260
A3	28.6	29.9	ft	88	12	24.2	25.8	30.0	--	622,000	45.12	--	--	<2.4	3.5	0.8	0.27 J	12	--	19	15	<0.48	0.13	24	1.2	0.07 J	<0.48	87
A3	29.9	33.4	ft	8	92	40.9	41.4	52.6	--	65,500	12.67	--	--	0.58 J	19	3.5	2.2	55	--	82	76	2500 E	0.36	100	2.7	1.5	0.42 J	410

TABLE 2
Laboratory Analytical Results - Metals, TOC, % Moisture, Grain Size
Conowingo, Maryland

Analytic Method				ASTM D422	ASTM D422	D2974-87	SM2540G	ASTM D422	SM22 2540G	SW-846 9060	ASTM D2974	SW-846 9014	9016	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 7196 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A
Units				%	%	%	%	%	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Coarse Grain	Fine Grain	Percent moisture	Percent moisture	Percent moisture	Percent moisture	Total Organic Carbon (mean)	Organic Matter	Cyanide	Cyanide, Free	Antimony	Arsenic	Beryllium	Cadmium	Chromium*	Hexavalent Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Central Maryland ATC															**4.9**			**30**				**1,400**					**1.5**	
Category 1 RSL												**23**		**3.1**	**0.68**	**16**	**7.1**	**12,000**	**0.3**	**310**	**400**	**180**	**1.1**	**150**	**39**	**39**	**0.078**	**2,300**
Category 2 RSL												**150**		**47**	**3**	**230**	**98**	**180,000**	**6.3**	**4,700**	**800**	**2,560**	**4.6**	**2,200**	**580**	**580**	**1.2**	**35,000**
Category 3 RSL Composite												**147**		**467**	**30**	**2290**	**982**	**1,750,000**	**63.3**	**46,700**	**800**	**25,600**	**46**	**22,400**	**5,840**	**5,840**	**11.7**	**350,000**
Category 3 RSL Construction												**32.6**		**136**	**142**	**618**	**277**	**509,000**	**425**	**13,600**	**800**	**5,530**	**9.49**	**5,570**	**1,700**	**1,700**	**3.39**	**102,000**
A3	34.7	36.2	ft	72	28	25.4	27.4	28.4	--	623,000	59.34	--	--	0.24 J	3.7	0.88	0.23 J	13	--	110	16	460	0.16	21	1.4	0.11 J	0.16 J	80
A3	41.6	43.4	ft	71	29	15.1	14.6	16.3	--	2,360	0.65	--	--	0.32 J	2.6	0.3 J	<0.41	8.9	--	5.5	4.9	**130**	<0.082	11	0.089 J	<0.41	<0.41	35
A3	44.6	47.4	ft	75	25	15.2	18.2	18.0	--	1,680	1.23	--	--	<2.2	2.7	0.27 J	<0.43	12	--	5.5	4.6	**150**	<0.087	9.9	0.064 J	<0.43	<0.43	33
C3	29.3	30.5	ft	7	93	44.5	42.7	72.5	--	85,000	14.49	--	--	0.5 J	16	2.5	3	37	--	63	62	2600 E	0.3	94	1.8	2.4	0.28 J	400
C3	30.6	35.5	ft	90	10	23.8	22.2	32.0	--	692,000	64.25	<6.383	<1.3	0.27 J	6.8	1.2	0.81	14	<1.3	32	23	560 E	0.16	34	1.7	0.71	<0.51	150
C3	38.2	40.5	ft	10	90	41.2	42.5	74.4	--	139,000	26.06	--	--	0.53 J	14	2.8	3	54	--	68	55	1700 E	0.3	84	2.1	3.1	0.23 J	430
C3	40.5	41.8	ft	90	10	25.8	28.9	29.2	--	791,000	69.50	--	--	0.31 J	4.4	0.79	0.32 J	14	--	31	13	290	0.12	21	1.5	0.33 J	<0.59	89
C3	46.7	50.5	ft	15	85	39.1	36.8	64.7	--	187,000	23.20	--	--	0.53 J	16	2.6	1.1	36	--	72	55	1000 E	0.34	61	3.7	0.88	0.26 J	330
C3	47.7	47.7	ft	--	--	--	45.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D3	24.4	25.9	ft	92	8	31.2	31.0	44.0	--	645,000	63.92	--	--	<3.2	4.8	0.93	0.22 J	6.2	--	22	14	300	0.17	19	1.8	0.099 J	<0.65	74
D3	26.2	30.9	ft	93	7	23.9	23.5	32.4	--	689,000	63.45	<6.522	<1.3	0.3 J	4.7	0.99	0.22 J	6.4	<1.3	24	16	320	0.15	22	1.7	0.098 J	<0.59	80
D3	32.0	35.9	ft	17	83	43.5	44.8	79.8	--	218,000	21.39	--	--	0.92 J	17	3.6	4.9	63	--	95	73	2000 E	0.42	110	2.8	4.9	0.34 J	600
D3	36.1	40.9	ft	11	89	43.6	46.0	72.7	--	126,000	18.00	--	--	0.78 J	17	3.9	3.7	66	--	98	75	2000 E	0.44	100	3.1	3.6	0.46 J	610
D3	40.9	45.9	ft	16	84	43.0	41.5	73.3	--	228,000	23.98	--	--	0.96 J	18	3.7	2.7	48	--	100	73	1400 E	0.5	84	3.8	2.4	0.32 J	540
D3	45.9	50.9	ft	3	97	39.4	39.2	65.4	--	178,000	19.64	--	--	0.78 J	19	3.4	1.4	43	--	92	71	1200 E	0.45	70	5.4	1.3	0.37 J	390
D3	50.9	53.2	ft	6	94	42.7	41.0	68.2	--	152,000	20.45	--	--	0.66 J	15	2.8	0.98	36	--	81	62	1200 E	0.7	63	3.5	0.34 J	0.3 J	330
Transect 4																												
C4	24.9	26.4	ft	54	46	35.9	38.7	45.5	--	438,000	42.13	--	--	<3	3.7	0.37 J	<0.59	16	--	7.3	6.1	200	<0.12	13	0.059 J	<0.59	<0.59	44
C4	26.4	28.0	ft	15	85	45.1	43.9	78.7	--	75,500	17.68	--	--	0.55 J	14	2.4	2.7	37	--	57	55	1700 E	0.23	77	1.4	3	0.27 J	340
C4	28.4	31.9	ft	88	12	21.1	22.5	26.0	--	492,000	60.63	<6	<1.5	0.32 J	4.8	0.91	0.25 J	7.6	<1.3	24	15	370	0.12	24	1.7	0.13 J	<0.58	88
C4	36.4	38.0	ft	6	94	43.3	43.8	80.8	--	111,000	17.53	--	--	0.73 J	17	3.2	4.5	62	--	85	71	2000 E	0.36	100	2.7	5.3	0.31 J	550
C4	41.4	43.0	ft	7	93	44.0	43.6	77.5	--	102,000	14.79	--	--	0.58 J	15	3.3	3.7	60	--	88	66	1700 E	0.36	88	2.2	3.1	0.29 J	560
C4	44.6	48.0	ft	2	98	45.3	44.8	80.5	--	101,000	15.95	--	--	0.69 J	17	4.3	3.3	56	--	110	78	1600 E	0.56	96	3	3.3	0.32 J	660
C4	48.0	53.0	ft	4	96	39.1	37.3	68.7	--	179,000	20.13	--	--	0.58 J	19	3	1.3	41	--	87	64	1000 E	0.37	65	5.1	1.3	0.31 J	380
C4	53.4	55.5	ft	51	49	35.4	35.1	48.8	--	462,000	42.21	--	--	0.48 J	7.3	1.4	0.34 J	12	--	41	30	570	0.34	31	3.1	0.11 J	<0.64	120
C4	55.5	58.0	ft	13	87	37.0	35.8	53.0	--	233,000	23.03	--	--	0.54 J	13	2.6	0.88	36	--	71	58	1300 E	0.45	77	3.4	0.34 J	0.3 J	310
Transect 5																												
B5	24.4	25.4	ft	12	88	46.1	50.0	89.1	--	47,900	11.23	--	--	0.43 J	11	2.2	1.2	28	--	42	39	2800 E	0.16 J	78	1.2	0.61 J	0.25 J	300
B5	27.0	27.0	ft	--	--	--	38.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B5	29.4	30.4	ft	88	12	21.3	21.0	28.4	--	345,000	40.29	--	--	0.32 J	5.9	1.1	0.32 J	7.9	--	27	18	370	0.12	30	2.2	0.12 J	<0.54	110
B5	30.6	31.0	ft	--	--	--	--	--	--	--	73.88	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B5	31.0	35.4	ft	89	11	34.8	35.7	32.4	--	400,000	--	--	--	0.28 J	4.7	0.93	0.26 J	6.5	--	23	16	310	0.14	22	1.7	0.11 J	<0.5	82
B5	35.4	40.4	ft	8	92	42.6	42.6	77.7	--	130,000	17.98	<6.186	<1.8	0.73 J	16	3.3	3.4	55	<1.8	85	66	1800 E	0.36	91	2.5	3.5	0.31 J	500
B5	40.4	45.4	ft	7	93	40.8	40.2	72.5	--	105,000	15.54	--	--	0.62 J	17	4.6	3.7	67	--	110	81	2100 E	0.5	110	2.9	4.8	0.69 J	700
B5	45.4	50.4	ft	2	98	43.0	42.9	68.2	--	135,000	16.36	--	--	0.9 J	18	4.5	2.8	58	--	110	80	1500 E	0.55	87	2.8	4.5	0.36 J	620
B5	50.4	51.9	ft	3	97	37.6	39.4	64.4	--	102,000	17.94	--	--	0.45 J	14	2.6	0.83	38	--	70	55	1300 E	0.43	57	3.2	0.63	0.28 J	280
B5	51.9	54.1	ft	40	60	29.9	34.8	46.0	--	338,000	27.60	<6.522	<1.4	0.42 J	13	2	0.65	25	<1.5	62	50	1100 E	0.4	51	3.7	0.3 J	0.22 J	230
C5	22.1	26.7	ft	86	14	27.2	27.6	38.9	--	527,000	58.22	<6.122	<1.4	0.52 J	6.7	1.6	0.45 J	11	<1.4	35	50	590 E	0.28	31	2.9	0.2 J	<0.59	190
C5	29.4	31.7	ft	1	99	38.7	43.2	83.0	--	66,700	13.58	--	--	0.74 J	18	3.2	4.1	55	--	85	75	2400 E	0.36	98	2	5.9	0.36 J	550

TABLE 2
Laboratory Analytical Results - Metals, TOC, % Moisture, Grain Size
Conowingo, Maryland

Analytic Method				ASTM D422	ASTM D422	D2974-87	SM2540G	ASTM D422	SM22 2540G	SW-846 9060	ASTM D2974	SW-846 9014	9016	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 7196 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A
Units				%	%	%	%	%	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Coarse Grain	Fine Grain	Percent moisture	Percent moisture	Percent moisture	Percent moisture	Total Organic Carbon (mean)	Organic Matter	Cyanide	Cyanide, Free	Antimony	Arsenic	Beryllium	Cadmium	Chromium*	Hexavalent Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Central Maryland ATC															**4.9**			**30**				**1,400**					**1.5**	
Category 1 RSL												**23**		**3.1**	**0.68**	**16**	**7.1**	**12,000**	**0.3**	**310**	**400**	**180**	**1.1**	**150**	**39**	**39**	**0.078**	**2,300**
Category 2 RSL												**150**		**47**	**3**	**230**	**98**	**180,000**	**6.3**	**4,700**	**800**	**2,560**	**4.6**	**2,200**	**580**	**580**	**1.2**	**35,000**
Category 3 RSL Composite												**147**		**467**	**30**	**2290**	**982**	**1,750,000**	**63.3**	**46,700**	**800**	**25,600**	**46**	**22,400**	**5,840**	**5,840**	**11.7**	**350,000**
Category 3 RSL Construction												**32.6**		**136**	**142**	**618**	**277**	**509,000**	**425**	**13,600**	**800**	**5,530**	**9.49**	**5,570**	**1,700**	**1,700**	**3.39**	**102,000**
C5	34.0	36.7	ft	2	98	40.2	41.7	73.5	--	92,500	12.41	--	--	0.71 J	17	3.6	3.8	65	--	86	71	1900 E	0.38	98	2.5	3.6	0.33 J	580
C5	36.7	41.7	ft	6	94	39.6	39.5	70.9	--	143,000	19.10	<5.66	<1.7	0.59 J	16	3.2	1.9	43	<1.7	83	67	1200 E	0.42	69	3.4	1.9	0.3 J	420
C5	43.5	46.7	ft	18	82	37.1	36.7	55.1	--	202,000	23.92	--	--	0.59 J	12	2.4	0.76	30	--	69	57	1100 E	0.61	56	3.8	0.27 J	0.25 J	260
C5	49.0	49.9	ft	29	71	26.0	25.3	36.0	--	118,000	18.53	--	--	0.3 J	7.6	1.1	0.25 J	15	--	30	25	870 E	0.2	27	2	0.079 J	<0.58	100
Transect 6																												
B6	41.0	45.3	ft	88	12	26.1	25.4	36.7	--	516,000	53.03	<6.316	<1.5	0.37 J	5.1	0.98	0.3 J	6.9	<1.3	27	18	450	0.14	24	2.1	0.16 J	<0.48	93
B6	46.6	48.5	ft	8	92	42.5	43.8	76.2	--	141,000	17.44	--	--	0.47 J	15	3.4	2.7	53	--	90	66	1600 E	0.45	90	2.4	3.2	0.31 J	550
B6	48.5	50.3	ft	1	99	39.7	41.8	65.8	--	97,500	16.15	--	--	0.59 J	20	3.5	1.4	45	--	95	73	1500 E	0.41	88	4.5	1.6	0.38 J	450
C6	19.7	19.7	ft	--	--	--	48.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C6	19.7	20.1	ft	37	63	40.5	43.5	77.8	--	298,000	28.92	--	--	<4.2	9.1	1.7	0.74 J	21	--	36	28	1600 E	0.23	54	1.5	0.41 J	<0.84	200
C6	20.1	20.8	ft	2	98	48.9	50.6	92.6	--	48,500	10.00	--	--	0.48 J	12	2.4	1.2	33	--	46	37	2800 E	0.17	84	1.1	0.84	0.27 J	330
C6	21.8	23.4	ft	87	13	29.2	30.7	43.0	--	624,000	63.31	0.12	<1.5	3.5	5.9	1.6	0.4 J	11	<1.4	33	27	1100 E	0.3	35	2.3	0.23 J	<0.61	120
C6	23.4	26.1	ft	7	93	45.8	44.0	80.3	--	66,300	11.95	--	--	0.41 J	12	2.2	1.3	30	--	50	39	2600 E	0.2	82	1.5	0.81	0.24 J	320
C6	27.2	28.3	ft	83	17	30.8	30.0	49.9	--	650,000	62.87	0.1		<2.8	4.1	0.93	0.25 J	10	<1.4	34	17	630 E	0.18	23	1.5	0.13 J	<0.56	82
C6	28.3	31.1	ft	3	97	43.4	43.7	75.0	--	64,400	9.09	--	--	0.49 J	12	2.8	1.8	38	--	54	51	2500 E	0.21	80	1.2	1.4	0.45 J	320
C6	31.1	33.9	ft	7	93	41.2	42.6	73.1	--	93,500	13.10	--	--	0.78 J	17	3.1	2.4	52	--	68	66	2600 E	0.28	84	1.6	2.1	0.44 J	350
C6	33.9	35.0	ft	19	81	34.3	37.6	59.4	--	227,000	25.93	--	--	0.8 J	15	2.8	1.8	42	--	74	52	1700 E	0.35	70	3.2	1.8	0.29 J	330
C6	35.0	36.1	ft	62	38	33.4	31.6	48.2	--	475,000	44.74	0.38	--	0.51 J	7.9	2	0.8	18	<1.4	45	32	830 E	0.28	40	3.3	0.59 J	0.19 J	180
C6	36.6	38.8	ft	71	29	29.6	31.7	41.9	--	504,000	42.74	0.28	--	0.55 J	7.5	1.8	0.66	51	<1.5	43	28	810 E	0.25	41	2.9	0.53 J	0.18 J	170
C6	38.8	39.8	ft	1	99	42.3	45.5	75.2	--	59,300	10.94	--	--	0.79 J	21	4.3	4.8	74	--	110	80	3200 E	0.41	120	2.1	7.2	0.47 J	660
C6	39.8	41.1	ft	3	97	40.7	41.2	68.9	--	98,300	15.00	--	--	0.88 J	20	4.4	3.9	74	--	100	69	2200 E	0.45	110	3.3	4	0.41 J	630
C6	41.5	43.6	ft	9	91	42.4	39.3	74.9	--	143,000	13.95	--	--	0.76 J	17	4.2	3.3	76	--	96	63	2100 E	0.42	99	3.1	3.1	0.36 J	600
C6	43.6	46.1	ft	1	99	42.3	42.5	70.2	--	98,200	11.16	--	--	0.74 J	19	4.7	2.8	64	--	110	71	1700 E	0.55	100	3.2	3.1	0.4 J	630
C6	46.1	49.5	ft	4	96	39.8	37.8	63.4	--	148,000	17.91	--	--	0.88 J	18	4	0.93	51	--	94	67	1300 E	0.68	90	4.5	0.48 J	0.45 J	380
C6	49.5	51.1	ft	36	64	18.7	18.0	22.9	--	8,770	1.94	--	--	<2.2	4.2	0.74	0.095 J	17	--	11	10	170	0.043 J	18	0.35 J	<0.43	<0.43	54
C6	52.3	54.2	ft	24	76	18.0	16.9	22.0	--	2,120	1.62	--	--	<2.8	6.9	0.73	<0.56	22	--	10	12	230	<0.11	18	0.31 J	<0.56	0.18 J	58
C6	54.2	56.1	ft	24	76	18.2	16.6	21.9	--	1,650	1.97	--	--	0.25 J	19	2.2	0.13 J	39	--	10	16	1200 E	0.034 J	58	0.36 J	<0.44	0.15 J	76
Transect 7																												
B7	37.6	39.6	ft	5	95	49.3	45.0	87.4	--	84,900	10.47	--	--	0.42 J	11	2.1	0.9	31	--	41	32	1900 E	0.14 J	64	1.1	0.5 J	0.26 J	250
B7	39.6	39.6	ft	70	30	--	--	37.5	--	--	21.94	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B7	39.6	40.6	ft	4	96	44.5	47.6	82.5	--	46,600	10.19	--	--	0.5 J	15	3	1.9	45	--	66	47	2600 E	0.18	110	1.3	1.1	0.37 J	430
B7	41.0	43.3	ft	7	93	42.3	40.7	67.0	--	82,500	12.68	0.21	--	0.55 J	14	2.7	1.7	39	<1.7	62	52	2100 E	0.26	69	2.2	1.3	0.3 J	330
B7	42.0	42.0	ft	--	--	--	43.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B7	43.3	45.6	ft	4	96	45.0	37.9	69.0	--	63,200	12.00	--	--	0.88 J	20	3.9	3.2	59	--	85	75	3600 E	0.35	110	2.4	3.1	0.44 J	470
B7	47.4	48.2	ft	49	51	32.9	34.5	51.7	--	468,000	37.50	--	--	0.75 J	12	2.9	1.1	28	--	67	46	1300 E	0.39	58	4.5	0.94	0.26 J	250
B7	48.2	50.6	ft	81	19	26.3	25.9	38.6	--	600,000	47.66	0.17	<1.6	0.61 J	8.6	2.1	0.59	15	<1.4	44	31	860 E	0.28	42	3.7	0.34 J	0.19 J	160
B7	51.0	52.5	ft	74	26	34.7	32.5	47.5	--	390,000	39.66	--	--	0.73 J	9.9	2.4	1	22	--	54	37	1200 E	0.31	54	3.6	0.63	0.21 J	230
B7	52.5	54.5	ft	1	99	46.3	44.3	76.5	--	58,300	9.41	--	--	0.53 J	14	2.9	2.8	55	--	71	65	2200 E	0.23	77	1.6	4.1	0.48 J	440
B7	54.5	55.6	ft	4	96	40.8	44.3	75.3	--	101,000	15.03	--	--	0.77 J	19	3.9	4	75	--	98	74	2300 E	0.4	110	3.3	5.2	0.41 J	630

TABLE 2
Laboratory Analytical Results - Metals, TOC, % Moisture, Grain Size
Conowingo, Maryland

Analytic Method				ASTM D422	ASTM D422	D2974-87	SM2540G	ASTM D422	SM22 2540G	SW-846 9060	ASTM D2974	SW-846 9014	9016	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 7196 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A
Units				%	%	%	%	%	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Coarse Grain	Fine Grain	Percent moisture	Percent moisture	Percent moisture	Percent moisture	Total Organic Carbon (mean)	Organic Matter	Cyanide	Cyanide, Free	Antimony	Arsenic	Beryllium	Cadmium	Chromium*	Hexavalent Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Central Maryland ATC															**4.9**			**30**				**1,400**					**1.5**	
Category 1 RSL												**23**		**3.1**	**0.68**	**16**	**7.1**	**12,000**	**0.3**	**310**	**400**	**180**	**1.1**	**150**	**39**	**39**	**0.078**	**2,300**
Category 2 RSL												**150**		**47**	**3**	**230**	**98**	**180,000**	**6.3**	**4,700**	**800**	**2,560**	**4.6**	**2,200**	**580**	**580**	**1.2**	**35,000**
Category 3 RSL Composite												**147**		**467**	**30**	**2290**	**982**	**1,750,000**	**63.3**	**46,700**	**800**	**25,600**	**46**	**22,400**	**5,840**	**5,840**	**11.7**	**350,000**
Category 3 RSL Construction												**32.6**		**136**	**142**	**618**	**277**	**509,000**	**425**	**13,600**	**800**	**5,530**	**9.49**	**5,570**	**1,700**	**1,700**	**3.39**	**102,000**
B7	55.6	58.1	ft	8	92	44.5	44.5	78.0	--	164,000	15.50	--	--	0.76 J	16	3.4	3.2	76	--	80	62	2000 E	0.33	96	2.9	4	0.34 J	510
B7	58.1	60.6	ft	4	96	43.3	42.7	74.4	--	87,300	12.96	0.37	--	0.76 J	18	4.6	3.6	70	<1.7	100	79	2100 E	0.45	110	3.2	4	0.4 J	690
B7	60.6	63.1	ft	6	94	42.8	44.1	76.9	--	106,000	11.89	--	--	0.63 J	16	4	2.5	80	--	89	65	1400 E	0.46	86	2.9	3.2	0.37 J	590
B7	63.1	65.6	ft	2	98	43.0	43.5	67.1	--	108,000	15.45	--	--	0.74 J	20	4	1.6	50	--	92	70	1400 E	0.44	83	4.9	1.8	0.44 J	460
B7	65.6	66.7	ft	1	99	43.7	38.2	63.4	--	109,000	17.00	--	--	0.6 J	17	3.3	1	43	--	72	59	1200 E	0.33	62	4.4	0.85	0.4 J	330
B7	66.7	68.1	ft	2	98	39.2	39.3	63.7	--	119,000	15.53	--	--	0.59 J	16	3.1	0.99	40	--	74	58	1900 E	0.4	73	3.8	0.5 J	0.36 J	350
C7	29.3	30.0	ft	1	99	58.7	53.5	124.4	--	45,900	7.63	--	--	<3.6	12	2	0.73	30	--	41	36	2100 E	0.12 J	62	0.87	0.35 J	0.25 J	240
C7	30.0	30.8	ft	78	22	27.1	24.7	38.2	--	410,000	22.11	--	--	<3	4.7	1	0.28 J	7.7	--	24	16	550	0.13	26	1.4	0.11 J	<0.59	86
C7	33.9	35.8	ft	5	95	44.5	45.3	74.7	--	64,500	9.84	--	--	0.42 J	13	2	0.91	32	--	43	39	2100 E	0.15	67	0.91	0.63 J	0.24 J	270
C7	36.5	37.3	ft	87	13	27.7	29.4	38.8	--	594,000	62.88	--	--	<3	4.1	0.96	0.24 J	7.8	--	24	19	620 E	0.18	24	2	0.14 J	<0.6	83
C7	37.3	38.7	ft	82	18	25.4	25.7	29.5	--	403,000	21.78	--	--	<2.9	3.8	0.81	0.25 J	9.9	--	22	19	700 E	0.12	28	1.6	0.11 J	<0.58	97
C7	38.7	40.8	ft	3	97	42.5	41.5	79.4	--	57,300	10.30	--	--	0.38 J	12	2.1	1.3	32	--	50	46	2700 E	0.18	83	1.3	1	0.27 J	320
C7	41.7	43.4	ft	88	12	25.6	25.3	35.1	--	610,000	60.00	0.089	<1.3	<2.9	3.8	0.88	0.22 J	17	<1.4	21	15	540	0.17	22	1.6	0.12 J	<0.58	130
C7	43.4	45.8	ft	2	98	38.1	42.3	68.2	--	55,800	9.32	--	--	0.54 J	16	2.9	2.1	43	--	66	66	2900 E	0.28	90	1.6	2	0.32 J	380
C7	46.3	47.0	ft	4	96	37.0	38.6	64.4	--	98,500	12.72	--	--	0.46 J	15	2.4	2.1	41	--	62	59	2600 E	0.26	75	2.1	2.1	0.28 J	340
C7	47.0	50.8	ft	5	95	--	--	63.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C7	53.2	55.3	ft	68	32	33.4	31.1	49.6	--	467,000	45.21	0.53	--	0.46 J	7.5	1.5	0.66	15	<1.5	42	30	830 E	0.26	39	2.9	0.56 J	<0.62	160
C7	55.8	58.3	ft	11	89	43.8	42.7	79.0	--	112,000	20.67	--	--	0.66 J	17	3	3.1	56	--	89	70	2200 E	0.37	93	2.6	4.3	0.32 J	520
C7	58.3	60.8	ft	3	97	40.3	41.9	78.0	--	155,000	13.95	--	--	0.67 J	17	3.6	2.9	56	--	91	69	2100 E	0.37	110	2.8	3.3	0.3 J	580
C7	60.8	65.8	ft	2	98	43.0	43.5	80.8	--	106,000	15.94	--	--	0.73 J	17	4.1	2.7	63	--	97	71	1600 E	0.52	110	2.6	3.4	0.35 J	610
C7	61.8	65.8	ft	1	99	--	--	74.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C7	65.8	68.8	ft	1	99	36.2	38.3	63.5	--	131,000	16.92	--	--	0.62 J	19	3.7	1.2	52	--	100	68	1400 E	0.56	75	5.1	0.91	0.48 J	400
C7	67.0	67.0	ft	--	--	--	37.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C7	68.8	70.8	ft	16	84	32.0	31.4	46.3	--	215,000	21.05	0.25	--	0.57 J	16	2.8	0.82	38	<1.4	80	57	1300 E	0.56	60	4.1	0.36 J	0.32 J	300
C7	70.8	71.9	ft	0	100	38.9	39.1	65.6	--	82,000	13.53	--	--	0.61 J	20	3.8	0.91	46	--	110	80	1700 E	0.81	100	4.5	0.55 J	0.4 J	460
C7	71.9	72.3	ft	93	7	--	--	36.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Transect 8																												
A8	41.2	42.3	ft	1	99	54.8	52.1	115.3	--	40,300	7.84	--	--	<5	12	2.2	0.91 J	35	--	42	36	1800 E	0.15 J	61	1.2	0.5 J	0.28 J	250
A8	45.2	47.3	ft	3	97	52.1	53.3	110.8	--	47,600	8.59	--	--	<4.3	11	2.3	1	33	--	40	36	2100 E	0.14 J	64	1.1	0.45 J	0.27 J	260
A8	50.5	52.3	ft	3	97	48.0	47.9	92.1	--	47,400	9.09	--	--	0.47 J	13	2.7	1.1	36	--	46	40	2500 E	0.17	78	1.3	0.64 J	0.3 J	320
A8	53.1	57.3	ft	6	94	50.3	49.6	95.9	--	61,200	11.01	--	--	0.51 J	13	3.2	1.5	37	--	53	46	3000 E	0.2	100	1.4	1	0.32 J	400
A8	57.8	62.3	ft	2	98	45.9	50.4	86.2	--	51,900	9.41	0.24	<2	0.56 J	14	3	2	46	<2	63	63	2200 E	0.21	84	1.5	1.5	0.38 J	370
A8	62.3	62.3	ft	--	--	--	43.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
A8	62.9	67.3	ft	2	98	45.6	42.8	82.0	--	70,000	8.74	--	--	0.81 J	16	3.6	2.9	59	--	78	63	2000 E	0.33	91	2.7	3.3	0.35 J	500
A8	67.3	72.3	ft	1	99	44.6	41.6	76.9	--	77,000	12.33	--	--	0.75 J	19	3.6	1.3	51	--	84	65	1200 E	0.37	81	4.1	0.99	0.39 J	420
A8	72.3	74.8	ft	5	95	41.9	40.8	66.0	--	108,000	18.68	--	--	0.82 J	19	3.8	1.1	62	--	90	72	1700 E	0.51	83	3.9	0.56 J	0.43 J	400
B8	63.7	66.7	ft	3	97	48.1	46.1	87.6	--	78,600	13.41	--	--	0.57 J	15	3.1	1.7	43	--	70	60	1900 E	0.36	73	2.9	1.5	0.34 J	370
B8	66.7	66.7	ft	--	--	--	16.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B8	66.7	67.2	ft	83	17	21.2	16.9	18.8	--	5,870	--	--	--	<2.4	2.2	0.41 J	0.082 J	6.8	--	6.5	5.9	280	<0.098	13	0.14 J	<0.49	<0.49	45

TABLE 2
Laboratory Analytical Results - Metals, TOC, % Moisture, Grain Size
Conowingo, Maryland

Analytic Method				ASTM D422	ASTM D422	D2974-87	SM2540G	ASTM D422	SM22 2540G	SW-846 9060	ASTM D2974	SW-846 9014	9016	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 7196 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A	SW-846 6020 A
Units				%	%	%	%	%	%	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Coarse Grain	Fine Grain	Percent moisture	Percent moisture	Percent moisture	Percent moisture	Total Organic Carbon (mean)	Organic Matter	Cyanide	Cyanide, Free	Antimony	Arsenic	Beryllium	Cadmium	Chromium*	Hexavalent Chromium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Central Maryland ATC															**4.9**			**30**				**1,400**					**1.5**	
Category 1 RSL												**23**		**3.1**	**0.68**	**16**	**7.1**	**12,000**	**0.3**	**310**	**400**	**180**	**1.1**	**150**	**39**	**39**	**0.078**	**2,300**
Category 2 RSL												**150**		**47**	**3**	**230**	**98**	**180,000**	**6.3**	**4,700**	**800**	**2,560**	**4.6**	**2,200**	**580**	**580**	**1.2**	**35,000**
Category 3 RSL Composite												**147**		**467**	**30**	**2290**	**982**	**1,750,000**	**63.3**	**46,700**	**800**	**25,600**	**46**	**22,400**	**5,840**	**5,840**	**11.7**	**350,000**
Category 3 RSL Construction												**32.6**		**136**	**142**	**618**	**277**	**509,000**	**425**	**13,600**	**800**	**5,530**	**9.49**	**5,570**	**1,700**	**1,700**	**3.39**	**102,000**
B8	67.2	68.7	ft	68	32	12.8	12.4	14.8	--	1,330	1.11	<0.065	<1.2	<2	3.4	0.31 J	<0.41	11	<1.1	6.5	5.7	200	<0.082	9.8	0.18 J	<0.41	<0.41	29
B8	69.6	71.2	ft	--	--	12.6	14.1	--	--	1,500	1.64	--	--	<2.4	2.9	0.38 J	<0.48	11	--	6	5.3	220	<0.096	12	0.08 J	<0.48	<0.48	32
B8A	58.8	60.0	ft	2	98	54.8	55.1	110.8	--	37,400	8.67	--	--	<4.6	13	2.8	1.2	38	--	49	42	2500 E	0.17 J	81	1.2	0.81 J	0.44 J	330
B8A	68.7	70.0	ft	77	23	28.4	26.1	39.8	--	428,000	40.46	0.21	--	0.48 J	6.5	1.8	0.53	15	<1.4	37	27	810 E	0.23	35	2.5	0.48 J	0.17 J	150
B8A	71.9	75.0	ft	7	93	47.1	45.5	94.5	--	83,500	13.66	0.36	--	0.6 J	16	4	3	62	<1.9	83	64	1900 E	0.34	93	2.6	3.9	0.33 J	550
B8A	75.3	80.0	ft	1	99	41.7	43.1	67.9	--	117,000	13.64	0.43	--	0.66 J	19	4.4	1.7	60	<1.7	94	71	1400 E	0.45	79	4.3	1.7	0.4 J	470
B8A	81.1	82.4	ft	51	49	36.3	35.7	58.2	--	423,000	35.76	0.24	--	0.64 J	11	2.3	0.73	23	<1.5	55	41	800 E	0.42	48	4.6	0.2 J	0.23 J	210
B8A	81.5	81.5	ft	--	--	--	43.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C8	48.6	49.7	ft	5	95	55.6	56.4	100.6	--	45,200	8.90	0.21	--	<4.3	14	2.3	0.66 J	38	<2.3	40	33	2100 E	0.11 J	62	0.96	0.26 J	0.26 J	230
C8	61.6	65.6	ft	5	95	45.5	46.1	93.5	--	73,100	11.02	0.18	--	0.37 J	14	2.9	1.5	38	<1.8	53	45	2500 E	0.19	89	1.4	1.1	0.28 J	360
C8	65.6	70.6	ft	5	95	45.4	42.2	81.1	--	60,300	10.63	0.25	--	0.47 J	13	2.8	1.6	44	<1.7	60	56	1800 E	0.2	78	1.5	1.4	0.33 J	320
C8	72.7	75.0	ft	62	38	38.0	35.5	58.8	--	579,000	41.18	0.36	<2.1	0.77 J	12	3	1.5	31	<1.6	60	55	1300 E	0.34	59	3.4	1.6	0.26 J	300
C8	76.2	76.2	ft	--	--	--	52.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D8	47.2	49.0	ft	--	--	47.0	47.1	--	--	129,000	15.28	0.22	--	0.43 J	11	2.5	1.1	31	<1.9	47	43	1800 E	0.24	65	1.9	0.67 J	0.24 J	270
D8	48.0	48.0	ft	--	--	--	44.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D8	55.0	59.0	ft	3	97	47.7	50.2	102.1	--	74,200	10.88	0.2	--	0.52 J	14	2.9	1.5	39	<2	54	46	2700 E	0.19	89	1.8	1.1	0.29 J	360
D8	60.6	64.0	ft	1	99	48.8	47.8	96.1	--	50,300	10.04	0.26	<2	0.57 J	16	3.4	2	51	<1.9	69	66	2500 E	0.23	90	2	1.7	0.38 J	390
D8	64.0	69.0	ft	8	92	42.3	43.8	80.2	--	79,500	13.20	--	--	0.61 J	18	4.1	2.8	65	--	84	68	2200 E	0.34	96	2.9	3.1	0.38 J	490
D8	69.0	74.0	ft	1	99	43.6	44.2	74.3	--	112,000	15.45	--	--	0.67 J	19	4.8	2.3	64	--	98	73	1500 E	0.41	94	4.2	2.4	0.39 J	570
D8	75.5	79.0	ft	3	97	41.4	39.9	69.6	--	161,000	20.20	0.45	--	0.85 J	19	4.3	1.1	47	<1.7	100	72	1500 E	0.72	77	5.2	0.48 J	0.38 J	400
Stockpile Samples																												
STOCKPILE QUADRANT 1	NA	NA	NA	78	22	--	--	--	22.2	240,000	15.9	0.17 J	0.69 J B	0.25	4.7	0.86	0.34	8.3 B	--	21	17	450	0.051	29	1.0	0.17	0.12	93
STOCKPILE QUADRANT 2	NA	NA	NA	72	28	--	--	--	26.1	130,000	13.8	<0.26	0.86 J B	0.24	4.7	0.84	0.40	10 B	--	19	17	490	0.028	37	0.88	0.19	0.13	95
STOCKPILE QUADRANT 3	NA	NA	NA	73	27	--	--	--	21.1	270,000	20.7	0.22 J	0.68 J B	0.24	4.8	0.89	0.42	9.4 B	--	21	19	500	0.039	30	0.94	0.20	0.12	99
STOCKPILE QUADRANT 4	NA	NA	NA	73	27	--	--	--	26.6	220,000	13.2	0.18 J	0.59 J B	0.25	5.0	0.89	0.40	9.7 B	--	20	19	510	0.035	33	0.91	0.19	0.12	100
STOCKPILE QUADRANTS 1-4	NA	NA	NA	--	--	--	--	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Analyte concentration exceeds the standard for:		Source:	Abbreviations:
🟧	Central Maryland Anticipated Typical Concentration	2008	% - percent
🟨	Maryland Dredging Category 1 RSL	November 2020	mg/kg - milligrams per kilogram
🟩	Maryland Dredging Category 2 RSL	November 2020	ft - feet
🟦	Maryland Dredging Category 3 RSL Composite	December 2019	-- not analyzed
🟦	Maryland Dredging Category 3 RSL Construction	December 2019	NA - not applicable

Notes:

E - the data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.

J - the analyte was positively identified below the reporting limit but greater than the method detection limit.

B - Parameter was found in the lab blank and sample

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc

Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA

* - screening levels for chromium based on chromium III

Stockpile metals parameters analyzed by analytical method SW-846 6020B, mercury analyzed by SW-846 7471B

Stockpile samples not analyzed for hexavalent chromium based on past analytical data and approval from MDE.

TABLE 3
Laboratory Analytical Results - VOCs
Conowingo, Maryland

Lab Name				PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE
Analytic Method				**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**	**SW-846 8260 B**
Units				**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
Parameter	**Depth (Top)**	**Depth (Bottom)**	**Depth Units**	**1,1,1-Trichloroethane**	**1,1,2,2-Tetrachloroethane**	**1,1,2-Trichloroethane**	**1,1,2-Trichlorotrifluoroethane**	**1,1-Dichloroethane**	**1,1-Dichloroethene**	**1,2,3-Trichlorobenzene**	**1,2,4-Trichlorobenzene**	**1,2,4-Trimethylbenzene**	**1,2-Dibromo-3-chloropropane**
Category 1 RSL				**810,000**	**600**	**150**	**670,000**	**3,600**	**23,000**	**6,300**	**5,800**	**30,000**	**5**
Category 2 RSL				**3,600,000**	**2,700**	**630**	**2,800,000**	**16,000**	**100,000**	**93,000**	**26,000**	**180,000**	**64**
Category 3 RSL Composite				**35,600,000**	**26,700**	**6,310**	**28,100,000**	**155,000**	**995,000**	**934,000**	**256,000**	**1,770,000**	**643**
Category 3 RSL Construction				**7,430,000**	**152,000**	**1,310**	**5,860,000**	**849,000**	**208,000**	**272,000**	**53,700**	**384,000**	**3,510**
Transect 3													
C3	47.7	47.7	ft	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Transect 5													
B5	27.0	27.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Transect 6													
C6	19.7	19.7	ft	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1
Transect 7													
B7	42.0	42.0	ft	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
C7	67.0	67.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Transect 8													
A8	62.3	62.3	ft	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
B8	66.7	66.7	ft	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94
B8A	81.5	81.5	ft	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
C8	76.2	76.2	ft	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
D8	48.0	48.0	ft	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

TABLE 3
Laboratory Analytical Results - VOCs
Conowingo, Maryland

Lab Name				PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE
Analytic Method				SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	2-Butanone	2-Hexanone	4-Methyl-2-pentanone	Acetone	Benzene
Category 1 RSL				180,000	460	1,600	27,000		2,600	2,700,000	20,000	3,300,000	6,100,000	1,200
Category 2 RSL				930,000	2,000	6,600	150,000		11,000	19,000,000	130,000	14,000,000	67,000,000	5,100
Category 3 RSL Composite				9,330,000	20,400	12,400	1,510,000		114,000	193,000,000	1,340,000	139,000,000	670,000,000	50,800
Category 3 RSL Construction				1,990,000	28,800	13,800	327,000		623,000	43,700,000	299,000	28,900,000	170,000,000	90,200
Transect 3														
C3	47.7	47.7	ft	<2	<2	<2	<2	<2	<2	<9.9	<2	<2	<40	<2
Transect 5														
B5	27.0	27.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1	<1.6	<1.6	**51**	<1.6
Transect 6														
C6	19.7	19.7	ft	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<11	<2.1	<2.1	**51**	<2.1
Transect 7														
B7	42.0	42.0	ft	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<9.4	<1.9	<1.9	**63**	<1.9
C7	67.0	67.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1	<1.6	<1.6	**36**	<1.6
Transect 8														
A8	62.3	62.3	ft	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<9.2	<1.8	<1.8	**83**	<1.8
B8	66.7	66.7	ft	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<4.7	<0.94	<0.94	<19	<0.94
B8A	81.5	81.5	ft	<2	<2	<2	<2	<2	<2	<9.8	<2	<2	<39	<2
C8	76.2	76.2	ft	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<12	<2.4	<2.4	**170**	<2.4
D8	48.0	48.0	ft	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<11	<2.2	<2.2	**170**	<2.2

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

TABLE 3
Laboratory Analytical Results - VOCs
Conowingo, Maryland

Lab Name				PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE
Analytic Method				SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Bromochloromethane	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	cis-1,2-Dichloroethene
Category 1 RSL				15,000	290	19,000	680	77,000	650	28,000	1,400,000	320	11,000	16,000
Category 2 RSL				63,000	1,300	86,000	3,000	350,000	2,900	130,000	5,700,000	1,400	46,000	230,000
Category 3 RSL Composite				628,000	12,800	857,000	30,100	3,470,000	28,700	1,330,000	56,700,000	13,800	463,000	2,340,000
Category 3 RSL Construction				131,000	70,000	4,940,000	6,280	728,000	124,000	282,000	11,800,000	75,300	96,400	679,000
Transect 3														
C3	47.7	47.7	ft	<2	<2	<2	<2	<2	<2	<2	<2	<9.9	<2	<2
Transect 5														
B5	27.0	27.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1	<1.6	<1.6
Transect 6														
C6	19.7	19.7	ft	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<11	<2.1	<2.1
Transect 7														
B7	42.0	42.0	ft	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<9.4	<1.9	<1.9
C7	67.0	67.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1	<1.6	<1.6
Transect 8														
A8	62.3	62.3	ft	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<9.2	<1.8	<1.8
B8	66.7	66.7	ft	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<4.7	<0.94	<0.94
B8A	81.5	81.5	ft	<2	<2	<2	<2	<2	<2	<2	<2	<9.8	<2	<2
C8	76.2	76.2	ft	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<12	<2.4	<2.4
D8	48.0	48.0	ft	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<11	<2.2	<2.2

Analyte concentration exceeds the standard for:	**Source:**
🟨 Maryland Dredging Category 1 RSL	November 2020
🟩 Maryland Dredging Category 2 RSL	November 2020
🟦 Maryland Dredging Category 3 RSL Composite	December 2019
🟦 Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

TABLE 3
Laboratory Analytical Results - VOCs
Conowingo, Maryland

Lab Name				PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE
Analytic Method				SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	cis-1,3-Dichloropropene	Cyclohexane	Cyclohexane, Methyl-	Dibromo-chloromethane	Dichloro-difluoromethane	Ethylbenzene	Ethylene dibromide	Isopropylbenzene	m,p-Xylene	Methyl Acetate
Category 1 RSL					**650,000**		**8,300**	**8,700**	**5,800**	**36**	**190,000**		**7,800,000**
Category 2 RSL					**2,700,000**		**39,000**	**37,000**	**25,000**	**160**	**990,000**		**120,000,000**
Category 3 RSL Composite					**27,400,000**		**389,000**	**368,000**	**254,000**	**1,590**	**9,950,000**		**1,170,000,000**
Category 3 RSL Construction					**5,700,000**		**2,950,000**	**76,500**	**1,410,000**	**8,890**	**2,120,000**		**339,000,000**
Transect 3													
C3	47.7	47.7	ft	<2	<2	<2	<2	<2	<2	<2	<2	<4	<49
Transect 5													
B5	27.0	27.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<3.2	<40
Transect 6													
C6	19.7	19.7	ft	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<4.3	<54
Transect 7													
B7	42.0	42.0	ft	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<3.7	<47
C7	67.0	67.0	ft	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<3.2	<41
Transect 8													
A8	62.3	62.3	ft	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<3.7	<46
B8	66.7	66.7	ft	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<1.9	<24
B8A	81.5	81.5	ft	<2	<2	<2	<2	<2	<2	<2	<2	<3.9	<49
C8	76.2	76.2	ft	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<4.7	<59
D8	48.0	48.0	ft	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<4.4	<55

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

TABLE 3
Laboratory Analytical Results - VOCs
Conowingo, Maryland

Lab Name				PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE	PHASE
Analytic Method				SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B	SW-846 8260 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Methylene chloride	MTBE	o-Xylene	Styrene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene	Trichloro-fluoromethane	Vinylchloride
Category 1 RSL				**35,000**	**47,000**	**65,000**	**600,000**	**8,100**	**490,000**	**7,000**		**410**	**2,300,000**	**59**
Category 2 RSL				**320,000**	**210,000**	**280,000**	**3,500,000**	**39,000**	**4,700,000**	**30,000**		**1,900**	**35,000,000**	**1,700**
Category 3 RSL Composite				**3,160,000**	**2,050,000**	**2,790,000**	**34,800,000**	**389,000**	**46,800,000**	**23,400,000**		**18,700**	**350,000,000**	**16,800**
Category 3 RSL Construction				**754,000**	**11,500,000**	**583,000**	**7,570,000**	**82,100**	**11,400,000**	**6,790,000**		**3,930**	**656,000**	**80,200**
Transect 3														
C3	47.7	47.7	ft	<9.9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<9.9
Transect 5														
B5	27.0	27.0	ft	<8.1	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1
Transect 6														
C6	19.7	19.7	ft	<11	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<2.1	<11
Transect 7														
B7	42.0	42.0	ft	<9.4	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<9.4
C7	67.0	67.0	ft	<8.1	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<8.1
Transect 8														
A8	62.3	62.3	ft	<9.2	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<9.2
B8	66.7	66.7	ft	<4.7	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<0.94	<4.7
B8A	81.5	81.5	ft	<9.8	<2	<2	<2	<2	<2	<2	<2	<2	<2	<9.8
C8	76.2	76.2	ft	<12	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<12
D8	48.0	48.0	ft	<11	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<11

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

TABLE 4
Laboratory Analytical Results - SVOCs
Conowingo, Maryland

Analytic Method				SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Biphenyl, 1,1'-	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	2,4-Dichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2,4-Dinitrotoluene	2,6-Dinitrotoluene	2-Chloronaphthalene	2-Chlorophenol	2-Methylnaphthalene	2-Methylphenol	2-Nitroaniline	2-Nitrophenol	3&4-Methylphenol
Category 1 RSL				4,700	630,000	6,300	19,000	130,000	13,000	1,700	360	480,000	39,000	24,000	320,000	63,000		
Category 2 RSL				20,000	8,200,000	82,000	250,000	1,600,000	160,000	7,400	1,500	6,000,000	580,000	300,000	4,100,000	800,000		
Category 3 RSL Composite				200,000	82,100,000	821,000	2,460,000	16,400,000	1,640,000	73,700	15,400	60,300,000	5,840,000	3,010,000	41,000,000	7,990,000		
Category 3 RSL Construction				41,500	25,700,000	257,000	771,000	5,140,000	514,000	60,000	77,300	19,200,000	1,700,000	958,000	12,800,000	2,240,000		
Transect 3																		
C3	30.6	35.5	ft	<43	<43	<43	<43	<43	<210	<86	<86	<43	<43	<11	<43	<86	<43	<43
D3	26.2	30.9	ft	<43	<43	<43	<43	<43	<220	<87	<87	<43	<43	**14**	<43	<87	<43	<43
Transect 4																		
C4	28.4	31.9	ft	<43	<43	<43	<43	<43	<220	<86	<86	<43	<43	<11	<43	<86	<43	<43
Transect 5																		
B5	35.4	40.4	ft	<58	<58	<58	<58	<58	<290	<120	<120	<58	<58	<15	<58	<120	<58	<58
B5	51.9	54.1	ft	<51	<51	<51	<51	<51	<260	<100	<100	<51	<51	<13	<51	<100	<51	<51
C5	22.1	26.7	ft	<46	<46	<46	<46	<46	<230	<92	<92	<46	<46	**16**	<46	<92	<46	<46
C5	36.7	41.7	ft	<55	<55	<55	<55	<55	<270	<110	<110	<55	<55	<14	<55	<110	<55	<55
Transect 6																		
B6	41.0	45.3	ft	<45	<45	<45	<45	<45	<220	<90	<90	<45	<45	**34**	<45	<90	<45	<45
C6	21.8	23.4	ft	<48	<48	<48	<48	<48	<240	<96	<96	<48	<48	**34**	<48	<96	<48	<48
C6	27.2	28.3	ft	<47	<47	<47	<47	<47	<240	<94	<94	<47	<47	**52**	<47	<94	<47	<47
C6	35.0	36.1	ft	<49	<49	<49	<49	<49	<240	<98	<98	<49	<49	**27**	<49	<98	<49	<49
C6	36.6	38.8	ft	<48	<48	<48	<48	<48	<240	<97	<97	<48	<48	**23**	<48	<97	<48	<48
Transect 7																		
B7	41.0	43.3	ft	<56	<56	<56	<56	<56	<280	<110	<110	<56	<56	<14	<56	<110	<56	<56
B7	48.2	50.6	ft	<45	<45	<45	<45	<45	<230	<90	<90	<45	<45	**32**	<45	<90	<45	<45
B7	58.1	60.6	ft	<58	<58	<58	<58	<58	<290	<120	<120	<58	<58	<15	<58	<120	<58	<58
C7	41.7	43.4	ft	<44	<44	<44	<44	<44	<220	<89	<89	<44	<44	**36**	<44	<89	<44	<44
C7	53.2	55.3	ft	<49	<49	<49	<49	<49	<240	<97	<97	<49	<49	**47**	<49	<97	<49	<49
C7	68.8	70.8	ft	<49	<49	<49	<49	<49	<240	<97	<97	<49	<49	**23**	<49	<97	<49	<49
Transect 8																		
A8	57.8	62.3	ft	<67	<67	<67	<67	<67	<330	<130	<130	<67	<67	<17	<67	<130	<67	<67
B8	67.2	68.7	ft	<38	<38	<38	<38	<38	<190	<76	<76	<38	<38	<9.5	<38	<76	<38	<38
B8A	68.7	70.0	ft	<45	<45	<45	<45	<45	<220	<90	<90	<45	<45	**28**	<45	<90	<45	<45
B8A	71.9	75.0	ft	<61	<61	<61	<61	<61	<300	<120	<120	<61	<61	<15	<61	<120	<61	<61
B8A	75.3	80.0	ft	<59	<59	<59	<59	<59	<290	<120	<120	<59	<59	<15	<59	<120	<59	<59
B8A	81.1	82.4	ft	<51	<51	<51	<51	<51	<260	<100	<100	<51	<51	**21**	<51	<100	<51	<51
C8	48.6	49.7	ft	<76	<76	<76	<76	<76	<380	<150	<150	<76	<76	<19	<76	<150	<76	<76
C8	61.6	65.6	ft	<62	<62	<62	<62	<62	<310	<120	<120	<62	<62	<15	<62	<120	<62	<62
C8	65.6	70.6	ft	<57	<57	<57	<57	<57	<290	<110	<110	<57	<57	<14	<57	<110	<57	<57
C8	72.7	75.0	ft	<52	<52	<52	<52	<52	<260	<100	<100	<52	<52	<13	<52	<100	<52	<52
D8	47.2	49.0	ft	<63	<63	<63	<63	<63	<320	<130	<130	<63	<63	<16	<63	<130	<63	<63
D8	55.0	59.0	ft	<66	<66	<66	<66	<66	<330	<130	<130	<66	<66	<17	<66	<130	<66	<66
D8	60.6	64.0	ft	<64	<64	<64	<64	<64	<320	<130	<130	<64	<64	<16	<64	<130	<64	<64
D8	75.5	79.0	ft	<56	<56	<56	<56	<56	<280	<110	<110	<56	<56	<14	<56	<110	<56	<56
STOCKPILE QUADRANT 1	NA	NA	NA	**20 J**	<42	<42	<8.6	<42	<420	<42	<42	<8.6	<42	**79**	<42	<220	<42	**33 J**
STOCKPILE QUADRANT 2	NA	NA	NA	<67	<67	<67	<14	<67	<670	<67	<67	<14	<67	**49**	<67	<340	<67	**34 J**
STOCKPILE QUADRANT 3	NA	NA	NA	**23 J**	<62	<62	<13	<62	<620	<62	<62	<13	<62	**91**	<62	<320	<62	**34 J**
STOCKPILE QUADRANT 4	NA	NA	NA	<67	<67	<67	<14	<67	<670	<67	<67	<14	<67	**73**	<67	<350	<67	**44 J**

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram
ft - feet
-- not analyzed
A - not applicable

Notes:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8270E LL

TABLE 4
Laboratory Analytical Results - SVOCs
Conowingo, Maryland

Analytic Method				SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	3,3'-Dichlorobenzidine	3-Nitroaniline	4,6-Dinitro-2-methylphenol	4-Bromophenyl-phenylether	4-Chloro-3-methylphenol	4-Chloroaniline	4-Chlorophenyl-phenylether	4-Nitroaniline	4-Nitrophenol	Acenaphthene	Acenaphthylene	Acetophenone	Anthracene	Benzo(a) anthracene	Benzo(a)pyrene
Category 1 RSL				1,200		510		6,300,000	2,700		25,000		360,000		780,000	1,800,000	1,100	110
Category 2 RSL				5,100		6,600		82,000,000	11,000		110,000		4,500,000		12,000,000	23,000,000	21,000	2,100
Category 3 RSL Composite				51,100		65,700		82,100,000	115,000		1,150,000		45,200,000		117,000,000	226,000,000	206,000	21,100
Category 3 RSL Construction				417,000		20,600		25,700,000	938,000		1,030,000		14,400,000		33,900,000	71,900,000	1,690,000	65,100
Transect 3																		
C3	30.6	35.5	ft	<43	<86	<210	<43	<43	<43	<43	<86	<210	15	<11	<43	43	83	62
D3	26.2	30.9	ft	<43	<87	<220	<43	<43	<43	<43	<87	<220	<11	22	<43	30	91	88
Transect 4																		
C4	28.4	31.9	ft	<43	<86	<220	<43	<43	<43	<43	<86	<220	<11	16	<43	35	85	68
Transect 5																		
B5	35.4	40.4	ft	<58	<120	<290	<58	<58	<58	<58	<120	<290	<15	<15	<58	<15	23	23
B5	51.9	54.1	ft	<51	<100	<260	<51	<51	<51	<51	<100	<260	<13	25	<51	<13	29	38
C5	22.1	26.7	ft	<46	<92	<230	<46	<46	<46	<46	<92	<230	<11	18	<46	41	95	84
C5	36.7	41.7	ft	<55	<110	<270	<55	<55	<55	<55	<110	<270	<14	<14	<55	<14	15	14 J
Transect 6																		
B6	41.0	45.3	ft	<45	<90	<220	<45	<45	<45	<45	<90	<220	<11	24	<45	35	84	76
C6	21.8	23.4	ft	<48	<96	<240	<48	<48	<48	<48	<96	<240	13	47	<48	94	250	210
C6	27.2	28.3	ft	<47	<94	<240	<47	<47	<47	<47	<94	<240	41	140	<47	450	1100	1000
C6	35.0	36.1	ft	<49	<98	<240	<49	<49	<49	<49	<98	<240	<12	55	<49	47	160	180
C6	36.6	38.8	ft	<48	<97	<240	<48	<48	<48	<48	<97	<240	<12	38	<48	60	150	150
Transect 7																		
B7	41.0	43.3	ft	<56	<110	<280	<56	<56	<56	<56	<110	<280	<14	<14	<56	<14	<14	<14
B7	48.2	50.6	ft	<45	<90	<230	<45	<45	<45	<45	<90	<230	<11	33	<45	56	150	150
B7	58.1	60.6	ft	<58	<120	<290	<58	<58	<58	<58	<120	<290	<15	<15	<58	<15	20	18
C7	41.7	43.4	ft	<44	<89	<220	<44	<44	<44	<44	<89	<220	24	86	<44	180	370	310
C7	53.2	55.3	ft	<49	<97	<240	<49	<49	<49	<49	<97	<240	<12	100	<49	90	300	330
C7	68.8	70.8	ft	<49	<97	<240	<49	<49	<49	<49	<97	<240	<12	20	<49	14	49	55
Transect 8																		
A8	57.8	62.3	ft	<67	<130	<330	<67	<67	<67	<67	<130	<330	<17	<17	<67	<17	<17	<17
B8	67.2	68.7	ft	<38	<76	<190	<38	<38	<38	<38	<76	<190	<9.5	<9.5	<38	<9.5	<9.5	<9.5
B8A	68.7	70.0	ft	<45	<90	<220	<45	<45	<45	<45	<90	<220	<11	90	<45	110	1200	400
B8A	71.9	75.0	ft	<61	<120	<300	<61	<61	<61	<61	<120	<300	<15	<15	<61	<15	24	30
B8A	75.3	80.0	ft	<59	<120	<290	<59	<59	<59	<59	<120	<290	<15	<15	<59	<15	<15	<15
B8A	81.1	82.4	ft	<51	<100	<260	<51	<51	<51	<51	<100	<260	<13	84	<51	90	290	310
C8	48.6	49.7	ft	<76	<150	<380	<76	<76	<76	<76	<150	<380	<19	<19	<76	<19	<19	<19
C8	61.6	65.6	ft	<62	<120	<310	<62	<62	<62	<62	<120	<310	<15	<15	<62	<15	<15	<15
C8	65.6	70.6	ft	<57	<110	<290	<57	<57	<57	<57	<110	<290	<14	<14	<57	<14	<14	<14
C8	72.7	75.0	ft	<52	<100	<260	<52	<52	<52	<52	<100	<260	<13	39	<52	35	160	170
D8	47.2	49.0	ft	<63	<130	<320	<63	<63	<63	<63	<130	<320	<16	<16	<63	<16	<16	<16
D8	55.0	59.0	ft	<66	<130	<330	<66	<66	<66	<66	<130	<330	<17	<17	<66	<17	<17	<17
D8	60.6	64.0	ft	<64	<130	<320	<64	<64	<64	<64	<130	<320	<16	<16	<64	<16	<16	<16
D8	75.5	79.0	ft	<56	<110	<280	<56	<56	<56	<56	<110	<280	<14	<14	<56	<14	<14	<14
STOCKPILE QUADRANT 1	NA	NA	NA	<42	<220	<220	<42	<42	<42	<42	<220	<220	14	28	<86	42	64	45
STOCKPILE QUADRANT 2	NA	NA	NA	<67	<340	<340	<67	<67	<67	<67	<340	<340	9.0 J	23	<140	32	65	54
STOCKPILE QUADRANT 3	NA	NA	NA	<62	<320	<320	<62	<62	<62	<62	<320	<320	21	34	<130	63	110	85
STOCKPILE QUADRANT 4	NA	NA	NA	<67	<350	<350	<67	<67	<67	<67	<350	<350	12 J	30	<140	46	91	68

Analyte concentration exceeds the standard for:		Source:
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:
µg/kg - micrograms per kilogram
ft - feet
-- not analyzed
NA - not applicable

Notes:
Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8270E LL

TABLE 4
Laboratory Analytical Results - SVOCs
Conowingo, Maryland

Analytic Method				SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	bis(2-Chloro-ethoxy)methane	bis(2-Chloroethyl)ether	bis(2-Chloro-isopropyl)ether	bis(2-Ethyl-hexyl)phthalate	Butyl benzyl phthalate	Caprolactam	Carbazole	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran
Category 1 RSL				1,100		11,000	19,000	230	310,000	39,000	290,000	3,100,000		110,000	110	7,800
Category 2 RSL				21,000		210,000	250,000	1,000	4,700,000	160,000	1,200,000	40,000,000		2,100,000	2,100	120,000
Category 3 RSL Composite				211,000		2,110,000	2,460,000	10,300	46,700,000	1,640,000	12,100,000	398,000,000		21,100,000	21,100	1,040,000
Category 3 RSL Construction				1,750,000		17,500,000	771,000	62,100	13,600,000	5,140,000	51,400,000	110,000,000		175,000,000	175,000	310,000
Transect 3																
C3	30.6	35.5	ft	**54**	**35**	**46**	<43	<43	<43	<43	<43	<86	<43	**83**	**18**	<43
D3	26.2	30.9	ft	**64**	**43**	**49**	<43	<43	<43	<43	<43	<87	<43	**87**	**16**	<43
Transect 4																
C4	28.4	31.9	ft	**42**	**30**	**54**	<43	<43	<43	<43	<43	<86	<43	**76**	**15**	<43
Transect 5																
B5	35.4	40.4	ft	<15	<15	**15 J**	<58	<58	<58	<58	<58	<120	<58	**17**	<15	<58
B5	51.9	54.1	ft	**24**	**26**	**26**	<51	<51	<51	<51	<51	<100	<51	**27**	<13	<51
C5	22.1	26.7	ft	**52**	**38**	**61**	<46	<46	<46	<46	<46	<92	<46	**90**	**19**	<46
C5	36.7	41.7	ft	<14	<14	<14	<55	<55	<55	<55	<55	<110	<55	<14	<14	<55
Transect 6																
B6	41.0	45.3	ft	**48**	**42**	**60**	<45	<45	<45	<45	<45	<90	<45	**86**	**16**	<45
C6	21.8	23.4	ft	**180**	**100**	**140**	<48	<48	<48	**190**	<48	<96	<48	**250**	**37**	<48
C6	27.2	28.3	ft	**700**	**550**	**720**	<47	<47	<47	**97**	<47	<94	**64**	**1100**	**140**	<47
C6	35.0	36.1	ft	**81**	**79**	**120**	<49	<49	<49	<49	<49	<98	<49	**170**	**23**	<49
C6	36.6	38.8	ft	**99**	**76**	**110**	<48	<48	<48	<48	<48	<97	<48	**160**	**22**	<48
Transect 7																
B7	41.0	43.3	ft	<14	**21**	<14	<56	<56	<56	<56	<56	<110	<56	<14	**14 J**	<56
B7	48.2	50.6	ft	**110**	**71**	**82**	<45	<45	<45	<45	<45	<90	<45	**150**	**20**	<45
B7	58.1	60.6	ft	<15	<15	<15	<58	<58	<58	<58	<58	<120	<58	**16**	<15	<58
C7	41.7	43.4	ft	**250**	**140**	**220**	<44	<44	<44	<44	<44	<89	<44	**360**	**51**	<44
C7	53.2	55.3	ft	**160**	**140**	**210**	<49	<49	<49	<49	<49	<97	<49	**310**	**43**	<49
C7	68.8	70.8	ft	**28**	**26**	**36**	<49	<49	<49	<49	<49	<97	<49	**49**	<12	<49
Transect 8																
A8	57.8	62.3	ft	<17	<17	<17	<67	<67	<67	<67	<67	<130	<67	<17	<17	<67
B8	67.2	68.7	ft	<9.5	<9.5	<9.5	<38	<38	<38	<38	<38	<76	<38	<9.5	<9.5	<38
B8A	68.7	70.0	ft	**320**	**190**	**310**	<45	<45	<45	<45	<45	<90	<45	**1100**	**50**	<45
B8A	71.9	75.0	ft	**22**	**36**	**28**	<61	<61	<61	<61	<61	<120	<61	**20**	**25**	<61
B8A	75.3	80.0	ft	<15	<15	<15	<59	<59	<59	<59	<59	<120	<59	<15	<15	<59
B8A	81.1	82.4	ft	**200**	**160**	**200**	<51	<51	<51	<51	<51	<100	<51	**310**	**55**	<51
C8	48.6	49.7	ft	<19	<19	<19	<76	<76	<76	<76	<76	<150	<76	<19	<19	<76
C8	61.6	65.6	ft	<15	<15	<15	<62	<62	<62	<62	<62	<120	<62	<15	<15	<62
C8	65.6	70.6	ft	<14	<14	<14	<57	<57	<57	<57	<57	<110	<57	<14	<14	<57
C8	72.7	75.0	ft	**86**	**78**	**120**	<52	<52	<52	<52	<52	<100	<52	**160**	**21**	<52
D8	47.2	49.0	ft	<16	<16	<16	<63	<63	<63	<63	<63	<130	<63	<16	<16	<63
D8	55.0	59.0	ft	<17	<17	<17	<66	<66	<66	<66	<66	<130	<66	<17	<17	<66
D8	60.6	64.0	ft	<16	<16	<16	<64	<64	<64	<64	<64	<130	<64	<16	<16	<64
D8	75.5	79.0	ft	<14	<14	<14	<56	<56	<56	<56	<56	<110	<56	<14	<14	<56
STOCKPILE QUADRANT 1	NA	NA	NA	**66**	**41**	**20**	<42	<8.6	<8.6	**150 J**	<42	<220	**5.7 J**	**69**	**11**	<42
STOCKPILE QUADRANT 2	NA	NA	NA	**70**	**47**	**21**	<67	<14	<14	**84 J**	<67	<340	**4.7 J**	**66**	**12 J**	<67
STOCKPILE QUADRANT 3	NA	NA	NA	**110**	**79**	**30**	<62	<13	<13	**110 J**	<62	<320	**11 J**	**110**	**20**	<62
STOCKPILE QUADRANT 4	NA	NA	NA	**92**	**64**	**26**	<67	<14	<14	**100 J**	<67	<350	**7.2 J**	**92**	**17**	<67

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram
ft - feet
-- not analyzed
NA - not applicable

Notes:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8270E LL

TABLE 4
Laboratory Analytical Results - SVOCs
Conowingo, Maryland

Analytic Method				SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Diethylphthalate	Dimethyl phthalate	Di-N-Butyl phthalate	Di-N-Octyl phthalate	Fluoranthene	Fluorene	Hexachlorobenzene	Hexachlorocyclopentadiene	Hexachloroethane	Indeno(1,2,3-cd)pyrene	Isophorone	Nitrobenzene
Category 1 RSL				**5,100,000**		**630,000**	**63,000**	**240,000**	**240,000**	**210**	**180**	**1,800**	**1,100**	**570,000**	**5,100**
Category 2 RSL				**66,000,000**		**8,200,000**	**820,000**	**3,000,000**	**3,000,000**	**960**	**750**	**8,000**	**21,000**	**2,400,000**	**22,000**
Category 3 RSL Composite				**657,000,000**		**82,100,000**	**8,210,000**	**30,100,000**	**30,100,000**	**9,600**	**7,450**	**80,500**	**211,000**	**24,200,000**	**224,000**
Category 3 RSL Construction				**206,000,000**		**25,700,000**	**2,570,000**	**9,580,000**	**9,580,000**	**60,100**	**1,550**	**114,000**	**1,750,000**	**51,400,000**	**319,000**
Transect 3															
C3	30.6	35.5	ft	<43	<43	<43	<86	**180**	**24**	<43	<86	<43	**35**	<43	<43
D3	26.2	30.9	ft	<43	<43	<43	<87	**140**	**12**	<43	<87	<43	**50**	<43	<43
Transect 4															
C4	28.4	31.9	ft	<43	<43	<43	<86	**170**	**27**	<43	<86	<43	**34**	<43	<43
Transect 5															
B5	35.4	40.4	ft	<58	<58	<58	<120	**27**	<15	<58	<120	<58	<15	<58	<58
B5	51.9	54.1	ft	<51	<51	<51	<100	**28**	<13	<51	<100	<51	**24**	<51	<51
C5	22.1	26.7	ft	<46	<46	<46	<92	**150**	**17**	<46	<92	<46	**44**	<46	<46
C5	36.7	41.7	ft	<55	<55	<55	<110	<14	<14	<55	<110	<55	<14	<55	<55
Transect 6															
B6	41.0	45.3	ft	<45	<45	<45	<90	**150**	**18**	<45	<90	<45	**43**	<45	<45
C6	21.8	23.4	ft	<48	<48	<48	<96	**460**	**36**	<48	<96	<48	**110**	<48	<48
C6	27.2	28.3	ft	<47	<47	<47	<94	**2000**	**90**	<47	<94	<47	**640**	<47	<47
C6	35.0	36.1	ft	<49	<49	<49	<98	**210**	**21**	<49	<98	<49	**97**	<49	<49
C6	36.6	38.8	ft	<48	<48	<48	<97	**290**	**27**	<48	<97	<48	**85**	<48	<48
Transect 7															
B7	41.0	43.3	ft	<56	<56	<56	<110	<14	<14	<56	<110	<56	**16**	<56	<56
B7	48.2	50.6	ft	<45	<45	<45	<90	**260**	**26**	<45	<90	<45	**78**	<45	<45
B7	58.1	60.6	ft	<58	<58	<58	<120	**20**	<15	<58	<120	<58	<15	<58	<58
C7	41.7	43.4	ft	<44	<44	<44	<89	**750**	**69**	<44	<89	<44	**160**	<44	<44
C7	53.2	55.3	ft	<49	<49	<49	<97	**350**	**25**	<49	<97	<49	**150**	<49	<49
C7	68.8	70.8	ft	<49	<49	<49	<97	**56**	<12	<49	<97	<49	**28**	<49	<49
Transect 8															
A8	57.8	62.3	ft	<67	<67	<67	<130	<17	<17	<67	<130	<67	<17	<67	<67
B8	67.2	68.7	ft	<38	<38	<38	<76	<9.5	<9.5	<38	<76	<38	<9.5	<38	<38
B8A	68.7	70.0	ft	<45	<45	<45	<90	**520**	**26**	<45	<90	<45	**230**	<45	<45
B8A	71.9	75.0	ft	<61	<61	<61	<120	<15	<15	<61	<120	<61	**30**	<61	<61
B8A	75.3	80.0	ft	<59	<59	<59	<120	<15	<15	<59	<120	<59	<15	<59	<59
B8A	81.1	82.4	ft	<51	<51	<51	<100	**370**	**26**	<51	<100	<51	**180**	<51	<51
C8	48.6	49.7	ft	<76	<76	<76	<150	<19	<19	<76	<150	<76	<19	<76	<76
C8	61.6	65.6	ft	<62	<62	<62	<120	<15	<15	<62	<120	<62	<15	<62	<62
C8	65.6	70.6	ft	<57	<57	<57	<110	<14	<14	<57	<110	<57	<14	<57	<57
C8	72.7	75.0	ft	<52	<52	<52	<100	**200**	**13 J**	<52	<100	<52	**83**	<52	<52
D8	47.2	49.0	ft	<63	<63	<63	<130	<16	<16	<63	<130	<63	<16	<63	<63
D8	55.0	59.0	ft	<66	<66	<66	<130	<17	<17	<66	<130	<66	<17	<66	<66
D8	60.6	64.0	ft	<64	<64	<64	<130	<16	<16	<64	<130	<64	<16	<64	<64
D8	75.5	79.0	ft	<56	<56	<56	<110	<14	<14	<56	<110	<56	<14	<56	<56
STOCKPILE QUADRANT 1	NA	NA	NA	<42	<42	<42	<42	**110**	**33**	<8.6	<42	<42	**36**	<42	<86
STOCKPILE QUADRANT 2	NA	NA	NA	<67	<67	<67	<67	**97**	**21**	<14	<67	<67	**41**	<67	<140
STOCKPILE QUADRANT 3	NA	NA	NA	<62	<62	<62	<62	**190**	**41**	<13	<62	<62	**66**	<62	<130
STOCKPILE QUADRANT 4	NA	NA	NA	<67	<67	<67	<67	**130**	**29**	<14	<67	<67	**56**	<67	<140

Analyte concentration exceeds the standard for:

		Source:
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:
µg/kg - micrograms per kilogram
ft - feet
-- not analyzed
NA - not applicable

Notes:
Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8270E LL

TABLE 4
Laboratory Analytical Results - SVOCs
Conowingo, Maryland

Analytic Method				SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270 C	SW-846 8270E LL
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	ug/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	N-Nitroso-di-N-propylamine	N-Nitrosodiphenylamine	Pentachlorophenol	Phenanthrene	Phenol	Pyrene	Hexachloro-butadiene	Naphthalene	Pyridine	Atrazine	Benzaldehyde
Category 1 RSL				**78**	**110,000**	**1,000**		**1,900,000**	**180,000**	**1,200**	**2,000**	**7,800**	**2,400**	**170,000**
Category 2 RSL				**330**	**470,000**	**4,000**		**25,000,000**	**2,300,000**	**5,300**	**8,600**	**120,000**	**10,000**	**820,000**
Category 3 RSL Composite				**3,280**	**4,690,000**	**39,700**		**246,000,000**	**22,600,000**	**52,600**	**167,000**	**1,170,000**	**99,900**	**8,180,000**
Category 3 RSL Construction				**26,800**	**5,140,000**	**344,000**		**77,000,000**	**7,190,000**	**296,000**	**123,000**	**339,000**	**816,000**	**33,900,000**
Transect 3														
C3	30.6	35.5	ft	<43	<43	<86	**170**	<43	**140**	<43	**21**	<43	<86	--
D3	26.2	30.9	ft	<43	<43	<87	**76**	<43	**170**	<43	**25**	<43	<87	--
Transect 4														
C4	28.4	31.9	ft	<43	<43	<86	**150**	<43	**140**	<43	<11	<43	<86	--
Transect 5														
B5	35.4	40.4	ft	<58	<58	<120	<15	<58	**41**	<58	<15	<58	<120	--
B5	51.9	54.1	ft	<51	<51	<100	**32**	<51	**36**	<51	**21**	<51	<100	--
C5	22.1	26.7	ft	<46	<46	<92	**100**	<46	**150**	<46	**25**	<46	<92	--
C5	36.7	41.7	ft	<55	<55	<110	<14	<55	**16**	<55	**19**	<55	<110	--
Transect 6														
B6	41.0	45.3	ft	<45	<45	<90	**89**	<45	**150**	<45	**66**	<45	<90	--
C6	21.8	23.4	ft	<48	<48	<96	**280**	<48	**420**	<48	**54**	<48	<96	--
C6	27.2	28.3	ft	<47	<47	<94	**890**	<47	**1900**	<47	**82**	<47	<94	--
C6	35.0	36.1	ft	<49	<49	<98	**130**	<49	**250**	<49	**56**	<49	<98	--
C6	36.6	38.8	ft	<48	<48	<97	**220**	<48	**290**	<48	**42**	<48	<97	--
Transect 7														
B7	41.0	43.3	ft	<56	<56	<110	<14	<56	<14	<56	<14	<56	<110	--
B7	48.2	50.6	ft	<45	<45	<90	**160**	<45	**280**	<45	**55**	<45	<90	--
B7	58.1	60.6	ft	<58	<58	<120	<15	<58	**24**	<58	<15	<58	<120	--
C7	41.7	43.4	ft	<44	<44	<89	**490**	<44	**570**	<44	**63**	<44	<89	--
C7	53.2	55.3	ft	<49	<49	<97	**140**	<49	**420**	<49	**85**	<49	<97	--
C7	68.8	70.8	ft	<49	<49	<97	**34**	<49	**71**	<49	**56**	<49	<97	--
Transect 8														
A8	57.8	62.3	ft	<67	<67	<130	<17	<67	<17	<67	<17	<67	<130	--
B8	67.2	68.7	ft	<38	<38	<76	<9.5	<38	<9.5	<38	<9.5	<38	<76	--
B8A	68.7	70.0	ft	<45	<45	<90	**200**	<45	**540**	<45	**48**	<45	<90	--
B8A	71.9	75.0	ft	<61	<61	<120	<15	<61	<15	<61	<15	<61	<120	--
B8A	75.3	80.0	ft	<59	<59	<120	<15	<59	<15	<59	**21**	<59	<120	--
B8A	81.1	82.4	ft	<51	<51	<100	**200**	<51	**380**	<51	**42**	<51	<100	--
C8	48.6	49.7	ft	<76	<76	<150	<19	<76	<19	<76	<19	<76	<150	--
C8	61.6	65.6	ft	<62	<62	<120	<15	<62	<15	<62	<15	<62	<120	--
C8	65.6	70.6	ft	<57	<57	<110	<14	<57	<14	<57	<14	<57	<110	--
C8	72.7	75.0	ft	<52	<52	<100	**100**	<52	**250**	<52	**17**	<52	<100	--
D8	47.2	49.0	ft	<63	<63	<130	<16	<63	<16	<63	<16	<63	<130	--
D8	55.0	59.0	ft	<66	<66	<130	<17	<66	<17	<66	<17	<66	<130	--
D8	60.6	64.0	ft	<64	<64	<130	<16	<64	<16	<64	<16	<64	<130	--
D8	75.5	79.0	ft	<56	<56	<110	<14	<56	<14	<56	**24**	<56	<110	--
STOCKPILE QUADRANT 1	NA	NA	NA	<8.6	<42	<220	**140**	<42	**140**	<8.6	**130**	--	<86	<86
STOCKPILE QUADRANT 2	NA	NA	NA	<14	<67	<340	**92**	<67	**120**	<14	**73**	--	<140	<140
STOCKPILE QUADRANT 3	NA	NA	NA	<13	<62	<320	**200**	<62	**240**	<13	**140**	--	<130	<130
STOCKPILE QUADRANT 4	NA	NA	NA	<14	<67	<350	**140**	<67	**180**	<14	**110**	--	<140	<140

Analyte concentration exceeds the standard for:		Source:
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram
ft - feet
-- not analyzed
NA - not applicable

Notes:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA Stockpile samples analyzed by analytical method SW-846 8270E LL

TABLE 5
Laboratory Analytical Results - PCBs
Conowingo, Maryland

			Analytic Method	SW-846 8082 A						
			Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
Category 1 RSL				**410**	**200**	**170**	**230**	**230**	**120**	**240**
Category 2 RSL				**5,100**	**830**	**720**	**950**	**940**	**970**	**990**
Category 3 RSL Composite				**51,300**	**8,320**	**7,190**	**9,500**	**9,540**	**9,720**	**9,910**
Category 3 RSL Construction				**16,400**	**62,800**	**51,600**	**76,000**	**76,500**	**4,680**	**81,000**
Transect 3										
C3	30.6	35.5	ft	<63	<63	<63	<63	<63	<63	<63
D3	26.2	30.9	ft	<65	<65	<65	<65	<65	<65	<65
Transect 4										
C4	28.4	31.9	ft	<64	<64	<64	<64	<64	<64	<64
Transect 5										
B5	35.4	40.4	ft	<87	<87	<87	<87	<87	<87	<87
B5	51.9	54.1	ft	<76	<76	<76	<76	<76	<76	<76
C5	22.1	26.7	ft	<67	<67	<67	<67	<67	<67	<67
C5	36.7	41.7	ft	<84	<84	<84	<84	<84	<84	<84
Transect 6										
B6	41.0	45.3	ft	<68	<68	<68	<68	<68	<68	<68
C6	21.8	23.4	ft	<71	<71	<71	<71	<71	<71	<71
C6	27.2	28.3	ft	<71	<71	<71	<71	<71	<71	<71
C6	35.0	36.1	ft	<72	<72	<72	<72	<72	<72	<72
C6	36.6	38.8	ft	<72	<72	<72	<72	<72	<72	<72
Transect 7										
B7	41.0	43.3	ft	<83	<83	<83	<83	<83	<83	<83
B7	48.2	50.6	ft	<69	<69	<69	<69	<69	<69	<69
B7	58.1	60.6	ft	<84	<84	<84	<84	<84	<84	<84
C7	41.7	43.4	ft	<68	<68	<68	<68	<68	<68	<68
C7	53.2	55.3	ft	<72	<72	<72	<72	<72	<72	<72
C7	68.8	70.8	ft	<73	<73	<73	<73	<73	<73	<73

TABLE 5
Laboratory Analytical Results - PCBs
Conowingo, Maryland

Analytic Method				SW-846 8082 A						
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
Category 1 RSL				**410**	**200**	**170**	**230**	**230**	**120**	**240**
Category 2 RSL				**5,100**	**830**	**720**	**950**	**940**	**970**	**990**
Category 3 RSL Composite				**51,300**	**8,320**	**7,190**	**9,500**	**9,540**	**9,720**	**9,910**
Category 3 RSL Construction				**16,400**	**62,800**	**51,600**	**76,000**	**76,500**	**4,680**	**81,000**
Transect 8										
A8	57.8	62.3	ft	<100	<100	<100	<100	<100	<100	<100
B8	67.2	68.7	ft	<55	<55	<55	<55	<55	<55	<55
B8A	68.7	70.0	ft	<67	<67	<67	<67	<67	<67	<67
B8A	71.9	75.0	ft	<89	<89	<89	<89	<89	<89	<89
B8A	75.3	80.0	ft	<88	<88	<88	<88	<88	<88	<88
B8A	81.1	82.4	ft	<78	<78	<78	<78	<78	<78	<78
C8	48.6	49.7	ft	<120	<120	<120	<120	<120	<120	<120
C8	61.6	65.6	ft	<94	<94	<94	<94	<94	<94	<94
C8	65.6	70.6	ft	<84	<84	<84	<84	<84	<84	<84
C8	72.7	75.0	ft	<77	<77	<77	<77	<77	<77	<77
D8	47.2	49.0	ft	<90	<90	<90	<90	<90	<90	<90
D8	55.0	59.0	ft	<97	<97	<97	<97	<97	<97	<97
D8	60.6	64.0	ft	<95	<95	<95	<95	<95	<95	<95
D8	75.5	79.0	ft	<81	<81	<81	<81	<81	<81	<81
Stockpile Samples										
STOCKPILE QUADRANT 1	NA	NA	NA	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	**4.5**
STOCKPILE QUADRANT 2	NA	NA	NA	<0.56	<0.56	<0.56	<0.56	<0.56	<0.56	**1.9**
STOCKPILE QUADRANT 3	NA	NA	NA	<0.53	<0.53	<0.53	<0.53	<0.53	<0.53	**7.1**
STOCKPILE QUADRANT 4	NA	NA	NA	<0.57	<0.57	<0.57	<0.57	<0.57	<0.57	**3.2**
STOCKPILE QUADRANTS 1-4	NA	NA	NA	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	**3.2**

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram

ft - feet

NA - not applicable

Notes:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc

Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA

TABLE 6
Laboratory Analytical Results - Organochlorine Pesticides
Conowingo, Maryland

Analytic Method				SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Alpha-BHC	Alpha-chlordane	Beta-BHC	Chlordane	Delta-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate
Category 1 RSL				190	2,000	1,900	39	86		300	1,700		34			38,000
Category 2 RSL				2,500	9,300	8,500	180	360		1,300	7,700		140			490,000
Category 3 RSL Composite				95,700	92,800	85,300	1,840	3,650		12,800	76,600		1,440			
Category 3 RSL Construction				514,000	693,000	155,000	10,200	29,800		104,000	130,000		11,700			
Transect 3																
C3	30.6	35.5	ft	<5	<5	<5	<5	<5	<5	<5	<130	<5	<5	<5	<5	<5
D3	26.2	30.9	ft	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<130	<5.2	<5.2	<5.2	<5.2	<5.2
Transect 4																
C4	28.4	31.9	ft	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<130	<5.1	<5.1	<5.1	<5.1	<5.1
Transect 5																
B5	35.4	40.4	ft	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<170	<6.9	<6.9	<6.9	<6.9	<6.9
B5	51.9	54.1	ft	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<150	<6.1	<6.1	<6.1	<6.1	<6.1
C5	22.1	26.7	ft	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<130	<5.3	<5.3	<5.3	<5.3	<5.3
C5	36.7	41.7	ft	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<170	<6.7	<6.7	<6.7	<6.7	<6.7
Transect 6																
B6	41.0	45.3	ft	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<140	<5.4	<5.4	<5.4	<5.4	<5.4
C6	21.8	23.4	ft	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<140	<5.7	<5.7	<5.7	<5.7	<5.7
C6	27.2	28.3	ft	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<140	<5.6	<5.6	<5.6	<5.6	<5.6
C6	35.0	36.1	ft	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<140	<5.7	<5.7	<5.7	<5.7	<5.7
C6	36.6	38.8	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<140	<5.8	<5.8	<5.8	<5.8	<5.8
Transect 7																
B7	41.0	43.3	ft	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<170	<6.6	<6.6	<6.6	<6.6	<6.6
B7	48.2	50.6	ft	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<140	<5.6	<5.6	<5.6	<5.6	<5.6
B7	58.1	60.6	ft	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<170	<6.8	<6.8	<6.8	<6.8	<6.8
C7	41.7	43.4	ft	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<140	<5.4	<5.4	<5.4	<5.4	<5.4
C7	53.2	55.3	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<140	<5.8	<5.8	<5.8	<5.8	<5.8
C7	68.8	70.8	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<150	<5.8	<5.8	<5.8	<5.8	<5.8
Transect 8																
A8	57.8	62.3	ft	<8.1	<8.1	<8.1	<8.1	<8.1	<8.1	<8.1	<200	<8.1	<8.1	<8.1	<8.1	<8.1
B8	67.2	68.7	ft	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<110	<4.4	<4.4	<4.4	<4.4	<4.4
B8A	68.7	70.0	ft	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<130	<5.3	<5.3	<5.3	<5.3	<5.3
B8A	71.9	75.0	ft	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<180	<7.1	<7.1	<7.1	<7.1	<7.1
B8A	75.3	80.0	ft	<7	<7	<7	<7	<7	<7	<7	<180	<7	<7	<7	<7	<7
B8A	81.1	82.4	ft	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<160	<6.2	<6.2	<6.2	<6.2	<6.2
C8	48.6	49.7	ft	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<230	<9.2	<9.2	<9.2	<9.2	<9.2
C8	61.6	65.6	ft	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<190	<7.5	<7.5	<7.5	<7.5	<7.5
C8	65.6	70.6	ft	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<170	<6.7	<6.7	<6.7	<6.7	<6.7
C8	72.7	75.0	ft	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<150	<6.1	<6.1	<6.1	<6.1	<6.1
D8	47.2	49.0	ft	<7.2	<7.2	<7.2	<7.2	<7.2	<7.2	<7.2	<180	<7.2	<7.2	<7.2	<7.2	<7.2
D8	55.0	59.0	ft	<7.8	<7.8	<7.8	<7.8	<7.8	<7.8	<7.8	<190	<7.8	<7.8	<7.8	<7.8	<7.8
D8	60.6	64.0	ft	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<190	<7.6	<7.6	<7.6	<7.6	<7.6
D8	75.5	79.0	ft	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<160	<6.5	<6.5	<6.5	<6.5	<6.5
Stockpile Samples																
STOCKPILE QUADRANT 1	NA	NA	NA	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.54[1]	<0.27	<0.27	<0.27	<0.27	<0.27
STOCKPILE QUADRANT 2	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.56[1]	<0.28	<0.28	<0.28	<0.28	<0.28
STOCKPILE QUADRANT 3	NA	NA	NA	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.52[1]	<0.26	<0.26	<0.26	<0.26	<0.26
STOCKPILE QUADRANT 4	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.56[1]	<0.28	<0.28	<0.28	<0.28	<0.28
STOCKPILE QUADRANTS 1-4	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.56[1]	<0.28	<0.28	<0.28	<0.28	<0.28

Analyte concentration exceeds the standard for:	Source:
🟨 Maryland Dredging Category 1 RSL	November 2020
🟩 Maryland Dredging Category 2 RSL	November 2020
🟦 Maryland Dredging Category 3 RSL Composite	December 2019
🟦 Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

µg/kg - micrograms per kilogram
ft - feet
NA - not applicable

Notes:

1 - Chlordane calculated by adding cis- and trans-Chlordane
Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8081B LL

TABLE 6
Laboratory Analytical Results - Organochlorine Pesticides
Conowingo, Maryland

Analytic Method				SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B	SW-846 8081 B
Units				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Parameter	**Depth (Top)**	**Depth (Bottom)**	**Depth Units**	**Endrin**	**Endrin Aldehyde**	**Endrin Ketone**	**Gamma-BHC**	**Gamma-Chlordane**	**Heptachlor**	**Heptachlor Epoxide**	**Methoxychlor**	**Toxaphene**
Category 1 RSL				**1,900**			**570**		**130**	**70**	**32,000**	**490**
Category 2 RSL				**25,000**			**2,500**		**630**	**330**	**410,000**	**2,100**
Category 3 RSL Composite				**246,000**			**25,400**		**6,260**	**3,300**	**4,100,000**	**20,900**
Category 3 RSL Construction				**77,100**			**90,200**		**45,000**	**4,410**	**1,280,000**	**171,000**
Transect 3												
C3	30.6	35.5	ft	<5	<5	<5	<5	<5	<5	<5	<5	<130
D3	26.2	30.9	ft	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<130
Transect 4												
C4	28.4	31.9	ft	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<5.1	<130
Transect 5												
B5	35.4	40.4	ft	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<6.9	<170
B5	51.9	54.1	ft	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<150
C5	22.1	26.7	ft	<5.3	**5.9**	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<130
C5	36.7	41.7	ft	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<170
Transect 6												
B6	41.0	45.3	ft	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<140
C6	21.8	23.4	ft	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<140
C6	27.2	28.3	ft	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<140
C6	35.0	36.1	ft	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<5.7	<140
C6	36.6	38.8	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<140
Transect 7												
B7	41.0	43.3	ft	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<6.6	<170
B7	48.2	50.6	ft	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<5.6	<140
B7	58.1	60.6	ft	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<170
C7	41.7	43.4	ft	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<140
C7	53.2	55.3	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<140
C7	68.8	70.8	ft	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<5.8	<150
Transect 8												
A8	57.8	62.3	ft	<8.1	<8.1	<8.1	<8.1	<8.1	<8.1	<8.1	<8.1	<200
B8	67.2	68.7	ft	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<110
B8A	68.7	70.0	ft	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<5.3	<130
B8A	71.9	75.0	ft	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<7.1	<180
B8A	75.3	80.0	ft	<7	<7	<7	<7	<7	<7	<7	<7	<180
B8A	81.1	82.4	ft	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<160
C8	48.6	49.7	ft	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<230
C8	61.6	65.6	ft	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<7.5	<190
C8	65.6	70.6	ft	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<6.7	<170
C8	72.7	75.0	ft	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<6.1	<150
D8	47.2	49.0	ft	<7.2	<7.2	<7.2	<7.2	<7.2	<7.2	<7.2	<7.2	<180
D8	55.0	59.0	ft	<7.8	<7.8	<7.8	<7.8	<7.8	<7.8	<7.8	<7.8	<190
D8	60.6	64.0	ft	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<7.6	<190
D8	75.5	79.0	ft	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<6.5	<160
Stockpile Samples												
STOCKPILE QUADRANT 1	NA	NA	NA	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<0.27	<11
STOCKPILE QUADRANT 2	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<11
STOCKPILE QUADRANT 3	NA	NA	NA	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	<11
STOCKPILE QUADRANT 4	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<11
STOCKPILE QUADRANTS 1-4	NA	NA	NA	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<0.28	<11

	Analyte concentration exceeds the standard for:	**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

TABLE 7
Laboratory Analytical Results - Dioxins and Furans
Conowingo, Maryland

Analytic Method				SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290
Units				pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	Total HPCDD	Total HPCDF	Total HXCDD	Total HXCDF	Total PECDD	Total PECDF	Total TCDD	Total TCDF	1,2,3,4,6,7,8-HPCDD	1,2,3,4,6,7,8-HPCDF	1,2,3,4,7,8,9-HPCDF	1,2,3,4,7,8-HXCDD	1,2,3,4,7,8-HXCDF
Category 1 RSL						**100**						**500**	**500**	**500**	**50**	**50**
Category 2 RSL						**470**						**2,170**	**2,210**	**2,210**	**223**	**218**
Category 3 RSL Composite						**4,680**						**21,700**	**22,100**	**22,100**	**2,230**	**2,180**
Category 3 RSL Construction						**36,400**						**167,000**	**21,700**	**21,700**	**2,170**	**2,160**
Transect 3																
C3	30.6	35.5	ft	<5	<5	<5	<5	<5	<5	<1	<1	<5	<5	<5	<5	<5
D3	26.2	30.9	ft	**22**	<5	<5	<5	<5	<5	<1	<1	**8.6**	<5	<5	<5	<5
Transect 4																
C4	28.4	31.9	ft	**11**	**32**	<5	<5	<5	<5	<1	<1	**5**	**21**	<5	<5	<5
Transect 5																
B5	35.4	40.4	ft	**55**	**18**	**12**	<5	<5	<5	<1	**13**	**21**	**9.3**	<5	<5	<5
B5	51.9	54.1	ft	<5	<5	<5	<5	<5	<5	<1	<1	<5	<5	<5	<5	<5
C5	22.1	26.7	ft	**25**	**5.9**	<5	<5	<5	<5	<1	**1.1**	**11**	<5	<5	<5	<5
C5	36.7	41.7	ft	**29**	**15**	<5	<5	<5	<5	<1	**1.3**	**11**	**6.5**	<5	<5	<5
Transect 6																
B6	41	45.3	ft	**15**	<5	<5	<5	<5	<5	<1	<1	**6.8**	<5	<5	<5	<5
C6	21.8	23.4	ft	**43**	<5	<5	<5	<5	<5	<1	**2.2**	**17**	<5	<5	<5	<5
Transect 7																
B7	48.2	50.6	ft	**22**	**23**	<5	<5	<5	<5	<1	**3.4**	**9.8**	**12**	<5	<5	<5
C7	41.7	43.4	ft	**13**	<5	<5	<5	<5	<5	<1	<1	**5**	<5	<5	<5	<5
Transect 8																
A8	57.8	62.3	ft	**34**	<5	<5	<5	<5	<5	**1.1**	<1	**14**	<5	<5	<5	<5
B8	67.2	68.7	ft	<5	<5	<5	<5	<5	<5	<1	<1	<5	<5	<5	<5	<5
C8	72.7	75	ft	**21 J**	<5	<5	<5	<5	<5	<1	<1	**10 J**	<5	<5	<5	<5
D8	60.6	64	ft	**59**	**12**	<5	<5	<5	<5	**1.5**	**5.2**	**25**	**5.4**	<5	<5	<5
STOCKPILE QUADRANT 1	NA	NA	NA	**25 B**	**5.7 IE B**	**5.3 IE B**	**5.2 IE B**	**0.61 J IE**	**6.7 IE B**	**1.7 IE B**	**12 IE**	**11 B**	**2.5 J IE B**	<4.9	**0.29 J IE B**	**0.45 J IE B**
STOCKPILE QUADRANT 2	NA	NA	NA	**37 B**	**7.6 IE B**	**6.4 IE B**	**6.1 IE B**	**9.1 IE**	**7.9 IE B**	**2.3 IE B**	**13 IE**	**17 B**	**3.1 J B**	**0.26 J IE**	**0.36 J IE B**	**0.47 J B**
STOCKPILE QUADRANT 3	NA	NA	NA	**36 B**	**6.5 B**	**7.2 IE B**	**6.1 IE B**	**1.7 J IE**	**8.3 IE B**	**2.6 IE B**	**16 IE**	**16 B**	**2.8 J B**	**0.24 J**	**0.44 J IE B**	**0.47 J B**
STOCKPILE QUADRANT 4	NA	NA	NA	**29 B**	**4.4 J B**	**5.4 IE B**	**5.0 IE B**	**1.4 J IE**	**6.6 IE B**	**1.8 IE B**	**10 IE**	**13 B**	**2.0 J B**	<4.9	**0.30 J IE B**	**0.35 J B**
STOCKPILE QUADRANTS 1-4	NA	NA	NA	**63 B**	**11 IE B**	**12 IE B**	**10 IE B**	**3.1 J IE**	**14 IE B**	**3.9 IE B**	**21 IE**	**27 B**	**4.6 J B**	**0.49 J IE**	**0.56 J B**	**0.78 J B**

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Notes/Abbreviations:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc
Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA
Stockpile samples analyzed by analytical method SW-846 8290A
J - the analyte was positively identified below the reporting limit but greater than the method detection limit.
B - Parameter was found in the lab blank and sample
IE - Value is EMPC (estimated maximum possible concentration).
pg/g - picograms per gram

ft - feet

NA - not applicable

TABLE 7
Laboratory Analytical Results - Dioxins and Furans
Conowingo, Maryland

Analytic Method				SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290	SW8290
Units				pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g	pg/g
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	1,2,3,6,7,8-HXCDD	1,2,3,6,7,8-HXCDF	1,2,3,7,8,9-HXCDD	1,2,3,7,8,9-HXCDF	1,2,3,7,8-PECDD	1,2,3,7,8-PECDF	2,3,4,6,7,8-HXCDF	2,3,4,7,8-PECDF	2,3,7,8-TCDD	2,3,7,8-TCDF	OCDD	OCDF
Category 1 RSL				**50**	**50**	**50**	**50**	**50**	**200**	**50**	**16**	**5**	**50**	**16,000**	**16,000**
Category 2 RSL				**223**	**218**	**223**	**223**	**22**	**744**	**223**	**74**	**22**	**217**	**74,400**	**74,400**
Category 3 RSL Composite				**2,230**	**2,180**	**2,230**	**2,230**	**223**	**7,440**	**2,230**	**744**	**216**	**2,170**	**744,000**	**744,000**
Category 3 RSL Construction				**2,170**	**2,160**	**2,170**	**2,170**	**217**	**7,220**	**2,170**	**722**	**216**	**2,160**	**722,000**	**722,000**
Transect 3															
C3	30.6	35.5	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**45**	<10
D3	26.2	30.9	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**150**	<10
Transect 4															
C4	28.4	31.9	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**85**	<10
Transect 5															
B5	35.4	40.4	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	**1.9**	**590**	**16**
B5	51.9	54.1	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**220**	<10
C5	22.1	26.7	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**190**	<10
C5	36.7	41.7	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**310**	<10
Transect 6															
B6	41	45.3	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**150**	<10
C6	21.8	23.4	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**230**	<10
Transect 7															
B7	48.2	50.6	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	**1.2**	**190**	<10
C7	41.7	43.4	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**97**	<10
Transect 8															
A8	57.8	62.3	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**540**	<10
B8	67.2	68.7	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	<10	<10
C8	72.7	75	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	**190**	<10
D8	60.6	64	ft	<5	<5	<5	<5	<5	<5	<5	<5	<1	**1.1**	**990**	<10
STOCKPILE QUADRANT 1	NA	NA	NA	**0.47 J IE B**	**0.42 J**	**0.69 J IE B**	<4.9	<4.9	**0.14 J IE B**	**0.23 J B**	**0.23 J IE B**	**0.12 J IE B**	**1.4**	**230 B**	**4.1 J B**
STOCKPILE QUADRANT 2	NA	NA	NA	**0.63 J B**	**0.43 J**	**0.63 J IE B**	<4.8	**0.29 J IE**	**0.26 J B**	**0.20 J IE B**	**0.34 J B**	**0.084 J IE B**	**0.78 J IE**	**370 B**	**5.2 J B**
STOCKPILE QUADRANT 3	NA	NA	NA	**0.66 J IE B**	**0.48 J**	**0.68 J B**	<4.8	**0.24 J IE**	**0.22 J IE B**	**0.24 J IE B**	**0.34 J IE B**	**0.11 J IE B**	**1.1**	**360 B**	**4.7 J B**
STOCKPILE QUADRANT 4	NA	NA	NA	**0.48 J B**	**0.35 J**	**0.56 J B**	<4.9	**0.22 J IE**	**0.17 J B**	**0.19 J B**	**0.26 J IE B**	**0.091 J B**	**0.62 J**	**300 B**	**3.5 J B**
STOCKPILE QUADRANTS 1-4	NA	NA	NA	**1.1 J IE B**	**0.62 J IE**	**1.1 J IE B**	<4.8	**0.36 J**	**0.33 J B**	**0.32 J B**	**0.55 J B**	**0.21 J B**	**1.2 IE**	**640 B**	**7.6 J B**

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Notes/Abbreviations:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc

Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA

Stockpile samples analyzed by analytical method SW-846 8290A

J - the analyte was positively identified below the reporting limit but greater than the metho

B - Parameter was found in the lab blank and sample

IE - Value is EMPC (estimated maximum possible concentration).

pg/g - picograms per gram

ft - feet

NA - not applicable

TABLE 8
Laboratory Analytical Results - Total Petroleum Hydrocarbons
Conowingo, Maryland

			Analytic Method	SW-846 8015C GRO	SW-846 8015C DRO[1]
			Units	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	TPH as Gasoline (C6-C10)	TPH as Diesel (C10-C28)
Category 1 RSL				**230**	**230**
Category 2 RSL				**620**	**620**
Category 3 RSL Composite				**620**	**620**
Category 3 RSL Construction				**620**	**620**
Transect 3					
C3	30.6	35.5	ft	<0.13	30
D3	26.2	30.9	ft	<0.13	22
Transect 4					
C4	28.4	31.9	ft	<0.13	18
Transect 5					
B5	35.4	40.4	ft	<0.18	15
B5	51.9	54.1	ft	--	37
C5	22.1	26.7	ft	<0.13	45
C5	36.7	41.7	ft	<0.16	18
Transect 6					
B6	41.0	45.3	ft	--	34
C6	21.8	23.4	ft	--	52
C6	27.2	28.3	ft	--	170
C6	35.0	36.1	ft	--	64
C6	36.6	38.8	ft	--	77
Transect 7					
B7	41.0	43.3	ft	--	17
B7	42.0	42.0	ft	<0.17	--
B7	48.2	50.6	ft	--	44
B7	58.1	60.6	ft	--	18
C7	41.7	43.4	ft	--	47
C7	53.2	55.3	ft	--	56
C7	68.8	70.8	ft	--	23
Transect 8					
A8	57.8	62.3	ft	--	6.9
A8	62.3	62.3	ft	<0.18	--
B8	66.7	66.7	ft	<0.11	--
B8	67.2	68.7	ft	--	<3.8
B8A	68.7	70.0	ft	--	53
B8A	71.9	75.0	ft	--	11
B8A	75.3	80.0	ft	--	7.4
B8A	81.1	82.4	ft	--	58
B8A	81.5	81.5	ft	<0.2	--

TABLE 8
Laboratory Analytical Results - Total Petroleum Hydrocarbons
Conowingo, Maryland

			Analytic Method	SW-846 8015C GRO	SW-846 8015C DRO[1]
			Units	mg/kg	mg/kg
Parameter	Depth (Top)	Depth (Bottom)	Depth Units	TPH as Gasoline (C6-C10)	TPH as Diesel (C10-C28)
Category 1 RSL				**230**	**230**
Category 2 RSL				**620**	**620**
Category 3 RSL Composite				**620**	**620**
Category 3 RSL Construction				**620**	**620**
C8	48.6	49.7	ft	--	<7.6
C8	61.6	65.6	ft	--	<6.2
C8	65.6	70.6	ft	--	5.9
C8	72.7	75.0	ft	--	62
C8	76.2	76.2	ft	<0.24	--
D8	47.2	49.0	ft	--	<6.2
D8	48.0	48.0	ft	<0.23	--
D8	55.0	59.0	ft	--	<6.7
D8	60.6	64.0	ft	--	7.5
D8	75.5	79.0	ft	--	15
Stockpile Samples					
STOCKPILE QUADRANT 1	NA	NA	NA	--	180
STOCKPILE QUADRANT 2	NA	NA	NA	--	140
STOCKPILE QUADRANT 3	NA	NA	NA	--	150
STOCKPILE QUADRANT 4	NA	NA	NA	--	98

Analyte concentration exceeds the standard for:		**Source:**
🟨	Maryland Dredging Category 1 RSL	November 2020
🟩	Maryland Dredging Category 2 RSL	November 2020
🟦	Maryland Dredging Category 3 RSL Composite	December 2019
🟦	Maryland Dredging Category 3 RSL Construction	December 2019

Abbreviations:

mg/kg - milligrams per kilogram

ft - feet

-- not analyzed

Notes:

Stockpile samples analyzed by analytical method SW-846 8015D DRO

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc

Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA

TABLE 9
Laboratory Analytical Results - Nutrients and Salts
Conowingo, Maryland

			Analytic Method	Standard	EPA 365.3	EPA 300.0	SM 4500-NH3-F -2011	EPA 351.2	SM 4500-S2 D 2000
			Units	ms/cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	**Depth (Top)**	**Depth (Bottom)**	**Depth Units**	**Soluble Salts**	**Phosphorus, Total (as P)**	**Sulfate**	**Nitrogen, Ammonia (As N)**	**Nitrogen, Kjeldahl[1]**	**Sulfide[1]**
Transect 3									
C3	30.6	35.5	ft	0.08	28	<64	190	380	<12
D3	26.2	30.9	ft	0.09	23	<67	210	470	<13
Transect 4									
C4	28.4	31.9	ft	0.1	30	<63	250	608 J	<13
Transect 5									
B5	35.4	40.4	ft	0.15	81	<86	840	2790	5.9 J
B5	51.9	54.1	ft	0.11	95	<79	310	524	4.5 J
C5	22.1	26.7	ft	0.1	36	<72	210	724	<14
C5	36.7	41.7	ft	0.17	51	<81	590	1990	7.8 J
Transect 6									
B6	41.0	45.3	ft	0.11	31	<69	220	302	<13
C6	21.8	23.4	ft	0.1	65	<68	280	967	<14
C6	27.2	28.3	ft	0.1	56	22 J	210	806	5.6 J
C6	35.0	36.1	ft	0.12	120	<71	280	842	<16
C6	36.6	38.8	ft	0.11	94	<75	280	966	<15
Transect 7									
B7	41.0	43.3	ft	0.12	410	<83	550	2290	11 J
B7	48.2	50.6	ft	0.15	91	<66	210	622 J	<14
B7	58.1	60.6	ft	0.21	270	<83	730	2580	<18
C7	41.7	43.4	ft	0.09	40	<68	180	776	<13
C7	53.2	55.3	ft	0.12	74	<76	310	1340	<14
C7	68.8	70.8	ft	0.13	72	<71	330	2020	<15
Transect 8									
A8	57.8	62.3	ft	0.18	500	<100	860	3090	13 J
B8	67.2	68.7	ft	0.06	11	<57	11	189	<11
B8A	68.7	70.0	ft	0.12	80	<67	270	1090	<14
B8A	71.9	75.0	ft	0.21	440	<90	840	2470	8.2 J
B8A	75.3	80.0	ft	0.16	320	<84	620	1720 J	13 J
B8A	81.1	82.4	ft	0.11	99	<75	290	<205	<14
C8	48.6	49.7	ft	0	330	<120	400	1010	11 J
C8	61.6	65.6	ft	0.12	290	<89	840	1460	8.3 J
C8	65.6	70.6	ft	0.12	410	<91	730	1190	19
C8	72.7	75.0	ft	0.15	140	<74	430	788	6.9 J
D8	47.2	49.0	ft	0.16	320	<92	360	1430	6.9 J
D8	55.0	59.0	ft	0.18	320	<100	760	1420	27
D8	60.6	64.0	ft	0.01	490	<93	850	1570	7.2 J
D8	75.5	79.0	ft	0.15	170	<87	410	2080	<17

TABLE 9
Laboratory Analytical Results - Nutrients and Salts
Conowingo, Maryland

Analytic Method				Standard	EPA 365.3	EPA 300.0	SM 4500-NH3-F -2011	EPA 351.2	SM 4500-S2 D 2000
Units				ms/cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Parameter	**Depth (Top)**	**Depth (Bottom)**	**Depth Units**	**Soluble Salts**	**Phosphorus, Total (as P)**	**Sulfate**	**Nitrogen, Ammonia (As N)**	**Nitrogen, Kjeldahl[1]**	**Sulfide[1]**
Stockpile Samples									
STOCKPILE QUADRANT 1	NA	NA	NA	--	--	130	--	1,600	<39
STOCKPILE QUADRANT 2	NA	NA	NA	--	--	50	--	1,400	<41
STOCKPILE QUADRANT 3	NA	NA	NA	--	--	230	--	1,300	<38
STOCKPILE QUADRANT 4	NA	NA	NA	--	--	67	--	1,200	<41

Abbreviations:

mg/kg - milligrams per kilogram

ms/cm - millisiemens per centimeter

1 - Concentrations are estimated values due to matrix interference due to high organic carbon content; laboratory control samples were within laboratory control limits.

