CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: April 6, 2018 FILE REF: Alum Permitting

TO: Marsha Burzynski

FROM: Scott Inman

SUBJECT: Permitting alum in water's of the state at the Ashland Superfund Site

Introduction

You have inquired about the permit process used to discharge aluminum sulfate $Al_2(SO_4)_3$ (alum) in waters of the state to assist with the control of total suspended solids and contaminates of concern (PAHs and VOCs) during contaminated sediment dredging at the Ashland Superfund site in Ashland, WI.

I understand the inquiry to be based on contractors proposing to use alum during cap placement to control relatively clean total suspended solids at the Burnham Canal project that is expected to occur this year. I pulled together the following information to help inform the WPDES program on the Burnham Canal project, and also to document all of this information in one place.

Background

Alum was first identified at Ashland as a possibility in a *Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study* to accelerate the settling of total suspended solids from the clay substrate and site related COCs. The agencies were concerned with the degree of NAPL at the site and potential releases from multiple curtain system. The Work Plan included a series of bench scale column settling tests with site water to determine the efficacy of different additives. The pros and cons of alum listed in the Work Plan are shown below:

Pro	Con
Highly effective/efficient Application rates 15-20 mg/L (150-250 lbs/acre) Floc formed not toxic to fish	In systems with low alkalinity, alum may depress pH, causing adverse effects to fish (aluminum is toxic to fish if pH decrease below 4.5)
Used to control phosphorous in lake wide applications low cost	pH levels could have a delayed decline due to phytoplankton reduction
Floc visible after 10 minutes with up to 97% turbidity reduction in 48-hours aquatic invertebrates not sensitive to aluminum	96-hour LC 50 of fathead minnows at an alkalinity of 14.5 mg/L in 60 mg/L of Alum

Permitting

Alum use was permitting on a trial basis in 2016 for the Wet Dredge Pilot Study. At that time, there was an existing individual WPDES permit equivalency (WDPES Permit No. WI-0065382-01-0, attached). The permit equivalency covered both the short term (contact water from upland remediation in 2014 and 2015) and long-term water treatment associated with the permanent water treatment system from the extraction of contaminated groundwater. The alum approval was documented in memo to