-- not analyzed

NA - not applicable

ft - feet

J - the analyte was positively identified below the reporting limit but greater than the method detection limit.

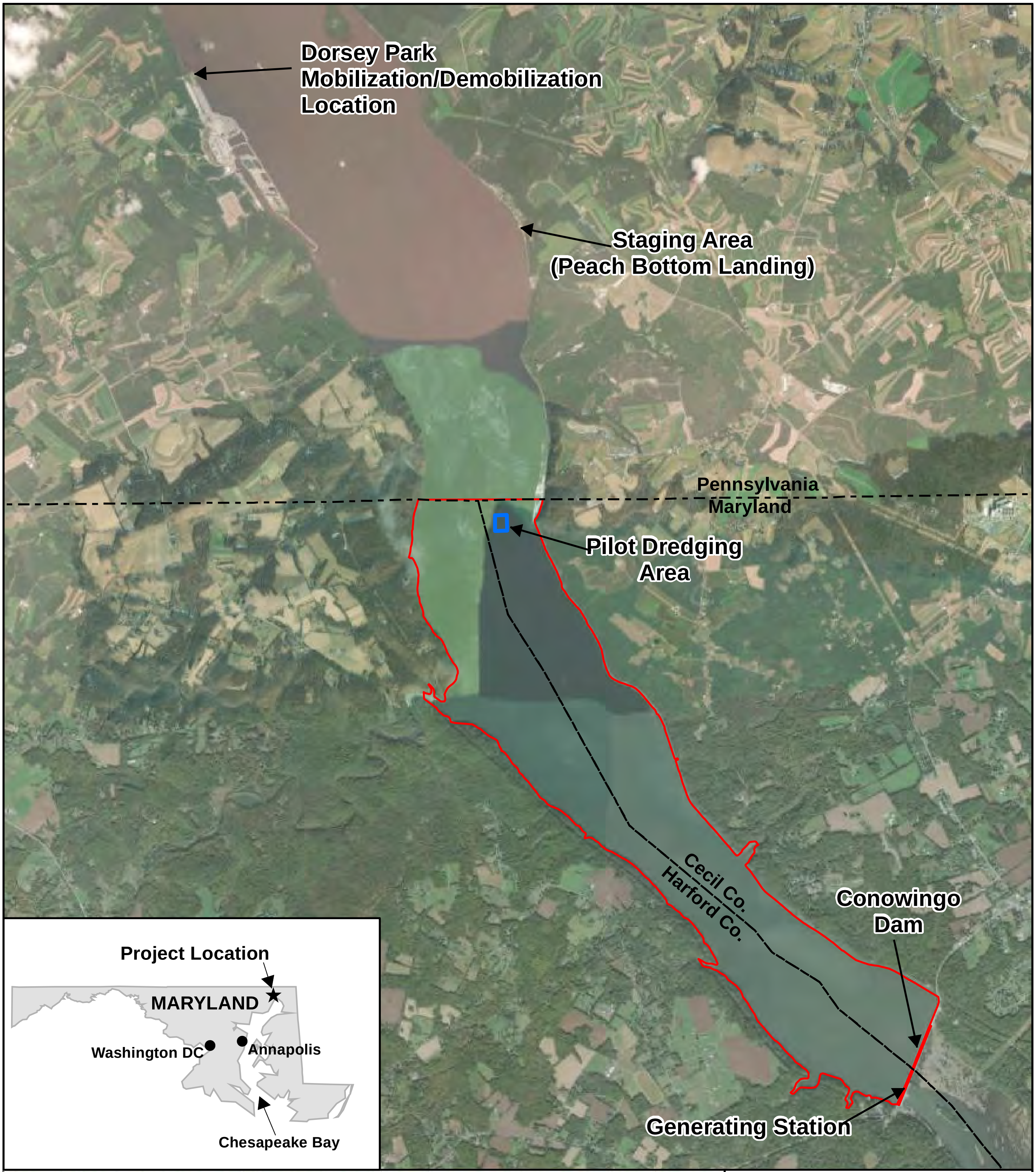
Notes:

Laboratory Analysis of Transect Samples by Phase Separation Science, Inc

Laboratory Analysis of Stockpile Samples by Eurofins Scientific USA

Stockpile samples analyzed by analytical method MCAWW 351.2 for Kjedahl, SW-846 9034 for Sulfide and SW-846 9056A Sulfate

FIGURES



⬭ Project Area

N

1:54,000 (1" = 4,500 at tabloid size)

0 2,250 4,500
Feet

Data sources: Project Location (Northgate, 2019);
Photo (ESRI basemap, 2019)

Figure 1

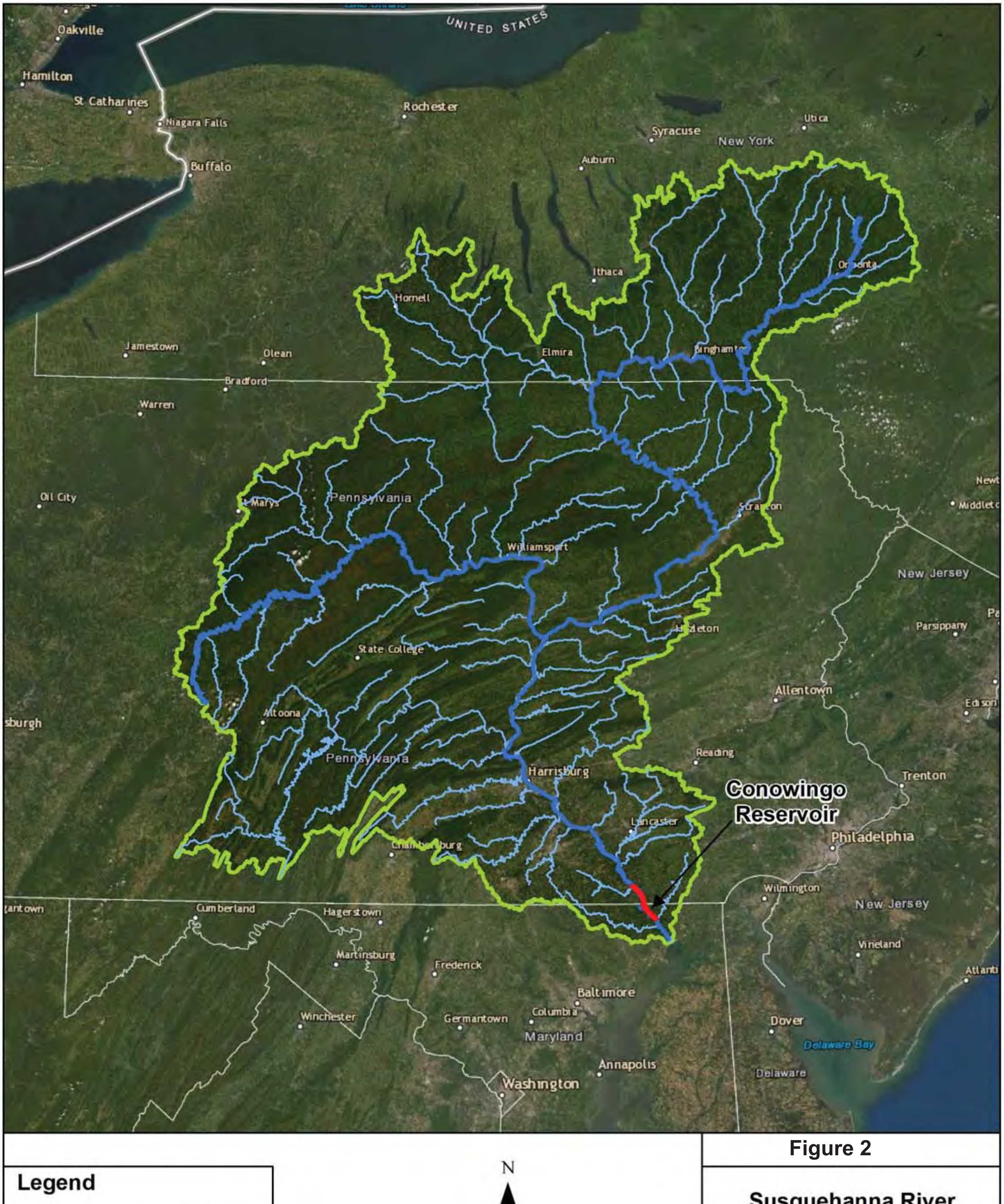
Project Location

Conowingo Reservoir
Maryland

DATE	PROJECT #
3/30/2022	03037.02

northgate

Document Path: M:\ArcGIS\Packages\Conowingo_Ext\project-area-map_2021-0426dag.mxd



Legend

▬ Susquehanna River

— Major Tributaries

○ Susquehanna River Watershed

N

1:2,534,400 (1" = 40 mi at letter size)

0 20 40 Mi

Data sources: Watershed (SRBC, 2006);
River (Bucknell GIS) Basemap (ESRI, 2019)

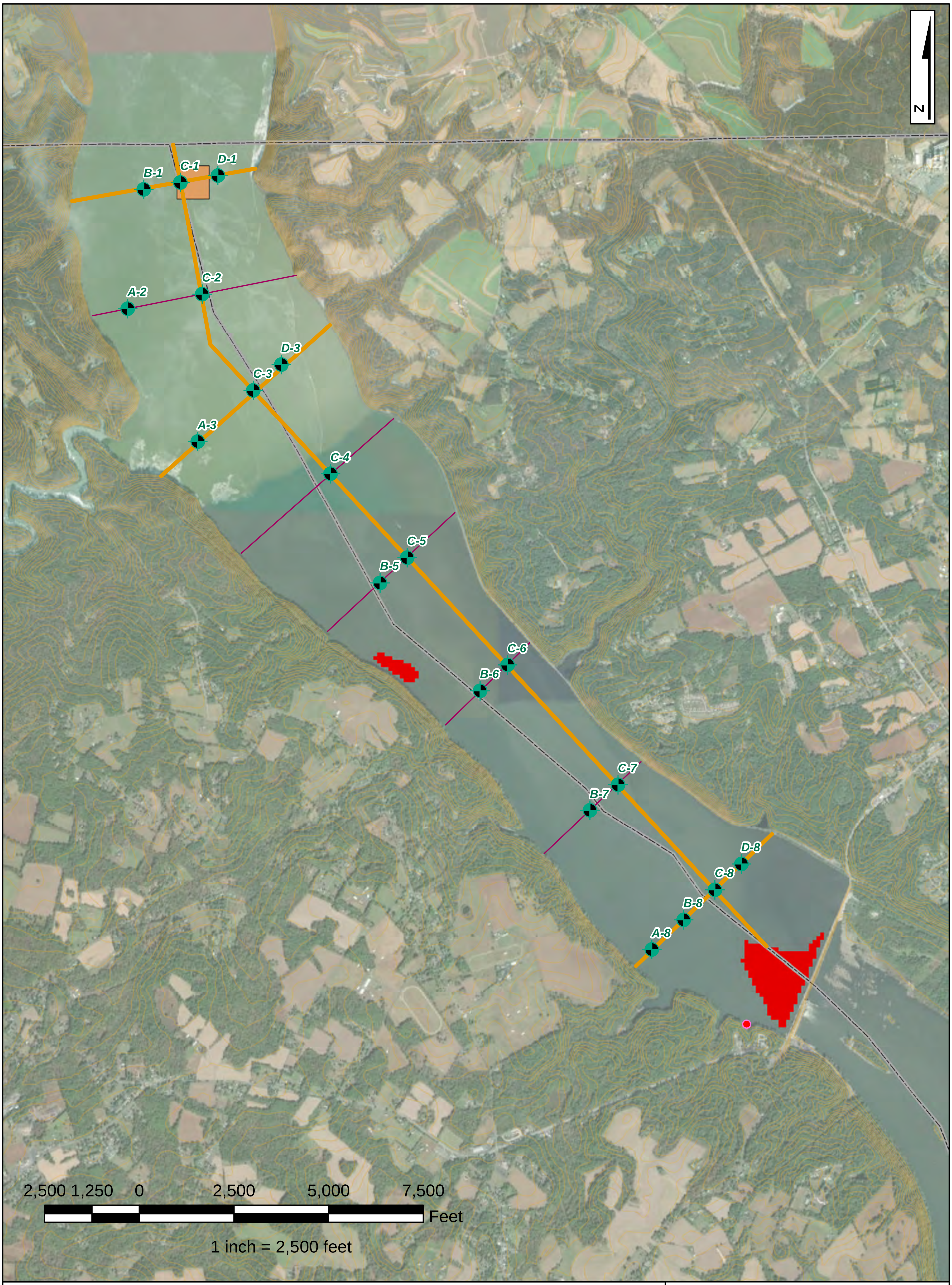
Figure 2

Susquehanna River Watershed

Conowingo Reservoir
Maryland

DATE	PROJECT #	
6/19/2019	03037.02	northgate

Document Path: C:\Users\Daniel\Box Sync\Susquehanna\Chesapeake Bay\GIS\MXD\susquehanna-watershed_2019-0716dag.mxd



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3

Core Locations
As Built

Conowingo Reservoir
Maryland

DATE	PROJECT NUMBER
4/20/2021	03037.02

northgate environmental management, inc.

Document Path: C:\Projects\Conowingo\GIS\Map Files\AsBuilt040621.mxd

APPENDIX A

STOCKPILE PID READINGS

Conowingo IR-BU Demonstration Project
PID Readings

Project # 3037.02
Recorded by: S. Bedosky

Date	Time	Sample #	Sample Type	PID Reading (PPM)
10/13/2021	12:38	Background	Ambient Air	0.2 - 0.5
10/13/2021	12:39	Background	Ambient Air	0.4
10/13/2021	12:40	1	Barge Sediment	1.2
10/13/2021	12:42	2	Barge Sediment	1.7
10/13/2021	12:44	3	Barge Sediment	0.9
10/13/2021	12:46	4	Barge Sediment	1.4
10/13/2021	13:41	5	Stockpile Sediment	1.9
10/13/2021	13:45	6	Stockpile Sediment	1.1
10/13/2021	13:47	7	Stockpile Sediment	2.0
10/13/2021	13:51	8	Stockpile Sediment	1.4
10/13/2021	13:59	9	Stockpile Sediment	1.4
10/13/2021	15:01	10	Stockpile Sediment	1.1
10/13/2021	15:04	11	Stockpile Sediment	0.8
10/13/2021	15:08	12	Stockpile Sediment	1.2
10/13/2021	15:10	13	Stockpile Sediment	1.3
10/14/2021	10:25	Background	Ambient Air	0.2 - 0.6
10/14/2021	10:30	14	Stockpile Sediment	1.4
10/14/2021	10:34	15	Stockpile Sediment	0.8
10/14/2021	10:41	16	Stockpile Sediment	0.7
10/14/2021	10:44	17	Stockpile Sediment	1.1
10/14/2021	10:49	18	Stockpile Sediment	2
10/14/2021	10:56	19	Stockpile Sediment	1.9
10/14/2021	11:10	20	Stockpile Sediment	0.9
10/14/2021	11:14	21	Stockpile Sediment	0.8
10/14/2021	13:51	22	Stockpile Sediment	1.3
10/14/2021	14:22	23	Stockpile Sediment	0.8
10/14/2021	14:31	24	Stockpile Sediment	1.4
10/14/2021	14:36	25	Stockpile Sediment	1.2
10/14/2021	14:44	26	Stockpile Sediment	0.9
10/14/2021	14:51	27	Stockpile Sediment	1.3
10/14/2021	15:02	28	Stockpile Sediment	1.3
10/14/2021	15:11	29	Stockpile Sediment	1.1
10/14/2021	15:17	30	Stockpile Sediment	1.6
10/18/2021	8:10	Background	Ambient Air	0.2 - 0.5
10/18/2021	8:15	31	Stockpile Sediment	1.1
10/18/2021	8:19	32	Stockpile Sediment	0.9
10/18/2021	8:23	33	Stockpile Sediment	0.8
10/18/2021	8:31	34	Stockpile Sediment	1.4

Date	Time	Sample #	Sample Type	PID Reading (PPM)
10/18/2021	8:36	35	Stockpile Sediment	1.7
10/18/2021	9:24	36	Stockpile Sediment	1.3
10/18/2021	9:32	37	Stockpile Sediment	2.1
10/18/2021	9:43	38	Stockpile Sediment	0.9
10/18/2021	9:49	39	Stockpile Sediment	1.2
10/18/2021	10:19	40	Stockpile Sediment	1.2
10/18/2021	10:26	41	Stockpile Sediment	0.9
10/18/2021	10:34	42	Stockpile Sediment	1.6
10/18/2021	10:39	43	Stockpile Sediment	0.8
10/18/2021	10:45	44	Stockpile Sediment	0.9
10/18/2021	10:51	45	Stockpile Sediment	1.4

APPENDIX B

CHAIN OF CUSTODY FORM

northgate
environmental management, inc.

CHAIN OF CUSTODY / ANALYSIS REQUEST FORM

Project No: 3037.02
Project Location: Perryville MD
Date: 11/3/21
Project Name: Conowingo Pilot Study/Stockpile Sampling
Field Logbook No: N/A
Serial No: N/A
Samplers: STEVE BEDOSKY ERIN ZANE

SAMPLES						ANALYSES																	
Sample No.	Date	Time	Lab Sample No.	No. of Containers	Sample Type	Grain Size Distribution	Loss on Ignition (% Coal)	Percent Moisture	Priority Pollutant Metals + Hg	Total Cyanide	Free Cyanide	Total Sulfate	Total Sulfide	Total Organic Carbon	SVOCs (inc. PAHs)	Organochlorine Pesticides	PCBs (Aroclors)	Dioxins/Furans	Total Petroleum Hydrocarbons - DRO	Total Kjeldahl Nitrogen	HOLD	RUSH	REMARKS
Stockpile Quadrant 1	11/3/21	0848		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 2		0903		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 3		0912		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 4		0925		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrants 1-4		0921		2	Sediment											✓	✓	✓					20 point composite

Relinquished by: (Signature)	Date: 11/4/21	Time: 1254	Received by: (Signature)	Date: 11/4/21	Time: 1254
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
Method of Shipment:	Date:	Time:	Lab Comments:		

Sample Collector:
Northgate Environmental Management, Inc.
47 East All Saints Street
Frederick, MD 21701
(850) 508-5313

Analytical Laboratory:
Test America, 7526 Connelley Drive, Hanover, MD, 21076

APPENDIX C

EUROFINS LABORATORY – QUALITY ASSURANCE MANUAL

Quality Assurance Manual

Eurofins TestAmerica Pittsburgh
301 Alpha Drive
Pittsburgh, PA 15238
Phone No. 412-963-7058
Fax No. 412-963-2468

www.testamericainc.com

Copyright Information:
This documentation has been prepared by TestAmerica Laboratories, Inc. d/b/a Eurofins TestAmerica and its affiliates ("Eurofins TestAmerica"), solely for their own use and the use of their customers in evaluating their qualifications and capabilities in connection with a particular project. The user of this document agrees by its acceptance to return it to Eurofins TestAmerica upon request and not to reproduce, copy, lend, or otherwise disclose its contents, directly or indirectly, and not to use it for any purpose other than that for which it was specifically provided. The user also agrees not to give access to this document to any third parties including but not limited to consultants, unless such third parties specifically agree to these conditions.

THIS DOCUMENT CONTAINS VALUABLE CONFIDENTIAL AND PROPRIETARY INFORMATION. DISCLOSURE, USE OR REPRODUCTION OF THESE MATERIALS WITHOUT THE WRITTEN AUTHORIZATION OF EUROFINS TESTAMERICA IS STRICTLY PROHIBITED. THIS UNPUBLISHED WORK BY EUROFINS TESTAMERICA IS PROTECTED BY STATE AND FEDERAL LAW OF THE UNITED STATES. IF PUBLICATION OF THIS WORK SHOULD OCCUR THE FOLLOWING NOTICE SHALL APPLY:

©COPYRIGHT 2020 TESTAMERICA LABORATORIES, INC. d/b/a EUROFINS TESTAMERICA ALL RIGHTS RESERVED

Distributed To: Intranet
This is a Controlled Document. When Printed it Becomes Uncontrolled.

Title Page:

Quality Assurance Manual
Approval Signatures

Laboratory Director - Deborah L. Lowe	4/15/2020 Date
Quality Assurance Manager – Virginia Zusman	3/23/2020 Date
Health and Safety Coordinator - Steve Jackson	4/6/2020 Date
Technical Director - Larry Matko	3/24/2020 Date
Department/Technical Manager (Organics) - Sharon Bacha	4/13/2020 Date
Department/Technical Manager (Inorganics) - Roseann Ruyechan	4/6/2020 Date
Department Manager (Sample Management) - Chris Kovitch	4/16/2020 Date

SECTION 2 - TABLE OF CONTENTS

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
-	QUALITY ASSURANCE MANUAL COVER PAGE	V1M2 Sec. 4.2.8.3			1
1.0	TITLE PAGE				2
2.0	- TABLE OF CONTENTS	V1M2 Secs. 4.2.8.3-4.2.8.4		8.1.2, 8.2.1	3
3.0	INTRODUCTION, SCOPE AND APPLICABILITY	V1M2 Sec. 4.2.8.4			14
3.1	Introduction And Compliance References	V1M2 Secs. 1.1; 1.2; 2.0; 3.2; 4.1.2; 4.2.4	4.1.2; 4.2.4	5.3, 5.4, 8.2.4, 8.3.1	14
3.2	Terms And Definitions	V1M2 Secs. 3.0; 4.2.4	4.2.4		14
3.3	Scope / Fields Of Testing	V1M2 Secs. 1.2; 4.2.4	4.1.2; 4.2.4	5.3, 5.4, 8.2.1, 8.2.4	15
3.4	Management Of The Manual	V1M2 Secs. 4.2.1; 4.2.7; 4.3.3.2; 4.3.3.3	4.2.1; 4.2.7; 4.3.3.2; 4.3.3.3	5.3	17
4.0	MANAGEMENT REQUIREMENTS	V1M2 Sec. 4		8.2.4, 8.2.5	17
4.1	Overview	V1M2 Secs. 4.1.1, 4.1.3; 4.1.5	4.1.1; 4.1.3; 4.1.5; 4.2.Z2	5.1, 5.2, 5.5, 5.6, 6.2.1, 6.2.4	17
4.2	Roles And Responsibilities	V1M2 Secs. 4.1.4; 4.1.5; 4.1.6; 4.2.1; 4.2.6; 5.2.4	4.1.3; 4.1.5; 4.1.Z1; 4.1.6; 4.2.1; 4.2.Z2; 4.2.6; 5.2.4	4.1.1 to 4.1.3; 4.1.5, 5.5, 5.6, 6.2.1, 6.2.4, 6.2.6, 8.2.2	17
4.3	Deputies	V1M2 Secs. 4.1.5; 4.1.7.2; 4.2.7	4.1.5; 4.2.Z2		29
5.0	QUALITY SYSTEM			6.1, 8.2.4	32
5.1	Quality Policy Statement	V1M2 Secs. 4.1.5; 4.2.2; 4.2.3; 4.2.8.3	4.1.5; 4.2.2; 4.2.3	8.2.3, 8.6.1	32
5.2	Ethics And Data Integrity	V1M2 Secs. 4.1.5; 4.16; 4.2.2; 4.2.8.1; 5.2.7	4.1.5; 4.2.2	4.1.1 to 4.1.3; 4.2.1, 6.2.1, 8.2.2, 8.2.3	33
5.3	Quality System Documentation	V1M2 Secs. 4.1.5; 4.2.2; 4.2.5	4.2.2; 4.2.5	8.2.4	33
5.4	Qa/Qc Objectives For The Measurement Of Data	V1M2 Sec. 4.2.2	4.1.5; 4.2.2	6.2.4	34
5.5	Criteria For Quality Indicators				36
5.6	Statistical Quality Control				36
5.7	Quality System Metrics				37
5.8	Laboratory Accreditation	V1M2 Sec. 4.2.8.4.i			37
6.0	DOCUMENT CONTROL	V1M2 Secs. 4.2.7; 4.3.1; 4.3.2.2 ; 4.3.3.3; 4.3.3.4	4.2.7; 4.3.1; 4.3.2.2; 4.3.3.3; 4.3.3.4	8.2.4, 8.3.1	38
6.1	Overview			8.2.5, 8.3.1, 8.3.2	38
6.2	Document Approval And Issue	V1M2 Secs. 4.3.2; 4.3.2.1-4.3.2.3; 4.3.3.1	4.3.2.1; 4.3.2.2; 4.3.2.3; 4.3.3.1	8.2.5, 8.3.2	38
6.3	Procedures For Document Control Policy	V1M2 Secs. 4.3.2.1–4.3.2.2; 4.3.3.1	4.3.2.1; 4.3.2.2; 4.3.3.1	8.2.5, 8.3.2	39
6.4	Obsolete Documents	V1M2 Secs. 4.3.2.1–4.3.2.2	4.3.2.1; 4.3.2.2	8.2.5, 8.3.2	39
7.0	SERVICE TO THE CLIENT	V1M2 Secs. 4.4.1 - 4.4.4	4.4.1; 4.4.2; 4.4.3; 4.4.4	7.1.1, 7.1.1.4, 7.1.1.5, 7.1.1.8, 7.1.2.1	40

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
7.1	Overview	V1M2 Secs. 4.4.5; 4.5.5; 5.7.1	4.4.5; 5.7.1		40
7.2	Review Sequence And Key Personnel	V1M2 Sec. 4.4.5	4.4.5	7.1.1.6	41
7.3	Documentation	V1M2 Sec. 5.7.1	5.7.1		42
7.4	Special Services	V1M2 Secs. 4.7.1-4.7.2	4.7.1; 4.7.2	7.1.1.3, 7.1.1.7	43
7.5	Client Communication	V1M2 Secs. 4.7.1-4.7.2	4.7.1; 4.7.2	7.1.1.7	43
7.6	Reporting	V1M2 Secs. 4.7.1-4.7.2	4.7.1; 4.7.2	7.1.1.7	43
7.7	Client Surveys	V1M2 Secs. 4.7.1-4.7.2	4.7.1; 4.7.2	7.1.1.7, 8.6.2	44
8.0	SUBCONTRACTING OF TESTS	V1M2 Secs. 4.4.3; 4.5.4	4.4.3; 4.5.4		44
8.1	Overview	V1M2 Secs. 4.5.1 - 4.5.3; 4.5.5; 5.3.1	4.5.1; 4.5.2; 4.5.3; 5.3.1	6.6.1, 7.1.2.1, 7.1.2.2	44
8.2	Qualifying And Monitoring Subcontractors	V1M2 Secs. 4.5.1; 4.5.2; 4.5.3; 4.5.5	4.5.1; 4.5.2; 4.5.3	6.6.1, 7.1.2.1, 7.1.2.2	45
8.3	Oversight and Reporting	V1M2 Sec. 4.5.5			45
8.4	Contingency Planning				47
9.0	PURCHASING SERVICES AND SUPPLIES	V1M2 Sec. 4.6.1	4.6.1		47
9.1	Overview	V1M2 Secs. 4.6.2; 4.6.3; 4.6.4	4.6.2; 4.6.3; 4.6.4	6.6.1, 6.6.2	47
9.2	Glassware	V1M2 Sec. 5.5.13.1			47
9.3	Reagents, Standards & Supplies	V1M2 Secs. 4.6.2; 4.6.3; 4.6.4	4.6.2; 4.6.3; 4.6.4	6.6.1 to 6.6.3	47
9.4	Purchase Of Equipment / Instruments / Software				50
9.5	Services				50
9.6	Suppliers				51
10.0	COMPLAINTS	V1M2 Sec. 4.8	4.8	8.6.1, 8.6.2	52
10.1	Overview			7.9.1 to 7.9.3, 8.6.1, 8.6.2	52
10.2	External Complaints			7.9.2 to 7.9.7, 8.6.1, 8.6.2	52
10.3	Internal Complaints			8.6.1, 8.6.2	53
10.4	Management Review			8.6.1, 8.6.2	53
11.0	CONTROL OF NON-CONFORMING WORK	V1M2 Secs. 4.9.1; 5.10.5	4.9.1; 5.10.Z.10	7.10.1	53
11.1	Overview	V1M2 Secs. 4.9.1; 4.11.3; 4.11.5	4.9.1; 4.11.3; 4.11.5	7.10.1	53
11.2	Responsibilities And Authorities	V1M2 Secs. 4.9.1; 4.11.3; 4.11.5; 5.2.7	4.9.1; 4.11.3; 4.11.5	7.10.1	54
11.3	Evaluation Of Significance And Actions Taken	V1M2 Secs. 4.9.1; 4.11.3; 4.11.5	4.9.1; 4.11.3; 4.11.5	4.1.5, 7.10.1, 7.10.2, 8.5.3	54
11.4	Prevention Of Nonconforming Work	V1M2 Secs. 4.9.4; 4.11.2	4.9.2; 4.11.2	7.10.2, 7.10.3, 8.5.3	55
11.5	Method Suspension/Restriction (Stop Work Procedures)	V1M2 Secs. 4.9.1; 4.9.2; 4.11.5	4.9.1; 4.9.2; 4.11.5	7.10.1, 7.10.2	55
12.0	CORRECTIVE ACTION	V1M2 Sec. 4.11		4.1.4, 4.1.5	56
12.1	Overview	V1M2 Secs. 4.9.2; 4.11.1; 4.11.2	4.9.2; 4.11.1; 4.11.2	7.10.2, 8.7.1, 8.7.3	56

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
12.2	General	V1M2 Sec. 4.11.2; 4.11.3	4.11.2; 4.11.3	7.7.2, 8.5.3, 8.7.1	56
12.3	Closed Loop Corrective Action Process	V1M2 Sec. 4.11.2; 4.11.3; 4.11.4; 4.11.6; 4.11.7; 4.12.2	4.11.2; 4.11.3; 4.11.4; 4.12.2	8.5.3, 8.6.1, 8.7.2	57
12.4	Technical Corrective Actions	V1M2 Sec. 4.11.6		8.7.1	58
12.5	Basic Corrections	V1M2 Secs. 4.11.1; 4.13.2.3	4.11.1; 4.13.2.3	7.5.3, 8.7.1	59
13.0	PREVENTIVE ACTION / IMPROVEMENT	V1M2 Secs. 4.10; 4.12.1; 4.12.2	4.10; 4.12.1; 4.12.2	4.1.4	65
13.1	Overview	V1M2 Secs. 4.15.1; 4.15.2	4.15.1; 4.15.2	8.6.2	65
13.2	Management Of Change				66
14.0	CONTROL OF RECORDS	V1M2 Secs. 4.2.7; 4.13.1.1; 4.13.3	4.2.7; 4.13.1.1	8.4.2	67
14.1	Overview	V1M2 Secs. 4.13.1.1; 4.13.1.2; 4.13.1.3; 4.13.1.4; 4.13.2.1; 4.13.2.2; 4.13.2.3; 4.13.3	4.13.1.1; 4.13.1.2; 4.13.1.3; 4.13.1.4; 4.13.2.1; 4.13.2.2; 4.13.2.3	8.4.1, 8.4.2	67
14.2	Technical And Analytical Records	V1M2 Sec. 4.13.2.2 - 4.13.2.3	4.13.2.2; 4.13.2.3	7.5.1, 8.4.2	70
14.3	Laboratory Support Activities			7.5.2, 8.4.2	71
14.4	Administrative Records			8.4.2	72
14.5	Records Management, Storage And Disposal	V1M2 Sec. 4.13.3		4.2.1, 8.4.2	72
15.0	AUDITS				73
15.1	Internal Audits	V1M2 Sec. 4.2.8.1; 4.14; 4.14.1; 4.14.2 ; 4.14.3; 4.14.5; 5.9.1; 5.9.2	4.14.1; 4.14.2; 4.14.3; 5.9.1; 5.9.A.15	8.6.1, 8.8.1, 8.8.2	73
15.2	External Audits	V1M2 Secs.4.14.2; 4.14.3	4.14.2; 4.14.3; 4.14.4	4.2.1, 8.6.1	75
15.3	Audit Findings	V1M2 Secs. 4.14.2; 4.14.3; 4.14.5		8.6.1	76
16.0	MANAGEMENT REVIEWS	V1M2 Sec. 4.1.6; 4.15; 4.15.1; 4.15.2	4.1.6; 4.15.1; 4.15.2	4.1.4, 8.5.1, 8.6.1, 8.9.1, 8.9.2	76
16.1	Quality Assurance Report			8.5.1	76
16.2	Annual Management Review	V1M2 Sec. 4.2.2; 4.15.3	4.2.2	4.1.1, 4.1.4, 4.2.1, 7.1.1.3, 8.2.2, 8.5.1 to 8.5.3, 8.6.1, 8.9.3	77
16.3	Potential Integrity Related Managerial Reviews			4.1.5, 8.5.1, 8.6.1	78
17.0	PERSONNEL	V1M2 Secs. 5.2; 5.2.1	5.2.1	6.1, 8.2.3	78
17.1	Overview	V1M2 Secs. 5.2.2; 5.2.3; 5.2.5	5.2.2; 5.2.3; 5.2.5	6.2.2	78
17.2	Education And Experience Requirements For Technical Personnel	V1M2 Secs. 5.2.1; 5.2.3; 5.2.4	5.2.1; 5.2.3; 5.2.4	6.2.2 to 6.2.4	79
17.3	Training	V1M2 Sec. 5.2.5	5.2.5	4.2.1, 6.2.2, 6.2.4, 6.2.5	80
17.4	Data Integrity And Ethics Training Program	V1M2 Sec. 4.2.8.1; 5.2.7		4.1.1	81

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
18.0	ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS	V1M2 Sec. 5.3		6.1, 6.3.1	83
18.1	Overview	V1M2 Secs. 5.3.1; 5.3.3; 5.3.4; 5.3.5	5.3.1; 5.3.3; 5.3.4; 5.3.5	6.3.1	83
18.2	Environment	V1M2 Secs. 5.3.1; 5.3.2; 5.3.3; 5.3.4; 5.3.5	5.3.1; 5.3.2; 5.3.3; 5.3.4; 5.3.5	6.3.1 to 6.3.5	83
18.3	Work Areas	V1M2 Secs. 5.3.3; 5.3.4; 5.3.5	5.3.3; 5.3.4; 5.3.5	6.3.1	84
18.4	Floor Plan				84
18.5	Building Security	V1M2 Sec. 5.3.4	5.3.4	6.3.4	84
19.0	TEST METHODS AND METHOD VALIDATION	V1M2 Sec. 5.4.1	5.4.1	7.2.1.1, 8.2.5	85
19.1	Overview	V1M2 Sec. 5.4.1	5.4.1; 5.4.5.1	6.2.3, 7.2.1.1 to 7.2.1.3	85
19.2	Standard Operating Procedures (Sops)	V1M2 Secs. 4.2.8.5; 4.3.3.1; 5.4.2	4.3.3.1; 5.4.2	7.2.1.4	85
19.3	Laboratory Methods Manual	V1M2 Sec. 4.2.8.5		6.2.3	85
19.4	Selection Of Methods	V1M2 Secs. 4.13.3; 5.4.1; 5.4.2; 5.4.3. V1M4 Secs. 1.4; 1.5.1; 1.6.1; 1.6.2; 1.6.2.1; 1.6.2.2	5.4.1; 5.4.2; 5.4.3; 5.4.4; 5.4.5.1; 5.4.5.2; 5.4.5.3	7.1.1.2, 7.2, 7.2.1.2, 7.2.1.3, 7.1.2.4 to 7.2.1.7, 7.2.2.1 to 7.2.1.7, 7.2.2.1	86
19.5	Laboratory Developed Methods And Non-Standard Methods	V1M2 Sec. 5.4.2. V1M4 Sec. 1.5.1	5.4.2; 5.4.4; 5.4.5.2; 5.4.5.3; 5.4.Z.3	7.1.1.2, 7.2.1.4 to 7.2.1.7, 7.2.2.1, 7.2.2.3, 8.2.5	89
19.6	Validation Of Methods	V1M2 Sec. 5.4.2. V1M4 Secs. 1.5.1; 1.5.2; 1.5.2.1; 1.5.2.2; 1.5.3	5.4.2; 5.4.4; 5.4.5.2; 5.4.5.3; 5.4.Z.3	7.1.1.2, 7.1.2.4, 7.2.1.6, 7.2.2.1 to 7.2.2.4	89
19.7	Method Detection Limits (Mdl)/ Limits Of Detection (Lod)	V1M2 Sec. 5.9.3. V1M4 Secs. 1.5.2; 1.5.2.1; 1.5.2.2	5.4.Z.3	7.2.2.3	91
19.8	Verification of Detection Limits	V1M2 Sec. 5.9.3			91
19.10	Instrument Detection Limits	V1M2 Sec. 5.9.3. V1M4 Sec. 1.5.2.1			91
19.10	Limit of Quantitation	V1M2 Sec. 5.9.3			91
19.11	Retention Time Windows	V1M2 Sec. 5.9.3			91
19.1219.12	Evaluation Of Selectivity	V1M2 Sec. 5.9.3. V1M4 Sec. 1.5.4; 1.7.3.6			92
19.13	Estimation Of Uncertainty Of Measurement	V1M2 Sec. 5.1.1; 5.1.2; 5.4.6	5.1.1; 5.1.2; 5.4.6.1; 5.4.6.2; 5.4.6.3; 5.4.Z.4	7.6.1, 7.6.2, 7.6.3	92
19.14	Sample Reanalysis Guidelines	V1M2 Sec 5.9.1	5.9.1		93
19.15	Control Of Data	V1M2 Secs. 5.4.7.1; 5.4.7.2; 5.9.1	5.4.7.1; 5.4.7.2; 5.9.1;	7.11.1 to 7.11.6	93
20.0	EQUIPMENT AND CALIBRATIONS	V1M2 Secs. 5.5.4; 5.5.5; 5.5.6	5.5.4; 5.5.5; 5.5.Z.5; 5.5.6; 5.5.Z.6	6.1, 6.4.3, 6.4.6, 6.4.9	100
20.1	Overview	V1M2 Secs. 5.5.1; 5.5.2; 5.5.3; 5.5.5; 5.5.10	5.5.1; 5.5.2; 5.5.3; 5.5.5; 5.5.10; 5.6.1; 5.6.Z.8	6.4.1, 6.4.4 to 6.4.6, 6.4.9, 6.4.11	100
20.2	Preventive Maintenance	V1M2 Secs. 5.5.1; 5.5.3; 5.5.7; 5.5.9	5.5.1; 5.5.3; 5.5.7; 5.5.9; 5.6.1; 5.6.Z.8	6.4.1 to 6.4.3, 6.4.6, 6.4.10	100

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
20.3	Support Equipment	V1M2 Secs. 5.5.10; 5.5.11; 5.5.13.1	5.5.10; 5.5.11; 5.6.2.1.2; 5.6.2.2.1; 5.6.2.2.2	6.4.11, 6.4.12, 6.5.1, 6.5.2, 6.5.3	101
20.4	Instrument Calibrations	V1M2 Secs. 5.5.8; 5.5.10; 5.6.3.1. V1M4 Sec. 1.7.1.1; 1.7.2	5.5.8; 5.5.Z.6; 5.5.10; 5.6.1; 5.6.Z.8; 5.6.3.1	6.4.2, 6.4.3, 6.4.6 to 6.4.8, 6.4.11, 6.4.13, 6.4.14, 6.5.1, 6.5.2	104
20.5	Tentatively Identified Compounds (Tics) – GC/MS Analysis				107
20.6	Gc/Ms Tuning				107
21.0	MEASUREMENT TRACEABILITY				109
21.1	Overview	V1M2 Sec. 5.6.3.1	5.6.2.1.2; 5.6.2.2.2; 5.6.3.1	6.4.14, 6.5.1, 6.5.2, 6.5.3	109
21.2	Nist-Traceable Weights And Thermometers	V1M2 Secs. 5.5.13.1; 5.6.3.1; 5.6.3.2	5.6.3.1; 5.6.3.2	6.4.14	109
21.3	Reference Standards / Materials	V1M2 Secs. 5.6.3.1; 5.6.3.2; 5.6.3.3; 5.6.3.4; 5.6.4.1; 5.6.4.2; 5.9.1; 5.9.3	5.6.3.1; 5.6.3.2; 5.6.3.3; 5.6.3.4; 5.9.1	6.4.14	109
21.4	Documentation And Labeling Of Standards, Reagents, And Reference Materials	V1M2 Secs. 5.6.4.2; 5.9.3			110
22.0	SAMPLING				112
22.1	Overview	V1M2 Secs. 5.7.1; 5.7.3	5.7.1; 5.7.3	7.3.1, 7.3.2, 7.3.3	112
22.2	Sampling Containers				112
22.3	Definition Of Holding Time				113
22.4	Sampling Containers, Preservation Requirements, Holding Times				113
22.5	Sample Aliquots / Subsampling	V1M2 Sec. 5.7.1	5.7.1	7.3.1, 7.3.2	113
23.0	HANDLING OF SAMPLES	V1M2 Sec. 5.8.1	5.8.1	7.4.1	114
23.1	Chain Of Custody (Coc)	V1M2 Secs. 5.7.2; 5.7.4; 5.8.4; 5.8.7.5; 5.8.8; 5.9.1	5.7.2; 5.8.4; 5.9.1	7.1.1.6, 7.4.1	114
23.2	Sample Receipt	V1M2 Secs. 5.8.1; 5.8.2; 5.8.3; 5.8.5; 5.8.7.3; 5.8.7.4; 5.8.7.5	5.8.2; 5.8.3	7.4.3	115
23.3	Sample Acceptance Policy	V1M2 Secs. 5.8.6; 5.8.7.2			116
23.4	Sample Storage	V1M2 Secs. 5.7.4; 5.8.4	5.8.4	7.4.1, 7.4.4	117
23.5	Hazardous Samples And Foreign Soils				118
23.6	Sample Shipping	V1M2 Sec. 5.8.2	5.8.2	7.4.2	118
23.7	Sample Disposal				119
24.0	ASSURING THE QUALITY OF TEST RESULTS				125
24.1	Overview	V1M2 Secs. 5.9.2; 5.9.3	5.9.2	7.7.2 to 7.7.3	125
24.2	Controls	V1M2 Secs. 5.9.2; 5.9.3	5.9.2	7.7.1, 7.7.3	125

Sect. No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005(E) Reference	ISO/IEC 17025:2017(E) Reference	Page No.
24.3	Negative Controls	V1M2 Secs. 5.9.2; 5.9.3 V1M4 Secs. 1.7.3; 1.7.3.1; 1.7.4.1	5.9.2	7.7.1, 7.7.3	125
24.4	Positive Controls	V1M2 Secs 5.9.2; 5.9.3. V1M4 Secs. 1.7.3; 1.7.3.2; 1.7.3.2.1; 1.7.3.2.2; 1.7.3.2.3	5.9.2	7.7.1, 7.7.3	127
24.5	Sample Matrix Controls	V1M2 Secs 5.9.2; 5.9.3. V1M4 Secs. 1.7.3; 1.7.3.2; 1.7.3.2.1; 1.7.3.2.2; 1.7.3.2.3	5.9.2	7.7.1, 7.7.3	129
24.6	Acceptance Criteria (Control Limits)	V1M2 Sec. 5.9.3. V1M4 Secs. 1.7.4.3		7.7.1, 7.7.3	129
24.7	Additional Procedures To Assure Quality C	V1M2 Sec. 5.9.3. V1M4 Secs. 1.7.4.3		7.7.1, 7.7.3	132
25.0	REPORTING RESULTS				132
25.1	Overview	-V1M2 Secs. 5.10.1; 5.10.2; 5.10.8	5.10.1; 5.10.2; 5.10.8	7.8.1 to 7.8.2	132
25.2	Test Reports	V1M2 Secs. 5.10.1; 5.10.2; 5.10.3.1; 5.10.3.2; 5.10.5; 5.10.6; 5.10.7; 5.10.8; 5.10.10; 5.10.11	5.10.1; 5.10.2; 5.10.3.1; 5.10.3.2; 5.10.5; 5.10.6; 5.10.7; 5.10.8	7.8.2.1, 7.8.2.2, 7.8.3, 7.8.5	133
25.3	Reporting Levels or Report Types	V1M2 Secs. 5.10.1; 5.10.7; 5.10.8	5.10.1; 5.10.7; 5.10.8		135
25.4	Supplemental Information for Test	V1M2 Secs. 5.10.1; 5.10.3.1; 5.10.5	5.10.1; 5.10.3.1; 5.10.5	7.1.1.3, 7.8.6.1, 7.8.7.1 to 7.8.7.3	136
25.5	Environmental Testing Obtained From Subcontractors	V1M2 Secs. 4.5.5; 5.10.1; 5.10.6	5.10.1; 5.10.6		137
25.6	Client Confidentiality	V1M2 Secs. 4.1.5; 5.10.7	4.1.5; 5.10.7	7.2.1 to 4.2.4	137
25.7	Format Of Reports	V1M2 Sec. 5.10.8	5.10.8		138
25.8	Amendments To Test Reports	V1M2 Sec. 5.10.9	5.10.1; 5.10.9	7.8.8.1 to 7.8.8.3	138
25.9	Policies on Client Requests for Amendments	V1M2 Secs. 5.9.1; 5.10.9	5.9.1; 5.10.1; 5.10.5; 5.10.9		138

LIST OF TABLES

Table No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005 Reference	ISO/IEC 17025:2017(E) Reference	Page
12-1	General Corrective Action Procedures	V1M2 Sec. 4.11.6. V1M4 Sec. 1.7.4.1	4.11.2		60
14-1	Record Index		4.13.1.1		67
14-2	Special Record Retention Requirements				69
15-1	Types of Internal Audits and Frequency		4.14.1		73
17-1	General Requirements for Analytical Staff				79
17-2	Employee Training Examples				81
20-1	Example – Instrumentation List		5.5.4; 5.5.5		108
20-2	Example - Schedule of Routine Maintenance				108
24-1	Example - Negative Controls				125
24-2	Negative Controls for Microbiology				126
24-3	Sample Matrix Control				129

LIST OF FIGURES

Figure No.	Title	2009 TNI Standard Reference	ISO/IEC 17025:2005 Reference	ISO/IEC 17025:2017(E) Reference	Page
4-1	Laboratory Organizational Chart	V1M2 Sec. 4.1.5	4.1.3; 4.1.5; 4.2.Z2		31
12-1	Example – Corrective Action Report				63
19-1	Example - Demonstration of Capability Documentation				98
19-2	Example - Work Flow				199
23-1	Example - Chain of Custody (COC)				120
23-2	Sample Acceptance Policy	V1M2 Sec. 5.8.6; 5.8.7.1. V1M4 Sec. 1.7.5			121
23-3	Example - Sample Receipt Checklist		5.8.3		124

LIST OF APPENDICES

Appendix No.	Title	Page
1	Laboratory Floor Plan	139
2	Glossary / Acronyms	140
3	Laboratory Certifications, Accreditations, Validations	148
4	Example - SOP List	149

REFERENCED CORPORATE SOPS AND POLICIES

SOP / Policy Reference	Title
CA-C-S-001	Worksharing Program
CA-I-P-002	Electronic Reporting and Signature Policy
CA-L-P-002	Contract Compliance Policy
CA-L-S-004	Subcontracting
CA-Q-M-002	Corporate Quality Management Plan
CA-Q-QM-001	Policy on Tentatively Identified Compounds (TICs) – GC/MS Analysis
CA-Q-S-001	Acid and Solvent Lot Testing and Approval Program
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-006	Detection and Quantitation Limits
CA-Q-S-009	Root Cause Analysis
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health & Safety Manual
CW-F-P-002	Company-Wide Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Fixed Asset Acquisition, Retention and Safeguarding
CW-I-M-001	IT Change Control Procedure Manual
CW-L-P-001	Records Retention Policy
CW-L-P-004	Ethics Policy
CW-L-S-002	Internal Investigation
CW-L-S-004	Subcontracting
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-Q-S-003	Internal Auditing
CW-Q-S-004	Management Systems Review
CW-Q-S-005	Data Recall Process

REFERENCED LABORATORY DOCUMENTS

SOP Reference	Title
PT-QA-001	Employee Orientation and Training (DOCs)
PT-QA-002	Internal Auditing
PT-QA-005	Measurement Uncertainty
PT-QA-006	Procurement of Standards and Materials; Labeling and Traceability
PT-QA-007	Detection Limits
PT-QA-008	Thermometer and Barometer Verification and Temperature Monitoring
PT-QA-010	Document and Spreadsheet Development & Control
PT-QA-012	Selection and Calibration of Balances and Weights
PT-QA-013	Independent QA Data Review
PT-QA-016	Nonconformance and Corrective Action System
PT-QA-017	Aqueous Pipette / Dispenser Calibration – Gravimetric Method
PT-QA-018	Technical Data Review Requirements
PT-QA-019	Records Management, Retention and Archive
PT-QA-021	Laboratory Quality Control Program
PT-QA-022	Equipment Maintenance
PT-QA-024	Subsampling
PT-QA-WI-002	Master Document List

SECTION 3
INTRODUCTION, SCOPE AND APPLICABILITY

3.1 INTRODUCTION AND COMPLIANCE REFERENCES

Eurofins TestAmerica Pittsburgh's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving Eurofins TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2017(E). In addition, the policies and procedures outlined in this manual are compliant with Eurofins TestAmerica's Corporate Quality Management Plan (CQMP) CA-Q-M-002, and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of Eurofins TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all Eurofins TestAmerica facilities shall conduct their operations.

This QAM has been prepared to be consistent with requirements of the following documents:

- EPA *Requirements for Quality Management Programs* (QA/R-2), EPA/240/B-01/002, May 31, 2006
- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008, Final Update V, August 2015*
- *Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, 22nd and on-line Editions
- *U.S. Department of Energy* Order 414.1D, *Quality Assurance*, April 25, 2011
- Nuclear Regulatory Commission (NRC) quality assurance requirements
- Marine Protection, Research, and Sanctuaries Act (MPRSA)
- Toxic Substances Control Act (TSCA)

3.2 TERMS AND DEFINITIONS

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The Eurofins TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 SCOPE / FIELDS OF TESTING

The laboratory analyzes a broad range of environmental and industrial samples. Sample matrices vary among effluent water, surface water, groundwater, hazardous waste, sludge, soils, sediments, and tissue. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in the Statement of Qualifications (SOQ). The current list of accredited methods is maintained in Total Access. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab’s best interest to follow the less stringent requirements.

3.3.1 Specialty Analyses

3.3.1.1 Dredged Material Evaluations

Eurofins TestAmerica Pittsburgh offers trace level testing of waters (site-waters and elutriates), sediments, and tissues in support of Dredged Material Evaluations for in-water (ocean and inland waters) and upland (Confined Disposal Facilities (CDFs), beneficial use, etc.) disposal options. In-house capabilities for commonly requested sediment program parameters include:

- Organochlorine Pesticides
- Organophosphorus Pesticides
- PCBs (as Aroclors and Congeners)
- Volatile Organics
- Semivolatile Organics
- Metals
- Cyanide
- Total Sulfides
- Acid Volatile Sulfide (AVS) and Simultaneously Extracted Metals (SEM)
- Nitrogen, Ammonia
- Nitrogen, Nitrate + Nitrite
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Total Organic Carbon (combustion procedure for sediments)

- Total Solids/Moisture Content
- Total Volatile Solids
- Lipids
- With teaming arrangements with other Eurofins TestAmerica facilities, additional sediment program capabilities include:
    - Polychlorinated Dibenzo-Dioxins and Furans (PCDDs/PCDFs)
    - Butyl Tins (mono – tetra)
    - Total Kjeldahl Nitrogen
    - Total Phosphorus
    - Grain Size
    - Specific Gravity
    - Atterberg Limits

Eurofins TestAmerica Pittsburgh also generates elutriate samples following appropriate U.S. Army Corps of Engineers procedures. These include:

- Standard Elutriate Test (SET) for in-water disposal evaluations, and
- Modified Elutriate Test (MET) or Effluent Elutriate Test (EET) for CDF disposal evaluations.
- Illinois Resuspension Tests (Supernatant and Elutriate Tests).
- Dredge Elutriate Test (DRET)

Eurofins TestAmerica Pittsburgh currently supports dredge material evaluation projects following several state specific programs, as well as, under the following guidance documents:

- Ocean Testing Manual or OTM (USACE, 1991).
- New Jersey’s Tidal Waters Technical Manual (NJDEP, 1997).
- Inland Testing Manual or ITM (USACE, 1998).
- Upland Testing Manual or UTM (USACE, 2003).

3.3.1.2 <u>Tissue Analyses</u>

Eurofins TestAmerica Pittsburgh has extensive experience in supporting projects requiring tissue analyses. These include analyses of laboratory cultured reference species from bioaccumulation tests associated with dredged material evaluations to a variety of field collected species (aquatic and terrestrial). Eurofins TestAmerica Pittsburgh has developed modifications to the standard solid methodologies (where possible) to allow for the use of smaller sample weights and achieve lower quantitation limits. In-house capabilities for commonly requested tissue parameters include:

- Organochlorine Pesticides
- PCBs (as Aroclors and Congeners)
- Semivolatile Organics
- Metals
- Lipids
- Moisture Content

- With teaming arrangements with other Eurofins TestAmerica facilities, additional tissue capabilities include:
  - Polychlorinated Dibenzo-Dioxins and Furans (PCDDs/PCDFs)
  - Butyl Tins (mono – tetra)

3.4 MANAGEMENT OF THE MANUAL

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed every two years by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to Pittsburgh laboratory SOP No. PT-QA-010, *Document Development and Control*.

SECTION 4

MANAGEMENT REQUIREMENTS

4.1 Overview

Eurofins TestAmerica Pittsburgh is a local operating unit of Eurofins TestAmerica Laboratories, Inc.. The organizational structure, responsibilities and authorities of the Corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President and Chief Executive Officer (CEO), Chief Operating Officer (COO), Executive Vice President (VP) Operations, Corporate Quality etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & Eurofins TestAmerica Pittsburgh is presented in Figure 4-1.

4.2 Roles And Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks impartially and in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for corporate personnel are defined in the CQMP. This manual is specific to the operations of Eurofins TestAmerica's Pittsburgh laboratory.

4.2.2 President and Chief Executive Officer (CEO)

The President and CEO is a member of the Board of Directors and is ultimately responsible for the quality and performance of all Eurofins TestAmerica facilities. The President and CEO establishes the overall quality standard and data integrity program for the Analytical Business, providing the necessary leadership and resources to assure that the quality standard and integrity program are met.

4.2.3 Chief Operation Officer (COO)

The COO reports directly to the President and CEO of Eurofins TestAmerica. The COO is responsible for the operations of Eurofins TestAmerica's subsidiary companies and the company's strategic growth.

4.2.4 Senior Vice President of Operations and Client Services

The SVP of Operations and Client Services leads the Client Services Organization (CSO) and oversees the operations of all Eurofins TestAmerica Laboratories, the Corporate Technical Services group and the Sales Opportunity Optimization efforts. The SVP provides direction to the VPs of Operations, Client Services Directors, Manager or Project Managers, Director of Technical Services and a Director of Sales. The SVP of Operations and Client Services reports directly to the President and CEO of Eurofins TestAmerica.

4.2.5 Vice President of Operations (VPO)

Each VP of Operations (VPO) reports directly to the SVP of Operations and Client Services. Each VPO is responsible for the overall administrative and operational management of their respective laboratories. The VPO's responsibilities include allocation of personnel and resources, long-term planning, goal setting, and achieving the financial, business, and quality objectives of Eurofins TestAmerica. The VPOs ensure timely compliance with Corporate Management directives, policies, and management systems reviews. The VPOs are also responsible for restricting any laboratory from performing analyses that cannot be consistently and successfully performed to meet the standards set forth in this manual.

4.2.6 Vice President of Quality and Environmental Health and Safety (VP-QA/EHS)

The Vice President (VP) of QA/EHS reports directly to the President and CEO. With the aid of the Executive Committee, Laboratory Directors, Quality Directors, Safety Managers, EH&S Coordinators and QA Managers, the VP-QA/EHS has the responsibility for the establishment, general overview and Corporate maintenance of the Quality Assurance and EH&S Programs within Eurofins TestAmerica. Additional responsibilities include:

- Review of QA/QC and EHS aspects of Corporate SOPs & Policies, national projects and expansions or changes in services.
- Work with various organizations outside of Eurofins TestAmerica to further the development of quality standards and represent Eurofins TestAmerica at various trade meetings.
- Prepare monthly reports for quality and EH&S metrics across the analytical laboratories and a summary of any quality related initiatives and issues.
- With the assistance of the Corporate Senior Management Teams and the EHS Managers, development and implementation of the Eurofins TestAmerica Environmental, Health and Safety Program.

4.2.7 Quality Assessment Director

The Quality Assessment Director reports to the VP-QA/EHS. The Quality Assessment Director has QA oversight of laboratories; is responsible for the internal audit system, schedule and procedure; monitors laboratory internal audit findings; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Compliance Director, the Quality Systems Director, and the VP-QA/EHS, the Quality Assessment Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins TestAmerica.

4.2.8 Quality Compliance Director

The Quality Compliance Director reports to the VP-QA/EHS. The Quality Compliance Director has QA oversight of laboratories; monitors and communicates DoD / DoE requirements; develops Corporate tools for ensuring and improving compliance; develops Corporate assessment tools; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Systems Director and the VP-QA/EHS, the Quality Compliance Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins TestAmerica.

4.2.9 Quality Systems Director

The Quality Systems Director reports to the VP-QA/EHS. The Quality Systems Director has QA oversight of laboratories; develops quality policies, procedures and management tools; monitors and communicates regulatory and certification requirements; identifies common laboratory weaknesses; and monitors corrective action closures. Together with the Quality Assessment Director, Quality Compliance Director and the VP-QA/EHS, the Quality Systems Director has the responsibility for the establishment, general overview and maintenance of the Analytical Quality Assurance Program within Eurofins TestAmerica.

4.2.10 Quality Information Manager

The Quality Information Manager is responsible for managing all company official documents (e.g., Policies, Procedures, Work Instructions), the company's accreditation database, intranet websites, external laboratory subcontracting, regulatory limits for clients on the company's TotalAccess website; internal and external client support for various company groups (e.g., Client Services, EH&S, Legal, IT, Sales) for both quality and operational functions. The Quality Information Manager reports to the VP-QA/EHS; and works alongside the Quality Assessment, Quality Compliance and Quality System Directors and EHS Managers to support both the Analytical Quality Assurance and EHS Programs within Eurofins TestAmerica.

4.2.11 Technical Services Director

The Technical Services Director is responsible for establishing, implementing and communicating Eurofins TestAmerica's Analytical Business's Technical Policies, SOPs, and Manuals. Other responsibilities include conducting technical assessments as required, acting as a technical resource in national contracts review, coordinating new technologies, establishing best practices, advising staff on technology advances, innovations, and applications.

4.2.12 Ethics and Compliance Officers (ECOs)

Eurofins TestAmerica has designated two senior members of the Corporate staff to fulfill the role of Ethics and Compliance Officer (ECO) – i.e., the Corporate Counsel & VP of Human Resources and the VP-QA/EHS. Each ECO acts as a back-up to the other ECO and both are involved when data investigations occur. Each ECO has a direct line of communication to the entire senior Corporate and lab management staff.

The ECOs ensure that the organization distributes the data integrity and ethical practices policies to all employees and ensures annual trainings and orientation of new hires to the ethics program and its policies. The ECO is responsible for establishing a mechanism to foster employee reporting of incidents of illegal, unethical, or improper practices in a safe and confidential environment.

The ECOs monitor and audit procedures to determine compliance with policies and to make recommendations for policy enhancements to the President and CEO, VPOs, Laboratory Director or other appropriate individuals within the laboratory. The ECO will assist the laboratory QA Manager in the coordination of internal auditing of ethical policy related activities and processes within the laboratory, in conjunction with the laboratory's regular internal auditing function.

The ECOs will also participate in investigations of alleged violations of policies and work with the appropriate internal departments to investigate misconduct, remedy the situation, and prevent recurrence of any such activity.

4.2.13 Chief Information Officer (CIO)

The CIO is responsible for establishing, implementing and communicating Eurofins TestAmerica's Information Technology (IT) Policies, SOPs and Manuals. Other responsibilities include coordinating new technologies, development of electronic communication tools such as Eurofins TestAmerica's intranet and internet sites, ensuring data security and documentation of software, ensuring compliance with the NELAC standard, and assistance in establishing, updating, and maintaining Laboratory Information Management Systems (LIMS) at the various Eurofins TestAmerica facilities.

4.2.14 Environmental Health and Safety Managers (Corporate)

The EHS Managers report directly to the VP-QA/EHS. The EHS Managers are responsible for the development and implementation of the Eurofins TestAmerica Environmental, Health and Safety program. Responsibilities include:

- Consolidation and tracking all safety and health-related information and reports for the company, and managing compliance activities for Eurofins TestAmerica locations
- Coordination/preparation of the Corporate Environmental, Health and Safety Manual Template that is used by each laboratory to prepare its own laboratory-specific Safety Manual/ CHP
- Preparation of information and training materials for laboratory EHS Coordinators
- Assistance in the coordination of employee exposure and medical monitoring programs to insure compliance with applicable safety and health regulations

- Serving as Department of Transportation (D.O.T.) focal point and providing technical assistance to location management
- Serving as Hazardous Waste Management main contact and providing technical assistance to location management

4.2.15 Laboratory Director (Business Unit Manager or BUMA)

Pittsburgh's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director is also responsible for any service centers connected with their laboratory that perform any tests, such as short holding time analysis for pH. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program. The Laboratory Director can also serve as the Technical Manager.

Specific responsibilities include, but are not limited to:

- Providing one or more technical managers for the appropriate fields of testing. If the Technical Manager is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Manager to temporarily perform this function. If the absence exceeds 20 consecutive calendar days, the primary accrediting authority must be notified in writing.
- Ensuring that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensuring that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensuring Eurofins TestAmerica's human resource policies are adhered to and maintained.
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensuring that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviewing and approving all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursuing and maintaining appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensuring client specific reporting and quality control requirements are met.
- Captaining the management team, consisting of the QA Manager, the Technical Managers and the Department Managers.
- Monitoring the validity of the analyses performed and data generated in the laboratory.
- Providing training and development programs to applicable laboratory staff as new hires and, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- The Technical Manager meets the requirements specified in the Section 5.2.6.1 of the TNI standards.

4.2.16 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system at the laboratory where they work. The QA Manager is also responsible for any service centers connected with their laboratory that perform any tests, such as short holding time analysis for pH. The QA Manager reports directly to the Laboratory Director and their Corporate Quality Director. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA Specialists to accomplish specific responsibilities, which include, but are not limited to:

- Serving as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.
- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Having documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- Maintaining records of all ethics-related training, including the type and proof of attendance.
- Maintaining, improving, and evaluating the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitoring standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Having the responsibility and final authority to accept or reject data and to stop work in progress in the event that procedures and practices compromise the validity and integrity of analytical data.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information. Controlling distribution of controlled documents.
- Reviewing a percentage of all final data reports for internal consistency, including Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness

of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.

- Reviewing of external audit reports and data validation requests.
- Following-up with audits to ensure client QAPP requirements are met.
- Establishing reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Developing suggestions and recommendations to improve quality systems.
- Researching current state and federal requirements and guidelines.
- Captaining the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Evaluating the thoroughness and effectiveness of training.
- Ensuring Compliance with ISO 17025, and other national and state programs, as applicable
- Notifying the accrediting authorities within 30 days of a change in the legal name of the laboratory or a change in any information provided on the application submitted for accreditation.
- Notifying the primary accrediting authority of any change in the laboratories ability to produce valid analytical results that persists for more than 90 calendar days for any analyte/method/matrix combination for which the laboratory holds accreditation.

4.2.17 Technical Director

The Technical Director reports directly to the Laboratory Director. He/she is accountable for all analyses and analysts under their experienced supervision and for compliance with the ISO 17025:2017 standard. He/she serves as a technical resource for Eurofins TestAmerica’s personnel and clients in their field of expertise. The scope of responsibility ranges from the new-hire process and existing technology through on-going training and development programs for existing analysts and new instrumentation, Specific responsibilities include, but are not limited to:

- Managing technical projects and evaluating technologies, reviewing technical data
- Solving technical problems in the laboratory including troubleshooting instruments and developing or modifying methods as needed to meet customer requirements.
- Maintaining and repairing analytical instruments to reduce downtime.
- Consulting with clients, regulators, and others regarding technical aspects of analyses.
- Suggesting and implementing process improvements to maximize productivity, save costs, and decrease turn-around time.
- Participating in Eurofins TestAmerica’s best practice process to spread best technical practices and developing Eurofins TestAmerica Standard Operating Procedures (SOPs). Leads the implementation and follow-up of the best practices and SOPs in the laboratory.
- Evaluating and adapting new technologies and methodologies. Performs non-routine analysis as required to meet the needs of current long-term clients or as a means to capture new clients in support of business development efforts.
- Training analysts and technicians in area of expertise.
- Assisting with the development of health and safety protocols.

- Consulting with Project Managers and sales staff regarding analytical techniques and capabilities.
- Investigating issues raised by clients, QA, sales, and other departments to find root cause and implement corrective action and proper response.
- Contributing technical information and evaluation for deciding major new equipment purchases and capital expenditures.
- Ensuring compliance with ISO 17025, and other national and state programs.

4.2.18 Quality Assurance Specialist

The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assisting the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitating external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assisting the QA Manager in the preparation of new SOPs and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Managing the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Assisting with review and maintenance of training records.
- Assisting the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Assisting with management of and applications for certifications and accreditations.
- Monitoring for compliance the following QA Metrics: temperature monitoring of refrigeration units and incubators; thermometer calibrations; balance calibrations; Eppendorf/pipette calibrations; and proper standard/reagent storage.
- Performing Technical Data Audits and the Audit Miner data file review process for organic instrumentation. Maintain tracking of reviews.
- Assisting with technical review of data packages which require QA review.

4.2.19 Technical Manager / Department Manager

The Technical Manager reports directly to the Laboratory Director. The scope of responsibility ranges from the new-hire training and existing technology through the ongoing training and development programs for existing analysts and new instrumentation and for compliance with the ISO 17025 Standard. Specific responsibilities include, but are not limited to:

- Exercising day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results. Coordinating, writing, and reviewing preparation of all test methods, i. e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples. He/she insures that the SOPs are properly managed and adhered to at the bench. He/she develops standard costing of SOPs to include supplies, labor, overhead, and capacity (design vs. demonstrated versus first-run yield) utilization.

- Reviewing and approving, with input from the QA Manager, proposals from marketing, in accordance with an established procedure for the review of requests and contracts. This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. All work subcontracted by the laboratory must be approved by the client. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.
- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc..
- Captaining department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinating audit responses with the QA Manager.
- Ensuring compliance with ISO 17025, and other national and state programs

4.2.20 Manger of Project Management

The Manager of Project Management reports directly to the Client Services Director with dotted line reporting to the Laboratory Director. There is an entire staff of Project Managers that makes up the Project Management team. With the overall goal of total client satisfaction. In addition to the responsibilities of the Project Manager, listed in section 4.2.21, the MPM's responsibilities include, but are not limited to:

- Training project managers in technical procedures and promoting the growth of the Project Management Team
- Acting as liaison between laboratory management and the Project Management Team
- Managing human resources for the Project Management Team

4.2.21 Project Manager

The PM reports to the Manager of Project Management and serves as the interface between the laboratory's technical departments and the laboratory's clients. The responsibilities of this position include, but are not limited to:

- Ensuring that clients receive the proper sampling supplies
- Responding to client inquiries concerning sample status
- Assisting clients with the resolution of problems concerning COC
- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory
- Notifying the supervisors of incoming projects and sample delivery schedules
- Maintaining communication with clients on sample progress from daily status meeting with agreed-upon due dates
- Discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff
- Familiarizing laboratory staff with specific quotes, sample log-in review, and final report completeness
- Informing QA Manager of special client requests that are outside of standard operating procedure
- Monitoring the status of all data package projects in-house to ensure timely and accurate delivery of reports
- Informing clients of data package-related problems and resolve service issues
- Coordinating requests for sample containers and other services
- Verifying that subcontract laboratories hold the required certification for all analytes, methods, and matrices to be sent.

4.2.22 Project Manager Assistant (PMA)

The PMA reports to the Manager of Project Management and serves as the interface between the laboratory's technical departments and the laboratory's clients. The responsibilities of this position include, but are not limited to:

- Collating data reports, expanded deliverables and CLP data packages for delivery to clients and reviews for accuracy
- Assisting the CSMs and PMs in the reporting process
- Printing reports as needed for Project Managers
- Monitoring report due dates for timely delivery
- Providing clerical support to the CSMs, PMs and other laboratory staff as needed
- Generating credit or debit invoices to ensure proper payment in compliance with client requirements as established and communicated
- Sending final data to clients via email or courier

4.2.23 Team Leader/Supervisor

The Team Leader/Supervisor reports directly to the Organics or Inorganics Manager and/or Laboratory Director or designee. The responsibilities of this position include, but are not limited to:

- Ensuring that analysts in their department adhere to applicable SOPs and the QA Manual. He/she performs frequent SOP review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- Overseeing training, development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts and documents these activities in accordance with systems developed by the QA and Personnel Departments.
- Providing guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Manager(s) and/or QA Manager. Each is responsible ensuring 100% implementation of the data review and documentation, non-conformance and corrective action issues, the timely and accurate completion of performance evaluation samples and MDLs, for his/her department.
- Ensuring that all logbooks are maintained, current, and properly labeled or archived.
- Ensuring that all data is properly entered into the LIMS system and is reviewed and approved as required by laboratory documentation policy.
- Reporting all non-conformance conditions to the QA Manager and Department Manager.
- Ensuring that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He/she is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.
- Maintaining adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieving optimum turnaround time on analyses and compliance with holding times.
- Assisting QA department with root cause investigations and corrective action proposals for responses to external and internal audit issues, system failures and client complaints.

4.2.24 Laboratory Analyst

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the team leader or supervisor. The responsibilities of the analysts include, but are not limited to:

- Performing analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Ensuring sample and data integrity by adhering to internal chain-of-custody procedures.
- Documenting standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on bench sheets, lab notebooks, run logs, and/or the Non-Conformance Database.
- Reporting all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, Department Manager, and/or the QA Manager or member of QA staff.
- Performing 100% review of the data generated prior to entering and submitting for secondary level review. Performs data processing using available tools/software.
- Suggesting method improvements to their supervisor, the Technical Manager (s), and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the

optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.

- Working cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.
    - A “work cell” is considered to be all those individuals who see a sample through the complete process of preparation, extraction, and analysis. To ensure that the entire preparation, extraction, and analysis process is completed by a group of capable individuals, the laboratory shall ensure that each member of the work cell (including a new member entering an already existing work cell) demonstrates capability in his/her area of responsibility in the sequence. Even though the work cell operates as a “team,” the demonstration of capability at each individual step in the sequence, as performed by each individual analyst/team member, remains of utmost importance. A work cell may NOT be defined as a group of analysts who perform the same step in the same process (for example, extractions for Method 8270), represented by one analyst who has demonstrated capability for that step.

4.2.25 Sample Management Manager

The Sample Receiving Manager reports to the Laboratory Director and Client Services Manager. The responsibilities of this position include, but are not limited to:

- Ensuring implementation of proper sample receipt procedures, including maintenance of chain-of-custody.
- Reporting nonconformances associated with condition-upon-receipt of samples.
- Ensuring accurate login of samples into TALS.
- Ensuring that all samples are stored in the proper environment.
- Assisting Environmental Health and Safety staff with sample disposal.

4.2.26 Field Service Technician

The Field Service Technicians report to the Sample Management Department Manager. The responsibilities of the Field Service Technician include, but are not limited to:

- Performing sample collection and sample pick-up
- Ensuring sample containers are prepared for sampling
- Performing field tests and measurements and operating and maintaining equipment used for those purposes.

4.2.27 Environmental Health and Safety Coordinator

The Health and Safety Coordinator reports to the Laboratory Director and ensures that systems are maintained for the safe operation of the laboratory. The EH&S Coordinator :

- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Safety Data Sheet (SDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.
- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.

- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is “reasonable” and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by Eurofins TestAmerica’s medical consultants.

4.2.28 Hazardous Waste Coordinator

The Hazardous Waste Coordinator reports directly to the Laboratory Director. The duties include, but are not limited to:

- Staying current with the hazardous waste regulations
- Continuing training on hazardous waste issues
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste

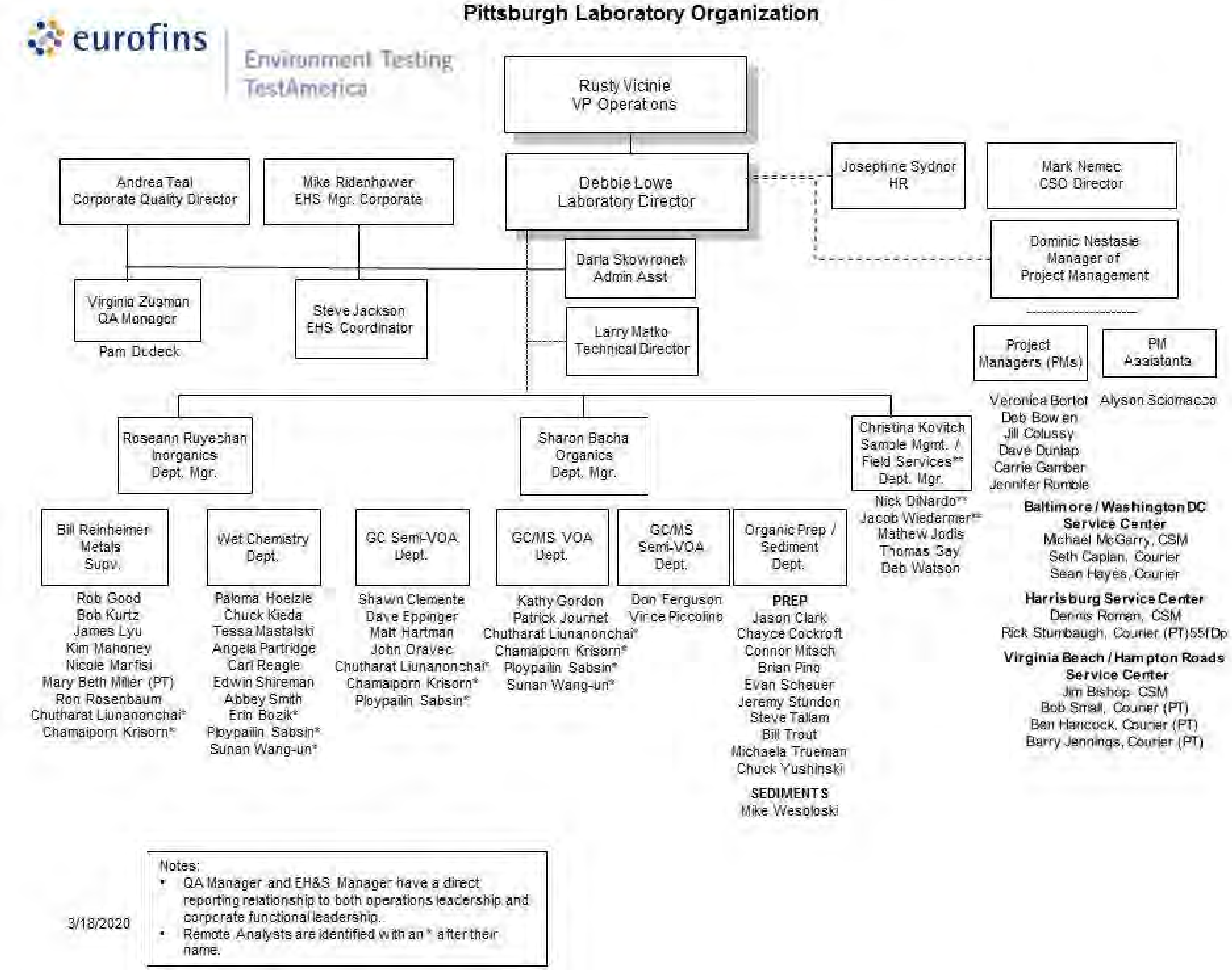
4.3 DEPUTIES

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy	Comment
Laboratory Director: Deborah Lowe	Project Technical Manager – Dave Dunlap	NELAP Technical Manager (entire laboratory)
Quality Assurance Manager: Virginia Zusman	Quality Assurance Specialist: Pam Dudeck	
Technical Director: Larry Matko	Laboratory Director: Deborah Lowe	NELAP Technical Manager (Lipids & 8141)
Organics Department Manager: Sharon Bacha	Designated Senior GC and GCMS Analyst	NELAP Technical Manager (Organics)
Inorganics Department Manager: Roseann Ruyechan	Designated Metals and Wet Chemistry Supervisors / Senior Analyst	NELAP Technical Manager (Inorganics, Inorganics-Non-metals)
Organic Prep Team Leader: Sharon Bacha/Larry Matko	Designated Senior Organic Prep Analyst	
Sample Management Department Manager: Christina Kovitch	Lab Director or Designated person in the Sample Management group	

If the NELAP Technical Manager is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Manager to temporarily perform this function. If the absence exceeds 30 consecutive calendar days, the primary accrediting authority must be notified in writing.

Figure 4-1 - Laboratory Organization Chart



Notes:
- QA Manager and EH&S Manager have a direct reporting relationship to both operations leadership and corporate functional leadership.
- Remote Analysts are identified with an * after their name.

Note: Organization Charts are subject to change - contact the laboratory for the most recent version

SECTION 5

QUALITY SYSTEM

5.1 Quality Policy Statement

It is Eurofins TestAmerica's Policy to provide the highest quality data achievable by:

implementing the process in our work.

- Following all recordkeeping requirements; describing clearly and accurately all activities performed; recording "real time" as the task is carried out; understanding that it is never acceptable to "back date" entries and should additional information be required at a later date, the actual date and by whom the notation is made must be documented.
- Reading and understanding all of the quality documents applicable to each position and the data generated. Data is attributable, legible, contemporaneously recorded, original or a true copy, and accurate (ALCOA). This applies to manual paper documentation and
- Ensuring data integrity through the completeness, consistency, impartiality and accuracy of electronic records.
- Providing accountability and traceability for each sample analyzed through proper sample handling, labeling, preparation, instrument calibration/qualification/validation, analysis, and reporting; establishing an audit trail (the who, what, when, and why) that identifies date, time, analyst, instrument used, instrument conditions, quality control samples (where appropriate and/or required by the method), and associated standard material.
- Emphasizing a total quality management process which provides impartiality, accuracy, and strict compliance with agency regulations and client requirements, giving the highest degree of confidence; understanding that meeting the requirements of the next employee in the work flow process is just as important as meeting the needs of the external client.
- Providing thorough documentation and explanation to qualify reported data that may not meet all requirements and specifications, but is still of use to the client; understanding this occurs only after discussion with the client on the data limitations and acceptability of this approach.
- Responding immediately to indications of questionable data, out-of-specification occurrences, equipment malfunctions, and other types of laboratory problems, with investigation and applicable corrective action; documenting these activities completely, including the reasons for the decisions made.
- Providing a work environment that ensures accessibility to to all levels of management and encourages questions and expression of concerns on quality issues to management. Eurofins recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff
- Continually improve systems and manage risk to support quality improvement efforts in laboratory, administrative and managerial activities
- We each take personal responsibility to provide this quality product while meeting the company's high standards of integrity and ethics, understanding that improprieties, such as failure to conduct the required test, manipulation of test procedures or data, or inaccurate documentation will not be tolerated. Intentional misrepresentation of the activities performed is considered fraud and is grounds for termination.
- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.

- To comply with the ISO/IEC 17025:2017(E) International Standard, the 2009 and 2016 TNI Standards and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics And Data Integrity

Eurofins TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of Eurofins TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy No. CW-L-P-004) and Employee Ethics Statements
- Ethics and Compliance Officers (ECOs)
- A Training Program
- Self-governance through disciplinary action for violations
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP No. CW-L-S-002)
- Procedures and guidance for recalling data if necessary (Corporate SOP No. CW-Q-S-005)
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15 and laboratory SOP PT-QA-002 on Internal Auditing)
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs)
- Present services in a confidential, honest and forthright manner
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry
- Provide procedures and guidance to ensure the impartiality and confidentiality of all data and customer information.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same
- Educate clients as to the extent and kinds of services available
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab specific quality assurance manual.
- Corporate SOPs and Policies - Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.

- Work Instructions - A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives For The Measurement Of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. The client is responsible for developing the QAPP, however, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity.

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (above the Method Detection Limit) or quantified (above the Reporting Limit).

5.5 Criteria For Quality Indicators

The laboratory maintains tables, housed in TALS, that summarizes the precision and accuracy acceptability limits for analyses performed at Eurofins TestAmerica Pittsburgh. This summary includes an effective date, is updated each time new limits are generated and is managed by the laboratory's QA department. Limits are archived within the LIMS when replaced. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in laboratory SOP PT-QA-021, *Laboratory Quality Control Program*.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. Analysts are restricted to using only the current limits within TALS, controlled as discussed above. The Quality Assurance department maintains an archive of all limits used within the laboratory. These limits are maintained in TALS as part of the analytical historical record. If a method defines the QC limits, the method limits are used. For further details refer to laboratory SOP PT-QA-021.

If a method, or program, defines the QC limits, the required limits are used, unless laboratory developed limits are tighter.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of TALS following the guidelines described in Section 24 and laboratory SOP PT-QA-021. All calculations and limits are documented and dated when approved and effective. On occasion, a client may request contract-specified limits for a specific project.

Current QC limits are entered and maintained in TALS analyte database. As sample results and the related QC are entered into TALS the sample QC values are compared with the limits in TALS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

The generation and use of QC Charts (Control Charts) are described in laboratory SOP PT-QA-021. The QA department evaluates control charts to determine if adjustments need to be made to existing limits or corrective actions are necessary. All findings are documented and kept on file.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

5.8 Laboratory Certification/Accreditation

The Laboratory Quality System is designed to meet the requirements of all governing bodies through which it holds certification / accreditation.

- A list of certifications and accredited scopes is maintained by the QA Department, and current certificates are posted in the laboratory lobby. Expired certificates are maintained in the QA archive.
- Certification renewal is completed on an annual basis, or within the time frame required by each accrediting agency.
- The laboratory shall read and follow all accrediting agencies' accreditation requirements before applying and when renewing accreditations.
- The laboratory indicates clearly in its reports which certifications it holds,
- The laboratory does not use their NELAP or any state certificate of accreditation, accreditation status, or accrediting agency logo to imply endorsement by any accrediting body.
- The laboratory distinguishes on data reports between testing for which the laboratory is accredited and testing for which the laboratory is not accredited. The laboratory's primary AB accreditation number is also included on all data reports.
- Upon expiration, suspension, revocation or voluntary relinquishment of accreditation, a laboratory shall:
    - Discontinue use of all catalogs, advertising, business solicitations, proposals, quotations, laboratory analytical results or other materials that contain reference to the laboratory's past accreditation status.
    - Discontinue use or display of the Department's logo.
    - Return unexpired certificates of accreditation to the Department within 48 hours.
    - Discontinuing all testing for the affected fields of accreditation.
    - Notify all customers affected by the loss or suspension in writing within 72 hours of receiving notice of the change in accreditation status.

- If there is a change in laboratory ownership, the laboratory must notify all accreditors within 10 days. Some accrediting agencies require additional change applications be submitted within 30 days.

SECTION 6

DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Logbooks and Calculation Spreadsheets
- Corporate Policies and Procedures distributed outside the intranet
- External documents that are used as part of the laboratory's Quality System

The Corporate QA Department posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP No. CW-Q-S-001, *Corporate Document Control and Archiving*. The laboratory's internal document control procedure is defined in laboratory SOP PT-QA-010, *Document Development and Control*.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports and Nonconformance Memos (NCMs). Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval And Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a responsible manager submits an electronic or paper draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retain that document as the official document on file. That document is then provided to all applicable operational units. Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every two years, or more often as required, and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures For Document Control Policy

For creation of or changes to SOPs and QA manual, refer to Corporate SOP No. CW-Q-S-002, *Writing a Standard Operating Procedure (SOP)* and laboratory SOP No. PT-QA-010.

Uncontrolled copies must not be used within the laboratory. Controlled documents are marked as such, and posted to a controlled laboratory access drive by the QA department. Controlled distribution is achieved electronically. Controlled hardcopies must be obtained through the QA Department. Previous revisions and back-up data are stored on a restricted access drive by the QA department. Details of the numbering system, required format, and controlled distribution of documents are described in laboratory SOP No. PT-QA-010. Editable copies are stored on a restricted access drive.

Forms, worksheets, work instructions and information are organized by department by the QA office. Controlled electronic versions are distributed through the intranet and hard copies can be printed out as needed. Editable versions are stored on a restricted access drive. All forms used in the laboratory are tracked in the controlled documents database which can be accessed by the QA department and the IT group. The procedure for the care of these documents is in laboratory SOP No. PT-QA-010.

6.4 Obsolete Documents

All invalid or obsolete documents are removed from general laboratory access, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. Obsolete hardcopy documents are collected from employees according to distribution lists and are destroyed. At least one electronic copy of the obsolete document is archived according to laboratory SOP No. PT-QA-019, *Records Information Management*.

SECTION 7

SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily fit into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (%Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another Eurofins TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or Eurofins TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence And Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the Client Relationship Manager or Proposal Team, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in Eurofins TestAmerica's Corporate Policy No. CA-L-P-002**,** *Contract Compliance Policy*.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Contract Administrator
- VP of Operations
- Laboratory Project Management
- Laboratory Director / Technical Manager
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate EH&S
- The laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The Sales Director, Contract Administrator, Account Executive or Proposal Coordinator then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

7.3 Documentation

The Contracts Department maintains copies of all signed contracts. In the Pittsburgh laboratory, copies of contracts are maintained in the laboratory network public drive by the sales/marketing personnel.

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Contracts review documentation and is maintained in the network public drive.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Account Manager. A copy of the contract and formal quote will be filed with the laboratory PM and the Lab Director.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log or an electronic record of conversations with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, a PM is assigned to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production and operations meetings. Such changes are updated to the project notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 25).

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client
- Assist client-specified third party data validators as specified in the client's contract
- Supplemental information pertaining to the analysis of their samples

  Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

When the client requests a statement of conformity to a specification or standard based on the analysis performed by the laboratory (e.g., pass/fail, in-tolerance/out-of-tolerance), the decision rule shall be clearly defined. Unless inherent in the requested specification or standard, the decision rule selected shall be communicated to the client. Associated reporting requirements are addressed in Section 25.2.18.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

Technical Managers, or their designees, are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

To the extent possible, results of testing or analysis of environmental samples shall be reported only if all quality control, analytical testing and sample acceptance measures are acceptable. If a quality control, analytical testing or sample acceptance measure is found to be out of control and the results of the testing or analysis of environmental samples are to be reported, all environmental samples associated with the failed quality control measure shall be documented and the results flagged in an unambiguous manner on the sample analysis report with the appropriate data qualifiers.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. Eurofins TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction. Survey results and both complaints and compliments are tracked in the monthly quality metrics report.

SECTION 8

SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the Eurofins TestAmerica laboratories. To distinguish between an external laboratory and a Eurofins TestAmerica laboratory at a different location, the phrase "work sharing" or "work share lab" refers to internal subcontracting between Eurofins TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to Corporate SOP No. CA-L-S-004, *Subcontracting*, and CA-C-S-001, *Worksharing Process*.

When outsourcing analytical services, the laboratory will assure, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor or work share lab and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required.

Project Managers (PMs) and Account Executives (AE) for the Export Lab (i.e. the Eurofins TestAmerica laboratory that transfers samples to another laboratory) are responsible for obtaining client approval prior to subcontracting or work sharing any samples. The laboratory will advise the client of a subcontract arrangement in writing and when possible approval from the client shall be obtained and retained in the project folder. These approvals may be granted by the client in written contractual agreements between the client and Eurofins TestAmerica.

Note: In addition to the client, some regulating agencies, (e.g, USDA) or contracts may require notification prior to placing such work**.** Client notification and approval must be documented.

8.2 Qualifying And Monitoring Subcontractors

Whenever a PM, Account Executive (AE) or Customer Service Manager (CSM) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- Subcontractors specified by the client – In these circumstances, the client assumes responsibility for the quality of the data generated from the use of a subcontractor.
- Subcontractors reviewed by Eurofins TestAmerica – Firms which have been reviewed by the company and are known to meet standards for accreditations (e.g. State, TNI); technical specifications; legal and financial information.

A list of approved vendors is available on the Eurofins TestAmerica intranet site. Approved vendors' capabilities and certifications are found in the individual folders maintained on that site.

All Eurofins TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations and can adhere to the project/program requirements. The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (See Corporate SOP No. CA-C-S-001, *Work Sharing Process*, for details).

8.2.1 When the potential sub-contract laboratory has not been previously approved, Account Executives or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Client Relations Manager (CRM) or Laboratory Director. The CRM or Laboratory Director requests that the QA Manager or Project Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP No. CA-L-S-004, Subcontracting. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability and forwarded to the Corporate Quality Information Manager (QIM) for review. After the Corporate QIM reviews the documents for completeness, the information is forwarded to the Finance Department for formal signature and contracting with the laboratory. The approved vendor will be added to the approved subcontractor list on the intranet site and the finance group is concurrently notified.

The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. Eurofins TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.3 Oversight and Reporting

8.3.1 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Quality department and includes an annual review process (see Subcontracting SOP CW-L-S-004). Any problems identified will be brought to the attention of Eurofins TestAmerica's Corporate Finance, Legal or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor’s file on the intranet site. Complaints are posted using the Vendor Performance Report.

- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. CSO personnel will notify all Eurofins TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all CSO personnel, Laboratory Directors, QA Managers, and Sales Personnel.

Prior to initially sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it’s current and scope-inclusive. The information is documented within the project records.

8.3.2 For continued use of an approved external subcontractor, current certifications are viewed by the responsible Project Manager on the intranet site. For Eurofins TestAmerica laboratories, certifications can be viewed on through TALS.

8.3.3 All subcontracted samples must be accompanied by a Eurofins TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must be available in TALS for all samples workshared within Eurofins TestAmerica. Client COCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client COCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor’s report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a Eurofins TestAmerica work sharing laboratory may be transferred electronically and the results reported by the Eurofins TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

If a report including workshare data is sent to West Virginia clients, then individual reports per laboratory must be generated.

Note: If samples are subcontracted for SDWA compliance testing, the following information must be provided to the subcontract laboratory along with all other required chain-of-custody information: Public Water System ID Number and name of the system providing the sample, sample location ID number, and name and contact number of the Public Water System.

8.4 Contingency Planning

The full qualification of a subcontractor may be waived to meet emergency needs. This decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and COC.

In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract agreement with Eurofins TestAmerica at this time.

The use of any emergency subcontractor will require the PM to complete a JDE New Vendor Add Form in order to process payment to the vendor and add them to TALS. This form requires the user to define the subcontractor's category/s of testing and the reason for testing.

SECTION 9

PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with Eurofins TestAmerica's *Fixed Asset Acquisitions, Retention and Safeguarding* SOP No. CW-F-S-007.

Contracts will be signed in accordance with Eurofins TestAmerica's Corporate Policy No. CW-F-P-002, *Company-Wide Authorization Matrix*. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in Eurofins TestAmerica's Corporate Policy No. CW-F-P-004, *Procurement and Contracts Policy*. RFP's allow Eurofins TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the Eurofins TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pretested in accordance with Eurofins TestAmerica's Corporate SOP No. CA-Q-S-001, *Solvent & Acid Lot Testing and Approval Program*. Approval information for the solvents and acids tested under Corporate SOP No. CA-Q-S-001 is stored on the Eurofins TestAmerica intranet SharePoint, under Solvent Approvals. A master list of all tested materials, as well as the certificates of analysis for the materials, is stored in the same location. Additional approval and traceability instructions are found in laboratory SOP PT-QA-006, *Procurement of Standards and Materials; Labeling and Traceability*.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst completes the Material Request Sheet when requesting reagents, standards, or supplies, or they may check the item out of the on-site consignment system that contains items approved for laboratory use.

If an item is not in the consignment system, the analyst must obtain approval from the area team leader/supervisor and Laboratory Director prior to the order being placed by the purchasing department. The responsible analyst places the order.

9.3.2 Receiving

It is the responsibility of the Sample Receiving department to receive the shipment. It is the responsibility of the analyst or manager who ordered the materials to document the date the materials were received. Once the ordered reagents or materials are received, the analyst or designee compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. This is documented through the addition of the received date and reviewers initials to the packing slip.

Lot numbers of solvents and acids are checked against the approved solvent/acid list. If the material is listed as unapproved, or is not listed, it is sequestered and returned to the vendor. Alternatively, the laboratory may test the material for the intended use, and if it is acceptable, document the approval on the approval list. Records of any testing performed locally are maintained by the QA department, and lots approvals and certificates of analysis are stored on the Eurofins TestAmerica intranet Pittsburgh SharePoint site.

Materials may not be released for use in the laboratory until they have been inspected, verified as suitable for use, and the inspection/verification has been documented.

Safety Data Sheets (SDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOPs expiration date unless verified as outlined below.

- An expiration date **cannot** be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded. In this case, the dry chemical/solvent must be discarded.

- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).

- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained on-file and available for review with each lab department and copy forwarded to QA department. Recertification is documented in TALS.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. To prevent a tank from going to dryness, or introducing potential impurities, the pressure should be closely watched as it decreases to approximately 15% of the original reading, at which point it should be replaced. For example, a standard sized laboratory gas cylinder containing 3,000 psig of gas should be replaced when it drops to approximately 500 psig. The quality of the gases must meet method or manufacturer specifications or be of a grade that does not cuase any analytical interference.

Water used in the preparation of samples, standards or reagents must have a specific conductivity of less than 1- µmho /cm (or specific resistivity of greater than 1.0 megohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical Managers/Supervisors must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified clean by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

NOTE: Each bottleware type must be documented as clean down to the laboratory MDL for all target analytes for use with samples from Wisconsin.

Records of manufacturer's certification and traceability statements are maintained in files or binders in each laboratory section. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Department Manager or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. No. CW-E-M-001), method SOPs, or manufacturer instructions.

9.4 Purchase Of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Department Manager and/or the Laboratory Director. If they agree with the request, the procedures outlined in Corporate Policy No. CA-T-P-001, *Qualified Products List*, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19).

For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained in the laboratory in a designated area or near the instrument.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Technical Managers. The service providers that perform the services are approved by the Laboratory or Technical Director.

Analytical balances are serviced and calibrated annually in accordance with laboratory SOP No. PT-QA-012, *Selection and Calibration of Balances and Weights*. The calibration and maintenance services are performed on-site, and the balances are returned to use immediately following successful calibration. When the calibration certificates are received (usually within 24 hours of the service), they are reviewed, and documentation of the review is filed with the certificates. If the calibration was unsuccessful, the balance is immediately removed from service and segregated pending either further maintenance or disposal.

Calibration services for support equipment such as thermometers, weight sets, autopipettors, etc, are obtained from vendors with current and valid ISO 17025 accreditation for calibration of the specific piece of equipment. Prior to utilizing the vendor's services, the vendor's accreditation status is verified. Once the equipment has been calibrated, the calibration certificates are reviewed by the QA department, and documentation of the review is filed with the calibration certificates. The equipment is then returned to service within the laboratory.

9.6 Suppliers

Eurofins TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Policy No. CW-F-P-004. The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on Eurofins TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

Suppliers are subject to re-evaluation, as deemed appropriate, through the use of Vendor Performance Reports used to summarize and review to determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the ORACLE purchasing system.

9.6.1 New Vendor Procedure

Eurofins TestAmerica employees who wish to request the addition of a new vendor must complete a Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with Eurofins TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technical Services Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10

COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures client knowledge that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following laboratory SOP PT-QA-016, *Non-Conformance and Corrective Action System*. A copy of this procedure will be made available to any interested party on request.

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint in the database, according to laboratory SOP PT-QA-016.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Acknowledge receipt of complaint, whenever possible
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the Laboratory Director and Quality Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Systems Review (Section 16).

SECTION 11

CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. When an analyst encounters such a situation, the problem is presented to their manager for advice. The manager may elect to discuss it with the Laboratory Director or QA Manager or have a PM contact the client to decide on a logical course of action. Once an approach is agreed upon, the analyst documents it using the laboratories non-conformance/corrective action system described in Section 12. This information can then be supplied to the client in the form of a case narrative with the report.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Laboratory Director and QA Manager, documented and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities And Authorities

Under certain circumstances, the Laboratory Director, a Technical Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information is documented on a Nonconformance Memo (NCM) and may also be documented in logbooks and/or data review checklists as appropriate*.* Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Technical Managers. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an ECO (e.g., the VP-QA/EHS) and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director, QA Manager, ECOs, VP of Operations, and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation Of Significance And Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

Corporate SOP entitled Data Recalls (CW-Q-S-005) is the procedure to be followed when it is discovered that erroneous or biased data may have been reported to clients or regulatory agencies.

Corporate SOP entitled Internal Investigations (CW-L-S-002) is the procedure to be followed for investigation and correction of situations involving alleged incidents of misconduct or violation of the company's ethics policy.

Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in Eurofins TestAmerica's Corporate SOP No. CW-Q-S-005.

11.4 Prevention Of Nonconforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. On at least a monthly basis, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process must be followed.

11.5 Method Suspension/Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target analyte which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 4.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line. The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be e-mailed by the laboratory to the appropriate VP of Operations and member of Corporate QA. This e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc.). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (e.g., Laboratory Director, Technical Manager, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete.

SECTION 12

CORRECTIVE ACTION

12.1 Overview

A major component of Eurofins TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Eurofins TestAmerica employs two systemsto manage non-conformances. Issues suspected of being systematic in nature and for which root cause analysis and a formal Corrective Action Report (CAR) are needed are documented in the Incident Corrective Action Tracking (ICAT) database. Routine batch non-conformances, events that are understood to be isolated in nature, are documented in the TALS non-conformance memo (NCM) system. See Figure 12-1 for an example CAR.

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Memo (NCM) - is used to document the following types of corrective actions:

- Isolated deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client Complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips (Forms of documentation other than NCMs in TALS are also acceptable.)
- Anomalies that occur during sample receipt, preparation or analysis

12.2.2 Corrective Action Documented in the ICAT Database

- Internal and external audit findings
- Failed or Unacceptable PT results
- Identified poor process or method performance trends
- Systematic reporting / calculation errors.

- Data recall investigations
- Questionable trends that are found in the review of NCMs
- Client complaints
- Excessive revised reports

The ICAT database is used to document background information, track the results of corrective action investigations and root cause analysis, and to provide reports of corrective action plans.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An entry into the ICAT system must be initiated. Someone is assigned to investigate the issue and the event is investigated for root cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.
- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the root cause is not readily obvious, the Technical Director, Laboratory Director, Technical Manager, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.

- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.

- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The ICAT record is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness. Corporate SOP No. CA-Q-S-009, *Root Cause Analysis*, describes this procedure.

Systematically analyze and document the root causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the root cause data from these incidents to identify root causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Technical Manager and QA Manager are responsible to ensure that the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Technical Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- The QA Manager reviews monthly NCMs and ICAT records for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory’s compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or record in the ICAT system.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original uncorrected file must be maintained intact and a second corrected file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Table 12-1

Example – General Corrective Action Procedures

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Initial Instrument Blank *(Analyst)*	- Instrument response < MDL	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards *(Analyst, Technical Manager(s))*	- Correlation coefficient > 0.99 or 0.995 or: standard concentration value - Read-back errors within acceptance range - % Recovery within acceptance range - See details in Method SOP	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Technical Manager(s))*	- % Recovery within control limits	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in LIMS	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. - If the LCS is within acceptable limits the batch is acceptable. - The results of the duplicates, matrix spikes and the LCS are reported with the data set. - For matrix spike or duplicate results outside criteria the data for that sample shall be reported with qualifiers.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in LIMS	- Batch must be re-prepared and re-analyzed. This includes any allowable marginal exceedance. When not using marginal exceedances, the following exceptions apply: 1) when the acceptance criteria for the positive control are exceeded high (i.e., high bias) and there are associated samples that are non-detects, then those non-detects may be reported with data qualifying codes; 2) when the acceptance criteria for the positive control are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level with data qualifying codes. **Note:** If there is insufficient sample or the holding time cannot be met, contact client and report with flags.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean	- Individual sample must be repeated. Place comment in TALS. - Surrogate results outside criteria shall be reported with qualifiers.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1] For common lab contaminants, no analytes detected at greater than and equal to RL.	- Reanalyze blank. - If still positive, determine source of contamination. If necessary, reprocess (i.e. digest or extract) entire sample batch. Report blank results. - Qualify the result(s) if the concentration of a targeted analyte in the MB is at or above the reporting limit and is > 1/10 of the amount measured in the sample.
Proficiency Testing (PT) Samples *(QA Manager, Technical Manager(s))*	- Criteria supplied by PT Supplier	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Technical Manager(s), Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through ICAT system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, *Technical Manager(s)*, QA Manager, Corporate QA, Corporate Management)	- Corporate SOP CW-Q-S-005, Data Recall	- Corrective action is determined by type of error. Follow the procedures in Corporate SOP CW-L-S-002, Internal Investigations, or laboratory SOP PT-QA-016.

QC Activity ***(Individual Responsible for Initiation/Assessment)***	**Acceptance Criteria**	**Recommended Corrective Action**
Client Complaints *(Project Managers, Lab Director, Sales and Marketing)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated).
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, Lab Director, *Technical Manager(s)*)	- QAM, SOPs	- Corrective action is determined by the type of issue. For example, NCMs and ICAT records for the month are reviewed and possible trends are investigated.
Health and Safety Violation (Safety Officer, Lab Director, *Technical Manager(s)*)	- Environmental Health and Safety (EHS) Manual	- Non-conformance is investigated and corrected through ICAT system.

Note:

1. Except as noted below for certain compounds, the method blank should be below the reporting limit unless there is a client specific requirement or method requirement to be evaluated to a lower level. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates provided that they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit.

Figure 12-1

Example – Corrective Action Report (iCAT)

incident/Corrective Action Tracker (iCAT)

Edit Corrective Action Record

Created By:	zusmanv
Created On:	X/XX/2017
Laboratory Function:	Other Lab Functions
Corrective Action Type:	PT and/or Double Blind Failures
Finding Number:	
Finding Reference:	
Subject:	PT study Failure
Client:	
Project (if applicable):	
Planned Issue Closure Date:	X/XX/2017
Assigned To:	Analyst Doe
Response Due to QA:	X/XX/2017
Priority:	1
Follow-Up Assigned To:	
Date Follow-Up Due:	
Date Follow-Up Done:	
Planned Closure Date:	X/XX/2017
Date Closed:	
Status:	Open

Figure 12-1

Example – Corrective Action Report (iCAT) Cont.

Describe the Required Action:

Investigation/Response:

Root Cause:

Corrective Action Plan:

Select for Notification

Selected	Name	Title
☐		

SECTION 13

PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process if improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, the laboratory continually strives to improve customer service and client satisfaction through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered through any of the following on the Preventative Action Schedule:

Preventative Action	Frequency
Management System Review	Annually
Review of QA Metrics	Monthly
Trending NCMs	Monthly
Review of Control Charts of QC Results	At least annually
Trending PT Results	Semi-annually
Trending Client Complaints	Monthly
Review of Revised Reports and Invoices	Monthly
Review of Process Operations	At least annually
Staff Observations and Suggestions	As they arise

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. The metrics report is reviewed monthly by laboratory management, Corporate QA and Eurofins TestAmerica's Executive Committee. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

Items identified as continuous improvement opportunities to the management system may be issued as goals from the annual management systems review, recommendations from internal audits, white papers, Lesson Learned, Technical Services audit report, Technical Best Practices, or as Corporate or management initiatives.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action and non-conformances provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action/process improvement system:

- Identification of an opportunity for preventive action or process improvement
- Process for the preventive action or improvement
- Define the measurements of the effectiveness of the process once undertake
- Execution of the preventive action or improvement
- Evaluation of the plan using the defined measurements
- Verification of the effectiveness of the preventive action or improvement
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action or Process Improvement. Documentation of Preventive Action/ Process Improvement is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions/ Process Improvements undertaken or attempted shall be taken into account during the Annual Management Systems Review (Section 16). A highly detailed report is not required; however a summary of success and failure within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management Of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of indicators monitored under this collective system include:

Change Type	Examples
Facility Changes	-movement of prep or instrument groups to a new location in the laboratory -introduction of significant changes in air handling or gas and solvent delivery systems -significant room additions or renovations -significant electrical or network upgrades or changes
Major Accreditation Changes	-voluntary surrender of accreditations no longer deemed necessary to the laboratory -loss of accreditation -addition of new accreditation programs
Reagents and Waste Streams	- new chemicals/reagents not previously used in the laboratory -deletion of chemicals/reagents that will mean they are no longer used at all in the laboratory -major changes to the volume of chemicals/reagents being used - a new waste stream must be developed Note: See EHS for changes in waste streams
Addition or Deletion of Laboratory Capabilities	-implementation of new regulated methods -“retiring” of active methods -method development for “in-house” methods Note: New regulatory methods and method development require specific processes and documentation before the process can begin or the method can enter production. See QA and EHS for requirements.
LIMS changes	-large system upgrades -additions of new capabilities Note: These changes are handled on a Corporate level
Key Personnel Changes	-key personnel promotions and their effect on that individuals group (experience, productivity, leadership, manpower) -key personnel losses -impact of new personnel that may add new experience or capabilities to the laboratory
New Types of	-addition of a new instrument class/technology

Instrumentation	-significant instrument upgrades that impact sensitivity, productivity or capability Note: New instrumentation requires collection and submission of instrument IDOC information before entering production. See QA for requirements.
Changes in Quality Systems and Policies	-implementation of a new Corrective Action System -changes to the Internal Audit program -implementation of uploads for Proficiency Testing samples

SECTION 14

CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued. Exceptions for programs with longer retention requirements are discussed in section 14.1.2.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. More detailed information on retention of specific records is provided in Corporate Policy No.CW-L-P-001, *Records Retention Policy*, and Work Instruction No. CW-L-WI-001, *Eurofins TestAmerica Records Retention/Storage Schedule*. Quality records are maintained by the Quality Assurance (QA) department electronically on the corporate designated QA network drive which is backed up as part of the regular network backup. Records are of two types; either electronic or hard copy paper formats, depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the CSO group, HR, and the QA department and as outlined in laboratory SOP PT-QA-019.

Table 14-1 Record Index[1]

	Record Types [1]:	**Retention Time:**
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals - Published Methods	Indefinitely
QA Records	- Certifications - Method and Software Validation / Verification Data	Indefinitely

	Record Types [1]:	**Retention Time:**
QA Records	- Internal & External Audits/Responses - Corrective/Preventive Actions - Management Reviews - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documents - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*
Administrative Records	Financial and Business Operations	Refer to CW-L-WI-001
	EH&S Manual, Permits	Indefinitely
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies	Indefinitely
	Technical Training Records	7 years
	Legal Records	Indefinitely
	HR Records	Refer to CW-L-WI-001
	IT Records	Refer to CW-L-WI-001
	Corporate Governance Records	Refer to CW-L-WI-001
	Sales & Marketing	5 years
	Real Estate	Indefinitely

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or an offsite location that provides a suitable environment to prevent damage or deterioration and to prevent loss at the laboratory or the Iron Mountain data storage facility. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log**.** Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Retention of records are maintained on-site at the laboratory for at least 1 year after their generation and moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2 Special Record Retention Requirements

Program	[1]Retention Requirement
Drinking Water – All States	10 years (lab reports and raw data)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Ohio VAP	10 years and State contact prior to disposal
OSHA	30 years

[1] Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.15.1 and laboratory SOP PT-QA-019, Records Management, Retention, and Archive, for more information.

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the chain of custody is stored with the invoice and the work order sheets generated by TALS. Details of the COC linking procedure are described in SOP PT-SR-001. The chain of custody would indicate the name of the sampler. Any sampling notes provided with the chain of custody are also scanned into TALS.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.
- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set are described in SOP PT-QA-019. Instrument data is stored sequentially by instrument. Run logs are maintained for each instrument; a copy of each day's run long is stored in the electronic files along with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data or the data is entered directly into TALS as the analysis is done. Standard and reagent information is recorded in electronic standard log in TALS, and is associated with each preparation and analytical batch for which they are used.
- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in TALS or instrument data are recorded in audit trails.
- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".
- All generated data, except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.
- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data is lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP PT-QA-019.
- Also refer to Section 19.15.1 'Computer and Electronic Data Related Requirements'**.**

14.2 Technical And Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in TALS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- Laboratory sample ID code**;**
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook, on a benchsheet or in TALS.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in method specific SOPs or in instrument maintenance logs where available.
- analysis type**;**
- all manual calculations and manual integrations**;**
- analyst's or operator's initials/signature**;**
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents**;**
- test results**;**
- standard and reagent origin, receipt, preparation, and use**;**
- calibration criteria, frequency and acceptance criteria**;**
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions**;**
- quality control protocols and assessment**;**
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the TALS and on specific analytical report formats**.**

14.2.4 All logbooks used during receipt, preparation, storage, analysis, and reporting of samples or monitoring of support equipment shall undergo a periodic, documented supervisory or peer review.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**
- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value**;**
- copies of final reports**;**
- archived SOPs**;**
- correspondence relating to laboratory activities for a specific project**;**
- all corrective action reports, audits and audit responses**;**
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage And Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access**.**

The laboratory has a record management system (a.k.a., document control) for control of laboratory notebooks/benchsheets, instrument/equipment logbooks, and records for data reduction, validation and reporting. Laboratory notebooks are issued on a per analysis basis, as needed, and are numbered sequentially. All sample data are recorded in TALS. Bench sheets are filed sequentially. Standards are maintained in the electronic standards in TALS**.** Records are considered archived when noted as such in the records management system (a.k.a., document control).

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the Corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years, unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15

AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and when requested to Corporate management.

Audits are conducted and documented as described in the Corporate SOP No. CW-Q-S-003, *Internal Auditing*. More detail on the specific elements for internal audits and data audit is described in Pittsburgh Laboratory SOP No. PT-QA-002, *Internal Auditing*. The types and frequency of routine internal audits are shown in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1 Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits QA Technical Data Audits*	Joint responsibility: a) QA Manager or designee b) Technical Manager or Designee (Refer to CW-Q-S-003)	50% of methods annually

Description	Performed by	Frequency
SOP Method Compliance*	Joint responsibility: c) QA Manager or designee d) Technical Manager or Designee (Refer to CW-Q-S-003)	Every 2 years
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

*Technical Data and Method Compliance audits are in addition to the annual Quality Systems Audit

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, Eurofins TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including, but not limited to, data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant. See SOP PT-QA-002 for auditing area details.

Effectiveness of training will be determined during our annual QA systems evaluation. Evidence of successful training includes:

- Audit and surveillance results, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback, and management reviews in efforts to monitor trends and continually improve the quality system:
- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and for people cross-trained.
- Analysts knowledge of QA Manual and SOPs. Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision.

15.1.2 QA Technical Data Audits

QA technical audits assess data authenticity and analyst integrity. These audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., Chrom AuditMiner) are used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period. All analysts and data reviewers should be reviewed over the course of a two year period through at least one QA Technical Audit.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the QA department, Technical Manager, or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, reviews (new IDOC) of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Water Pollution Program, Water Supply Program, Hazardous Waste Program, client supplied PTs and Lab internal PTs.

It is Eurofins TestAmerica’s policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Unacceptable PT results are required to be entered into the ICAT system for investigation. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 EXTERNAL AUDITS

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is Eurofins TestAmerica’s policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory’s performance in relation to work performed for the client. The client may only view data and systems related directly to the client’s work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as “a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment.” When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as “trade secret”, “proprietary” or “company confidential”. Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the ICAT system (see Section 12). The laboratory’s corrective action responses may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Technical Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory’s test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly, in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after completion of the investigation.

SECTION 16
MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory’s QA Department and forwarded to the Laboratory Director, Technical Managers, their Quality Director as well as the VP of Operations. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, VP of Operations, or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and VPs of Operations.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, QA Manager, and Technical Managers) conducts a review annually of its quality systems and TALS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals & objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel is to be included in this meeting at the discretion of the Laboratory Director. The TALS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the TALS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

The Management System Review (see Corporate SOP No. CW-Q-S-004, *Management System Review*, and Work Instruction No. CW-Q-WI-003) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review
- Prior Monthly QA Reports issues
- Laboratory QA Metrics
- Review of report reissue requests
- Review of client feedback and complaints
- Issues arising from any prior management or staff meetings
- Minutes from prior senior lab management meetings - Issues that may be raised from these meetings include:

    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.

- The annual internal double blind PT program sample performance
- Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity
- Review of Corrective and Preventative Actions, assessments by external bodies and recommendations for improvement
- Evaluation of overall risk, including risks to impartiality, confidentiality, reporting statements of conformity, and nonconforming work.

A report is generated by the QA Manager and management. The report is distributed to the appropriate VP of Operation and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants
- A reference to the existing data quality related documents and topics that were reviewed

- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)]

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. Eurofins TestAmerica's Corporate Internal Investigation and Data Recall SOPs shall be followed (SOP No. CW-L-S-002 and CW-Q-S-005). All investigations that result in finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

Eurofins TestAmerica's President and CEO, Executive VP of Operations, VP of Client & Technical Services, VPs of Operation, and Quality Directors receive a monthly report from the VP-QA/EHS summarizing any current data integrity or data recall investigations. The VP's of Operation are also made aware of progress on these issues for their specific labs.

SECTION 17

PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education And Experience Requirements For Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. For supervisory positions, the Pennsylvania DEP has education and experience requirements that must be met by the Pittsburgh laboratory personnel, and these are reflected in Table 17-1 below. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for Eurofins TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the Eurofins TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, pipette or quantitation techniques, etc., are also considered).

Table 17-1 General Requirements for Analytical Staff

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience

Specialty	Education	Experience
Technical Manager (s) – **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years' experience in environmental analysis of representative analytes for which they will oversee
Technical Manager (s) – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience
Technical Managers - **Microbiology**	Bachelors degree in applied science with at least 16 semester hours in general microbiology and biology An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years of relevant experience (1 year if laboratory analysis is limited to coliforms and heterotrophic plate count)
Technical Managers – **Microbiology** limited to analysis of fecal coliforms, total coliforms or heterotrophic bacteria	Associates degree in an applied science or engineering and at least 4 credit hours in biology	And 2 years of relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training.

Table 17-2 Employee Training Examples

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics –New Hire Comprehensive	30 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	30 days of hire	All
Ethics – Comprehensive Refresher	Annually (within 14 months of previous)	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Pittsburgh Laboratory SOP No. PT-QA-001, *Employee Orientation and Training*.

17.4 Data Integrity And Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of Eurofins TestAmerica and is provided for each employee at Eurofins TestAmerica. It is a formal part of the initial employee comprehensive ethics and data integrity training within 30 days of their start date, and an annual (within at most 14 months of the previous training) refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance Eurofins TestAmerica places on maintaining high ethical standards at all times; Eurofins TestAmerica has established a Corporate Policy No. CW-L-P-004, *Ethics Policy*, and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize Eurofins TestAmerica's ability to do work on Government contracts, and for that reason, Eurofins TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting
- Ethics Policy
- How and when to report ethical/data integrity issues and confidential reporting
- Record keeping
- Discussion regarding data integrity procedures
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring, investigations, and data recalls
- Consequences for infractions, including potential for immediate termination, debarment, or criminal prosecution
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient

Additionally, a data integrity hotline (1-800-736-9407) is maintained by Eurofins TestAmerica and administered by the Corporate Quality Department.

SECTION 18

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 33,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory. Systems are controlled and monitored to assure constant and consistent test conditions.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and TALS are regulated to protect against raw data loss.

When a laboratory performs laboratory activities at sites of facilities outside its permanent control, it shall ensure that the requirements related to facilities and environmental conditions of this document are met.

Specific requirements for facility and environmental conditions, as well as periodic monitoring of conditions, are given in the Environmental Health & Safety Manual plus each laboratory's Facility Addendum.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Microbiological culture handling and sample incubation areas
- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory
- Sample receipt areas
- Sample storage areas
- Chemical and waste storage areas
- Data handling and storage areas
- Sample processing areas
- Sample analysis areas

Refer to the following documents and procedures for specific requirements for microbiological laboratory facilities:

- Standard Methods, 9020B, Sec. 2
- TNI V1M5, 1.7.3.7.a

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19

TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPs)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory. A SOP list is included in Appendix 4. The most current list of SOPs is maintained in the QA SOP directory, Work Instruction PT-QA-WI-002.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to Eurofins TestAmerica's Corporate SOP No. CW-Q-S-002, *Writing a Standard Operating Procedure*, or Pittsburgh SOP PT-QA-010, *Document Development and Control*.
- SOPs are reviewed at a minimum of every 2 years, and where necessary, revised to ensure continuing suitability and compliance with applicable requirements. SOPs related to drinking water testing are reviewed every year.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index (PT-QA-WI-002) for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection Of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Analysis and Sampling Procedures; 40CFR Part 136 as amended by Method Update Rule, August 28, 2017*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th /on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II,*

September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008, Final Update V, August 2015

- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*
- *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual, U.S. Army Corps of Engineers, January, 2003*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC) is performed whenever there is a change in instrument type (e.g., new instrumentation), matrix, method or personnel (e.g., analyst hasn't performed the test within the last 12 months). The IDOC must meet the control limits specified in the reference method, if any, or meet method LCS criteria if no IDOC specific controls are provided. (see laboratory SOP No. PT-QA-001, *Employee Orientation and Training*, for details)

Note: The laboratory shall have a DOC for all analytes included in the methods that the laboratory performs, and proficiency DOCs for each analyst shall include all analytes that the laboratory routinely performs. Addition of non-routine analytes does not require new DOCs for all analysts if those analysts are already qualified for routine analytes tested using identical chemistry and instrument conditions.

The initial demonstration of capability must be thoroughly documented and approved by the Technical Manager and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and DOC). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

Initial Demonstration and Capability (IDOC) procedure is described in laboratory SOP No. PT-QA-001.

19.4.3.1 The spiking standard used to prepare IDOCs must be prepared independently from those used in instrument calibration.

19.4.3.2 The analyte(s) shall be diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified by a method or the laboratory SOP.

19.4.3.3 At least four aliquots shall be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.4 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest.

19.4.3.5 When it is not possible to determine the mean and standard deviations, such as for presence/absence and logarithmic values, the laboratory will assess performance against criteria described in the method SOP.

19.4.3.6 Compare the information obtained above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in the laboratory generated acceptance criteria (LCS or interim criteria) if there is no mandatory criteria established. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

19.4.3.7 When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to either option below:

- Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with 19.4.3.3 above.
- Beginning with 19.4.3.3 above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source

of the problem and repeat the test for all parameters beginning with 19.4.3.1 above.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (Figure 19-1) shall be used to document the completion of each initial and continuing demonstration of capability. A copy of the certification is archived in the analyst's training file.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits for methods for which standards exist.

19.5 Laboratory Developed Methods And Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation Of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Validation of a method is a planned activity. A coordinator is designated for the process, who's responsibility it is to communicate the process and progress to all involved personnel.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

When changes are made to any validated methods, the influence of such changes shall be documented and, if appropriate, a new validation shall be performed.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Detection limit studies are conducted as described in Section 19.7 below. Where other protocols for estimations and/or demonstrations of sensitivity are required by regulation or client agreement, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Limit of Quantitation (LOQ)

An important characteristic of expression of sensitivity is the distinction between the LOD and the LOQ. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The LOQ is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias, equivalent to the laboratory's routine reporting limit (RL). For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the LOQ. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the LOQ, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL)/ Limits Of Detection (LOD)

The MDL is the minimum measured quantity of a substance that can be reported with 99% confidence that the concentration is distinguishable from method blank results, consistent with 40CFR Part 136 Appendix B, August, 2017. The MDL is equivalent to the TNI LOD, and is also equivalent to the DoD/DOE Quality Systems Manual (QSM) DL. The working or final MDL is the higher of the MDL value determined from spikes (MDLs) and the MDL value determined from blanks (MDLb). An initial MDL study shall be performed during the method validation process and when the method Is altered in a way that can reasonably be expected to change the sensitivity. On-going data are collected during each quarter in which samples are being analyzed. At least once every 13 months, the MDLs and MDLb are re-calculated and re-evaluated using data collected during the preceding period. Details of Eurofins TestAmerica's procedure for conducting MDL studies are given in SOP No. CA-Q-S-006.

19.8 Verification of Detection Limits

If it is found during the re-evaluation of detection limit results that more than 5% of the spiked samples do not return numeric results that meet the method qualitative identification criteria, then the spiking level shall be increased and the initial MDL study re-performed at the new spiking concentration.

19.9 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3 x the absolute value of the standard deviation.

19.10 Limit of Quantitation

The LOQ shall be at a concentration equivalent to the lowest calibration standard concentration, with the exception of methods using a single-point calibration, and shall be greater than the MSL. The LOQ is verified by preparing and analyzing spikes at or below the LOQ concentration, employing the complete analytical process.

When the laboratory establishes a quantitation limit, it must be initially verified by the analysis of two low level standards or QC samples at the reporting limit and quarterly thereafter. The laboratory will comply with any additional regulatory requirements.

19.11 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept on-file and available for review. Complete details are available in the laboratory SOPs.

19.12 Evaluation Of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.13 Estimation Of Uncertainty Of Measurement

19.13.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty" defined as the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.13.2 Uncertainty is not error. Error is a single value (i.e. the difference between the true result and the measured result). On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.13.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.13.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k =3. As an example, for a reported result of 1.0 mg/L with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 +/- 0.5 mg/L. Uncertainty determination is further described in laboratory SOP PT-QA-005, *Measurement Uncertainty*.

19.13.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.14 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats. **Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.**

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within ± 1 reporting limit for samples ≤ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported.
- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.
- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.
- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Technical Manager/Supervisor or Laboratory Director if unsure.

19.15 Control Of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.15.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently using the Eurofins TestAmerica TALS LIMS system, which has been highly customized to meet the needs of the laboratory. It is referred ti as TALS throughout this document. More setailed descriptions of computer systems and associated controls are given in the IT Change Control Procedure Manual (CW-I-M-001) and policies and procedures posted on Eurofins TestAmerica's Intranet site, Oasis.

19.15.1.1 **Maintain the Database Integrity:** Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, documentation of system failures and corrective actions taken, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.15.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.15.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval, when electronically transmitting data.

19.15.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in TALS. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s). The applicable data/spreadsheet is scanned in TALS with the batch.

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the Eurofins TestAmerica Corporate SOP No. CA-Q-S-002, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.15.2.1 All raw data must be retained in the worklist folder, computer file (if appropriate), and/or run log. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.15.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter (µg/l) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1**%.** Units are defined in each lab SOP.

19.15.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to TALS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report.

19.15.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with TALS, the raw results and dilution factors are entered directly into TALS by the analyst, and the software calculates the final result for the analytical report. TALS has a defined significant figure criterion for each analyte.

19.15.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the TALS, the raw results and dilution factors are transferred into TALS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file. The data file is stored on the server and every night backed up to a tape file.

19.15.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the Technical Manager / QA Manager at the facility.
    - Any cells that perform calculations must have the calculation verified and the cell locked so that the formula cannot be changed.
    - The QA Manager controls all worksheets following the procedures in Section 6.

19.15.4 Review / Verification Procedures

Review procedures are outlined in several SOPs (e.g. laboratory SOPs PT-QA-013, *Independent QA Data Review*; PT-QA-018, *Technical Data Review*; and PT-SR-001, *Sample Receipt and Login*) to ensure that reported date are free from calculation and transcription errors, and that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data (CA-Q-S-002). The general review concepts are discussed below. More specific information can be found in the SOPs.

19.15.4.1 Log-In Review - The data review process starts at the sample receipt stage. Sample control personnel review chain-of-custody forms and project instructions from the project management group. This is the basis of the sample information and analytical instructions entered into the TALS. The log-in instructions are reviewed by the personnel entering the information, and a second level review is conducted by the project management staff.

19.15.4.2 First Level Data Review - The next level of data review occurs with the analysts. As data are generated, analysts review their work to ensure that the results meet project and SOP requirements. First level reviews include inspection of all raw data (e.g., instrument output for continuous analyzers, chromatograms, spectra, and manual integrations), evaluation of calibration/calibration verification data in the day's analytical run, evaluation of QC data, documentation of standards and reagents, and reliability of sample results. The analyst transfers data into TALS, data qualifiers are added as needed. All first level reviews are documented.

19.15.4.3 Second Level Data Review – All analytical data are subject to review by a second qualified analyst or supervisor. Second level reviews include inspection of all raw data (e.g., instrument output, chromatograms, and spectra) including 100% of data associated with any changes made by the primary analyst, such as manual integrations or reassignment of peaks to different analytes, or elimination of false negative analytes. The second review also includes evaluation of initial calibration/calibration verification data in the day's analytical run, evaluation of QC data, documentation of standards and reagents, reliability of sample results, qualifiers and NCM narratives. Manual calculations are checked in second level review. All second level reviews are documented.

Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.15.4.4 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, Technical Director, Department Manager or section Supervisor for further investigation. Corrective action is initiated whenever necessary.

19.15.4.5 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.15.4.6 As a final review prior to the release of the report, the Project Manager (or designee) reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that the COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met. The Project Manager may also evaluate the validity of results for different test methods given expected chemical relationships.

19.15.4.7 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager (or designee) then signs the final report. They also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.15.4.8 As a further check of the system, the QA department reviews both selected and random analytical batches and final reports.

19.15.4.9 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.15.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using Corporate SOP No. CA-Q-S-002.

19.15.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.15.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principles and policy and is grounds for immediate termination.

19.15.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.15.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “before” and “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented Corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1

Example - Demonstration of Capability Documentation

DEMONSTRATION OF CAPABILITIY (DOC)

Laboratory Name:____
Laboratory Address:____
Method:____________________________________ Matrix:_____________________________
Date:__________________ Analyst(s):____
Source of Analyte(s):____

Analytical Results

Analyst	Conc. (Units)	Rep 1	Rep 2	Rep 3	Rep 4	Avg. % Recovery	% RSD
__________	__________	_____	_____	_____	_____	______________	_______

% RSD = Percent relative standard deviation = standard deviation divided by average % Recovery

Raw data reference: ________________________________

Certification Statement:

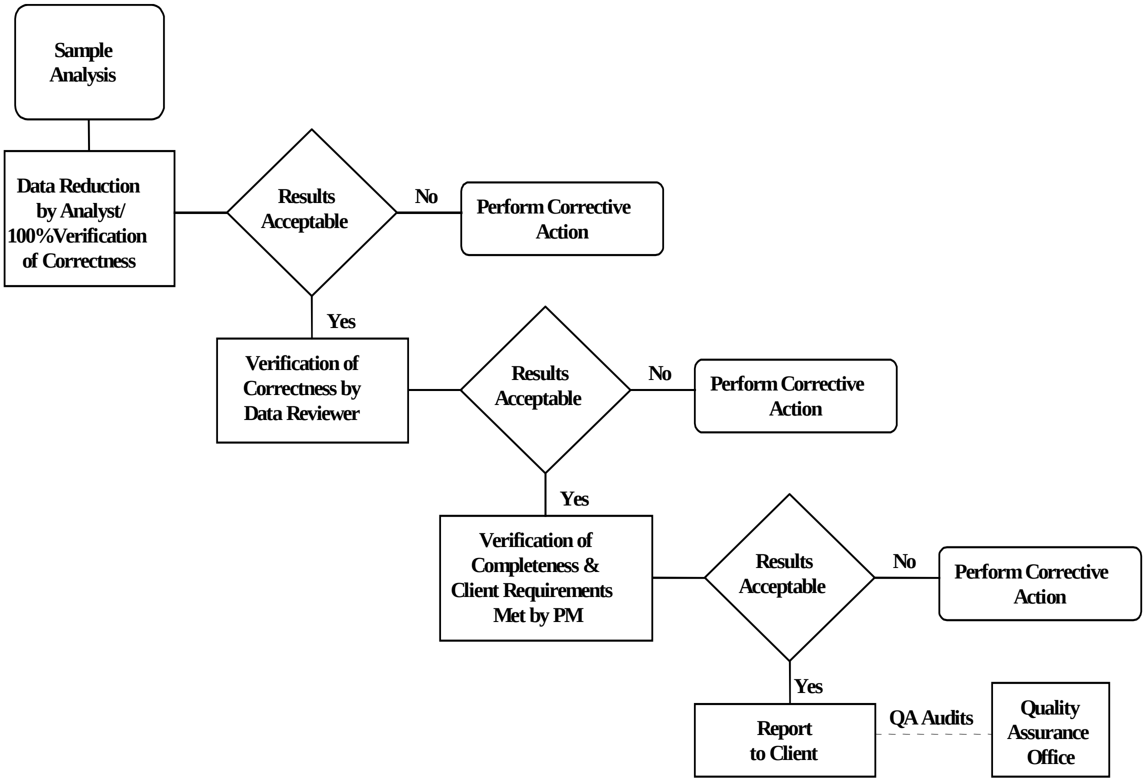
We, the undersigned, certify that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the laboratory's Quality Assurance Plan, has completed the Demonstration of Capability (DOC).
2. The test method(s) was performed by the analyst identified on this certificate.
3. A copy of the test method and the laboratory-specific SOPs are available for all personnel on site. These documents have been reviewed by the analyst as part of this DOC.
4. The data associated with the demonstration of capability are true, accurate, complete, and self-explanatory.
5. All raw data necessary to reconstruct and validate these analyses have been retained at the facility, and the associated information is well organized and available for review.

______________________________________ Analyst Signature	__________ Date
______________________________________ Technical Manager Signature	__________ Date
______________________________________ Quality Assurance Coordinator Signature	__________ Date

Figure 19-2

Example Work Flow



SECTION 20

EQUIPMENT AND CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified laboratory analytical SOPs. Also see Corporate Policy No. CA-Q-P-003, *Calibration Curves and Selection of Calibration Points*.

A list of laboratory instrumentation types is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturer’s instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Technical Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures are outlined in analytical SOPs or instrument manuals. Further detail for equipment maintenance is included in SOP No. PT-QA-022 and individual analytical SOPs. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.

- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This attached document must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back-up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back-up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and the laboratory MDL verified prior to return to lab operations following the requirements in SOP PT-QA-007.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

Support equipment that provides quantitative results are calibrated or calibration verified to a recognized national metrology standard, such as NIST, where available, over the expected range of use. The acceptability for use shall be according to the needs of the analysis or application for which the equipment is being used.

Calibration and calibration verification scheduling and documentation for support equipment is maintained by the QA department. All equipment is labeled with the most recent calibration information and the next verification due date.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least three certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains “calibration only” ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to Pittsburgh Laboratory SOP No. PT-QA-012, *Selection and Calibration of Balances and Weights*, for details.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters used in the laboratory are capable of measuring conductivity with an error not exceeding 1% or one umhos/cm, whichever is greater. The meters are also calibrated before each use with a known standard.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity laboratory analytical SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes and thermocouples are calibrated quarterly. IR thermometers are checked daily for calibration accuracy against an NIST thermometer daily before use.

- If the temperature measuring device is used over a range of 10℃ or less, then a single point verification within the range of use is acceptable;
- If the temperature measuring device is used over a range of greater than 10℃, then the verification must bracket the range of use.

IR thermometers, digital probes and thermocouples are calibrated quarterly.

Mercury or digital NIST thermometers are recalibrated every five years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of at least 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometers are used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method or device-specific logbooks. More information on this subject can be found in Pittsburgh Laboratory SOP No. PT-QA-008, *Thermometer and Barometer Verification and Temperature Monitoring*.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day. Sample storage temperatures are monitored continuously (24/7).

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logbooks or electronically. Refer to laboratory SOP PT-QA-008.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices, including burettes, (except Class A Glassware and glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. Glass micro-syringes are considered the same as Class A glassware.

For those dispensers that are not used for analytical measurements, a label shall be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements. Pipette calibration is described in Pittsburgh Laboratory SOP No. PT-QA-017, *Aqueous Pipette Calibration*.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an “Accuracy and Precision Statement of Conformance” from Hamilton attesting established accuracy.

20.3.6 Field Sampling Devices (Isco Auto Samplers)

Each Auto Sampler (ISCO) is assigned a unique identification number in order to keep track of the calibration. This number is also recorded on the sampling documentation.

The Auto Sampler is calibrated quarterly by setting the sample volume to 100ml and recording the volume received. The results are filed in a logbook/binder. The Auto Sampler is programmed to run three (3) cycles and each of the three cycles is measured into a graduated cylinder to verify 100ml are received.

If the RSD (Relative Standard Deviation) between the 3 cycles is greater than 10%, the procedure is repeated and if the result is still greater than 10%, then the Auto Sampler is taken out of service until it is repaired and calibration verification criteria can be met. The results of this check are kept in a logbook/binder.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP and ICP-MS methods or other methods which define the working range with periodic linear dynamic range studies, rather than through the range of concentrations of daily calibration standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst at a different time or by a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 and 2016 TNI standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification (ICV) is with a standard source secondary (second source standard) to the calibration standards, but continuing calibration verifications (CCV) may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i. e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Generally, the initial calibrations must be verified by an ICV analyzed immediately following initial calibration and before sample analysis. The ICV may be used as the first bracketing CCV if criteria for both are met.

A continuing instrument calibration verification (CCV) is generally analyzed at the beginning of each 12-hour analytical shift during which samples are analyzed. (The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard is MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift. For methods that have quantitation by external calibration models, a CCV is analyzed at the end of each analytical sequence. Some methods have more frequent CCV requirements see specific SOPs.

Most Inorganic methods require the CCV to be analyzed after every 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (e.g., GCMS and some GC methods) then bracketing standards are not required, only daily verifications are needed, except as specified by program or method requirements.

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument / method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with a unacceptable calibration verification may be fully useable and may be reported, based upon discussion and approval of the client, under the following special conditions:

a) When the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative comment explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b) When the acceptance criteria for the CCV are exceeded low (i.e., low bias), samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported under one of the conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs.) Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on %Drift or %Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

Note: Some programs require additional verification steps for linear and quadratic calibration – i.e. reading the lowest, or all, initial calibration level standard against the curve, or verification at a low and a high concentration. See analytical SOPs and project notes for details.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Further details are given in policy memorandum CA-Q-QM-001, Policy on Tentatively Identified Compounds (TICs) – GC/MS Analysis.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

20.6 GC/MS TUNING

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spectrometer the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1

Eurofins TestAmerica Pittsburgh Instrumentation Type List
(see PT-QA-WI-045 for the most current full listing of instrumentation and equipment)

GC	GC/MS	ICP	ICP/MS	IC	Carbon Analyzer	Auto-Analyzer	Variable Spectro-photometer	Electrode Meter
√	√	√	√	√	√	√	√	√

Tables 20-2

Example - Schedule of Routine Maintenance
(See SOP No. PT-QA-022 for more instrument specific information)

Daily	Weekly	Monthly	Quarterly	Annually	As Needed
Check sample waste container level.	Check peristaltic pump: proper roller pressure, sample introduction tubing, correct pump rotation, and condition of drain tubing.	Clean all filters and fans.	Replace oil in roughing pumps.	Replace oil in turbo-molecular pump.	Check electronic settings for optimum sensitivity: resolution, mass calibration, ion optics, CEM, deflector voltage.
Check quartz torch condition.	Check condition of sampler and skimmer cones.	Check recirculator water level.			
Measure quartz torch for proper alignment.	Check and drain oil mist eliminator on roughing pumps.				
Clean spray chamber and nebulizer.					
Check oil level of roughing pumps.					

SECTION 21

MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Microsyringes can be verified at least semi-annually or disposed of after 6 months of use. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights And Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.
For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program) or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia – Pacific Laboratory Accreditation Cooperation). A certificate and scope of accreditation is kept on file at the laboratory.

Additional details can be found in laboratory SOP No’s. PT-QA-008 and PT-QA-012.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared reference standards, to the extent available, are purchased from vendors accredited to ISO Guide 34 and ISO/IEC Guide 17025. All reference standards from commercial vendors shall be accompanied by a certificate that includes at least the following information:

- Manufacturer
- Analytes or parameters calibrated
- Identification or lot number
- Calibration method
- Concentration with associated uncertainties
- Purity

If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented in the LIMS. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the true value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g. calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer’s requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory has contingency procedures for re-verifying expired standards. See Pittsburgh Laboratory SOP No. PT-QA-006, *Procurement of Standards and Materials, Labeling and Traceability*.

21.4 Documentation And Labeling Of Standards, Reagents, And Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company-wide purchase. (Refer to Eurofins TestAmerica’s Corporate SOP No. CA-Q-S-001, *Acid & Solvent Lot Testing and Approval*.)

All manufacturer or vendor supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the QA public drive and in the LIMS, scanned into Reagent log. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to laboratory analytical SOPs and SOP PT-QA-006.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials that may affect quality must be labeled in an unambiguous manner. Standards are logged into TALS, and are assigned a unique identification number. The following information is typically recorded within TALS.

- Standard ID
- Description of Standard
- Department
- Preparer’s name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation Date or Date opened
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer’s name or initials. Preparation procedures are provided in the laboratory analytical SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Date prepared or Date opened
- Expiration Date (include prep date for reagents)
- Standard ID (from electronic standard log in TALS)
- Special Health/Safety warnings if applicable

Records must also be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in standard/reagent log. Health and safety warning are in the SDS (Safety Data Sheets) which is accessed through the company intranet site.

21.4.3 In addition, the following information may be included:

- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include, expiration date and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22

SAMPLING

22.1 Overview

The laboratory provides sampling services for the following matrices:

- Groundwater
- Wastewater
- Potable Water
- Wastes
- Soil and Sediment

The laboratory also offers the following services:

- Flow Monitoring
- Field Parameter Analysis

Field Analyses are address in Eurofins TestAmerica Pittsburgh SOP No.'s:

- PT-FS-001 – Field Measurement of Dissolved Oxygen (DO)
- PT-FS-002 – Field Measurement of Total Residual Chlorine
- PT-FS-003 – Field Measurement of pH
- PT-FS-004 – General Sampling

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Certificates of cleanliness for bottles and preservatives are provided by the supplier and are

maintained at the laboratory. Alternatively, the certificates may be maintained by the supplier and available to the laboratory on-line.
For detailed information regarding container/bottle order, refer to laboratory SOP No. PT-SR-002, *Bottle Order Preparation and Shipping*.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In general, containers are purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – AR Select (ACS) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – AR Select (ACS), Trace-Metals Grade or equivalent
- Sodium Hydroxide – AR Select (ACS) or equivalent
- Sulfuric Acid – AR Select (ACS) or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent
- Sodium Bisulfate – ACS Grade or equivalent

22.3 Definition Of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in days (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in hours (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is. Holding times for analysis include any necessary reanalysis.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The container type, preservation, and holding time criteria specified in the SOPs are derived from the source documents for the methods. If method required holding times as specified in the SOPs or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible, or “ASAP”, is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory’s responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines for subsampling are located in laboratory SOP PT-QA-024.

SECTION 23

HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal. Details can be found in laboratory SOP No. PT-SR-001, *Sample Receipt and Login*, and PT-HS-001, *Pittsburgh Facility Addendum EH&S Manual*.

23.1 Chain Of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to Eurofins TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a Eurofins TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the CoC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by laboratory when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in login by date; it lists all receipts for each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

If samples are identified for legal/evidentiary purposes on the COC, login will complete the custody seal retain the shipping record with the COC, and initiate an internal COC for laboratory use by analysts and a sample disposal record.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

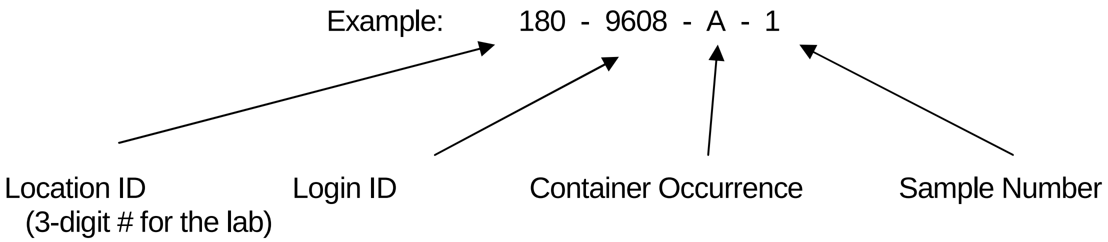
23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Samples and COC must meet the laboratory Sample Acceptance Policy (Figure 23-2). Any non-conformance, irregularity, or compromised sample receipt must be documented in TALS on the Sample Receipt checklist (Figure 23-3), and must be brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record. This procedure is further described in laboratory SOP PT-SR-01.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that Eurofins TestAmerica Pittsburgh Laboratory (Location 180). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 180 - 9608 - A - 1 - **A** ← **Secondary Container Occurrence**

Example: 180-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC must filled out completely
- samples must be properly labeled
- proper sample containers with adequate volume for the analysis and necessary QC
- samples must be preserved according to the requirements of the requested analytical method
- sample holding times must be adhered to
- Samples that require chilling must be received proper temperature
- the project manager will be notified if any sample is received in damaged condition

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.3.1.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.1.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation on the chain-of-custody will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or

- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria. Include information for the case narrative of the report.

- If the conditions listed on the Acceptance Policy are not satisfactory and when lacking direction or agreement with the client, the sample may be rejected by the laboratory.

- Any deviation that impacts sample results, such as temperature and preservation, shall be noted on sample results.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the TALS according to laboratory SOP PT-SR-001.

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers, or protected locations suitable for the sample matrix. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed at least every two weeks. See laboratory SOP PT-MS-005, *Volatile Holding Blanks*.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated storage location and place them on carts, analyze the sample, and return the remaining sample or empty container to the storage location from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. Raw samples requiring cold storage are kept in the cold room for approximately 30 days after reported. Volatile samples are stored in the VOA refrigerator. All sample extracts are kept in the refrigerators for approximately two to four weeks after analysis, which meets or exceeds most sample holding times. After the cold storage time, the samples are moved to dry room-temperature sample archive area, where they are stored for an additional four weeks before they are disposed of. This holding period allows samples to be checked if a discrepancy or question arises. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of Eurofins TestAmerica.

23.5 Hazardous Samples And Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous, for any sample that is known to be hazardous at the time of receipt a cautionary email communication should be sent to all applicable laboratory personnel by the project manager or designee. All hazardous samples are disposed of appropriately through a hazardous waste disposal process. Foreign soil samples are sent out for incineration by an USDA-approved waste disposal facility. Analysts will notify Sample Control of any sample determined to be hazardous after completion of analysis by sending an email. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm that lab-packs all hazardous samples and removes them from the laboratory. Foreign soil samples are sent out for incineration by a USDA-approved waste disposal facility.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses. The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a Eurofins TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

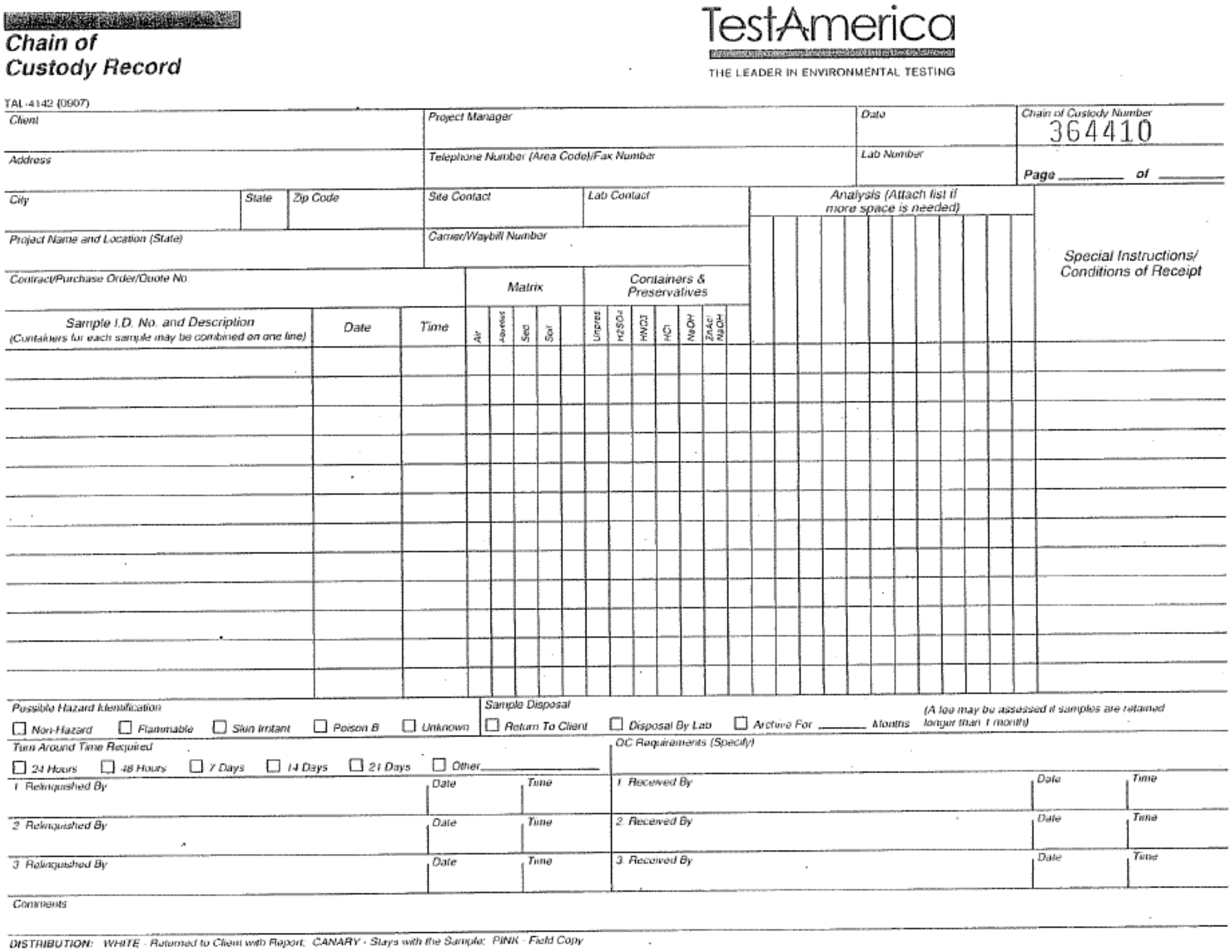
23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP No. PT-HS-001). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample's disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Waste Disposal Record should be completed.

Figure 23-1

Example: Chain of Custody (COC)



Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TAL-4142 (0907)

Client	Project Manager	Date	Chain of Custody Number 364410
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page ______ of ______

City	State	Zip Code	Site Contact	Lab Contact
Project Name and Location (State)			Carrier/Waybill Number	
Contract/Purchase Order/Quote No.				

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives							Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil		Unpres.	H_2SO_4	HNO_3	HCl	NaOH	ZnAc/ NaOH														

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Figure 23-2

Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
    - *Client name, address, phone number and fax number (if available)*
    - *Project name and/or number*
    - *Unique sample identification*
    - *Date, time and location of sampling*
    - *The collectors name*
    - *The matrix description*
    - *The container description*
    - *The total number of each type of container*
    - *Preservatives used*
    - *Analysis requested*
    - *Requested turnaround time (TAT)*
    - *Any special instructions*
    - *Purchase Order number or billing information (e.g. quote number) if available*
    - *The date and time that each person received or relinquished the sample(s), including their signed name.*
    - **Information must be legible**

2) Samples must be properly labeled.
    - Use durable labels (labels provided by Eurofins TestAmerica are preferred)
    - Include a unique identification number
    - Include sampling date and time & sampler ID
    - Include preservative used.
    - Use indelible ink
    - **Information must be legible**

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested.

4) Samples must be preserved according to the requirements of the requested analytical method. (See Sampling Guide)

5) Most analytical methods require chilling samples to 4^{o} C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6^{o} C and above freezing (0^{o}C). For methods with other temperature criteria (e.g. some bacteriological methods require $\leq$ 10 ^{o}C), the samples must arrive within ± 2^{o} C of the required temperature or within the method specified range. **Note:** Samples that are hand delivered to the laboratory immediately after

collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

5i.) Samples that are delivered to the laboratory on the same day they are collected may not meet the requirements of Section 5. In these cases, the samples shall be considered acceptable if the samples were received on ice.
5ii.) If sample analysis is begun within fifteen (15) minutes of collection, thermal preservation is not required.
5iii.) Thermal preservation is not required in the field if the laboratory receives and refrigerates the sample within fifteen (15) minutes of collection.

- Chemical preservation (pH) will be verified prior to analysis and documented, either in sample control or at the analyst’s level. The project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- **FOR WATER SAMPLES TESTED FOR AVAILABLE / FREE CYANIDE (Method OIA-1677)**
  - In the Field: Samples will be collected in pre-preserved bottles for both a regular sample collection and a 1:10 diluted sample in case of the presence of sulfide.
    - The lab will test the samples for sulfide using lead acetate paper at the time of analysis and if sulfide is present in the sample above 50mg/L, the diluted sample will be analyzed.
    - If the water being collected may contain residual chlorine or other oxidizer, the sample should be treated at time of collection with sodium arsenite.

- Water samples that require ortho-phosphorus must be filtered in the field within 15 minutes of sampling. Samples received without indication of filtration in the field will have results flagged for improper preservation.

- Water samples being collected for dissolved metals analysis should be filtered in the field within 15 minutes of sampling and prior to preservation.

- Samples for coliform analysis must be in sterile containers and must be free of residual chlorine. The bottle must be filled to above the 100mL mark.

6) For the laboratory to meet method requirements for the analysis of *Duplicate, Matrix Spikes* and/ or *Matrix Spike Duplicates*, extra volume for at least 1 samples should be collected.
   - If *Matrix Spikes* are required on a specific sample for your project, separate sample volumes for the required QC must be collected for the requested analyses.

7) For Volatile Organic analyses: Efforts should be made to minimize any air bubbles in aqueous volatile samples. Air bubbles also the escape of volatile organics. This is especially important because air bubbles tend to form in iced samples. Volatile vials containing air bubbles larger than a pea will be treated as non-conformances.

8) All samples submitted for Volatile Organic analyses, including by method 8011, must have a Trip Blank submitted at the same time. Eurofins TestAmerica will supply a blank with the bottle order.

9) Sample Holding Times

   - Eurofins TestAmerica will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48hr HT) sample must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

- Analyses that are designated as “field” analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, Eurofins TestAmerica will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for “field” analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. Samples analyzed in the laboratory will be qualified on the final report to indicate holding time exceedance.

10) The project manager will be notified if any sample is received in damaged condition. Eurofins TestAmerica will request that a sample be resubmitted for analysis. The laboratory will notify the client upon sample receipt if the samples exhibit obvious signs of damage, contamination or inadequate preservation.

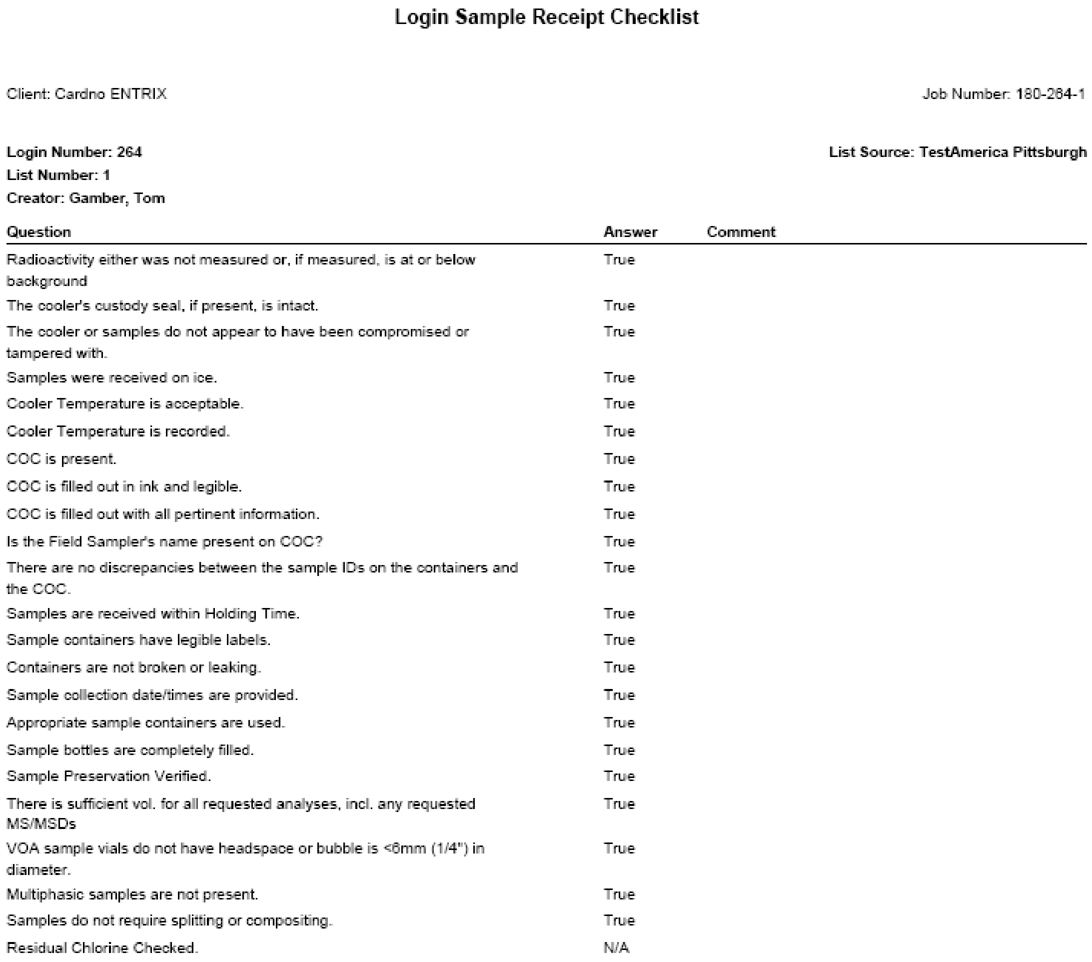
11) Recommendations for packing samples for shipment.

    - Pack samples in Ice rather than “Blue” ice packs.
    - Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
    - Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
    - Fill extra cooler space with bubble wrap.

12) If the conditions listed on the Acceptance Policy are not satisfactory and when lacking direction or agreement with the client, the sample will be rejected by the laboratory.

Figure 23-3

Example: Sample Receipt Checklist



Login Sample Receipt Checklist

Client: Cardno ENTRIX

Job Number: 180-264-1

Login Number: 264
List Number: 1
Creator: Gamber, Tom

List Source: TestAmerica Pittsburgh

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	True	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

SECTION 24

ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, solvent extraction, sonication, acid digestion, filtration, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Negative Controls

Control Type	Details
Method Blank (MB)	are used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	are prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.

Table 24-1. Negative Controls

Control Type	Details
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blank [1]	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (TNI)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis. Also further detail is provided in SOP No. PT-QA-021.

24.3.1 **Negative Controls for Microbiological Methods** – Microbiological Methods utilize a variety of negative controls throughout the process to ensure that false positive results are not obtained. These controls are critical to the validity of the microbiological analyses. Some of these negative controls are:

Table 24-2. Negative Controls for Microbiology

Control Type	Details
Sterility Checks (Media)	are analyzed for each lot of pre-prepared media, ready-to-use media and for each batch of medium prepared by the laboratory.
Filtration Blanks	blanks are run at the beginning and end for each sterilized filtration unit used in a filtration series. For pre-sterilized single use funnels a sterility check is performed on at least one funnel per lot.
Sterility checks (Sample Containers)	are performed on at least one container per lot of purchased, pre-sterilized containers. If containers are prepared and sterilized by the laboratory, one container per sterilization batch is checked. Container sterility checks are performed using non-selective growth media.

Sterility Checks (Dilution Water)	are performed on each batch of dilution water prepared by the laboratory and on each batch of pre-prepared dilution water. All checks are performed using non-selective growth media.
Sterility Checks (Filters)	are also performed on at least one filter from each new lot of membrane filters using non-selective growth media.

Negative culture controls demonstrate that a media does not support the growth of non-target organisms and ensures that there is not an atypical positive reaction from the target organisms. Prior to the first use of the media, each lot of pre-prepared selective media or batch of laboratory prepared selective media is analyzed with at least one known negative culture control as appropriate to the method.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard may be reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.4.2 Positive Controls for Microbiological Methods

- Each lot of pre-prepared media (including chromofluorogenic reagent) and each batch of laboratory prepared media is tested with a pure culture of known positive reaction.

- In addition, every analytical batch also contains a pure culture of known positive reaction.

  A pure culture of known negative reaction is also tested with each analytical batch to ensure specificity of the procedure.

24.5 Sample Matrix Controls

Table 24-3 Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV) (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

- The maximum acceptable recovery limit will be 150%.

- The maximum acceptable RPD limit will be 35% for waters and 40% for soils. The minimum RPD limit is 15%.

- If either the high or low end of the control limit changes by ≤ 5% from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no effect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. Current and historical limits are maintained in the LIMS, along with the effective dates. In addition, the laboratory must be able to recreate historical control limits. Refer to laboratory SOP PT-QA-021, *Quality Control Program*, for details on the creation, evaluation and application of statistical control limits.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit. For further detail refer to laboratory SOP PT-QA-021 and method specific SOPs.

- For TNI work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

  - Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).

  - Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

  - Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated parent sample are reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in SOP No. PT-QA-021 – Laboratory Quality Control Program, analytical method SOPs and in Section 12 of this document.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

Use of formulae to reduce data is discussed in the method SOPs and in Section 20.

Selection of appropriate reagents and standards is included in Section 9 and 21.

A discussion on selectivity of the test is included in Section 5.

Constant and consistent test conditions are discussed in Section 18.

The laboratories sample acceptance policy is included in Section 23.

SECTION 25

REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g. Analytical Report) on the cover page with a “Result” column header on the sample result page

25.2.2 The cover page shall include the laboratory name, address and telephone number

25.2.3 A unique identification of the report (e.g. Eurofins TestAmerica Job ID#) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end

Note: Page numbers of report are represented as page # of ## at the bottom of the page. Where the first number is the page number and the second is the total number of pages

25.2.4 A copy of the chain of custody (COC)

- Any COCs involved with Subcontracting are included

25.2.5 The name and address of client and a project name/number, if applicable

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code

25.2.8 Date of receipt of sample, date and time of collection, and date(s) and time of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours

25.2.9 Date reported or date of revision, if applicable

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc)

25.2.11 Reporting Limit

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND)

25.2.14 Sample results

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits are included unless the client specifies they do not require reporting the QC

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in the case narrative or by attaching sample login sheets. The temperature is documented on the sample receipt checklist and noted in the report case narrative.

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory, except when information is provided by the client. When data is provided by the client there shall be a clear indication of it, and a disclaimer shall be put in the report when the client supplied data can affect the validity of the test.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue (Signatories are appointed by the Lab Director)

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not

25.2.22 If applicable, the laboratory includes a cover letter

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., preliminary report). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-Eurofins TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All Eurofins TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 A clear statement notifying the client that non-accredited tests were performed and directing the client to the laboratory’s accreditation certificates of approval shall be provided when non-accredited tests are included in the report.

25.2.29 Where the laboratory is responsible for the sampling stage, in addition to the requirements listed above, reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:

- The date of sampling
- Unambiguous identification of the material sampled
- The location of sampling
- A reference to the sampling plan and procedures, and deviations, additions to or exclusions from the sampling procedures
- Details of any environmental conditions during sampling that affect the interpretation of test results
- Information required to evaluate measurement uncertainty for subsequent testing

Note: It is required by the PA DEP that non-accredited parameters be clearly identified on the sample results.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (No. CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level Or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above.
- Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data is provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of Eurofins TestAmerica’s services in addition to the test report as described in section 25.2. When NELAP accreditation is required and both a test report and EDD are provided to the client, the official version of the test report will be the combined information of the report and the EDD. Data qualifiers appearing on the test report must be included in the EDD.

Pittsburgh offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), Staged Electronic Data Deliverable (SEDD) Environmental Quality Information System (EQuIS), Electronic Deliverable Format (EDF), Excel and custom files as requested by the client.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information For Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as estimated.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

When, as required by the client and agreed to by Eurofins TestAmerica, the report includes a statement of conformity to specification or standard (see Special Services, Section 7.4), the report shall clearly identify:

- To which results the statement applies
- Which specifications, standard or parts thereof are met or not
- The decision rule that was applied unless the decision rule is inherent in the requested specification or standard, taking into account the level of risk (such as false accept and false reject and statistical assumptions) associated with the decision rule.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the

Manager(s)/Team Leaders or as assigned by the lab Director. This is the only form of “interpretation” of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP # CW-L-S-004).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of Eurofins TestAmerica are reported to the client on the subcontract laboratory’s original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

Eurofins TestAmerica is responsible for maintaining in confidence all client information obtained or created. In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

Eurofins TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by Eurofins TestAmerica or any information disclosed to Eurofins TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity’s proprietary rights will not be released.

Information about the client obtained from sources other than the client (r.g, complaint, regulators) shall be confidential between client and laboratory. The source of this information shall be confidential to the laboratory and shall not be shared with the client, unless agreed to by the source.

Note: This shall not apply to the extent that the information is required to be disclosed by Eurofins TestAmerica under the compulsion of legal process. Eurofins TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are to meet all requirements of this document, including a cover letter.

25.7 Format Of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments To Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the data server, as is the original report. The revised report is stored in the data server under the job number followed by “Rev (n)” where ‘n’ is the revision number. The revised report will have the words “Revision (n)” on the report cover page beneath the report date.

When the report is re-issued, a notation of “report re-issue“ is placed on the cover/signature page of the report or at the top of the narrative page with a brief explanation of reason for the re-issue and a reference back to the last final report generated.

25.9 Policies On Client Requests For Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

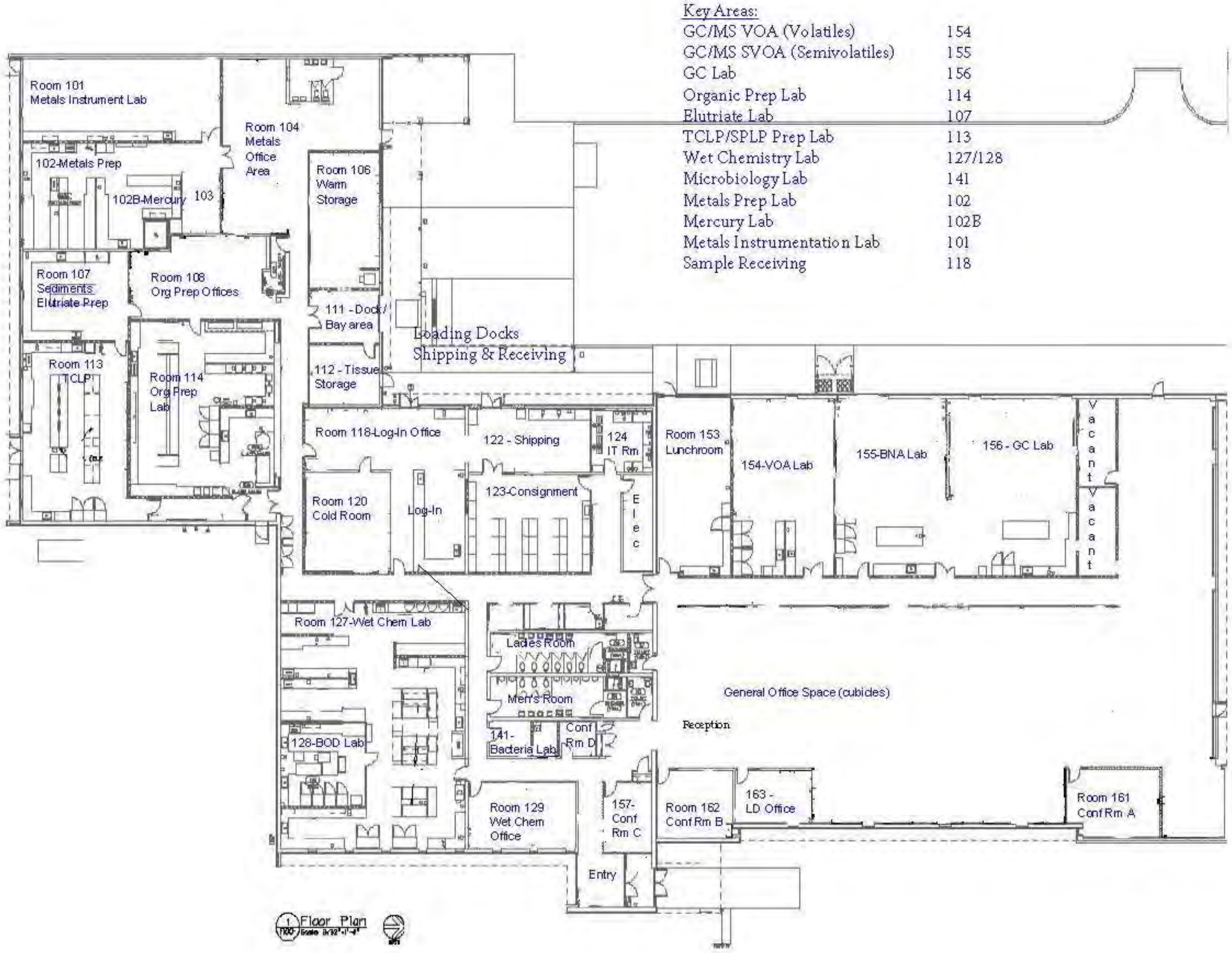
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error
- Sample identification is indeterminate (confusion between COC and sample labels)
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

Eurofins TestAmerica does not issue multiple reports for the same job number where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1
Laboratory Floor Plan



Key Areas:

GC/MS VOA (Volatiles)	154
GC/MS SVOA (Semivolatiles)	155
GC Lab	156
Organic Prep Lab	114
Elutriate Lab	107
TCLP/SPLP Prep Lab	113
Wet Chemistry Lab	127/128
Microbiology Lab	141
Metals Prep Lab	102
Mercury Lab	102B
Metals Instrumentation Lab	101
Sample Receiving	118

Appendix 2
Glossary/Acronyms

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst: The designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (TNI)

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Anomaly: A condition or event, other than a deficiency, that may affect the quality of the data, whether in the laboratory’s control or not.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample’s true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material, accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form**:** Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction*:* Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis**.** No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria). (TNI)

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Data Review Checker: Automated data review feature in TALS that compares data entered to list of control and preventative review requirements and presents all findings to the first level data reviewer for response or correction.

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC), whether in the laboratory's control or not.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times : The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method, or more frequently if so required by the reference method, except for analytes for which spiking solutions are not available such as, total volatile solids, odor, temperature, or dissolved oxygen. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit of Detection (LOD): [a.k.a., Method Detection Limit (MDL]: The MDL is the minimum measured quantity of a substance that can be reported with 99% confidence that the concentration is distinguishable from method blank results, consistent with 40CFR Part 136 Appendix B, August, 2017.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with <15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air *& Emissions*: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.
Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: See Limit of Detection (LOD)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance**:** An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Observation: A record of phenomena that (1) may assist in evaluation of the sample data; (2) may be of importance to the project manager and/or the client, and yet not at the time of the observation have any known effect on quality.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (TNIS)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment,~~,~~ reporting and quality improvement to ensure that a process, item, ~~product~~ or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting NELAC and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank:
A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty:
A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification Check Standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
TNI – The NELAC Institute
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP: Standard Operating Procedure
TAT – Turn-Around-Time
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3

Laboratory Certifications, Accreditations, Validations

Pittsburgh maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation / certification / licensing with the following organizations:

Organization	**Certificate Number Or Laboratory ID Number**
Arkansas	88-0690
California ELAP	2891
Connecticut	PH-0688
Florida	E871008
Illinois	002602
Kansas	E-10350
Kentucky	KY98043
Louisiana	04041
Maine	2020007
Minnesota	042-999-482
Nevada	PA00164
New Hampshire	203010
New Jersey	PA005
New York	11182
North Carolina	434
North Dakota	R-227
Oregon	PA-2151
Pennsylvania	02-00416
Rhode Island	LAO00362
South Carolina	89014002
Texas	T104704528
Utah	STLP
USDA	P330-10-00139
USDA	P-Soil -01
Virginia VELAP	460189
West Virginia	142
Wisconsin	998027800

The certificates and parameter lists (which may differ) are available, upon request, from a laboratory representative. They may be found on the Corporate web site, the laboratory's public server and in the QA web page.

Appendix 4

Pittsburgh Laboratory SOP List

Document No.	Title
PT-FS-001	Field Measurement of Dissolved Oxygen (DO) Method: SM 4500-O G
PT-FS-002	Field Measurement of Total Residual Chlorine Method: SM 4500-Cl G
PT-FS-003	Field Measurement of pH Method: SM 4500 H+B
PT-FS-004	General Sampling Instructions
PT-GC-001	Gas Chromatographic Analysis of Herbicides, SW-846 Method 8151A
PT-GC-002	Analysis of Organochlorine Pesticides and PCBs by Method 608
PT-GC-004	1,2-Dibromoethane(EDB) and 1,2-Dibromo-3-Chloropropane(DBCP) in Water by Microextraction and Gas Chromatography, Method 8011
PT-GC-005	Polychlorinated Biphenyls (PCBs) and PCBs as Congeners by GC/ECD - Method: SW-846 8082 and 8082A
PT-GC-006	Chlorinated Pesticides - Method: SW-846 8081A/B
PT-GC-007	Organophosphorus Pesticides by Gas Chromatography - Method: SW-846 8141A and 8141B
PT-GC-009	Determination of Inorganic Anions by Ion Chromatography EPA Method 300 SW-846 Method 9056A
PT-GC-010	TOC Analysis for Solids by Lloyd Kahn Method
PT-GC-013	Determination of Particulate Organic Carbon in Sediment and Estuarine / Coastal Water Matrices
PT-GC-014	Halogenated Organic Compounds by Direct Injection GC/ECD
PT-GC-015	Analysis of Organochlorine Pesticides and PCBs by EPA Method 608.3
PT-HS-001	Pittsburgh Facility Addendum to Eurofins TestAmerica Corporate Environmental Health & Safety Manual (CW-E-M-001)
PT-HS-002	Bloodborne Pathogen Exposure Control Path
PT-IP-002	Acid Digestion of Soils, SW-846 Method 3050B
PT-IP-003	Acid Digestion of Aqueous Samples by SW-846 Methods 3005A, 3010A and EPA Methods 200.7 and 200.8
PT-IT-001	Data Backup Procedures
PT-MI-001	Total Coliforms and E. coli – Presence/Absence Test Using Colilert
PT-MS-001	Semivolatile Organic Anaysis by GC/MS, Method 625
PT-MS-002	Volatile Organics by GC/MS Based on Method 624
PT-MS-005	VOA Holding Blanks

Document No.	Title
PT-MS-008	GC/MS Analysis for Semivolatile Organics, Methods: SW-846 8270C & D
PT-MS-010	Determination of Volatile Organics by GC/MS Methods: SW-846 8260B & C
PT-MS-011	Semivolatile Organic Analysis by GCMS, EPA Method 625.1
PT-MS-012	Volatile Organic Analysis by GCMS, EPA Method 624.1
PT-MT-001	Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analyses, SW-846 Method 6010B, 6010C, 6010D and EPA Method 200.7
PT-MT-002	Analysis of Metals by Inductively Coupled Plasma/Mass Spectrometry (ICPMS) for Methods 200.8, 6020, 6020A
PT-MT-005	Preparation and Analysis of Mercury by Cold Vapor Atomic Absorption
PT-OP-001	Extraction and Cleanup of Organic Compounds from Waters and Solids, Based on SW-846 3500 and 600 Series Methods
PT-OP-002	Simplified Laboratory Runoff Procedure (SLRP)
PT-OP-003	Standard Elutriate Test (SET)
PT-OP-004	Toxicity Characteristic Leaching Procedure and Synthetic Precipitation Leaching Procedure
PT-OP-005	Modified and Effluent Elutriate Tests (MET and EET)
PT-OP-006	Long Tube Column Settling Test
PT-OP-007	Illinois Re-suspension Tests
PT-OP-008	Dredging Elutriate Test (DRET)
PT-OP-009	Sequential Batch Leach Test (SBLT) for Freshwater Sediments
PT-OP-011	Extractable Residue (Lipids) from Animal Tissue
PT-OP-015	Modified Multiple Extraction Procedure Method: SW-846 1320
PT-OP-016	Porewater Generation
PT-OP-017	Liquid-Solid Partitioning as a Function of Extract pH in Solid Materials using a Parallel Batch Procedure SW-846 Method 1313
PT-OP-018	Liquid-Solid Partitioning as a Function of Liquid-to-Solid Ratio in Solid Materials using a Parallel Batch Procedure SW-846 Method 1316
PT-OP-019	Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials using a Semi-Dynamic Tank Leaching Procedure SW-846 Method 1315
PT-OP-020	Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments ASTM D4646-03
PT-OP-021	Liquid-Solid Partitioning as a Function of Liquid-to-Solid Ratio for Constituents in Solid Materials using an Up-Flow Percolation Column Procedure SW-846 Method 1314

Document No.	Title
PT-OP-022	Low Volume Extraction and Cleanup of Organic Compounds from Waters Method: SW846 3500 Series
PT-OP-023	Measurement of the Leachability of Solidified Wastes by a Short Term Test Procedure Modified ANSI/ANS-16.1-2003
PT-OP-025	Soil/Sediment Amendment Procedure
PT-OP-026	Extraction of Organic Compounds from Solids, Sediments, Tissues, and Wipes Based on SW-846 3500 Series Methods
PT-OP-027	Extraction of Herbicides by SW846 Method 8151A
PT-OP-028	Clean-up of Organic Extracts by SW-846 3600 Series Methods
PT-OP-030	Handling and Preparation of Biota and Tissue Samples
PT-OP-031	Australian Standard Leaching Procedure - AS 4439.3-1997
PT-QA-001	Employee Orientation & Training
PT-QA-002	Internal Auditing
PT-QA-003	Glassware Clean-up for Organic/Inorganic Procedures
PT-QA-004	Quarantine Soil Procedure
PT-QA-005	Measurement Uncertainty
PT-QA-006	Procurement of Standards and Materials; Labeling and Traceability
PT-QA-007	Detection Limits
PT-QA-008	Thermometer and Barometer Calibration and Temperature Monitoring
PT-QA-009	Rounding and Significant Figures
PT-QA-010	Document Development and Control
PT-QA-012	Selection and Calibration of Balances and Weights
PT-QA-013	Independent QA Data Review
PT-QA-014	Reporting Limits
PT-QA-016	Nonconformance & Corrective Action System
PT-QA-017	Aqueous Pipette Calibration – Gravimetric Method
PT-QA-018	Technical Data Review Requirements
PT-QA-019	Records Information Management
PT-QA-021	Laboratory Quality Control Program

Document No.	Title
PT-QA-022	Equipment Maintenance
PT-QA-024	Subsampling
PT-QA-026	Container Accuracy Verification – Gravimetric
PT-QA-031	Internal Chain of Custody
PT-SR-001	Sample Receipt & Login
PT-SR-002	Bottle Order Preparation and Shipping
PT-WC-001	Determination of Total and Total Volatile Solids in Waters and Wastes (Methods EPA160.4 and SM 2540B & 2540E)
PT-WC-002	Color, Method 110.2
PT-WC-003	Alkalinity, SM Method 2320B
PT-WC-004	Total Hardness (mg/L as CaCO3) by Method SM 2340C; and Hardness by Calculation SM 2340B
PT-WC-005	Turbidity by Method 180.1
PT-WC-007	Nitrate/Nitrite-N EPA Method 353.2
PT-WC-008	Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM) in Sediment
PT-WC-009	Performance Checks on Spectronic 21 and Model 1001 Spectro-Photometers
PT-WC-010	Total Sulfide as Acid Soluble Sulfide, Method 9030B/9034, Standard Method 20th Ed. 4500S-2-F
PT-WC-013	Specific Conductance by 120.1, 2510B, and 9050A
PT-WC-014	Nitrogen, Ammonia (Automated), Method 350.1
PT-WC-015	Chromium, Hexavalent (Colorimetric) by SM3500-Cr-B, SW846 3060A/7196
PT-WC-016	Biochemical Oxygen Demand (BOD) and Carbonaceous Biochemical Oxygen Demand (CBOD) by Dissolved Oxygen Probe - SM5210B
PT-WC-017	Total Organic Carbon (TOC) and Total Inorganic Carbon (TIC), Methods SM 5310C and SW-846 9060/9060A
PT-WC-018	Cyanide – Semi-Automated, Pyridine-Barbituric Acid For Total and Amenable, Cyanide in Water (Methods 335.4) and Soil Analyses (Method 9012A/9012B)
PT-WC-020	Percent Moisture, Ash, Organic Matter and Total Solids in Soil Samples - SM 2540G and ASTM D297-84
PT-WC-021	Flash Point by Pensky-Martens Closed Tester, SW-846 Method 1010A and ASTM D93-08
PT-WC-022	Ignitability of Solids for Waste Characterization EPA SW-846 Chapter 7, Section 7.1
PT-WC-023	Chemical Oxygen Demand, Low Level, Method 410.4
PT-WC-025	n-hexane extractable material (HEM) in Sludge, Sediment and Soil samples - 9071B

Document No.	Title
PT-WC-026	PH Electrometric by SM 4500 H+B and SW-846 Methods: 9045C/D and 9040B/C
PT-WC-027	Salinity by Calculation, Electrical Conductivity Method SM 2520B
PT-WC-028	Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated Hexane Extractable Material (SGT-HEM; TPH), Method 1664A/1664B and 9070A
PT-WC-029	Available Cyanide by Ligand Exchange and Flow Injection Analysis (FIA) Method 1677
PT-WC-031	Cyanide Extraction Procedure for Solids and Oils, SW-846 Method 9013
PT-WC-032	Total Organic Carbon Analysis for Solid Matrices by Walkley Black
PT-WC-033	DI-Leachate Procedure for Solids (1 Hour Routine DI Leachate Procedure)
PT-WC-034	Paint Filter Liquids Test, SW-846 Method 9095B
PT-WC-035	Acidity of Water and Waste Water, SM Method 2310B
PT-WC-036	Flash Point of Liquids by Setaflash (Small Scale) Closed-Cup Apparatus, SW-846 Method 1020B and ASTM Standard D 3278-96
PT-WC-037	Oxidation Reduction Potential, SM 2580B (20th Ed)
PT-WC-038	Phenolics (Automated), Method 420.1/420.2, SW-846 9065/9066
PT-WC-039	Screening Apparent Specific Gravity and Bulk Density of Waste - Method: ASTM D 5057-90
PT-WC-040	Anion Surfactants as MBAS, Standard Methods 5540C
PT-WC-041	Compatibility of Screening Analysis of Waste, Method: ASTM D5058 Test Method C – Water Compatibility
PT-WC-042	Acid Titration of Samples for Bechtel Bettis (NaOH Solution for Caustic and Na2CO3 Concentration), Bechtel-Bettis SOP - WAPD-MT(CAC)-2141, Revision 0
PT-WC-043	Determination of Total and Volatile Suspended Solids in Waters and Wastes - EPA 160.4 and SM 2540D & 2540E
PT-WC-044	Determination of Settleable Solids in Water SM 2540F
PT-WC-045	Determination of Total Dissolved and Volatile Dissolved Solids in Water and Wastes, SM 2540C & 2540E
PT-WC-046	ASTM 18-Hour Leaching Procedure

Note: The SOPs are subject to change, refer to PT-QA-WI-002 for current list of SOPs and revision numbers.

APPENDIX D

DATA VALIDATION REPORTS

REVIEW OF SEDIMENT STOCKPILE ANALYTICAL DATA REPORT

This appendix summarizes the data review and validation performed for soil samples collected in November 2021 from a sediment stockpile as described in *IR/BU Materials Management Plan (RE01); Conowingo Sediment Characterization and Innovative Reuse and Beneficial Use (IR/BU) Pilot Project ID No. 1-18-3-21-8R Cecil and Harford Counties, Maryland* (Northgate, 2019) (PLAN). The PLAN was approved by MDE.

Four, five-point composites were collected from each quadrant of a sediment stockpile and one composite sample comprised of 20 subsamples (5 from each quadrant of the stockpile) were collected on November 3, 2021 and submitted to Eurofins TestAmerica Pittsburgh (Eurofins). The samples analytical methods summary is shown on Table 1. Note that the single twenty-point composite sample was analyzed only for organochlorine pesticides, PCB aroclors and dioxins and furans. The four five-point composites were analyzed for the remainder of the analyses as shown on the table. Physical and geotechnical analyses were performed by Eurofins Burlington facility and chemistry analyses were performed at the Eurofins Pittsburgh facility.

Samples were analyzed as one sample delivery group and a single laboratory deliverable included data summarized as well as raw data for the samples, associated calibrations, and QA/QC samples was provided. Additional relevant information was included in the Analytical Report (Appendix C). An electronic data deliverable (EDD) was also provided in an appropriate format for inclusion in the project analytical database. Two revisions of the report and data were produced. Revision 1 was produced to include analysis for manganese which had been omitted in the initial analysis requests, Revision 2 included previous revisions and addressed a request for laboratory calculation of total dioxins and total furans. The laboratory report is attached to this data review and validation.

Procedures and Results

Laboratory analytical results (data) were reviewed, and validation was performed on the data to ensure that the results produced were credible, and of known and defensive quality. The data were reviewed in accordance with the approved PLAN, the laboratory SOPs, the principles present in USEPA National Functional Guidelines for Laboratory Data Review - Organics (EPA, 1998) and USEPA National Functional Guidelines for Laboratory Data Review - Inorganics (EPA, 2017b), and the professional judgment of the validation team. A validation application within the Conowingo data management environment was applied to the data to scan for validation issues. For the purpose of this review, if an analyte or analyte group is not presented, no consideration or flagging other than that included in the laboratory report or as discussed below is necessary.

The following sampling and analysis event elements were reviewed:

- Completeness of Laboratory Reports: The analytical report was considered complete. It contained the following information: laboratory/client/sample IDs, project name, sample matrix, sample collection/preservation/preparation/ extraction/analysis dates, analytical methods, analytes, reporting units/limits, dilution factors, report page numbering system, designated title and signatures.
- Chain of Custody: A Chain of Custody form was included in the analytical report. The Chain of Custody was properly completed.
- Analytic Methods: Analytic methods used by the laboratory matched those shown in Table 1.
- Sample Containers and Conditions: Sample containers were appropriate. Sample container conditions were noted as normal on the Sample Receipt forms.
- Holding Times:
    - Total Kjeldahl Nitrogen (TKN) MCAWW 351.2: The following samples were prepared for analysis within holding time for TKN but analyzed outside of analytical holding time due to instrumentation issues: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4). The samples required dilution due to the higher than anticipated concentration of TKN detected. The hold time for TKN is 28 days. Due to the dilution required, analysis occurred approximately 1-2 hours beyond the 28-day limit. The laboratory appropriately flagged the results. The National Functional Guidelines are not specific on additional flagging for hold time exceedances since each occurrence must be based on individual circumstances. In this instance, because the samples were being controlled within the laboratory environment, no additional flagging is required, and the data are adequate for determining concentrations of TKN in the sediment stockpile.
- Preservation: All samples were properly preserved during transport and storage as specified in the Laboratory SOPs. The laboratory verified the preservation integrity on sample receipt.
- Field Duplicates: In consultation with and approval of MDE, field duplicates were not collected.

- Dilutions:
    - Semi-volatiles (SW-846 8270E LL): Analytes were diluted due to the sample matrix. The laboratory adjusted the RLs (RL), accordingly. The semi-volatile analyses included detected analytes. However, none of the elevated RLs were above the lowest regulatory limit. Therefore, the dilutions did not impact the determination of potential regulatory exceedances.
    - Pesticides (SW-846 8081B LL) analytes were diluted due to the sample matrix. No pesticide analytes were detected above the RLs and none of the RLs were above the lowest regulatory limit. Therefore, the dilutions did not impact the determination of potential regulatory limit exceedances.
- Surrogate Recoveries: Surrogates are used in most organic analyses to demonstrate matrix compatibility with the chosen method of analysis. Each sample is spiked with a known concentration of surrogate compound(s) prior to the preparation and analysis of the sample. Low biased surrogate results could suggest that more chemical is present than is being reported. High biased surrogate results could suggest that less chemical is present than is being reported
    - Pesticides - SW-846 8081B LL: Surrogate recovery for the following samples were greater than the laboratory control limits; STOCKPILE QUADRANT 1, STOCKPILE QUADRANT 2, STOCKPILE QUADRANT 3, STOCKPILE QUADRANT 4 and STOCKPILE QUADRANTS 1-4. The laboratory indicated that there was evidence of matrix interference; therefore, re-extraction and/or re-analysis was not performed. Results are biased high. The pesticide results are below the RLs and the RLs are all below the lowest regulatory limits, the high bias does not impact potential regulatory exceedances. The laboratory flagged the samples appropriately.
    - PCBs - SW-846 8082A Surrogate recovery for the following samples were outside control limits: STOCKPILE QUADRANT 3 (180-129635-3), STOCKPILE QUADRANT 4 (180-129635-4) and STOCKPILE QUADRANTS 1-4 (180-129635-5). The laboratory indicated that there was evidence of matrix interference; therefore, re-extraction and/or re-analysis was not performed. Results are biased high. Since the reported results were all below the RLs and the RLs are all below the lowest regulatory limits, the high bias does not impact potential regulatory exceedances. The laboratory flagged the samples appropriately.
- Method Blanks: A method blank (MB) is an analyte-free matrix such as deionized water for liquids or cleaned sand for solids and/or soils that is processed in the same manner as the samples. MBs are prepared and analyzed for each method normally at an increment of one per sample delivery group. The main function of the MB is to

document contamination resulting from the analytical process The importance of the MB is the confidence it provides in assuring the reported values found in your samples are “real” and not the result of laboratory contamination.

- Dioxins SW-846 8290 A: Several dioxin/furan analytes were detected in MB sample MB 140-56482/17-A at levels that were above the method detection limit (MDL) but below the RL. The MB exceedances should be considered estimates and have been flagged with a “J”. The laboratory correctly flagged associated samples that reported a result above the RL and were detected in the method blank with a “B” qualifier denoting blank contamination. Samples that reported an estimated dioxin/furan result (“J”) between the MDL and the RL were reported as estimated (“J”) with blank contamination (“B”) and were additionally flagged by the laboratory with an “I” (modified to “IE” in report tables). The “IE” flag indicates that the value is the estimated maximum possible concentration (EMPC). The total concentrations of the dioxins/furans, which were calculated by the laboratory are all also correctly flagged. None of the laboratory reported dioxin/furan concentrations that were associated with method blank contamination were above the lowest applicable regulatory limit.
- Metals SW-846 6020B and SW-846 7471B: A single MB was analyzed for metals. The method blank for analysis batch 379482 contained manganese above the RL. Associated samples (STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4) were not re-extracted and/or re-analyzed because manganese results for those samples were greater than 10X the concentration found in the method blank.

  Chromium was detected in MB 180-379074/1-A at a level that was above the MDL but below the RL. The value should be considered an estimate, and the laboratory correctly flagged the results with a “J” flag. The laboratory correctly flagged associated samples that reported a result above the RL (all samples analyzed for chromium) and were detected in the method blank with a “B” qualifier denoting blank contamination.
- General Chemistry: Free Cyanide SW-846 9016: A single method blank was analyzed for the method. Free cyanide was detected in method blank MB 460-813502/1-B at a level that was above the MDL but below the RL. The value should be considered an estimate and was correctly flagged (“J”) by the laboratory. All single quadrant samples showed reported free cyanide concentrations with results between the MDL and RL and were correctly flagged by the laboratory with a “J” flag for estimated concentration and a “B” flag for method blank contamination

- Laboratory Control Samples (LCS): are samples prepared in the laboratory that contain analytes that are representative of the analytes of interest in client submitted samples. Known concentrations of analytes are added to sand and are processed in the same manner as the client samples.
    - Pesticides - SW-846 8081B LL: The %RPD between the primary and confirmation column/detector for 4,4'-DDE is >40%. The lower value has been reported and the analysis was correctly flagged (“p”) by the laboratory. Since all concentrations of 4-4’-DDE were not detected at the RL, this is an appropriate procedure, and no additional flagging is required.
    - Dioxins SW-846 8290 A: One or more Isotope Dilution Analyte (IDA) recoveries associated with the following sample is below the method recommended limit:(LCS 140-56482/16-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s). All target analytes were within control limits.
- Laboratory QC Samples (Matrix Spike (MS) and Matrix Spike Duplicate (MSD). The purpose of the MS/MSD sample is to provide information on the accuracy and precision of the specific analytical method employed in the analysis of that specific sample. It may be indicative of interference in the analytical method introduced in the matrix (in this project; sediment) of the sample.
    - Metals SW-846 6020B and SW-846 7471B: Antimony, Selenium and Manganese failed the recovery criteria low for the MS of sample STOCKPILE QUADRANT 1MS (180-129635-1) in batch 180-379482. Several analytes failed the recovery criteria low, and Manganese failed the recovery criteria high for the MSD of sample STOCKPILE QUADRANT 1MSD (180-129635-1) in batch 180-379482. The laboratory correctly flagged the results (“F1”). A secondary flag, “4”, was applied to analytes where the concentration in the un-spiked sample exceeded four times the spiking amount.
    - Total Kjeldahl Nitrogen MCAWW 351.2: Total Kjeldahl Nitrogen failed the recovery criteria low for the MS of sample STOCKPILE QUADRANT 1MS (180-129635-1) in batch 480-607363. The lab qualified the data with a flag of “4” indicating that the concentration in the un-spiked sample exceeded four times the spiking amount.

RECOMMENDATIONS AND CONCLUSIONS

Chemical analyses of sediments and soils that have been subjected to high degrees of saturation, extensive reworking and/or diverse source material commonly exhibit matrix interference. Matrix interferences may be caused by contaminants that are coextracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature and diversity of the source material. The effect of matrix interference is generally to raise RLs of individual analytes. Laboratories should be notified of the source of the samples and analysis preparation methods should be reviewed for sensitive analytes as there are sample preparation methods that can be applied to minimize interference.

Based on this validation, all data collected through implementation of the PLAN satisfy data quality requirements for the Project. The analyses followed the approved methods and included acceptable QC procedures. Some matrix effects were noted, which are typical of real environmental samples. No outstanding issues were identified that impacted the interpretation or application of the data during the data validation review. Overall, the presented data (including the qualified results) are reliable and useable for project decision making.

Table 1. IR/BU Stockpile Sampling Analytical Methods Summary

	Physical Geotech		**Metals and Inorganics**							**Organics**								**Nutrients**			
IR/BU Analyses (1,000 cy stockpile)	Grain Size Distribution (ASTM D422)	Percent Coal - Loss on Ignition Method (ASTM 2974)	Percent Moisture (SM 2540G)	Priority Pollutant Metals + Hg (EPA 6020B & 7471B)	Hexavalent Chromium (EPA 7196A)	Cyanide , Total (EPA 9014)	Cyanide , Free (EPA 9016)	Sulfate (EPA 300.0)	Sulfide, Total (SM 4500 S2)	Total Organic Carbon - (EPA 9060)	Volatile Organic Compounds (EPA 8260C)	Semi-Volatile Organic Compounds (EPA 8270D)	Organochlorine Pesticides (EPA 8081B)	PCBs Aroclors (EPA 8082A)	Dioxins / Furans (EPA 8290A / 1631)	Total Petroleum Hydrocarbons - DRO (EPA 8015D)	Total Petroleum Hydrocarbons - GRO (EPA 8015C/5035 prep)	Total Kjeldahl Nitrogen (EPA 351.2)	Ammonia, Nitrogen (SM4500-NH3B or F/EPA 350.1)	Total Phosphorus (EPA 365.3 / 365.4)	Soluble Salts EC - : 2 (V:V) (Lab SOP)
# Samples	4	4	4	4	--	4	4	4	4	4	--	4	5*	5*	5*	4	--	4	--	--	--

Note: This matrix includes analyses of samples collected from the stockpile. End users performed additional physical/geotechnical and nutrient testing as needed.

* = One stockpile composite sample comprised of the four quadrant composite samples and 4 quadrant composite samples each comprised of five aliquots from their respective quadrant of the stockpile .

4 = Four quadrant composite samples, each comprised of five aliquots from their respective quadrant of the stockpile.

-- = Not analyzed.

APPENDIX E

EUROFINS - ANALYTICAL REPORT

1
2
3
4
5
6
7
8
9
10
11
12
13

ANALYTICAL REPORT

Eurofins Pittsburgh
301 Alpha Drive
RIDC Park
Pittsburgh, PA 15238
Tel: (412)963-7058

Laboratory Job ID: 180-129635-1
Client Project/Site: Conowingo Pilot Study/Stockpile
Revision: 2

For:
Northgate Environmental Management Inc.
20251 Century Boulevard
Suite 315
Germantown, Maryland 20874

Attn: Sam Merrill

Samantha Bayura

Authorized for release by:
2/17/2022 12:15:20 PM
Samantha Bayura, Project Manager I
samantha.bayura@eurofinset.com

Designee for

Carrie Gamber, Senior Project Manager
(412)963-2428
Carrie.Gamber@Eurofinset.com

PA Lab ID: 02-00416

Table of Contents

Cover Page 1
Table of Contents 2
Case Narrative 3
Definitions/Glossary 6
Certification Summary 8
Sample Summary 13
Method Summary 14
Lab Chronicle 15
Client Sample Results 22
QC Sample Results 52
QC Association Summary 65
Chain of Custody 72
Receipt Checklists 82

Job ID: 180-129635-1

Laboratory: Eurofins Pittsburgh

Narrative

CASE NARRATIVE

Client: Northgate Environmental Management Inc.

Project: Conowingo Pilot Study/Stockpile

Report Number: 180-129635-1 REVISED

NOTE: This report has been revised to include dioxin, totals.

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

RECEIPT

The samples were received on 11/05/2021; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 2.5 C.

SEMIVOLATILES

The following samples were diluted due to the nature of the sample matrix: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4). Elevated reporting limits (RLs) are provided.

DRO

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

PESTICIDES

The following samples were diluted due to the nature of the sample matrix: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3), STOCKPILE QUADRANT 4 (180-129635-4) and STOCKPILE QUADRANTS 1-4 (180-129635-5). Elevated reporting limits (RLs) are provided.

Surrogate recovery for the following samples were outside control limits: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3), STOCKPILE QUADRANT 4 (180-129635-4) and STOCKPILE QUADRANTS 1-4 (180-129635-5). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

The continuing calibration verification (CCV) associated with 378906 recovered low and outside the control limits for delta-BHC on one column. Results are confirmed on both columns and reported from the passing column. The associated samples are: (CCVIS 180-378906/133), (CCVIS 180-378906/30), (CCVIS 180-378906/56) and (CCVIS 180-378906/81).

The continuing calibration verification (CCV) associated with 378906 recovered low and outside the control limits for 4,4-DDE on one column. Results are confirmed on both columns and reported from the passing column. The associated samples are: (CCVIS 180-378906/107), (CCVIS 180-378906/133), (CCVIS 180-378906/30), (CCVIS 180-378906/56) and (CCVIS 180-378906/81).

The continuing calibration verification (CCV) associated with 378906 recovered high and outside the control limits for Endosulfan II on one column. Results are confirmed on both columns and reported from the passing column. The associated samples are: (CCVIS

Job ID: 180-129635-1 (Continued)

Laboratory: Eurofins Pittsburgh (Continued)

180-378906/107), (CCVIS 180-378906/133), (CCVIS 180-378906/30), (CCVIS 180-378906/56) and (CCVIS 180-378906/81).

The continuing calibration verification (CCV) associated with 378906 recovered high and outside the control limits for Endrin Aldehyde on one column. Results are confirmed on both columns and reported from the passing column. The associated samples are: (CCVIS 180-378906/107), (CCVIS 180-378906/133), (CCVIS 180-378906/30), (CCVIS 180-378906/56) and (CCVIS 180-378906/81).

The continuing calibration verification (CCV) associated with 378906 recovered low and outside the control limits for Toxaphene and Chlordane on one column. Results are confirmed on both columns and reported from the passing column. The associated samples are: (CCV 180-378906/129) and (CCV 180-378906/130).

PCBs
The first internal standard recovered low. No PCBs were calculated from this internal standard; therefore, the results were reported as is: STOCKPILE QUADRANT 3 (180-129635-3)

Surrogate recovery for the following samples were outside control limits: STOCKPILE QUADRANT 3 (180-129635-3), STOCKPILE QUADRANT 4 (180-129635-4) and STOCKPILE QUADRANTS 1-4 (180-129635-5). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

9056A
No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

DIOXINS
One or more Isotope Dilution Analyte (IDA) recoveries associated with the following sample is below the method recommended limit: STOCKPILE QUADRANTS 1-4 (180-129635-5). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s).

The Isotope Dilution Analyte (IDA) recovery associated with the following samples is below the method recommended limit: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s).

Several analytes were detected in method blank MB 140-56482/17-A at levels that were above the method detection limit but below the reporting limit. The values should be considered estimates, and have been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged.

One or more Isotope Dilution Analyte (IDA) recoveries associated with the following sample is below the method recommended limit: (LCS 140-56482/16-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s). All target analytes were within control limits.

One or more Isotope Dilution Anlyte (IDA) recoveries associated with the following sample is below the recommended limit: STOCKPILE QUADRANTS 1-4 (180-129635-5). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s).

METALS
The method blank for 379482 contained manganese above the reporting limit (RL). Associated samples were not re-extracted and/or re-analyzed because results were greater than 10X the value found in the method blank.STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4).

Chromium was detected in method blank MB 180-379074/1-A at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged.

Antimony, Selenium and Manganese failed the recovery criteria low for the MS of sample STOCKPILE QUADRANT 1MS (180-129635-1) in batch 180-379482. Several analytes failed the recovery criteria low and Manganese failed the recovery criteria high for the MSD of sample STOCKPILE QUADRANT 1MSD (180-129635-1) in batch 180-379482. The presence of the '4' qualifier indicates analytes where the

Job ID: 180-129635-1 (Continued)

Laboratory: Eurofins Pittsburgh (Continued)

concentration in the unspiked sample exceeded four times the spiking amount.

GENERAL CHEMSITRY
The following samples were prepped within holding time for TKN, but analyzed outside of analytical holding time due to instrumentation issues: STOCKPILE QUADRANT 1 (180-129635-1), STOCKPILE QUADRANT 2 (180-129635-2), STOCKPILE QUADRANT 3 (180-129635-3) and STOCKPILE QUADRANT 4 (180-129635-4). The samples required dilution due to the concentration of TKN detected.

Total Kjeldahl Nitrogen failed the recovery criteria low for the MS of sample STOCKPILE QUADRANT 1MS (180-129635-1) in batch 480-607363. The presence of the '4' qualifier indicates analytes where the concentration in the unspiked sample exceeded four times the spiking amount.

Cyanide, Free was detected in method blank MB 460-813502/1-B at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged.

The reporting limit for Lloyd Kahn TOC analysis is a nominal value and does not reflect adjustments in sample mass processed on an individual basis.

GEOTECHNICAL
No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Definitions/Glossary

Qualifiers

GC/MS Semi VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC Semi VOA

Qualifier	Qualifier Description
*3	ISTD response or retention time outside acceptable limits.
p	The %RPD between the primary and confirmation column/detector is >40%. The lower value has been reported.
S1+	Surrogate recovery exceeds control limits, high biased.

Dioxin

Qualifier	Qualifier Description
*5-	Isotope dilution analyte is outside acceptance limits, low biased.
B	Compound was found in the blank and sample.
I	Value is EMPC (estimated maximum possible concentration).
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Metals

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
B	Compound was found in the blank and sample.
F1	MS and/or MSD recovery exceeds control limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
B	Compound was found in the blank and sample.
H	Sample was prepped or analyzed beyond the specified holding time
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)

Glossary (Continued)

Abbreviation	These commonly used abbreviations may or may not be present in this report.
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Accreditation/Certification Summary

Laboratory: Eurofins Pittsburgh

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Louisiana	NELAP	04041	12-21-21

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
2540G		Sediment	Percent Moisture
2540G		Sediment	Percent Solids
ASTM D2974		Sediment	Loss on Ignition
EPA 6020B	3050B	Sediment	Antimony
EPA 6020B	3050B	Sediment	Arsenic
EPA 6020B	3050B	Sediment	Beryllium
EPA 6020B	3050B	Sediment	Cadmium
EPA 6020B	3050B	Sediment	Chromium
EPA 6020B	3050B	Sediment	Copper
EPA 6020B	3050B	Sediment	Lead
EPA 6020B	3050B	Sediment	Manganese
EPA 6020B	3050B	Sediment	Nickel
EPA 6020B	3050B	Sediment	Selenium
EPA 6020B	3050B	Sediment	Silver
EPA 6020B	3050B	Sediment	Thallium
EPA 6020B	3050B	Sediment	Zinc
EPA 8270E LL	3541	Sediment	1,1'-Biphenyl
EPA 8270E LL	3541	Sediment	2,2'-oxybis[1-chloropropane]
EPA 8270E LL	3541	Sediment	2,4,5-Trichlorophenol
EPA 8270E LL	3541	Sediment	2,4,6-Trichlorophenol
EPA 8270E LL	3541	Sediment	2,4-Dichlorophenol
EPA 8270E LL	3541	Sediment	2,4-Dimethylphenol
EPA 8270E LL	3541	Sediment	2,4-Dinitrophenol
EPA 8270E LL	3541	Sediment	2,4-Dinitrotoluene
EPA 8270E LL	3541	Sediment	2,6-Dinitrotoluene
EPA 8270E LL	3541	Sediment	2-Chloronaphthalene
EPA 8270E LL	3541	Sediment	2-Chlorophenol
EPA 8270E LL	3541	Sediment	2-Methylnaphthalene
EPA 8270E LL	3541	Sediment	2-Methylphenol
EPA 8270E LL	3541	Sediment	2-Nitroaniline
EPA 8270E LL	3541	Sediment	2-Nitrophenol
EPA 8270E LL	3541	Sediment	3,3'-Dichlorobenzidine
EPA 8270E LL	3541	Sediment	3-Nitroaniline
EPA 8270E LL	3541	Sediment	4,6-Dinitro-2-methylphenol
EPA 8270E LL	3541	Sediment	4-Bromophenyl phenyl ether
EPA 8270E LL	3541	Sediment	4-Chloro-3-methylphenol
EPA 8270E LL	3541	Sediment	4-Chloroaniline
EPA 8270E LL	3541	Sediment	4-Chlorophenyl phenyl ether
EPA 8270E LL	3541	Sediment	4-Nitroaniline
EPA 8270E LL	3541	Sediment	4-Nitrophenol
EPA 8270E LL	3541	Sediment	Acenaphthene
EPA 8270E LL	3541	Sediment	Acenaphthylene
EPA 8270E LL	3541	Sediment	Acetophenone
EPA 8270E LL	3541	Sediment	Anthracene
EPA 8270E LL	3541	Sediment	Atrazine

Accreditation/Certification Summary

Laboratory: Eurofins Pittsburgh (Continued)

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
EPA 8270E LL	3541	Sediment	Benzaldehyde
EPA 8270E LL	3541	Sediment	Benzo[a]anthracene
EPA 8270E LL	3541	Sediment	Benzo[a]pyrene
EPA 8270E LL	3541	Sediment	Benzo[b]fluoranthene
EPA 8270E LL	3541	Sediment	Benzo[g,h,i]perylene
EPA 8270E LL	3541	Sediment	Benzo[k]fluoranthene
EPA 8270E LL	3541	Sediment	Bis(2-chloroethoxy)methane
EPA 8270E LL	3541	Sediment	Bis(2-chloroethyl)ether
EPA 8270E LL	3541	Sediment	Bis(2-ethylhexyl) phthalate
EPA 8270E LL	3541	Sediment	Butyl benzyl phthalate
EPA 8270E LL	3541	Sediment	Caprolactam
EPA 8270E LL	3541	Sediment	Carbazole
EPA 8270E LL	3541	Sediment	Chrysene
EPA 8270E LL	3541	Sediment	Dibenz(a,h)anthracene
EPA 8270E LL	3541	Sediment	Dibenzofuran
EPA 8270E LL	3541	Sediment	Diethyl phthalate
EPA 8270E LL	3541	Sediment	Dimethyl phthalate
EPA 8270E LL	3541	Sediment	Di-n-butyl phthalate
EPA 8270E LL	3541	Sediment	Di-n-octyl phthalate
EPA 8270E LL	3541	Sediment	Fluoranthene
EPA 8270E LL	3541	Sediment	Fluorene
EPA 8270E LL	3541	Sediment	Hexachlorobenzene
EPA 8270E LL	3541	Sediment	Hexachlorobutadiene
EPA 8270E LL	3541	Sediment	Hexachlorocyclopentadiene
EPA 8270E LL	3541	Sediment	Hexachloroethane
EPA 8270E LL	3541	Sediment	Indeno[1,2,3-cd]pyrene
EPA 8270E LL	3541	Sediment	Isophorone
EPA 8270E LL	3541	Sediment	Methylphenol, 3 & 4
EPA 8270E LL	3541	Sediment	Naphthalene
EPA 8270E LL	3541	Sediment	Nitrobenzene
EPA 8270E LL	3541	Sediment	N-Nitrosodi-n-propylamine
EPA 8270E LL	3541	Sediment	N-Nitrosodiphenylamine
EPA 8270E LL	3541	Sediment	Pentachlorophenol
EPA 8270E LL	3541	Sediment	Phenanthrene
EPA 8270E LL	3541	Sediment	Phenol
EPA 8270E LL	3541	Sediment	Pyrene
EPA-Lloyd Kahn		Sediment	Total Organic Carbon - Duplicates

Laboratory: Eurofins Buffalo

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Arkansas DEQ	State	88-0686	07-06-22
Connecticut	State	PH-0568	09-30-22
Florida	NELAP	E87672	12-31-21
Georgia	State	10026 (NY)	03-31-22
Georgia	State Program	N/A	03-31-09 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Accreditation/Certification Summary

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Job ID: 180-129635-1

Laboratory: Eurofins Buffalo (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Georgia (DW)	State	956	03-31-22
Illinois	NELAP	200003	09-30-22
Iowa	State	374	03-01-23
Iowa	State Program	374	03-01-09 *
Kansas	NELAP	E-10187	01-31-22
Kentucky (DW)	State	90029	12-31-21
Kentucky (UST)	State	30	04-01-22
Kentucky (WW)	State	KY90029	12-31-21
Louisiana	NELAP	02031	06-30-22
Maine	State	NY00044	01-18-22
Maryland	State	294	04-02-22
Massachusetts	State	M-NY044	12-31-21
Michigan	State	9937	04-01-22
Michigan	State Program	9937	04-01-09 *
Minnesota	NELAP	1524384	01-01-22
New Hampshire	NELAP	2973	09-11-19 *
New Hampshire	NELAP	2337	11-17-22
New Jersey	NELAP	NY455	06-30-22
New York	NELAP	10026	12-06-21
Oregon	NELAP	NY200003	06-12-22
Pennsylvania	NELAP	68-00281	07-31-22
Rhode Island	State	LAO00328	12-31-21
Tennessee	State	02970	03-31-22
Texas	NELAP	T104704412-18-10	07-31-22
USDA	US Federal Programs	P330-18-00039	03-25-24
Virginia	NELAP	460185	09-14-22
Washington	State	C784	02-10-22
Wisconsin	State	998310390	08-31-22

Laboratory: Eurofins Burlington

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
ANAB	Dept. of Defense ELAP	L2336	02-25-23
Connecticut	State	PH-0751	09-30-21 *
DE Haz. Subst. Cleanup Act (HSCA)	State	N/A	05-17-22
Florida	NELAP	E87467	06-30-22
Minnesota	NELAP	050-999-436	12-31-22
New Hampshire	NELAP	2006	12-18-21
New Jersey	NELAP	VT972	06-30-22
New York	NELAP	10391	04-01-22
Pennsylvania	NELAP	68-00489	12-21-21
Rhode Island	State	LAO00298	12-29-21
US Fish & Wildlife	US Federal Programs	058448	07-31-22
USDA	US Federal Programs	P330-17-00272	10-30-23
Vermont	State	VT4000	02-09-22
Virginia	NELAP	460209	12-14-21
Wisconsin	State	399133350	08-31-22

Laboratory: Eurofins Canton

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Laboratory: Eurofins Canton (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
California	State	2927	01-26-22
Connecticut	State	PH-0590	12-31-21
Florida	NELAP	E87225	12-31-21
Georgia	State	4062	02-23-22
Illinois	NELAP	200004	07-31-22
Iowa	State	421	06-01-23
Kansas	NELAP	E-10336	04-30-22
Kentucky (UST)	State	112225	02-23-22
Kentucky (WW)	State	KY98016	12-31-21
Minnesota	NELAP	039-999-348	12-27-21
Minnesota (Petrofund)	State	3506	08-01-23
New Jersey	NELAP	OH001	11-06-22
New York	NELAP	10975	03-31-22
Ohio VAP	State	CL0024	12-21-23
Oregon	NELAP	4062	12-06-21
Pennsylvania	NELAP	68-00340	12-13-21
Texas	NELAP	T104704517-21-14	08-31-22
Virginia	NELAP	11570	09-14-22
Washington	State	C971	01-12-22
West Virginia DEP	State	210	12-21-21

Laboratory: Eurofins Edison

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Connecticut	State	PH-0200	09-30-22
DE Haz. Subst. Cleanup Act (HSCA)	State	N/A	12-31-21
Georgia	State	12028 (NJ)	06-30-22
Massachusetts	State	M-NJ312	01-11-22
New Jersey	NELAP	12028	11-22-21
New York	NELAP	11452	12-09-21
Pennsylvania	NELAP	68-00522	02-03-22
Rhode Island	State	LAO00376	12-30-21
USDA	US Federal Programs	P330-20-00244	11-03-23

Laboratory: Eurofins Knoxville

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
	AFCEE	N/A	
ANAB	Dept. of Defense ELAP	L2311	02-03-22
ANAB	Dept. of Energy	L2311.01	02-03-22
ANAB	ISO/IEC 17025	L2311	02-03-22
Arkansas DEQ	State	88-0688	06-17-22
California	State	2423	06-30-22
Colorado	State	TN00009	02-28-22
Connecticut	State	PH-0223	09-30-23
Florida	NELAP	E87177	06-30-22
Georgia (DW)	State	906	12-11-22
Hawaii	State	NA	12-11-22
Kansas	NELAP	E-10349	10-31-22

Accreditation/Certification Summary

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Laboratory: Eurofins Knoxville (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Kentucky (DW)	State	90101	12-31-22
Louisiana	NELAP	83979	06-30-22
Louisiana (DW)	State	LA019	12-31-22
Maryland	State	277	03-31-22
Michigan	State	9933	12-11-22
Nevada	State	TN00009	07-31-22
New Hampshire	NELAP	299919	01-17-22
New Jersey	NELAP	TN001	06-30-22
New York	NELAP	10781	03-31-22
North Carolina (DW)	State	21705	07-31-22
North Carolina (WW/SW)	State	64	12-31-22
Ohio VAP	State	CL0059	06-02-23
Oklahoma	State	9415	08-31-22
Oregon	NELAP	TNI0189	12-31-22
Pennsylvania	NELAP	68-00576	12-31-22
Tennessee	State	02014	12-11-22
Texas	NELAP	T104704380-18-12	08-31-22
US Fish & Wildlife	US Federal Programs	058448	07-31-22
USDA	US Federal Programs	P330-19-00236	08-20-22
Utah	NELAP	TN00009	07-31-22
Virginia	NELAP	460176	09-14-22
Washington	State	C593	01-19-22
West Virginia (DW)	State	9955C	12-31-22
West Virginia DEP	State	345	04-30-22
Wisconsin	State	998044300	08-31-22

Sample Summary

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Job ID: 180-129635-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
180-129635-1	STOCKPILE QUADRANT 1	Sediment	11/03/21 08:48	11/05/21 10:00
180-129635-2	STOCKPILE QUADRANT 2	Sediment	11/03/21 09:03	11/05/21 10:00
180-129635-3	STOCKPILE QUADRANT 3	Sediment	11/03/21 09:14	11/05/21 10:00
180-129635-4	STOCKPILE QUADRANT 4	Sediment	11/03/21 09:25	11/05/21 10:00
180-129635-5	STOCKPILE QUADRANTS 1-4	Sediment	11/03/21 09:31	11/05/21 10:00

Method Summary

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Method	Method Description	Protocol	Laboratory
EPA 8270E LL	Semivolatile Organic Compounds (GC/MS)	SW846	TAL PIT
8015D	Diesel Range Organics (DRO) (GC)	SW846	TAL CAN
EPA 8081B LL	Organochlorine Pesticides (GC)	SW846	TAL PIT
EPA 8082A	Polychlorinated Biphenyls (PCBs) (GC)	SW846	TAL PIT
EPA 9056A	Anions, Ion Chromatography	SW846	TAL PIT
8290A	Dioxins and Furans (HRGC/HRMS)	SW846	TAL KNX
EPA 6020B	Metals (ICP/MS)	SW846	TAL PIT
EPA 7471B	Mercury (CVAA)	SW846	TAL PIT
2540G	SM 2540G	SM22	TAL PIT
351.2	Nitrogen, Total Kjeldahl	MCAWW	TAL BUF
9016	Cyanide, Free	SW846	TAL EDI
EPA 9014	Cyanide	SW846	TAL PIT
EPA 9034	Sulfide, Acid soluble and Insoluble (Titrimetric)	SW846	TAL PIT
EPA-Lloyd Kahn	Organic Carbon, Total (TOC)	EPA	TAL PIT
ASTM D2974	Moisture, Ash and Organic Matter	ASTM	TAL PIT
D422	Grain Size	ASTM	TAL BUR
3050B	Preparation, Metals	SW846	TAL PIT
351.2	Nitrogen, Total Kjeldahl	MCAWW	TAL BUF
3541	Automated Soxhlet Extraction (Low Level)	SW846	TAL PIT
3546	Microwave Extraction	SW846	TAL CAN
3640A	Gel-Permeation Cleanup	SW846	TAL PIT
3660B	Sulfur Cleanup	SW846	TAL PIT
3665A	Sulfuric Acid/Permanganate Cleanup	SW846	TAL PIT
7471B	Preparation, Mercury	SW846	TAL PIT
8290	Soxhlet Extraction of Dioxins and Furans	SW846	TAL KNX
9010C	Cyanide, Distillation	SW846	TAL PIT
9016	Cyanide, Preparation	SW846	TAL EDI
9016	Cyanide Extraction (Solids and Oils)	SW846	TAL EDI
9030B	Sulfide, Distillation (Acid Soluble and Insoluble)	SW846	TAL PIT
DI Leach	Deionized Water Leaching Procedure	ASTM	TAL PIT

Protocol References:

ASTM = ASTM International
EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM22 = Standard Methods For The Examination Of Water And Wastewater, 22nd Edition
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL BUF = Eurofins Buffalo, 10 Hazelwood Drive, Amherst, NY 14228-2298, TEL (716)691-2600
TAL BUR = Eurofins Burlington, 530 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990
TAL CAN = Eurofins Canton, 180 S. Van Buren Avenue, Barberton, OH 44203, TEL (330)497-9396
TAL EDI = Eurofins Edison, 777 New Durham Road, Edison, NJ 08817, TEL (732)549-3900
TAL KNX = Eurofins Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000
TAL PIT = Eurofins Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Lab Chronicle

Client Sample ID: STOCKPILE QUADRANT 1

Lab Sample ID: 180-129635-1
Date Collected: 11/03/21 08:48
Matrix: Sediment
Date Received: 11/05/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			378237	11/09/21 11:59	HEK	TAL PIT
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	ASTM D2974		1			380493	11/30/21 09:04	JCR	TAL PIT
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	D422		1			174709	12/02/21 17:47	CPF	TAL BUR
	Instrument ID:	D422_import								

Client Sample ID: STOCKPILE QUADRANT 1

Lab Sample ID: 180-129635-1
Date Collected: 11/03/21 08:48
Matrix: Sediment
Date Received: 11/05/21 10:00
Percent Solids: 77.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			30.0 g	0.5 mL	378309	11/09/21 18:40	CSC	TAL PIT
Total/NA	Analysis	EPA 8270E LL		2	1 mL	1 mL	378370	11/10/21 22:25	VVP	TAL PIT
	Instrument ID:	CH722								
Total/NA	Prep	3546			9.77 g	5 mL	512431	11/11/21 06:30	EMB	TAL CAN
Total/NA	Analysis	8015D		1			512687	11/12/21 14:39	OCR	TAL CAN
	Instrument ID:	A2HP6R								
Total/NA	Prep	3541			30.1 g	10.0 mL	378136	11/08/21 22:11	CSC	TAL PIT
Total/NA	Cleanup	3640A			5.0 mL	0.5 mL	378548	11/11/21 08:38	VJC	TAL PIT
Total/NA	Analysis	EPA 8081B LL		5			378906	11/16/21 00:45	JMO	TAL PIT
	Instrument ID:	CHGC15								
Total/NA	Prep	3541			30.1 g	1.0 mL	378137	11/09/21 09:04	CBY	TAL PIT
Total/NA	Cleanup	3665A			2 mL	2 mL	378327	11/10/21 06:16	JMO	TAL PIT
Total/NA	Cleanup	3660B			2 mL	2 mL	378328	11/10/21 06:17	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1			378882	11/14/21 22:33	JMO	TAL PIT
	Instrument ID:	CHGC20								
Soluble	Leach	DI Leach			10.05 g	100 mL	377909	11/06/21 08:46	JRB	TAL PIT
Soluble	Analysis	EPA 9056A		1			377893	11/06/21 13:19	JRB	TAL PIT
	Instrument ID:	CHIC2100A								
Total/NA	Prep	8290			13.03 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57559	12/31/21 01:31	PMP	TAL KNX
	Instrument ID:	D12C								
Total/NA	Prep	8290			13.03 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57534	12/30/21 02:40	PMP	TAL KNX
	Instrument ID:	D4A								
Total/NA	Prep	3050B			2.00 g	100 mL	379074	11/16/21 09:49	RGM	TAL PIT
Total/NA	Analysis	EPA 6020B		1			379482	11/18/21 16:44	RSK	TAL PIT
	Instrument ID:	DORY								
Total/NA	Prep	7471B			1.31 g	100 mL	378234	11/09/21 11:48	RJR	TAL PIT
Total/NA	Analysis	EPA 7471B		1			378742	11/12/21 10:18	RJR	TAL PIT
	Instrument ID:	HGY								
Total/NA	Prep	351.2			0.5158 mL	25 mL	606990	11/30/21 05:50	CLT	TAL BUF
Total/NA	Analysis	351.2		10			607363	12/02/21 10:41	CLT	TAL BUF
	Instrument ID:	KONE1								

Lab Chronicle

Client Sample ID: STOCKPILE QUADRANT 1

Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 77.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Leach	9016			1.0 g	500 mL	813502	11/16/21 07:13	IAA	TAL EDI
Total/NA	Prep	9016			3.0 mL	1.3 mL	813592	11/16/21 11:55	IAA	TAL EDI
Total/NA	Analysis	9016		1			813612	11/16/21 13:59	OXG	TAL EDI
	Instrument ID:	Wet9016								
Total/NA	Prep	9010C			0.54 g	10 mL	378813	11/15/21 14:30	CMR	TAL PIT
Total/NA	Analysis	EPA 9014		1			379207	11/15/21 19:08	CMR	TAL PIT
	Instrument ID:	SEAL1								
Total/NA	Prep	9030B			5.00 mL	50 mL	377926	11/06/21 13:00	HEK	TAL PIT
Total/NA	Analysis	EPA 9034		1			377953	11/06/21 15:24	HEK	TAL PIT
	Instrument ID:	Q								
Total/NA	Analysis	EPA-Lloyd Kahn		1			378529	11/10/21 15:49	DLF	TAL PIT
	Instrument ID:	FLASHEA								

Client Sample ID: STOCKPILE QUADRANT 2

Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03

Matrix: Sediment

Date Received: 11/05/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			378237	11/09/21 11:59	HEK	TAL PIT
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	ASTM D2974		1			380493	11/30/21 09:04	JCR	TAL PIT
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	D422		1			174709	12/02/21 17:49	CPF	TAL BUR
	Instrument ID:	D422_import								

Client Sample ID: STOCKPILE QUADRANT 2

Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 73.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			30.1 g	0.5 mL	378309	11/09/21 18:40	CSC	TAL PIT
Total/NA	Analysis	EPA 8270E LL		3	1 mL	1 mL	378370	11/10/21 22:47	VVP	TAL PIT
	Instrument ID:	CH722								
Total/NA	Prep	3546			10.07 g	5 mL	512431	11/11/21 06:30	EMB	TAL CAN
Total/NA	Analysis	8015D		1			512687	11/12/21 15:58	OCR	TAL CAN
	Instrument ID:	A2HP6R								
Total/NA	Prep	3541			30.0 g	10.0 mL	378136	11/08/21 22:11	CSC	TAL PIT
Total/NA	Cleanup	3640A			5.0 mL	0.5 mL	378548	11/11/21 08:38	VJC	TAL PIT
Total/NA	Analysis	EPA 8081B LL		5			378906	11/16/21 01:00	JMO	TAL PIT
	Instrument ID:	CHGC15								
Total/NA	Prep	3541			30.3 g	1.0 mL	378137	11/09/21 09:04	CBY	TAL PIT
Total/NA	Cleanup	3665A			2 mL	2 mL	378327	11/10/21 06:16	JMO	TAL PIT
Total/NA	Cleanup	3660B			2 mL	2 mL	378328	11/10/21 06:17	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1			378882	11/14/21 22:52	JMO	TAL PIT
	Instrument ID:	CHGC20								

Lab Chronicle

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Job ID: 180-129635-1

Client Sample ID: STOCKPILE QUADRANT 2

Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 73.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Soluble	Leach	DI Leach			10.04 g	100 mL	377909	11/06/21 08:46	JRB	TAL PIT
Soluble	Analysis	EPA 9056A		1			377893	11/06/21 13:31	JRB	TAL PIT
	Instrument ID: CHIC2100A									
Total/NA	Prep	8290			14.11 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57534	12/30/21 03:40	PMP	TAL KNX
	Instrument ID: D4A									
Total/NA	Prep	3050B			2.03 g	100 mL	379074	11/16/21 09:49	RGM	TAL PIT
Total/NA	Analysis	EPA 6020B		1			379482	11/18/21 17:07	RSK	TAL PIT
	Instrument ID: DORY									
Total/NA	Prep	7471B			1.50 g	100 mL	378234	11/09/21 11:48	RJR	TAL PIT
Total/NA	Analysis	EPA 7471B		1			378742	11/12/21 10:19	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	351.2			0.5550 mL	25 mL	606990	11/30/21 05:50	CLT	TAL BUF
Total/NA	Analysis	351.2		10			607363	12/02/21 10:41	CLT	TAL BUF
	Instrument ID: KONE1									
Total/NA	Leach	9016			1.0 g	500 mL	813502	11/16/21 07:13	IAA	TAL EDI
Total/NA	Prep	9016			3.0 mL	1.3 mL	813592	11/16/21 11:55	IAA	TAL EDI
Total/NA	Analysis	9016		1			813612	11/16/21 13:59	OXG	TAL EDI
	Instrument ID: Wet9016									
Total/NA	Prep	9010C			0.53 g	10 mL	378813	11/15/21 14:30	CMR	TAL PIT
Total/NA	Analysis	EPA 9014		1			379207	11/15/21 19:10	CMR	TAL PIT
	Instrument ID: SEAL1									
Total/NA	Prep	9030B			4.98 mL	50 mL	377926	11/06/21 13:00	HEK	TAL PIT
Total/NA	Analysis	EPA 9034		1			377953	11/06/21 15:27	HEK	TAL PIT
	Instrument ID: Q									
Total/NA	Analysis	EPA-Lloyd Kahn		1			378529	11/10/21 16:22	DLF	TAL PIT
	Instrument ID: FLASHEA									

Client Sample ID: STOCKPILE QUADRANT 3

Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14

Matrix: Sediment

Date Received: 11/05/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			378237	11/09/21 11:59	HEK	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	ASTM D2974		1			380493	11/30/21 09:04	JCR	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	D422		1			174709	12/02/21 17:51	CPF	TAL BUR
	Instrument ID: D422_import									

Lab Chronicle

Client Sample ID: STOCKPILE QUADRANT 3

Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 78.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			30.2 g	0.5 mL	378309	11/09/21 18:40	CSC	TAL PIT
Total/NA	Analysis	EPA 8270E LL		3	1 mL	1 mL	378370	11/10/21 23:09	VVP	TAL PIT
	Instrument ID:	CH722								
Total/NA	Prep	3546			10.15 g	5 mL	512431	11/11/21 06:30	EMB	TAL CAN
Total/NA	Analysis	8015D		1			512687	11/12/21 16:24	OCR	TAL CAN
	Instrument ID:	A2HP6R								
Total/NA	Prep	3541			30.1 g	10.0 mL	378136	11/08/21 22:11	CSC	TAL PIT
Total/NA	Cleanup	3640A			5.0 mL	0.5 mL	378548	11/11/21 08:38	VJC	TAL PIT
Total/NA	Analysis	EPA 8081B LL		5			378906	11/16/21 01:16	JMO	TAL PIT
	Instrument ID:	CHGC15								
Total/NA	Prep	3541			30.1 g	1.0 mL	378137	11/09/21 09:04	CBY	TAL PIT
Total/NA	Cleanup	3665A			2 mL	2 mL	378327	11/10/21 06:16	JMO	TAL PIT
Total/NA	Cleanup	3660B			2 mL	2 mL	378328	11/10/21 06:17	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1			378882	11/14/21 23:10	JMO	TAL PIT
	Instrument ID:	CHGC20								
Soluble	Leach	DI Leach			10.05 g	100 mL	377909	11/06/21 08:46	JRB	TAL PIT
Soluble	Analysis	EPA 9056A		1			377893	11/06/21 13:43	JRB	TAL PIT
	Instrument ID:	CHIC2100A								
Total/NA	Prep	8290			13.24 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57559	12/31/21 02:01	PMP	TAL KNX
	Instrument ID:	D12C								
Total/NA	Prep	8290			13.24 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57534	12/30/21 04:40	PMP	TAL KNX
	Instrument ID:	D4A								
Total/NA	Prep	3050B			2.02 g	100 mL	379074	11/16/21 09:49	RGM	TAL PIT
Total/NA	Analysis	EPA 6020B		1			379482	11/18/21 17:10	RSK	TAL PIT
	Instrument ID:	DORY								
Total/NA	Prep	7471B			1.32 g	100 mL	378234	11/09/21 11:48	RJR	TAL PIT
Total/NA	Analysis	EPA 7471B		1			378742	11/12/21 10:20	RJR	TAL PIT
	Instrument ID:	HGY								
Total/NA	Prep	351.2			0.5872 mL	25 mL	606990	11/30/21 05:50	CLT	TAL BUF
Total/NA	Analysis	351.2		10			607363	12/02/21 10:47	CLT	TAL BUF
	Instrument ID:	KONE1								
Total/NA	Leach	9016			1.0 g	500 mL	813502	11/16/21 07:13	IAA	TAL EDI
Total/NA	Prep	9016			3.0 mL	1.3 mL	813592	11/16/21 11:55	IAA	TAL EDI
Total/NA	Analysis	9016		1			813612	11/16/21 13:59	OXG	TAL EDI
	Instrument ID:	Wet9016								
Total/NA	Prep	9010C			0.49 g	10 mL	378813	11/15/21 14:30	CMR	TAL PIT
Total/NA	Analysis	EPA 9014		1			379207	11/15/21 19:12	CMR	TAL PIT
	Instrument ID:	SEAL1								
Total/NA	Prep	9030B			5.00 mL	50 mL	377926	11/06/21 13:00	HEK	TAL PIT
Total/NA	Analysis	EPA 9034		1			377953	11/06/21 15:30	HEK	TAL PIT
	Instrument ID:	Q								
Total/NA	Analysis	EPA-Lloyd Kahn		1			378529	11/10/21 16:45	DLF	TAL PIT
	Instrument ID:	FLASHEA								

Lab Chronicle

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: STOCKPILE QUADRANT 4 Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25 **Matrix: Sediment**
Date Received: 11/05/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			378482	11/10/21 16:08	HEK	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	ASTM D2974		1			380493	11/30/21 09:04	JCR	TAL PIT
	Instrument ID: NOEQUIP									
Total/NA	Analysis	D422		1			174709	12/02/21 17:53	CPF	TAL BUR
	Instrument ID: D422_import									

Client Sample ID: STOCKPILE QUADRANT 4 Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 73.4**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			30.1 g	0.5 mL	378309	11/09/21 18:40	CSC	TAL PIT
Total/NA	Analysis	EPA 8270E LL		3	1 mL	1 mL	378370	11/10/21 23:32	VVP	TAL PIT
	Instrument ID: CH722									
Total/NA	Prep	3546			9.98 g	5 mL	512431	11/11/21 06:30	EMB	TAL CAN
Total/NA	Analysis	8015D		1			512687	11/12/21 16:51	OCR	TAL CAN
	Instrument ID: A2HP6R									
Total/NA	Prep	3541			30.0 g	10.0 mL	378136	11/08/21 22:11	CSC	TAL PIT
Total/NA	Cleanup	3640A			5.0 mL	0.5 mL	378548	11/11/21 08:38	VJC	TAL PIT
Total/NA	Analysis	EPA 8081B LL		5			378906	11/16/21 01:32	JMO	TAL PIT
	Instrument ID: CHGC15									
Total/NA	Prep	3541			30.1 g	1.0 mL	378137	11/09/21 09:04	CBY	TAL PIT
Total/NA	Cleanup	3665A			2 mL	2 mL	378327	11/10/21 06:16	JMO	TAL PIT
Total/NA	Cleanup	3660B			2 mL	2 mL	378328	11/10/21 06:17	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1			378882	11/14/21 23:29	JMO	TAL PIT
	Instrument ID: CHGC20									
Soluble	Leach	DI Leach			10.06 g	100 mL	377909	11/06/21 08:46	JRB	TAL PIT
Soluble	Analysis	EPA 9056A		1			377893	11/06/21 13:58	JRB	TAL PIT
	Instrument ID: CHIC2100A									
Total/NA	Prep	8290			13.78 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57534	12/30/21 05:40	PMP	TAL KNX
	Instrument ID: D4A									
Total/NA	Prep	3050B			2.00 g	100 mL	379074	11/16/21 09:49	RGM	TAL PIT
Total/NA	Analysis	EPA 6020B		1			379482	11/18/21 17:13	RSK	TAL PIT
	Instrument ID: DORY									
Total/NA	Prep	7471B			1.21 g	100 mL	378234	11/09/21 11:48	RJR	TAL PIT
Total/NA	Analysis	EPA 7471B		1			378742	11/12/21 10:21	RJR	TAL PIT
	Instrument ID: HGY									
Total/NA	Prep	351.2			0.5960 mL	25 mL	606990	11/30/21 05:50	CLT	TAL BUF
Total/NA	Analysis	351.2		10			607363	12/02/21 10:47	CLT	TAL BUF
	Instrument ID: KONE1									
Total/NA	Leach	9016			1.0 g	500 mL	813502	11/16/21 07:13	IAA	TAL EDI
Total/NA	Prep	9016			3.0 mL	1.3 mL	813592	11/16/21 11:55	IAA	TAL EDI
Total/NA	Analysis	9016		1			813612	11/16/21 13:59	OXG	TAL EDI
	Instrument ID: Wet9016									

Lab Chronicle

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 4 Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 73.4**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9010C			0.52 g	10 mL	378813	11/15/21 14:30	CMR	TAL PIT
Total/NA	Analysis	EPA 9014		1			379207	11/15/21 19:13	CMR	TAL PIT
	Instrument ID: SEAL1									
Total/NA	Prep	9030B			5.02 mL	50 mL	377926	11/06/21 13:00	HEK	TAL PIT
Total/NA	Analysis	EPA 9034		1			377953	11/06/21 15:39	HEK	TAL PIT
	Instrument ID: Q									
Total/NA	Analysis	EPA-Lloyd Kahn		1			378697	11/11/21 14:09	DLF	TAL PIT
	Instrument ID: FLASHEA									

Client Sample ID: STOCKPILE QUADRANTS 1-4 Lab Sample ID: 180-129635-5

Date Collected: 11/03/21 09:31 **Matrix: Sediment**
Date Received: 11/05/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	2540G		1			378652	11/11/21 16:09	BAC	TAL PIT
	Instrument ID: NOEQUIP									

Client Sample ID: STOCKPILE QUADRANTS 1-4 Lab Sample ID: 180-129635-5

Date Collected: 11/03/21 09:31 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 75.0**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3541			30.0 g	10.0 mL	378136	11/08/21 22:11	CSC	TAL PIT
Total/NA	Cleanup	3640A			5.0 mL	0.5 mL	378548	11/11/21 08:38	VJC	TAL PIT
Total/NA	Analysis	EPA 8081B LL		5			378906	11/16/21 01:47	JMO	TAL PIT
	Instrument ID: CHGC15									
Total/NA	Prep	3541			30.2 g	1.0 mL	378137	11/09/21 09:04	CBY	TAL PIT
Total/NA	Cleanup	3665A			2 mL	2 mL	378327	11/10/21 06:16	JMO	TAL PIT
Total/NA	Cleanup	3660B			2 mL	2 mL	378328	11/10/21 06:17	JMO	TAL PIT
Total/NA	Analysis	EPA 8082A		1			378882	11/14/21 23:47	JMO	TAL PIT
	Instrument ID: CHGC20									
Total/NA	Prep	8290			13.98 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57605	01/04/22 06:11	LKM	TAL KNX
	Instrument ID: D12C									
Total/NA	Prep	8290			13.98 g	20 uL	56482	11/30/21 11:04	SSS	TAL KNX
Total/NA	Analysis	8290A		1			57699	01/07/22 16:29	KBL	TAL KNX
	Instrument ID: D4A									

Laboratory References:

TAL BUF = Eurofins Buffalo, 10 Hazelwood Drive, Amherst, NY 14228-2298, TEL (716)691-2600
TAL BUR = Eurofins Burlington, 530 Community Drive, Suite 11, South Burlington, VT 05403, TEL (802)660-1990
TAL CAN = Eurofins Canton, 180 S. Van Buren Avenue, Barberton, OH 44203, TEL (330)497-9396
TAL EDI = Eurofins Edison, 777 New Durham Road, Edison, NJ 08817, TEL (732)549-3900
TAL KNX = Eurofins Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000
TAL PIT = Eurofins Pittsburgh, 301 Alpha Drive, RIDC Park, Pittsburgh, PA 15238, TEL (412)963-7058

Analyst References:

- Lab: TAL BUF
  - Batch Type: Prep
    - CLT = Christine Thomas
  - Batch Type: Analysis
    - CLT = Christine Thomas
- Lab: TAL BUR
  - Batch Type: Analysis
    - CPF = Fred Cota
- Lab: TAL CAN
  - Batch Type: Prep
    - EMB = Elizabeth Border
  - Batch Type: Analysis
    - OCR = Olguita Colon
- Lab: TAL EDI
  - Batch Type: Leach
    - IAA = Izabella Afremova
  - Batch Type: Prep
    - IAA = Izabella Afremova
  - Batch Type: Analysis
    - OXG = Olivia Guerrero
- Lab: TAL KNX
  - Batch Type: Prep
    - SSS = Samuel Stockton
  - Batch Type: Analysis
    - KBL = Kathryn Lay
    - LKM = Linda McWhirter
    - PMP = Trish Parsly
- Lab: TAL PIT
  - Batch Type: Cleanup
    - JMO = John Oravec
    - JRB = James Burzio
    - VJC = Vincent Cervone
  - Batch Type: Prep
    - CBY = Charles Yushinski
    - CMR = Carl Reagle
    - CSC = Chayce Cockroft
    - HEK = Hope Kiesling
    - RGM = Rebecca Manns
    - RJR = Ron Rosenbaum
  - Batch Type: Analysis
    - BAC = Blase Cindric
    - CMR = Carl Reagle
    - DLF = Donald Ferguson
    - HEK = Hope Kiesling
    - JCR = Jessica Rodgers
    - JMO = John Oravec
    - JRB = James Burzio
    - RJR = Ron Rosenbaum
    - RSK = Robert Kurtz
    - VVP = Vincent Piccolino

Client Sample Results

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 1 Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 77.8**

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**14**		8.6	2.5	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Acenaphthylene	**28**		8.6	1.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Anthracene	**42**		8.6	2.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzo[a]anthracene	**64**		8.6	3.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzo[a]pyrene	**45**		8.6	3.7	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzo[b]fluoranthene	**66**		8.6	2.1	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzo[g,h,i]perylene	**41**		8.6	1.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzo[k]fluoranthene	**20**		8.6	2.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Bis(2-chloroethyl)ether	ND		8.6	1.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Bis(2-chloroethoxy)methane	ND		42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,2'-oxybis[1-chloropropane]	ND		8.6	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Bis(2-ethylhexyl) phthalate	**150**	**J**	420	46	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Bromophenyl phenyl ether	ND		42	18	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Butyl benzyl phthalate	ND		42	30	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Chloroaniline	ND		42	11	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Chloronaphthalene	ND		8.6	2.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Chlorophenyl phenyl ether	ND		42	14	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Chrysene	**69**		8.6	4.8	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Dibenz(a,h)anthracene	**11**		8.6	5.5	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Dibenzofuran	ND		42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Di-n-butyl phthalate	ND		42	19	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
3,3'-Dichlorobenzidine	ND		42	40	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Diethyl phthalate	ND		42	15	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Dimethyl phthalate	ND		42	17	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4-Dinitrotoluene	ND		42	26	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,6-Dinitrotoluene	ND		42	17	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Di-n-octyl phthalate	ND		42	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Fluoranthene	**110**		8.6	2.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Fluorene	**33**		8.6	1.7	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Hexachlorobenzene	ND		8.6	3.1	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Hexachlorobutadiene	ND		8.6	2.5	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Hexachlorocyclopentadiene	ND		42	4.4	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Hexachloroethane	ND		42	15	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Indeno[1,2,3-cd]pyrene	**36**		8.6	4.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Isophorone	ND		42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Methylnaphthalene	**79**		8.6	2.1	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Naphthalene	**130**		8.6	1.7	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Nitroaniline	ND		220	20	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
3-Nitroaniline	ND		220	11	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Nitroaniline	ND		220	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Nitrobenzene	ND		86	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
N-Nitrosodi-n-propylamine	ND		8.6	2.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
N-Nitrosodiphenylamine	ND		42	14	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Phenanthrene	**140**		8.6	2.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Pyrene	**140**		8.6	2.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Carbazole	**5.7**	**J**	8.6	2.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Acetophenone	ND		86	15	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Atrazine	ND		86	19	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Benzaldehyde	ND		86	5.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2

Client Sample Results

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 1 Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 77.8**

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1'-Biphenyl	**20**	**J**	42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Caprolactam	ND		220	28	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Chloro-3-methylphenol	ND		42	15	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Chlorophenol	ND		42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Methylphenol	ND		42	12	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Methylphenol, 3 & 4	**33**	**J**	42	13	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4-Dichlorophenol	ND		8.6	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4-Dimethylphenol	ND		42	14	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4-Dinitrophenol	ND		420	270	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4,6-Dinitro-2-methylphenol	ND		220	74	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2-Nitrophenol	ND		42	16	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
4-Nitrophenol	ND		220	30	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Pentachlorophenol	ND		220	69	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
Phenol	ND		42	13	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4,5-Trichlorophenol	ND		42	15	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2
2,4,6-Trichlorophenol	ND		42	14	ug/Kg	☼	11/09/21 18:40	11/10/21 22:25	2

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*47*		*35 - 105*	*11/09/21 18:40*	*11/10/21 22:25*	*2*
2-Fluorophenol (Surr)	*55*		*32 - 105*	*11/09/21 18:40*	*11/10/21 22:25*	*2*
2,4,6-Tribromophenol (Surr)	*47*		*20 - 119*	*11/09/21 18:40*	*11/10/21 22:25*	*2*
Nitrobenzene-d5 (Surr)	*52*		*34 - 109*	*11/09/21 18:40*	*11/10/21 22:25*	*2*
Phenol-d5 (Surr)	*53*		*34 - 105*	*11/09/21 18:40*	*11/10/21 22:25*	*2*
Terphenyl-d14 (Surr)	*53*		*20 - 117*	*11/09/21 18:40*	*11/10/21 22:25*	*2*

Method: 8015D - Diesel Range Organics (DRO) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics [C10 - C28]	**180**		66	45	mg/Kg	☼	11/11/21 06:30	11/12/21 14:39	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*89*		*39 - 120*	*11/11/21 06:30*	*11/12/21 14:39*	*1*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.27	0.083	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
alpha-BHC	ND		0.27	0.066	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
beta-BHC	ND		0.27	0.073	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
delta-BHC	ND		0.27	0.085	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
gamma-BHC (Lindane)	ND		0.27	0.069	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
cis-Chlordane	ND		0.27	0.067	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
trans-Chlordane	ND		0.27	0.062	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
4,4'-DDD	ND		0.27	0.11	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
4,4'-DDE	ND		0.27	0.054	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
4,4'-DDT	ND		0.27	0.19	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Dieldrin	ND		0.27	0.067	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Endosulfan I	ND		0.27	0.072	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Endosulfan II	ND		0.27	0.059	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Endosulfan sulfate	ND		0.27	0.069	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Endrin	ND		0.27	0.050	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Endrin aldehyde	ND		0.27	0.095	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5

Client Sample Results

Client Sample ID: STOCKPILE QUADRANT 1
Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48
Matrix: Sediment
Date Received: 11/05/21 10:00
Percent Solids: 77.8

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endrin ketone	ND		0.27	0.037	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Heptachlor	ND		0.27	0.084	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Heptachlor epoxide	ND		0.27	0.068	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Methoxychlor	ND		0.27	0.10	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5
Toxaphene	ND		11	7.2	ug/Kg	☼	11/08/21 22:11	11/16/21 00:45	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*38*		*10 - 105*	*11/08/21 22:11*	*11/16/21 00:45*	*5*
Tetrachloro-m-xylene (Surr)	*44*		*10 - 105*	*11/08/21 22:11*	*11/16/21 00:45*	*5*
DCB Decachlorobiphenyl (Surr)	*136*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 00:45*	*5*
DCB Decachlorobiphenyl (Surr)	*159*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 00:45*	*5*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.53	0.17	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1221	ND		0.53	0.19	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1232	ND		0.53	0.13	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1242	ND		0.53	0.078	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1248	ND		0.53	0.13	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1254	ND		0.53	0.16	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1
PCB-1260	**4.5**		0.53	0.15	ug/Kg	☼	11/09/21 09:04	11/14/21 22:33	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*133*		*26 - 170*	*11/09/21 09:04*	*11/14/21 22:33*	*1*
DCB Decachlorobiphenyl (Surr)	*140*		*26 - 170*	*11/09/21 09:04*	*11/14/21 22:33*	*1*
Tetrachloro-m-xylene (Surr)	*74*		*33 - 126*	*11/09/21 09:04*	*11/14/21 22:33*	*1*
Tetrachloro-m-xylene (Surr)	*66*		*33 - 126*	*11/09/21 09:04*	*11/14/21 22:33*	*1*

Method: EPA 9056A - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	**130**		13	8.7	mg/Kg	☼		11/06/21 13:19	1

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	**0.12**	**J I B**	0.99	0.033	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,7,8-PeCDD	ND		4.9	0.089	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,4,7,8-HxCDD	**0.29**	**J I B**	4.9	0.13	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,6,7,8-HxCDD	**0.47**	**J I B**	4.9	0.12	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,7,8,9-HxCDD	**0.69**	**J I B**	4.9	0.12	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,4,6,7,8-HpCDD	**11**	**B**	4.9	0.25	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
OCDD	**230**	**B**	9.9	0.22	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
2,3,7,8-TCDF	**1.4**		0.99	0.23	pg/g	☼	11/30/21 11:04	12/31/21 01:31	1
1,2,3,7,8-PeCDF	**0.14**	**J I B**	4.9	0.049	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
2,3,4,7,8-PeCDF	**0.23**	**J I B**	4.9	0.041	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,4,7,8-HxCDF	**0.45**	**J I B**	4.9	0.055	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,6,7,8-HxCDF	**0.42**	**J**	4.9	0.059	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
2,3,4,6,7,8-HxCDF	**0.23**	**J B**	4.9	0.056	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,7,8,9-HxCDF	ND		4.9	0.067	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,4,6,7,8-HpCDF	**2.5**	**J I B**	4.9	0.15	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
1,2,3,4,7,8,9-HpCDF	ND		4.9	0.19	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
OCDF	**4.1**	**J B**	9.9	0.18	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1

1
2
3
4
5
6
7
8
9
10
11
12
13

Client Sample ID: STOCKPILE QUADRANT 1

Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48
Date Received: 11/05/21 10:00
Matrix: Sediment
Percent Solids: 77.8

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
Total PeCDD	**0.61**	**J I**	4.9	0.089	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total TCDF	**12**	**I**	0.99	0.046	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total HxCDF	**5.2**	**I B**	4.9	0.059	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total TCDD	**1.7**	**I B**	0.99	0.033	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total PeCDF	**6.7**	**I B**	4.9	0.045	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total HpCDD	**25**	**B**	4.9	0.25	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total HxCDD	**5.3**	**I B**	4.9	0.12	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1
Total HpCDF	**5.7**	**I B**	4.9	0.17	pg/g	☼	11/30/21 11:04	12/30/21 02:40	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*41*		*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,7,8-PeCDD	*36*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,4,7,8-HxCDD	*33*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,6,7,8-HxCDD	*36*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*35*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-OCDD	*29*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-2,3,7,8-TCDF	*43*		*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-2,3,7,8-TCDF	*45*		*40 - 135*	*11/30/21 11:04*	*12/31/21 01:31*	*1*
13C-1,2,3,7,8-PeCDF	*38*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-2,3,4,7,8-PeCDF	*41*		*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,4,7,8-HxCDF	*40*		*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,6,7,8-HxCDF	*35*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-2,3,4,6,7,8-HxCDF	*41*		*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,7,8,9-HxCDF	*39*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*36*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*37*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*
13C-OCDF	*27*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 02:40*	*1*

Method: EPA 6020B - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**4.7**	**F1**	0.064	0.021	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Cadmium	**0.34**		0.064	0.011	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Chromium	**8.3**	**B**	0.13	0.054	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Lead	**17**		0.064	0.064	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Selenium	**1.0**	**F1**	0.32	0.078	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Silver	**0.17**	**F1**	0.064	0.018	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Beryllium	**0.86**		0.064	0.046	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Thallium	**0.12**		0.064	0.045	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Antimony	**0.25**	**F1**	0.13	0.028	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Nickel	**29**		0.064	0.060	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Zinc	**93**		0.32	0.31	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Copper	**21**	**F1**	0.19	0.13	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1
Manganese	**450**	**B**	0.32	0.28	mg/Kg	☼	11/16/21 09:49	11/18/21 16:44	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.051**		0.019	0.012	mg/Kg	☼	11/09/21 11:48	11/12/21 10:18	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**22.2**		0.1	0.1	%			11/09/21 11:59	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: STOCKPILE QUADRANT 1

Lab Sample ID: 180-129635-1

Date Collected: 11/03/21 08:48
Matrix: Sediment
Date Received: 11/05/21 10:00
Percent Solids: 77.8

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**77.8**		0.1	0.1	%			11/09/21 11:59	1
Total Kjeldahl Nitrogen	**1600**	**H**	120	54	mg/Kg	☼	11/30/21 05:50	12/02/21 10:41	10
Cyanide, Free	**0.69**	**J B**	1.4	0.49	mg/Kg	☼	11/16/21 11:55	11/16/21 13:59	1
Cyanide, Total	**0.17**	**J**	0.24	0.073	mg/Kg	☼	11/15/21 14:30	11/15/21 19:08	1
Sulfide	ND		39	13	mg/Kg	☼	11/06/21 13:00	11/06/21 15:24	1
Total Organic Carbon - Duplicates	**240000**		1300	960	mg/Kg	☼		11/10/21 15:49	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	**15.9**		0.5	0.5	%			11/30/21 09:04	1

Method: D422 - Grain Size

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gravel	**0.0**				%			12/02/21 17:47	1
Sieve Size 3 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Sand	**78.1**				%			12/02/21 17:47	1
Sieve Size 2 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Coarse Sand	**0.3**				%			12/02/21 17:47	1
Sieve Size 1.5 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Medium Sand	**20.2**				%			12/02/21 17:47	1
Sieve Size 1 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Fine Sand	**57.6**				%			12/02/21 17:47	1
Sieve Size 0.75 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Sieve Size 0.375 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Silt	**13.8**				%			12/02/21 17:47	1
Clay	**8.1**				%			12/02/21 17:47	1
Sieve Size #4 - Percent Finer	**100.0**				% Passing			12/02/21 17:47	1
Sieve Size #10 - Percent Finer	**99.7**				% Passing			12/02/21 17:47	1
Sieve Size #20 - Percent Finer	**95.4**				% Passing			12/02/21 17:47	1
Sieve Size #40 - Percent Finer	**79.5**				% Passing			12/02/21 17:47	1
Sieve Size #60 - Percent Finer	**63.7**				% Passing			12/02/21 17:47	1
Sieve Size #80 - Percent Finer	**53.9**				% Passing			12/02/21 17:47	1
Sieve Size #100 - Percent Finer	**41.1**				% Passing			12/02/21 17:47	1
Sieve Size #200 - Percent Finer	**21.9**				% Passing			12/02/21 17:47	1
Hydrometer Reading 1 - Percent Finer	**16.7**				% Passing			12/02/21 17:47	1
Hydrometer Reading 2 - Percent Finer	**13.6**				% Passing			12/02/21 17:47	1
Hydrometer Reading 3 - Percent Finer	**11.7**				% Passing			12/02/21 17:47	1
Hydrometer Reading 4 - Percent Finer	**9.9**				% Passing			12/02/21 17:47	1
Hydrometer Reading 5 - Percent Finer	**8.1**				% Passing			12/02/21 17:47	1
Hydrometer Reading 6 - Percent Finer	**6.2**				% Passing			12/02/21 17:47	1
Hydrometer Reading 7 - Percent Finer	**4.4**				% Passing			12/02/21 17:47	1

Client Sample Results

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 2

Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03
Date Received: 11/05/21 10:00

Matrix: Sediment
Percent Solids: 73.9

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**9.0**	**J**	14	3.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Acenaphthylene	**23**		14	3.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Anthracene	**32**		14	3.5	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzo[a]anthracene	**65**		14	6.1	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzo[a]pyrene	**54**		14	5.8	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzo[b]fluoranthene	**70**		14	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzo[g,h,i]perylene	**47**		14	2.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzo[k]fluoranthene	**21**		14	4.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Bis(2-chloroethyl)ether	ND		14	2.4	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Bis(2-chloroethoxy)methane	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,2'-oxybis[1-chloropropane]	ND		14	5.0	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Bis(2-ethylhexyl) phthalate	**84**	**J**	670	72	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Bromophenyl phenyl ether	ND		67	29	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Butyl benzyl phthalate	ND		67	47	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Chloroaniline	ND		67	18	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Chloronaphthalene	ND		14	3.1	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Chlorophenyl phenyl ether	ND		67	22	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Chrysene	**66**		14	7.5	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Dibenz(a,h)anthracene	**12**	**J**	14	8.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Dibenzofuran	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Di-n-butyl phthalate	ND		67	30	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
3,3'-Dichlorobenzidine	ND		67	63	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Diethyl phthalate	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Dimethyl phthalate	ND		67	27	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4-Dinitrotoluene	ND		67	40	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,6-Dinitrotoluene	ND		67	26	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Di-n-octyl phthalate	ND		67	39	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Fluoranthene	**97**		14	3.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Fluorene	**21**		14	2.7	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Hexachlorobenzene	ND		14	4.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Hexachlorobutadiene	ND		14	3.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Hexachlorocyclopentadiene	ND		67	6.9	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Hexachloroethane	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Indeno[1,2,3-cd]pyrene	**41**		14	6.7	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Isophorone	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Methylnaphthalene	**49**		14	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Naphthalene	**73**		14	2.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Nitroaniline	ND		340	31	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
3-Nitroaniline	ND		340	17	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Nitroaniline	ND		340	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Nitrobenzene	ND		140	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
N-Nitrosodi-n-propylamine	ND		14	4.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
N-Nitrosodiphenylamine	ND		67	22	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Phenanthrene	**92**		14	3.6	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Pyrene	**120**		14	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Carbazole	**4.7**	**J**	14	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Acetophenone	ND		140	24	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Atrazine	ND		140	30	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Benzaldehyde	ND		140	8.4	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3

Client Sample ID: STOCKPILE QUADRANT 2 Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 73.9**

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1'-Biphenyl	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Caprolactam	ND		340	44	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Chloro-3-methylphenol	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Chlorophenol	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Methylphenol	ND		67	19	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Methylphenol, 3 & 4	**34**	**J**	67	20	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4-Dichlorophenol	ND		14	5.2	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4-Dimethylphenol	ND		67	23	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4-Dinitrophenol	ND		670	420	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4,6-Dinitro-2-methylphenol	ND		340	120	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2-Nitrophenol	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
4-Nitrophenol	ND		340	47	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Pentachlorophenol	ND		340	110	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
Phenol	ND		67	20	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4,5-Trichlorophenol	ND		67	23	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3
2,4,6-Trichlorophenol	ND		67	22	ug/Kg	☼	11/09/21 18:40	11/10/21 22:47	3

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*56*		*35 - 105*	*11/09/21 18:40*	*11/10/21 22:47*	*3*
2-Fluorophenol (Surr)	*64*		*32 - 105*	*11/09/21 18:40*	*11/10/21 22:47*	*3*
2,4,6-Tribromophenol (Surr)	*56*		*20 - 119*	*11/09/21 18:40*	*11/10/21 22:47*	*3*
Nitrobenzene-d5 (Surr)	*59*		*34 - 109*	*11/09/21 18:40*	*11/10/21 22:47*	*3*
Phenol-d5 (Surr)	*61*		*34 - 105*	*11/09/21 18:40*	*11/10/21 22:47*	*3*
Terphenyl-d14 (Surr)	*70*		*20 - 117*	*11/09/21 18:40*	*11/10/21 22:47*	*3*

Method: 8015D - Diesel Range Organics (DRO) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics [C10 - C28]	**140**		67	46	mg/Kg	☼	11/11/21 06:30	11/12/21 15:58	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*74*		*39 - 120*	*11/11/21 06:30*	*11/12/21 15:58*	*1*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.28	0.088	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
alpha-BHC	ND		0.28	0.069	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
beta-BHC	ND		0.28	0.078	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
delta-BHC	ND		0.28	0.089	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
gamma-BHC (Lindane)	ND		0.28	0.073	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
cis-Chlordane	ND		0.28	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
trans-Chlordane	ND		0.28	0.066	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
4,4'-DDD	ND		0.28	0.12	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
4,4'-DDE	ND		0.28	0.058	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
4,4'-DDT	ND		0.28	0.20	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Dieldrin	ND		0.28	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Endosulfan I	ND		0.28	0.076	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Endosulfan II	ND		0.28	0.062	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Endosulfan sulfate	ND		0.28	0.073	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Endrin	ND		0.28	0.053	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Endrin aldehyde	ND		0.28	0.10	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5

Client Sample ID: STOCKPILE QUADRANT 2

Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 73.9

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endrin ketone	ND		0.28	0.039	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Heptachlor	ND		0.28	0.088	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Heptachlor epoxide	ND		0.28	0.072	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Methoxychlor	ND		0.28	0.11	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5
Toxaphene	ND		11	7.6	ug/Kg	☼	11/08/21 22:11	11/16/21 01:00	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*38*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:00*	*5*
Tetrachloro-m-xylene (Surr)	*49*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:00*	*5*
DCB Decachlorobiphenyl (Surr)	*158*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:00*	*5*
DCB Decachlorobiphenyl (Surr)	*165*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:00*	*5*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.56	0.18	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1221	ND		0.56	0.20	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1232	ND		0.56	0.14	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1242	ND		0.56	0.082	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1248	ND		0.56	0.14	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1254	ND		0.56	0.17	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1
PCB-1260	**1.9**		0.56	0.16	ug/Kg	☼	11/09/21 09:04	11/14/21 22:52	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*159*		*26 - 170*	*11/09/21 09:04*	*11/14/21 22:52*	*1*
DCB Decachlorobiphenyl (Surr)	*160*		*26 - 170*	*11/09/21 09:04*	*11/14/21 22:52*	*1*
Tetrachloro-m-xylene (Surr)	*118*		*33 - 126*	*11/09/21 09:04*	*11/14/21 22:52*	*1*
Tetrachloro-m-xylene (Surr)	*108*		*33 - 126*	*11/09/21 09:04*	*11/14/21 22:52*	*1*

Method: EPA 9056A - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	**50**		13	9.1	mg/Kg	☼		11/06/21 13:31	1

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	**0.084**	**J I B**	0.96	0.027	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,7,8-PeCDD	**0.29**	**J I**	4.8	0.082	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,4,7,8-HxCDD	**0.36**	**J I B**	4.8	0.026	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,6,7,8-HxCDD	**0.63**	**J B**	4.8	0.025	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,7,8,9-HxCDD	**0.63**	**J I B**	4.8	0.024	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,4,6,7,8-HpCDD	**17**	**B**	4.8	0.14	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
OCDD	**370**	**B**	9.6	0.12	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
2,3,7,8-TCDF	**0.78**	**J I**	0.96	0.047	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,7,8-PeCDF	**0.26**	**J B**	4.8	0.026	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
2,3,4,7,8-PeCDF	**0.34**	**J B**	4.8	0.022	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,4,7,8-HxCDF	**0.47**	**J B**	4.8	0.045	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,6,7,8-HxCDF	**0.43**	**J**	4.8	0.047	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
2,3,4,6,7,8-HxCDF	**0.20**	**J I B**	4.8	0.045	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,7,8,9-HxCDF	ND		4.8	0.054	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,4,6,7,8-HpCDF	**3.1**	**J B**	4.8	0.063	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
1,2,3,4,7,8,9-HpCDF	**0.26**	**J I**	4.8	0.083	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
OCDF	**5.2**	**J B**	9.6	0.11	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1

Client Sample Results

Client Sample ID: STOCKPILE QUADRANT 2 Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 73.9**

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
Total PeCDD	**9.1**	**I**	4.8	0.082	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total TCDF	**13**	**I**	0.96	0.047	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total HxCDF	**6.1**	**I B**	4.8	0.048	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total TCDD	**2.3**	**I B**	0.96	0.027	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total PeCDF	**7.9**	**I B**	4.8	0.024	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total HpCDD	**37**	**B**	4.8	0.14	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total HxCDD	**6.4**	**I B**	4.8	0.025	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1
Total HpCDF	**7.6**	**I B**	4.8	0.073	pg/g	☼	11/30/21 11:04	12/30/21 03:40	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*51*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,7,8-PeCDD	*48*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,4,7,8-HxCDD	*47*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,6,7,8-HxCDD	*48*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-OCDD	*42*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-2,3,7,8-TCDF	*53*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,7,8-PeCDF	*48*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-2,3,4,7,8-PeCDF	*53*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,4,7,8-HxCDF	*54*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,6,7,8-HxCDF	*48*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-2,3,4,6,7,8-HxCDF	*56*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,7,8,9-HxCDF	*55*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*
13C-OCDF	*39*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 03:40*	*1*

Method: EPA 6020B - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**4.7**		0.067	0.021	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Cadmium	**0.40**		0.067	0.011	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Chromium	**10**	**B**	0.13	0.056	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Lead	**17**		0.067	0.067	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Selenium	**0.88**		0.33	0.081	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Silver	**0.19**		0.067	0.019	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Beryllium	**0.84**		0.067	0.048	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Thallium	**0.13**		0.067	0.047	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Antimony	**0.24**		0.13	0.029	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Nickel	**37**		0.067	0.063	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Zinc	**95**		0.33	0.32	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Copper	**19**		0.20	0.14	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1
Manganese	**490**	**B**	0.33	0.29	mg/Kg	☼	11/16/21 09:49	11/18/21 17:07	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.028**		0.018	0.011	mg/Kg	☼	11/09/21 11:48	11/12/21 10:19	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**26.1**		0.1	0.1	%			11/09/21 11:59	1
Percent Solids	**73.9**		0.1	0.1	%			11/09/21 11:59	1

Client Sample Results

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 2 Lab Sample ID: 180-129635-2

Date Collected: 11/03/21 09:03 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 73.9**

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Kjeldahl Nitrogen	**1400**	**H**	120	53	mg/Kg	☼	11/30/21 05:50	12/02/21 10:41	10
Cyanide, Free	**0.86**	**J B**	1.5	0.52	mg/Kg	☼	11/16/21 11:55	11/16/21 13:59	1
Cyanide, Total	ND		0.26	0.078	mg/Kg	☼	11/15/21 14:30	11/15/21 19:10	1
Sulfide	ND		41	14	mg/Kg	☼	11/06/21 13:00	11/06/21 15:27	1
Total Organic Carbon - Duplicates	**130000**		1400	1000	mg/Kg	☼		11/10/21 16:22	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	**13.8**		0.5	0.5	%			11/30/21 09:04	1

Method: D422 - Grain Size

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gravel	**0.0**				%			12/02/21 17:49	1
Sieve Size 3 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Sand	**72.0**				%			12/02/21 17:49	1
Sieve Size 2 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Coarse Sand	**1.4**				%			12/02/21 17:49	1
Sieve Size 1.5 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Medium Sand	**17.1**				%			12/02/21 17:49	1
Sieve Size 1 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Fine Sand	**53.5**				%			12/02/21 17:49	1
Sieve Size 0.75 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Sieve Size 0.375 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Silt	**16.4**				%			12/02/21 17:49	1
Clay	**11.6**				%			12/02/21 17:49	1
Sieve Size #4 - Percent Finer	**100.0**				% Passing			12/02/21 17:49	1
Sieve Size #10 - Percent Finer	**98.6**				% Passing			12/02/21 17:49	1
Sieve Size #20 - Percent Finer	**94.9**				% Passing			12/02/21 17:49	1
Sieve Size #40 - Percent Finer	**81.5**				% Passing			12/02/21 17:49	1
Sieve Size #60 - Percent Finer	**68.1**				% Passing			12/02/21 17:49	1
Sieve Size #80 - Percent Finer	**57.6**				% Passing			12/02/21 17:49	1
Sieve Size #100 - Percent Finer	**47.4**				% Passing			12/02/21 17:49	1
Sieve Size #200 - Percent Finer	**28.0**				% Passing			12/02/21 17:49	1
Hydrometer Reading 1 - Percent Finer	**22.5**				% Passing			12/02/21 17:49	1
Hydrometer Reading 2 - Percent Finer	**20.2**				% Passing			12/02/21 17:49	1
Hydrometer Reading 3 - Percent Finer	**17.3**				% Passing			12/02/21 17:49	1
Hydrometer Reading 4 - Percent Finer	**14.4**				% Passing			12/02/21 17:49	1
Hydrometer Reading 5 - Percent Finer	**11.6**				% Passing			12/02/21 17:49	1
Hydrometer Reading 6 - Percent Finer	**8.7**				% Passing			12/02/21 17:49	1
Hydrometer Reading 7 - Percent Finer	**6.4**				% Passing			12/02/21 17:49	1

Client Sample Results

Client: Northgate Environmental Management Inc. Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 3 Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 78.9**

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**21**		13	3.6	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Acenaphthylene	**34**		13	2.8	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Anthracene	**63**		13	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzo[a]anthracene	**110**		13	5.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzo[a]pyrene	**85**		13	5.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzo[b]fluoranthene	**110**		13	3.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzo[g,h,i]perylene	**79**		13	2.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzo[k]fluoranthene	**30**		13	3.8	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Bis(2-chloroethyl)ether	ND		13	2.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Bis(2-chloroethoxy)methane	ND		62	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,2'-oxybis[1-chloropropane]	ND		13	4.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Bis(2-ethylhexyl) phthalate	**110**	**J**	620	67	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Bromophenyl phenyl ether	ND		62	27	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Butyl benzyl phthalate	ND		62	43	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Chloroaniline	ND		62	17	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Chloronaphthalene	ND		13	2.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Chlorophenyl phenyl ether	ND		62	21	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Chrysene	**110**		13	7.0	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Dibenz(a,h)anthracene	**20**		13	8.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Dibenzofuran	ND		62	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Di-n-butyl phthalate	ND		62	28	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
3,3'-Dichlorobenzidine	ND		62	59	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Diethyl phthalate	ND		62	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Dimethyl phthalate	ND		62	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4-Dinitrotoluene	ND		62	38	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,6-Dinitrotoluene	ND		62	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Di-n-octyl phthalate	ND		62	37	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Fluoranthene	**190**		13	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Fluorene	**41**		13	2.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Hexachlorobenzene	ND		13	4.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Hexachlorobutadiene	ND		13	3.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Hexachlorocyclopentadiene	ND		62	6.4	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Hexachloroethane	ND		62	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Indeno[1,2,3-cd]pyrene	**66**		13	6.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Isophorone	ND		62	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Methylnaphthalene	**91**		13	3.0	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Naphthalene	**140**		13	2.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Nitroaniline	ND		320	29	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
3-Nitroaniline	ND		320	16	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Nitroaniline	ND		320	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Nitrobenzene	ND		130	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
N-Nitrosodi-n-propylamine	ND		13	4.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
N-Nitrosodiphenylamine	ND		62	21	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Phenanthrene	**200**		13	3.4	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Pyrene	**240**		13	3.0	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Carbazole	**11**	**J**	13	2.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Acetophenone	ND		130	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Atrazine	ND		130	28	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Benzaldehyde	ND		130	7.8	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3

Client Sample ID: STOCKPILE QUADRANT 3

Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14

Matrix: Sediment

Date Received: 11/05/21 10:00

Percent Solids: 78.9

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1'-Biphenyl	**23**	**J**	62	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Caprolactam	ND		320	41	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Chloro-3-methylphenol	ND		62	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Chlorophenol	ND		62	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Methylphenol	ND		62	18	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Methylphenol, 3 & 4	**34**	**J**	62	19	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4-Dichlorophenol	ND		13	4.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4-Dimethylphenol	ND		62	21	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4-Dinitrophenol	ND		620	390	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4,6-Dinitro-2-methylphenol	ND		320	110	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2-Nitrophenol	ND		62	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
4-Nitrophenol	ND		320	44	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Pentachlorophenol	ND		320	100	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
Phenol	ND		62	19	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4,5-Trichlorophenol	ND		62	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3
2,4,6-Trichlorophenol	ND		62	21	ug/Kg	☼	11/09/21 18:40	11/10/21 23:09	3

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*65*		*35 - 105*	*11/09/21 18:40*	*11/10/21 23:09*	*3*
2-Fluorophenol (Surr)	*70*		*32 - 105*	*11/09/21 18:40*	*11/10/21 23:09*	*3*
2,4,6-Tribromophenol (Surr)	*67*		*20 - 119*	*11/09/21 18:40*	*11/10/21 23:09*	*3*
Nitrobenzene-d5 (Surr)	*66*		*34 - 109*	*11/09/21 18:40*	*11/10/21 23:09*	*3*
Phenol-d5 (Surr)	*70*		*34 - 105*	*11/09/21 18:40*	*11/10/21 23:09*	*3*
Terphenyl-d14 (Surr)	*77*		*20 - 117*	*11/09/21 18:40*	*11/10/21 23:09*	*3*

Method: 8015D - Diesel Range Organics (DRO) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics [C10 - C28]	**150**		62	43	mg/Kg	☼	11/11/21 06:30	11/12/21 16:24	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*77*		*39 - 120*	*11/11/21 06:30*	*11/12/21 16:24*	*1*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.26	0.082	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
alpha-BHC	ND		0.26	0.065	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
beta-BHC	ND		0.26	0.072	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
delta-BHC	ND		0.26	0.083	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
gamma-BHC (Lindane)	ND		0.26	0.068	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
cis-Chlordane	ND		0.26	0.066	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
trans-Chlordane	ND		0.26	0.061	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
4,4'-DDD	ND		0.26	0.11	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
4,4'-DDE	ND		0.26	0.054	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
4,4'-DDT	ND		0.26	0.19	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Dieldrin	ND		0.26	0.066	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Endosulfan I	ND		0.26	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Endosulfan II	ND		0.26	0.058	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Endosulfan sulfate	ND		0.26	0.069	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Endrin	ND		0.26	0.049	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Endrin aldehyde	ND		0.26	0.094	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5

Client Sample ID: STOCKPILE QUADRANT 3 Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 78.9**

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endrin ketone	ND		0.26	0.036	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Heptachlor	ND		0.26	0.082	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Heptachlor epoxide	ND		0.26	0.067	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Methoxychlor	ND		0.26	0.10	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5
Toxaphene	ND		11	7.1	ug/Kg	☼	11/08/21 22:11	11/16/21 01:16	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*35*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:16*	*5*
Tetrachloro-m-xylene (Surr)	*45*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:16*	*5*
DCB Decachlorobiphenyl (Surr)	*177*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:16*	*5*
DCB Decachlorobiphenyl (Surr)	*190*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:16*	*5*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND	*3	0.53	0.17	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1221	ND	*3	0.53	0.19	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1232	ND	*3	0.53	0.13	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1242	ND	*3	0.53	0.077	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1248	ND	*3	0.53	0.13	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1254	ND	*3	0.53	0.16	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1
PCB-1260	**7.1**		0.53	0.15	ug/Kg	☼	11/09/21 09:04	11/14/21 23:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*200*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:10*	*1*
DCB Decachlorobiphenyl (Surr)	*206*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:10*	*1*
Tetrachloro-m-xylene (Surr)	*127*	**3 S1+*	*33 - 126*	*11/09/21 09:04*	*11/14/21 23:10*	*1*
Tetrachloro-m-xylene (Surr)	*110*	**3*	*33 - 126*	*11/09/21 09:04*	*11/14/21 23:10*	*1*

Method: EPA 9056A - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	**230**		13	8.6	mg/Kg	☼		11/06/21 13:43	1

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	**0.11**	**J I B**	0.96	0.032	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,7,8-PeCDD	**0.24**	**J I**	4.8	0.069	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,4,7,8-HxCDD	**0.44**	**J I B**	4.8	0.029	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,6,7,8-HxCDD	**0.66**	**J I B**	4.8	0.027	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,7,8,9-HxCDD	**0.68**	**J B**	4.8	0.027	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,4,6,7,8-HpCDD	**16**	**B**	4.8	0.092	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
OCDD	**360**	**B**	9.6	0.065	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
2,3,7,8-TCDF	**1.1**		0.96	0.13	pg/g	☼	11/30/21 11:04	12/31/21 02:01	1
1,2,3,7,8-PeCDF	**0.22**	**J I B**	4.8	0.032	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
2,3,4,7,8-PeCDF	**0.34**	**J I B**	4.8	0.027	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,4,7,8-HxCDF	**0.47**	**J B**	4.8	0.047	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,6,7,8-HxCDF	**0.48**	**J**	4.8	0.049	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
2,3,4,6,7,8-HxCDF	**0.24**	**J I B**	4.8	0.047	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,7,8,9-HxCDF	ND		4.8	0.053	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,4,6,7,8-HpCDF	**2.8**	**J B**	4.8	0.048	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
1,2,3,4,7,8,9-HpCDF	**0.24**	**J**	4.8	0.061	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
OCDF	**4.7**	**J B**	9.6	0.088	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1

Client Sample Results

Client: Northgate Environmental Management Inc. | Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Client Sample ID: STOCKPILE QUADRANT 3 | Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14 | **Matrix: Sediment**
Date Received: 11/05/21 10:00 | **Percent Solids: 78.9**

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
Total PeCDD	**1.7**	**J I**	4.8	0.069	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total TCDF	**16**	**I**	0.96	0.035	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total HxCDF	**6.1**	**I B**	4.8	0.049	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total TCDD	**2.6**	**I B**	0.96	0.032	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total PeCDF	**8.3**	**I B**	4.8	0.029	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total HpCDD	**36**	**B**	4.8	0.092	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total HxCDD	**7.2**	**I B**	4.8	0.028	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1
Total HpCDF	**6.5**	**B**	4.8	0.055	pg/g	☼	11/30/21 11:04	12/30/21 04:40	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,7,8-PeCDD	*47*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,4,7,8-HxCDD	*45*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,6,7,8-HxCDD	*46*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-OCDD	*43*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-2,3,7,8-TCDF	*51*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-2,3,7,8-TCDF	*53*		*40 - 135*	*11/30/21 11:04*	*12/31/21 02:01*	*1*
13C-1,2,3,7,8-PeCDF	*48*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-2,3,4,7,8-PeCDF	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,4,7,8-HxCDF	*52*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,6,7,8-HxCDF	*46*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-2,3,4,6,7,8-HxCDF	*53*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,7,8,9-HxCDF	*54*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*
13C-OCDF	*38*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 04:40*	*1*

Method: EPA 6020B - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**4.8**		0.063	0.020	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Cadmium	**0.42**		0.063	0.011	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Chromium	**9.4**	**B**	0.13	0.053	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Lead	**19**		0.063	0.063	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Selenium	**0.94**		0.31	0.077	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Silver	**0.20**		0.063	0.018	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Beryllium	**0.89**		0.063	0.045	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Thallium	**0.12**		0.063	0.044	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Antimony	**0.24**		0.13	0.028	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Nickel	**30**		0.063	0.059	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Zinc	**99**		0.31	0.30	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Copper	**21**		0.19	0.13	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1
Manganese	**500**	**B**	0.31	0.27	mg/Kg	☼	11/16/21 09:49	11/18/21 17:10	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.039**		0.019	0.012	mg/Kg	☼	11/09/21 11:48	11/12/21 10:20	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**21.1**		0.1	0.1	%			11/09/21 11:59	1

Client Sample ID: STOCKPILE QUADRANT 3

Lab Sample ID: 180-129635-3

Date Collected: 11/03/21 09:14
Date Received: 11/05/21 10:00

Matrix: Sediment
Percent Solids: 78.9

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**78.9**		0.1	0.1	%			11/09/21 11:59	1
Total Kjeldahl Nitrogen	**1300**	**H**	110	47	mg/Kg	☼	11/30/21 05:50	12/02/21 10:47	10
Cyanide, Free	**0.68**	**J B**	1.4	0.49	mg/Kg	☼	11/16/21 11:55	11/16/21 13:59	1
Cyanide, Total	**0.22**	**J**	0.26	0.079	mg/Kg	☼	11/15/21 14:30	11/15/21 19:12	1
Sulfide	ND		38	13	mg/Kg	☼	11/06/21 13:00	11/06/21 15:30	1
Total Organic Carbon - Duplicates	**270000**		1300	950	mg/Kg	☼		11/10/21 16:45	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	**20.7**		0.5	0.5	%			11/30/21 09:04	1

Method: D422 - Grain Size

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gravel	**0.0**				%			12/02/21 17:51	1
Sieve Size 3 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Sand	**73.3**				%			12/02/21 17:51	1
Sieve Size 2 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Coarse Sand	**0.3**				%			12/02/21 17:51	1
Sieve Size 1.5 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Medium Sand	**18.7**				%			12/02/21 17:51	1
Sieve Size 1 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Fine Sand	**54.3**				%			12/02/21 17:51	1
Sieve Size 0.75 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Sieve Size 0.375 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Silt	**17.6**				%			12/02/21 17:51	1
Clay	**9.1**				%			12/02/21 17:51	1
Sieve Size #4 - Percent Finer	**100.0**				% Passing			12/02/21 17:51	1
Sieve Size #10 - Percent Finer	**99.7**				% Passing			12/02/21 17:51	1
Sieve Size #20 - Percent Finer	**95.6**				% Passing			12/02/21 17:51	1
Sieve Size #40 - Percent Finer	**81.0**				% Passing			12/02/21 17:51	1
Sieve Size #60 - Percent Finer	**66.9**				% Passing			12/02/21 17:51	1
Sieve Size #80 - Percent Finer	**58.5**				% Passing			12/02/21 17:51	1
Sieve Size #100 - Percent Finer	**47.0**				% Passing			12/02/21 17:51	1
Sieve Size #200 - Percent Finer	**26.7**				% Passing			12/02/21 17:51	1
Hydrometer Reading 1 - Percent Finer	**22.0**				% Passing			12/02/21 17:51	1
Hydrometer Reading 2 - Percent Finer	**16.9**				% Passing			12/02/21 17:51	1
Hydrometer Reading 3 - Percent Finer	**13.6**				% Passing			12/02/21 17:51	1
Hydrometer Reading 4 - Percent Finer	**11.3**				% Passing			12/02/21 17:51	1
Hydrometer Reading 5 - Percent Finer	**9.1**				% Passing			12/02/21 17:51	1
Hydrometer Reading 6 - Percent Finer	**6.3**				% Passing			12/02/21 17:51	1
Hydrometer Reading 7 - Percent Finer	**4.0**				% Passing			12/02/21 17:51	1

Client Sample Results

Client Sample ID: STOCKPILE QUADRANT 4

Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25
Matrix: Sediment
Date Received: 11/05/21 10:00
Percent Solids: 73.4

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	**12**	**J**	14	3.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Acenaphthylene	**30**		14	3.0	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Anthracene	**46**		14	3.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzo[a]anthracene	**91**		14	6.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzo[a]pyrene	**68**		14	5.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzo[b]fluoranthene	**92**		14	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzo[g,h,i]perylene	**64**		14	2.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzo[k]fluoranthene	**26**		14	4.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Bis(2-chloroethyl)ether	ND		14	2.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Bis(2-chloroethoxy)methane	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,2'-oxybis[1-chloropropane]	ND		14	5.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Bis(2-ethylhexyl) phthalate	**100**	**J**	670	73	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Bromophenyl phenyl ether	ND		67	29	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Butyl benzyl phthalate	ND		67	47	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Chloroaniline	ND		67	18	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Chloronaphthalene	ND		14	3.1	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Chlorophenyl phenyl ether	ND		67	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Chrysene	**92**		14	7.5	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Dibenz(a,h)anthracene	**17**		14	8.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Dibenzofuran	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Di-n-butyl phthalate	ND		67	30	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
3,3'-Dichlorobenzidine	ND		67	64	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Diethyl phthalate	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Dimethyl phthalate	ND		67	27	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4-Dinitrotoluene	ND		67	40	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,6-Dinitrotoluene	ND		67	26	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Di-n-octyl phthalate	ND		67	40	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Fluoranthene	**130**		14	3.6	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Fluorene	**29**		14	2.7	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Hexachlorobenzene	ND		14	4.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Hexachlorobutadiene	ND		14	4.0	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Hexachlorocyclopentadiene	ND		67	6.9	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Hexachloroethane	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Indeno[1,2,3-cd]pyrene	**56**		14	6.8	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Isophorone	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Methylnaphthalene	**73**		14	3.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Naphthalene	**110**		14	2.6	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Nitroaniline	ND		350	31	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
3-Nitroaniline	ND		350	17	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Nitroaniline	ND		350	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Nitrobenzene	ND		140	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
N-Nitrosodi-n-propylamine	ND		14	4.6	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
N-Nitrosodiphenylamine	ND		67	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Phenanthrene	**140**		14	3.6	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Pyrene	**180**		14	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Carbazole	**7.2**	**J**	14	3.2	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Acetophenone	ND		140	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Atrazine	ND		140	30	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Benzaldehyde	ND		140	8.4	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3

Client Sample ID: STOCKPILE QUADRANT 4 — Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25 — **Matrix: Sediment**
Date Received: 11/05/21 10:00 — **Percent Solids: 73.4**

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1'-Biphenyl	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Caprolactam	ND		350	44	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Chloro-3-methylphenol	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Chlorophenol	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Methylphenol	ND		67	19	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Methylphenol, 3 & 4	**44**	**J**	67	20	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4-Dichlorophenol	ND		14	5.3	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4-Dimethylphenol	ND		67	23	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4-Dinitrophenol	ND		670	420	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4,6-Dinitro-2-methylphenol	ND		350	120	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2-Nitrophenol	ND		67	25	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
4-Nitrophenol	ND		350	48	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Pentachlorophenol	ND		350	110	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
Phenol	ND		67	21	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4,5-Trichlorophenol	ND		67	24	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3
2,4,6-Trichlorophenol	ND		67	22	ug/Kg	☼	11/09/21 18:40	11/10/21 23:32	3

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*55*		*35 - 105*	*11/09/21 18:40*	*11/10/21 23:32*	*3*
2-Fluorophenol (Surr)	*46*		*32 - 105*	*11/09/21 18:40*	*11/10/21 23:32*	*3*
2,4,6-Tribromophenol (Surr)	*59*		*20 - 119*	*11/09/21 18:40*	*11/10/21 23:32*	*3*
Nitrobenzene-d5 (Surr)	*47*		*34 - 109*	*11/09/21 18:40*	*11/10/21 23:32*	*3*
Phenol-d5 (Surr)	*54*		*34 - 105*	*11/09/21 18:40*	*11/10/21 23:32*	*3*
Terphenyl-d14 (Surr)	*67*		*20 - 117*	*11/09/21 18:40*	*11/10/21 23:32*	*3*

Method: 8015D - Diesel Range Organics (DRO) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics [C10 - C28]	**98**		68	47	mg/Kg	☼	11/11/21 06:30	11/12/21 16:51	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*43*		*39 - 120*	*11/11/21 06:30*	*11/12/21 16:51*	*1*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.28	0.088	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
alpha-BHC	ND		0.28	0.070	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
beta-BHC	ND		0.28	0.078	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
delta-BHC	ND		0.28	0.090	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
gamma-BHC (Lindane)	ND		0.28	0.073	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
cis-Chlordane	ND		0.28	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
trans-Chlordane	ND		0.28	0.066	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
4,4'-DDD	ND		0.28	0.12	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
4,4'-DDE	ND		0.28	0.058	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
4,4'-DDT	ND		0.28	0.20	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Dieldrin	ND		0.28	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Endosulfan I	ND		0.28	0.077	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Endosulfan II	ND		0.28	0.063	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Endosulfan sulfate	ND		0.28	0.074	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Endrin	ND		0.28	0.053	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Endrin aldehyde	ND		0.28	0.10	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5

Client Sample Results

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Job ID: 180-129635-1

Client Sample ID: STOCKPILE QUADRANT 4

Date Collected: 11/03/21 09:25
Date Received: 11/05/21 10:00

Lab Sample ID: 180-129635-4

Matrix: Sediment
Percent Solids: 73.4

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endrin ketone	ND		0.28	0.039	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Heptachlor	ND		0.28	0.089	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Heptachlor epoxide	ND		0.28	0.073	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Methoxychlor	ND		0.28	0.11	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5
Toxaphene	ND		11	7.7	ug/Kg	☼	11/08/21 22:11	11/16/21 01:32	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*36*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:32*	*5*
Tetrachloro-m-xylene (Surr)	*40*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:32*	*5*
DCB Decachlorobiphenyl (Surr)	*146*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:32*	*5*
DCB Decachlorobiphenyl (Surr)	*163*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:32*	*5*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.57	0.18	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1221	ND		0.57	0.20	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1232	ND		0.57	0.14	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1242	ND		0.57	0.083	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1248	ND		0.57	0.14	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1254	ND		0.57	0.17	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1
PCB-1260	**3.2**		0.57	0.16	ug/Kg	☼	11/09/21 09:04	11/14/21 23:29	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*193*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:29*	*1*
DCB Decachlorobiphenyl (Surr)	*191*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:29*	*1*
Tetrachloro-m-xylene (Surr)	*112*		*33 - 126*	*11/09/21 09:04*	*11/14/21 23:29*	*1*
Tetrachloro-m-xylene (Surr)	*100*		*33 - 126*	*11/09/21 09:04*	*11/14/21 23:29*	*1*

Method: EPA 9056A - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	**67**		14	9.2	mg/Kg	☼		11/06/21 13:58	1

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	**0.091**	**J B**	0.99	0.041	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,7,8-PeCDD	**0.22**	**J I**	4.9	0.030	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,4,7,8-HxCDD	**0.30**	**J I B**	4.9	0.026	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,6,7,8-HxCDD	**0.48**	**J B**	4.9	0.024	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,7,8,9-HxCDD	**0.56**	**J B**	4.9	0.024	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,4,6,7,8-HpCDD	**13**	**B**	4.9	0.10	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
OCDD	**300**	**B**	9.9	0.075	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
2,3,7,8-TCDF	**0.62**	**J**	0.99	0.035	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,7,8-PeCDF	**0.17**	**J B**	4.9	0.029	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
2,3,4,7,8-PeCDF	**0.26**	**J I B**	4.9	0.025	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,4,7,8-HxCDF	**0.35**	**J B**	4.9	0.059	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,6,7,8-HxCDF	**0.35**	**J**	4.9	0.063	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
2,3,4,6,7,8-HxCDF	**0.19**	**J B**	4.9	0.061	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,7,8,9-HxCDF	ND		4.9	0.073	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,4,6,7,8-HpCDF	**2.0**	**J B**	4.9	0.078	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
1,2,3,4,7,8,9-HpCDF	ND		4.9	0.10	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
OCDF	**3.5**	**J B**	9.9	0.10	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1

Client Sample Results

Client: Northgate Environmental Management Inc.
Project/Site: Conowingo Pilot Study/Stockpile

Job ID: 180-129635-1

Client Sample ID: STOCKPILE QUADRANT 4

Date Collected: 11/03/21 09:25
Date Received: 11/05/21 10:00

Lab Sample ID: 180-129635-4

Matrix: Sediment
Percent Solids: 73.4

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
Total PeCDD	**1.4**	**J I**	4.9	0.030	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total TCDF	**10**	**I**	0.99	0.035	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total HxCDF	**5.0**	**I B**	4.9	0.064	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total TCDD	**1.8**	**I B**	0.99	0.041	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total PeCDF	**6.6**	**I B**	4.9	0.027	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total HpCDD	**29**	**B**	4.9	0.10	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total HxCDD	**5.4**	**I B**	4.9	0.025	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1
Total HpCDF	**4.4**	**J B**	4.9	0.091	pg/g	☼	11/30/21 11:04	12/30/21 05:40	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,7,8-PeCDD	*46*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,4,7,8-HxCDD	*46*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,6,7,8-HxCDD	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*49*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-OCDD	*43*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-2,3,7,8-TCDF	*51*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,7,8-PeCDF	*47*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-2,3,4,7,8-PeCDF	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,4,7,8-HxCDF	*53*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,6,7,8-HxCDF	*47*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-2,3,4,6,7,8-HxCDF	*54*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,7,8,9-HxCDF	*52*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*51*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*50*		*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*
13C-OCDF	*38*	**5-*	*40 - 135*	*11/30/21 11:04*	*12/30/21 05:40*	*1*

Method: EPA 6020B - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	**5.0**		0.068	0.022	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Cadmium	**0.40**		0.068	0.012	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Chromium	**9.7**	**B**	0.14	0.057	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Lead	**19**		0.068	0.068	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Selenium	**0.91**		0.34	0.083	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Silver	**0.19**		0.068	0.019	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Beryllium	**0.89**		0.068	0.049	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Thallium	**0.12**		0.068	0.048	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Antimony	**0.25**		0.14	0.030	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Nickel	**33**		0.068	0.064	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Zinc	**100**		0.34	0.33	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Copper	**20**		0.20	0.14	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1
Manganese	**510**	**B**	0.34	0.29	mg/Kg	☼	11/16/21 09:49	11/18/21 17:13	1

Method: EPA 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.035**		0.022	0.014	mg/Kg	☼	11/09/21 11:48	11/12/21 10:21	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**26.6**		0.1	0.1	%			11/10/21 16:08	1
Percent Solids	**73.4**		0.1	0.1	%			11/10/21 16:08	1

Client Sample ID: STOCKPILE QUADRANT 4

Lab Sample ID: 180-129635-4

Date Collected: 11/03/21 09:25
Date Received: 11/05/21 10:00
Matrix: Sediment
Percent Solids: 73.4

General Chemistry (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Kjeldahl Nitrogen	**1200**	**H**	110	50	mg/Kg	☼	11/30/21 05:50	12/02/21 10:47	10
Cyanide, Free	**0.59**	**J B**	1.5	0.52	mg/Kg	☼	11/16/21 11:55	11/16/21 13:59	1
Cyanide, Total	**0.18**	**J**	0.26	0.080	mg/Kg	☼	11/15/21 14:30	11/15/21 19:13	1
Sulfide	ND		41	14	mg/Kg	☼	11/06/21 13:00	11/06/21 15:39	1
Total Organic Carbon - Duplicates	**220000**		1400	1000	mg/Kg	☼		11/11/21 14:09	1

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Loss on Ignition	**13.2**		0.5	0.5	%			11/30/21 09:04	1

Method: D422 - Grain Size

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gravel	**0.0**				%			12/02/21 17:53	1
Sieve Size 3 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Sand	**72.6**				%			12/02/21 17:53	1
Sieve Size 2 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Coarse Sand	**0.5**				%			12/02/21 17:53	1
Sieve Size 1.5 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Medium Sand	**18.0**				%			12/02/21 17:53	1
Sieve Size 1 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Fine Sand	**54.1**				%			12/02/21 17:53	1
Sieve Size 0.75 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Sieve Size 0.375 inch - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Silt	**16.3**				%			12/02/21 17:53	1
Clay	**11.1**				%			12/02/21 17:53	1
Sieve Size #4 - Percent Finer	**100.0**				% Passing			12/02/21 17:53	1
Sieve Size #10 - Percent Finer	**99.5**				% Passing			12/02/21 17:53	1
Sieve Size #20 - Percent Finer	**95.8**				% Passing			12/02/21 17:53	1
Sieve Size #40 - Percent Finer	**81.5**				% Passing			12/02/21 17:53	1
Sieve Size #60 - Percent Finer	**67.7**				% Passing			12/02/21 17:53	1
Sieve Size #80 - Percent Finer	**56.9**				% Passing			12/02/21 17:53	1
Sieve Size #100 - Percent Finer	**46.2**				% Passing			12/02/21 17:53	1
Sieve Size #200 - Percent Finer	**27.4**				% Passing			12/02/21 17:53	1
Hydrometer Reading 1 - Percent Finer	**22.6**				% Passing			12/02/21 17:53	1
Hydrometer Reading 2 - Percent Finer	**19.6**				% Passing			12/02/21 17:53	1
Hydrometer Reading 3 - Percent Finer	**15.3**				% Passing			12/02/21 17:53	1
Hydrometer Reading 4 - Percent Finer	**13.5**				% Passing			12/02/21 17:53	1
Hydrometer Reading 5 - Percent Finer	**11.1**				% Passing			12/02/21 17:53	1
Hydrometer Reading 6 - Percent Finer	**8.0**				% Passing			12/02/21 17:53	1
Hydrometer Reading 7 - Percent Finer	**5.6**				% Passing			12/02/21 17:53	1

Client Sample ID: STOCKPILE QUADRANTS 1-4

Lab Sample ID: 180-129635-5

Date Collected: 11/03/21 09:31
Date Received: 11/05/21 10:00
Matrix: Sediment
Percent Solids: 75.0

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.28	0.086	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
alpha-BHC	ND		0.28	0.068	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
beta-BHC	ND		0.28	0.076	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
delta-BHC	ND		0.28	0.088	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
gamma-BHC (Lindane)	ND		0.28	0.072	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
cis-Chlordane	ND		0.28	0.070	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
trans-Chlordane	ND		0.28	0.065	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
4,4'-DDD	ND		0.28	0.12	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
4,4'-DDE	ND		0.28	0.057	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
4,4'-DDT	ND		0.28	0.20	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Dieldrin	ND		0.28	0.070	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endosulfan I	ND		0.28	0.075	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endosulfan II	ND		0.28	0.061	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endosulfan sulfate	ND		0.28	0.072	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endrin	ND		0.28	0.052	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endrin aldehyde	ND		0.28	0.099	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Endrin ketone	ND		0.28	0.038	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Heptachlor	ND		0.28	0.087	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Heptachlor epoxide	ND		0.28	0.071	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Methoxychlor	ND		0.28	0.11	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5
Toxaphene	ND		11	7.5	ug/Kg	☼	11/08/21 22:11	11/16/21 01:47	5

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*34*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:47*	*5*
Tetrachloro-m-xylene (Surr)	*47*		*10 - 105*	*11/08/21 22:11*	*11/16/21 01:47*	*5*
DCB Decachlorobiphenyl (Surr)	*129*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:47*	*5*
DCB Decachlorobiphenyl (Surr)	*160*	*S1+*	*25 - 107*	*11/08/21 22:11*	*11/16/21 01:47*	*5*

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.55	0.18	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1221	ND		0.55	0.20	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1232	ND		0.55	0.14	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1242	ND		0.55	0.081	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1248	ND		0.55	0.13	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1254	ND		0.55	0.17	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1
PCB-1260	**3.2**		0.55	0.16	ug/Kg	☼	11/09/21 09:04	11/14/21 23:47	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*204*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:47*	*1*
DCB Decachlorobiphenyl (Surr)	*205*	*S1+*	*26 - 170*	*11/09/21 09:04*	*11/14/21 23:47*	*1*
Tetrachloro-m-xylene (Surr)	*100*		*33 - 126*	*11/09/21 09:04*	*11/14/21 23:47*	*1*
Tetrachloro-m-xylene (Surr)	*91*		*33 - 126*	*11/09/21 09:04*	*11/14/21 23:47*	*1*

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	**0.21**	**J B**	0.95	0.035	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,7,8-PeCDD	**0.36**	**J**	4.8	0.029	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,4,7,8-HxCDD	**0.56**	**J B**	4.8	0.020	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,6,7,8-HxCDD	**1.1**	**J I B**	4.8	0.017	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1

Client Sample ID: STOCKPILE QUADRANTS 1-4 Lab Sample ID: 180-129635-5

Date Collected: 11/03/21 09:31 **Matrix: Sediment**
Date Received: 11/05/21 10:00 **Percent Solids: 75.0**

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Analyte	Result	Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
1,2,3,7,8,9-HxCDD	**1.1**	**J I B**	4.8	0.018	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,4,6,7,8-HpCDD	**27**	**B**	4.8	0.13	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
OCDD	**640**	**B**	9.5	0.060	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
2,3,7,8-TCDF	**1.2**	**I**	0.95	0.15	pg/g	☼	11/30/21 11:04	01/04/22 06:11	1
1,2,3,7,8-PeCDF	**0.33**	**J B**	4.8	0.028	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
2,3,4,7,8-PeCDF	**0.55**	**J B**	4.8	0.024	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,4,7,8-HxCDF	**0.78**	**J B**	4.8	0.072	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,6,7,8-HxCDF	**0.62**	**J I**	4.8	0.075	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
2,3,4,6,7,8-HxCDF	**0.32**	**J B**	4.8	0.077	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,7,8,9-HxCDF	ND		4.8	0.089	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,4,6,7,8-HpCDF	**4.6**	**J B**	4.8	0.068	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
1,2,3,4,7,8,9-HpCDF	**0.49**	**J I**	4.8	0.097	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
OCDF	**7.6**	**J B**	9.5	0.11	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total PeCDD	**3.1**	**J I**	4.8	0.029	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total TCDF	**21**	**I**	0.95	0.026	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total HxCDF	**10**	**I B**	4.8	0.078	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total TCDD	**3.9**	**I B**	0.95	0.035	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total PeCDF	**14**	**I B**	4.8	0.026	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total HpCDD	**63**	**B**	4.8	0.13	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total HxCDD	**12**	**I B**	4.8	0.018	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1
Total HpCDF	**11**	**I B**	4.8	0.082	pg/g	☼	11/30/21 11:04	01/07/22 16:29	1

Isotope Dilution	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*50*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,7,8-PeCDD	*40*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,4,7,8-HxCDD	*41*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,6,7,8-HxCDD	*47*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*41*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-OCDD	*32*	**5-*	*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-2,3,7,8-TCDF	*55*		*40 - 135*	*11/30/21 11:04*	*01/04/22 06:11*	*1*
13C-2,3,7,8-TCDF	*56*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,7,8-PeCDF	*45*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-2,3,4,7,8-PeCDF	*47*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,4,7,8-HxCDF	*51*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,6,7,8-HxCDF	*47*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-2,3,4,6,7,8-HxCDF	*52*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,7,8,9-HxCDF	*53*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*46*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*41*		*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*
13C-OCDF	*29*	**5-*	*40 - 135*	*11/30/21 11:04*	*01/07/22 16:29*	*1*

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	**25.0**		0.1	0.1	%			11/11/21 16:09	1
Percent Solids	**75.0**		0.1	0.1	%			11/11/21 16:09	1

1 2 3 4 5 6 7 8 9 10 11 12 13

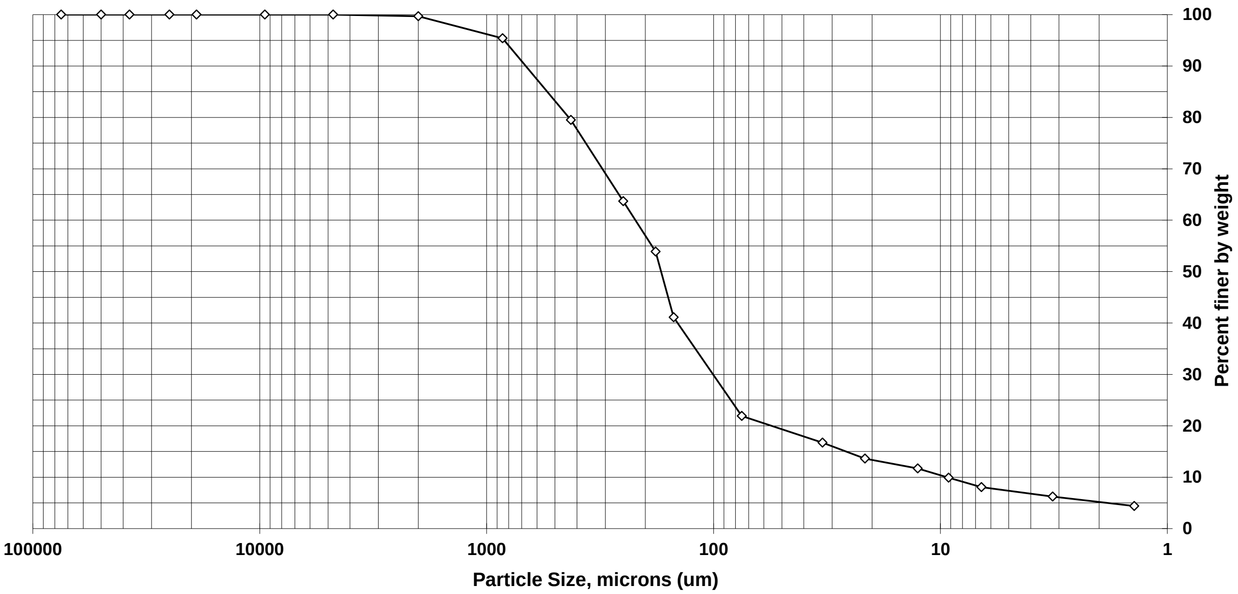
Particle Size of Soils by ASTM D422

				Date Received:	11/5/2021
Sample ID:	STOCKPILE QUADRANT 1	**Percent Solids:**	76.7%	**Start Date:**	12/2/2021
Lab ID:	180-129635-A-1	**Specific Gravity:**	2.650	**End Date:**	12/9/2021

Shape (> #10): na

Non-soil material: plant

Hardness (> #10): na



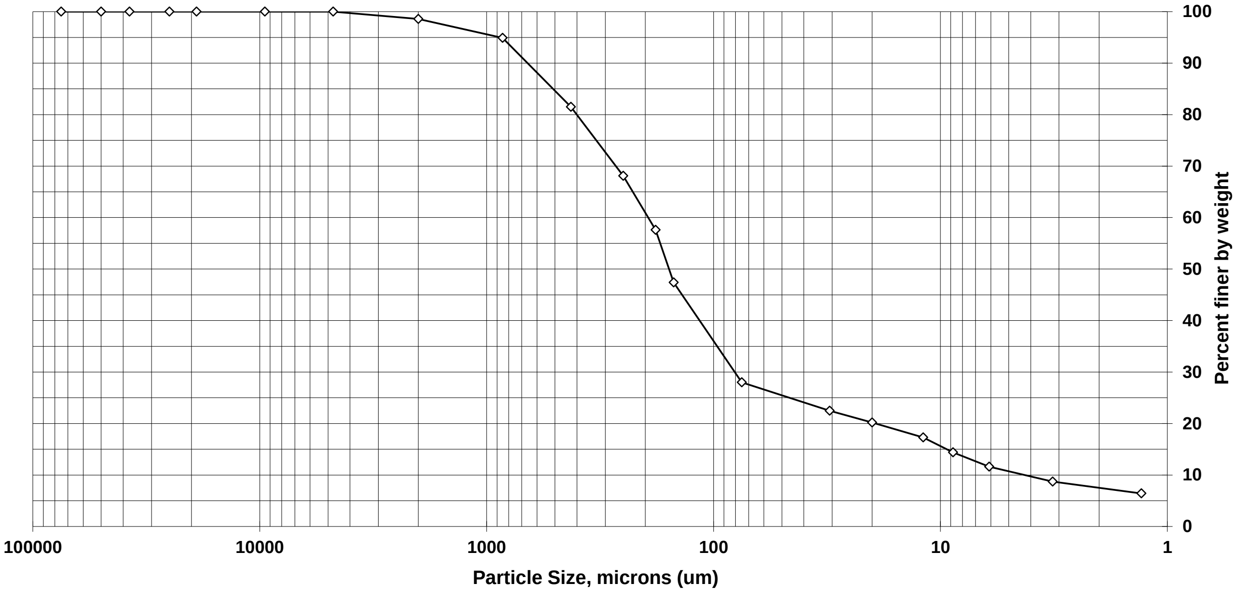
Sieve size	Particle size, um	Percent finer	Incremental percent
3 inch	75000	100.0	0.0
2 inch	50000	100.0	0.0
1.5 inch	37500	100.0	0.0
1 inch	25000	100.0	0.0
3/4 inch	19000	100.0	0.0
3/8 inch	9500	100.0	0.0
#4	4750	100.0	0.0
#10	2000	99.7	0.3
#20	850	95.4	4.3
#40	425	79.5	15.9
#60	250	63.7	15.8
#80	180	53.9	9.8
#100	150	41.1	12.8
#200	75	21.9	19.2
Hyd1	33.1	16.7	5.2
Hyd2	21.5	13.6	3.1
Hyd3	12.6	11.7	1.9
Hyd4	9.2	9.9	1.8
Hyd5	6.6	8.1	1.8
Hyd6	3.2	6.2	1.8
Hyd7	1.4	4.4	1.8

Soil Classification	Percent of sample
Gravel	0.0
Sand	78.1
Coarse Sand	0.3
Medium Sand	20.2
Fine Sand	57.6
Silt	13.8
Clay	8.1

Particle Size of Soils by ASTM D422

Date Received: 11/5/2021
Sample ID: STOCKPILE QUADRANT 2 **Percent Solids:** 72.4% **Start Date:** 12/2/2021
Lab ID: 180-129635-A-2 **Specific Gravity:** 2.650 **End Date:** 12/9/2021

Shape (> #10): subrounded **Non-soil material:** plant
Hardness (> #10): hard



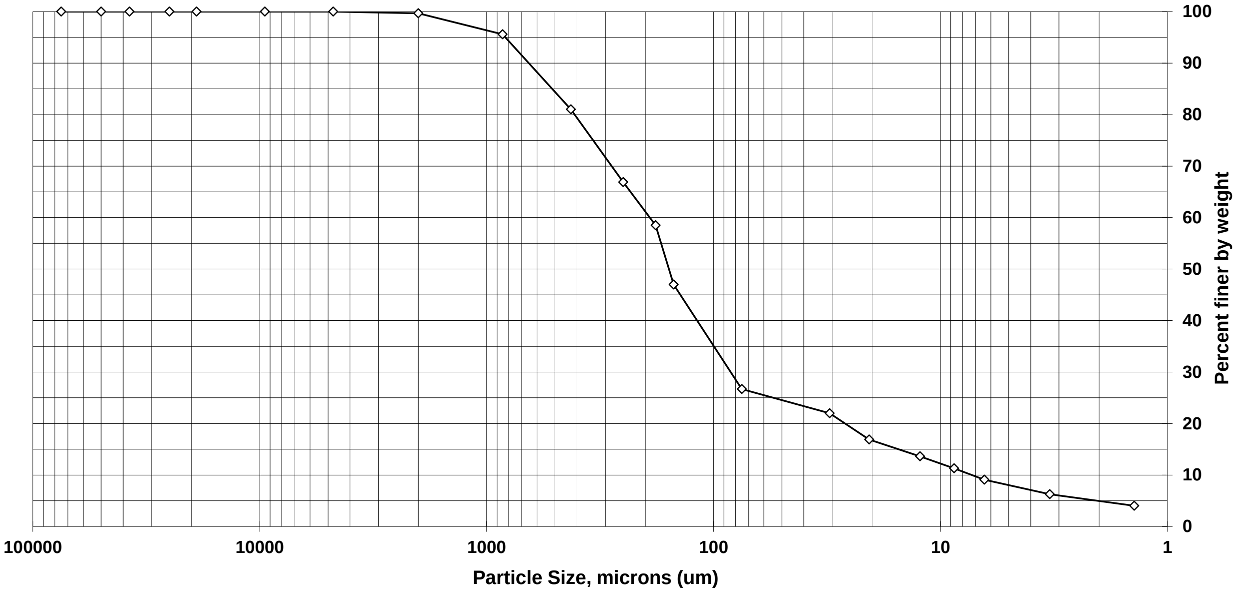
Sieve size	Particle size, um	Percent finer	Incremental percent
3 inch	75000	100.0	0.0
2 inch	50000	100.0	0.0
1.5 inch	37500	100.0	0.0
1 inch	25000	100.0	0.0
3/4 inch	19000	100.0	0.0
3/8 inch	9500	100.0	0.0
#4	4750	100.0	0.0
#10	2000	98.6	1.4
#20	850	94.9	3.7
#40	425	81.5	13.4
#60	250	68.1	13.4
#80	180	57.6	10.5
#100	150	47.4	10.2
#200	75	28.0	19.4
Hyd1	30.8	22.5	5.5
Hyd2	20	20.2	2.3
Hyd3	11.9	17.3	2.9
Hyd4	8.8	14.4	2.9
Hyd5	6.1	11.6	2.8
Hyd6	3.2	8.7	2.9
Hyd7	1.3	6.4	2.3

Soil Classification	Percent of sample
Gravel	0.0
Sand	72.0
Coarse Sand	1.4
Medium Sand	17.1
Fine Sand	53.5
Silt	16.4
Clay	11.6

Particle Size of Soils by ASTM D422

Date Received: 11/5/2021
Sample ID: STOCKPILE QUADRANT 3
Percent Solids: 77.4%
Start Date: 12/2/2021
Lab ID: 180-129635-A-3
Specific Gravity: 2.650
End Date: 12/9/2021

Shape (> #10): na
Non-soil material: plant
Hardness (> #10): na



Sieve size	Particle size, um	Percent finer	Incremental percent
3 inch	75000	100.0	0.0
2 inch	50000	100.0	0.0
1.5 inch	37500	100.0	0.0
1 inch	25000	100.0	0.0
3/4 inch	19000	100.0	0.0
3/8 inch	9500	100.0	0.0
#4	4750	100.0	0.0
#10	2000	99.7	0.3
#20	850	95.6	4.1
#40	425	81.0	14.6
#60	250	66.9	14.1
#80	180	58.5	8.4
#100	150	47.0	11.5
#200	75	26.7	20.3
Hyd1	30.8	22.0	4.7
Hyd2	20.6	16.9	5.1
Hyd3	12.3	13.6	3.3
Hyd4	8.7	11.3	2.3
Hyd5	6.4	9.1	2.2
Hyd6	3.3	6.3	2.8
Hyd7	1.4	4.0	2.3

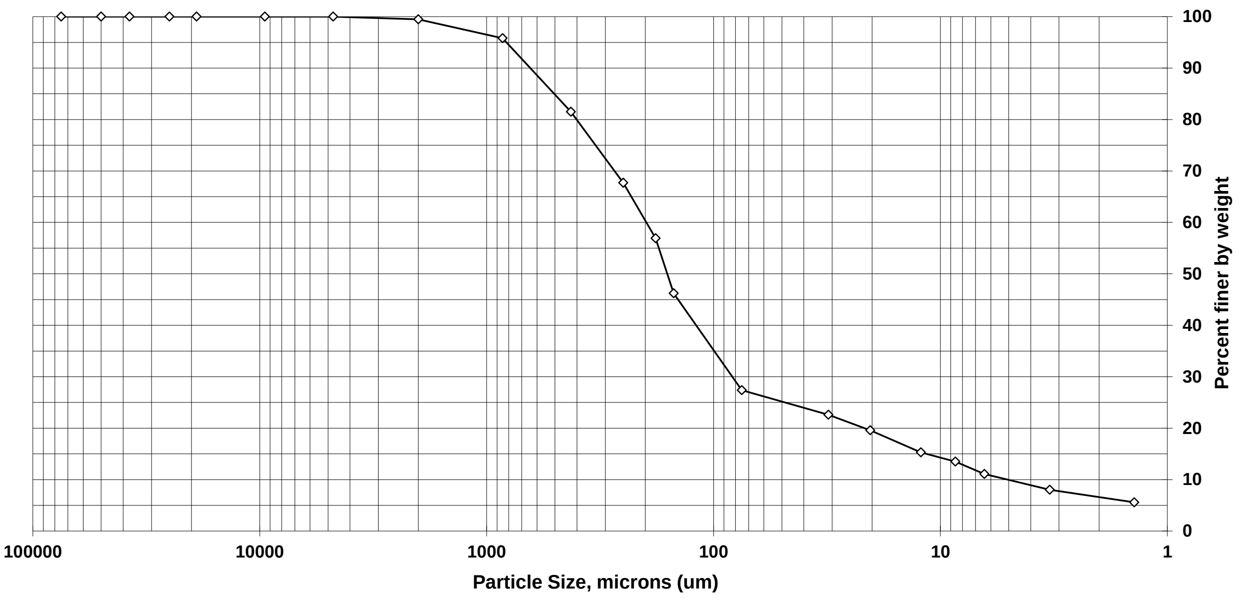
Soil Classification	Percent of sample
Gravel	0.0
Sand	73.3
Coarse Sand	0.3
Medium Sand	18.7
Fine Sand	54.3
Silt	17.6
Clay	9.1

1
2
3
4
5
6
7
8
9
10
11
12
13

Particle Size of Soils by ASTM D422

Date Received: 11/5/2021
Sample ID: STOCKPILE QUADRANT 4 **Percent Solids:** 73.2% **Start Date:** 12/2/2021
Lab ID: 180-129635-A-4 **Specific Gravity:** 2.650 **End Date:** 12/9/2021

Shape (> #10): na **Non-soil material:** plant
Hardness (> #10): na



Sieve size	Particle size, um	Percent finer	Incremental percent
3 inch	75000	100.0	0.0
2 inch	50000	100.0	0.0
1.5 inch	37500	100.0	0.0
1 inch	25000	100.0	0.0
3/4 inch	19000	100.0	0.0
3/8 inch	9500	100.0	0.0
#4	4750	100.0	0.0
#10	2000	99.5	0.5
#20	850	95.8	3.7
#40	425	81.5	14.3
#60	250	67.7	13.8
#80	180	56.9	10.8
#100	150	46.2	10.7
#200	75	27.4	18.8
Hyd1	31.2	22.6	4.8
Hyd2	20.4	19.6	3.0
Hyd3	12.2	15.3	4.3
Hyd4	8.6	13.5	1.8
Hyd5	6.4	11.1	2.4
Hyd6	3.3	8.0	3.1
Hyd7	1.4	5.6	2.4

Soil Classification	Percent of sample
Gravel	0.0
Sand	72.6
Coarse Sand	0.5
Medium Sand	18.0
Fine Sand	54.1
Silt	16.3
Clay	11.1

TestAmerica Burlington

Sediment Grain Size - D422

Client	
Client Sample ID	STOCKPILE QUADRANT 1
Lab Sample ID	180-129635-A-1

Date Received	11/5/2021
Start Date	12/02/2021 17:47
End Date	12/09/2021 8:35

Non-soil material:	plant
Shape (> #10):	na
Hardness (> #10):	na

Date/Time in oven	12/02/2021 17:48
Date/Time out of oven	12/03/2021 17:37

Dry Weight Determination

Tin Weight	1.02	g
Wet Sample + Tin	19.40	g
Dry Sample + Tin	15.11	g
% Moisture	23.34	%

Sample Weights	Tare (g)	Pan+Samp (g)	Samp (g)
Sample Weight (Wet)	47.62	218.84	171.22
Sample Weight (Oven Dried)			131

Sample Split (oven dried)	Tare (g)	Pan+Samp (g)	Samp (g)
Sample >=#10			0.41
Sample <#10			131
% Passing #10			76.5

Hydrometer Data

Serial Number	542318
Calib. Date (mm/dd/yyyy)	12/18/2019
Low Temp (C)	17.0
Reading at Low Temp	1.0035
High Temp (C)	23.0
Reading at High Temp	1.0025
Hydrometer Cal Slope	-0.000166667
Hydrometer Cal Intercept	1.006333333
Default Soil Gravity	2.6500

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare (g)	Pan+Sample (g)	Sample		% Finer	Classification	Sub Class
3 inch	75000			0.00	g	100.0	Gravel	
2 inch	50000			0.00	g	100.0	Gravel	
1.5 inch	37500			0.00	g	100.0	Gravel	
1 inch	25000			0.00	g	100.0	Gravel	
3/4 inch	19000			0.00	g	100.0	Gravel	
3/8 inch	9500			0.00	g	100.0	Gravel	
#4	4750			0.00	g	100.0	Gravel	
#10	2000	462.59	463.00	0.41	g	99.7	Sand	Coarse
#20	850	378.17	383.79	5.62	g	95.4	Sand	Medium
#40	425	366.54	387.43	20.89	g	79.5	Sand	Medium
#60	250	348.07	368.74	20.67	g	63.7	Sand	Fine
#80	180	337.47	350.30	12.83	g	53.9	Sand	Fine
#100	150	327.66	344.41	16.75	g	41.1	Sand	Fine
#200	75	312.57	337.78	25.21	g	21.9	Sand	Fine
				0.00	g	21.9		

Adjusted Hydrometer Sample Mass

Hydrometer Sample Mass (g)	131

Silt/Clay Fraction (Hydrometer Test)

Hydrometer Test Time (min)	Actual	Spec. Gravity	Temp C	Particle Size (Micron)	% Finer	Classification	Sub Class
2	2	1.0165	20.5	33.1	16.7	Silt	
5	5	1.0140	20.5	21.5	13.6	Silt	
15	15	1.0125	20.5	12.6	11.7	Silt	
30	29	1.0110	20.5	9.2	9.91	Silt	
60	58	1.0095	20.5	6.6	8.07	Silt	
250	250	1.0080	20.5	3.2	6.23	Clay	
1440	1434	1.0065	20.5	1.4	4.39	Clay	

1
2
3
4
5
6
7
8
9
10
11
12
13

TestAmerica Burlington

Sediment Grain Size - D422

Client	
Client Sample ID	STOCKPILE QUADRANT 2
Lab Sample ID	180-129635-A-2

Date Received	11/5/2021
Start Date	12/02/2021 17:49
End Date	12/09/2021 8:39

Dry Weight Determination

Tin Weight	1.02	g
Wet Sample + Tin	27.57	g
Dry Sample + Tin	20.24	g
% Moisture	27.61	%

Non-soil material:	plant
Shape (> #10):	subrounded
Hardness (> #10):	hard

Date/Time in oven	12/02/2021 17:50
Date/Time out of oven	12/03/2021 17:38

Sample Weights	Tare (g)	Pan+Samp (g)	Samp (g)
Sample Weight (Wet)	47.83	241.72	193.89
Sample Weight (Oven Dried)			140

Sample Split (oven dried)	Tare (g)	Pan+Samp (g)	Samp (g)
Sample >=#10			1.95
Sample <#10			138
% Passing #10			71.2

Hydrometer Data

Serial Number	542318
Calib. Date (mm/dd/yyyy)	12/18/2019
Low Temp (C)	17.0
Reading at Low Temp	1.0035
High Temp (C)	23.0
Reading at High Temp	1.0025
Hydrometer Cal Slope	-0.000166667
Hydrometer Cal Intercept	1.006333333
Default Soil Gravity	2.6500

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare (g)	Pan+Sample (g)	Sample	% Finer	Classification	Sub Class
3 inch	75000			0.00 g	100.0	Gravel	
2 inch	50000			0.00 g	100.0	Gravel	
1.5 inch	37500			0.00 g	100.0	Gravel	
1 inch	25000			0.00 g	100.0	Gravel	
3/4 inch	19000			0.00 g	100.0	Gravel	
3/8 inch	9500			0.00 g	100.0	Gravel	
#4	4750			0.00 g	100.0	Gravel	
#10	2000	462.59	464.54	1.95 g	98.6	Sand	Coarse
#20	850	373.41	378.56	5.15 g	94.9	Sand	Medium
#40	425	361.84	380.63	18.79 g	81.5	Sand	Medium
#60	250	351.94	370.66	18.72 g	68.1	Sand	Fine
#80	180	318.93	333.70	14.77 g	57.6	Sand	Fine
#100	150	328.25	342.52	14.27 g	47.4	Sand	Fine
#200	75	313.99	341.09	27.10 g	28.0	Sand	Fine
				0.00 g	28.0		

Adjusted Hydrometer Sample Mass

Hydrometer Sample Mass (g)	140

Silt/Clay Fraction (Hydrometer Test)

Hydrometer Test Time (min)	Actual	Spec. Gravity	Temp C	Particle Size (Micron)	% Finer	Classification	Sub Class
2	2	1.0225	20.5	30.8	22.5	Silt	
5	5	1.0205	20.5	20	20.2	Silt	
15	15	1.0180	20.5	11.9	17.3	Silt	
30	29	1.0155	20.5	8.8	14.4	Silt	
60	63	1.0130	20.5	6.1	11.6	Silt	
250	250	1.0105	20.5	3.2	8.7	Clay	
1440	1434	1.0085	20.5	1.3	6.41	Clay	

1
2
3
4
5
6
7
8
9
10
11
12
13

Sediment Grain Size - D422

Client	
Client Sample ID	STOCKPILE QUADRANT 3
Lab Sample ID	180-129635-A-3

Date Received	11/5/2021
Start Date	12/02/2021 17:51
End Date	12/09/2021 8:48

Dry Weight Determination

Tin Weight	1.00	g
Wet Sample + Tin	22.28	g
Dry Sample + Tin	17.47	g
% Moisture	22.60	%

Non-soil material:	plant
Shape (> #10):	na
Hardness (> #10):	na

Date/Time in oven	12/02/2021 17:52
Date/Time out of oven	12/03/2021 17:38

Sample Weights	Tare (g)	Pan+Samp (g)	Samp (g)
Sample Weight (Wet)	47.51	232.35	184.84
Sample Weight (Oven Dried)			143

Sample Split (oven dried)	Tare (g)	Pan+Samp (g)	Samp (g)
Sample >=#10			0.37
Sample <#10			143
% Passing #10			77.4

Hydrometer Data

Serial Number	542318
Calib. Date (mm/dd/yyyy)	12/18/2019
Low Temp (C)	17.0
Reading at Low Temp	1.0035
High Temp (C)	23.0
Reading at High Temp	1.0025
Hydrometer Cal Slope	-0.000166667
Hydrometer Cal Intercept	1.006333333
Default Soil Gravity	2.6500

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare (g)	Pan+Sample (g)	Sample		% Finer	Classification	Sub Class
3 inch	75000			0.00	g	100.0	Gravel	
2 inch	50000			0.00	g	100.0	Gravel	
1.5 inch	37500			0.00	g	100.0	Gravel	
1 inch	25000			0.00	g	100.0	Gravel	
3/4 inch	19000			0.00	g	100.0	Gravel	
3/8 inch	9500			0.00	g	100.0	Gravel	
#4	4750			0.00	g	100.0	Gravel	
#10	2000	462.59	462.96	0.37	g	99.7	Sand	Coarse
#20	850	378.17	384.01	5.84	g	95.6	Sand	Medium
#40	425	366.54	387.37	20.83	g	81.0	Sand	Medium
#60	250	348.07	368.24	20.17	g	66.9	Sand	Fine
#80	180	337.47	349.43	11.96	g	58.5	Sand	Fine
#100	150	327.66	344.06	16.40	g	47.0	Sand	Fine
#200	75	312.57	341.53	28.96	g	26.7	Sand	Fine
				0.00	g	26.7		

Adjusted Hydrometer Sample Mass

Hydrometer Sample Mass (g)	143

Silt/Clay Fraction (Hydrometer Test)

Hydrometer Test Time (min)	Actual	Spec. Gravity	Temp C	Particle Size (Micron)	% Finer	Classification	Sub Class
2	2	1.0225	20.5	30.8	22	Silt	
5	5	1.0180	20.5	20.6	16.9	Silt	
15	15	1.0150	20.5	12.3	13.6	Silt	
30	31	1.0130	20.5	8.7	11.3	Silt	
60	60	1.0110	20.5	6.4	9.08	Silt	
250	240	1.0085	20.5	3.3	6.27	Clay	
1440	1424	1.0065	20.5	1.4	4.02	Clay	

TestAmerica Burlington

Sediment Grain Size - D422

Client	
Client Sample ID	STOCKPILE QUADRANT 4
Lab Sample ID	180-129635-A-4

Date Received	11/5/2021
Start Date	12/02/2021 17:53
End Date	12/09/2021 8:52

Dry Weight Determination

Tin Weight	1.02	g
Wet Sample + Tin	27.99	g
Dry Sample + Tin	20.75	g
% Moisture	26.84	%

Non-soil material:	plant
Shape (> #10):	na
Hardness (> #10):	na

Date/Time in oven	12/02/2021 17:54
Date/Time out of oven	12/03/2021 17:38

Sample Weights	Tare (g)	Pan+Samp (g)	Samp (g)
Sample Weight (Wet)	47.94	227.85	179.91
Sample Weight (Oven Dried)			132

Sample Split (oven dried)	Tare (g)	Pan+Samp (g)	Samp (g)
Sample >=#10			0.69
Sample <#10			131
% Passing #10			72.8

Hydrometer Data

Serial Number	542318
Calib. Date (mm/dd/yyyy)	12/18/2019
Low Temp (C)	17.0
Reading at Low Temp	1.0035
High Temp (C)	23.0
Reading at High Temp	1.0025
Hydrometer Cal Slope	-0.000166667
Hydrometer Cal Intercept	1.006333333
Default Soil Gravity	2.6500

Gravel/Sand Fraction (Sieves)

Sample Fraction	Size (um)	Pan Tare (g)	Pan+Sample (g)	Sample		% Finer	Classification	Sub Class
3 inch	75000			0.00	g	100.0	Gravel	
2 inch	50000			0.00	g	100.0	Gravel	
1.5 inch	37500			0.00	g	100.0	Gravel	
1 inch	25000			0.00	g	100.0	Gravel	
3/4 inch	19000			0.00	g	100.0	Gravel	
3/8 inch	9500			0.00	g	100.0	Gravel	
#4	4750			0.00	g	100.0	Gravel	
#10	2000	462.59	463.28	0.69	g	99.5	Sand	Coarse
#20	850	373.41	378.30	4.89	g	95.8	Sand	Medium
#40	425	361.84	380.66	18.82	g	81.5	Sand	Medium
#60	250	351.94	370.11	18.17	g	67.7	Sand	Fine
#80	180	318.93	333.16	14.23	g	56.9	Sand	Fine
#100	150	328.25	342.38	14.13	g	46.2	Sand	Fine
#200	75	313.99	338.83	24.84	g	27.4	Sand	Fine
				0.00	g	27.4		

Adjusted Hydrometer Sample Mass

Hydrometer Sample Mass (g)	132

Silt/Clay Fraction (Hydrometer Test)

Hydrometer Test Time (min)	Actual	Spec. Gravity	Temp C	Particle Size (Micron)	% Finer	Classification	Sub Class
2	2	1.0215	20.5	31.2	22.6	Silt	
5	5	1.0190	20.5	20.4	19.6	Silt	
15	15	1.0155	20.5	12.2	15.3	Silt	
30	31	1.0140	20.5	8.6	13.5	Silt	
60	59	1.0120	20.5	6.4	11.1	Silt	
250	234	1.0095	20.5	3.3	8.01	Clay	
1440	1418	1.0075	20.5	1.4	5.58	Clay	

QC Sample Results

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 180-378309/1-A
Matrix: Sediment
Analysis Batch: 378370

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378309

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		3.4	0.96	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Acenaphthylene	ND		3.4	0.73	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Anthracene	ND		3.4	0.87	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Benzo[a]anthracene	ND		3.4	1.5	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Benzo[a]pyrene	ND		3.4	1.4	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Benzo[b]fluoranthene	ND		3.4	0.82	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Benzo[g,h,i]perylene	ND		3.4	0.72	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Benzo[k]fluoranthene	ND		3.4	1.0	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Bis(2-chloroethyl)ether	ND		3.4	0.61	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Bis(2-chloroethoxy)methane	ND		17	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,2'-oxybis[1-chloropropane]	ND		3.4	1.2	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Bis(2-ethylhexyl) phthalate	ND		170	18	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Bromophenyl phenyl ether	ND		17	7.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Butyl benzyl phthalate	ND		17	12	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Chloroaniline	ND		17	4.4	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Chloronaphthalene	ND		3.4	0.77	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Chlorophenyl phenyl ether	ND		17	5.5	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Chrysene	ND		3.4	1.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Dibenz(a,h)anthracene	ND		3.4	2.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Dibenzofuran	ND		17	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Di-n-butyl phthalate	ND		17	7.3	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
3,3'-Dichlorobenzidine	ND		17	16	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Diethyl phthalate	ND		17	5.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Dimethyl phthalate	ND		17	6.6	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4-Dinitrotoluene	ND		17	9.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,6-Dinitrotoluene	ND		17	6.5	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Di-n-octyl phthalate	ND		17	9.7	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Fluoranthene	ND		3.4	0.88	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Fluorene	ND		3.4	0.66	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Hexachlorobenzene	ND		3.4	1.2	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Hexachlorobutadiene	ND		3.4	0.98	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Hexachlorocyclopentadiene	ND		17	1.7	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Hexachloroethane	ND		17	5.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Indeno[1,2,3-cd]pyrene	ND		3.4	1.7	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Isophorone	ND		17	6.2	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Methylnaphthalene	ND		3.4	0.80	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Naphthalene	ND		3.4	0.65	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Nitroaniline	ND		85	7.6	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
3-Nitroaniline	ND		85	4.2	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Nitroaniline	ND		85	6.2	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Nitrobenzene	ND		33	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
N-Nitrosodi-n-propylamine	ND		3.4	1.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
N-Nitrosodiphenylamine	ND		17	5.6	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Phenanthrene	ND		3.4	0.90	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Pyrene	ND		3.4	0.79	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Carbazole	ND		3.4	0.78	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Acetophenone	ND		34	5.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Atrazine	ND		34	7.3	ug/Kg		11/09/21 18:40	11/10/21 13:04	1

QC Sample Results

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 180-378309/1-A
Matrix: Sediment
Analysis Batch: 378370

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378309

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzaldehyde	ND		34	2.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
1,1'-Biphenyl	ND		17	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Caprolactam	ND		85	11	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Chloro-3-methylphenol	ND		17	5.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Chlorophenol	ND		17	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Methylphenol	ND		17	4.8	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Methylphenol, 3 & 4	ND		17	4.9	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4-Dichlorophenol	ND		3.4	1.3	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4-Dimethylphenol	ND		17	5.6	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4-Dinitrophenol	ND		170	100	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4,6-Dinitro-2-methylphenol	ND		85	29	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2-Nitrophenol	ND		17	6.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
4-Nitrophenol	ND		85	12	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Pentachlorophenol	ND		85	27	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
Phenol	ND		17	5.1	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4,5-Trichlorophenol	ND		17	5.8	ug/Kg		11/09/21 18:40	11/10/21 13:04	1
2,4,6-Trichlorophenol	ND		17	5.5	ug/Kg		11/09/21 18:40	11/10/21 13:04	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorobiphenyl	*60*		*35 - 105*	*11/09/21 18:40*	*11/10/21 13:04*	*1*
2-Fluorophenol (Surr)	*70*		*32 - 105*	*11/09/21 18:40*	*11/10/21 13:04*	*1*
2,4,6-Tribromophenol (Surr)	*61*		*20 - 119*	*11/09/21 18:40*	*11/10/21 13:04*	*1*
Nitrobenzene-d5 (Surr)	*63*		*34 - 109*	*11/09/21 18:40*	*11/10/21 13:04*	*1*
Phenol-d5 (Surr)	*68*		*34 - 105*	*11/09/21 18:40*	*11/10/21 13:04*	*1*
Terphenyl-d14 (Surr)	*74*		*20 - 117*	*11/09/21 18:40*	*11/10/21 13:04*	*1*

Lab Sample ID: LCS 180-378309/2-A
Matrix: Sediment
Analysis Batch: 378370

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378309

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	333	223		ug/Kg		67	41 - 100
Acenaphthylene	333	228		ug/Kg		69	45 - 100
Anthracene	333	250		ug/Kg		75	47 - 100
Benzo[a]anthracene	333	263		ug/Kg		79	47 - 100
Benzo[a]pyrene	333	224		ug/Kg		67	45 - 101
Benzo[b]fluoranthene	333	227		ug/Kg		68	44 - 100
Benzo[g,h,i]perylene	333	212		ug/Kg		64	45 - 103
Benzo[k]fluoranthene	333	217		ug/Kg		65	43 - 100
Bis(2-chloroethyl)ether	333	212		ug/Kg		64	39 - 101
Bis(2-chloroethoxy)methane	333	190		ug/Kg		57	45 - 100
2,2'-oxybis[1-chloropropane]	333	208		ug/Kg		62	33 - 101
Bis(2-ethylhexyl) phthalate	333	268		ug/Kg		80	45 - 109
4-Bromophenyl phenyl ether	333	247		ug/Kg		74	17 - 104
Butyl benzyl phthalate	333	299		ug/Kg		90	45 - 110
4-Chloroaniline	333	222		ug/Kg		66	38 - 100
2-Chloronaphthalene	333	217		ug/Kg		65	47 - 100
4-Chlorophenyl phenyl ether	333	227		ug/Kg		68	45 - 100

QC Sample Results

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 180-378309/2-A
Client Sample ID: Lab Control Sample
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 378370
Prep Batch: 378309

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Chrysene	333	237		ug/Kg		71	44 - 100
Dibenz(a,h)anthracene	333	235		ug/Kg		70	46 - 107
Dibenzofuran	333	225		ug/Kg		68	47 - 100
Di-n-butyl phthalate	333	262		ug/Kg		79	50 - 105
3,3'-Dichlorobenzidine	333	224		ug/Kg		67	34 - 101
Diethyl phthalate	333	222		ug/Kg		66	45 - 105
Dimethyl phthalate	333	230		ug/Kg		69	46 - 101
2,4-Dinitrotoluene	333	254		ug/Kg		76	48 - 106
2,6-Dinitrotoluene	333	248		ug/Kg		74	48 - 109
Di-n-octyl phthalate	333	251		ug/Kg		75	34 - 106
Fluoranthene	333	247		ug/Kg		74	49 - 102
Fluorene	333	228		ug/Kg		68	46 - 100
Hexachlorobenzene	333	240		ug/Kg		72	45 - 101
Hexachlorobutadiene	333	201		ug/Kg		60	38 - 110
Hexachlorocyclopentadiene	333	228		ug/Kg		69	31 - 116
Hexachloroethane	333	201		ug/Kg		60	40 - 100
Indeno[1,2,3-cd]pyrene	333	233		ug/Kg		70	48 - 104
Isophorone	333	225		ug/Kg		67	46 - 105
2-Methylnaphthalene	333	222		ug/Kg		67	44 - 100
Naphthalene	333	213		ug/Kg		64	43 - 100
2-Nitroaniline	333	251		ug/Kg		75	40 - 122
3-Nitroaniline	333	266		ug/Kg		80	39 - 107
4-Nitroaniline	333	246		ug/Kg		74	41 - 110
Nitrobenzene	333	218		ug/Kg		65	43 - 107
N-Nitrosodi-n-propylamine	333	215		ug/Kg		65	40 - 109
N-Nitrosodiphenylamine	333	249		ug/Kg		75	46 - 100
Phenanthrene	333	243		ug/Kg		73	46 - 100
Pyrene	333	261		ug/Kg		78	44 - 102
Carbazole	333	249		ug/Kg		75	46 - 100
Acetophenone	333	211		ug/Kg		63	40 - 100
Atrazine	333	246		ug/Kg		74	46 - 102
Benzaldehyde	333	240		ug/Kg		72	10 - 125
1,1'-Biphenyl	333	219		ug/Kg		66	43 - 100
Caprolactam	333	254		ug/Kg		76	46 - 109
4-Chloro-3-methylphenol	333	236		ug/Kg		71	47 - 108
2-Chlorophenol	333	228		ug/Kg		68	43 - 100
2-Methylphenol	333	225		ug/Kg		67	43 - 101
Methylphenol, 3 & 4	333	225		ug/Kg		68	43 - 104
2,4-Dichlorophenol	333	225		ug/Kg		68	48 - 101
2,4-Dimethylphenol	333	222		ug/Kg		67	46 - 103
2,4-Dinitrophenol	667	454		ug/Kg		68	31 - 112
4,6-Dinitro-2-methylphenol	667	510		ug/Kg		76	47 - 104
2-Nitrophenol	333	254		ug/Kg		76	48 - 108
4-Nitrophenol	667	428		ug/Kg		64	33 - 131
Pentachlorophenol	667	507		ug/Kg		76	34 - 112
Phenol	333	226		ug/Kg		68	42 - 103
2,4,5-Trichlorophenol	333	242		ug/Kg		72	47 - 108
2,4,6-Trichlorophenol	333	236		ug/Kg		71	47 - 108

Method: EPA 8270E LL - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 180-378309/2-A
Matrix: Sediment
Analysis Batch: 378370

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378309

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorobiphenyl	*60*		*35 - 105*
2-Fluorophenol (Surr)	*68*		*32 - 105*
2,4,6-Tribromophenol (Surr)	*74*		*20 - 119*
Nitrobenzene-d5 (Surr)	*63*		*34 - 109*
Phenol-d5 (Surr)	*63*		*34 - 105*
Terphenyl-d14 (Surr)	*78*		*20 - 117*

Method: 8015D - Diesel Range Organics (DRO) (GC)

Lab Sample ID: MB 240-512431/8-A
Matrix: Sediment
Analysis Batch: 512687

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 512431

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics [C10 - C28]	ND		50	35	mg/Kg		11/11/21 06:30	11/12/21 13:19	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*101*		*39 - 120*	*11/11/21 06:30*	*11/12/21 13:19*	*1*

Lab Sample ID: LCS 240-512431/9-A
Matrix: Sediment
Analysis Batch: 512687

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 512431

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Diesel Range Organics [C10 - C28]	250	215		mg/Kg		86	49 - 120

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
o-Terphenyl	*87*		*39 - 120*

Method: EPA 8081B LL - Organochlorine Pesticides (GC)

Lab Sample ID: MB 180-378136/1-B
Matrix: Sediment
Analysis Batch: 378906

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378136

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aldrin	ND		0.042	0.013	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
alpha-BHC	ND		0.042	0.010	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
beta-BHC	ND		0.042	0.011	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
delta-BHC	ND		0.042	0.013	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
gamma-BHC (Lindane)	ND		0.042	0.011	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
cis-Chlordane	ND		0.042	0.010	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
trans-Chlordane	ND		0.042	0.0097	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
4,4'-DDD	ND		0.042	0.018	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
4,4'-DDE	ND		0.042	0.0085	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
4,4'-DDT	ND		0.042	0.030	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Dieldrin	ND		0.042	0.010	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Endosulfan I	ND		0.042	0.011	ug/Kg		11/08/21 22:11	11/16/21 22:09	1

QC Sample Results

Client: Northgate Environmental Management Inc.

Job ID: 180-129635-1

Project/Site: Conowingo Pilot Study/Stockpile

Method: EPA 8081B LL - Organochlorine Pesticides (GC) (Continued)

Lab Sample ID: MB 180-378136/1-B
Matrix: Sediment
Analysis Batch: 378906

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378136

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Endosulfan II	ND		0.042	0.0092	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Endosulfan sulfate	ND		0.042	0.011	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Endrin	ND		0.042	0.0078	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Endrin aldehyde	ND		0.042	0.015	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Endrin ketone	ND		0.042	0.0058	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Heptachlor	ND		0.042	0.013	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Heptachlor epoxide	ND		0.042	0.011	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Methoxychlor	ND		0.042	0.016	ug/Kg		11/08/21 22:11	11/16/21 22:09	1
Toxaphene	ND		1.7	1.1	ug/Kg		11/08/21 22:11	11/16/21 22:09	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Tetrachloro-m-xylene (Surr)	*45*		*10 - 105*	*11/08/21 22:11*	*11/16/21 22:09*	*1*
Tetrachloro-m-xylene (Surr)	*47*		*10 - 105*	*11/08/21 22:11*	*11/16/21 22:09*	*1*
DCB Decachlorobiphenyl (Surr)	*49*		*25 - 107*	*11/08/21 22:11*	*11/16/21 22:09*	*1*
DCB Decachlorobiphenyl (Surr)	*54*		*25 - 107*	*11/08/21 22:11*	*11/16/21 22:09*	*1*

Lab Sample ID: LCS 180-378136/2-B
Matrix: Sediment
Analysis Batch: 378906

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378136

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aldrin	1.67	0.955		ug/Kg		57	25 - 139
alpha-BHC	1.67	0.905		ug/Kg		54	30 - 131
beta-BHC	1.67	0.894		ug/Kg		54	26 - 128
delta-BHC	1.67	0.876		ug/Kg		53	20 - 133
gamma-BHC (Lindane)	1.67	0.786		ug/Kg		47	31 - 134
cis-Chlordane	1.67	0.935		ug/Kg		56	25 - 137
trans-Chlordane	1.67	0.930		ug/Kg		56	31 - 131
4,4'-DDD	1.67	1.09		ug/Kg		65	32 - 135
4,4'-DDE	1.67	0.615	p	ug/Kg		37	28 - 128
4,4'-DDT	1.67	0.902		ug/Kg		54	28 - 121
Dieldrin	1.67	1.06		ug/Kg		63	39 - 124
Endosulfan I	1.67	0.954		ug/Kg		57	24 - 141
Endosulfan II	1.67	1.40		ug/Kg		84	38 - 125
Endosulfan sulfate	1.67	0.986		ug/Kg		59	23 - 130
Endrin	1.67	1.07		ug/Kg		64	32 - 131
Endrin aldehyde	1.67	1.23		ug/Kg		74	27 - 124
Endrin ketone	1.67	1.12		ug/Kg		67	46 - 128
Heptachlor	1.67	0.987		ug/Kg		59	24 - 146
Heptachlor epoxide	1.67	0.828		ug/Kg		50	25 - 142
Methoxychlor	1.67	0.840		ug/Kg		50	31 - 136

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Tetrachloro-m-xylene (Surr)	*46*		*10 - 105*
Tetrachloro-m-xylene (Surr)	*47*		*10 - 105*
DCB Decachlorobiphenyl (Surr)	*49*		*25 - 107*
DCB Decachlorobiphenyl (Surr)	*56*		*25 - 107*

QC Sample Results

Method: EPA 8082A - Polychlorinated Biphenyls (PCBs) (GC)

Lab Sample ID: MB 180-378137/1-C
Matrix: Sediment
Analysis Batch: 378882

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378137

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PCB-1016	ND		0.42	0.14	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1221	ND		0.42	0.15	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1232	ND		0.42	0.10	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1242	ND		0.42	0.061	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1248	ND		0.42	0.10	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1254	ND		0.42	0.13	ug/Kg		11/09/21 09:04	11/14/21 20:59	1
PCB-1260	ND		0.42	0.12	ug/Kg		11/09/21 09:04	11/14/21 20:59	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
DCB Decachlorobiphenyl (Surr)	*94*		*26 - 170*	*11/09/21 09:04*	*11/14/21 20:59*	*1*
DCB Decachlorobiphenyl (Surr)	*94*		*26 - 170*	*11/09/21 09:04*	*11/14/21 20:59*	*1*
Tetrachloro-m-xylene (Surr)	*90*		*33 - 126*	*11/09/21 09:04*	*11/14/21 20:59*	*1*
Tetrachloro-m-xylene (Surr)	*90*		*33 - 126*	*11/09/21 09:04*	*11/14/21 20:59*	*1*

Lab Sample ID: LCS 180-378137/2-C
Matrix: Sediment
Analysis Batch: 378882

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378137

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
PCB-1016	33.3	27.8		ug/Kg		83	32 - 126
PCB-1260	33.3	27.0		ug/Kg		81	40 - 121

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
DCB Decachlorobiphenyl (Surr)	*104*		*26 - 170*
DCB Decachlorobiphenyl (Surr)	*99*		*26 - 170*
Tetrachloro-m-xylene (Surr)	*102*		*33 - 126*
Tetrachloro-m-xylene (Surr)	*98*		*33 - 126*

Method: EPA 9056A - Anions, Ion Chromatography

Lab Sample ID: MB 180-377909/2-A
Matrix: Sediment
Analysis Batch: 377893

Client Sample ID: Method Blank
Prep Type: Soluble

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfate	ND		10	6.8	mg/Kg			11/06/21 12:12	1

Lab Sample ID: LCS 180-377909/1-A
Matrix: Sediment
Analysis Batch: 377893

Client Sample ID: Lab Control Sample
Prep Type: Soluble

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfate	750	739		mg/Kg		98	80 - 120

QC Sample Results

Client: Northgate Environmental Management Inc.
Job ID: 180-129635-1
Project/Site: Conowingo Pilot Study/Stockpile

Method: 8290A - Dioxins and Furans (HRGC/HRMS)

Lab Sample ID: MB 140-56482/17-A
Matrix: Sediment
Analysis Batch: 57498

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 56482

Analyte	MB Result	MB Qualifier	RL	EDL	Unit	D	Prepared	Analyzed	Dil Fac
2,3,7,8-TCDD	0.0288	J I	1.0	0.027	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,7,8-PeCDD	ND		5.0	0.019	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,4,7,8-HxCDD	0.149	J	5.0	0.012	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,6,7,8-HxCDD	0.0391	J I	5.0	0.011	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,7,8,9-HxCDD	0.0730	J	5.0	0.011	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,4,6,7,8-HpCDD	0.239	J I	5.0	0.081	pg/g		11/30/21 11:04	12/29/21 13:47	1
OCDD	0.459	J	10	0.017	pg/g		11/30/21 11:04	12/29/21 13:47	1
2,3,7,8-TCDF	ND		1.0	0.024	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,7,8-PeCDF	0.0547	J I	5.0	0.016	pg/g		11/30/21 11:04	12/29/21 13:47	1
2,3,4,7,8-PeCDF	0.0540	J I	5.0	0.015	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,4,7,8-HxCDF	0.0908	J I	5.0	0.022	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,6,7,8-HxCDF	ND		5.0	0.025	pg/g		11/30/21 11:04	12/29/21 13:47	1
2,3,4,6,7,8-HxCDF	0.0726	J I	5.0	0.024	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,7,8,9-HxCDF	0.0960	J I	5.0	0.028	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,4,6,7,8-HpCDF	0.0768	J	5.0	0.018	pg/g		11/30/21 11:04	12/29/21 13:47	1
1,2,3,4,7,8,9-HpCDF	ND		5.0	0.024	pg/g		11/30/21 11:04	12/29/21 13:47	1
OCDF	0.131	J I	10	0.012	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total PeCDD	ND		5.0	0.019	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total TCDF	ND		1.0	0.024	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total HxCDF	0.259	J I	5.0	0.025	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total TCDD	0.139	J I	1.0	0.027	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total PeCDF	0.109	J I	5.0	0.015	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total HpCDD	0.239	J I	5.0	0.081	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total HxCDD	0.341	J I	5.0	0.012	pg/g		11/30/21 11:04	12/29/21 13:47	1
Total HpCDF	0.0768	J	5.0	0.021	pg/g		11/30/21 11:04	12/29/21 13:47	1

Isotope Dilution	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C-2,3,7,8-TCDD	*55*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,7,8-PeCDD	*53*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,4,7,8-HxCDD	*53*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,6,7,8-HxCDD	*61*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,4,6,7,8-HpCDD	*54*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-OCDD	*41*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-2,3,7,8-TCDF	*61*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,7,8-PeCDF	*57*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-2,3,4,7,8-PeCDF	*58*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,4,7,8-HxCDF	*64*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,6,7,8-HxCDF	*62*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-2,3,4,6,7,8-HxCDF	*63*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,7,8,9-HxCDF	*67*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,4,6,7,8-HpCDF	*61*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-1,2,3,4,7,8,9-HpCDF	*57*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*
13C-OCDF	*40*		*40 - 135*	*11/30/21 11:04*	*12/29/21 13:47*	*1*

QC Sample Results

Method: 8290A - Dioxins and Furans (HRGC/HRMS) (Continued)

Lab Sample ID: LCS 140-56482/16-A
Matrix: Sediment
Analysis Batch: 57498

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 56482

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
2,3,7,8-TCDD	20.0	19.6		pg/g		98	79 - 129
1,2,3,7,8-PeCDD	100	103		pg/g		103	79 - 129
1,2,3,4,7,8-HxCDD	100	106		pg/g		106	73 - 123
1,2,3,6,7,8-HxCDD	100	98.2		pg/g		98	74 - 124
1,2,3,7,8,9-HxCDD	100	121		pg/g		121	70 - 124
1,2,3,4,6,7,8-HpCDD	100	102		pg/g		102	73 - 123
OCDD	200	204		pg/g		102	75 - 125
2,3,7,8-TCDF	20.0	19.8		pg/g		99	75 - 125
1,2,3,7,8-PeCDF	100	98.0		pg/g		98	74 - 124
2,3,4,7,8-PeCDF	100	104		pg/g		104	75 - 125
1,2,3,4,7,8-HxCDF	100	90.2		pg/g		90	75 - 125
1,2,3,6,7,8-HxCDF	100	96.7		pg/g		97	76 - 126
2,3,4,6,7,8-HxCDF	100	101		pg/g		101	76 - 126
1,2,3,7,8,9-HxCDF	100	97.7		pg/g		98	77 - 127
1,2,3,4,6,7,8-HpCDF	100	97.3		pg/g		97	77 - 127
1,2,3,4,7,8,9-HpCDF	100	97.2		pg/g		97	73 - 123
OCDF	200	207		pg/g		103	49 - 128

Isotope Dilution	*LCS %Recovery*	*LCS Qualifier*	*Limits*
13C-2,3,7,8-TCDD	*51*		*40 - 135*
13C-1,2,3,7,8-PeCDD	*48*		*40 - 135*
13C-1,2,3,4,7,8-HxCDD	*49*		*40 - 135*
13C-1,2,3,6,7,8-HxCDD	*54*		*40 - 135*
13C-1,2,3,4,6,7,8-HpCDD	*51*		*40 - 135*
13C-OCDD	*38*	**5-*	*40 - 135*
13C-2,3,7,8-TCDF	*54*		*40 - 135*
13C-1,2,3,7,8-PeCDF	*52*		*40 - 135*
13C-2,3,4,7,8-PeCDF	*51*		*40 - 135*
13C-1,2,3,4,7,8-HxCDF	*59*		*40 - 135*
13C-1,2,3,6,7,8-HxCDF	*56*		*40 - 135*
13C-2,3,4,6,7,8-HxCDF	*62*		*40 - 135*
13C-1,2,3,7,8,9-HxCDF	*64*		*40 - 135*
13C-1,2,3,4,6,7,8-HpCDF	*56*		*40 - 135*
13C-1,2,3,4,7,8,9-HpCDF	*54*		*40 - 135*
13C-OCDF	*37*	**5-*	*40 - 135*

Method: EPA 6020B - Metals (ICP/MS)

Lab Sample ID: MB 180-379074/1-A
Matrix: Sediment
Analysis Batch: 379482

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 379074

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenic	ND		0.050	0.016	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Cadmium	ND		0.050	0.0085	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Chromium	0.0445	J	0.10	0.042	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Lead	ND		0.050	0.050	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Selenium	ND		0.25	0.061	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Silver	ND		0.050	0.014	mg/Kg		11/16/21 09:49	11/18/21 16:37	1

QC Sample Results

Method: EPA 6020B - Metals (ICP/MS) (Continued)

Lab Sample ID: MB 180-379074/1-A
Matrix: Sediment
Analysis Batch: 379482

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 379074

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Beryllium	ND		0.050	0.036	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Thallium	ND		0.050	0.035	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Antimony	ND		0.10	0.022	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Nickel	ND		0.050	0.047	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Zinc	ND		0.25	0.24	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Copper	ND		0.15	0.10	mg/Kg		11/16/21 09:49	11/18/21 16:37	1
Manganese	0.344		0.25	0.22	mg/Kg		11/16/21 09:49	11/18/21 16:37	1

Lab Sample ID: LCS 180-379074/2-A
Matrix: Sediment
Analysis Batch: 379482

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 379074

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	50.0	44.9		mg/Kg		90	80 - 120
Cadmium	25.0	23.8		mg/Kg		95	80 - 120
Chromium	25.0	25.3		mg/Kg		101	80 - 120
Lead	25.0	24.3		mg/Kg		97	80 - 120
Selenium	50.0	47.1		mg/Kg		94	80 - 120
Silver	12.5	11.4		mg/Kg		91	80 - 120
Beryllium	25.0	24.0		mg/Kg		96	80 - 120
Thallium	50.0	50.4		mg/Kg		101	80 - 120
Antimony	12.5	11.4		mg/Kg		91	80 - 120
Nickel	25.0	22.9		mg/Kg		92	80 - 120
Zinc	12.5	10.4		mg/Kg		83	80 - 120
Copper	25.0	23.2		mg/Kg		93	80 - 120
Manganese	25.0	24.1		mg/Kg		97	80 - 120

Lab Sample ID: 180-129635-1 MS
Matrix: Sediment
Analysis Batch: 379482

Client Sample ID: STOCKPILE QUADRANT 1
Prep Type: Total/NA
Prep Batch: 379074

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Arsenic	4.7	F1	64.2	54.4		mg/Kg	☼	77	75 - 125
Cadmium	0.34		32.1	26.2		mg/Kg	☼	81	75 - 125
Chromium	8.3	B	32.1	33.8		mg/Kg	☼	79	75 - 125
Lead	17		32.1	43.1		mg/Kg	☼	81	75 - 125
Selenium	1.0	F1	64.2	48.2	F1	mg/Kg	☼	73	75 - 125
Silver	0.17	F1	16.1	12.6		mg/Kg	☼	78	75 - 125
Beryllium	0.86		32.1	27.9		mg/Kg	☼	84	75 - 125
Thallium	0.12		64.2	53.4		mg/Kg	☼	83	75 - 125
Antimony	0.25	F1	16.1	9.34	F1	mg/Kg	☼	57	75 - 125
Nickel	29		32.1	54.7		mg/Kg	☼	81	75 - 125
Zinc	93		16.1	106	4	mg/Kg	☼	81	75 - 125
Copper	21	F1	32.1	45.2		mg/Kg	☼	76	75 - 125
Manganese	450	B	32.1	458	4	mg/Kg	☼	32	75 - 125

QC Sample Results

Method: EPA 6020B - Metals (ICP/MS) (Continued)

Lab Sample ID: 180-129635-1 MSD
Matrix: Sediment
Analysis Batch: 379482

Client Sample ID: STOCKPILE QUADRANT 1
Prep Type: Total/NA
Prep Batch: 379074

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Arsenic	4.7	F1	62.7	50.2	F1	mg/Kg	☼	73	75 - 125	8	20
Cadmium	0.34		31.3	24.1		mg/Kg	☼	76	75 - 125	8	20
Chromium	8.3	B	31.3	32.8		mg/Kg	☼	78	75 - 125	3	20
Lead	17		31.3	42.3		mg/Kg	☼	81	75 - 125	2	20
Selenium	1.0	F1	62.7	43.6	F1	mg/Kg	☼	68	75 - 125	10	20
Silver	0.17	F1	15.7	11.8	F1	mg/Kg	☼	74	75 - 125	7	20
Beryllium	0.86		31.3	25.5		mg/Kg	☼	79	75 - 125	9	20
Thallium	0.12		62.7	49.2		mg/Kg	☼	78	75 - 125	8	20
Antimony	0.25	F1	15.7	8.48	F1	mg/Kg	☼	53	75 - 125	10	20
Nickel	29		31.3	55.7		mg/Kg	☼	86	75 - 125	2	20
Zinc	93		15.7	112	4	mg/Kg	☼	121	75 - 125	5	20
Copper	21	F1	31.3	44.1	F1	mg/Kg	☼	74	75 - 125	2	20
Manganese	450	B	31.3	487	4	mg/Kg	☼	127	75 - 125	6	20

Method: EPA 7471B - Mercury (CVAA)

Lab Sample ID: MB 180-378234/1-A
Matrix: Sediment
Analysis Batch: 378742

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378234

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	ND		0.017	0.011	mg/Kg		11/09/21 11:48	11/12/21 10:00	1

Lab Sample ID: LCS 180-378234/2-A
Matrix: Sediment
Analysis Batch: 378742

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378234

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Mercury	0.208	0.209		mg/Kg		100	80 - 120

Method: 2540G - SM 2540G

Lab Sample ID: 180-129635-4 DU
Matrix: Sediment
Analysis Batch: 378482

Client Sample ID: STOCKPILE QUADRANT 4
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Percent Moisture	26.6		27.0		%		1	10
Percent Solids	73.4		73.0		%		0.5	10

Lab Sample ID: 180-129635-5 DU
Matrix: Sediment
Analysis Batch: 378652

Client Sample ID: STOCKPILE QUADRANTS 1-4
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Percent Moisture	25.0		26.4		%		5	10
Percent Solids	75.0		73.6		%		2	10

QC Sample Results

Method: 351.2 - Nitrogen, Total Kjeldahl

Lab Sample ID: MB 480-606990/1-A
Client Sample ID: Method Blank
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 607363
Prep Batch: 606990

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Kjeldahl Nitrogen	ND		9.3	4.1	mg/Kg		11/30/21 05:50	12/02/21 09:32	1

Lab Sample ID: LCS 480-606990/2-A
Client Sample ID: Lab Control Sample
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 607363
Prep Batch: 606990

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Kjeldahl Nitrogen	111	107		mg/Kg		97	90 - 110

Lab Sample ID: 180-129635-1 MS
Client Sample ID: STOCKPILE QUADRANT 1
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 607363
Prep Batch: 606990

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Kjeldahl Nitrogen	1600	H	60.4	1360	4	mg/Kg	☼	-456	90 - 110

Lab Sample ID: 180-129635-1 DU
Client Sample ID: STOCKPILE QUADRANT 1
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 607363
Prep Batch: 606990

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Kjeldahl Nitrogen	1600	H	1570		mg/Kg	☼	4	20

Method: 9016 - Cyanide, Free

Lab Sample ID: MB 460-813502/1-B
Client Sample ID: Method Blank
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 813612
Prep Batch: 813592

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cyanide, Free	0.635	J	1.1	0.39	mg/Kg		11/16/21 11:55	11/16/21 13:59	1

Lab Sample ID: LCS 460-813502/2-B
Client Sample ID: Lab Control Sample
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 813612
Prep Batch: 813592

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Free	25.0	26.3		mg/Kg		105	35 - 137

Lab Sample ID: 180-129635-1 MS
Client Sample ID: STOCKPILE QUADRANT 1
Matrix: Sediment
Prep Type: Total/NA
Analysis Batch: 813612
Prep Batch: 813592

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Free	0.69	J B	32.1	33.7		mg/Kg	☼	103	35 - 137

QC Sample Results

Method: 9016 - Cyanide, Free (Continued)

Lab Sample ID: 180-129635-1 MSD
Matrix: Sediment
Analysis Batch: 813612

Client Sample ID: STOCKPILE QUADRANT 1
Prep Type: Total/NA
Prep Batch: 813592

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Cyanide, Free	0.69	J B	32.1	33.0		mg/Kg	☼	101	35 - 137	2	25

Lab Sample ID: DLCK 460-813612/10
Matrix: Sediment
Analysis Batch: 813612

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	DLCK Result	DLCK Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Free	2.00	2.93	J	ug/L		147	36 - 171

Method: EPA 9014 - Cyanide

Lab Sample ID: MB 180-378813/4-A
Matrix: Sediment
Analysis Batch: 379207

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 378813

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cyanide, Total	ND		0.50	0.15	mg/Kg		11/15/21 14:30	11/15/21 18:11	1

Lab Sample ID: HLCS 180-378813/2-A
Matrix: Sediment
Analysis Batch: 379207

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378813

Analyte	Spike Added	HLCS Result	HLCS Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Total	0.250	0.252		mg/Kg		101	90 - 110

Lab Sample ID: LCS 180-378813/3-A
Matrix: Sediment
Analysis Batch: 379207

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378813

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Total	23.1	25.3		mg/Kg		110	25 - 150

Lab Sample ID: LLCS 180-378813/1-A
Matrix: Sediment
Analysis Batch: 379207

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 378813

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec. Limits
Cyanide, Total	0.0500	0.0515		mg/Kg		103	90 - 110

Method: EPA 9034 - Sulfide, Acid soluble and Insoluble (Titrimetric)

Lab Sample ID: MB 180-377926/1-A
Matrix: Sediment
Analysis Batch: 377953

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 377926

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Sulfide	ND		30	10	mg/Kg		11/06/21 13:00	11/06/21 15:02	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Method: EPA 9034 - Sulfide, Acid soluble and Insoluble (Titrimetric) (Continued)

Lab Sample ID: LCS 180-377926/2-A **Client Sample ID: Lab Control Sample**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 377953 **Prep Batch: 377926**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Sulfide	131	128		mg/Kg		98	85 - 115

Method: EPA-Lloyd Kahn - Organic Carbon, Total (TOC)

Lab Sample ID: MB 180-378529/4 **Client Sample ID: Method Blank**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 378529

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	750	mg/Kg			11/10/21 14:36	1

Lab Sample ID: LCS 180-378529/5 **Client Sample ID: Lab Control Sample**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 378529

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	38200	39600		mg/Kg		104	75 - 125

Lab Sample ID: MB 180-378697/4 **Client Sample ID: Method Blank**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 378697

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon - Duplicates	ND		1000	750	mg/Kg			11/11/21 13:46	1

Lab Sample ID: LCS 180-378697/5 **Client Sample ID: Lab Control Sample**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 378697

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon - Duplicates	38200	34900		mg/Kg		91	75 - 125

Method: ASTM D2974 - Moisture, Ash and Organic Matter

Lab Sample ID: 180-129635-1 DU **Client Sample ID: STOCKPILE QUADRANT 1**
Matrix: Sediment **Prep Type: Total/NA**
Analysis Batch: 380493

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Loss on Ignition	15.9		15.6		%		2	10

QC Association Summary

Client: Northgate Environmental Management Inc.

Job ID: 180-129635-1

Project/Site: Conowingo Pilot Study/Stockpile

GC/MS Semi VOA

Prep Batch: 378309

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3541	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3541	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3541	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3541	
MB 180-378309/1-A	Method Blank	Total/NA	Sediment	3541	
LCS 180-378309/2-A	Lab Control Sample	Total/NA	Sediment	3541	

Analysis Batch: 378370

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 8270E LL	378309
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 8270E LL	378309
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 8270E LL	378309
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 8270E LL	378309
MB 180-378309/1-A	Method Blank	Total/NA	Sediment	EPA 8270E LL	378309
LCS 180-378309/2-A	Lab Control Sample	Total/NA	Sediment	EPA 8270E LL	378309

GC Semi VOA

Prep Batch: 378136

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3541	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3541	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3541	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3541	
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	3541	
MB 180-378136/1-B	Method Blank	Total/NA	Sediment	3541	
LCS 180-378136/2-B	Lab Control Sample	Total/NA	Sediment	3541	

Prep Batch: 378137

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3541	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3541	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3541	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3541	
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	3541	
MB 180-378137/1-C	Method Blank	Total/NA	Sediment	3541	
LCS 180-378137/2-C	Lab Control Sample	Total/NA	Sediment	3541	

Cleanup Batch: 378327

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3665A	378137
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3665A	378137
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3665A	378137
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3665A	378137
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	3665A	378137
MB 180-378137/1-C	Method Blank	Total/NA	Sediment	3665A	378137
LCS 180-378137/2-C	Lab Control Sample	Total/NA	Sediment	3665A	378137

Cleanup Batch: 378328

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3660B	378327

GC Semi VOA (Continued)

Cleanup Batch: 378328 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3660B	378327
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3660B	378327
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3660B	378327
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	3660B	378327
MB 180-378137/1-C	Method Blank	Total/NA	Sediment	3660B	378327
LCS 180-378137/2-C	Lab Control Sample	Total/NA	Sediment	3660B	378327

Cleanup Batch: 378548

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3640A	378136
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3640A	378136
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3640A	378136
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3640A	378136
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	3640A	378136
MB 180-378136/1-B	Method Blank	Total/NA	Sediment	3640A	378136
LCS 180-378136/2-B	Lab Control Sample	Total/NA	Sediment	3640A	378136

Analysis Batch: 378882

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 8082A	378328
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 8082A	378328
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 8082A	378328
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 8082A	378328
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	EPA 8082A	378328
MB 180-378137/1-C	Method Blank	Total/NA	Sediment	EPA 8082A	378328
LCS 180-378137/2-C	Lab Control Sample	Total/NA	Sediment	EPA 8082A	378328

Analysis Batch: 378906

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 8081B LL	378548
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 8081B LL	378548
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 8081B LL	378548
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 8081B LL	378548
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	EPA 8081B LL	378548
MB 180-378136/1-B	Method Blank	Total/NA	Sediment	EPA 8081B LL	378548
LCS 180-378136/2-B	Lab Control Sample	Total/NA	Sediment	EPA 8081B LL	378548

Prep Batch: 512431

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3546	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3546	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3546	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3546	
MB 240-512431/8-A	Method Blank	Total/NA	Sediment	3546	
LCS 240-512431/9-A	Lab Control Sample	Total/NA	Sediment	3546	

Analysis Batch: 512687

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	8015D	512431
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	8015D	512431
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	8015D	512431

GC Semi VOA (Continued)

Analysis Batch: 512687 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	8015D	512431
MB 240-512431/8-A	Method Blank	Total/NA	Sediment	8015D	512431
LCS 240-512431/9-A	Lab Control Sample	Total/NA	Sediment	8015D	512431

HPLC/IC

Analysis Batch: 377893

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Soluble	Sediment	EPA 9056A	377909
180-129635-2	STOCKPILE QUADRANT 2	Soluble	Sediment	EPA 9056A	377909
180-129635-3	STOCKPILE QUADRANT 3	Soluble	Sediment	EPA 9056A	377909
180-129635-4	STOCKPILE QUADRANT 4	Soluble	Sediment	EPA 9056A	377909
MB 180-377909/2-A	Method Blank	Soluble	Sediment	EPA 9056A	377909
LCS 180-377909/1-A	Lab Control Sample	Soluble	Sediment	EPA 9056A	377909

Leach Batch: 377909

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Soluble	Sediment	DI Leach	
180-129635-2	STOCKPILE QUADRANT 2	Soluble	Sediment	DI Leach	
180-129635-3	STOCKPILE QUADRANT 3	Soluble	Sediment	DI Leach	
180-129635-4	STOCKPILE QUADRANT 4	Soluble	Sediment	DI Leach	
MB 180-377909/2-A	Method Blank	Soluble	Sediment	DI Leach	
LCS 180-377909/1-A	Lab Control Sample	Soluble	Sediment	DI Leach	

Specialty Organics

Prep Batch: 56482

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	8290	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	8290	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	8290	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	8290	
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	8290	
MB 140-56482/17-A	Method Blank	Total/NA	Sediment	8290	
LCS 140-56482/16-A	Lab Control Sample	Total/NA	Sediment	8290	

Analysis Batch: 57498

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 140-56482/17-A	Method Blank	Total/NA	Sediment	8290A	56482
LCS 140-56482/16-A	Lab Control Sample	Total/NA	Sediment	8290A	56482

Analysis Batch: 57534

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	8290A	56482
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	8290A	56482
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	8290A	56482
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	8290A	56482

Analysis Batch: 57559

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	8290A	56482
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	8290A	56482

Specialty Organics

Analysis Batch: 57605

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	8290A	56482

Analysis Batch: 57699

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	8290A	56482

Metals

Prep Batch: 378234

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	7471B	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	7471B	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	7471B	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	7471B	
MB 180-378234/1-A	Method Blank	Total/NA	Sediment	7471B	
LCS 180-378234/2-A	Lab Control Sample	Total/NA	Sediment	7471B	

Analysis Batch: 378742

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 7471B	378234
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 7471B	378234
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 7471B	378234
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 7471B	378234
MB 180-378234/1-A	Method Blank	Total/NA	Sediment	EPA 7471B	378234
LCS 180-378234/2-A	Lab Control Sample	Total/NA	Sediment	EPA 7471B	378234

Prep Batch: 379074

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	3050B	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	3050B	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	3050B	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	3050B	
MB 180-379074/1-A	Method Blank	Total/NA	Sediment	3050B	
LCS 180-379074/2-A	Lab Control Sample	Total/NA	Sediment	3050B	
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	3050B	
180-129635-1 MSD	STOCKPILE QUADRANT 1	Total/NA	Sediment	3050B	

Analysis Batch: 379482

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 6020B	379074
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 6020B	379074
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 6020B	379074
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 6020B	379074
MB 180-379074/1-A	Method Blank	Total/NA	Sediment	EPA 6020B	379074
LCS 180-379074/2-A	Lab Control Sample	Total/NA	Sediment	EPA 6020B	379074
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 6020B	379074
180-129635-1 MSD	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 6020B	379074

QC Association Summary

General Chemistry

Prep Batch: 377926

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	9030B	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	9030B	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	9030B	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	9030B	
MB 180-377926/1-A	Method Blank	Total/NA	Sediment	9030B	
LCS 180-377926/2-A	Lab Control Sample	Total/NA	Sediment	9030B	

Analysis Batch: 377953

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 9034	377926
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 9034	377926
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 9034	377926
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 9034	377926
MB 180-377926/1-A	Method Blank	Total/NA	Sediment	EPA 9034	377926
LCS 180-377926/2-A	Lab Control Sample	Total/NA	Sediment	EPA 9034	377926

Analysis Batch: 378237

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	2540G	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	2540G	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	2540G	

Analysis Batch: 378482

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	2540G	
180-129635-4 DU	STOCKPILE QUADRANT 4	Total/NA	Sediment	2540G	

Analysis Batch: 378529

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA-Lloyd Kahn	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA-Lloyd Kahn	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA-Lloyd Kahn	
MB 180-378529/4	Method Blank	Total/NA	Sediment	EPA-Lloyd Kahn	
LCS 180-378529/5	Lab Control Sample	Total/NA	Sediment	EPA-Lloyd Kahn	

Analysis Batch: 378652

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-5	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	2540G	
180-129635-5 DU	STOCKPILE QUADRANTS 1-4	Total/NA	Sediment	2540G	

Analysis Batch: 378697

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA-Lloyd Kahn	
MB 180-378697/4	Method Blank	Total/NA	Sediment	EPA-Lloyd Kahn	
LCS 180-378697/5	Lab Control Sample	Total/NA	Sediment	EPA-Lloyd Kahn	

Prep Batch: 378813

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	9010C	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	9010C	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	9010C	

General Chemistry (Continued)

Prep Batch: 378813 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	9010C	
MB 180-378813/4-A	Method Blank	Total/NA	Sediment	9010C	
HLCS 180-378813/2-A	Lab Control Sample	Total/NA	Sediment	9010C	
LCS 180-378813/3-A	Lab Control Sample	Total/NA	Sediment	9010C	
LLCS 180-378813/1-A	Lab Control Sample	Total/NA	Sediment	9010C	

Analysis Batch: 379207

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	EPA 9014	378813
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	EPA 9014	378813
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	EPA 9014	378813
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	EPA 9014	378813
MB 180-378813/4-A	Method Blank	Total/NA	Sediment	EPA 9014	378813
HLCS 180-378813/2-A	Lab Control Sample	Total/NA	Sediment	EPA 9014	378813
LCS 180-378813/3-A	Lab Control Sample	Total/NA	Sediment	EPA 9014	378813
LLCS 180-378813/1-A	Lab Control Sample	Total/NA	Sediment	EPA 9014	378813

Prep Batch: 606990

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	351.2	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	351.2	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	351.2	
MB 480-606990/1-A	Method Blank	Total/NA	Sediment	351.2	
LCS 480-606990/2-A	Lab Control Sample	Total/NA	Sediment	351.2	
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	
180-129635-1 DU	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	

Analysis Batch: 607363

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	606990
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	351.2	606990
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	351.2	606990
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	351.2	606990
MB 480-606990/1-A	Method Blank	Total/NA	Sediment	351.2	606990
LCS 480-606990/2-A	Lab Control Sample	Total/NA	Sediment	351.2	606990
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	606990
180-129635-1 DU	STOCKPILE QUADRANT 1	Total/NA	Sediment	351.2	606990

Leach Batch: 813502

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	9016	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	9016	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	9016	
MB 460-813502/1-B	Method Blank	Total/NA	Sediment	9016	
LCS 460-813502/2-B	Lab Control Sample	Total/NA	Sediment	9016	
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	
180-129635-1 MSD	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	

QC Association Summary

General Chemistry

Prep Batch: 813592

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813502
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	9016	813502
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	9016	813502
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	9016	813502
MB 460-813502/1-B	Method Blank	Total/NA	Sediment	9016	813502
LCS 460-813502/2-B	Lab Control Sample	Total/NA	Sediment	9016	813502
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813502
180-129635-1 MSD	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813502

Analysis Batch: 813612

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813592
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	9016	813592
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	9016	813592
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	9016	813592
MB 460-813502/1-B	Method Blank	Total/NA	Sediment	9016	813592
DLCK 460-813612/10	Lab Control Sample	Total/NA	Sediment	9016	
LCS 460-813502/2-B	Lab Control Sample	Total/NA	Sediment	9016	813592
180-129635-1 MS	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813592
180-129635-1 MSD	STOCKPILE QUADRANT 1	Total/NA	Sediment	9016	813592

Geotechnical

Analysis Batch: 174709

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	D422	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	D422	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	D422	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	D422	

Analysis Batch: 380493

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
180-129635-1	STOCKPILE QUADRANT 1	Total/NA	Sediment	ASTM D2974	
180-129635-2	STOCKPILE QUADRANT 2	Total/NA	Sediment	ASTM D2974	
180-129635-3	STOCKPILE QUADRANT 3	Total/NA	Sediment	ASTM D2974	
180-129635-4	STOCKPILE QUADRANT 4	Total/NA	Sediment	ASTM D2974	
180-129635-1 DU	STOCKPILE QUADRANT 1	Total/NA	Sediment	ASTM D2974	

northgate
environmental management, inc.

Baltimore
#201

CHAIN OF CUSTODY / ANALYSIS REQUEST FORM

Project No: 3037.02
Project Location: Perryville MD
Date: 11/3/21
Project Name: Conowingo Pilot Study/Stockpile Sampling
Field Logbook No: N/A
Serial No: N/A
Samplers: STEVE BEDOSKY ERIK ZANE

SAMPLES						ANALYSES																	
Sample No.	Date	Time	Lab Sample No.	No. of Containers	Sample Type	Grain Size Distribution	Loss on Ignition (% Coal)	Percent Moisture	Priority Pollutant Metals + Hg	Total Cyanide	Free Cyanide	Total Sulfate	Total Sulfide	Total Organic Carbon	SVOCs (inc. PAHs)	Organochlorine Pesticides	PCBs (Aroclors)	Dioxins/Furans	Total Petroleum Hydrocarbons - DRO	Total Kjeldahl Nitrogen	HOLD	RUSH	REMARKS
Stockpile Quadrant 1	11/2/21	0848		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 2		0903		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 3		0914		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrant 4		0925		6	Sediment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			5 point composite
Stockpile Quadrants 1-4		0921		2	Sediment											✓	✓	✓					20 point composite

Relinquished by: (Signature)	Date: 11/4/21	Time: 1254	Received by: (Signature)	Date: 11/4/21	Time: 1254
Relinquished by: (Signature)	Date: 11/4/21	Time: 1700	Received by: (Signature) D Watson ETA Pitt	Date: 11-5-21	Time:
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time: 1000
Method of Shipment:	Date:	Time:	Lab Comments:		

Sample Collector:
Northgate Environmental Management, Inc.
47 East All Saints Street
Frederick, MD 21701
(850) 508-5313

Analytical Laboratory:
Test America, 7526 Connelley Drive, Hanover, MD, 21076

180-129635 Chain of Custody

Do not lift using this tag.

1
11:30
A
0537
1.05

ORIGIN
SETH
EUROFI
7526 CONNE
SUITE F
BALTIMORE, MD 21226
UNITED STATES US

DATE: 04NOV21
20.00 LB
NET4400

180-129635 Waybill

TO SAMPLE RECEIVING
TEST AMERICA PITTSBURG
301 ALPHA DR
RIDC PARK
PITTSBURGH PA 15238
(412) 963-7058
INV:
PO:

REF: NORTHGATE CONOWINGO
DEPT:

56DJ2J9A7E/FE4A

FedEx Express

E

J212221101801uv

FRI - 05 NOV 11:30A
PRIORITY OVERNIGHT

TRK# 0201 7751 2166 0537

15238
PIT

NA AGCA

Uncorrected temp 2.5 °C
Thermometer ID 7
CF 0 Initials 8
PT-WI-SR-001 effective 11/8/18

Part # 156297-435 RRDW2 EXP 09/22

Eurofins TestAmerica, Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	Carrier Tracking No(s):	COC No: 180-448639.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Carrie.Gamber@Eurofinset.com	State of Origin: Maryland	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Louisiana		Job #: 180-129635-1
Address: 5815 Middlebrook Pike, ,	Due Date Requested: 12/12/2021			
City: Knoxville	TAT Requested (days):			
State, Zip: TN, 37921				
Phone: 865-291-3000(Tel) 865-584-4315(Fax)	PO #:			
Email:	WO #:			
Project Name: Conowingo Pilot Study/Stockpile	Project #: 18023948			
Site:	SSOW#:			

Preservation Codes:
A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)
Other:

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	8290A/8290_P_Sox Dioxins and Furans: Standard 17 Isomers	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
STOCKPILE QUADRANT 1 (180-129635-1)	11/3/21	08:48 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 2 (180-129635-2)	11/3/21	09:03 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 3 (180-129635-3)	11/3/21	09:14 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 4 (180-129635-4)	11/3/21	09:25 Eastern		Sediment			X	1	
STOCKPILE QUADRANTS 1-4 (180-129635-5)	11/3/21	09:31 Eastern		Sediment			X	1	

CUSTODY SEALS INTACT
RECEIVED AT RT 1.8/CT 1.7°C
SKD 11-9-21
1 COOLER FEDX# 517304411218 PD

180-129635 Chain of Custody

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipr ... ently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provic ... brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification
Unconfirmed

Deliverable Requested: I, II, III, IV, Other (specify)   Primary Deliverable Rank: 2

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ____ *Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by: Mo	Date/Time: 11-8-21 1700	Company: ETA RH	Received by:	Date/Time: 11-9-21 10:30	Company: ETA KNX
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

Loc: 180
129635

EUROFINS/TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST

Log In Number:

Review Items	Yes	No	NA	**If No, what was the problem?**	**Comments/Actions Taken**
1. Are the shipping containers intact?	✓			☐ **Containers, Broken**	
2. Were ambient air containers received intact?			✓	☐ Checked in lab	
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA	
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID : SC71 Correction factor: -0.1°c	✓			☐ **Cooler Out of Temp, Client Contacted, Proceed/Cancel** ☐ **Cooler Out of Temp, Same Day Receipt**	
5. Were all of the sample containers received intact?	✓			☐ **Containers, Broken**	
6. Were samples received in appropriate containers?	✓			☐ **Containers, Improper; Client Contacted; Proceed/Cancel**	
7. Do sample container labels match COC? (IDs, Dates, Times)	✓			☐ **COC & Samples Do Not Match** ☐ **COC Incorrect/Incomplete** ☐ **COC Not Received**	
8. Were all of the samples listed on the COC received?	✓			☐ **Sample Received, Not on COC** ☐ **Sample on COC, Not Received**	
9. Is the date/time of sample collection noted?	✓			☐ **COC; No Date/Time; Client Contacted**	**Labeling Verified by:** **Date:**
10. Was the sampler identified on the COC?			✓	☐ **Sampler Not Listed on COC**	
11. Is the client and project name/# identified?	✓			☐ **COC Incorrect/Incomplete**	**pH test strip lot number:**
12. Are tests/parameters listed for each sample?	✓			☐ **COC No tests on COC**	
13. Is the matrix of the samples noted?	✓			☐ **COC Incorrect/Incomplete**	
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ **COC Incorrect/Incomplete**	
15. Were samples received within holding time?	✓			☐ **Holding Time - Receipt**	
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ **pH Adjusted, pH Included (See box 16A)** ☐ **Incorrect Preservative**	
17. Were VOA samples received without headspace?			✓	☐ **Headspace (VOA only)**	
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ **Residual Chlorine**	
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust	
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info	

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: ______ PM Instructions: ______

Sample Receiving Associate: ______ Date: 11.9.21

QA026R32.doc, 062719

Eurofins TestAmerica, Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

180-129635 Chain of Custody

eurofins | Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	COC No: 180-448631.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Carrie.Gamber@Eurofinset.com State of Origin: Maryland	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Louisiana	Job #: 180-129635-1
Address: 530 Community Drive, Suite 11,	**Due Date Requested:** 12/12/2021		
City: South Burlington	**TAT Requested (days):**		
State, Zip: VT, 05403			
Phone: 802-660-1990(Tel) 802-660-1919(Fax)	PO #:		
Email:	WO #:		
Project Name: Conowingo Pilot Study/Stockpile	Project #: 18023948		
Site:	SSOW#:		

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Analysis Requested

Sample Identification - Client ID (Lab ID)	**Sample Date**	**Sample Time**	**Sample Type** (C=comp, G=grab)	**Matrix** (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	**Field Filtered Sample (Yes or No)**	**Perform MS/MSD (Yes or No)**	**D422/ Grain Size (Sieve and Hydrometer)**	**Total Number of containers**	**Special Instructions/Note:**
			Preservation Code:						
STOCKPILE QUADRANT 1 (180-129635-1)	11/3/21	08:48 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 2 (180-129635-2)	11/3/21	09:03 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 3 (180-129635-3)	11/3/21	09:14 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 4 (180-129635-4)	11/3/21	09:25 Eastern		Sediment			X	1	

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:		Time:	Method of Shipment:	
Relinquished by: Mo	Date/Time: 11-8-21 1700	Company	Received by:	Date/Time: 11/9/21 1130	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks:

Ver: 06/08/2021

FedEx®

Do not lift using this tag.

eurofins | Environment Testing
TestAmerica

Part # 159469-434 RIT2 EXP 05/22 •

ORIGIN ID:AGCA (412) 963-7058
PITTSBURGH SAMPLE RECEIVING
EUROFINS TESTAMERICA PITTSBURGH
301 ALPHA DRIVE

PITTSBURGH, PA 152381330
UNITED STATES US

SHIP DATE: 08NOV21
ACTWGT: 12.00 LB MAN
CAD: 741733/CAFE3507

BILL SENDER

TO SHIPPING/RECEIVING
TESTAMERICA LABORATORIES, INC.
530 COMMUNITY DRIVE
SUITE 11
SOUTH BURLINGTON VT 05403
(802) 660-1990 REF: 8180-75772
PO: YES DEPT: SAMPLE RECEIVING

570C2/9A7E/6F4D

FedEx
Express
E

J211020121101uv

TRK# 0201 5173 0441 1104

TUE - 09 NOV 11:30A
PRIORITY OVERNIGHT

NL BTVA

05403
VT-US BTV

Eurofins TestAmerica, Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	Carrier Tracking No(s):	COC No: 180-448644.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Carrie.Gamber@Eurofinset.com	State of Origin: Maryland	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Louisiana		Job #: 180-129635-1
Address: 4101 Shuffel Street NW, ,	Due Date Requested: 12/12/2021			
City: North Canton	TAT Requested (days):			
State, Zip: OH, 44720				
Phone: 330-497-9396(Tel) 330-497-0772(Fax)	PO #:			
Email:	WO #:			
Project Name: Conowingo Pilot Study/Stockpile	Project #: 18023948			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	8015D_DRO/3546 TPH-DRO [C10-C28]	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
STOCKPILE QUADRANT 1 (180-129635-1)	11/3/21	08:48 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 2 (180-129635-2)	11/3/21	09:03 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 3 (180-129635-3)	11/3/21	09:14 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 4 (180-129635-4)	11/3/21	09:25 Eastern		Sediment			X	1	

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification *Unconfirmed*	*Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)* ☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ________ Months*
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements:

Empty Kit Relinquished by:		Date:	Time:	Method of Shipment:	
Relinquished by:	Date/Time: 11-8-21 1700	Company [illegible]	Received by: Mondoly Block	Date/Time: 11-9-21 10:00	Company ETA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks:		

Ver: 06/08/2021

13 12 11 10 9 8 7 6 5 4 3 2 1

Eurofins TestAmerica Canton Sample Receipt Form/Narrative **Login # :** ____________
Canton Facility

Client ETA Pittsburgh Site Name ____________

Cooler Received on 11-9-21 Opened on 11-9-21

Cooler unpacked by: Mandelyn Blee

FedEx: 1st Grd [✓ Exp] UPS FAS Clipper Client Drop Off TestAmerica Courier Other ____________

Receipt After-hours: Drop-off Date/Time ____________ Storage Location ____________

TestAmerica Cooler # TA Foam Box Client Cooler Box Other ____________

Packing material used: [✓ Bubble Wrap] Foam Plastic Bag None Other ____________

COOLANT: [✓ Wet Ice] Blue Ice Dry Ice Water None

1. Cooler temperature upon receipt ☐ See Multiple Cooler Form
   IR GUN# IR-14 (CF +0.1 °C) Observed Cooler Temp. 2.8 °C Corrected Cooler Temp. 2.9 °C
   IR GUN #IR-15 (CF +0.2°C) Observed Cooler Temp. ______ °C Corrected Cooler Temp. ______ °C
2. Were tamper/custody seals on the outside of the cooler(s)? If Yes Quantity ______ [✓ Yes] No
   -Were the seals on the outside of the cooler(s) signed & dated? [✓ Yes] No NA
   -Were tamper/custody seals on the bottle(s) or bottle kits (LLHg/MeHg)? Yes [✓ No]
   -Were tamper/custody seals intact and uncompromised? [✓ Yes] No NA
3. Shippers' packing slip attached to the cooler(s)? [✓ Yes] No
4. Did custody papers accompany the sample(s)? [✓ Yes] No
5. Were the custody papers relinquished & signed in the appropriate place? [✓ Yes] No
6. Was/were the person(s) who collected the samples clearly identified on the COC? Yes [✓ No]
7. Did all bottles arrive in good condition (Unbroken)? [✓ Yes] No
8. Could all bottle labels (ID/Date/Time) be reconciled with the COC? [✓ Yes] No
9. For each sample, does the COC specify preservatives (Y/[✓ N]), # of containers ([✓ Y]/N), and sample type of grab/comp(Y/[✓ N])?
10. Were correct bottle(s) used for the test(s) indicated? [✓ Yes] No
11. Sufficient quantity received to perform indicated analyses? [✓ Yes] No
12. Are these work share samples and all listed on the COC? [✓ Yes] No
    If yes, Questions 13-17 have been checked at the originating laboratory.
13. Were all preserved sample(s) at the correct pH upon receipt? Yes No NA pH Strip Lot# **HC157842**
14. Were VOAs on the COC? Yes No
15. Were air bubbles >6 mm in any VOA vials? ● ⬅ Larger than this. Yes No NA
16. Was a VOA trip blank present in the cooler(s)? Trip Blank Lot # ____________ Yes No
17. Was a LL Hg or Me Hg trip blank present? ____________ Yes No

Tests that are not checked for pH by Receiving:

VOAs
Oil and Grease
TOC

Contacted PM ____________ Date ____________ by ____________ via Verbal Voice Mail Other

Concerning ____________

18. CHAIN OF CUSTODY & SAMPLE DISCREPANCIES ☐ additional next page

Samples processed by:

19. SAMPLE CONDITION

Sample(s) ____________ were received after the recommended holding time had expired.
Sample(s) ____________ were received in a broken container.
Sample(s) ____________ were received with bubble >6 mm in diameter. (Notify PM)

20. SAMPLE PRESERVATION

Sample(s) ____________ were further preserved in the laboratory.
Time preserved: ____________ Preservative(s) added/Lot number(s): ____________

VOA Sample Preservation - Date/Time VOAs Frozen: ____________

Eurofins TestAmerica, Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	Carrier Tracking No(s):	COC No: 180-448634.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Carrie.Gamber@Eurofinset.com	State of Origin: Maryland	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Louisiana		Job #: 180-129635-1
Address: 777 New Durham Road, ,	**Due Date Requested:** 12/12/2021	**Analysis Requested**		**Preservation Codes:**
City: Edison	**TAT Requested (days):**			
State, Zip: NJ, 08817				
Phone: 732-549-3900(Tel) 732-549-3679(Fax)	PO #:			
Email:	WO #:			
Project Name: Conowingo Pilot Study/Stockpile	Project #: 18023948			
Site:	SSOW#:			Other:

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9016/9016_ExtPrep Cyanide, Free	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
STOCKPILE QUADRANT 1 (180-129635-1)	11/3/21	08:48 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 2 (180-129635-2)	11/3/21	09:03 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 3 (180-129635-3)	11/3/21	09:14 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 4 (180-129635-4)	11/3/21	09:25 Eastern		Sediment			X	1	

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said complicance to Eurofins TestAmerica.

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Primary Deliverable Rank: 2
Special Instructions/QC Requirements:

Empty Kit Relinquished by:
Date:
Time:
Method of Shipment:

Relinquished by: Mo	Date/Time: 11-8-21 1700	Company etaPitt	Received by: /Via FedEx	Date/Time: 11/09/21 10:45	Company ETA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: FD#9-0.7=0.2

Ver: 06/08/2021

Eurofins TestAmerica, Pittsburgh
301 Alpha Drive RIDC Park
Pittsburgh, PA 15238
Phone: 412-963-7058 Fax: 412-963-2468

Chain of Custody Record

eurofins | Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Gamber, Carrie L	Carrier Tracking No(s):	COC No: 180-448645.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Carrie.Gamber@Eurofinset.com	State of Origin: Maryland	Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.		Accreditations Required (See note): NELAP - Louisiana		Job #: 180-129635-1
Address: 10 Hazelwood Drive, ,	**Due Date Requested:** 12/12/2021	**Analysis Requested**		**Preservation Codes:**
City: Amherst	**TAT Requested (days):**			
State, Zip: NY, 14228-2298				
Phone: 716-691-2600(Tel) 716-691-7991(Fax)	PO #:			
Email:	WO #:			
Project Name: Conowingo Pilot Study/Stockpile	Project #: 18023948			
Site:	SSOW#:			

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - pH 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	351.2/351.2_Prep	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
STOCKPILE QUADRANT 1 (180-129635-1)	11/3/21	08:48 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 2 (180-129635-2)	11/3/21	09:03 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 3 (180-129635-3)	11/3/21	09:14 Eastern		Sediment			X	1	
STOCKPILE QUADRANT 4 (180-129635-4)	11/3/21	09:25 Eastern		Sediment			X	1	

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins TestAmerica.

Possible Hazard Identification
Unconfirmed

Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Special Instructions/QC Requirements:

Empty Kit Relinquished by:		Date:	Time:		Method of Shipment:
Relinquished by:	Date/Time: 11-8-21 1200	Company EaRTH	Received by:	Date/Time: 11/9/21 1000	Company TA
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:		Cooler Temperature(s) °C and Other Remarks: 1.7 #1 ICE		

Ver: 06/08/2021

Login Sample Receipt Checklist

Client: Northgate Environmental Management Inc.

Job Number: 180-129635-1

Login Number: 129635

List Number: 1

Creator: Watson, Debbie

List Source: Eurofins Pittsburgh

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Northgate Environmental Management Inc.

Job Number: 180-129635-1

Login Number: 129635
List Number: 6
Creator: Kolb, Chris M

List Source: Eurofins Buffalo
List Creation: 11/11/21 02:28 PM

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	True	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	1.7 IR GUN #1 ICE
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	True	

Login Sample Receipt Checklist

Client: Northgate Environmental Management Inc. Job Number: 180-129635-1

Login Number: 129635
List Number: 2
Creator: Beane, John P

List Source: Eurofins Burlington
List Creation: 11/09/21 11:56 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	Lab does not accept radioactive samples.
The cooler's custody seal, if present, is intact.	N/A	Not present
Sample custody seals, if present, are intact.	N/A	Not Present
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	1.4ºC
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Northgate Environmental Management Inc.

Job Number: 180-129635-1

Login Number: 129635
List Number: 5
Creator: Armbruster, Chris

List Source: Eurofins Edison
List Creation: 11/10/21 11:44 AM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	0.2°C IR9
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

APPENDIX F

HOLCIM CONCRETE/ASPHALT BENCH SCALE TESTING RESULTS

Alternative Raw Material Program
Holcim

Evaluation of Dredge Material from Conowingo Reservoir for Concrete and Asphalt Sand

Introduction

Northgate Environmental provided a sample of the Conowingo sediment to Holcim in order to evaluate the material's suitability as a raw material in the concrete and asphalt manufacturing process. Holcim is the new corporate name for all of the family of companies that include LafargeHolcim, Aggregate Industries, Lafarge, and others.

Aggregate testing

Concrete

The samples received were washed and sieved in order to determine the gradations. These results were then compared to the requirements from ASTM C33 "Standard Specifications for Concrete Aggregates".

The sieves used in the analysis are defined here in Table 1 from ACI Education Bulletin E1-07, printed in 2007 by the American Concrete Institute.

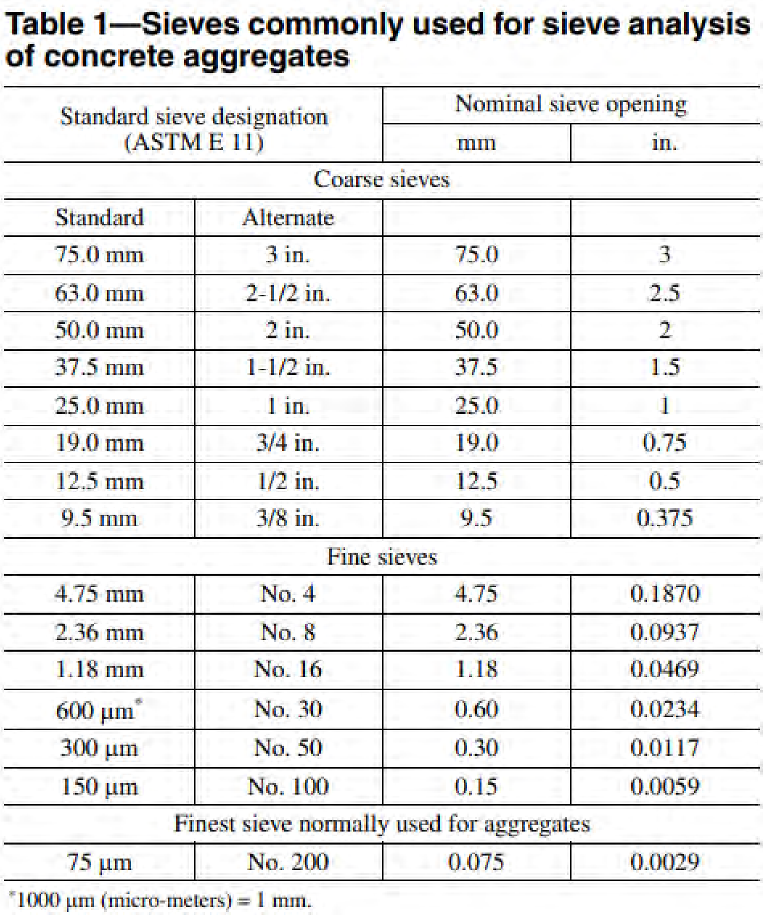
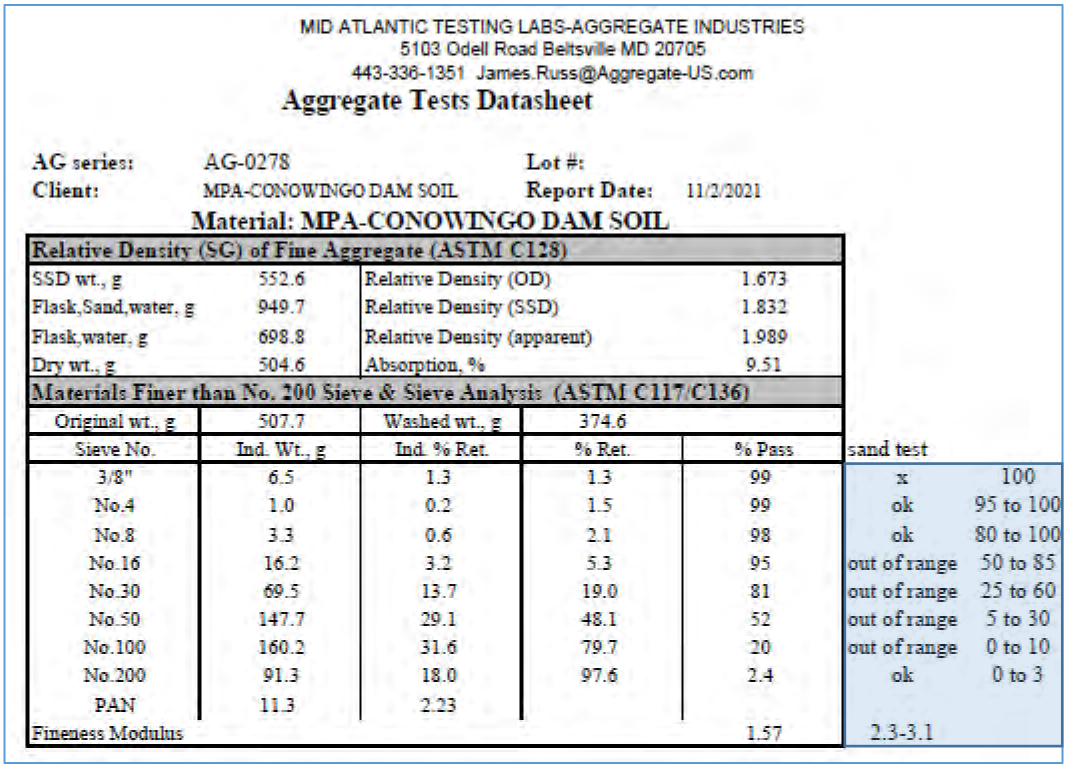


Table 1—Sieves commonly used for sieve analysis of concrete aggregates

Standard sieve designation (ASTM E 11)		Nominal sieve opening	
		mm	in.
Coarse sieves			
Standard	Alternate		
75.0 mm	3 in.	75.0	3
63.0 mm	2-1/2 in.	63.0	2.5
50.0 mm	2 in.	50.0	2
37.5 mm	1-1/2 in.	37.5	1.5
25.0 mm	1 in.	25.0	1
19.0 mm	3/4 in.	19.0	0.75
12.5 mm	1/2 in.	12.5	0.5
9.5 mm	3/8 in.	9.5	0.375
Fine sieves			
4.75 mm	No. 4	4.75	0.1870
2.36 mm	No. 8	2.36	0.0937
1.18 mm	No. 16	1.18	0.0469
600 µm*	No. 30	0.60	0.0234
300 µm	No. 50	0.30	0.0117
150 µm	No. 100	0.15	0.0059
Finest sieve normally used for aggregates			
75 µm	No. 200	0.075	0.0029

*1000 µm (micro-meters) = 1 mm.



MID ATLANTIC TESTING LABS-AGGREGATE INDUSTRIES
5103 Odell Road Beltsville MD 20705
443-336-1351 James.Russ@Aggregate-US.com

Aggregate Tests Datasheet

AG series: AG-0278 **Lot #:**
Client: MPA-CONOWINGO DAM SOIL **Report Date:** 11/2/2021

Material: MPA-CONOWINGO DAM SOIL

Relative Density (SG) of Fine Aggregate (ASTM C128)			
SSD wt., g	552.6	Relative Density (OD)	1.673
Flask,Sand,water, g	949.7	Relative Density (SSD)	1.832
Flask,water, g	698.8	Relative Density (apparent)	1.989
Dry wt., g	504.6	Absorption, %	9.51

Materials Finer than No. 200 Sieve & Sieve Analysis (ASTM C117/C136)						
Original wt., g	507.7	Washed wt., g	374.6			
Sieve No.	Ind. Wt., g	Ind. % Ret.	% Ret.	% Pass	sand test	
3/8"	6.5	1.3	1.3	99	x	100
No.4	1.0	0.2	1.5	99	ok	95 to 100
No.8	3.3	0.6	2.1	98	ok	80 to 100
No.16	16.2	3.2	5.3	95	out of range	50 to 85
No.30	69.5	13.7	19.0	81	out of range	25 to 60
No.50	147.7	29.1	48.1	52	out of range	5 to 30
No.100	160.2	31.6	79.7	20	out of range	0 to 10
No.200	91.3	18.0	97.6	2.4	ok	0 to 3
PAN	11.3	2.23				
Fineness Modulus				1.57	2.3-3.1	

Figure 1 AGGREGATE TESTS DATASHEET (PHYSICAL) FOR CONCRETE EVALUATION WITH ASTM C33 LIMITS IN BLUE

The results of the sieve analysis in Figure 1 show that the amount of material retained on the No. 16, No. 30, No. 50, and No. 100 was below threshold, meaning that the material did not have enough larger material in the required proportions. This was more apparent in the No. 30 and No. 50 screen size (conservative differences of over 20%).

Figure 2 Sieved materials in the Aggregate Industries Beltsville MD lab

Table 2 from the ACI Education Bulletin depicts the typical ranges for other physical properties in concrete sand. The Fineness Modulus (FM) range is 2.0 – 3.3, whereas the Conowingo sediment has a FM of 1.57 (Figure 1). The absorption value as tested is 9.51% (Figure 3), whereas the typical range is 0.5% - 4.0% per ASTM C33.

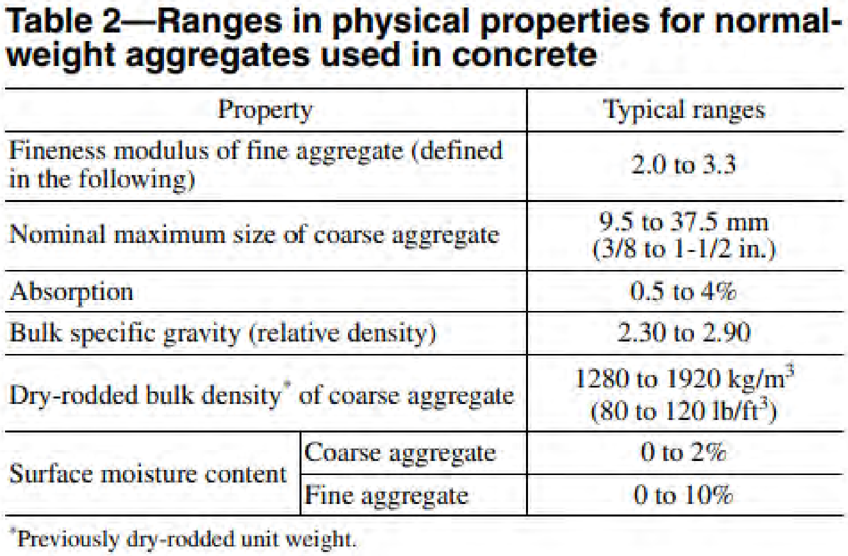
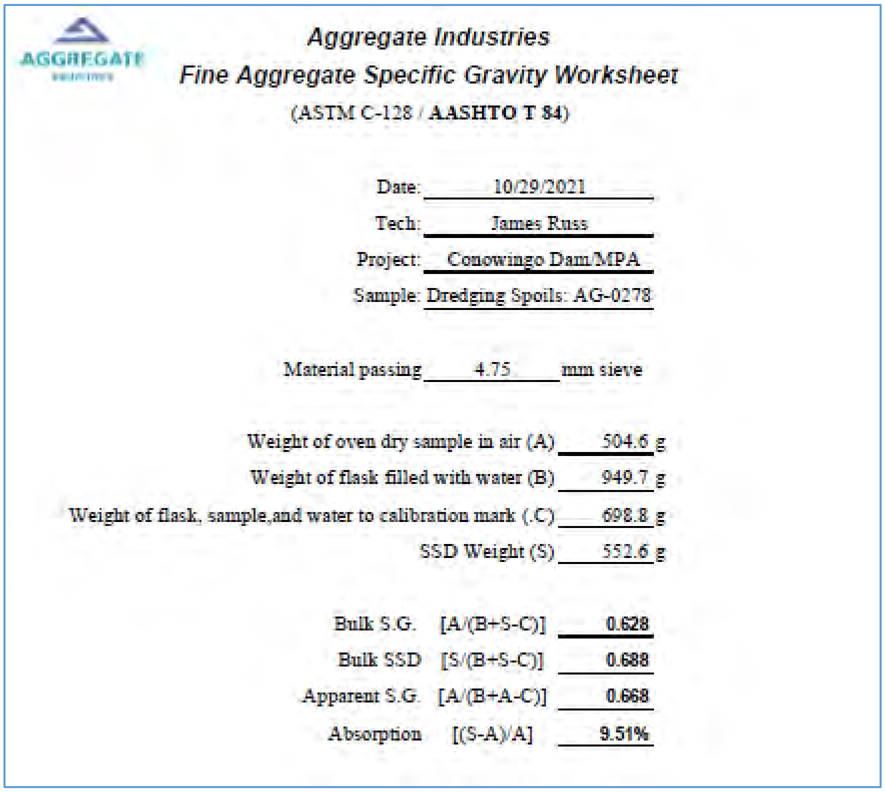


Table 2—Ranges in physical properties for normal-weight aggregates used in concrete

Property		Typical ranges
Fineness modulus of fine aggregate (defined in the following)		2.0 to 3.3
Nominal maximum size of coarse aggregate		9.5 to 37.5 mm (3/8 to 1-1/2 in.)
Absorption		0.5 to 4%
Bulk specific gravity (relative density)		2.30 to 2.90
Dry-rodded bulk density* of coarse aggregate		1280 to 1920 kg/m^3 (80 to 120 lb/ft^3)
Surface moisture content	Coarse aggregate	0 to 2%
	Fine aggregate	0 to 10%

*Previously dry-rodded unit weight.



Aggregate Industries

Fine Aggregate Specific Gravity Worksheet

(ASTM C-128 / **AASHTO T 84**)

Date: 10/29/2021

Tech: James Russ

Project: Conowingo Dam/MPA

Sample: Dredging Spoils: AG-0278

Material passing 4.75 mm sieve

Weight of oven dry sample in air (A) 504.6 g

Weight of flask filled with water (B) 949.7 g

Weight of flask, sample,and water to calibration mark (.C) 698.8 g

SSD Weight (S) 552.6 g

Bulk S.G. [A/(B+S-C)] **0.628**

Bulk SSD [S/(B+S-C)] **0.688**

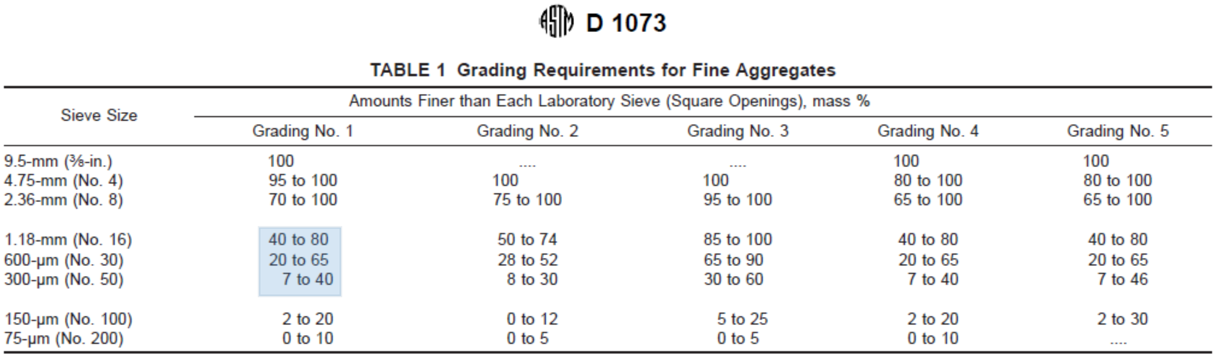
Apparent S.G. [A/(B+A-C)] **0.668**

Absorption [(S-A)/A] **9.51%**

Figure 3 SPECIFIC GRAVITY WORKSHEET

Asphalt

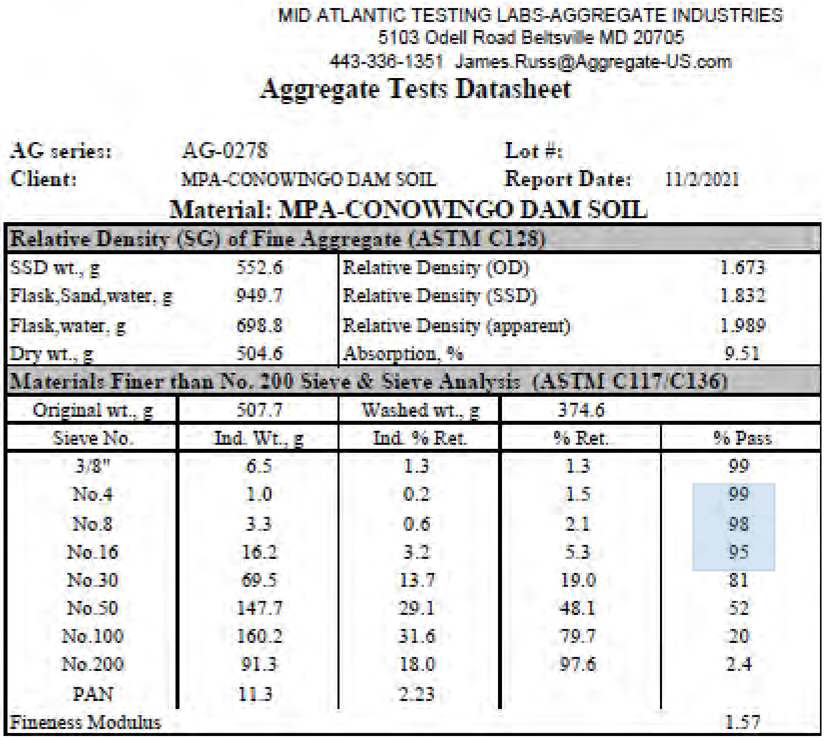
The sand was also considered for asphalt production. The sand does not meet the ASTM D 1073 'Standard Specification for Fine Aggregate for Bituminous Paving Mixtures". The grain size distribution is out of tolerance on the No. 16, No. 30 and No. 50 sieves. In all cases, the % passing exceeds the limit outlined in the specification.



D 1073

TABLE 1 Grading Requirements for Fine Aggregates

Sieve Size	Amounts Finer than Each Laboratory Sieve (Square Openings), mass %				
	Grading No. 1	Grading No. 2	Grading No. 3	Grading No. 4	Grading No. 5
9.5-mm (⅜-in.)	100	....	....	100	100
4.75-mm (No. 4)	95 to 100	100	100	80 to 100	80 to 100
2.36-mm (No. 8)	70 to 100	75 to 100	95 to 100	65 to 100	65 to 100
1.18-mm (No. 16)	40 to 80	50 to 74	85 to 100	40 to 80	40 to 80
600-μm (No. 30)	20 to 65	28 to 52	65 to 90	20 to 65	20 to 65
300-μm (No. 50)	7 to 40	8 to 30	30 to 60	7 to 40	7 to 46
150-μm (No. 100)	2 to 20	0 to 12	5 to 25	2 to 20	2 to 30
75-μm (No. 200)	0 to 10	0 to 5	0 to 5	0 to 10	....



MID ATLANTIC TESTING LABS-AGGREGATE INDUSTRIES
5103 Odell Road Beltsville MD 20705
443-336-1351 James.Russ@Aggregate-US.com

Aggregate Tests Datasheet

AG series:	AG-0278	**Lot #:**	
Client:	MPA-CONOWINGO DAM SOIL	**Report Date:**	11/2/2021

Material: MPA-CONOWINGO DAM SOIL

Relative Density (SG) of Fine Aggregate (ASTM C128)

SSD wt., g	552.6	Relative Density (OD)	1.673
Flask,Sand,water, g	949.7	Relative Density (SSD)	1.832
Flask,water, g	698.8	Relative Density (apparent)	1.989
Dry wt., g	504.6	Absorption, %	9.51

Materials Finer than No. 200 Sieve & Sieve Analysis (ASTM C117/C136)

Original wt., g	507.7	Washed wt., g	374.6	
Sieve No.	Ind. Wt., g	Ind. % Ret.	% Ret.	% Pass
3/8"	6.5	1.3	1.3	99
No.4	1.0	0.2	1.5	99
No.8	3.3	0.6	2.1	98
No.16	16.2	3.2	5.3	95
No.30	69.5	13.7	19.0	81
No.50	147.7	29.1	48.1	52
No.100	160.2	31.6	79.7	20
No.200	91.3	18.0	97.6	2.4
PAN	11.3	2.23		
Fineness Modulus				1.57

Conclusion

Ultimately, the Conowingo sediment cannot be used successfully as an alternative raw material in concrete or asphalt manufacturing in its current form. The material does not meet the ASTM C33 (concrete), specifications for size distribution, absorption and fineness modulus. The material also does not meet ASTM D1073 for asphalt. The material would need to be sieved in order to derive the sand fractions, and then possibly blended with other materials to meet the specification. In our opinion, all of this additional work to derive usable sand is not economically feasible.

APPENDIX G

HOLCIM CEMENT CLINKER BENCH SCALE TESTING RESULTS

Alternative Raw Material Program
Geocycle & LafargeHolcim

Evaluation of Dredge Soils from Conowingo Reservoir

Northgate Environmental provided a sample of the Conowingo sediment to Geocycle in order to evaluate the material's suitability as a raw material in the cement manufacturing process. Geocycle is a subsidiary of LafargeHolcim, which operates a manufacturing facility in Hagerstown, Maryland.

The chemical analysis of the Conowingo Reservoir sediment is shown in Table 1. For comparative purposes, the analytical data for shale and coal ash are also shown in the table. Shale and coal ash are both commonly used in the cement manufacturing process.

Material	**Conowingo Sediment**	Hagerstown Shale	Coal Ash
% Moisture	**46.14**	9.0	27.0
LOI, %	**17.06**	8.5	7.34
SiO2, %	**59.14**	60.23	47.81
Al2O3, %	**14.79**	15.6	26.03
Fe2O3, %	**7.53**	8.67	11.54
CaO, %	**0.59**	1.29	1.14
MgO, %	**1.04**	1.21	0.76
Na2O, %	**0.17**	0.11	0.26
K2O, %	**2.79**	3.34	2.18
SO3, %	**0.77**	0.07	0.1
TiO2, %	**0.91**	0.87	1.26
P2O5, %	**0.3**	0.18	0.35
Mn2O3, %	**0.38**	0.07	0.04

Table 1. Chemical analysis of Conowingo Sediment, Shale, and Coal Ash

The Hagerstown manufacturing facility is currently using shale as a source of SiO2 and Al2O3, and Conowingo sediment is nearly identical to shale in these compounds. Further, the deleterious alkali compounds, Na2O and K2O are lower in the sediment in comparison to the shale. The primary drawback to the Conowingo sediment is the elevated moisture in the product. This can be managed by commercially available drying equipment or equipment designed to handle and convey high moisture material.

Ultimately, the Conowingo Sediment can be used successfully as an alternative raw material in cement manufacturing through proper preprocessing and/or co-processing.

APPENDIX H

STANCILLS INC. BENCH SCALE TESTING RESULTS

Stancills

499 Mountain Hill Road
Perryville, MD 21903

Ph. (410) 939-2224
Fax (410) 939-2110
www.stancills.com

Bench Scale Testing of Conowingo Reservoir Sediment

In October 2021, approximately 1,000 cubic yards of sediment dredged from the Conowingo Reservoir were delivered to Stancills soil blending facility in Perryville, MD. The sediment was placed in a secure location on the Stancills property and maintained separately from other deliveries of source ingredients. On November 3, 2021, the sediment was sampled by Northgate Environmental Management (Northgate) and analyzed at an independent laboratory for a broad range of physical and chemical parameters. The laboratory analytical results were provided to Stancills. Atterberg limits, grain size analysis, organic matter testing was then performed by Stancills to better determine what soil mixes the material could be used in.

Based on the testing completed for Northgate and by Stancills, a series of soil blends were developed to determine if they could meet specification for the following types of material:

- Maryland State Highway Administration (SHA) Bioretention Soil – This material is typically used in interstate highway medians. It is used as a soil top layer applied over gravel layers laced with drainage piping. The blend is specifically developed to promote filtration along with sufficient permeability to avoid ponding of stormwater in grassy highway medians.
- SHA Topsoil – This material is used as a topsoil in roadway construction. As with bioretention soil, desired characteristics include, permeability to promote drainage, sufficient grain size gradation to help prevent erosion, and sufficient organic matter content to support plant growth (typically grass).
- Maryland Department of Environment (MDE) Bioretention Soil – This material is typically used on commercial and residential sites for bioretention ponds, swales and rain gardens. It is intended to provide water quality management by filtering storm water runoff. The material has a lower permeability rate and higher organic percentage compared to SHA bioretention soil.
- Topsoil – This material is for general use on commercial and residential sites for vegetative growth. Material is often custom blended to meet specifications and requirements of the customer.

The soil blends were prepared using varying amounts of dredged material, concrete sand, hardwood mulch, and proprietary amendments. Table 1 presents the ratios of each ingredient added to the various blends. Samples from each blend were sent to Geo-Technology Associates, Inc. geotechnical laboratory in Abingdon, MD. The samples were prepared according to ASTM D421 and analyzed for particle size (ASTM D422), moisture content (ASTM D2216), Atterberg

Limits (ASTM D4318), percent organic matter by loss on ignition (ASTM D2974), and soluble salt content (lab SOP).

The results of the laboratory analysis are summarized in Table 1. Complete laboratory reports are included in Attachment 1. The results indicate the following:

SHA Bioretention Soil

Sample SHA-BSM #1 was within specification for all parameters. A sample of this material was sent to the State Highway Administration project coordinator (Darren Swift) for confirmation and approval for use in a project that requires SHA bioretention soil. The SHA Office of Materials Technology analyzed the sample on June 24, 2022 and determined it met the SHA specification (Attachment 2). Sample SHA- BSM #2 exceeded the limit for clay content. Given that SHA-BSM-1 contained higher amount of dredged material, there is no need to modify the mix ratios to try to get SHA-BSM #2 within specifications.

SHA Topsoil

Sample SHA Topsoil #1 was a standard Stancills blend that did not contain dredge material. This sample was added for comparison purposes. Sample SHA Topsoil #2 containing 15% dredge material was within specification for all parameters. A sample of this material was sent to the State Highway Administration project coordinator (Darren Swift) for confirmation and approval for use in a project that requires SHA topsoil. The SHA Office of Materials Technology analyzed the sample on June 13, 2022 and determined it did not meet the SHA specification (Attachment 3) due to high organic matter content and soluble salts. Sample SHA Topsoil #3 exceeded the limit for sand content, below the limit for pH, and exceeded the limit for organic matter content.

MDE Bioretention Soil

Both samples MDE B.4.1 #1 and #2 were slightly outside of the limits. It is likely that slight modifications to the mix ratios could achieve a mix that was inside the limits. Further development will be considered if a project need develops that would consume a significant amount of the dredge material.

Topsoil (Non-SHA Specification)

Five of the blends were within the limits for producing a commercially acceptable topsoil for use at commercial developments or constructions sites. Version 6 slightly exceeded the 70% threshold for sand content. These results are promising for developing blends containing higher sediment content. Further development will be considered if a project need develops that would consume a significant amount of the dredge material.

In summary, a blend of the SHA bioretention soil (SHA-BSM #1) were analyzed by the Maryland State Highway Administration Office of Materials Technology and approved for use on upcoming projects. This is the most likely scenario for using Conowingo sediment in a real-world application. In addition, if a project opportunity arises for Stancills that would require MDE bioretention soil or non-SHA specification topsoil, Stancills can adjust blend ratios to meet the project requirements.

References

ASTM D421 - Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

ASTM D422 – Standard Test Methods for Particle-Size Analysis of Soils

ASTM D2216 – Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity of Soils.

ASTM D2974- Standard Test Method for Determining the Water (Moisture) Content, Ash Content, And Organic Material of Peat and Other Organic Soils.

Table 1

CONOWINGO MIXES

			Sand	Silt	Clay	pH		OM (LOI)	Salts
SHA Bio		**LIMITS**	79-94	4. - 20	1.0 - 10	5.7-7.4		MIN 1.5%	<500ppm
	Version 1	DREDGE AT 35%, SAND AT 35%, MULCH AT 30%							
	Sample ID	SHA-BSM #1	86	8	6	6.1		2.3	145
	Version 2	DREDGE AT 15%, SAND AT 55%, MULCH AT 20%, AMENDMENT AT 10%							
	Sample ID	SHA-BSM #2	81	7	12	6.2		2.1	73
			Sand	Silt	Clay	Silt & Clay	pH	OM (LOI)	Salts
SHA TOPSOIL		**LIMITS**	20-75	max 75	max 30	>25%	6.1 - 7.2	4.0 - 8.0	500PPM
	Version 1	DREDGE AT 0% (Stancills standard SHA topsoil for comparison)							
	Sample ID	SHA Topsoil #1	65.1	22.1	12.9	35	6.4	3.3	413
	Version 2	DREDGE AT 15%, SAND AT 15%, TOPSOIL AT 30%, AMENDMENT AT 40%							
	Sample ID	SHA Topsoil #2	67.5	17.2	15.3	32.5	6.1	6.9	473
	Version 3	DREDGE AT 30%, SAND AT 30%, AMENDMENT AT 40%							
	Sample ID	SHA Topsoil #3	76.6	9.9	13.4	23.3	6	8.2	450
			Classification		Clay	pH	OM		
MDE Bio		**LIMITS**	Loamy Sand or Sandy Loam		< 5%	5.5 - 7.0	>10%		
	Version 1 –	DREDGE AT 20%, SAND AT 20%, MULCH AT 10%, AMENDMENT AT 50%							
	Sampe ID	MDE B.4.1 #1	SAND		2	6.5	11.3		
	Version 2	DREDGE AT 30%, SAND AT 30%, AMENDMENT AT 40%							
		MDE B.4.1 #2	Loamy SAND		5.3	7.1	6.5		
			Sand	Silt	Clay	Silt & Clay	pH	OM (LOI)	Salts
TOPSOIL – no spec		**LIMITS**	20-70	max 75	max 30	>25%	6.1 - 7.2	3.0 - 8.0	500PPM
	Version 1	DREDGE AT 20%, TOPSOIL AT 60%, AMENDMENT AT 20%							
		Topsoil #1	55.3	36.4	8.3	44.7	6.1	6.9	420
	Version 2	DREDGE AT 40%, Topsoil AT 40%, AMENDMENT AT 20%							
		Topsoil #2	63.3	28.9	7.8	36.7	6.6	3.5	217
	Version 3	DREDGE AT 60%, TOPSOIL AT 20%, AMENDMENT AT 20%							
		Topsoil #3	70.6	24.9	4.6	29.5	6.7	3.4	490
	Version 4	DREDGE AT 20%, OVERBURDEN AT 60%, AMENDMENT AT 20%							
		Topsoil #4	58.7	37.3	4	41.3	6.5	3.9	413
	Version 5	DREDGE AT 40%, OVERBURDEN AT 40%, AMENDMENT AT 20%							
		Topsoil #5	63.7	33.5	2.8	36.3	6.4	3.5	370
	Version 6	DREDGE AT 60%, OVERBURDEN AT 20%, AMENDMENT AT 20%							
		Topsoil #6	72.1	24.2	3.7	27.9	6.6	3.4	470

Notes:

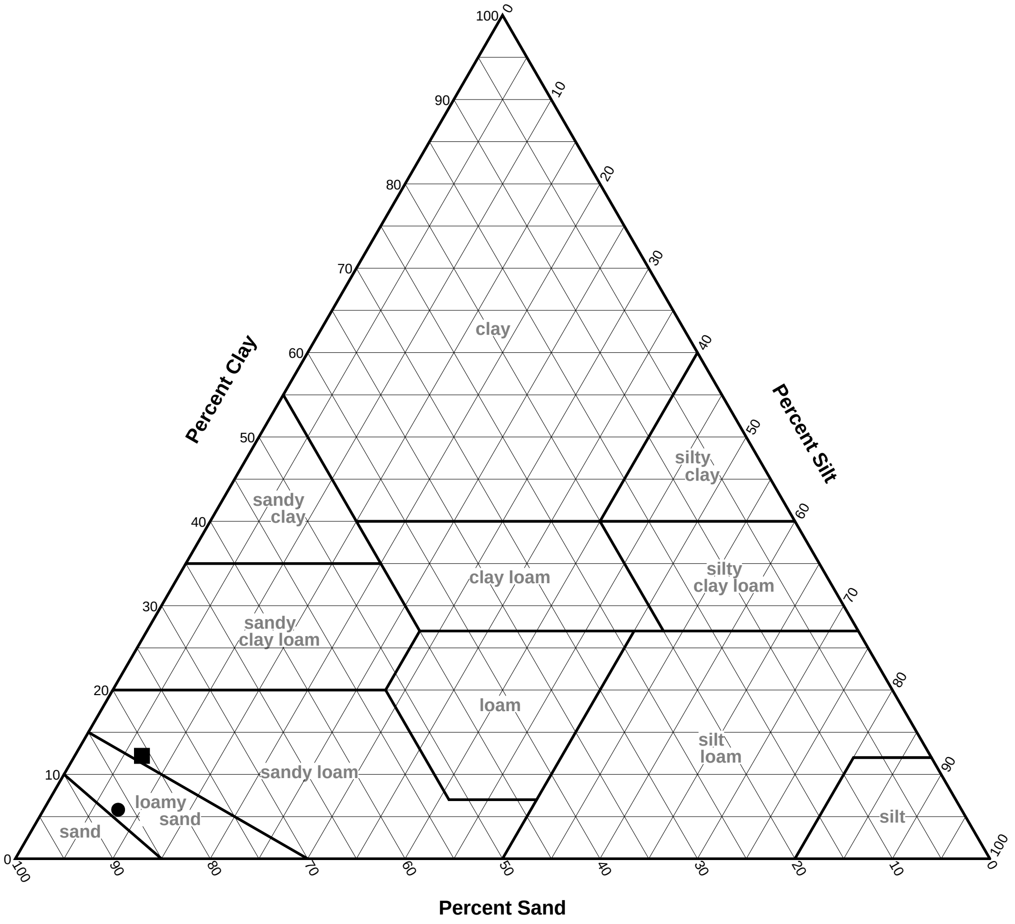
Samples analyzed at Geo-Technology Laboratories in Abingdon, MD on 4/20/2022.

🟩	Within limits
🟧	Outside limits

ATTACHMENT 1

GEO-TECHNOLOGY ASSOCIATES, INC.
LABORATORY REPORT

USDA Soil Classification



SOIL DATA

	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●	SHA BSM	#1		86.5	7.8	5.7	Loamy sand
■	SHA BSM	#2		80.9	7.0	12.2	Sandy loam

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

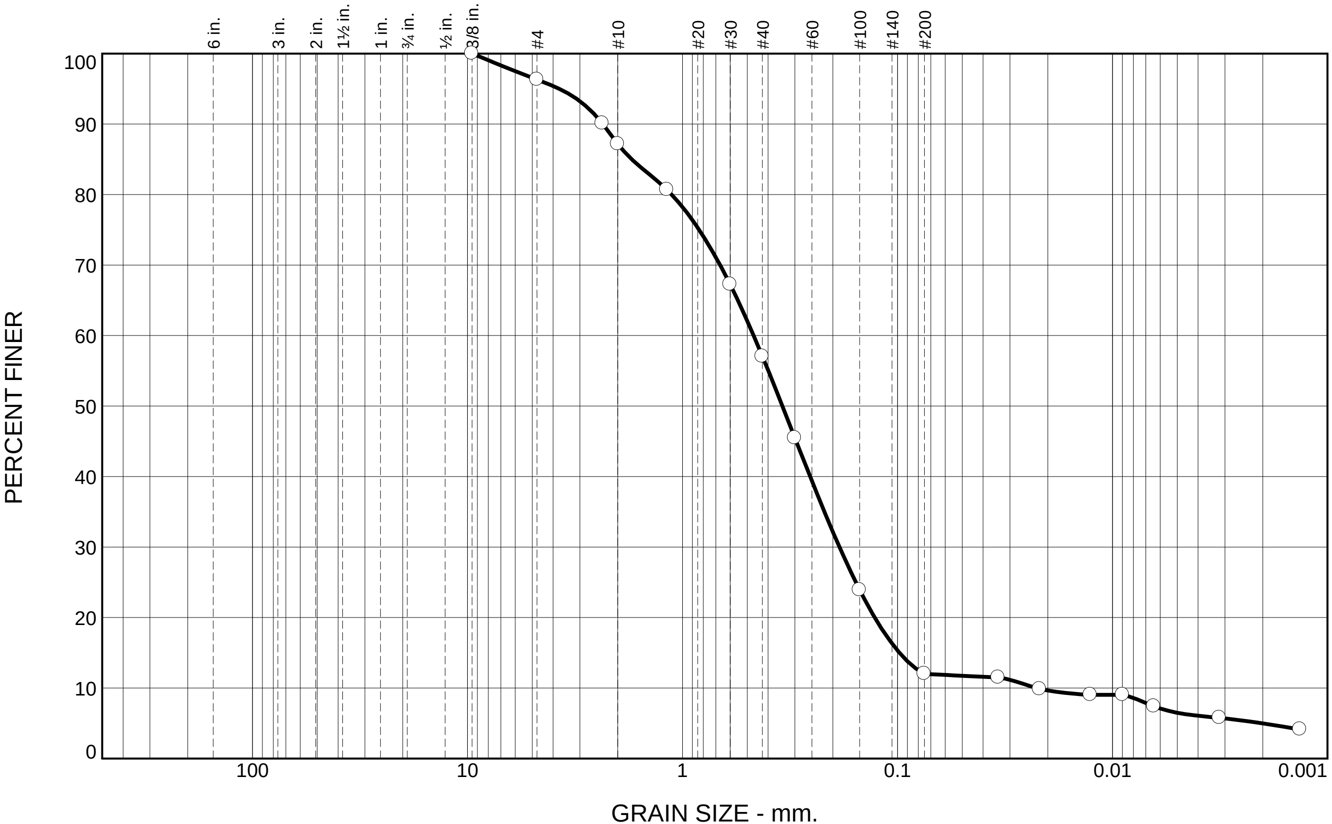
GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc

Project: Stancill's Laboratory Testing

Project No.: 120001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.7	9.1	30.1	45.1	5.5	6.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	96.3		
#8	90.1		
#10	87.2		
#16	80.7		
#30	67.2		
#40	57.1		
#50	45.5		
#100	23.9		
#200	12.0		
0.0340 mm.	11.5		
0.0218 mm.	9.8		
0.0127 mm.	9.0		
0.0090 mm.	9.0		
0.0064 mm.	7.4		
0.0032 mm.	5.8		
0.0013 mm.	4.1		

* (no specification provided)

Soil Description

USDA Classification - Loamy SAND
T88 Textural Analysis -
% Sand: 86.5 % Silt: 7.8 % Clay: 5.7

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 2.3466 D_{85}= 1.7209 D_{60}= 0.4668
D_{50}= 0.3430 D_{30}= 0.1862 D_{15}= 0.0980
D_{10}= 0.0227 C_u= 20.59 C_c= 3.28

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 2.3
pH: 6.1
Soluble Salts: 145 ppm

Source of Sample: SHA BSM
Sample Number: #1

Date: 4/20/2022

GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

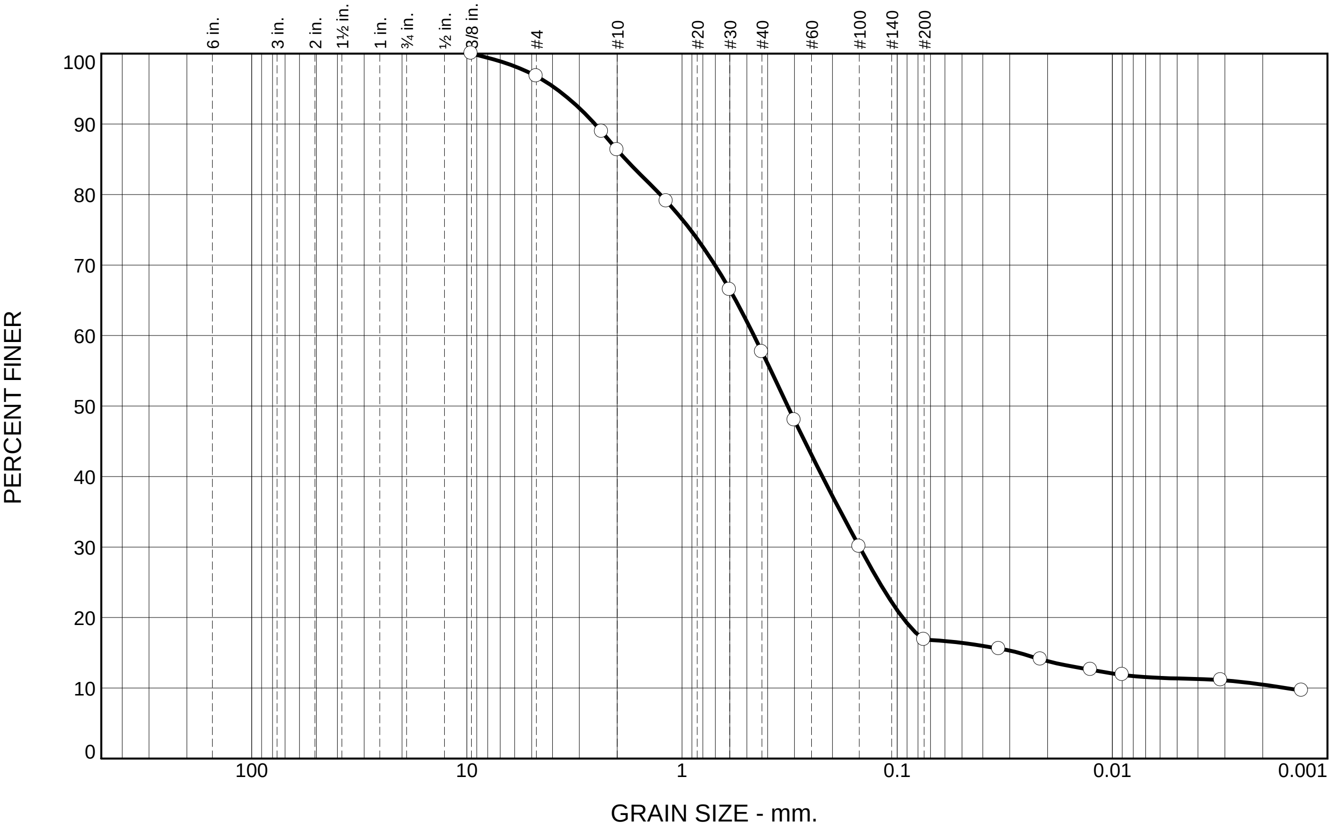
Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.2	10.5	28.6	40.9	5.4	11.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	96.8		
#8	88.9		
#10	86.3		
#16	79.1		
#30	66.5		
#40	57.7		
#50	48.0		
#100	30.1		
#200	16.8		
0.0336 mm.	15.5		
0.0215 mm.	14.1		
0.0126 mm.	12.6		
0.0090 mm.	11.9		
0.0031 mm.	11.1		
0.0013 mm.	9.6		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 80.9 % Silt: 7.0 % Clay: 12.1

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 2.5384 D_{85}= 1.8279 D_{60}= 0.4631
D_{50}= 0.3226 D_{30}= 0.1496 D_{15}= 0.0273
D_{10}= 0.0016 C_u= 295.93 C_c= 30.87

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 2.1
pH: 6.2
Soluble Salts: 73 ppm

Source of Sample: SHA BSM
Sample Number: #2

Date: 4/20/2022

GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001

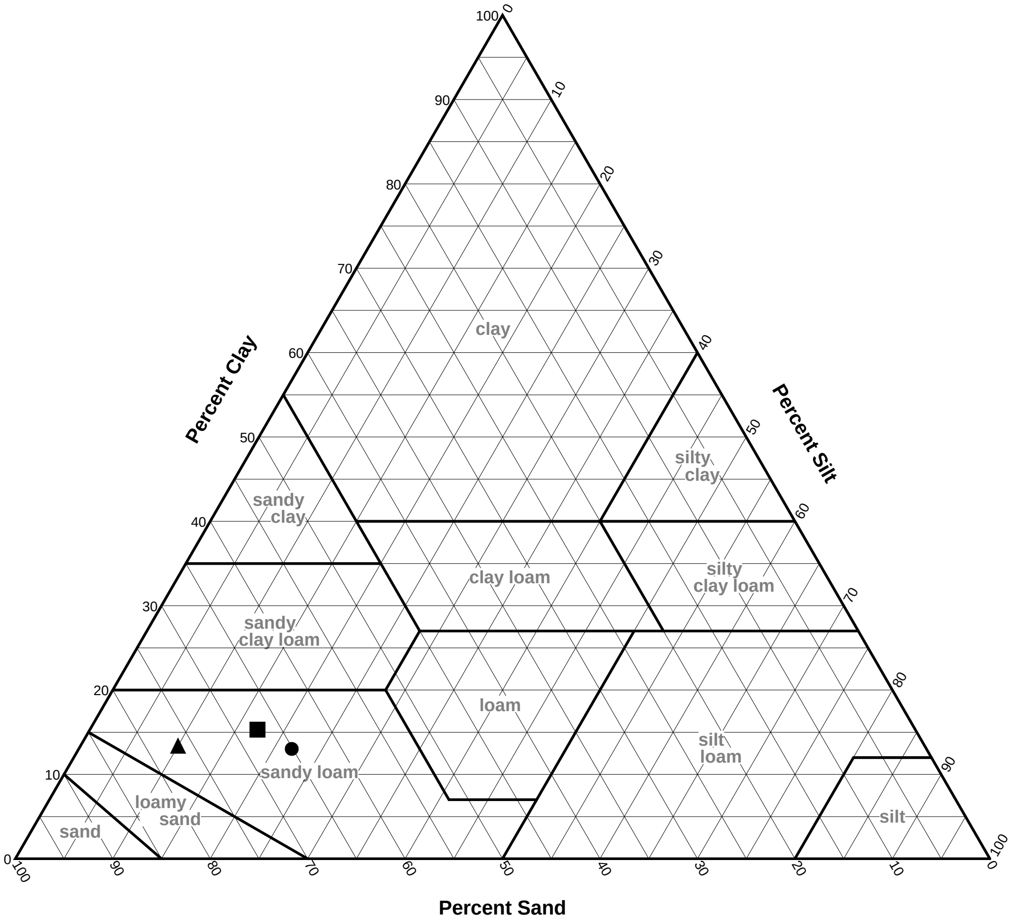
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland

Checked By: E. Church

USDA Soil Classification



SOIL DATA

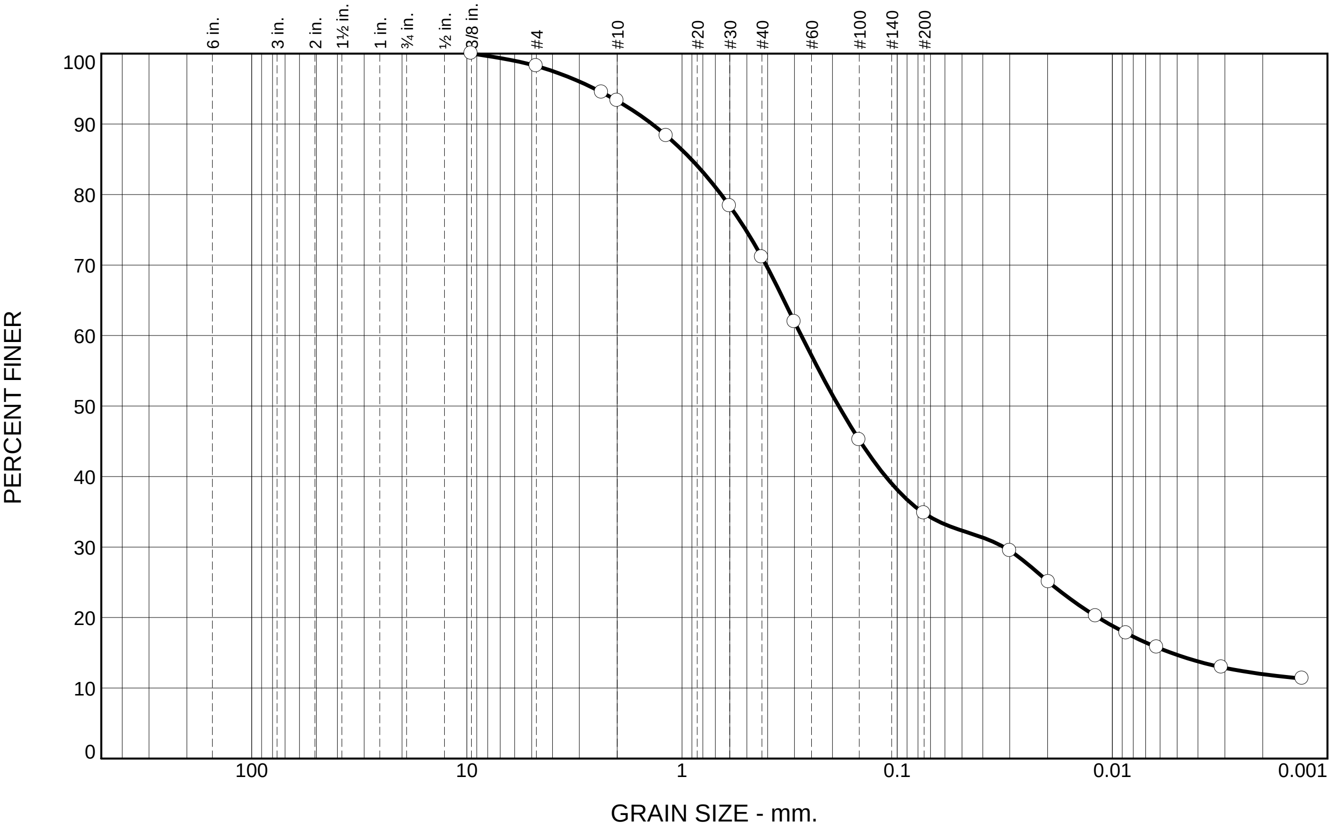
	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●	SHA Topsoil	#1		65.1	22.1	12.9	Sandy loam
■	SHA Topsoil	#2		67.5	17.2	15.3	Sandy loam
▲	SHA Topsoil	#3		76.6	9.9	13.4	Sandy loam

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No.: 120001
Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	4.9	22.2	36.3	20.1	14.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.2		
#8	94.5		
#10	93.3		
#16	88.3		
#30	78.4		
#40	71.1		
#50	61.9		
#100	45.2		
#200	34.8		
0.0299 mm.	29.5		
0.0198 mm.	25.0		
0.0119 mm.	20.2		
0.0086 mm.	17.8		
0.0062 mm.	15.8		
0.0031 mm.	12.9		
0.0013 mm.	11.3		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 65.0 % Silt: 22.1 % Clay: 12.9

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 1.3769 D_{85}= 0.9059 D_{60}= 0.2790
D_{50}= 0.1871 D_{30}= 0.0320 D_{15}= 0.0053
D_{10}= C_u= C_c=

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.3
pH: 6.4
Soluble Salts: 413 ppm

Source of Sample: SHA Topsoil
Sample Number: #1

Date: 4/20/2022

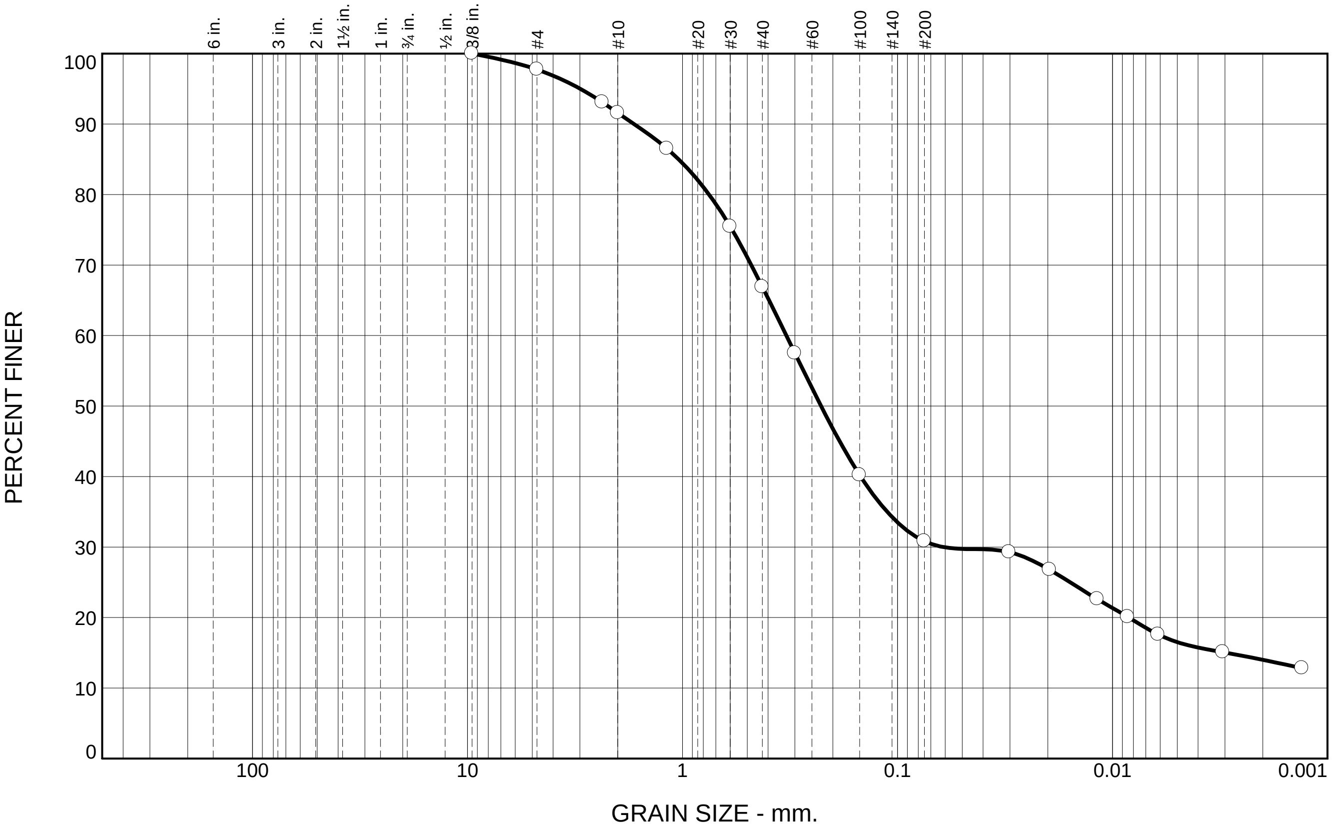
GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	6.1	24.7	36.1	14.3	16.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	97.7		
#8	93.1		
#10	91.6		
#16	86.5		
#30	75.5		
#40	66.9		
#50	57.5		
#100	40.2		
#200	30.8		
0.0303 mm.	29.3		
0.0196 mm.	26.8		
0.0118 mm.	22.6		
0.0085 mm.	20.1		
0.0061 mm.	17.6		
0.0031 mm.	15.1		
0.0013 mm.	12.8		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 67.5 % Silt: 17.2 % Clay: 15.3

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 1.6797	D_{85}= 1.0424	D_{60}= 0.3288
D_{50}= 0.2268	D_{30}= 0.0614	D_{15}= 0.0030
D_{10}=	C_u=	C_c=

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 6.9
pH: 6.1
Soluble Salts: 473 ppm

Source of Sample: SHA Topsoil
Sample Number: #2

Date: 4/20/2022

GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

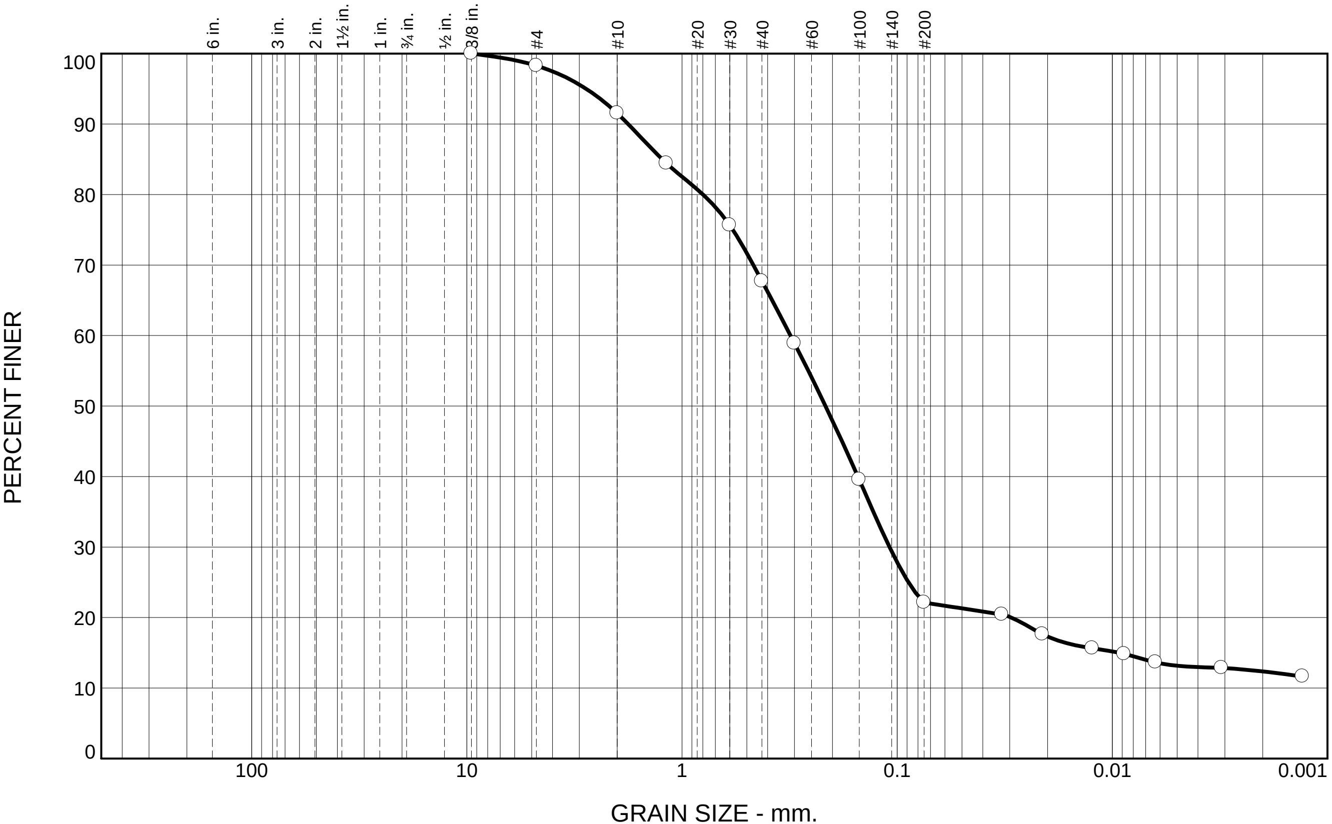
Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.7	6.8	23.8	45.6	8.9	13.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.3		
#10	91.5		
#16	84.4		
#30	75.6		
#40	67.7		
#50	58.9		
#100	39.5		
#200	22.1		
0.0326 mm.	20.4		
0.0211 mm.	17.6		
0.0124 mm.	15.6		
0.0088 mm.	14.8		
0.0063 mm.	13.6		
0.0031 mm.	12.8		
0.0013 mm.	11.6		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 76.6 % Silt: 10.0 % Clay: 13.4

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 1.7794 D_{85}= 1.2351 D_{60}= 0.3132
D_{50}= 0.2155 D_{30}= 0.1086 D_{15}= 0.0093
D_{10}= C_u= C_c=

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 8.2
pH: 6.0
Soluble Salts: 450 ppm

Source of Sample: SHA Topsoil
Sample Number: #3

Date: 4/20/2022

GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

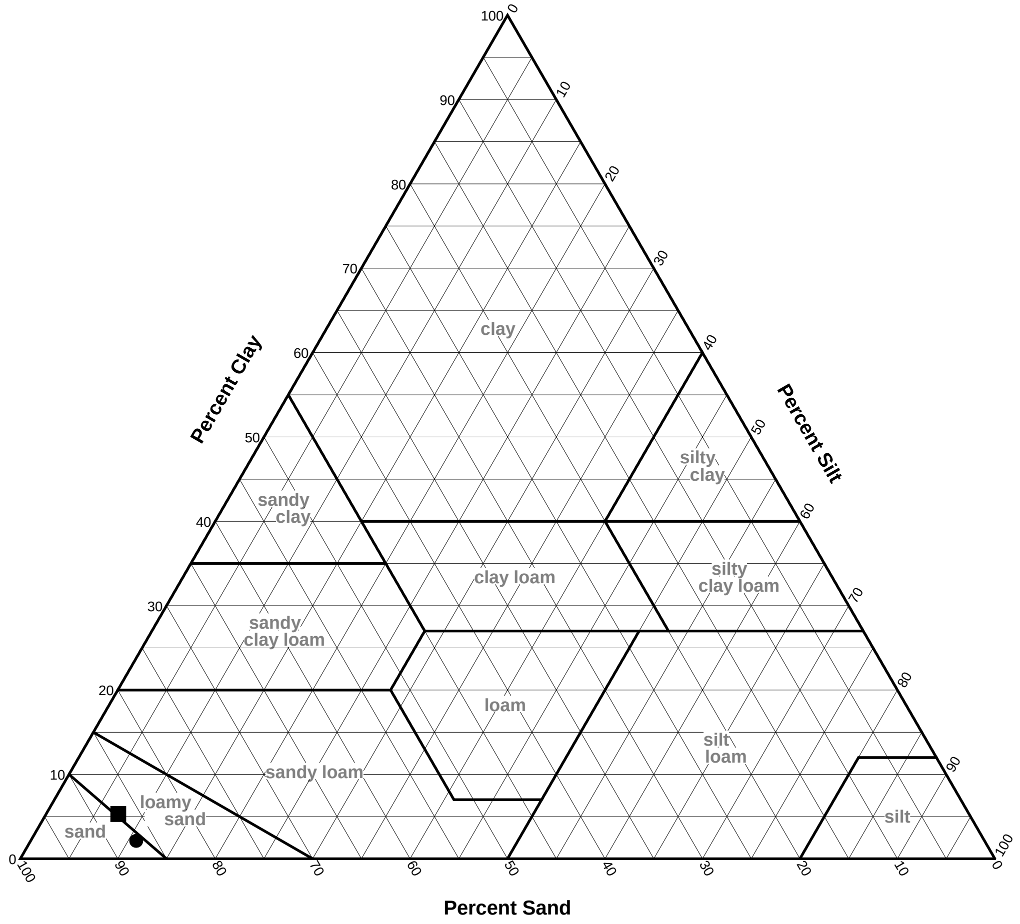
Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

USDA Soil Classification



SOIL DATA

	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●	MDE B.4.1	#1		87.0	11.1	2.0	Sand
■	MDE B.4.1	#2		87.3	7.4	5.3	Loamy sand

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

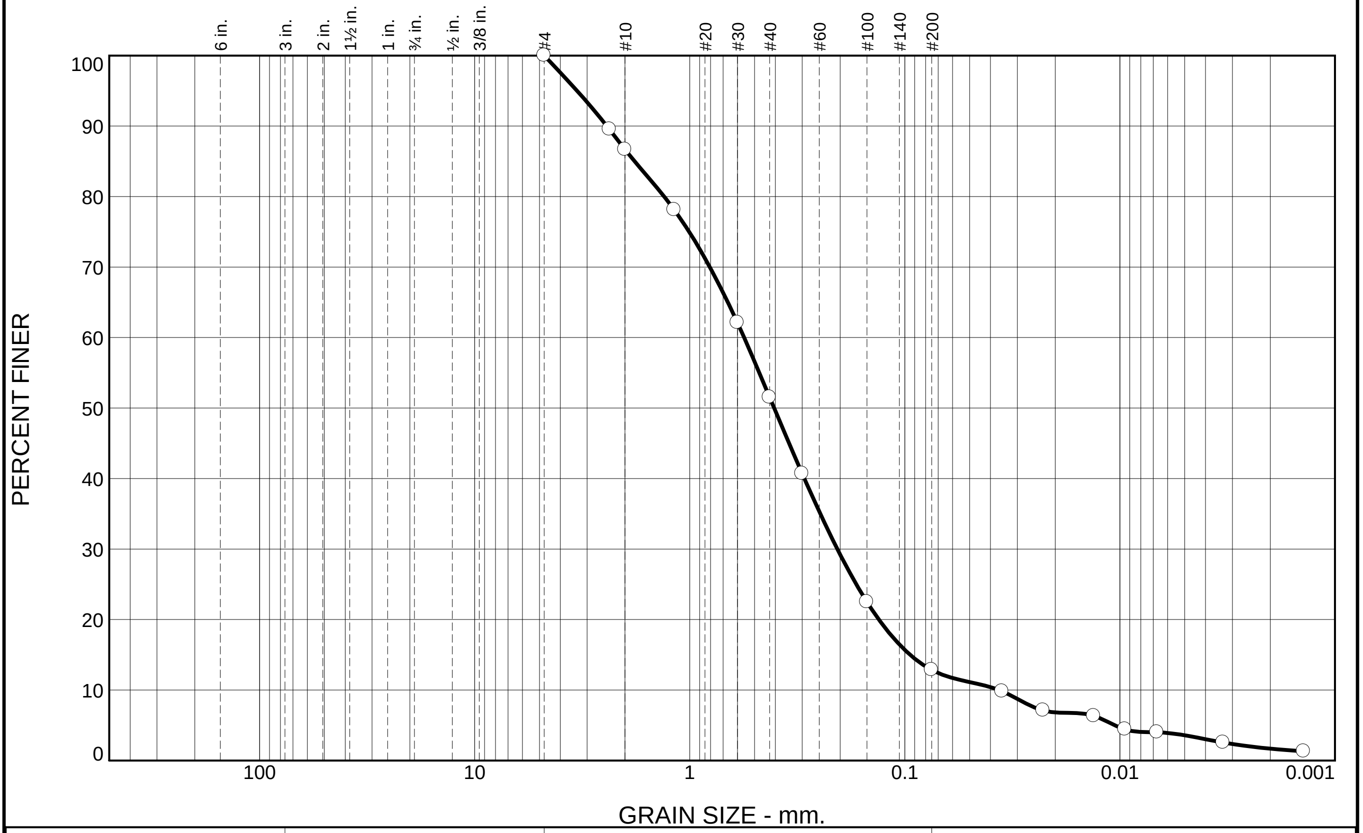
GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc

Project: Stancill's Laboratory Testing

Project No.: 120001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	13.3	35.2	38.6	9.3	3.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	89.5		
#10	86.7		
#16	78.1		
#30	62.1		
#40	51.5		
#50	40.7		
#100	22.5		
#200	12.9		
0.0352 mm.	9.8		
0.0228 mm.	7.1		
0.0132 mm.	6.3		
0.0095 mm.	4.4		
0.0067 mm.	4.0		
0.0033 mm.	2.5		
0.0014 mm.	1.3		

* (no specification provided)

Soil Description

USDA Classification - SAND
T88 Textural Analysis -
% Sand: 87.0 % Silt: 11.0 % Clay: 2.0

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 2.4280 D_{85}= 1.8045 D_{60}= 0.5589
D_{50}= 0.4051 D_{30}= 0.2060 D_{15}= 0.0945
D_{10}= 0.0365 C_u= 15.31 C_c= 2.08

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 11.3
pH: 6.5
Soluble Salts: 211 ppm

Source of Sample: MDE B.4.1
Sample Number: #1

Date: 4/20/2022

GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

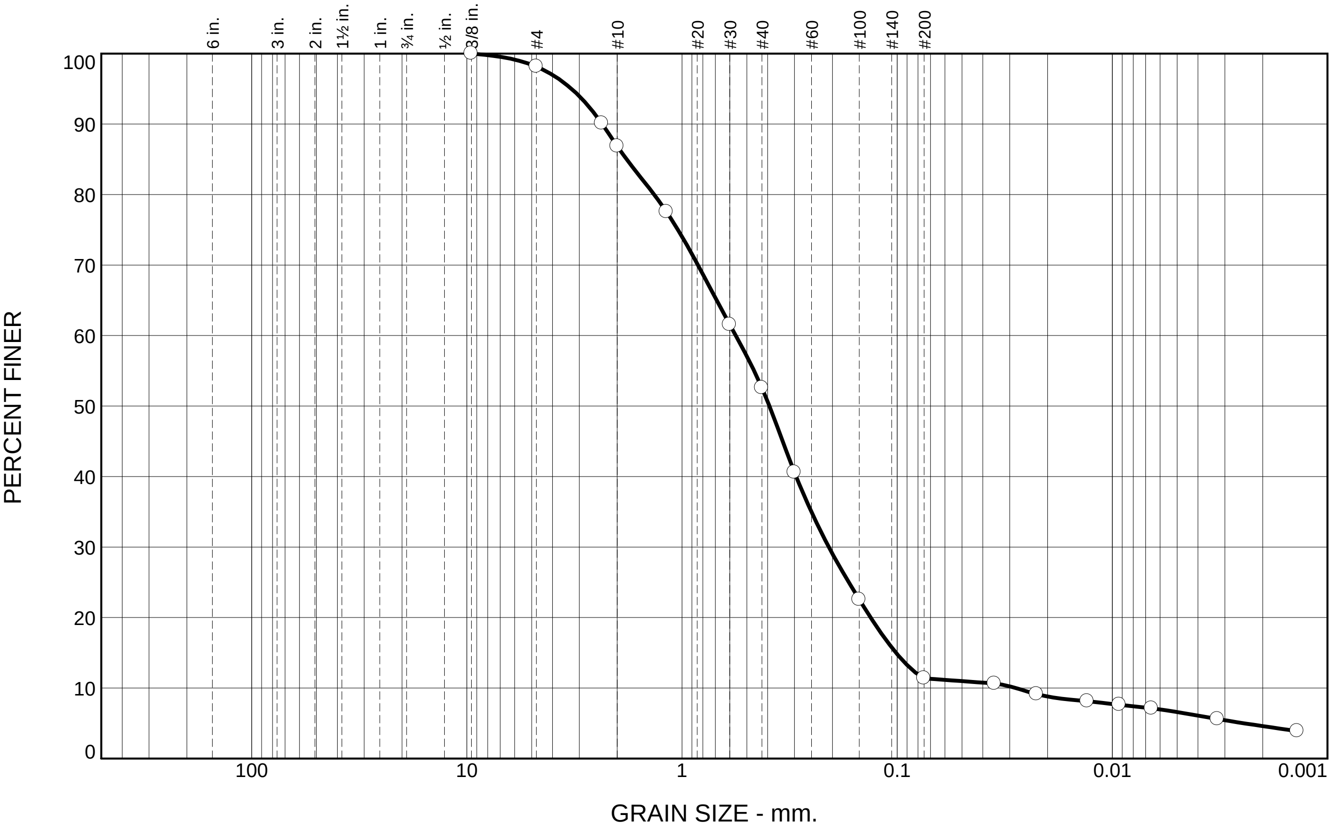
Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	11.3	34.2	41.2	4.8	6.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	98.1		
#8	90.1		
#10	86.8		
#16	77.5		
#30	61.5		
#40	52.6		
#50	40.6		
#100	22.5		
#200	11.4		
0.0352 mm.	10.6		
0.0225 mm.	9.1		
0.0131 mm.	8.1		
0.0093 mm.	7.6		
0.0066 mm.	7.1		
0.0032 mm.	5.6		
0.0014 mm.	3.9		

* (no specification provided)

Soil Description

USDA Classification - Loamy SAND
T88 Textural Analysis -
% Sand: 87.3 % Silt: 7.4 % Clay: 5.3

Atterberg Limits

PL= N/T **LL=** N/T **PI=** N/T **NM=** N/T

Coefficients

D_{90}= 2.3465 D_{85}= 1.8092 D_{60}= 0.5629
D_{50}= 0.3927 D_{30}= 0.2079 D_{15}= 0.1013
D_{10}= 0.0281 C_u= 20.01 C_c= 2.73

Classification

USCS= N/A **AASHTO=** N/A

Remarks

% Organics by LOI: 6.5
pH: 7.1
Soluble Salts: 860 ppm

Source of Sample: MDE B.4.1
Sample Number: #2

Date: 4/20/2022

GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

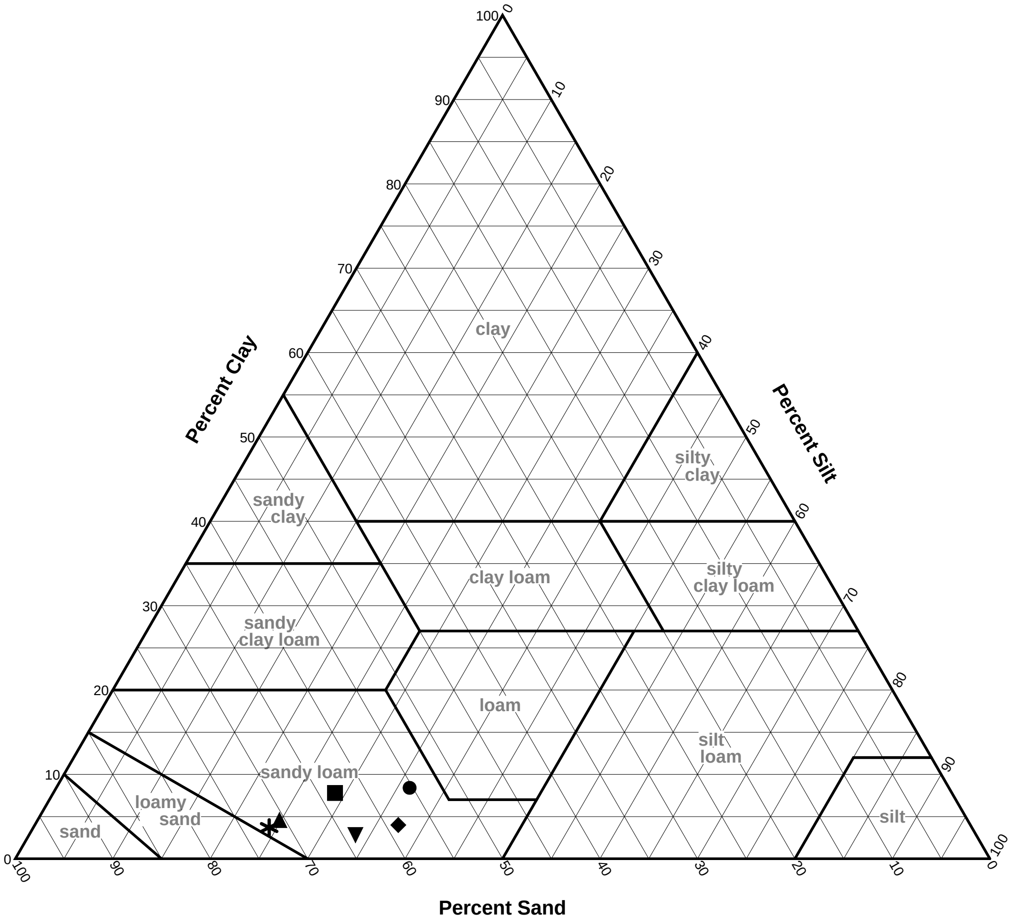
Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

USDA Soil Classification



SOIL DATA

	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●	Topsoil	#1		55.3	36.4	8.3	Sandy loam
■	Topsoil	#2		63.3	28.9	7.8	Sandy loam
▲	Topsoil	#3		70.6	24.9	4.6	Sandy loam
◆	Topsoil	#4		58.7	37.3	4.0	Sandy loam
▼	Topsoil	#5		63.7	33.5	2.8	Sandy loam
✱	Topsoil	#6		72.1	24.2	3.7	Sandy loam

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

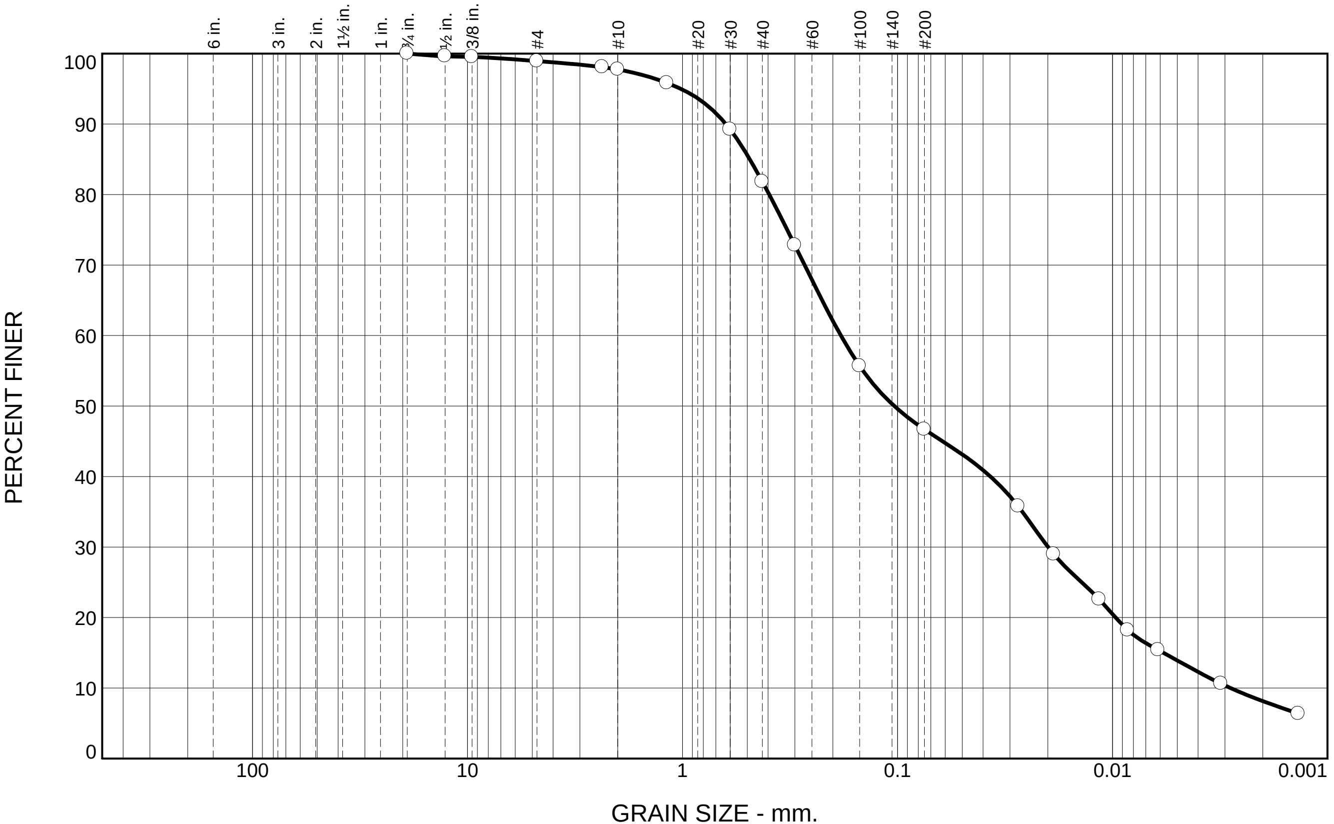
GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc

Project: Stancill's Laboratory Testing

Project No.: 120001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	1.2	15.9	35.1	32.8	13.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	99.6		
.375	99.5		
#4	98.9		
#8	98.1		
#10	97.7		
#16	95.8		
#30	89.2		
#40	81.8		
#50	72.8		
#100	55.7		
#200	46.7		
0.0274 mm.	35.8		
0.0187 mm.	29.0		
0.0115 mm.	22.6		
0.0085 mm.	18.2		
0.0061 mm.	15.4		
0.0031 mm.	10.6		
0.0014 mm.	6.4		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 55.3 % Silt: 36.4 % Clay: 8.3

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 0.6285	D_{85}= 0.4863	D_{60}= 0.1834
D_{50}= 0.1035	D_{30}= 0.0199	D_{15}= 0.0058
D_{10}= 0.0028	C_u= 64.88	C_c= 0.77

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 6.9
pH: 6.1
Soluble Salts: 420 ppm

Source of Sample: Topsoil
Sample Number: #1

Date: 4/20/2022

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

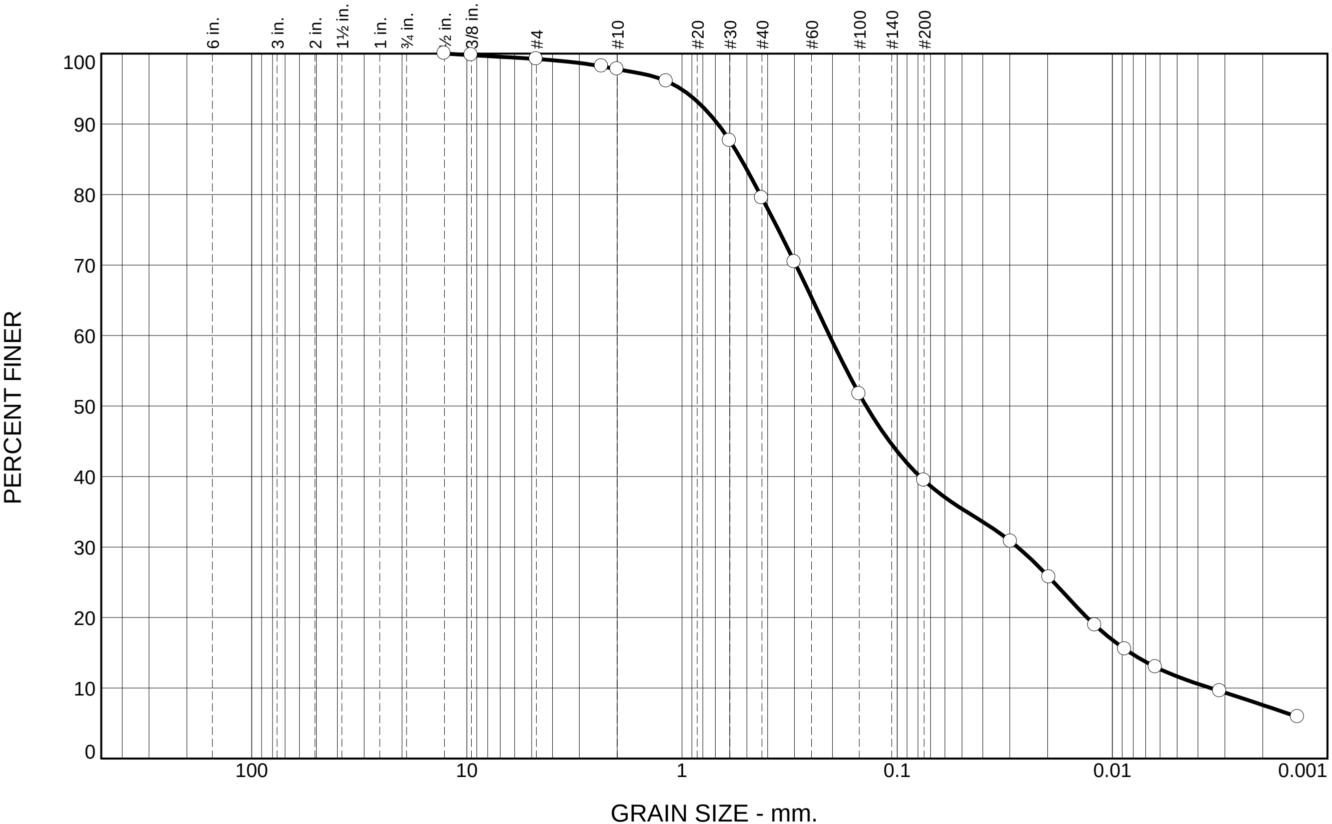
GTA
GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing

Project No: 120001 **Figure**

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	1.4	18.3	40.1	27.8	11.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	99.8		
#4	99.2		
#8	98.2		
#10	97.8		
#16	96.1		
#30	87.6		
#40	79.5		
#50	70.4		
#100	51.7		
#200	39.4		
0.0296 mm.	30.8		
0.0197 mm.	25.7		
0.0120 mm.	18.9		
0.0087 mm.	15.5		
0.0063 mm.	13.0		
0.0032 mm.	9.6		
0.0014 mm.	5.9		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 63.3 % Silt: 28.9 % Clay: 7.8

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 0.6807 D_{85}= 0.5315 D_{60}= 0.2064
D_{50}= 0.1393 D_{30}= 0.0276 D_{15}= 0.0082
D_{10}= 0.0035 C_u= 59.10 C_c= 1.05

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.5
pH: 6.6
Soluble Salts: 217 ppm

Source of Sample: Topsoil
Sample Number: #2

Date: 4/20/2022

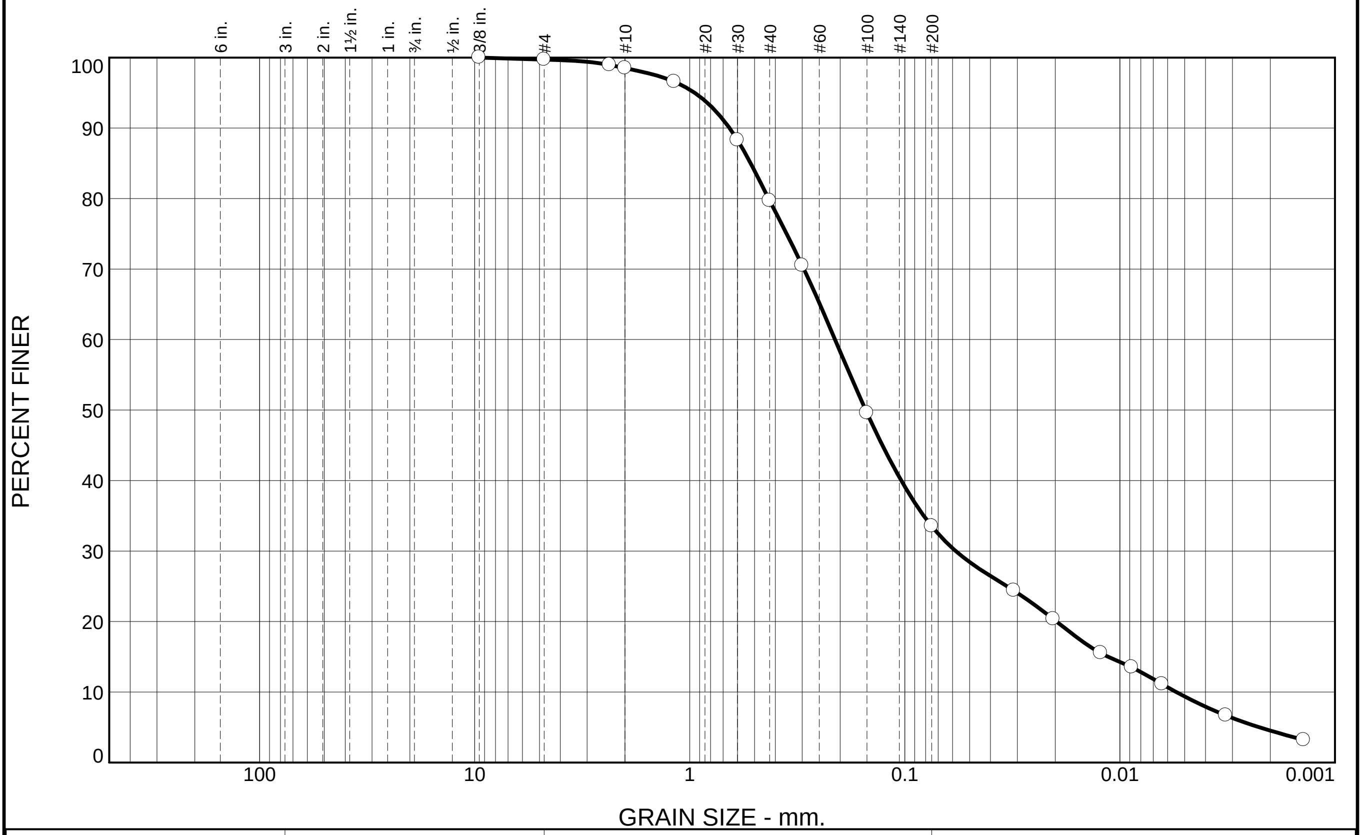
GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	**Fine**	**Coarse**	**Medium**	**Fine**	**Silt**	**Clay**
0.0	0.0	0.3	1.2	18.8	46.2	24.1	9.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	99.7		
#8	99.0		
#10	98.5		
#16	96.6		
#30	88.3		
#40	79.7		
#50	70.5		
#100	49.6		
#200	33.5		
0.0311 mm.	24.4		
0.0204 mm.	20.4		
0.0123 mm.	15.5		
0.0088 mm.	13.5		
0.0064 mm.	11.1		
0.0032 mm.	6.7		
0.0014 mm.	3.2		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 70.6 % Silt: 24.9 % Clay: 4.5

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 0.6534 D_{85}= 0.5210 D_{60}= 0.2112
D_{50}= 0.1521 D_{30}= 0.0580 D_{15}= 0.0113
D_{10}= 0.0055 C_u= 38.56 C_c= 2.91

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.4
pH: 6.7
Soluble Salts: 490 ppm

Source of Sample: Topsoil
Sample Number: #3
Date: 4/20/2022

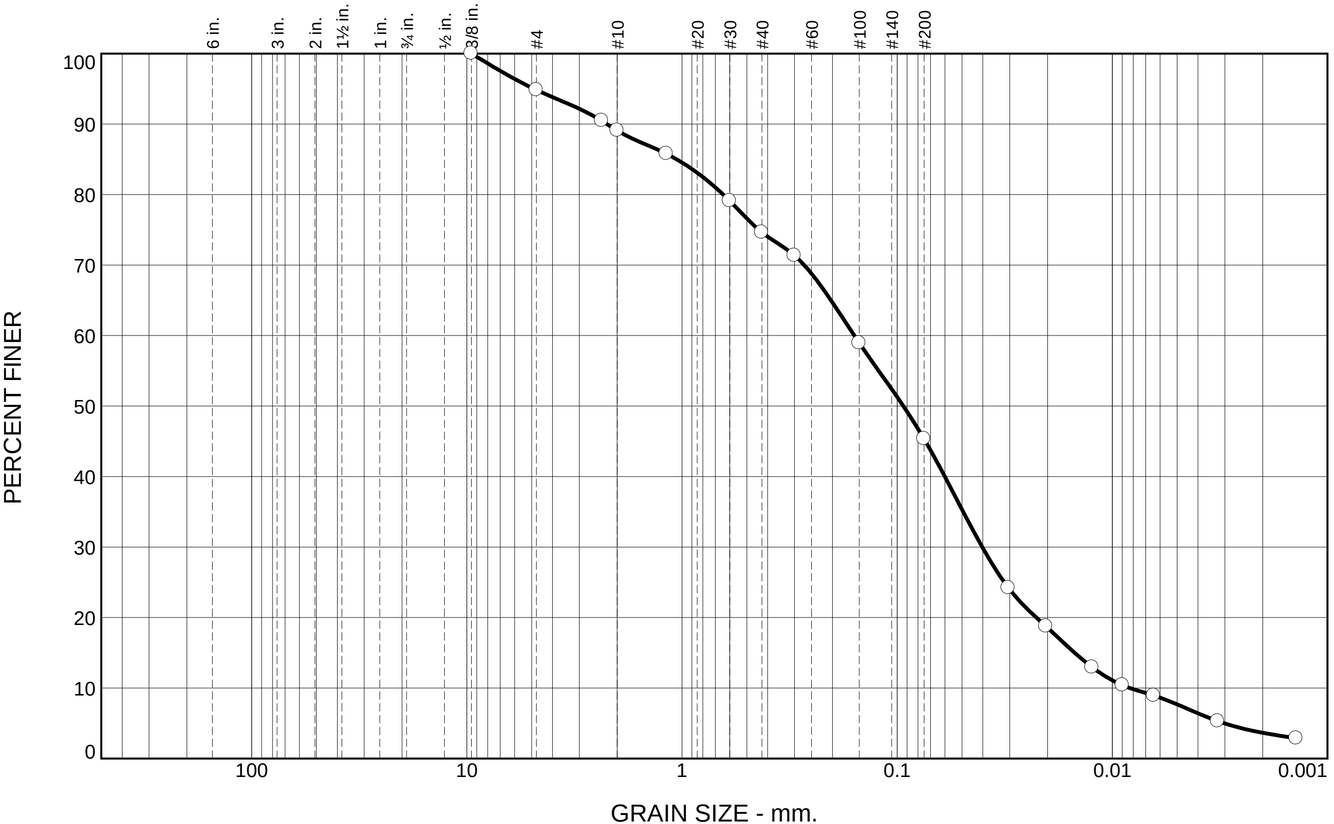
GEO-TECHNOLOGY
ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.2	5.7	14.5	29.3	37.6	7.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375	100.0		
#4	94.8		
#8	90.5		
#10	89.1		
#16	85.8		
#30	79.1		
#40	74.6		
#50	71.4		
#100	58.9		
#200	45.3		
0.0304 mm.	24.2		
0.0203 mm.	18.7		
0.0124 mm.	12.9		
0.0090 mm.	10.4		
0.0064 mm.	8.9		
0.0032 mm.	5.3		
0.0014 mm.	2.9		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 58.7 % Silt: 37.3 % Clay: 4.0

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 2.2332 D_{85}= 1.0583 D_{60}= 0.1583
D_{50}= 0.0936 D_{30}= 0.0402 D_{15}= 0.0150
D_{10}= 0.0083 C_u= 19.06 C_c= 1.23

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.9
pH: 6.5
Soluble Salts: 413 ppm

Source of Sample: Topsoil
Sample Number: #4

Date: 4/20/2022

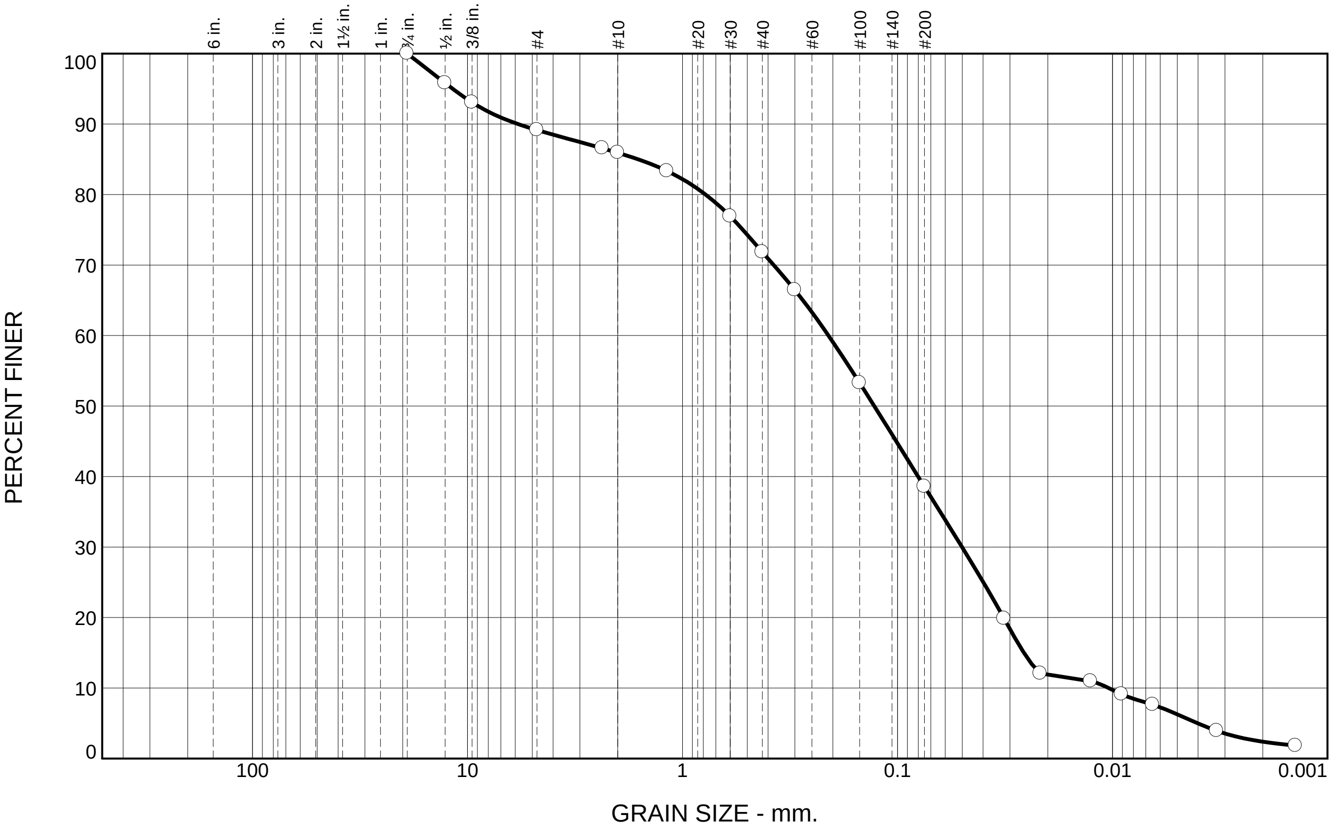
GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001 **Figure**

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.9	3.2	14.1	33.2	32.3	6.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	95.8		
.375	93.1		
#4	89.1		
#8	86.6		
#10	85.9		
#16	83.3		
#30	76.9		
#40	71.8		
#50	66.4		
#100	53.3		
#200	38.6		
0.0319 mm.	19.9		
0.0217 mm.	12.1		
0.0126 mm.	11.0		
0.0091 mm.	9.1		
0.0065 mm.	7.6		
0.0033 mm.	3.9		
0.0014 mm.	1.8		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 63.7 % Silt: 33.5 % Clay: 2.8

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 5.8167 D_{85}= 1.6090 D_{60}= 0.2096
D_{50}= 0.1283 D_{30}= 0.0501 D_{15}= 0.0258
D_{10}= 0.0104 C_u= 20.13 C_c= 1.15

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.5
pH: 6.4
Soluble Salts: 370 ppm

Source of Sample: Topsoil
Sample Number: #5

Date: 4/20/2022

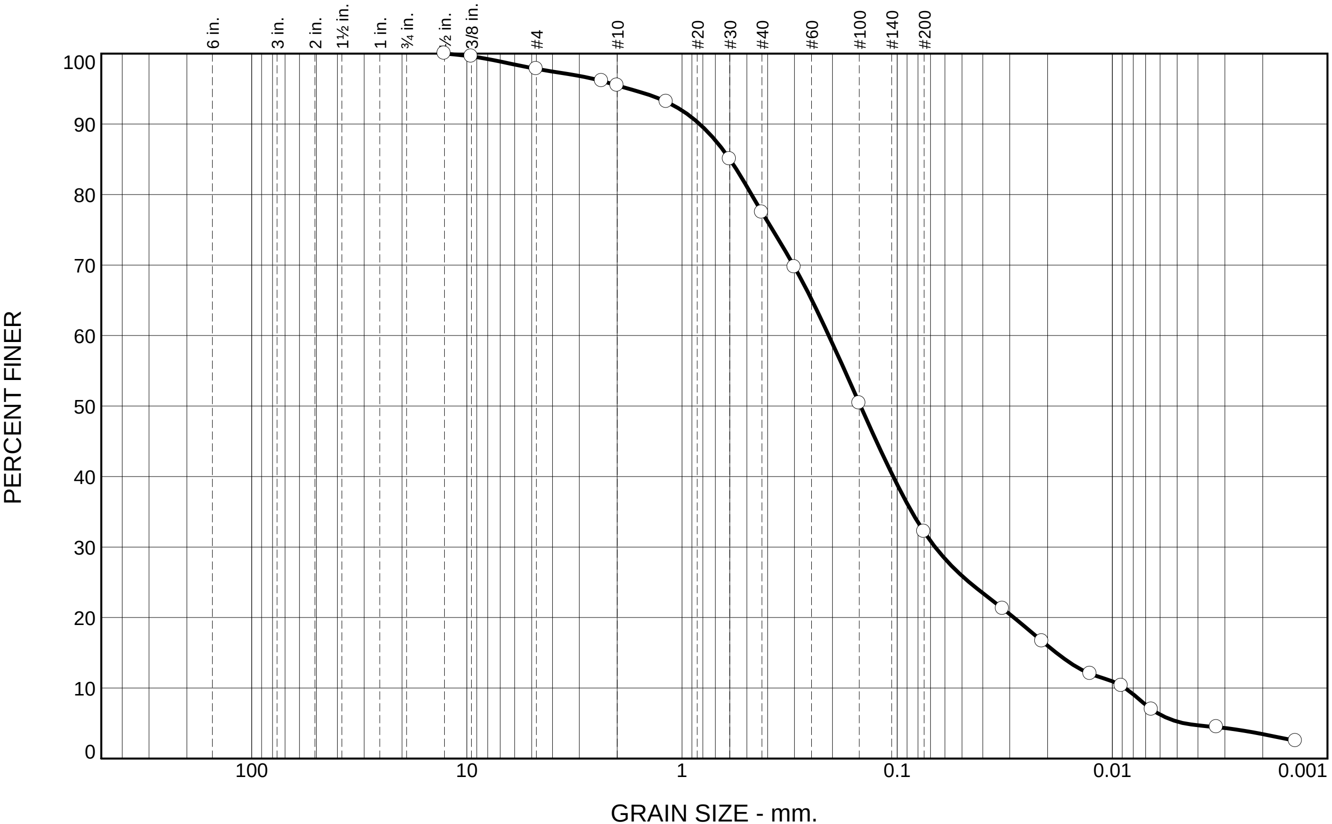
GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.2	2.3	18.0	45.3	27.0	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	99.6		
#4	97.8		
#8	96.1		
#10	95.5		
#16	93.1		
#30	85.0		
#40	77.5		
#50	69.7		
#100	50.4		
#200	32.2		
0.0323 mm.	21.3		
0.0212 mm.	16.6		
0.0127 mm.	12.0		
0.0091 mm.	10.3		
0.0066 mm.	7.0		
0.0033 mm.	4.4		
0.0014 mm.	2.5		

* (no specification provided)

Soil Description

USDA Classification - Sandy LOAM
T88 Textural Analysis -
% Sand: 72.1 % Silt: 24.2 % Clay: 3.7

Atterberg Limits

PL= N/T LL= N/T PI= N/T NM= N/T

Coefficients

D_{90}= 0.8281 D_{85}= 0.5995 D_{60}= 0.2079
D_{50}= 0.1480 D_{30}= 0.0667 D_{15}= 0.0182
D_{10}= 0.0087 C_u= 23.83 C_c= 2.45

Classification

USCS= N/A AASHTO= N/A

Remarks

% Organics by LOI: 3.4
pH: 6.6
Soluble Salts: 470 ppm

Source of Sample: Topsoil
Sample Number: #6

Date: 4/20/2022

GEO-TECHNOLOGY ASSOCIATES, INC.
3445-A Box Hill Corporate Center Drive
Abingdon, MD 21009

Client: Stancill's, Inc
Project: Stancill's Laboratory Testing
Project No: 120001
Figure

ASTM Specifications performed my include: D421, D422, D2216, D2217, and D4318.

Tested By: J. Heiland **Checked By:** E. Church

ATTACHMENT 2

MARYLAND STATE HIGHWAY ADMINISTRATION
SOIL TEST REPORT
SHA BIORETENTION SOIL VERSION #1

710

S.H.A. 73.0-27B
Rev. 6-16-06

MARYLAND STATE HIGHWAY ADMINISTRATION
Office of Materials Technology

ORIGINAL ______
ACCEPTANCE ______
OTHER ______

SOIL TEST REPORT

DESCRIPTION & IDENTIFICATION

Contract No. BC440005 Lab. No. 22/172 Project Serial No. ______
Date Sampled ______ F A P (s) No. ______
Material Specification BSM Quantity Represented ______
Proposal Item No. ______ Material for Use in/as ______
Material Produced by Stancills BSM Mix 2
Sample Taken From ______ Location/Station ______
Sampled by ______ Witnessed by ______
Project Engineer ______ Telephone Number ______ Fax Number ______
Remarks ______ Special Provisions ☐

FOR LAB USE ONLY

TEST RESULTS

% BY WEIGHT PASSING SIEVES											MINUS NO. 10 % BY WEIGHT			LL	PI	COMPACTION AASHO T-___-___	
2½"	2"	1½"	1"	¾"	½"	#4	#10	#40	#100	#200	Sand	Silt	Clay	—	—	* Max. Dry Den. pcf	Opt. Moist Cont., %
←	—	—	→	100	99	96	87	53	22	12	89	6	5				

Soil Classification Sand Organic Content 6.3 % pH 7.0 Other 0.245

To Plot Typical Curve of Field Density Determination, use following information: *Wet Weight at Opt. Moist, ______ pcf

Wet Wt. p.c.f. ______ ______ ______ ______ ______ ______
% Moisture ______ ______ ______ ______ ______ ______

Sample tested at the Hanover Lab and the material represented does ✓ meet specification requirements.
By: BTK Date: 6/24/22

REMARKS: ______

CC:
____Project Engineer
____District Office
____Landscape Operations Division
____QA Field Inspector

Contact the Landscape Operations Division at 410-545-8596 for:
____amending pH
____amending organic matter
____developing a Nutrient Management Plan

ATTACHMENT 3

MARYLAND STATE HIGHWAY ADMINISTRATION
SOIL TEST REPORT
SHA TOPSOIL VERSION #2

S.H.A. 73.0-27B
Rev. 6-16-06

813

MARYLAND STATE HIGHWAY ADMINISTRATION
Office of Materials Technology

ORIGINAL ______
ACCEPTANCE ______
OTHER ______

SOIL TEST REPORT

DESCRIPTION & IDENTIFICATION

Contract No. BC440005 Lab. No. 221173 Project Serial No. ______

Date Sampled ______ F A P (s) No. ______

Material Specification Topsoil Quantity Represented ______

Proposal Item No. ______ Material for Use in/as ______

Material Produced by Stancills -TS (2)

Sample Taken From ______ Location/Station ______

Sampled by ______ Witnessed by ______

Project Engineer ______ Telephone Number ______ Fax Number ______

Remarks ______ Special Provisions ☐

FOR LAB USE ONLY

TEST RESULTS

% BY WEIGHT PASSING SIEVES											MINUS NO. IO % BY WEIGHT			LL	PI	COMPACTION AASHO T- -	
2½"	2"	1½"	1"	¾"	½"	#4	#10	#40	#100	#200	Sand	Silt	Clay	—	—	* Max. Dry Den. pcf	Opt. Moist Cont., %
	←				100	98	92	69	38	27	75	16	9				

Soil Classification Sandy Loam Organic Content 14.1* % pH 6.4 Other * 1.227

To Plot Typical Curve of Field Density Determination, use following information: *Wet Weight at Opt. Moist, ______ pcf

Wet Wt. p.c.f. ______ ______ ______ ______ ______ ______

% Moisture ______ ______ ______ ______ ______ ______

Sample tested at the Hanover Lab and
the material represented does ✓
meet specification requirements.
By: BTK Date: 6/13/22

REMARKS: Does not meet organic 4-8
Does not meet sol. salts 0.780mMoh/cm

cc:
____Project Engineer
____District Office
____Landscape Operations Division
____QA Field Inspector

Contact the Landscape Operations Division at 410-545-8596 for:
____amending pH
____amending organic matter
____developing a Nutrient Management Plan

APPENDIX I

SUPPLEMENTAL CEMENTITIOUS MATERIAL BENCH SCALE TESTING RESULTS

Beneficial Use of Dredge Material

Daniel Benkeser, Dr. Kimberly Kurtis

School of Civil and Environmental Engineering

Georgia Institute of Technology

1.0 Objectives

The objective of the Georgia Tech portion of this investigation was to explore environmentally sound and economically viable productive reuse options for dredge materials obtained from the surroundings of the Conowingo Dam. Specific objectives within this scope of work included:

(1) Based upon documentation concerning the characteristics of this material, to receive samples of materials from various locations. Information on the particle size distribution will be performed by the GDOT Geotech lab, the finely grained cut of selected samples will be provided for testing, with additional testing being performed as recommended, within budget and scope of work.

(2) Through bench-scale testing, to evaluate the potential of the material to be used as feedstock material for the production of alternative SCMs, in comparison to existing standards and requirements for composition and performance, as defined for natural pozzolans in ASTM C618.

(3) To make recommendations for strategies for productive reuse of existing and future dredge materials from the Conowingo Dam environment.

Herein, those results are summarized.

2.0 Materials, Processing, and Characterization

Two five-gallon buckets were collected from the finely grained portion of the sediment from the Susquehanna River near the Conowingo Dam in Maryland. This sediment was collected from multiple locations along the riverbed, potentially leading to variation in phase composition. These buckets were subsequently labeled as samples S6 and S7.

During processing these samples were placed in a laboratory oven at 110 °C overnight. The sediment was subsequently ground in a soil crusher until a fine powder was retrieved. The crushed soil was then passed through a 90 µm (No. 170) sieve. As only particles below a 100 µm particle size exhibit pozzolanic reactivity, above this level, the same particles may instead contribute to an Alkali Silica Reaction (ASR) [1]. These samples were labeled samples S6/S7 raw, the chemical oxide composition, identified via X-Ray Fluorescence, of these samples are identified in Table 1.

Table 1: Chemical Oxide Composition of Conowingo Sediment

Wt. %	OPC	Quartz*	MK	Class F Ash	S6	S7
SiO_2	20.4	>99.5	51.4	55.3	66.1	66.0
Al_2O_3	4.8	0.03	44.8	27.2	16.5	16.5
Fe_2O_3	3.2	0.02	0.4	8.0	7.4	7.4
Sum of Oxides	28.4	>99.55	96.6	90.5	90.0	89.9
SO_3	2.8	0	0	0.1	0.3	0.3
CaO	63.0	0	0	1.3	0.5	0.5
Na_2O	0.1	0	0	0.5	0.6	0.6
MgO	3.2	0.02	0	1.2	1.2	1.2
K_2O	0.5	0.06	0	3.0	2.8	2.8
P_2O_5	0.1	0	0	0.2	0.2	0.3
TiO_2	0.2	0	1.5	1.4	1.1	1.1
SrO	-	-	-	-	0.0	0.0
BaO	-	-	-	-	0.1	0.1
Total	98.3	>99.63	98.1	98.1	96.8	96.8
Na_2O_e	0.41	0.04	0	2.5	2.5	2.5

*Data provided by manufacturer

These raw sediment samples were then calcined in a bench-scale muffle furnace (model N17/HR, Nabertherm) to de-hydroxylate the clay content present in these sediments. Upon de-hydroxylation the hydroxyl groups present in all clay minerals will leave the system in the form of water [2]. This process creates structural disorder and allows the silica and alumina to dissociate from the clay structure, thus allowing them to participate in the pozzolanic reaction [3], a reaction between amorphous silica/alumina with Calcium Hydroxide to form additional Calcium Silicate Hydrate and/or Calcium Alumino-Silicate Hydrate(C-S-H and/or C-A-S-H gel), the primary strength-giving phases in concrete. The sedient was heated in high-capacity porcelain crucibles at a rate of 300 °C/h. limited by the crucible. Upon reaching the target temperature (between

500 – 900 °C in 100 °C increments), this temperature is held for 1 hour. The resulting sediment is than removed from the furnace and allowed to cool to ambient temperatures. These resulting samples were labeled CS6 and CS7 respectively and amended with the target temperature (500 – 900 °C) and can be seen in Figure 1. The red coloration seen in some of the samples (CS7 700 °C) is likely caused by the oxidation of iron bearing elements. The inconsistency seen in some of these cases are likely caused by differing cooling times for different samples.

Figure 1: Calcined Conowingo Sediment Sample Coloration

An ASTM C150 Type I/II Portland Cement (Argos Cement) was utilized in all experiments [4]. The chemical oxide composition for this material can be seen in Table 1. The primary mineral phases of this material are Alite (C_3S, 56.5%), Belite (C_2S, 15.9%), tri-calcium aluminate (C_3A, 7.4%), and calcium aluminoferrite (C_4AF, 9.72%) determined via quantitative XRD analysis; this composition confirms its status as a Type I/II cement. The cement had an average particle size of 15.7 μm and a specific surface area of 260 m^2/kg, as determined via Blaine's air permeability test (ASTM C204) [5].

Three different materials, inert quartz, commercially available metakaolin, and a class F fly ash, were utilized as comparison materials for reactivity tests, primarily isothermal calorimetry and thermogravimetric analysis. The chemical oxide composition of these materials is given in Table 1. The inert quartz (U.S Research Nanomaterials Incorporated) is a polycrystalline α-quartz and was used as a non-reactive filler material to compare reactivity. This material had an average particle size of 45 μm, a purity of 99.5%, and a specific gravity of 2.65.

The commercially available metakaolin (Burgess Pigment Company) is a highly reactive pozzolan essentially used as high-reactivity reference material. This material was heat-treated at 800 °C as reported by the manufacturer. This material is characterized by a silica to alumina ratio of 1.15, confirming a high level of purity, and an average particle size of 1.44 μm. This material is classified as a Class N pozzolan in accordance with ASTM C618 [6].

The fly ash is classified as a Class F fly ash in accordance with ASTM C618 [6]. This fly ash had an average particle size of 17.37 μm, a primary oxide sum of 90.5%, and a calcium content of 1.3%, confirming it as a highly pozzolanic material. This fly ash was utilized as a real-world reference material.

3.0 Methods

Potentially reactive mineral phases were identified utilizing X-Ray Diffraction. XRD analysis was performed on a Ni filtered CuK α (λ = 1.54 Å). Scans were performed in the 5 – 80 ° 2θ range (Panalytical Xpert Pro Alpha-1 powder diffractometer). Scans were performed with a 1/4° incident divergence slit, a 5mm receiving divergence slit, a 0.04 rad soller slit, and a 20mm mask. The scanning program used a step size of 0.0334° and a count time of 29.84 seconds. Phase identification was performed using the PDF 4+ Database from the International Centre for Data Diffraction.

Other potentially pozzolanic phases were confirmed and identified via Scanning Electron Microscopy (SEM) (Hitachi SU8230). Analysis was performed on powdered samples prepared on carbon tape. Scans were performed with an acceleration voltage of 5 kV and a magnification of 5 – 30 μm.

The particle size distribution of these sediments was determined via wet dispersion laser diffraction (Mastersizer 3000) with ethanol dispersant. Samples were loaded to an obscuration range of 5 – 15% and ultra-sonicated for 30 seconds before an average of five measurements were taken. The particle size distribution was reported cumulatively and was used to determine the fineness of the sediments (ASTM C430) [7].

Pozzolanic reactivity was measured with blended cement pastes prepared in accordance with ASTM C305 [8]. These cement pastes were mixed using deionized water and a hand mixer (Hamilton Beach Model 62632R). Mixes were prepared with a water-to-binder (W/B) ratio of 0.4 and a cement replacement of 20% by weight. Once cured isothermal calorimetry and $Ca(OH)_2$ content (determined via thermogravimetric analysis) was determined for these samples.

Isothermal calorimetry was utilized to measure the evolved hydration heat of the blended cement pastes and to estimate the pozzolanic reactivity of these materials

(TAM air isothermal calorimeter, Thermometric TA Instruments). Analysis was performed at 23 °C over 48 hours with measurements taken every 30 seconds. The rate of heat released and cumulative heat released were reported over time and normalized by the solid binder mass.

Calcium hydroxide content was determined via thermogravimetric analysis on blended cement pastes (Hitachi Thermal Analysis System - TG/DTA7300). The samples were double bagged and allowed to cure in sealed containers held at 23 °C until testing at 7, 28, and 56 days. Samples were prepared first by crushing and passing the hardened paste through a No. 200 sieve. Samples were exposed to an inert nitrogen flow rate of 100 ml/min before being heated with the following heating profile. Samples are first held at a temperature of 40 °C for 1.5 hours until all free water is evaporated, as temperatures above this level will also release the bound water in CSH gel [9]. Sample heat was then raised at a rate of 10 °C/min until the sample reaches 1000 °C. Calcium hydroxide decomposition was determined as being between 330 – 450 °C. The calcium hydroxide content of these samples are calculated from the sample mass at these levels and normalized by sample mass recorded at 40 °C, as shown in Equation 1.

$$Ca(OH)_2\ \mathrm{Content}\ (\%) = ((\mathrm{Mass}_{330°\mathrm{C}} - \mathrm{Mass}_{450°\mathrm{C}}) \times \frac{4.113}{\mathrm{Mass}_{40°\mathrm{C}}}) \times 100 \qquad (1)$$

Blended mortar mixes (blended in a Hobart C100 Mixer) were cast into 2" [50mm] mortar cubes and tested for compressive strength in accordance with ASTM C305 and ASTM C109 [8] [10]. These mortars were blended with natural sand and deionized water at a constant W/B ratio of 0.484 and a cement replacement of 20% by weight. These mortar cubes were cured in a hydration chamber (~100% humidity) held at 23 °C for 24 hours before being submerged in a saturated $Ca(OH)_2$ solution at 23 °C until being tested. Three mortar cubes were tested at 7 and 28 days for the temperature optimization process and at 7, 28, and 56 days for the final calcination process (Satec Systems, MK111-C 400 PT). These mortar cubes were loaded at a rate of 12 – 24 kips/min (avg. 18 kips/min) until fracture. The relative compressive strength is reported as an average of the three samples against a 100% Portland cement mix.

The samples alkali silica reaction (ASR) mitigation potential was measured utilizing the accelerated mortar bar test ASTM C1567 [11]. Mortar mixes were prepared at a W/B ratio of 0.47, a cement replacement of 20% by weight, and blended with a highly reactive crushed sand. Mortar bars were cured in a hydration chamber (~100% humidity) at 23 °C for 24 hours. The samples were than submerged in deionized water and held in a laboratory oven at 80 °C for another 24 hours. After this zero day measurements were taken and the samples were then submerged in a 1 M NaOH solution at 80 °C until 28 days with measurements being taken periodically.

4.0 Findings

4.1 Identifying Pozzolanic Elements

4.1.1 Scanning Electron Microscopy

Potentially pozzolanic elements were identified in the raw and calcined sediments utilizing SEM microscopy and XRD analysis. These micrographs can be seen in Figure 2 – Figure 5, where numerous pozzolanic or potentially pozzolanic elements can be identified. The first of these images (Figure 2) indicate the presence of diatomaceous earth in the Conowingo sediment samples.

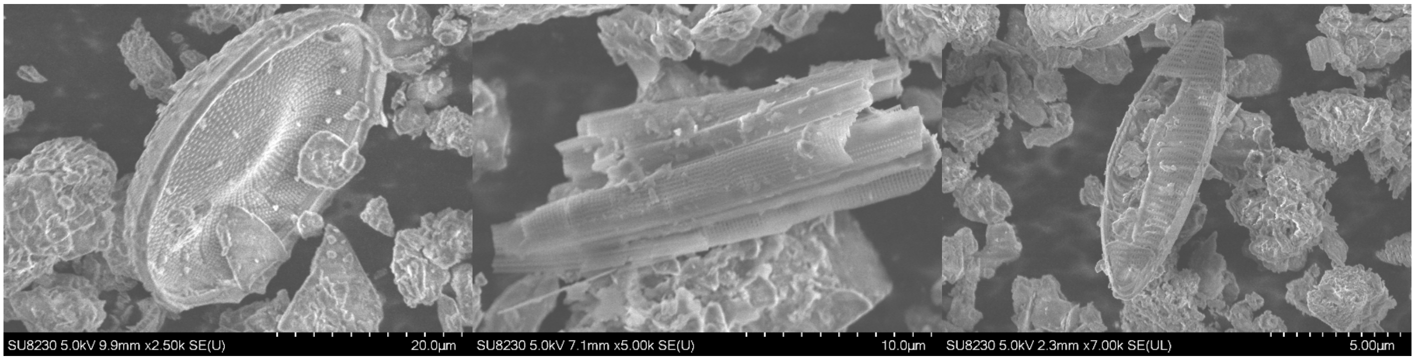


Figure 2: Microscopy of Diatoms in Conowingo Sediment - S6 (left), S7 (middle), and CS7 900 C (right)

Diatoms are single celled algae which are commonly found in marine environments. Diatomaceous earth is typically composed of over 90% silica with small quantities of alumina and ferric oxide. This composition, alongside its relatively small particle size (2 – 200 μm), lead diatomaceous earth to be commonly classified as an inherently high reactivity pozzolanic material [12] [13]. Any diatoms larger than 90 μm would have been removed from the system during the sieving process. However, the inherently high surface area of these materials would lead diatomaceous earth to possess a high-water demand, decreasing workability of the mixtures using SCM [14].

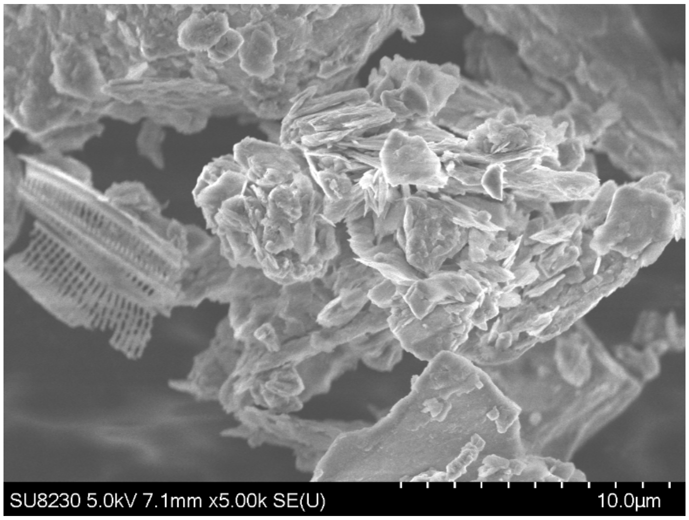


Figure 3: Kaolinite Clay Found in Conowingo Sediment (Sample S7)

The flaky sheets found in the microscopic image in Figure 3 shows kaolinite clay ($Al_2Si_2O_5(OH)_4$) in sample S7. This is confirmed as kaolinite clay via X-Ray Diffraction in (Figure 6 and Figure 7). When kaolinite is heated to temperatures between 400 – 600 °C it will de-hydroxylate, where the hydroxyl groups present in the clay structure leaves the structure in the form of water [2]. Once those hydroxyl groups leave the system the clay structure will become disordered (and thus available for the pozzolanic reaction) and transform into metakaolin ($Al_2Si_2O_7$), one of the most pozzolanically reactive materials in the market. Calcination at higher temperatures (up to 900 °C) will lead to a final structure with greater disorder, and thus a greater level of reactivity [2]. Kaolinite is the most potentially pozzolanic clay available. In addition, due to its relative abundance and relatively low needed calcination temperature, it is one of the most attractive calcined clays on the market.

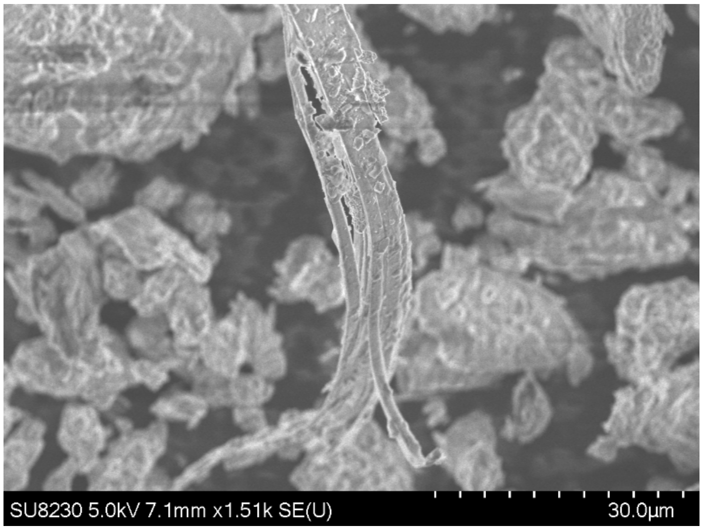


Figure 4: Montmorillonite Clay in Conowingo Sediment (Sample S7)

The image shown in Figure 4 shows the threadlike structure of montmorillonite clay ($(Na, Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2 \bullet nH_2O$). Which is a common sodium/calcium based 2:1 structured clay, one octahedral hydroxide sheet sandwiched between two tetrahedral silica sheets. Clays with a 2:1 structure typically possess a lower potential for pozzolanic reactivity in comparison to 1:1 structured clays (like kaolinite). Montmorillonite clay typically de – hydroxylates around 600 – 800 °C and overall possesses a lower quantity of hydroxyl groups in reference to the overall clay structure [2] [15]. Additionally, montmorillonite typically possesses a large specific surface area (800 m^2/g compared to kaolinites 15 m^2/g), leading to a greater water demand. These properties together lead to montmorillonite being unused in the realm of pozzolanic reactivity and is typically used more often as a sealant.

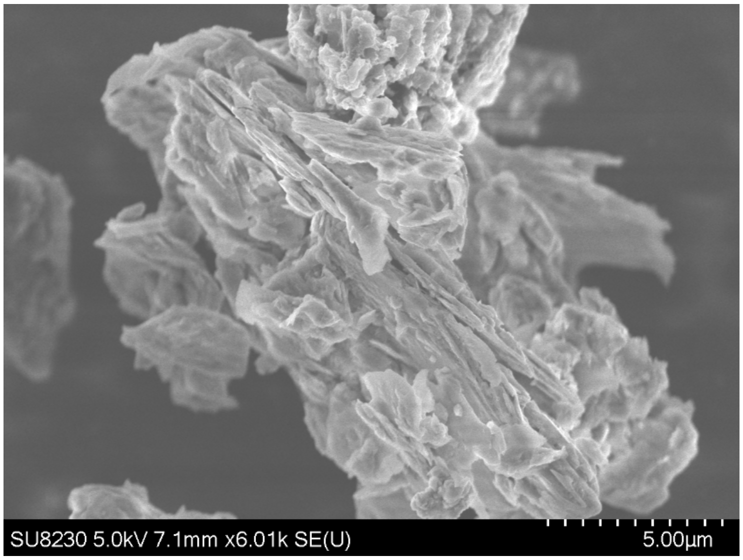
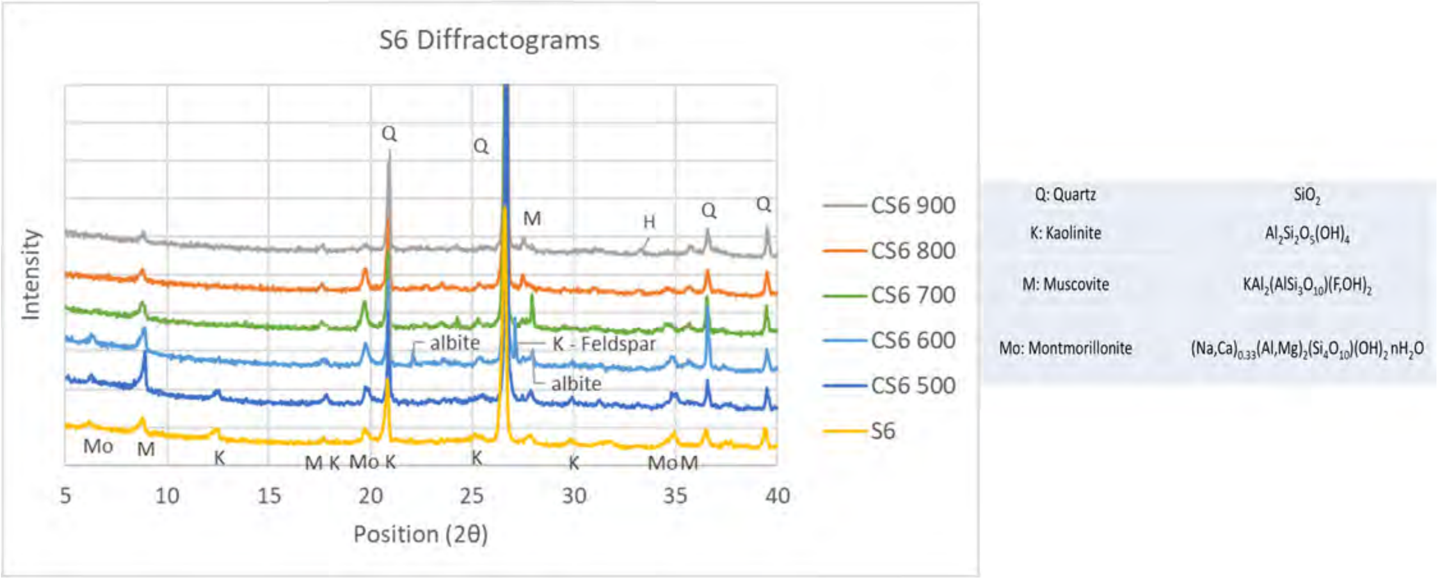


Figure 5: Muscovite Clay Present in Conowingo Sediment (Sample S7)

The muscovite mineral ($KAl_2(AlSi_3O_{10})(F,OH)_2$) found in Figure 5 is a common mica and is not commonly thought of as a clay mineral, as it can be found in the form of large sheets, as opposed to the sub-micron particle size of most clay minerals [16]. However, it is still considered a phyllosilicate (layered clay structure) and possesses a near identical structure to Illite, a 2:1 potassium based clay. Additionally, upon de-hydroxylation (750 – 1000 °C) it may exhibit a limited degree of pozzolanic reactivity [17] [18]. Although technically pozzolanic, its limited reactivity and status as a mica restrains its more widespread use.

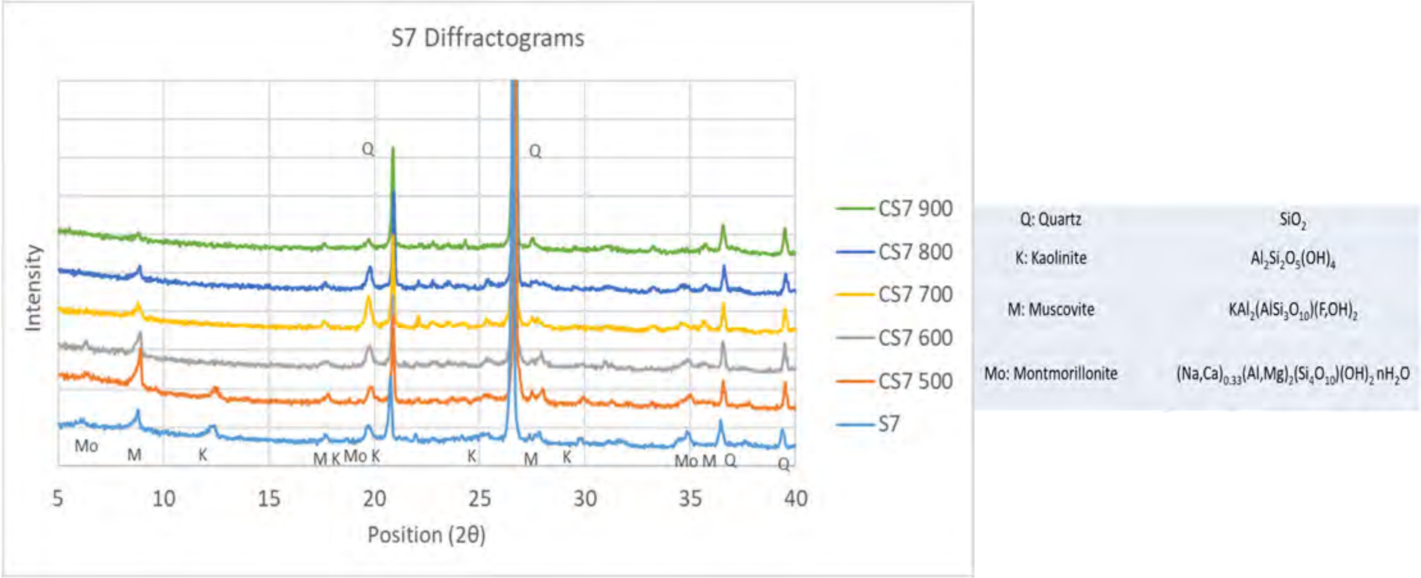
4.1.2 X-Ray Diffraction

X-ray diffraction analysis was performed on the raw and calcined Conowingo sediment samples (500 – 900 °C in 100 °C increments). The results of these scans can be seen in Figure 6 and Figure 7.



Q: Quartz	SiO_2
K: Kaolinite	$Al_2Si_2O_5(OH)_4$
M: Muscovite	$KAl_2(AlSi_3O_{10})(F,OH)_2$
Mo: Montmorillonite	$(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2\,nH_2O$

Figure 6: XRD Diffractograms for Sample S6 and CS6



Q: Quartz	SiO_2
K: Kaolinite	$Al_2Si_2O_5(OH)_4$
M: Muscovite	$KAl_2(AlSi_3O_{10})(F,OH)_2$
Mo: Montmorillonite	$(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2\,nH_2O$

Figure 7: XRD Diffractograms for Sample S7 and CS7

These scans confirm the presence of the kaolinite, montmorillonite, and muscovite identified with Scanning Electron Microscopy in both S6 and S7 samples. Additionally, these XRD scans confirm the presence of siliceous quartz along with limited quantities of Na and K based feldspars. These feldspars appear sporadically enough that they can be ignored in reference to the overall analysis. The disappearance, or reduced intensity, of clay peaks suggest the progression of de–hydroxylation and subsequent structural disorder of these clay minerals. For kaolinite complete de–hydroxylation occurs at 600 °C as reinforced by existing literature. Montmorillonite peaks remain until 700 °C, slightly earlier than existing literature suggests, likely due to the limited quantities of this mineral in the sediment. The muscovite peaks never completely disappear, suggesting that the muscovite never completely de – hydroxylates within this temperature range.

The limited pozzolanic reactivity and lack of de–hydroxylation of muscovite within this temperature range suggests that this material is a non-factor when determining the optimal calcination temperature. The muscovite mineral will likely de-hydroxylate at 1000 °C, which would allow it to fully contribute to pozzolanic reactivity. However, at and above 900 °C kaolinite will begin to recrystallize into Spinel and eventually mullite [19] [20]. Given the potential reactivity of metakaolin and the cost of high temperature calcination, this is not an attractive option. Thus the ideal calcination temperature will likely be based on the conversion of kaolinite and montmorillonite (500 – 700 °C) and will be determined based on the relative strength of sediments calcined at these temperatures as reported in the next section.

4.2 Calcination Temperature Optimization

4.2.1 Particle Size Distribution

The cumulative particle size distribution of the calcined sediments can be seen in Figure 8 and Figure 9.

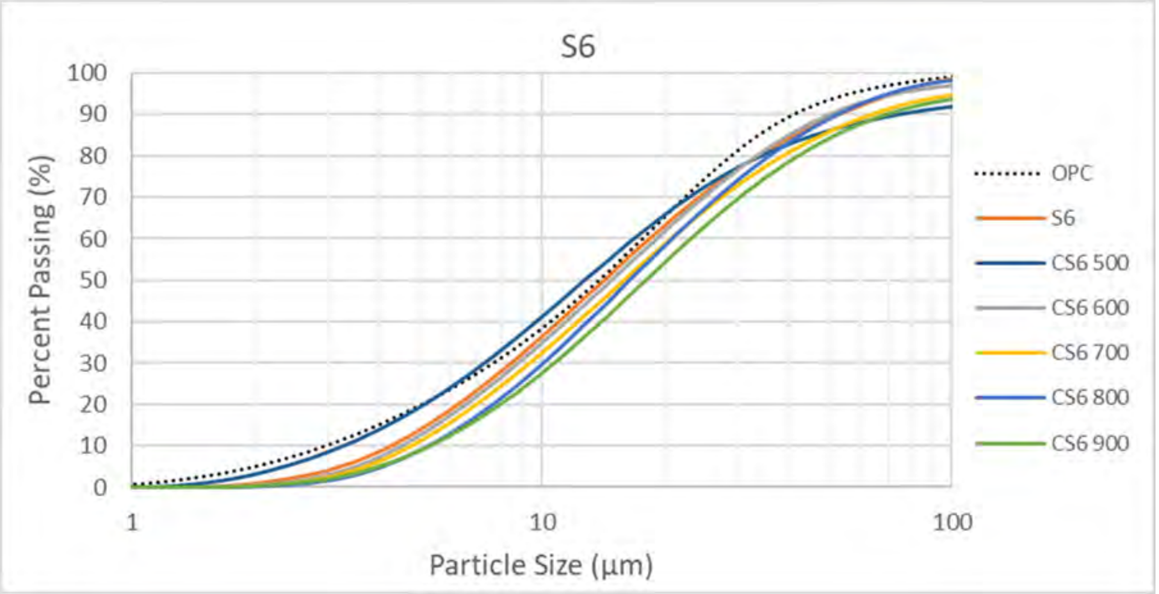


Figure 8: Cumulative Particle Size Distribution of Sample S6 and CS6

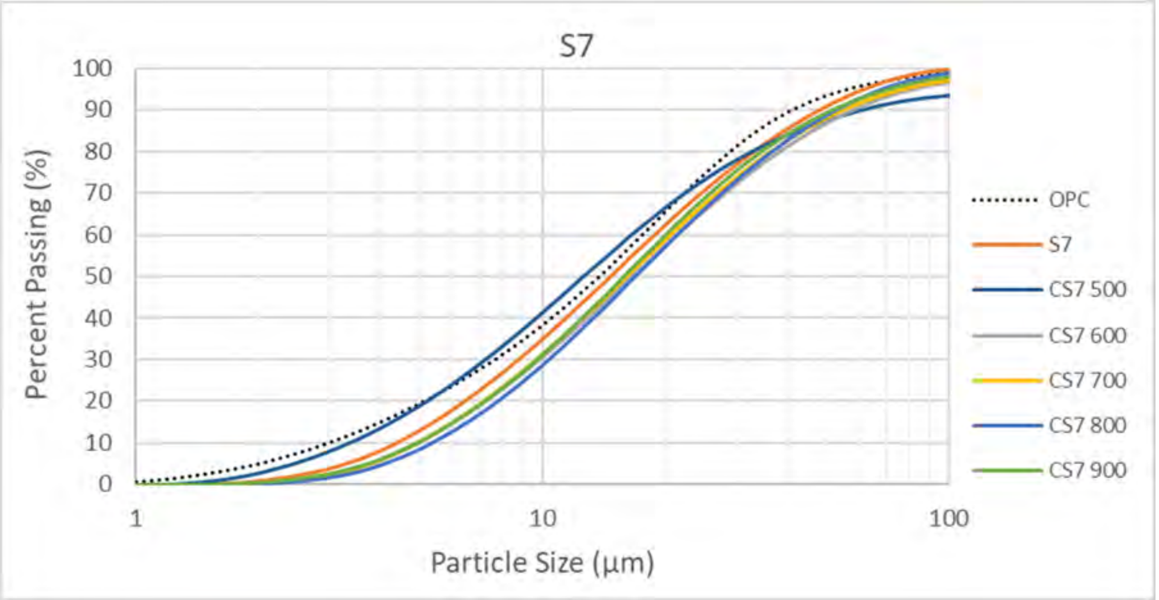


Figure 9: Cumulative Particle Size Distribution of Sample S7 and CS7

Generally, the average particle size distribution of both the raw and calcined sediments range between 15 – 20 µm. With higher temperatures generally leading to a coarser particle size distribution (Figure 10) likely due to the agglomeration and subsequent sintering of clay particles. The only exception to this rule is the CS6/7 500 °C which notably decreases in average particle size, likely due to the initial de-hydroxylation of clay minerals and combustion of organic particles. This particle size distribution is generally similar to and coarser than the ASTM Type I/II Portland cement which limits this sediments potential for particle packing and nucleating effects.

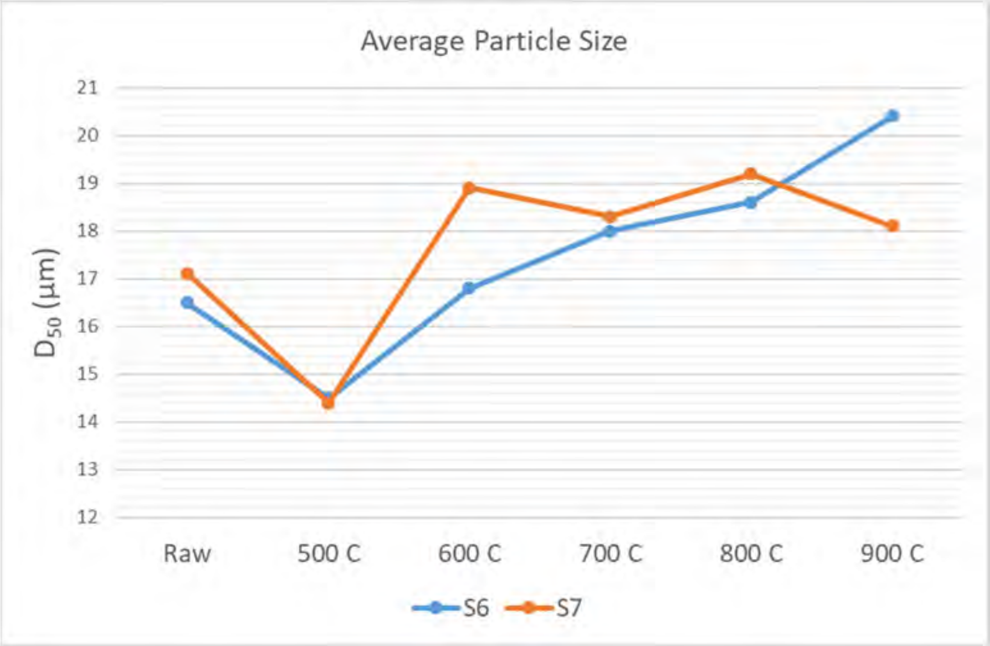


Figure 10: Average Particle Size of Raw and Calcined Sediments

4.2.2 Temperature Optimization based on Compressive Strength

The relative strength (in reference to 100% OPC) of each raw and calcined sediment samples are reported in Figure 11. The minimum relative strength at 7 or 28 days (as reported by ASTM C618) for Class N Pozzolans [6], is reported as a black line at 75% relative strength.

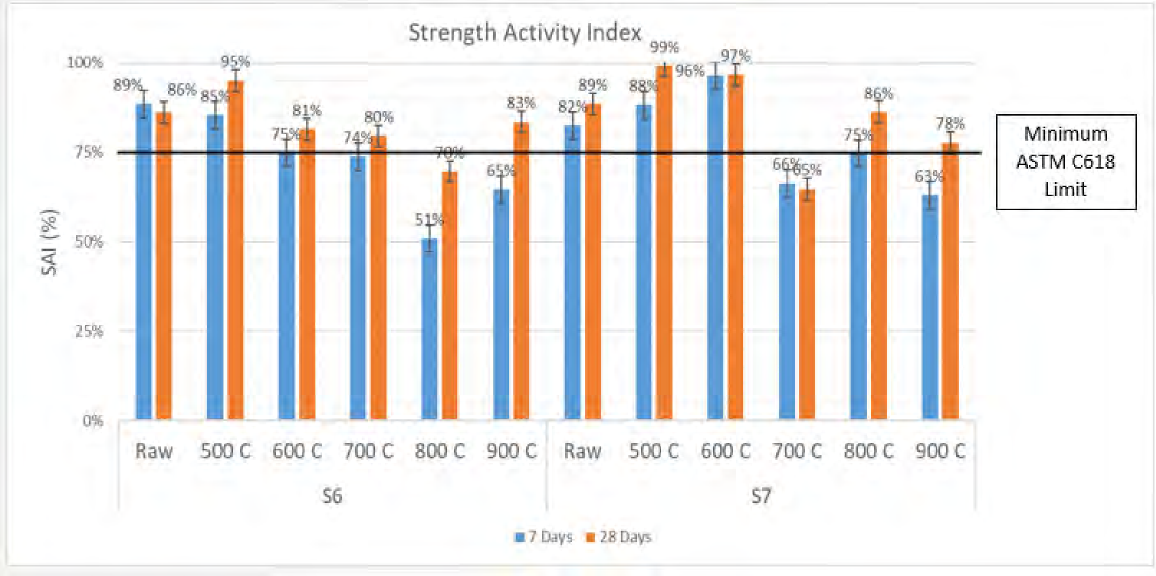


Figure 11: Relative Strength of Raw and Calcined Sediments (Temperature Optimization)

There is a large degree of variation in the relative compressive strength of the sediments with the calcination temperature. This varies from 51 – 96% at 7 days and 65 – 99% at 28 days. In general the relative strength of the sediments seem to decrease with higher temperature. This is likely due to a combination of factors first and foremost is the sintering and subsequent agglomeration of the heat treated particles mentioned in the previous section. The larger particle size leads to lower particle packing and nucleation capacity, additionally the subsequent lower surface area will decrease the reactivity of the product. Thus, it may be necessary to further grind river sediments after calcination in order to mitigate these issues. The next reason is due to the potential recrystallization of pozzolanic particles. Diatoms can crystallize and lose their reactivity if they are calcined at 800 – 900 °C for over 4 hours [21] [22]. Kaolinite can recrystallize into spinel and eventually mullite if calcined at or above 900 °C [19] [20]. The final potential reason for the high variation in the sediment quality is due to potential variability within the sample itself. These samples were collected from the (fine portion) sediment at multiple places along the riverbed. The potential variation in the sample may lead to variation within the compressive strength.

Based on these results, the greatest level of relative compressive strength achieved was at 500 °C for both sample S6 and S7 (max 95% and 99% at 28 days). This temperature is typically lower than what is used for calcined clays in industry, which typically use temperatures between 700 – 800 °C. However, due to the high levels of compressive strength recorded and the potential for cost savings during production, 500 °C was still utilized for the final process. Unfortunately, XRD results (Figure *6* and Figure *7*) suggest that not all of the kaolinite fully de-hydroxylate when prepared at this temperature. This does not seem to negatively affect compressive strength results but will have a significant effect on other durability properties (such as ASR mitigation). However, as the ideal calcination temperature was based on compressive strength, 500 °C was still the temperature chosen. However, the final production process had two changes in order to compensate for these changes. First the sediment was held at the target calcination temperature for two hours instead of one in order to further de-hydroxylate the kaolinite in the system. Additionally, after the calcination process the sediment was sieved through the 90 µm (No. 170) sieve a second time in order to remove the coarser (agglomerated) elements. Testing for this sieving process can be seen in Figure 12, where the relative strength of the CS samples calcined at 700 °C are compared between the original and re-sieved samples.

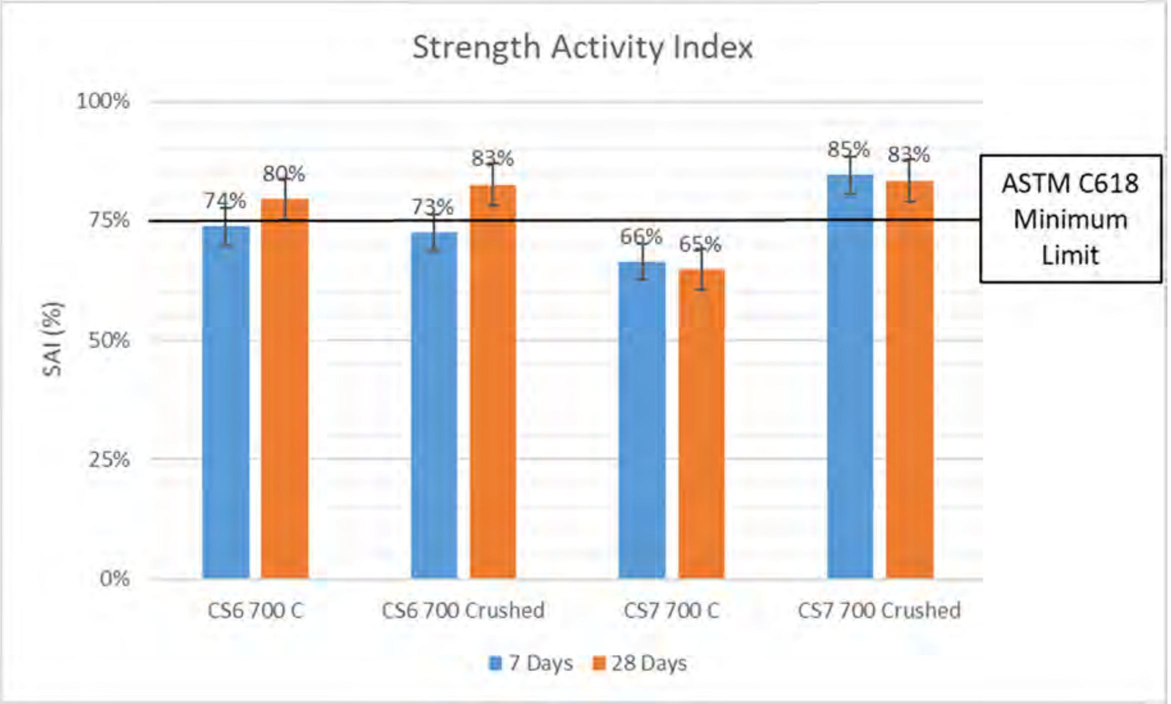


Figure 12: Relative Strength of CS 700 °C Samples Prepared with the Original Method and Re-Sieved

4.3 Final Product

4.3.1 XRD Diffraction

The X-Ray Diffractograms for the sediments calcined at 500 °C for one hour (initial process) and for 2 hours (final process) can be seen in Figure 13 and Figure 14.

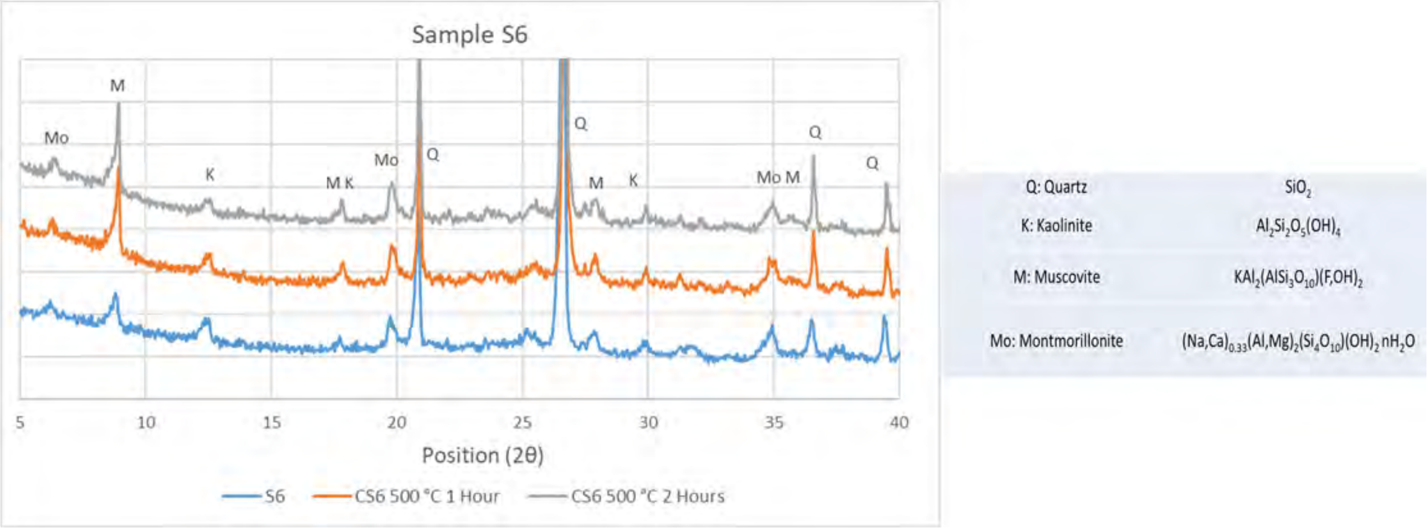


Figure 13: X-Ray Diffractograms of Sample S6 (Final Process)

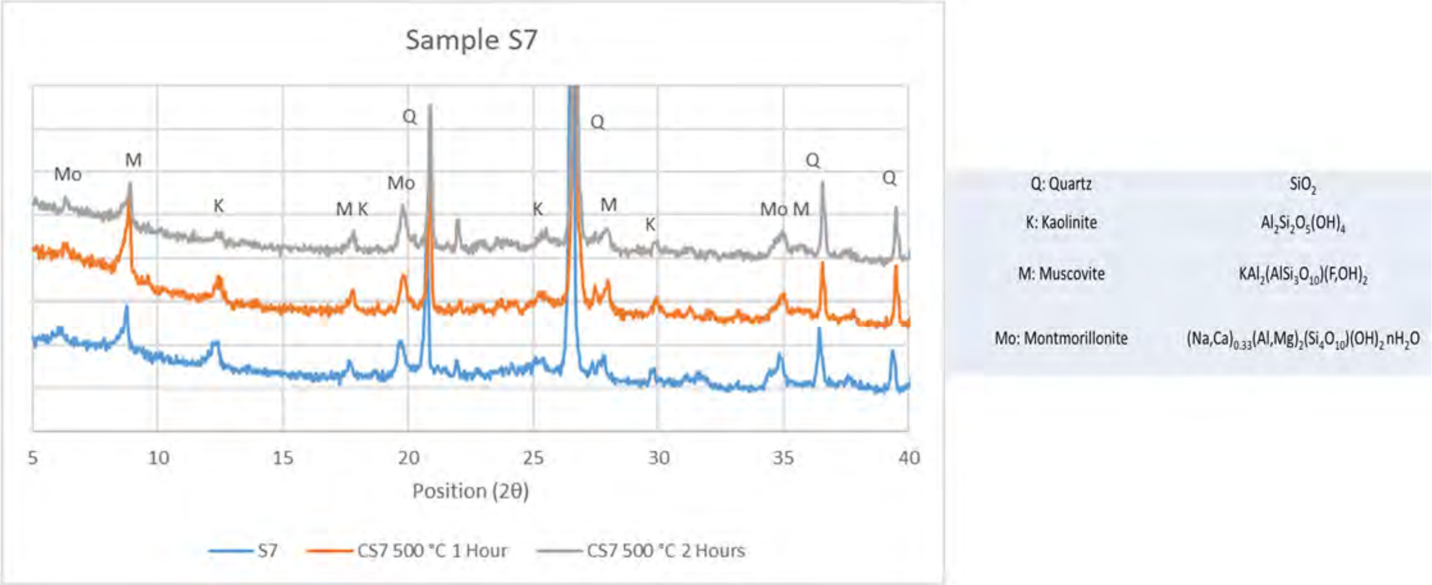


Figure 14: X-Ray Diffractograms of Sample S7 (Final Process)

These X-Ray Diffractograms show little change compared to the original process. All of the same primary mineral phases are still present. Primarily quartz, kaolinite, muscovite, and montmorillonite. The goal of the additional hour of calcination is primarily to de – hydroxylate a greater quantity of kaolinite in the sediment samples. The primary kaolinite peak (seen at 12.4 °2θ) does in fact decrease in intensity with increased calcination time (more notably seen in sample CS7). However, the kaolinite peak does not fully disappear, indicating that complete de-hydroxylation is not achieved. Thus it is unlikely that complete de-hydroxylation can be achieved through a simple increase in calcination time and it may be easier to simply increase the calcination temperature to 600 °C. This process (600 °C) was attempted when testing for the sediments ASR mitigation potential along with the 500 °C process. The rest of the experimentation proceeded with the 500 °C calcination temperature as planned.

4.3.2 Isothermal Calorimetry

The results of isothermal calorimetry test on blended cement pastes (in both normalized and cumulative forms) can be seen in Figure 15 and Figure 16. These results are normalized by solid binder mass and reported against time.

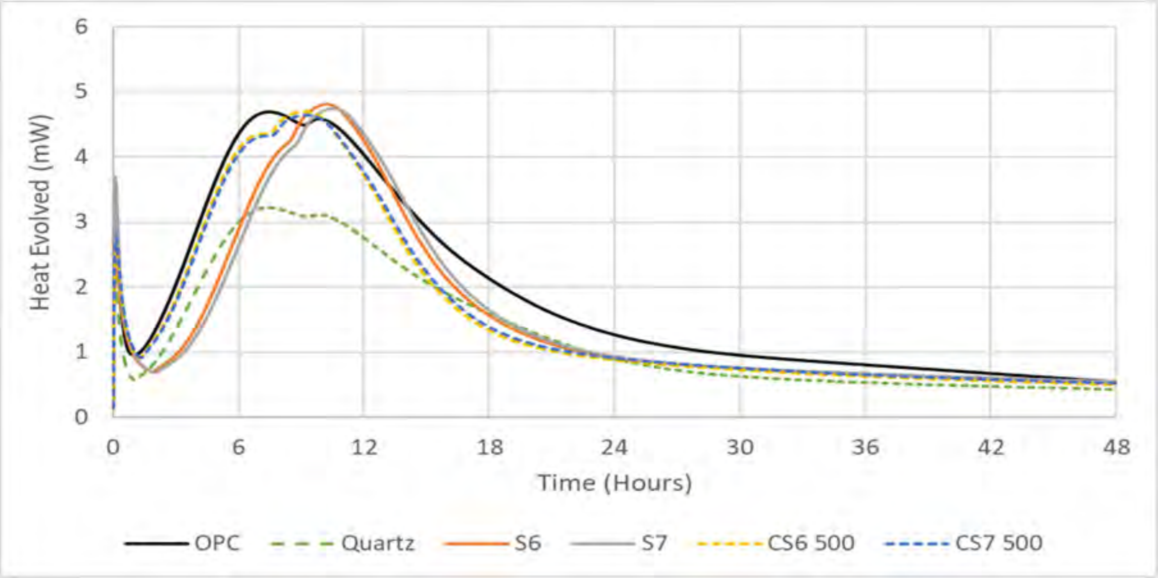


Figure 15: Normalized Rate of Heat Evolution of Calcined Sediments

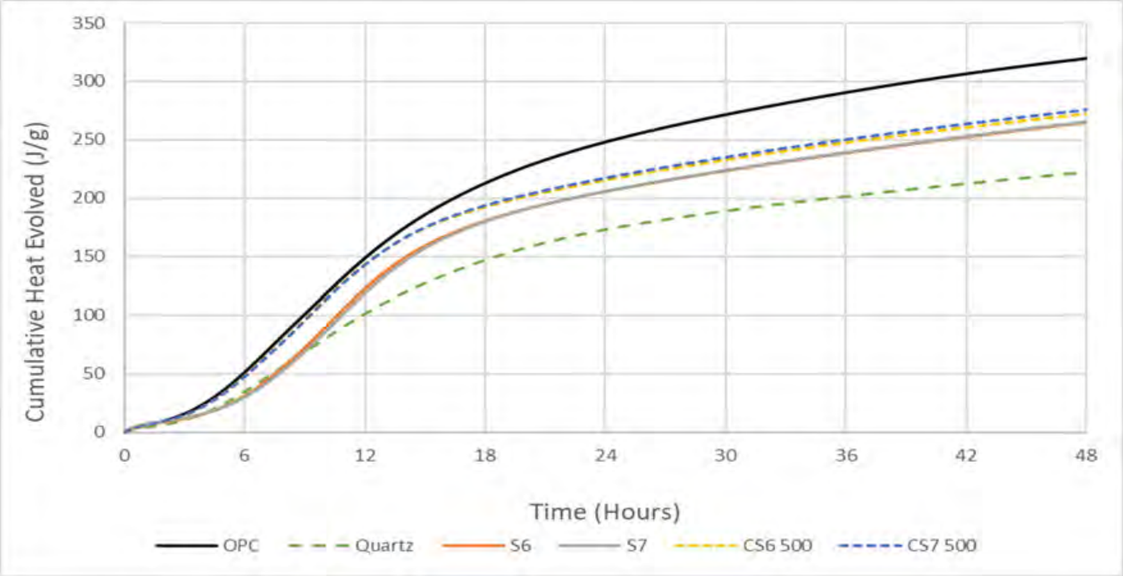


Figure 16: Cumulative Rate of Heat Evolution of Calcined Sediment

Figure 15 shows the normalized rate of heat evolution of the calcined sediments. The raw sediments in this experimentation show a net rightward shift in the heat rate. This delay is likely an artifact associated with the agglomeration of clay particles after being mixed with water. The clay particles may entrap water or cement particles thus slowing the rate of reaction. The magnitude of the heat released is very similar to that of Ordinary Portland Cement. This may potentially be due to an artificially low water-to-binder ratio (due to entrapped water mentioned earlier), nucleation effects, or due to the inherent pozzolanic reactivity of these raw sediments (due to the presence of diatomaceous earth). After calcination the sediments reaction rate accelerate to a level similar to that of Ordinary Portland Cement, indicating that the sediment no longer entraps water and cement. However, the magnitude of the heat evolution of the raw and calcined sediments do not change significantly.

The cumulative heat results shown in Figure 16 show a level of heat released at 48 hours in the raw sediments of 264 and 265 J/g (S6 and S7) compared to the hat released in the non – reactive quartz mix of 222 J/g. This is in comparison to the 100% OPC comparison of 319 J/g. The difference between the quartz and raw sediments are likely indicative of the reactivity of the diatoms in the raw sediment. After calcination there is a slight increase in the level of cumulative heat released to 272 and 275 J/g (CS6 and CS7) after calcination. Due to the lack of change in the magnitude in normalized heat evolved this is likely due to the acceleration observed in Figure 15 due to the lack of agglomeration, as opposed to a direct change in pozzolanic reactivity.

4.3.3 Thermogravimetric Analysis

The primary purpose of thermogravimetric analysis is to determine the calcium hydroxide content of blended cement pastes via thermal degradation. The extrapolated calcium hydroxide contents (7, 28, and 56 days) of cement pastes blended with calcined sediments can be seen in Figure 17.

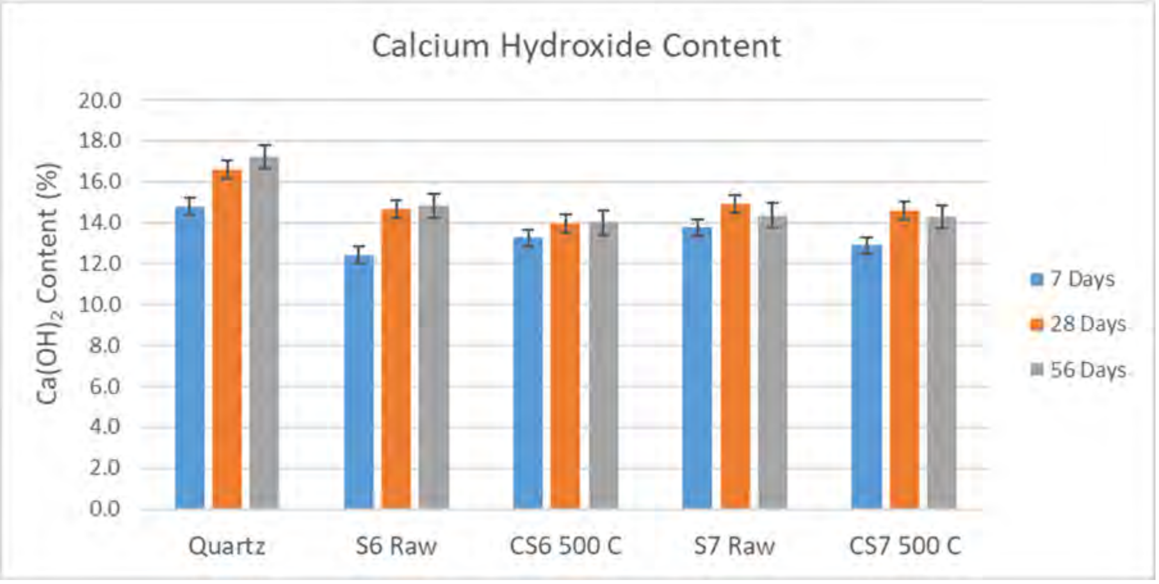


Figure 17: Calcium Hydroxide Content of Blended Cement Paste (Final Process)

The $Ca(OH)_2$ content of the non–reactive quartz mix raises from 14.8% at 7 days to 17.2% by 56 days due to the reaction of C_3S and C_2S to form Calcium Silicate Hydrate (C-S-H Gel – the primary strength giving phase in concrete) and $Ca(OH)_2$. The raw Conowingo sediment possess a $Ca(OH)_2$ content varying from 12.4% to 14.9% with time. This net drop in $Ca(OH)_2$ content of 7 – 17% can be attributed to the innate pozzolanic reactivity of the sediment (primarily caused by the presence of reactive diatoms). After calcination, the $Ca(OH)_2$ content of the sediments drops to 12.9% to 14.0% with time, a net drop of 10 – 19% compared to the non–reactive quartz. While there is a net drop in $Ca(OH)_2$ between the raw and calcined sediments, which would indicate a more aggressive pozzolanic reaction, this change is not significant. This

Ca(OH)2 drop does not exceed 1% at any point in time. In fact, for sample S7, the steady state (56 days) $Ca(OH)_2$ content for the raw and calcined samples are nearly identical, indicating that there is no difference between the raw and calcined sediments. This suggests that the reactivity of the calcined sediment is not fully activated by heat treatment at 500 °C, suggesting that a higher degree of calcination is needed for reliable use.

4.3.4 Relative Compressive Strength

In order test the efficacy of the new calcination process at a longer time frame, additional mortar cubes were mixed and tested with the same method discussed with the temperature optimization section. The results of this process can be seen in Figure 18which reports the relative strength of these mixes at 7, 28, and 56 days in reference to 100% OPC.

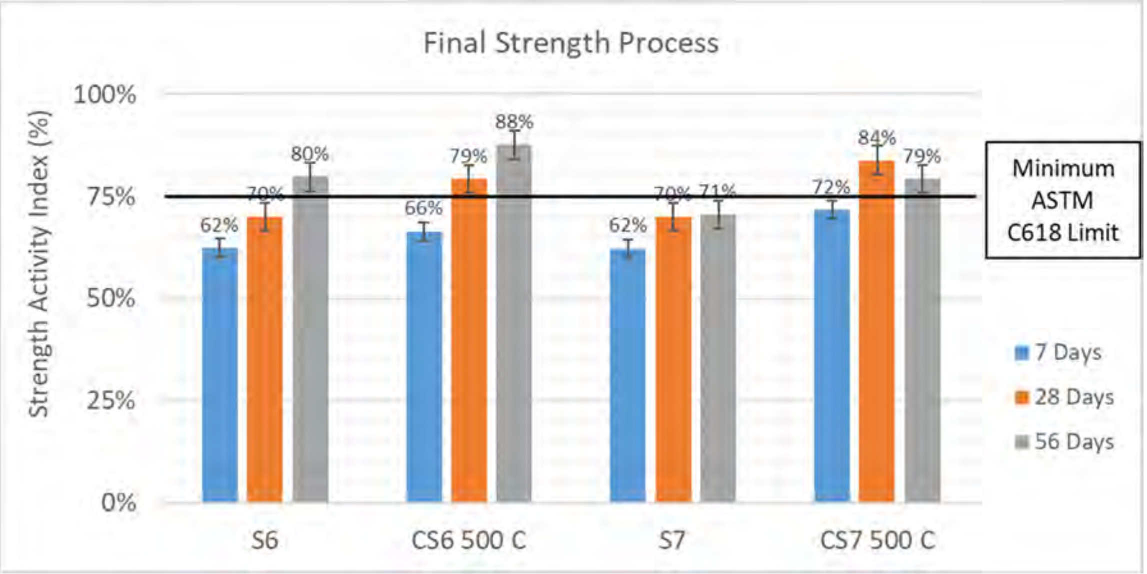


Figure 18: Relative Compressive Strength of Conowingo Sediment (Final Production Process)

The relative strength of the raw sediments vary with time from 62% to 80% for sample S6 and 62% to 71% for sample S7. This rise in relative compressive strength over time is an indication of the presence of the pozzolanic reaction. If the SCM used in this scenario were completely non – reactive the relative strength would generally stay constant with time. This steady rise in compressive strength is generally not explained by other potential effects that SCMs may influence, as the particle size distribution of the sediments are very similar to the distribution of OPC.

After calcination the relative strength of these sediments increase to 66 – 88% for sample CS6 and 72 – 84% for sample CS7. Given that the calcination of these sediments does not significantly decrease the particle size distribution of the sediment below the level of OPC, it is unlikely that this change is caused by significant physical differences between the samples. Instead it is more likely that this increase in relative compressive strength is caused by an increased degree of pozzolanic reactivity. However, more concerning is the noticeable difference between the results reported in Figure 11 and Figure 18. As the calcined sediments were treated with different methods (calcination time and sieving), these differences can be partially attributed to the differences in these processes. However, the raw sediments were prepared, mixed, and stored with the exact same methods. These sediments went from a relative compressive strength of 82 – 89% in the temperature optimization process to 62 – 70% relative strength with the second series of tests. The strength drop is not explainable by simple standard variation, instead it is due to a high degree of variation of the sample composition. Since the sample was collected from multiple points in the river bed, the different quantities of the mineral phases cause a similarly wide variation in sample performance. This variation in sample performance would make the final product unreliable.

4.3.5 ASR Mitigation

Calcined Conowingo sediment was mixed and set into mortar bars for the accelerated mortar bar test (ASTM C1567). Samples tested included S6, S7, CS6 500 °C, CS7 500 °C, CS6 600 °C, CS7 600 °C, Class F fly ash comparison, and the metakaolin comparison. All of the calcined Conowingo sediments were prepared using the final calcination process. For this experiment an additional series of tests were performed on sediments calcined at 600 °C. Based on prior experimentation, a 500 °C calcination temperature only provides marginal benefits to pozzolanic reactivity. A greater calcination temperature was utilized here in order to determine if 600 °C provides a significant difference in the mitigation of the Alkali Silica Reaction. The results of this experimentation can be seen in Figure 19, which reports averages expansion against time (Days).

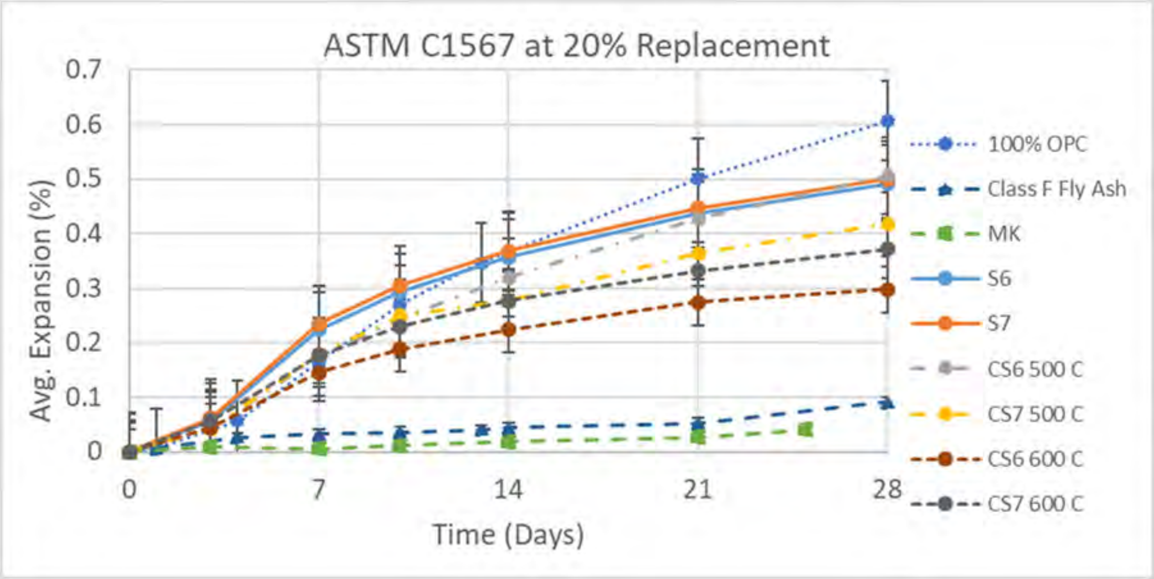


Figure 19: Accelerated Mortar Bar Test for Conowingo Sediments

(Note: MK sample was ended at 25 days due to issues with Covid-19)

The expansion of raw Conowingo sediments notably expand past the 0.1% expansion limit at 14 days as required by ASTM C1567 [11], reaching 0.37% expansion at 14 days and 0.5% expansion at 28 days. The rate of expansion for these sediments are notable as the rate of expansion at early ages 0 – 14 days actually exceed the expansion of the 100% OPC comparison. This unusual for non – reactive materials and especially unusual for pozzolanic materials, as there is usually some decrease in expansion when SCMs are blended in mortar regardless of the degree of reactivity. This may potentially be caused by the unusually high alkali content of these materials (Table 1), the sources of these alkali are likely the Na/K based clays in the sediments (montmorillonite and muscovite). The presence of these alkalis may aggravate the alkali silica reaction.

Calcination at 500 °C only marginally decreases the expansion of the blended mortar bars. Sample CS7 possesses a 28 day expansion of 0.41% and CS6 possesses a 28 day expansion of 0.5%, nearly indistinguishable to the 100% OPC comparison. According to Figure 13 the kaolinite peak for sample CS6 500 °C barely changes. Which would explain the lack of difference between the raw and calcined versions. Calcination at 600 °C decreases the expansion of these mortar bars even further, especially for the CS6 sample. These samples now reach a 28 day expansion of 0.3% for sample CS6 and 0.37% for sample CS7. A large drop in average expansion is noted for sample CS6 likely due to the larger quantity of kaolinite that is de – hydroxylated. None of these calcined samples actually pass the 14 day expansion limit, indicating a distinct lack of pozzolanic reactivity even when calcined at a higher temperature.

5.0 Summary and Recommendations

In accordance with Objective number 1, GDOT collected sediment from multiple locations in the riverbed. Geotechnical analysis, primarily particle size distribution, was performed and the finely grained cut of this sediment was delivered to the Georgia Institute of Technology. Two five gallon buckets of the finely grained cut of dredged river sediment from the riverbed of the Susquehanna River, near the Conowingo Dam in Maryland, were subsequently delivered.

Bench scale testing was than performed, in accordance with objective 2, in order to measure potential pozzolanic reactivity and it’s potential as a natural pozzolan as determined by ASTM C618. This material was dried, crushed, and passed through a No. 170 (90 µm) sieve before being calcined and tested. It was confirmed via scanning electron microscopy and X – Ray Diffraction that the river sediment possesses several potential sources of pozzolanic reactivity. This includes the presence of diatoms, single celled algae which readily exhibit pozzolanic reactivity, and several kinds of clay (kaolinite, montmorillonite, and muscovite) which can exhibit pozzolanic reactivity upon calcination. An ideal calcination temperature was determined through the relative compressive strength of mortars blended with calcined sediment between 500 – 900 °C in 100 °C intervals. The greatest level of compressive strength was identified at 500 °C, as such further testing was conducted at this level of calcination.

Unfortunately, further testing on pozzolanic reactivity (via Isothermal calorimetry and TGA) suggest that calcination at 500 °C only adds a marginal increase in reactivity in comparison to its raw source material. Experimentation on ASR mitigation (ASTM C1567) confirm that these calcined sediments provide little improvement to the durability of blended mortar. Increasing the calcination temperature to 600 °C mitigates the expansion of these mortar bars to a more noticeable degree. However, this mitigation never met the 0.1% 14-day expansion limit. Finally, additional compressive strength testing reveals a wide variation in the quality of the final product. In some cases this variation in relative compressive strength can reach up to 20%, likely due to variability within the sample composition.

To summarize, the sediments dredged from the Susquehanna River does possess a degree of potential pozzolanic reactivity. However, this pozzolanic reactivity is not fully realized at the ideal calcination temperature for relative compressive strength (500 °C). This lack of pozzolanic reactivity will lead to a tradeoff between compressive strength and other durability contributions (such as ASR mitigation) at higher temperatures. Additionally, the high variation of the source material contributes to a large degree of unpredictability in performance as a natural pozzolan.

In accordance with objective 3 recommendations will be made on future work and alternative uses for this sediment. Further investigation should be conducted on this material, including processing at higher calcination temperatures and through rapid cooling, to more completely determine the effects of materials variability and processing on durability. For example, a greater level of pozzolanic reactivity may be achieved if the sediment is forcibly cooled after the heating process, instead of allowing the sediment to naturally cool to ambient temperatures. The gradual cooling process currently utilized allows the material to more easily recrystallize. Additionally, a grinding process may be utilized after the calcination process in order to facilitate increased reactivity and particle packing effects. In its current state the calcined sediment possesses an average particle size one magnitude greater than the commercial metakaolin limiting its potential reactivity. There is therefore much room for improvement there. Additionally, the sample variation should be accounted for in some fashion. A geological survey could be conducted on sediment collected from the riverbed, in order to quantify the level of geological variation. Additionally, if the sediment is homogenized upon collection it would result in a more predictable final product.

6.0 Bibliography

[1] R. Blanks and H. Meissner, "Expansion Test as a Measure of Alkali-Aggregate Reaction," *Journal of the American Concrete Institute,* vol. 17, no. 5, pp. 517 - 539, 1946.

[2] R. Fernandez, F. Martirena and K. Scrivener, "The origin of pozzolanic activity of calcined clay minerals: A comparison between kaolinite, illite, and montmorillonite," *Cement and Concrete Research,* pp. 113-122, 2011.

[3] S. Hollanders, R. Adriaens, J. Skibsted, O. Cizer and J. Elsen, "Pozzolanic reactivity of pure calcined clays," *Applied Clay Science,* pp. 552-560, 2016.

[4] A. C150, "Standard Specification for Portland Cement," *American Society of Testing and Materials,* pp. 1-9, 2020.

[5] A. C204, "Standard Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus," *American Society for Testing and Materials,* pp. DOI: 10.1520/C0204-18E01, 2018.

[6] A. C618, "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete," *American Society for Testing and Materials,* pp. DOI: 10.1520/C0618-19, 2019.

[7] A. C430, "Standard Test Method for Fineness of Hydraulic Cement by the 45-micron (No. 325) Sieve," *American Society for Testing and Materials,* Vols. DOI: 10.1520/C0430-17, pp. 1-3, 2017.

[8] A. C305, "Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency," *American Society of Testing and Materials,* pp. 1-3, 2014.

[9] F. Silva, R. Junior, J. Silva, C. Brito, H. Andrade and J. Goncalves, "Consumption of calcium hydroxide and formation of C-S-H in cement pastes," *Journal of Thermal Analysis Calorimetry,* pp. 287-293, 2014.

[10] A. C109, "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)," *American Society for Testing and Materials,* pp. DOI: 10.1520/C0109_C0109M-20A, 2020.

[11] A. C1567, "Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)," *American Society of Testing and Materials,* pp. DOI: 10.1520/C1567-13, 2013.

[12] P. Lopez, J. Descles, A. Allen and C. Bowler, "Prospects in diatom research," *Current Opinion in Biotechnology,* vol. 16, no. 2, pp. 180-186, 2005.

[13] E. Sierra, S. Miller, A. Sakulich, K. MacKenzie and M. Barsoum, "Pozzolanic Activity of Diatomaceous Earth," *The American Ceramic Society,* pp. 3406-3410, 2010.

[14] J. Marsters and H. Christian, "Hydraulic Conductivity of Diatomaceous Sediment from the Peru Continental Margin Obtained during ODP Leg 112," *In Suess, E., von Huene, R., et al. Proc. ODP, Init. Repts,* pp. 633-638, 1990.

[15] C. He, E. Makovicky and B. Osbaeck, "Thermal Treatment and Pozzolanic activity of Na- and Ca-montmorillnoite," *Applied Clay Science,* vol. 10, no. 5, pp. 351-368, 1996.

[16] P.-I. Au, S.-Y. Siow, L. Avadiar, E.-M. Lee and Y.-K. Leong, "Muscovite mica and kaolin slurries: Yield stress-volume fraction and deflocculation point zeta potential comparison," *Powder Technology,* vol. 262, pp. 124-130, 2014.

[17] S. Guggenheim, Y.-H. Chang and A. Groos, "Muscovite dehydroxylation: High-Temperature Studies," *American Mineralogist,* vol. 72, pp. 537-550, 1987.

[18] G. Yao, H. Zang, J. Wang, P. Wu, J. Qiu and X. Lyu, "Effect of Mechanical Activation on the Pozzolanic Activity of Muscovite," *Clays and Clay Minerals,* vol. 67, pp. 209-216, 2019.

[19] M. Bellotto, A. Gualtieri, G. Artioli and S. Clark, "Kinetic Study of the Kaolinite-Mullite Reaction Sequence. Part I: Kaolinite Dehydroxylation," *Physics and Chemistry of Minerals,* vol. 22, pp. 207-214, 1995.

[20] A. Gualtieri, M. Bellotto, G. Artioli and S. Clark, "Kinetic Study of the Kaolinite-Mullite Reaction Sequence. Part II: Mullite Formation," *Phys Chem Minerals,* vol. 22, pp. 215-222, 1995.

[21] R. Reka and e. al, "Diatomaceous Earth: Characterization, thermal modification, and application," *Open Chemistry,* vol. 19, no. 1, pp. 451-461, 2021.

[22] R. Zheng, H. Gao, A. Zhang and Z. Bian, "Effects of Calcination on Silica Phase Transition in Diatomite," *Journal of Alloys and Compounds,* vol. 757, pp. 364-371, 2018.

APPENDIX J

STABILIZATION AND SOLIDIFICATION BENCH SCALE TESTING RESULTS

TIPPING POINT
RESOURCES GROUP

July 23, 2021

Stephen J. Bedosky, P.G.
Principal Hydrogeologist
Northgate Environmental Management, Inc.
Frederick, Maryland
Via email: steve.bedosky@ngem.com

Subject: Bench-Scale S/S Testing and Beneficial Use Evaluation
Conowingo Dam, Maryland

Dear Mr. Bedosky,

This letter report provides the results and interpretation of treatability testing activities conducted as part of the sediment investigation for the Conowingo Dam site located on the Susquehanna River, between Cecil and Harford Counties in Maryland. The sediment investigation is being conducted for Northgate Environmental Management ("NGEM") ahead of future sediment removal from within the dam pool.

NGEM retained Tipping Point Resources Group, LLC ("Tipping Point") to provide support services related to the geotechnical testing and potential structural innovative reuse/beneficial use ("IRBU") applications of sediment removed from behind the Conowingo Dam during the 2019-2020 pilot campaign. The objective of this study was to provide geotechnical stabilization information for the State of Maryland and the NGEM development team, to determine the most environmentally and economically responsible IRBU applications for Conowingo Dam sediment (for further analysis in later phases of the project). The sheer volume of sediment to be removed from within the dam pool will necessitate a multitude of IRBU alternatives, particularly to avoid the oversaturation of specific markets.

Tipping Point retained the Rutgers University GeoEnvironmental Laboratory ("Rutgers") to perform the laboratory treatability testing activities. The laboratory testing program was designed to determine the geotechnical properties of stabilized Conowingo Dam sediments as would be produced using both traditional and innovative pozzolanic binders for sediment stabilization/solidification and IRBU. The laboratory program included a range of binder types, binder addition rates, and sediment water contents to assess the range of representative stabilized Conowingo Dam sediment properties.

This letter report provides a summary of the compiled laboratory data as well as an assessment of IRBU opportunities that best align with the geotechnical properties of stabilized Conowingo Dam sediments. The unconfined compressive strength ("UCS") versus water-binder ratio ("W/C") rating curves presented herein can be used by engineers to determine the potential IRBU of the stabilized material and how much binder (including cost) will be needed to achieve the required material strength for the desired IRBU application.

Scope of Work

The laboratory treatability work presented in this letter report consisted of the following tasks and objectives:

Phase I – Organic Matter Content Analysis

Phase I consisted of the determination of organic matter content for 150 sediment samples (provided by NGEM) using the ASTM D2974 loss-on-ignition ("LOI") test procedure.

Phase II – Material Characterization & Evaluation of Stabilized Sediment

Phase II consisted of the creation and characterization of a composite material followed by stabilization and geotechnical testing of the stabilized sediment samples.

Phase III – Additional Evaluation of Stabilized Sediment

Phase III consisted of additional stabilization and geotechnical testing of dried and rehydrated composite sediment to assess the influence of moisture content on the stabilized material strength.

Phase I – Organic Matter Content Analysis

Phase I consisted of 150 loss-on-ignition tests to determine the organic matter content of the Conowingo Dam sediment samples, using the ASTM D2974 LOI test procedure. LOI testing was conducted on the suspicion that the sediments would contain a large fraction of coal. Individual subsamples containing 30 to 50 grams of sediment were dried in a 105°C oven for at least 16 hours and the mass of dry sediment was determined. Each sample was then placed in a 450°C muffle furnace for at least 16 hours and weighed to determine the organic mass lost. Tabular results were provided to NGEM on February 17, 2021. Figure 1 provides the cumulative frequency distribution of organic matter content for the 150 LOI samples.

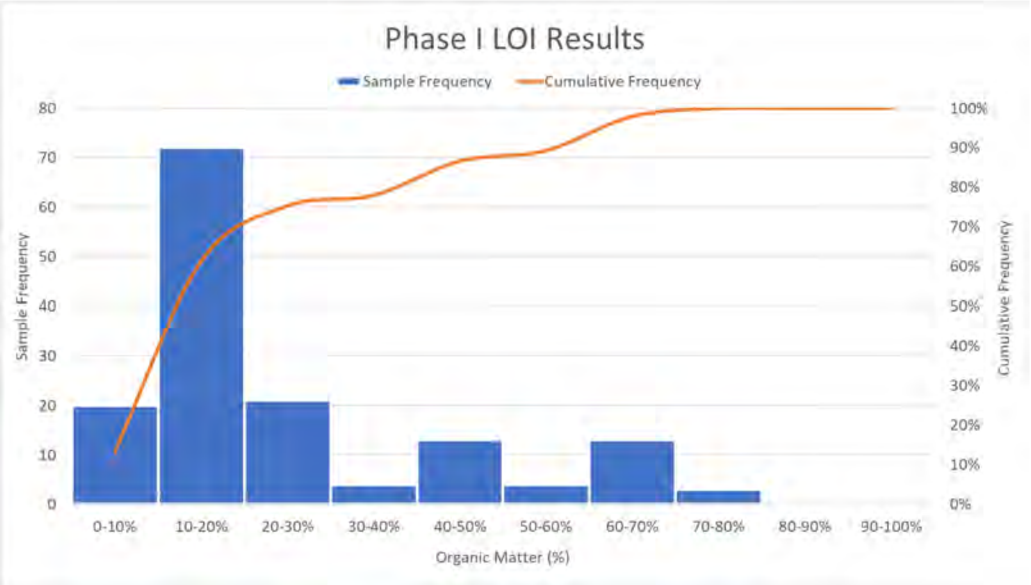


Figure 1. Distribution of LOI organic matter content of 150 Conowingo Dam sediment samples

The results indicate that almost 40% of samples contained organic matter greater than 20%, which is higher than typical values for freshwater sediments. This excess organic material is suspected to be coal, and particle size analysis of these samples revealed a coarse fraction of material presented in Figure 2.

Figure 2. Coarse fraction observed in Conowingo Dam sediment

Phase II – Material Characterization & Evaluation of Stabilized Sediment

Phase II consisted of the creation and characterization of a composite sediment followed by bench-scale stabilization and geotechnical testing of the stabilized sediment samples.

Material Processing/Characterization

Sediment samples were collected from the site and delivered to Rutgers in 5-gallon sealed buckets. The sediment from each bucket was homogenized in the lab to yield a single sample composite, which was characterized and used in subsequent stabilization testing. The natural water content of the composite was measured, and the composite was rehydrated to a target water content to facilitate mixing.

Index properties for the composite sample were measured using standard laboratory testing procedures. The index property test methods and results are presented in Table 1.

Table 1. Index Property Testing Procedures and Results

Test	ASTM Standard	Result
Natural Water Content, *Wn* (%)	ASTM D2216	63%
Organic Matter Content (%)	ASTM D2974	36%
Atterberg Limits (*LL, PL*)	ASTM D4318	Inconclusive*
Grain Size – Hydrometer Test	ASTM D7928	See Figure 2
Grain Size – Sieve	ASTM D6913	See Figure 2
Soil Classification	ASTM D2487	SM with Organic Fines

* The material sand fraction was too high for the testing method.

The composite material was classified according to the Unified Soil Classification System ("USCS") as Silty Sand with Organic Fines, consisting of 0% gravel, 68% sand, and 32% silt/clay. The grain size distribution of the composite sediment is presented in Figure 3.

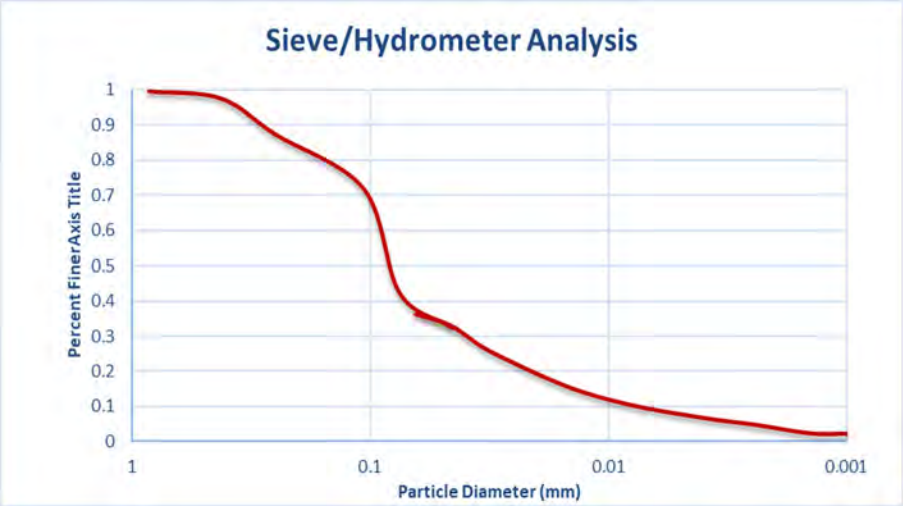


Figure 3. Grain size distribution of Conowingo Dam sediment composite

<u>Bench-Scale S/S Testing</u>

Following baseline characterization, the composite sediment was stabilized with three (3) binders: ordinary Portland cement, green cement (sourced from LafargeHolcim), and a 70:30 blend of Portland cement with blast furnace slag. Mixtures were prepared using each binder at 5% and 10% dosage rates, for a total of 6 unique mixtures. Each mixture was "mellowed" (air-dried) for 48 hours prior to undergoing modified Harvard Miniature compaction and sample preparation. The mellowing and sample preparation procedures were designed to simulate the processing and stockpiling of stabilized material prior to placement for IRBU. Triplicate samples were cured for 0, 3, 7, and 28 days post-compaction and tested for UCS and moisture content. Figures 4 and 5 present the UCS and moisture content results of the samples over time.

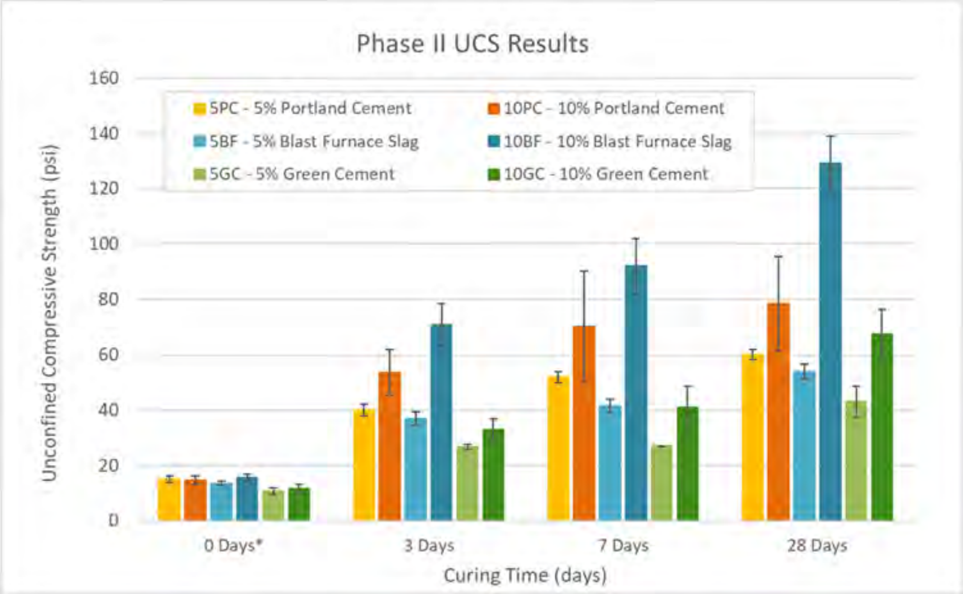


*Figure 4. Unconfined compressive strength vs. curing time (*excludes 48-hour mellowing period)*

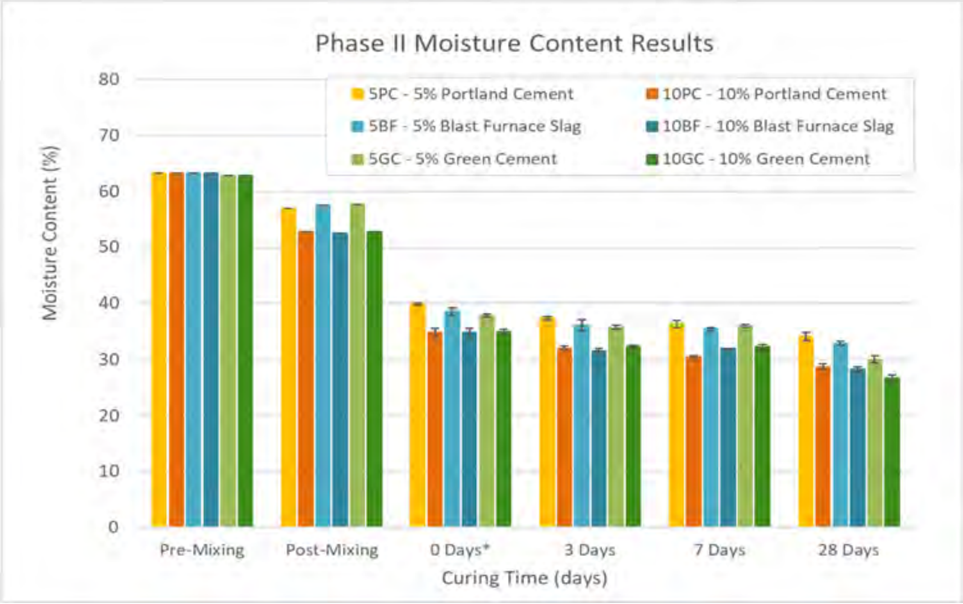


*Figure 5. Moisture content vs. curing time (*excludes 48-hour mellowing period)*

The results indicate that all three binders would produce stabilized material that achieves a minimum required strength for structural fill IRBU applications. Material strength specifications will vary with site-specific use and market applications, but the results indicate that the studied mix designs would be appropriate for the following structural IRBU applications:

- Controlled Low Strength Material (Type A – minimum 28-day UCS of 50 to 200 psi)
- Flowable Backfill (minimum 28-day UCS of 100 psi)

Resources and additional information and references regarding Maryland-specific IRBU material specifications is presented in Table 2 of the Innovative Reuse Interpretation section of this letter report. A lower range of strength values are generally allowable for nonstructural IRBU applications.

Figure 6 presents the UCS versus W/C curves for each of the three binders evaluated during this phase. W/C values were calculated using the mass of cement added in the mixing stage and the amount of water present in the sediment at that time. Presentation of the data as UCS versus W/C allows for a direct comparison of all samples generated during Phase II.

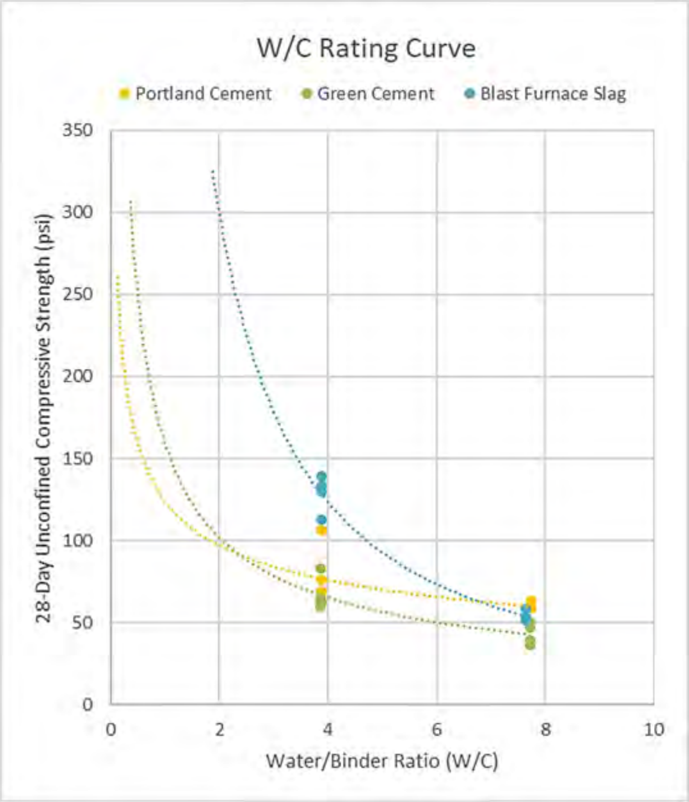


Figure 6. 28-day unconfined compressive strength versus water/cement ratio curves

The curves presented in Figure 6 were fit to the typical power equation relationship described by Dr. Masaki Kitazume[1] : $q_u = a(W/C)^b$. They predict the UCS performance of various mixtures of sediment with cement and water and can be used by engineers to determine appropriate reuse of the stabilized material and estimate the quantity of binder necessary to achieve the desired material strength for IRBU applications.

Phase III - Additional Evaluation of Stabilized Sediment

In Phase III, the composite sediment was dried, then rehydrated at 5 moisture contents (15%, 30%, 40%, 50%, and 65%) and stabilized with 5% and 10% Portland Cement to create a total of 10 unique mixtures. These mixtures were “mellowed” for 48 hours prior to undergoing modified Harvard Miniature compaction and sample preparation. Triplicate samples were cured for 7 days post-compaction and tested for UCS and moisture content.

Figure 7 presents the average 7-day UCS results versus moisture content for all 10 mixtures tested in Phase III.

---

[1] Kitazume M. (2017). *The Pneumatic Flow Mixing Method*. New York: CRC Press

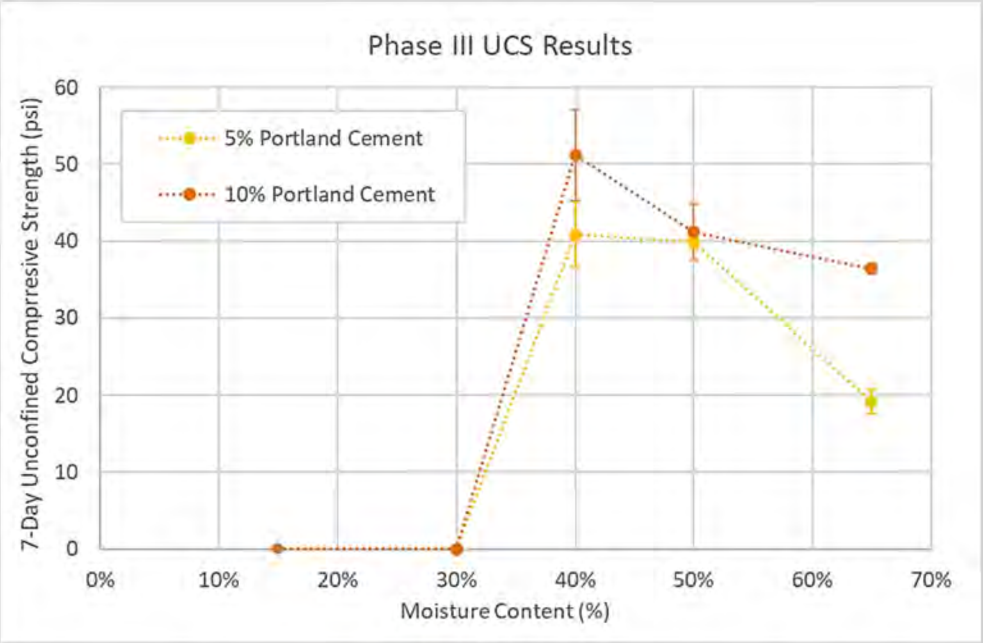


Figure 7. Average 7-day unconfined compressive strength versus moisture content results

The results of Phase III indicate that the optimum moisture content for stabilization/solidification of Conowingo Dam sediments is around 40%. Mixtures that had a moisture content of 30% or less (consisting of both 5% and 10% Portland cement) were unable to be compacted into self-supporting cores at the time of compaction, resulting in 7-day UCS values of 0 psi. The UCS results for mixtures that had moisture contents above 30% follow the pattern typically observed for Proctor compaction and are informative for use in construction and design.

Innovative Reuse Interpretation

Figure 8 provides a schematic of the potential pathways for Conowingo Dam sediment management, from dredging to disposal or IRBU. A number of processing and manufacturing technologies exist that can “plug in” to this pathway and add value to the fine-grained and/or coarse fractions of dredged sediment to generate usable products. This discussion of Conowingo Dam sediment IRBU will focus on the innovative Pneumatic Flow Tube Mixing (PFTM) process for the stabilization of soft sediments (< than 40% sand) and other removal and dewatering strategies for coarser grained material.

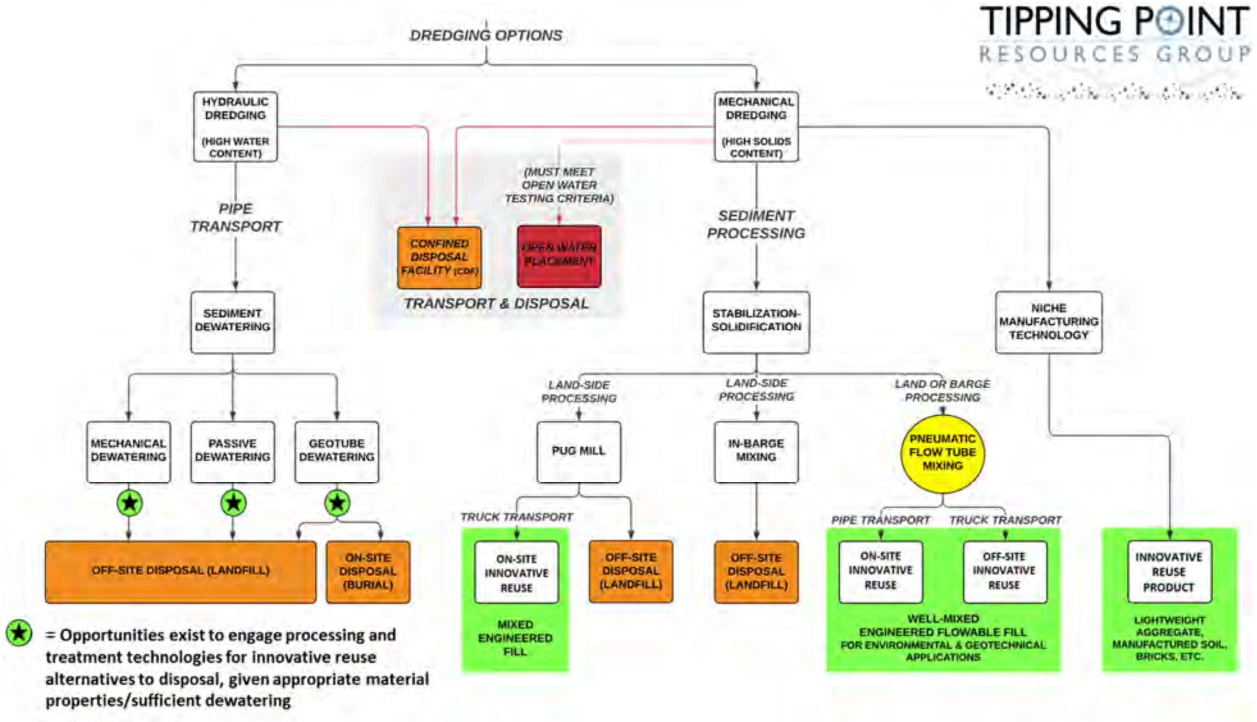


Figure 8. Schematic of sediment management pathways from dredging to disposal or IRBU

The PFTM process is not exclusive to Conowingo Dam sediment stabilization but could be complimentary to other processing and disposal/placement options. Key considerations for Conowingo Dam sediment management include the dam's location within a section of the Susquenna River where the staging of dredging and processing equipment would be limited. One contribution of the PFTM process to the IRBU of Conowingo Dam sediments is that PFTM can be operated directly on a barge, with subsequent pumping of the stabilized sediment mixture up to 1 kilometer (or further with booster pumps) to either an upland staging area (further upstream) or another barge. From there, the material could be further cured and transported for IRBU offsite. An additional advantage of the PFTM process for sediment stabilization is the homogeneity and reliability of the engineered sediment-binder mixture. Unlike other traditional stabilization/solidification processes, PFTM produces a well-mixed engineered flowable fill that is most comparable to controlled laboratory mixing, allowing the stabilized product to be designed and utilized for a number of structural IRBU applications. Table 2 provides examples of such applications, with corresponding material specifications defined by Maryland Department of Transportation construction specifications and other relevant resources.

Table 2. List of Material Specifications for Stabilized Sediment IRBU Applications - Maryland Focus

Application	Description	Shear Strength Specification	Specification Source	Achievable with Conowingo Dam Sediments?
Flowable Backfill	Uses include utility cut backfill, pipe backfill, or for filling abandoned pipes	Minimum 28-day UCS of 100 psi	MDOT SHA, 2021[2] (314.02)	**Yes**
Controlled Low Strength Material (CLSM) – Type A	Used where future excavation may be necessary, e.g., utilities trenches, pipe trenches, bridge abutments, and around box culverts	28-day UCS of 50 to 200 psi	MDOT SHA, 2021 (902.16)	**Yes**
Controlled Low Strength Material (CLSM) – Type B	Used where future excavation is not anticipated, e.g., filling abandoned conduits/pipes/tunnels/mines /etc. or replacing unsuitable soils below roadway and structure foundations	Minimum 28-day UCS of 500 psi	MDOT SHA, 2021 (902.16)	**Possibly**, given appropriate stabilization mix design
Cement Treated Base Course (CTB)	Road construction layer immediately beneath surface course, supplying additional load distribution and drainage contribution	Typical 7-day UCS between 450 to 700 psi	MDOT SHA, 2021 (502.03)	**Possibly**, given appropriate stabilization mix design
Cement Modified Subgrade (CMS)	Material upon which road construction layers (subbase, base, surface) are placed, often an influential factor in pavement performance	Typical 7-day UCS between 100 to 300 psi	MDOT SHA, 2021 (502.03)	**Possibly**, given appropriate stabilization mix design
Landfill Caps & Fills	High-volume application – uses include intermediate or daily cover, capping for closure, and general fill/grading for closure and possible redevelopment	Function of design specification (site-specific)	Maher et al., 2013[3]	**Yes**
Brownfield Caps & Fills (Including Abandoned Mine Sites)	High-volume application – uses include capping material and general fill. Examples of final (post-cap and fill) land uses include golf courses, parking lots, condominium complexes, and highway embankments	Function of design specification (site-specific)	Maher et al., 2013	**Yes**

---

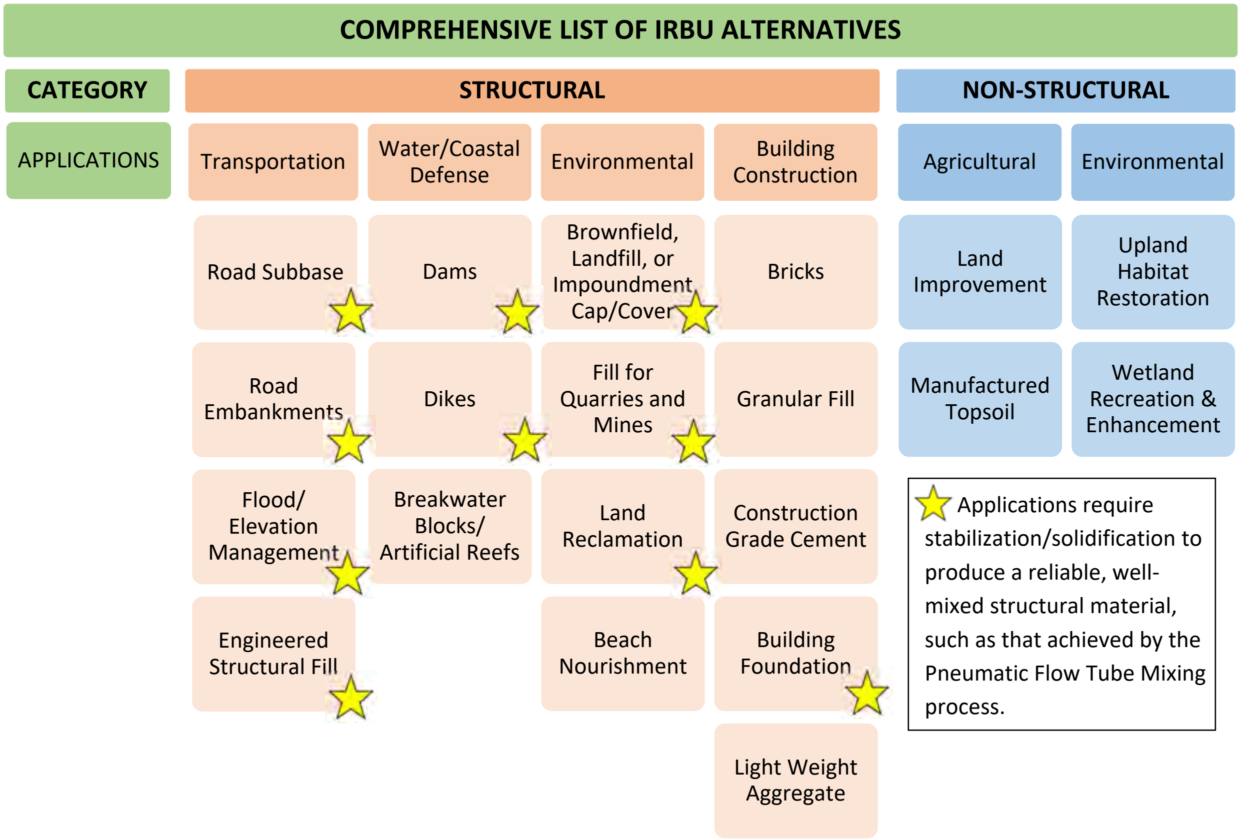
[2] Maryland Department of Transportation State Highway Administration (2021). *Standard Specifications for Construction and Materials.*

[3] Maher, A., Douglas, W. S., Jafari, F., & Pecchioli, J. (2013). *The Processing and Beneficial Use of Fine-Grained Dredged Material: A Manual for Engineers.*

The results of this treatability study indicate that pozzolanic binder (i.e., ordinary Portland cement) solidification/stabilization of sediment from the Conowingo Reservoir can achieve the material strength performance specifications for a variety of IRBU applications, given the appropriate mix design. Further opportunities may exist to offset the cement volume required for stabilization with industrial by-products or additives. Examples include green cement, blast furnace slag, and cement kiln dust. These additives are regionally specific/dependent on local supply chain.

Size-separation and reclamation of coarse-grained particles (predominantly medium to coarse sand fractions and/or presumed coal) present in the Conowingo Dam sediment may be considered prior to stabilization, whether through PFTM or another process. This may be done actively via technologies such as mechanical screening or hydrocyclones, or passively through gravity separation, depending on the timeline and processing area available. Size-separation would enable the possibility of multi-directional IRBU applications from Conowingo Dam sediments: finer grained material could be stabilized for structural and non-structural use applications, as described throughout this report, while the coarser fractions may potentially be utilized for applications such as beach nourishment (where appropriate based on granulometry and site beach characteristics), granular fill, or wetland habitat restoration.

TPRG has qualified a comprehensive list of potential IRBU alternatives for Conowingo Dam dredged sediments, presented in Figure 8. Applications are categorized as structural or non-structural and may benefit a broad variety of sectors, including transportation and building infrastructure, agriculture, water resources, coastal defense, and the environment.



COMPREHENSIVE LIST OF IRBU ALTERNATIVES

CATEGORY	STRUCTURAL				NON-STRUCTURAL	
APPLICATIONS	Transportation	Water/Coastal Defense	Environmental	Building Construction	Agricultural	Environmental
	Road Subbase ★	Dams ★	Brownfield, Landfill, or Impoundment Cap/Cover ★	Bricks	Land Improvement	Upland Habitat Restoration
	Road Embankments ★	Dikes ★	Fill for Quarries and Mines ★	Granular Fill	Manufactured Topsoil	Wetland Recreation & Enhancement
	Flood/ Elevation Management ★	Breakwater Blocks/ Artificial Reefs	Land Reclamation ★	Construction Grade Cement		
	Engineered Structural Fill ★		Beach Nourishment	Building Foundation ★		
				Light Weight Aggregate		

★ Applications require stabilization/solidification to produce a reliable, well-mixed structural material, such as that achieved by the Pneumatic Flow Tube Mixing process.

Figure 9. Comprehensive list of potential IRBU alternatives for Conowingo Dam sediments

In composing this list, Tipping Point considered both scenarios in which the full sediment volume would undergo stabilization/solidification, as well as scenarios in which the material would be size separated to facilitate other IRBU applications (particularly for cobbles and sand). Market over-saturation of one or more realistic IRBU options, based on the large volume of sediments that need to be removed from the Conowingo Dam reservoir, must be considered for the short to long-term horizons. Other important considerations include the relative distance from the processing areas to IRBU end-use/placement site, physical and environmental footprints of processing operations, and scale and efficiency of operations.

Tipping Point appreciates the opportunity to collaborate with NGEM and project partners to facilitate and contribute to the knowledge base of Conowingo Dam sediments and their applications for innovative reuse/beneficial use.

Should you have any questions or concerns, please do not hesitate to contact the undersigned at 203. 858.4034 and/or alfred@tprgllc.com.

Sincerely,

Alfred N. Kovalik, PE, LEP, LEED AP
Managing Partner
Tipping Point Resources Group, LLC

CC: Robert Miskewitz, PhD
Eric A. Stern

APPENDIX K

SOIL FERTILITY TESTING RESULTS

Project title: Germination of major crops in Conowingo reservoir dredge material

Submitted by: Ken Staver
UMD Wye Research and Education Center
124 Wye Narrows Drive
Queenstown, MD 21658
410-827-8056
kstaver@umd.edu

Background – Dredging has been proposed as a way to restore the Conowingo reservoir's capacity to trap sediment transported in Susquehanna River flow thereby reducing sediment and associated nutrient delivery to Chesapeake Bay. A component of this overall strategy is the development of approaches to utilize dredged sediments. This project supports the overall strategy in assessing the germination of major crop species and a turf grass in sediment dredged from Conowingo reservoir with and without locally available organic amendments. Studies have been conducted at the Wye Research and Education Center (WREC) for the last two decades on developing placement options for Chesapeake Bay dredge material and restoring vegetation on dredge material in the north cell of Hart-Miller Island. Ken Staver currently is a member of the Hart-Miller Island vegetation working group.

Objective – The objective of this project is to determine germination rates of major crop species in sediments dredged from Conowingo reservoir with and without additions of locally available organic amendments in a container greenhouse trial at WREC in early spring 2022.

Approach – Sediments dredged from Conowingo reservoir were delivered to WREC by Northgate Environmental Management on March 22, 2022. The material was delivered in sealed 5-gallon buckets and refrigerated immediately at 38 degrees F. Composted yard waste produced by Maryland Environmental Services (Leafgro) was delivered at the same time. The dredge material had a gravimetric moisture content of 0.24 gm water/gm dry soil which was too wet for mixing. On April 5, dredge material was screened through 12 mm square mesh screen to remove coarse material and spread in approximately 5 cm deep layers in fiberglass trays in a greenhouse for drying (Photo 1). Photographs are presented in Attachment A. The primary material removed by screening was small clam shells (Photo 2). On April 9 the material was screened and mixed using an electric mixer (Photo 3). The average gravimetric water content after mixing was 0.071 gm water/gm dry soil.

In addition to Leafgro, dredge material was amended with spent mushroom compost from a production facility in Warwick, MD and broiler chicken house floor manure (poultry litter) obtained from a research stockpile at WREC. The following three blends were created using an electric mixer:

1. Reservoir sediment + Leafgro at 20% of sediment weight (7% water content)
2. Reservoir sediment + mushroom compost at 20% of sediment weight (7% water content)
3. Reservoir sediment + poultry litter at 3% of sediment weight (7% water content)

In addition to these 3 mixes germination, unamended reservoir sediment and a commercial growing mix (81.25% peat moss, 13.75% perlite, 5% vermiculite, Theriault & Hachey Peat Moss Ltd., TH-1 growing mix) also was evaluated. The mixtures and the unamended sediment were tumbled for 5 minutes then 5% water was added to make the material more stable for planting. The commercial growing mix was viewed as a seed germination control treatment.

On April 11, the five growing substrates were placed in 10 cm x 10 cm x 12 cm tapered plastic pots with an approximate capacity of 700 cm^3. Twelve pots were filled level-full with each substrate. A 3 x 3 dibble was used to make 9 holes in the substrate in each plot for planting (Photo 4). Mixtures were planted with corn (*Zea maize*), soybean (*Glycine max*), wheat (*Triticum aestivum*), the three primary agricultural crops in Maryland, and red fescue (*Festuca rubra*) to test emergence of a smaller seeded grass often used in restoration plantings (Photo 5). For corn, soybeans, and wheat, one seed was planted in each hole (Photo 6), while 2 seeds of red fescue were planted in each hole. The pots were arranged by crop and substrate in a 5 x 12 matrix on a growing bench in a ventilated but unheated polyethylene greenhouse at WREC. Originally it was planned to totally randomize pot placement but a grouped arrangement was chosen to make visual differences apparent in photos included in this report. The matrix was surrounded with unplanted pots filled with unamended reservoir sediment to prevent direct sunlight from heating up the pots on the edge of the matrix (Photo 7). After planting all plots were watered with 110 ml of well water.

Early in the study, soil moisture was monitored by weighing unplanted pots of reservoir sediment. Water was supplied when pot weights had dropped approximately 100 gm. As plants emerged and water use varied due to differential plant growth, visual inspection also was used to determine when water was needed. On days when water was supplied, approximately 110 ml of water was supplied to each pot. Later in the study an additional 55 ml of water was supplied to corn and soybean plots that had much more plant growth than the wheat and red fescue treatments.

During the study, air temperature was monitored using a Solinst Levelogger suspended out of direct sunlight under the greenhouse bench. Solar radiation was measured at the WREC weather station with an Eppley PSP pyranometer.

The pots were monitored visually to determine emergence. Any visible plant material breaking through the soil surface was considered emergence. Emergence was tallied in the corn, soybean and wheat treatments on April 15, 16, 18, 19, 20, 21, 22, 25 and May 10. Emergence was slower in the red fescue treatments and emergence was tallied on April 18, 19, 20, 21, 22, 25, 27, 29 and May 4 and 10. All dates referenced are from 2022.

Plant height was monitored by taking visual reading of height of the center plant above the soil surface using a ruler (Photo 8). In the few cases where the center plant did not come up, the height of an adjacent plant was measured. Soybeans were not measured initially since they come out of the soil curled and, in some cases, lifted the soil surface until the next watering. Red fescue height measurement also began later due to slow emergence. Plant height measurements were taken in corn and wheat treatments on April 18, 19, 22, 25, 27, 29 and May 4 and 10. First readings were delayed in red fescue treatments until April 22 and in soybean treatments until April 25.

At the conclusion of the study on May 11, plants from each plot were cut at the soil surface and dried at 65 C to constant weight. Plants were weighed and ground to pass through a #20 mesh sieve. Three samples each of the planting mixtures and unamended reservoir sediment were dried and ground. Plant tissue and mixture samples were sent to Waypoint analytical laboratory in Richmond, Virginia for nutrient analysis.

SigmaStat version 3 was used to perform ANOVA procedures on plant tissue results followed by the post hoc pairwise Hom-Sidak method if the ANOVA was significant. If assumptions of ANOVA were not met, a non parametric ANOVA on ranks was performed followed by the non-parametric pairwise Student-Newman-Keuls method. The level to determine significance in all tests was 0.05.

Results – The daily average of 15 minute temperature readings taken under the greenhouse bench during the April 11 to May 10 study period was 15.9 C ranging from a daily average maximum of 22.2 C on April 14 to a daily average minimum of 8.1 on April 18. After these early extremes side curtains on the greenhouse were raised and lowered based on outside conditions and daily average temperature ranged from 10-19 C for the remainder of the trial. Ambient daily solar radiation during the study averaged 4.82 kW-hr/m^2 ranging from a minimum of 0.92 on May 7 to maximum of 7.35 kW-hr/m^2 on May 9. Light levels inside the greenhouse would be expected to be slightly less due to the polyethylene covering but plants showed no sign of light limitation during the study.

Plant emergence began on April 15, four days after planting (Photo 9). Crusting and cracking of the soil surface was especially apparent in the unamended reservoir soybean treatments (Photo 10) due to the cotyledons pushing through the soil surface in contrast to the other three grass test species which break through the soil surface with a pointed coleoptile (Photo 11). Emergence proceeded rapidly in corn, wheat, and soybean treatments and was largely complete by April 21 (day 10) with the exception of soybeans in the poultry litter amended treatments (Photo 12 and Figures 1-3). Figures are presented in Attachment B. Corn emergence also was slightly delayed in the poultry litter amended treatments but to a lesser extent than for soybeans. The cause of the delay in emergence is unclear, although likely to be related to ammonia present in poultry litter. Typical field practices are to delay planting a few days after poultry litter applications to allow for ammonia levels to drop but in this case planting was done within 24 hours of creating the mixtures. Despite the emergence delays in the poultry litter amended treatments, total emergence rates in all the mixtures and the unamended reservoir sediment were as high or higher than those in the potting mix treatment used as a control and 100% in the majority of the pots (29 of 36). Red fescue emergence was expectedly slower given the much smaller seed size and did not begin until day 7 of the trial (Figure 4). Emergence was notably more rapid in the potting mix, but eventually total emergence in all treatments was as high or higher than in the potting mix treatments.

Plant height also was most notably different in the poultry litter amended treatments. Despite generally slower emergence, soybean height was similar in all treatments by the end of the study and corn and wheat heights were highest in the poultry litter amended treatments at the end of the study (Figures 5-7). While yellowing of leaves consistent with nitrogen deficiency became highly apparent in other treatments as the study progressed (Figures 13-17), corn and wheat plants in the poultry litter treatments were greener in addition to being taller at the end of the study (Photo 18, 19, 20). Even in the soybean treatments, where height differences were minimal among all the treatments, lower leaves were noticeably greener in the poultry litter versus other treatments (Photos 21 and 22). A somewhat different pattern was observed in the red fescue treatments. More rapid emergence in the potting mix treatments resulted in higher initial heights and the differential was maintained through the end of the study (Figure 8).

Final plant biomass values (Attachment C) were consistent with height observations. Harvested corn biomass (Photo 23) in the poultry litter treatments was nearly double that of any other treatment and statistically higher than all other treatments. Despite the lack of yellowing lower leaves in the soybeans growing in the poultry litter amended mix, like height, final biomass was similar in all treatments and no significant differences detected. Wheat biomass followed the pattern of corn, with final biomass statistically higher in the poultry litter treatment than in all other treatments. Red fescue exhibited a somewhat different pattern as quicker emergence in the commercial potting mix carried through to significantly greater final biomass (Attachment C & Photo 24). Total red fescue biomass was approximately an order of magnitude lower than in the corn and wheat treatments suggesting that it did not deplete available nitrogen in any of the treatments to same extent as what likely occurred in the corn and wheat treatments. Final plant biomass in the unamended reservoir sediment treatments were lower than in all other treatments for the four species tested suggesting that the amendments all contributed in some way to higher plant growth rates.

Tissue nutrient results from harvested plants at the end of the study also suggested nitrogen availability as the main factor driving significantly higher corn and wheat biomass production in the poultry litter amended mix (Attachment C). In both corn and soybean treatments, final tissue nitrogen concentrations in the poultry litter mix were at least double those in other mixes. Although wheat samples in treatments other than the poultry litter amended mix were too small to do analysis on all the replicates, the average final tissue nitrogen concentration in the poultry litter treatment was approximately double those observed in pooled samples from the other treatments (Attachment C).

In addition to nitrogen being a critical factor determining early plant growth, other tissue nutrient concentrations and testing results for the mixes used in this study (Attachment D) suggest that low phosphorus and potassium availability may have contributed to the lower final biomass levels in the unamended reservoir sediment treatments. In addition to soil concentrations, Waypoint analytical reports a rating from a standpoint of potential for crop limitation (Attachment D). Extractable phosphorus and potassium in the unamended reservoir sediment were reported as Low and Very Row, respectively while in the High or Very High category in all of the amended mixes. Tissue potassium levels in both corn and soybean unamended reservoir sediment treatments were approximately half of those in all other treatments (Attachment C) while the differences in tissue phosphorus concentrations were less extreme although statistically significantly lower than the final soybean tissue concentrations in the mushroom compost, poultry litter and potting mix treatments. The mix testing results suggest that all three of the amendments could be used to raise phosphorus and potassium concentrations to levels adequate for optimum crop growth.

Other notable corn and soybean final biomass tissue testing results were that magnesium and manganese concentrations in the unamended reservoir sediment treatments were significantly higher than in all the other mixes (Attachment C). All of the mixes in this study were reported to have adequate (medium and high ratings) extractable magnesium and relatively similar manganese concentrations (very high rating) for crop growth (Attachment D). Consistently elevated total manganese concentrations were reported in the Northgate Sediment Characterization Study Report of the Conowingo reservoir (Table 8). Still, given the similar extractable manganese concentrations in the different mixes it is unclear why tissue concentrations in the unamended reservoir treatments were higher than in the other mixes with similar extractable manganese concentrations. Further studies would be needed to sort this out but it likely is related to potassium availability or possibly slightly lower pH in the unamended reservoir sediments versus the mixtures which would increase Mn availability.

Conclusions – Overall germination and emergence rates of corn, soybeans, wheat and red fescue were similar in unamended reservoir sediments in comparison to mixes containing Leafgro compost, spent mushroom compost, and poultry litter as well as a commercial peat-based potting mix used as a control. Poultry litter resulted in some emergence delays, and crusting appeared to physically impede emergence in soybean and small-seeded red fescue treatments but did not affect overall final rates. Higher nitrogen availability in the poultry litter amended treatments stimulated growth later in the study in the corn and wheat treatments and resulted in taller, greener plants with higher final biomass and tissue nitrogen concentrations. Final biomass tended to be lower in the unamended reservoir sediment treatments most likely due to low potassium availability. All three of the amendments used in this study appeared to have potential to mitigate any nutrient deficiencies of reservoir sediments and to improve overall suitability for plant growth. Inorganic potassium and phosphorus fertilizers also could be used to increase these two nutrients up to optimum levels for crop growth but would not provide the benefits of increased organic matter.

Attachments:

A. Photos
B. Figures
C. Plant tissue nutrient data with selected statistical comparisons
D. Test mixtures soil analysis results summary and reports from Waypoint Analytical

Germination of Major Crops in Conowingo Reservoir Dredge Material

Ken Staver, Associate Research Scientist

University of Maryland, College of Agriculture and Natural Resources
Wye Research and Education Center
124 Wye Narrows Drive
Queenstown, MD 21658

Attachment A

(Photos)

Photo 1. Conowingo reservoir sediment spread in trays to dry in preparation for creating mixes.

Photo 2. Clam shells screened from Conowingo reservoir sediment before making mixes for germination trials.

Photo 3. Partially dried and mixed Conowingo reservoir sediments in preparation for blending with amendments.

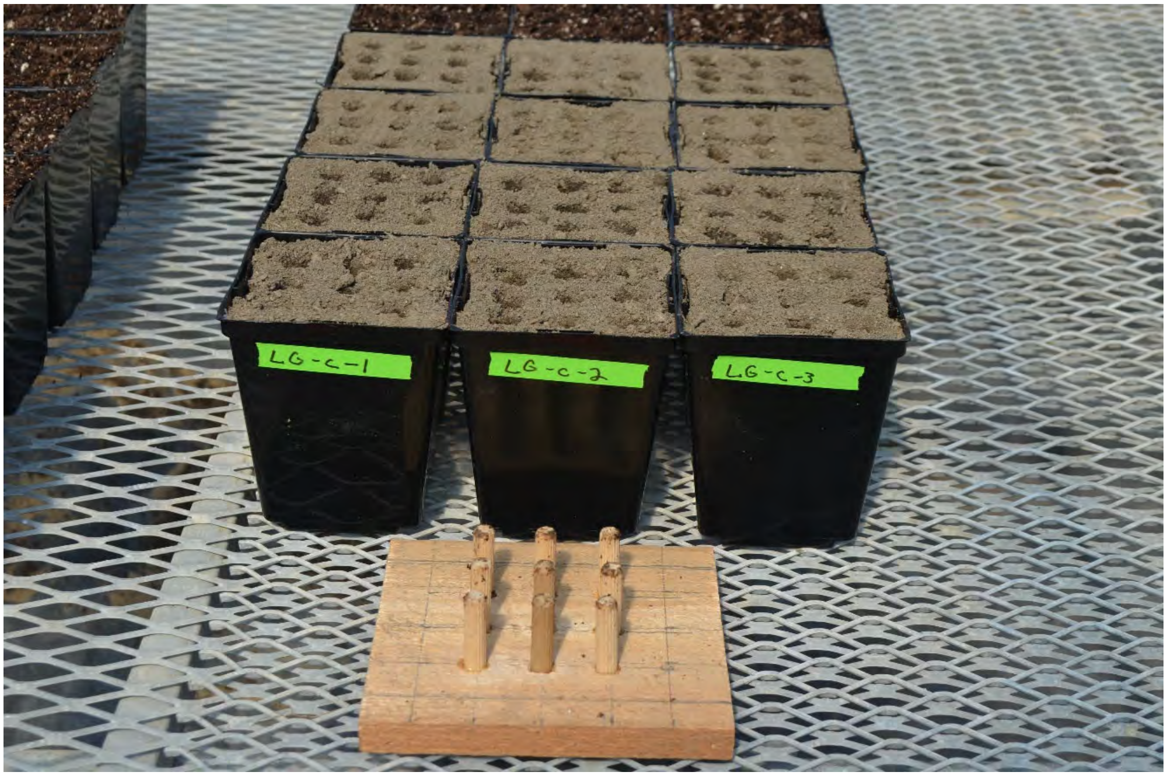


Photo 4. Dibble for making seed holes and pots filled with mixes ready for planting.

Photo 5. Clockwise from upper left, corn, soybean, red fescue, and wheat seed used in germination trials.

Photo 6. Overhead view of soybeans planting in dibble holes prior to covering.

Photo 7. Full trial 5 x 12 pot matrix surrounding by buffer pots after planting and watering on April 11, 2022 in a polyethylene greenhouse at UMD WREC.

Photo 8. Measuring plant height in the corn treatments on April 19, 2022.

Photo 9. Emergence just beginning on April 15, 2022 after watering.

Photo 10. Cracking of surface crust in unamended dredge material (center row) in soybean treatments on April 15, 2022 between poultry litter mix (front) and commercial potting mix (rear).

Photo 11. Close up of corn coleoptiles emerging April 15 (day 4) in Leafgro compost mix.

Photo 12. Full trial matrix on April 19, eight days after planting. From front to back, treatments are Leafgro mix, mushroom compost mix, poultry litter mix, unamended reservoir sediment, and peat-based commercial potting mix.

Photo 13. Full trial matrix on April 22. Red fescue block is on the right and still not barely visible.

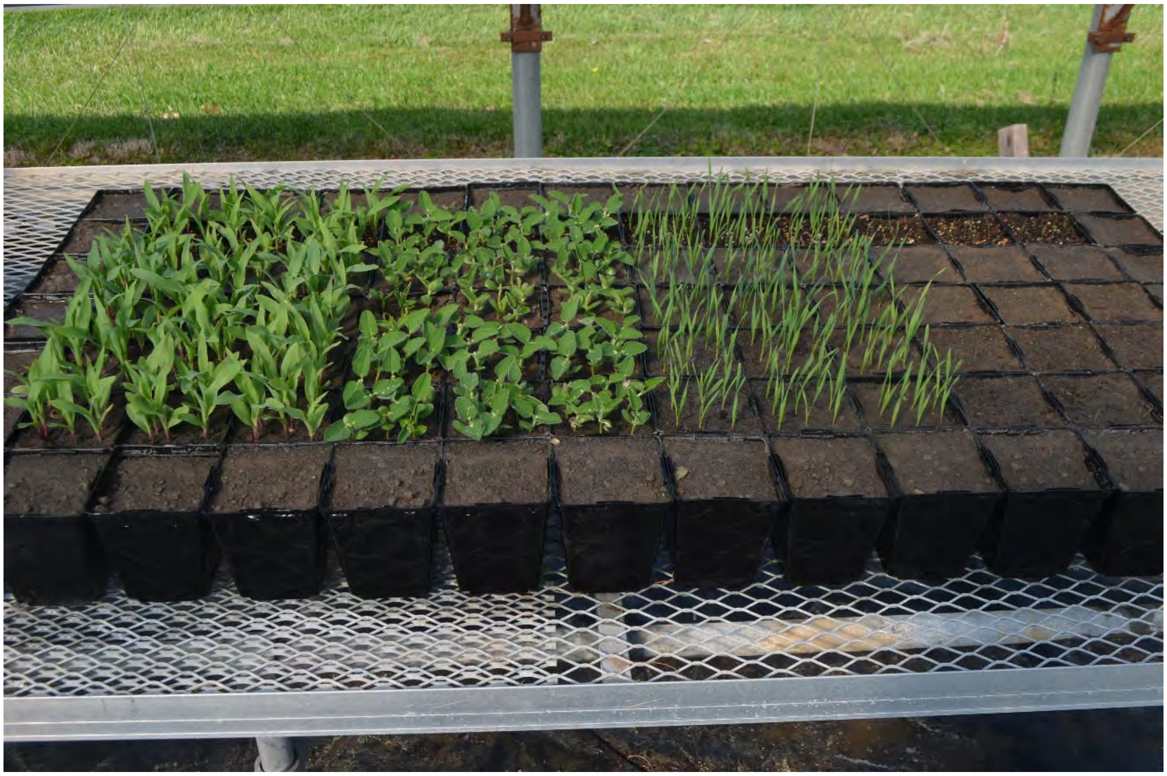


Photo 14. Full trial matrix on April 25, 14 days planting, just after watering.

Photo 15. Full trial matrix on April 27, 16 days after planting.

Photo 16. Full trial matrix on April 29, 18 days after planting. Note yellowing of corn in compost mixes in the foreground.

Photo 17. Full matrix on May 11, on month after planting and just prior to harvesting plants for biomass measurement and tissue nutrient analysis.

Photo 18. End view showing greater height and darker green color of corn in the poultry litter treatment on April 25.

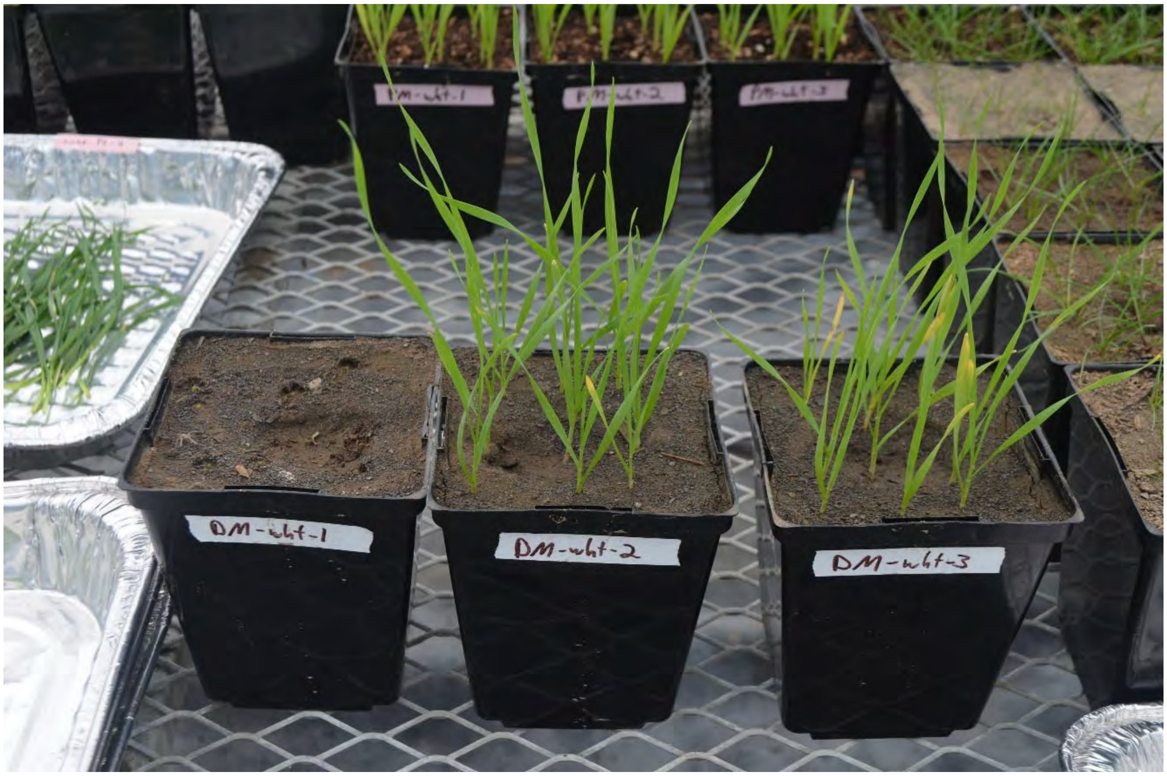


Photo 19. Wheat growing in unamended reservoir sediment just prior to harvest (replicate one already harvested) on May 11.

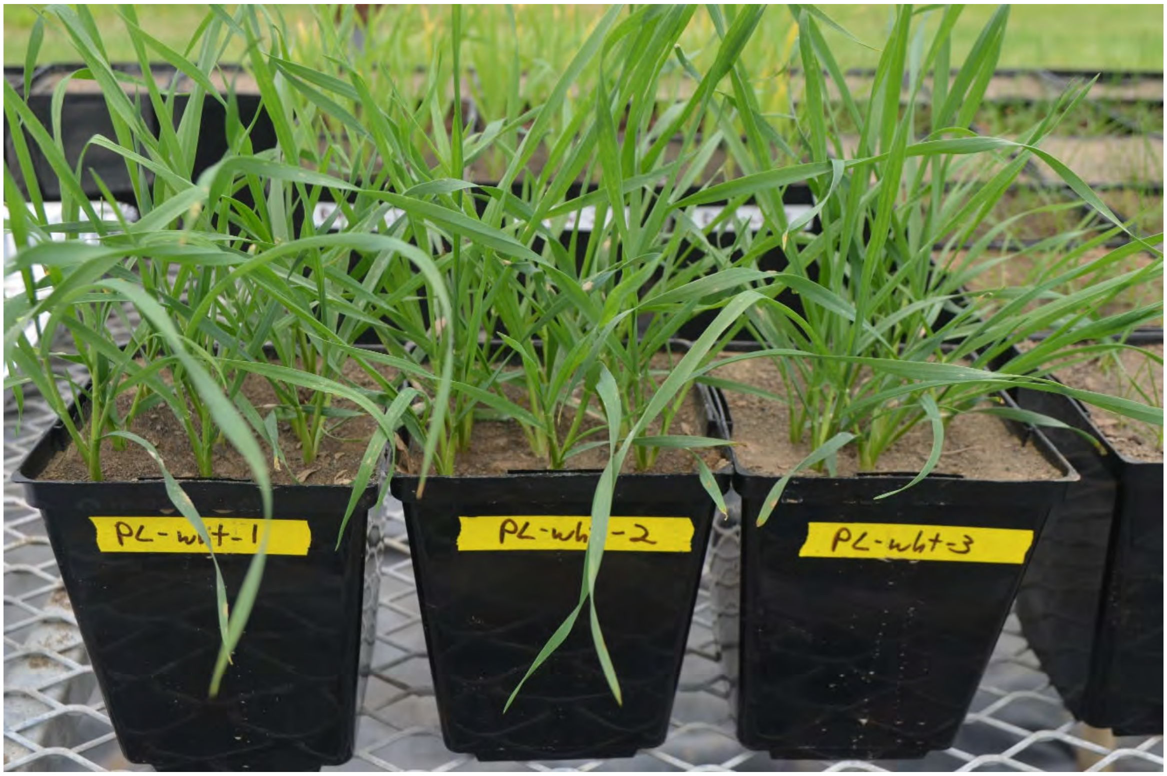


Photo 20. Wheat growing in poultry litter mix just prior to harvest on May 11.

Photo 21. Soybeans growing in unamended reservoir sediment just prior to harvest on May 11.

Photo 22. Soybeans growing in poultry litter mix just prior to harvest on May 11.

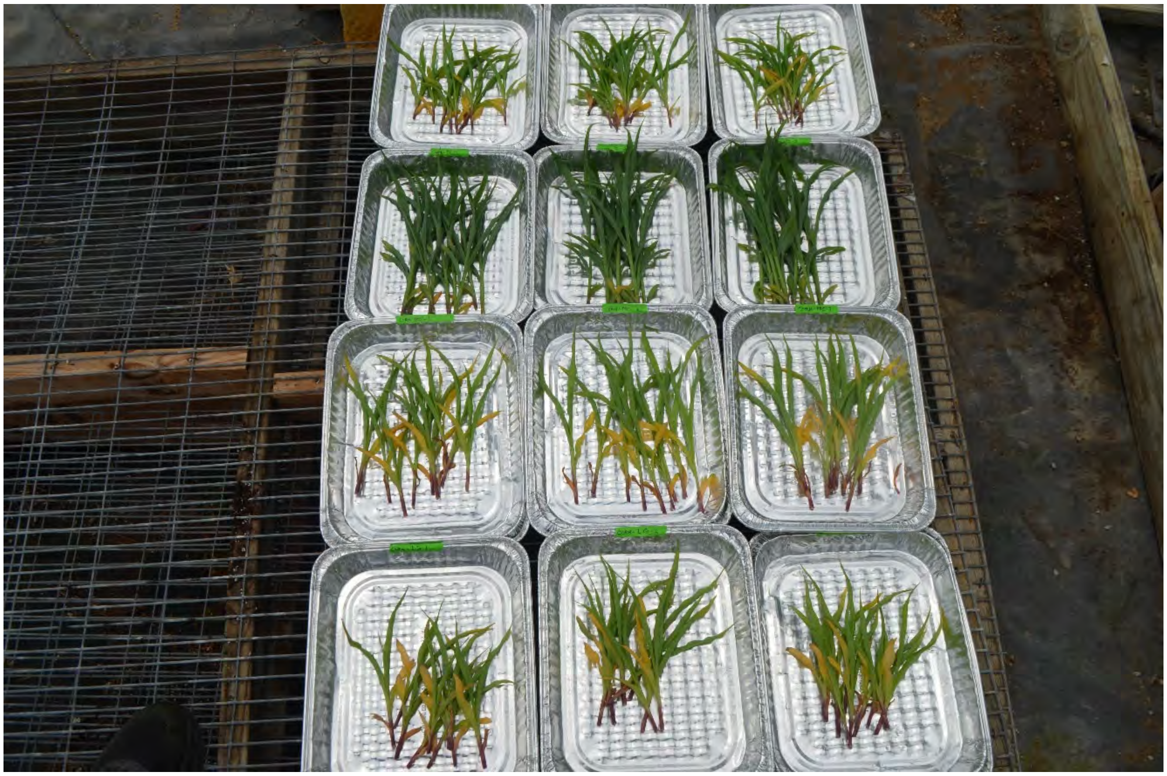


Photo 23. Corn harvested from mixes and unamended reservoir sediment prior to placing in the drying over. Poultry litter treatment is third from the front.

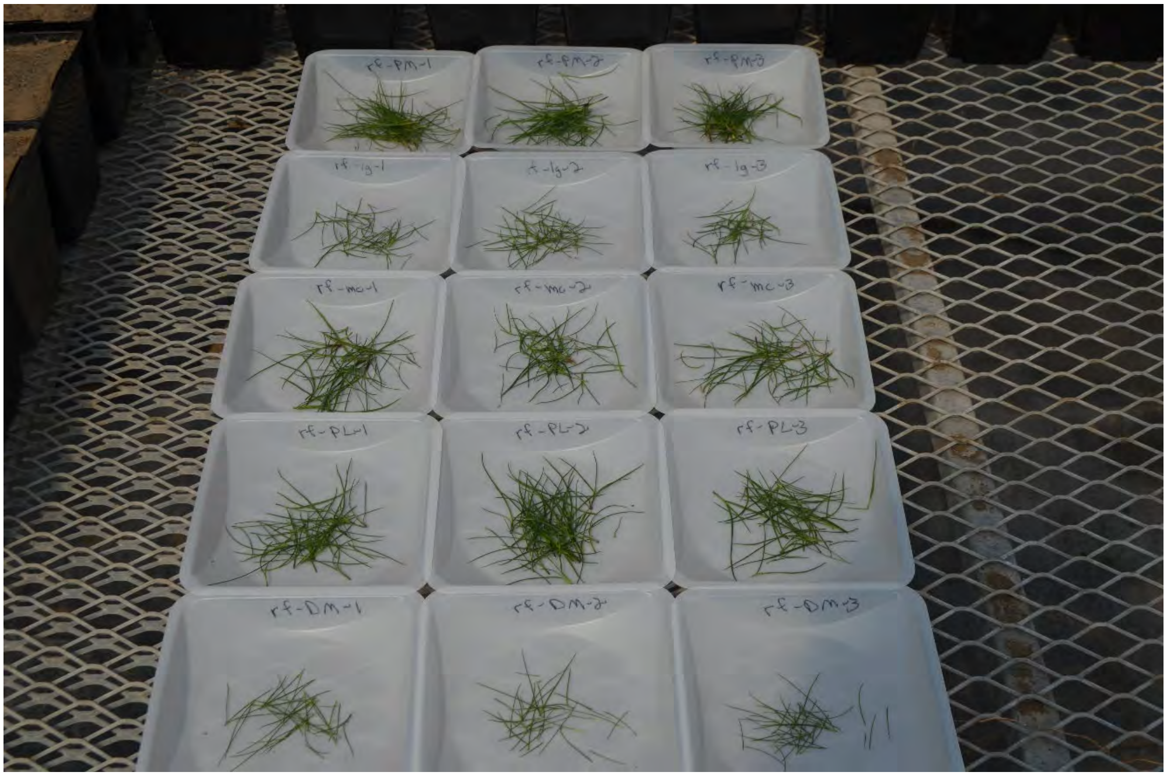


Photo 24. Red fescue harvested prior to drying on May 11. Notable higher biomass in potting mix (rear) and poultry litter (second from front) treatments.

Germination of Major Crops in Conowingo Reservoir Dredge Material

Ken Staver, Associate Research Scientist

University of Maryland, College of Agriculture and Natural Resources
Wye Research and Education Center
124 Wye Narrows Drive
Queenstown, MD 21658

Attachment B
(Figures)

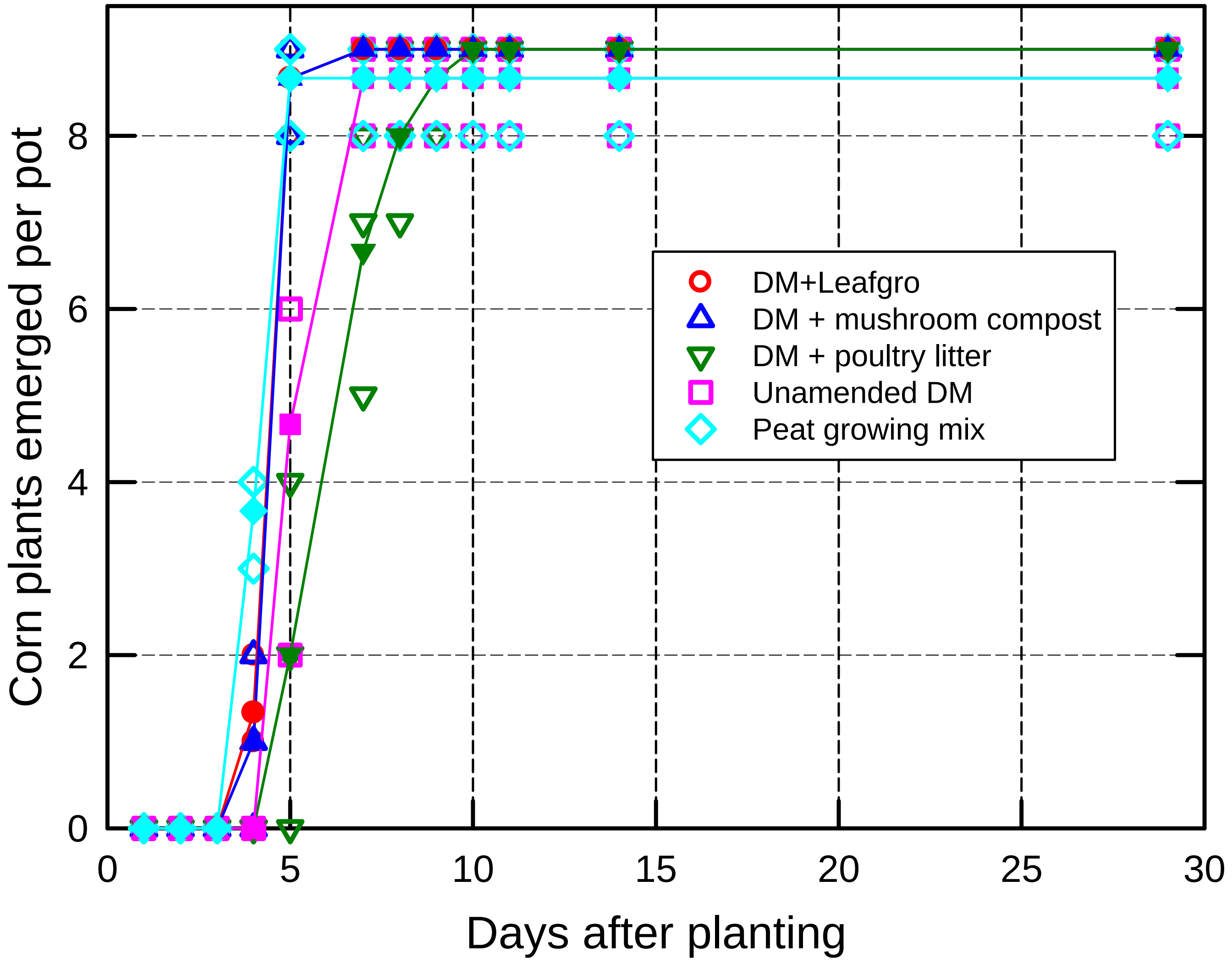


Figure1. Emergence of corn plants from different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Nine seeds were planted in each pot. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

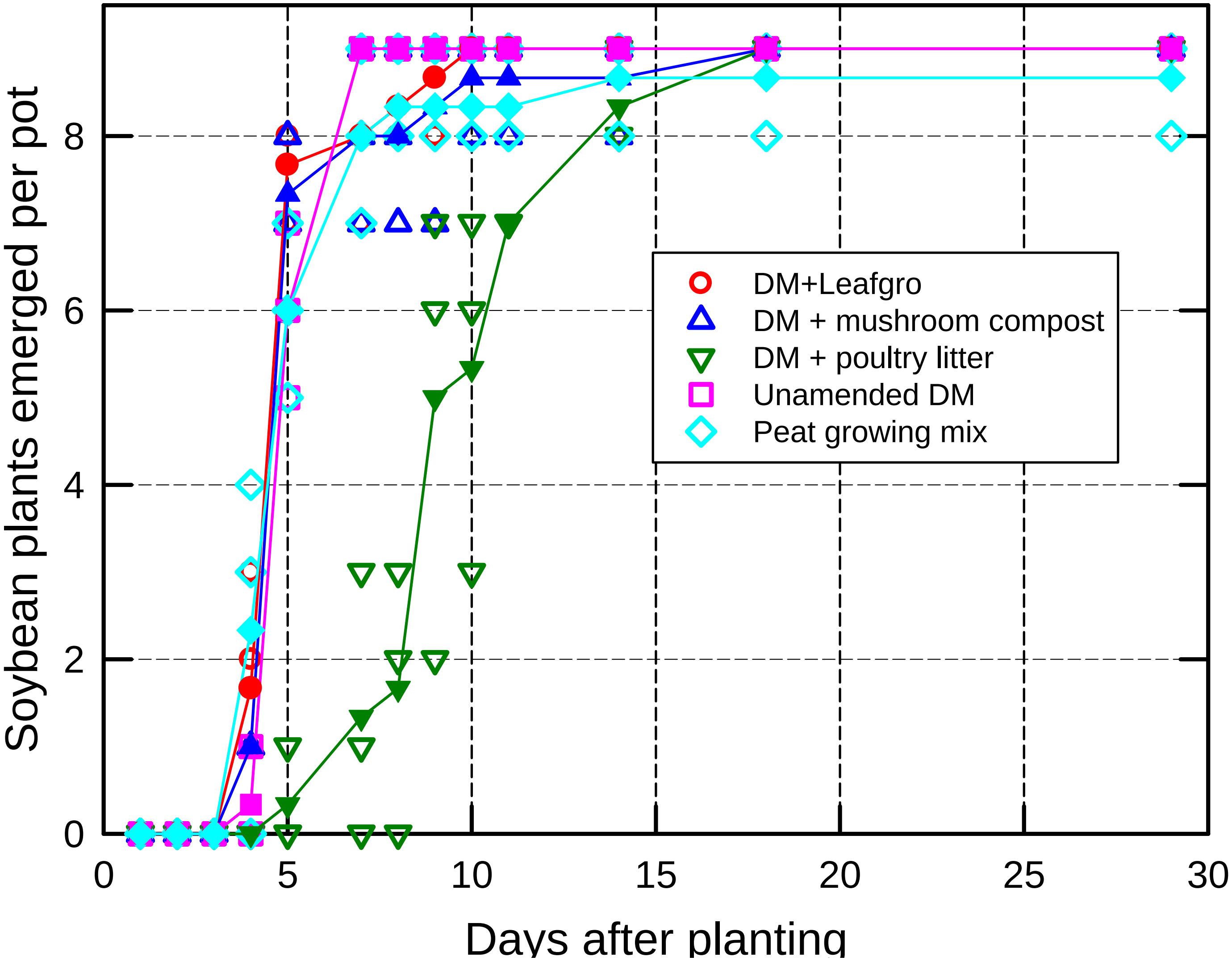


Figure 2. Emergence of soybean plants from different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Nine seeds were planted in each pot. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

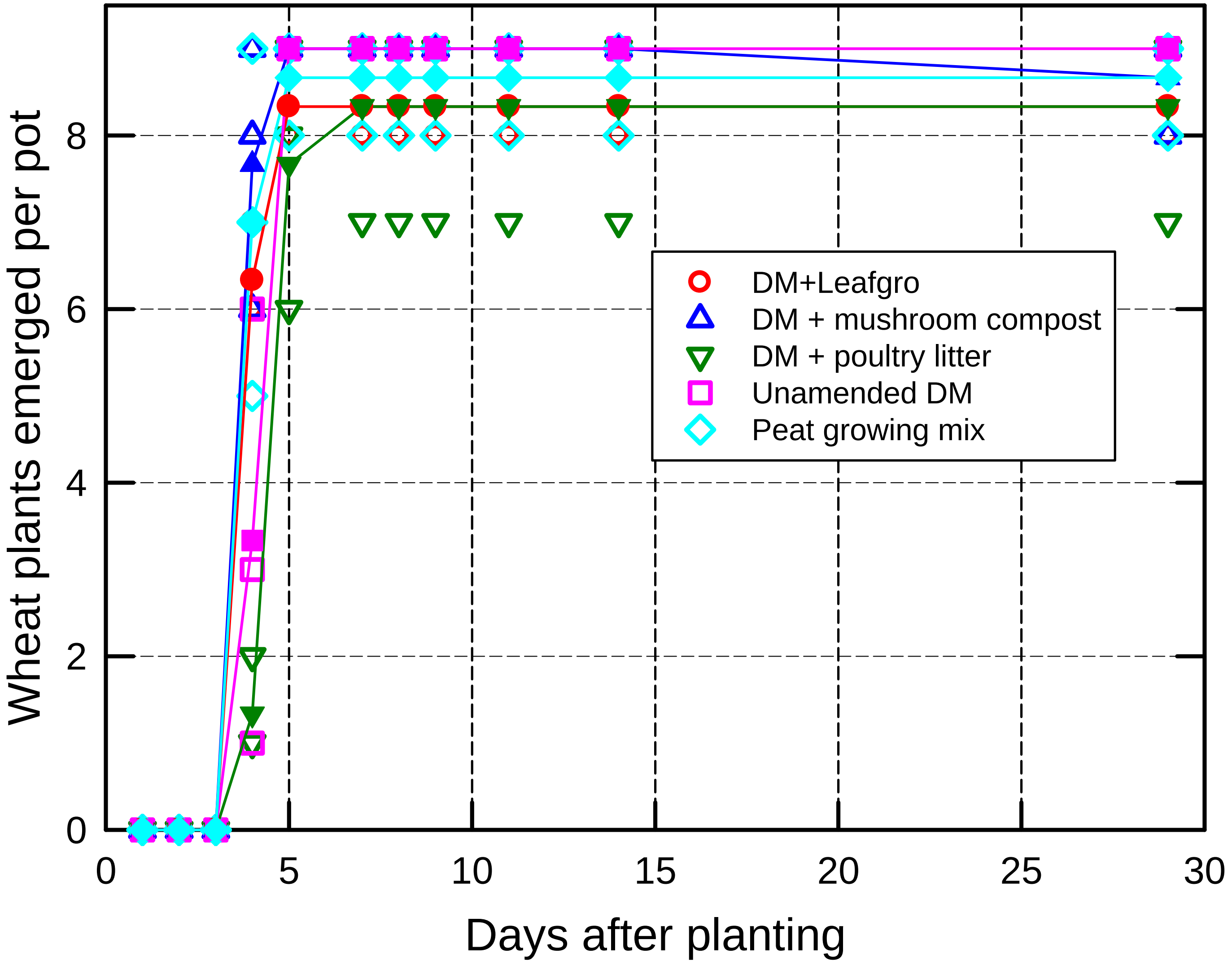


Figure 3. Emergence of wheat plants from different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Nine seeds were planted in each pot. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

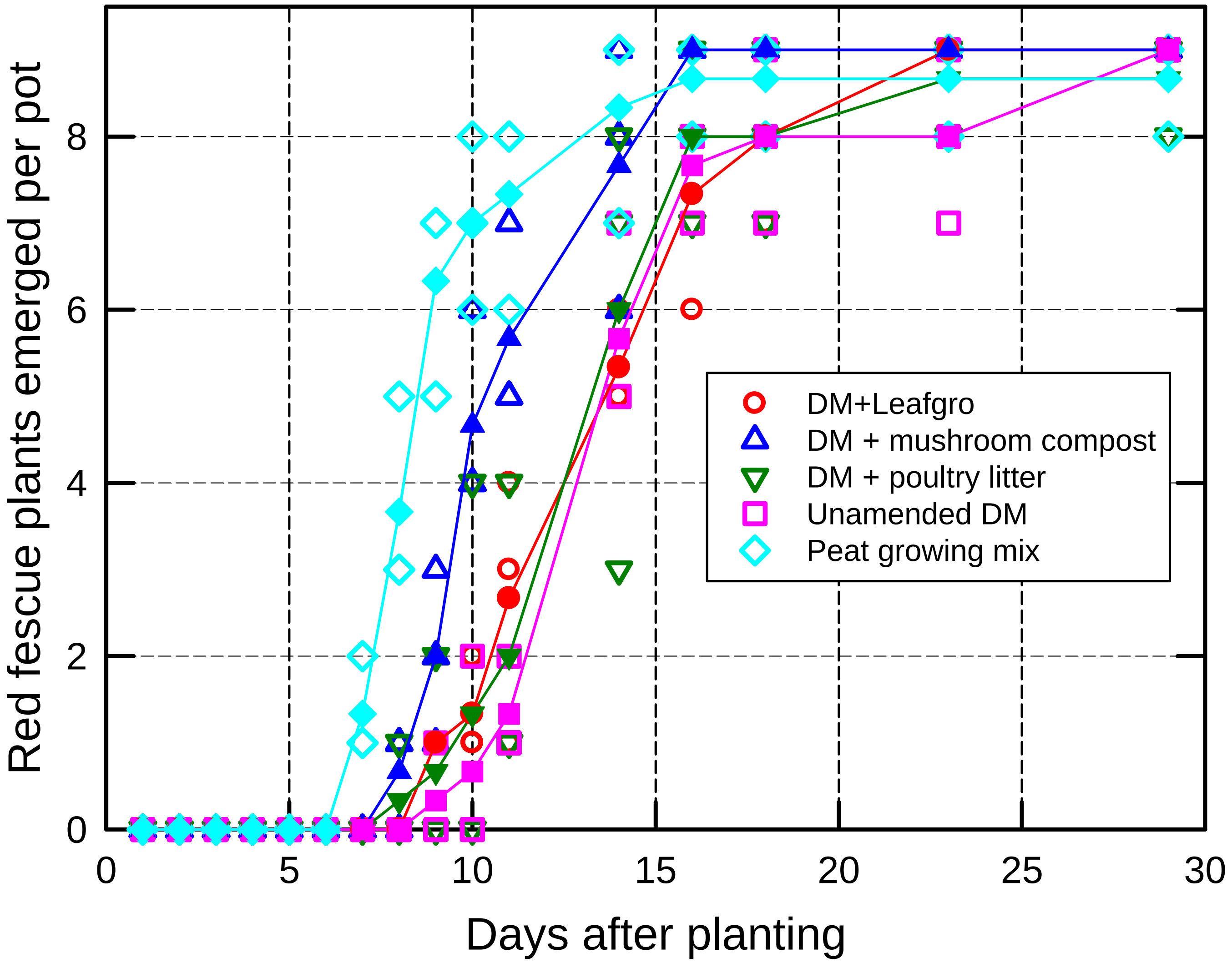


Figure 4. Emergence of red fescue plants from different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Eighteen seeds were planted in nine locations in each pot. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

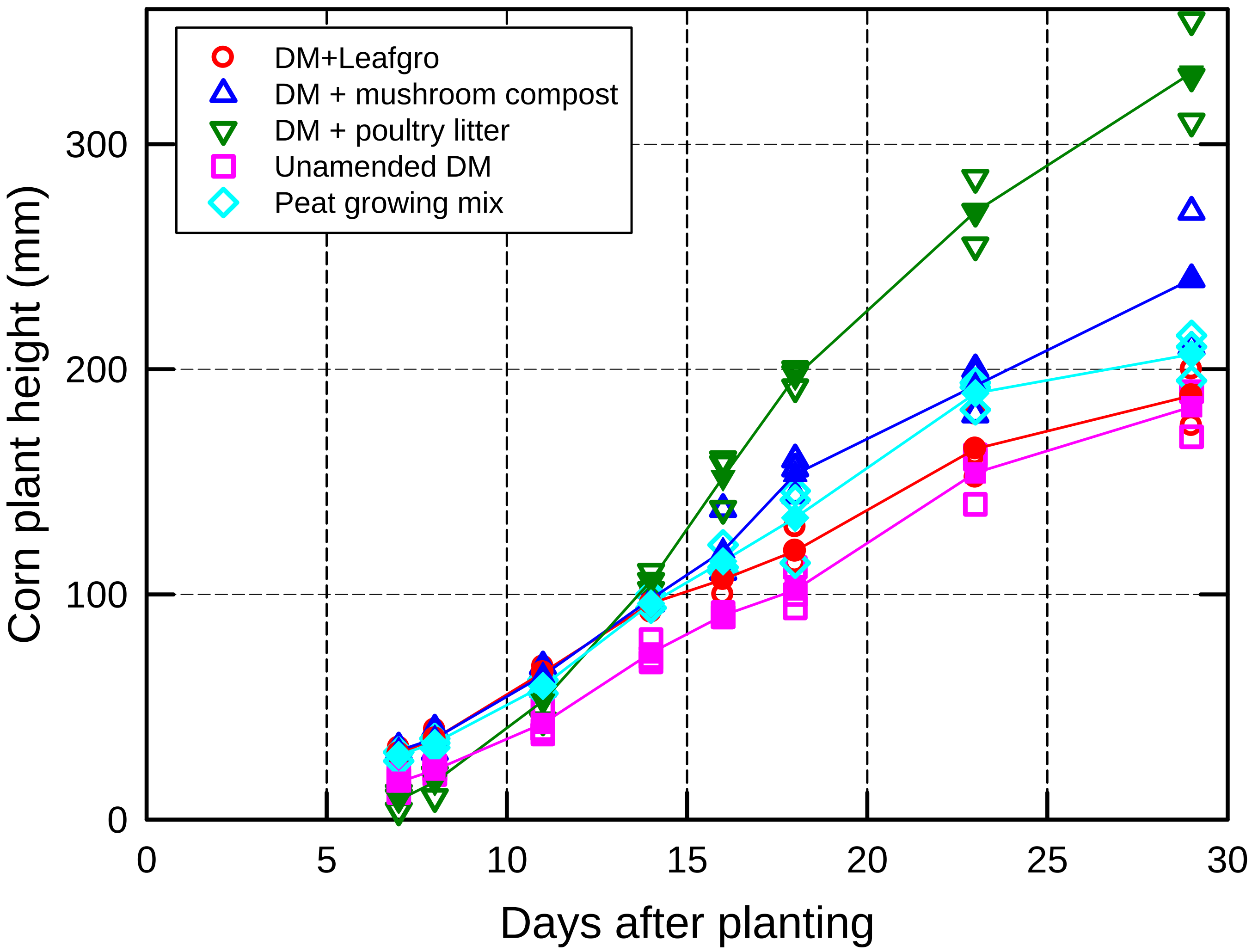


Figure 5. Height of corn plants grown in different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

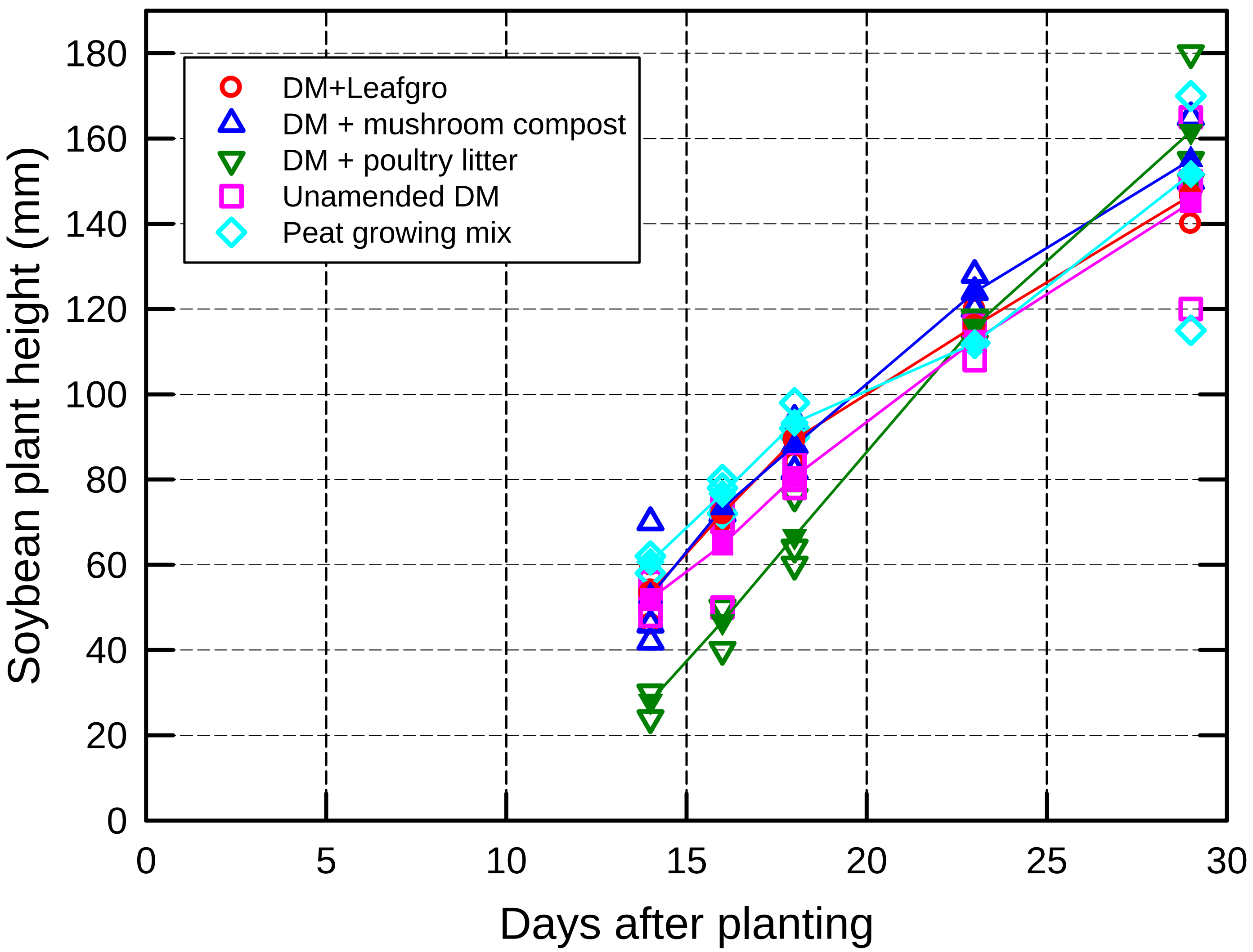


Figure 6. Height of soybean plants grown in different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

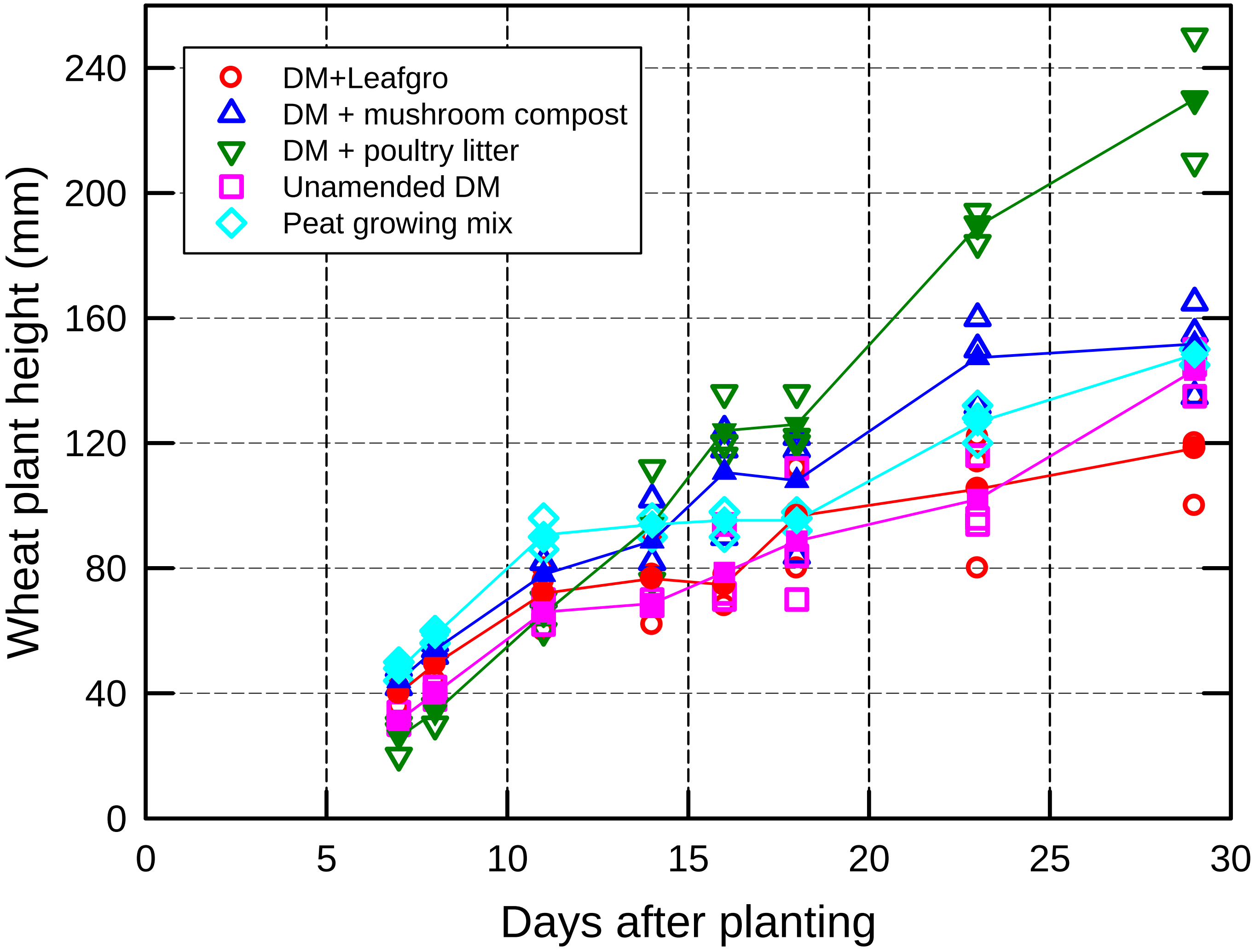


Figure 7. Height of wheat plants grown in different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

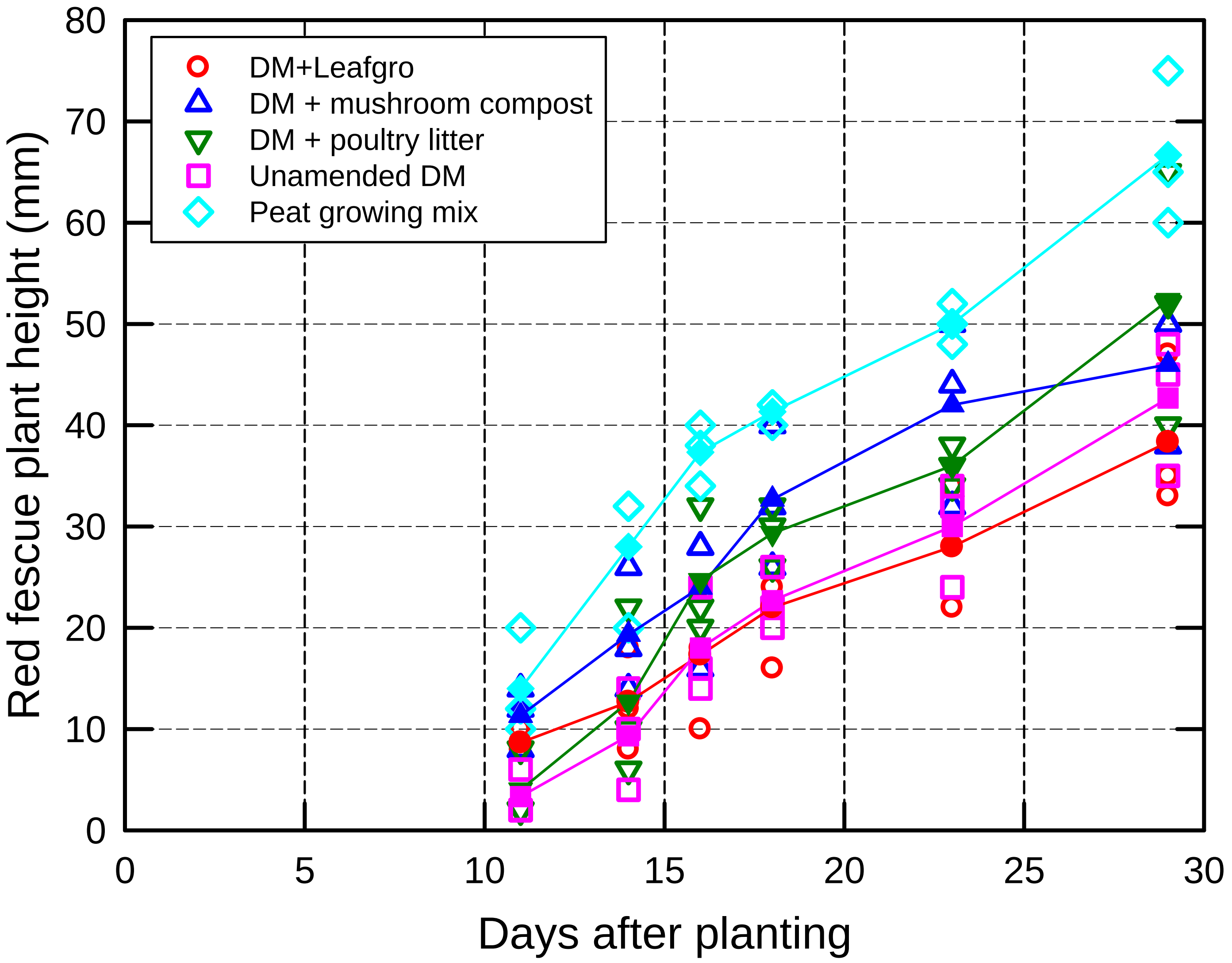


Figure 8. Height of red fescue plants grown in different mixtures created with Conowingo reservoir sediment (DM). Peat growing mix was used as a control. Hollow symbols are the individual pot values and solid symbols the average of three replicates.

Germination of major crops in Conowingo reservoir dredge material

Ken Staver, Associate Research Scientist

University of Maryland, College of Agriculture and Natural Resources
Wye Research and Education Center
124 Wye Narrows Drive
Queenstown, MD 21658

Attachment C

(Plant tissue nutrient data with selected statistical comparisons)

Summary of corn and soybean biomass and tissue nutrient concentrations harvested at the end of the trial. Common letters under means indicate no significant difference.

	Biomass	Nitrogen	Sulfur	Phosphorus	Potassium	Magnesium	Calcium	Sodium	Boron	Zinc	Manganese	Iron	Copper	Aluminum
	(gm/pot)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
<u>Corn</u>														
Corn LG-1	1.27	0.92	0.16	0.42	4.9	0.25	0.53	0.02	14	41	109	143	5	50
Corn LG-2	1.55	1	0.16	0.39	4.97	0.22	0.4	0.02	13	34	95	108	5	52
Corn LG-3	1.46	0.73	0.15	0.45	4.23	0.27	0.39	0.01	11	25	106	599	4	20
Corn LG-average	**1.43**	**0.88**	**0.16**	**0.42**	**4.70**	**0.25**	**0.44**	**0.02**	**12.7**	**33.3**	**103.3**	**283.3**	**4.7**	**40.7**
	a	a	a	a	a	a					a			
Corn MC-1	1.69		0.33	0.58	4.57	0.24	0.82	0.01	34	37	93	128	5	11
Corn MC-2	1.85	0.83	0.33	0.58	5.02	0.23	0.71	0.01	26	37	80	125	5	20
Corn MC-3	1.99	0.95	0.35	0.53	4.23	0.23	0.72	0.01	34	41	89	104	6	32
Corn MC-average	**1.84**	**0.89**	**0.34**	**0.56**	**4.61**	**0.23**	**0.75**	**0.01**	**31.3**	**38.3**	**87.3**	**119.0**	**5.3**	**21.0**
	b	a	a,b	b	a	a					a			
Corn PL-1	3.08	2.54	0.33	0.3	5.19	0.27	0.34	0.03	65	63	181	102	7	2
Corn PL-2	3.17	2.38	0.32	0.27	4.98	0.26	0.35	0.03	60	63	196	193	8	23
Corn PL-3	3.20	2.49	0.36	0.32	5.65	0.29	0.35	0.03	59	66	195	88	9	1
Corn PL-average	**3.15**	**2.47**	**0.34**	**0.30**	**5.27**	**0.27**	**0.35**	**0.03**	**61.3**	**64.0**	**190.7**	**127.7**	**8.0**	**8.7**
	c	b	a,b,c	c	a	a					a			
Corn DM-1	1.21	1.08	0.57	0.31	2.44	0.66	1	0.01	11	47	316	100	7	13
Corn DM-2	1.25	1.22	0.64	0.33	2.59	0.83	1.14	0.01	13	52	407	133	8	1
Corn DM-3	1.10	1.3	0.75	0.42	2.61	0.73	0.82	0.01	16	53	309	122	7	21
Corn DM-average	**1.19**	**1.20**	**0.65**	**0.35**	**2.55**	**0.74**	**0.99**	**0.01**	**13.3**	**50.7**	**344.0**	**118.3**	**7.3**	**11.7**
	a	c	b,c	a,c	b	b					b			
Corn PM-1	1.35	0.92	0.16	0.5	4.02	0.31	0.33	0.01	9	20	102	103	4	18
Corn PM-2	1.62	0.92	0.16	0.46	3.73	0.31	0.34	0.01	9	20	105	62	3	3
Corn PM-3	1.70	0.74	0.15	0.4	4.27	0.25	0.39	0.01	11	28	95	81	4	31
Corn PM-average	**1.56**	**0.86**	**0.16**	**0.45**	**4.01**	**0.29**	**0.35**	**0.01**	**9.7**	**22.7**	**100.7**	**82.0**	**3.7**	**17.3**
	a,b	a	a	a	a	a					a			

Summary of corn and soybean biomass and tissue nutrient concentrations harvested at the end of the trial. Common letters under means indicate no significant difference.

	Biomass	Nitrogen	Sulfur	Phosphorus	Potassium	Magnesium	Calcium	Sodium	Boron	Zinc	Manganese	Iron	Copper	Aluminum
	(gm/pot)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Soybeans														
Soybean LG-1	2.42	1.83	0.29	0.25	3.17	0.32	0.78	0.02	31	48	68	111	5	23
Soybean LG-2	2.44	1.89	0.3	0.25	3.27	0.39	0.94	0.02	34	54	85	224	6	49
Soybean LG-3	2.17	1.95	0.3	0.24	3.09	0.36	0.87	0.02	32	54	79	159	5	40
Soybean LG-average	**2.34**	**1.89**	**0.30**	**0.25**	**3.18**	**0.36**	**0.86**	**0.02**	**32.3**	**52.0**	**77.3**	**164.7**	**5.3**	**37.3**
	a	a	a	a	a	a					a			
Soybean MC-1	2.54	1.92	0.32	0.4	3.47	0.37	1.15	0.02	55	54	73	98	5	1
Soybean MC-2	2.27	2.1	0.35	0.38	3.1	0.39	1.11	0.03	57	52	63	135	5	35
Soybean MC-3	2.40	1.65	0.31	0.37	3.05	0.36	1.07	0.02	59	52	71	103	5	19
Soybean MC-average	**2.40**	**1.89**	**0.33**	**0.38**	**3.21**	**0.37**	**1.11**	**0.02**	**57.0**	**52.7**	**69.0**	**112.0**	**5.0**	**18.3**
	a	a	a,c	b	a	a					a			
Soybean PL-1	2.04	5.31	0.64	0.4	4.09	0.52	0.97	0.1	92	86	146	125	11	3
Soybean PL-2	2.49	5.15	0.61	0.38	4.35	0.5	0.93	0.1	90	83	145	237	11	40
Soybean PL-3	2.43	4.69	0.52	0.32	4.04	0.5	0.87	0.07	87	72	138	112	9	34
Soybean PL-average	**2.32**	**5.05**	**0.59**	**0.37**	**4.16**	**0.51**	**0.92**	**0.09**	**89.7**	**80.3**	**143.0**	**158.0**	**10.3**	**25.7**
	a	b	b	b	b	b					b			
Soybean DM-1	2.13	2.12	0.42	0.25	1.76	0.64	1.29	0.02	42	65	275	137	6	26
Soybean DM-2	2.08	2.13	0.42	0.25	1.56	0.6	1.29	0.02	43	62	273	145	5	31
Soybean DM-3	2.03	2.24	0.41	0.24	1.37	0.6	1.21	0.02	40	66	269	175	6	49
Soybean DM-average	**2.08**	**2.16**	**0.42**	**0.25**	**1.56**	**0.61**	**1.26**	**0.02**	**41.7**	**64.3**	**272.3**	**152.3**	**5.7**	**35.3**
	a	a	c	a	c	c					d			
Soybean PM-1	2.36	1.95	0.31	0.37	2.71	0.45	0.67	0.02	31	37	72	116	4	24
Soybean PM-2	2.15	1.97	0.32	0.4	2.87	0.45	0.68	0.02	33	38	70	156	4	26
Soybean PM-3	2.47	2.02	0.31	0.37	2.58	0.43	0.61	0.01	30	31	64	60	4	14
Soybean PM-average	**2.33**	**1.98**	**0.31**	**0.38**	**2.72**	**0.44**	**0.65**	**0.02**	**31.3**	**35.3**	**68.7**	**110.7**	**4.0**	**21.3**
	a	a	a,c	b	d	d					a			

Summary of wheat and red fescue biomass and tissue nutrient concentrations harvested at the end of the trial. Common letters under means indicate no significant difference.

	Biomass (gm/pot)	Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)
<u>Wheat</u>														
Wheat LG-1	0.27	Biomass too small for analysis of individual samples except for poultry litter treatment.												
Wheat LG-1	0.26													
Wheat LG-1	0.27													
Wheat LG-pooled	**0.27**	**1.81**	**0.51**	**0.87**	**5.07**	**0.29**	**0.52**	**0.02**	**14**	**28**	**107**	**81**	**10**	**1**
	a													
Wheat MC-1	0.50													
Wheat MC-2	0.46													
Wheat MC-3	0.43													
Wheat MC-pooled	**0.46**	**2.16**	**0.59**	**1.61**	**5.45**	**0.29**	**0.82**	**0.02**	**40**	**36**	**93**	**73**	**11**	**11**
	b													
Wheat PL-1	1.44	4.45	0.45	0.6	5.62	0.21	0.31	0.05	49	56	160	134	17	18
Wheat PL-2	1.48	4.03	0.46	0.6	5.71	0.21	0.31	0.05	51	52	172	132	17	1
Wheat PL-3	1.36	4.36	0.5	0.64	5.94	0.22	0.35	0.06	56	60	189	168	18	52
Wheat PL-average	**1.43**	**4.28**	**0.47**	**0.61**	**5.76**	**0.21**	**0.32**	**0.05**	**52.0**	**56.0**	**173.7**	**144.7**	**17.3**	**23.7**
	c													
Wheat DM-1	0.28													
Wheat DM-2	0.28													
Wheat DM-3	0.26													
Wheat DM-pooled	**0.27**	**2.07**	**0.8**	**0.36**	**4.07**	**0.39**	**0.64**	**0.02**	**9**	**31**	**675**	**176**	**10**	**24**
	a													
Wheat PM-1	0.36													
Wheat PM-2	0.40													
Wheat PM-3	0.37													
Wheat PM-pooled	**0.38**	**1.34**	**0.34**	**1.13**	**3.19**	**0.36**	**0.34**	**0.02**	**5**	**18**	**498**	**49**	**8**	**36**
	d													
<u>Red fescue</u>														
Red fescue LG-1	0.0404	Biomass samples too small for nutrient analysis												
Red fescue LG-2	0.0609													
Red fescue LG-3	0.0372													
Red fescue LG-average	**0.0462**													
	a													

Summary of wheat and red fescue biomass and tissue nutrient concentrations harvested at the end of the trial. Common letters under means indicate no significant difference.

	Biomass	Nitrogen	Sulfur	Phosphorus	Potassium	Magnesium	Calcium	Sodium	Boron	Zinc	Manganese	Iron	Copper	Aluminum
	(gm/pot)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Red fescue MC-1	0.1097													
Red fescue MC-2	0.0872													
Red fescue MC-3	0.0983													
Red fescue MC-average	**0.0984**													
	b													
Red fescue PL-1	0.0825													
Red fescue PL-2	0.1509													
Red fescue PL-3	0.0942													
Red fescue PL-average	**0.1092**													
	b													
Red fescue DM-1	0.0259													
Red fescue DM-2	0.0205													
Red fescue DM-3	0.0198													
Red fescue DM-average	**0.0221**													
	a													
Red fescue PM-1	0.1667													
Red fescue PM-2	0.1552													
Red fescue PM-3	0.1619													
Red fescue PM-average	**0.1613**													
	c													

Germination of major crops in Conowingo reservoir dredge material

Ken Staver, Associate research scientist

University of Maryland, College of Agriculture and Natural Resources
Wye Research and Education Center
124 Wye Narrows Drive
Queenstown, MD 21658

Attachment D

(Test mixtures soil analysis results summary and reports from Waypoint Analytical)

Summary and averages of soil testing results from Waypoint Analytical of mixtures and unammended reservoir sediments used for germination trials

Growth media	Organic Matter (%)	Estimated Nitrogen Release (lb/acre)	Mehlich-3 Phosphorus (ppm)	Mehlich-3 Potassium (ppm)	Mehlich-3 Magnesium (ppm)	Mehlich-3 Calcium (ppm)	Mehlich-3 Sodium (ppm)	pH	Buffer pH	Acidity H meq/100 g	Cation Exchange Capacity meq/100 g	Base Saturation					Sulfate-S (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Boron (ppm)	Soluble salts ms/cm
												Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Hydrogen (%)							
Leafgro Mix-1	4.9	133	71	428	261	1403	37	7.1	6.93	0	10.4	10.6	20.9	67.5	1.5	0	118	28.4	64	537	4	1.3	0.54
Leafgro Mix-2	4.5	126	68	453	245	1307	35	6.9	6.92	0.1	10	11.6	20.4	65.4	1.5	1	117	29.9	64	534	3.7	1.4	0.54
Lefgro Mix-3	4.7	129	69	443	266	1392	36	7	6.93	0	10.5	10.8	21.1	66.3	1.5	0	109	28.8	63	549	3.9	1.4	0.56
Leagro Mix avg	**4.7**	**129.3**	**69.3**	**441.3**	**257.3**	**1367.3**	**36.0**	**7.0**	**6.93**	**0.03**	**10.30**	**11.00**	**20.80**	**66.40**	**1.50**	**0.3**	**114.7**	**29.03**	**63.7**	**540.0**	**3.87**	**1.37**	**0.547**
Mushroom compost Mix-1	4.5	119	198	186	261	2432	38	7	6.93	0	15	3.2	14.5	81.1	1.1	0	450	32.1	56	486	5.1	1.9	1.18
Mushroom compost Mix-2	4.3	112	200	204	280	2766	38	6.9	6.91	0.2	17.1	3.1	13.6	80.9	1	1.2	445	34.3	59	491	5.3	2	1.17
Mushroom compost Mix-3	4.8	123	195	199	283	2587	40	7.1	6.93	0	16	3.2	14.7	80.8	1.1	0	490	32.7	60	509	5	2	1.26
MC Mix-avg	**4.53**	**118.0**	**197.7**	**196.3**	**274.7**	**2595.0**	**38.7**	**7.0**	**6.92**	**0.07**	**16.03**	**3.17**	**14.27**	**80.93**	**1.07**	**0.4**	**461.7**	**33.03**	**58.3**	**495.3**	**5.13**	**1.97**	**1.203**
Poultry litter Mix-1	3.3	103	109	511	247	923	212	6.9	6.92	0.1	9	14.6	22.9	51.3	10.2	1.1	317	39.8	79	538	6.3	1.9	1.31
Poultry litter Mix-2	3.6	110	109	483	239	900	202	6.9	6.92	0.1	8.7	14.2	22.9	51.7	10.1	1.1	305	39.7	77	530	5.9	1.9	1.29
Poultry litter Mix-3	3.5	106	97	562	251	950	234	6.8	6.9	0.3	9.6	15	21.8	49.5	10.6	3.1	348	42.7	81	536	6.9	2	1.31
PL Mix-avg	**3.47**	**106.3**	**105.0**	**518.7**	**245.7**	**924.3**	**216.0**	**6.9**	**6.91**	**0.17**	**9.10**	**14.60**	**22.53**	**50.83**	**10.30**	**1.8**	**323.3**	**40.73**	**79.0**	**534.7**	**6.37**	**1.93**	**1.303**
Unamended DM-1	2.7	95	29	36	182	762	24	6.4	6.88	0.5	6	1.5	25.3	63.5	1.7	8.3	122	32.6	70	625	4.9	1.3	0.45
Unamended DM-2	2.3	87	28	33	180	778	21	6.3	6.86	0.7	6.3	1.3	23.8	61.7	1.4	11.1	129	32.4	77	659	4.5	1.4	0.43
Unamended DM-3	2.7	95	28	32	169	771	22	6.3	6.87	0.6	6	1.4	23.5	64.3	1.6	10	122	32.7	81	655	4.2	1.4	0.43
Unamended DM-avg	**2.57**	**92.3**	**28.3**	**33.7**	**177.0**	**770.3**	**22.3**	**6.3**	**6.87**	**0.60**	**6.10**	**1.40**	**24.20**	**63.17**	**1.57**	**9.8**	**124.3**	**32.57**	**76.0**	**646.3**	**4.53**	**1.37**	**0.437**

Key to Waypoint results

Sample ID	Lab ID	Growth media
1	24919	Leafgro Mix-1
2	24920	Leafgro Mix-2
3	24921	Leafgro Mix-2
4	24923	Mushroom compost Mix-1
5	24924	Mushroom compost Mix-2
6	24925	Mushroom compost Mix-3
7	24926	Poultry litter Mix-1
8	24927	Poultry litter Mix-2
9	24928	Poultry litter Mix-3
10	24929	Unamended DM-1
11	24930	Unamended DM-2
12	24931	Unamended DM-3

Report Number: 22-158-0629

Account Number: 25365

Send To: WYE RESEARCH CENTER
KEN STAVER
124 Wye Narrows Dr
QUEENSTOWN MD 21658

Waypoint ANALYTICAL
"Every acre...Every year."TM
7621 Whitepine Road, Richmond, VA 23237
Main 804-743-9401 ° Fax 804-271-6446
www.waypointanalytical.com

Grower: Kwn Staver

SOIL ANALYSIS REPORT

Analytical Method(s): Mehlich 3 SMP Buffer pH Loss On Ignition Water pH

Date Received: 06/07/2022 **Date Of Analysis:** 06/08/2022 **Date Of Report:** 06/13/2022

Sample ID Field ID	Lab Number	OM	W/V	ENR	Phosphorus			Potassium	Magnesium	Calcium	Sodium	pH		Acidity	C.E.C
		% Rate	Soil Class	lbs/A	M3 ppm Rate	ppm Rate	ppm Rate	K ppm Rate	Mg ppm Rate	Ca ppm Rate	Na ppm Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
1	24919	4.9 M		133	71 H MD = 80			428 VH MD = 276	261 H MD = 201	1403 M MD = 150	37 VL	7.1		0.0	10.4
2	24920	4.5 M		126	68 H MD = 76			453 VH MD = 292	245 H MD = 189	1307 M MD = 138	35 VL	6.9		0.1	10.0
3	24921	4.7 M		129	69 H MD = 77			443 VH MD = 285	266 H MD = 204	1392 M MD = 149	36 VL	7.0		0.0	10.5
4	24923	4.5 M		119	198 VH MD = 218			186 VH MD = 119	261 M MD = 201	2432 H MD = 280	38 VL	7.0		0.0	15.0
5	24924	4.3 M		112	200 VH MD = 220			204 H MD = 130	280 M MD = 215	2766 H MD = 322	38 VL	6.9		0.2	17.1

Sample ID Field ID	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts			
	K %	Mg %	Ca %	Na %	H %	NO_3N ppm	Rate	S ppm	Rate	Zn ppm	Rate	Mn ppm	Rate	Fe ppm	Rate	Cu ppm	Rate	B ppm	Rate	SS ms/cm	Rate		
1	10.6	20.9	67.5	1.5	0.0			118	VH	28.4	VH	64	VH	537	VH	4.0	VH	1.3	H	0.54	L		
2	11.6	20.4	65.4	1.5	1.0			117	VH	29.9	VH	64	VH	534	VH	3.7	VH	1.4	H	0.54	L		
3	10.8	21.1	66.3	1.5	0.0			109	VH	28.8	VH	63	VH	549	VH	3.9	VH	1.4	H	0.56	L		
4	3.2	14.5	81.1	1.1	0.0			450	VH	32.1	VH	56	VH	486	VH	5.1	VH	1.9	H	1.18	M		
5	3.1	13.6	80.9	1.0	1.2			445	VH	34.3	VH	59	VH	491	VH	5.3	VH	2.0	H	1.17	M		

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric Mc Groary

Pauric Mc Groary Ph.D., CPAg

Report Number: 22-158-0629

Account Number: 25365

Waypoint ANALYTICAL

"Every acre...Every year."TM

7621 Whitepine Road, Richmond, VA 23237
Main 804-743-9401 ° Fax 804-271-6446
www.waypointanalytical.com

Send To: WYE RESEARCH CENTER
KEN STAVER
124 Wye Narrows Dr
QUEENSTOWN MD 21658

Grower: Kwn Staver

SOIL ANALYSIS REPORT

Analytical Method(s): Mehlich 3 SMP Buffer pH Loss On Ignition Water pH

Date Received: 06/07/2022 **Date Of Analysis:** 06/08/2022 **Date Of Report:** 06/13/2022

Sample ID Field ID	Lab Number	OM	W/V	ENR	Phosphorus						Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C
		% Rate	Soil Class	lbs/A	M3 ppm	Rate	ppm	Rate	ppm	Rate	K ppm	Rate	Mg ppm	Rate	Ca ppm	Rate	Na ppm	Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
6	24925	4.8 M		123	195 MD = 214	VH					199 MD = 127	H	283 MD = 217	M	2587 MD = 299	H	40	VL	7.1		0.0	16.0
7	24926	3.3 M		103	109 MD = 121	VH					511 MD = 329	VH	247 MD = 190	H	923 MD = 90	M	212	VH	6.9		0.1	9.0
8	24927	3.6 M		110	109 MD = 121	VH					483 MD = 311	VH	239 MD = 184	H	900 MD = 87	M	202	VH	6.9		0.1	8.7
9	24928	3.5 M		106	97 MD = 108	H					562 MD = 362	VH	251 MD = 193	H	950 MD = 93	L	234	VH	6.8		0.3	9.6
10	24929	2.7 M		95	29 MD = 34	L					36 MD = 21	VL	182 MD = 141	VH	762 MD = 69	M	24	VL	6.4		0.5	6.0

Sample ID Field ID	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts			
	K %	Mg %	Ca %	Na %	H %	NO_3 N ppm	Rate	S ppm	Rate	Zn ppm	Rate	Mn ppm	Rate	Fe ppm	Rate	Cu ppm	Rate	B ppm	Rate	SS ms/cm	Rate		
6	3.2	14.7	80.8	1.1	0.0			490	VH	32.7	VH	60	VH	509	VH	5.0	VH	2.0	H	1.26	M		
7	14.6	22.9	51.3	10.2	1.1			317	VH	39.8	VH	79	VH	538	VH	6.3	VH	1.9	H	1.31	H		
8	14.2	22.9	51.7	10.1	1.1			305	VH	39.7	VH	77	VH	530	VH	5.9	VH	1.9	H	1.29	M		
9	15.0	21.8	49.5	10.6	3.1			348	VH	42.7	VH	81	VH	536	VH	6.9	VH	2.0	H	1.31	H		
10	1.5	25.3	63.5	1.7	8.3			122	VH	32.6	VH	70	VH	625	VH	4.9	VH	1.3	H	0.45	VL		

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric Mc Groary

Pauric Mc Groary Ph.D., CPAg

7621 Whitepine Road, Richmond, VA 23237
Main 804-743-9401 ° Fax 804-271-6446
www.waypointanalytical.com

"Every acre...Every year."™

Send To: WYE RESEARCH CENTER
KEN STAVER
124 Wye Narrows Dr
QUEENSTOWN MD 21658

Grower: Kwn Staver

Comments:

24926 The sodium rating is high on this sample rather than optimum.
24927 The sodium rating is high on this sample rather than optimum.
24928 The sodium rating is high on this sample rather than optimum.

Pauric Mc Groary

Pauric Mc Groary Ph.D., CPAg

Report Number: 22-158-0629
Account Number: 25365

Waypoint ANALYTICAL
7621 Whitepine Road, Richmond, VA 23237
Main 804-743-9401 ° Fax 804-271-6446
www.waypointanalytical.com

"Every acre...Every year."™

Send To: WYE RESEARCH CENTER
KEN STAVER
124 Wye Narrows Dr
QUEENSTOWN MD 21658

Grower: Kwn Staver

SOIL ANALYSIS REPORT

Analytical Method(s): Mehlich 3 SMP Buffer pH Loss On Ignition Water pH

Date Received: 06/07/2022 **Date Of Analysis:** 06/08/2022 **Date Of Report:** 06/13/2022

Sample ID Field ID	Lab Number	OM	W/V	ENR	Phosphorus						Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C
		% Rate	Soil Class	lbs/A	M3 ppm	Rate	ppm	Rate	ppm	Rate	K ppm	Rate	Mg ppm	Rate	Ca ppm	Rate	Na ppm	Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
11	24930	2.3 L		87	28 MD = 33	L					33 MD = 20	VL	180 MD = 139	H	778 MD = 71	M	21	VL	6.3		0.7	6.3
12	24931	2.7 M		95	28 MD = 33	L					32 MD = 19	VL	169 MD = 131	H	771 MD = 71	M	22	VL	6.3		0.6	6.0

Sample ID Field ID	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts			
	K %	Mg %	Ca %	Na %	H %	NO_3 N ppm	Rate	S ppm	Rate	Zn ppm	Rate	Mn ppm	Rate	Fe ppm	Rate	Cu ppm	Rate	B ppm	Rate	SS ms/cm	Rate		
11	1.3	23.8	61.7	1.4	11.1			129	VH	32.4	VH	77	VH	659	VH	4.5	VH	1.4	H	0.43	VL		
12	1.4	23.5	64.3	1.6	10.0			122	VH	32.7	VH	81	VH	655	VH	4.2	VH	1.4	H	0.43	VL		

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric Mc Groary

Pauric Mc Groary Ph.D., CPAg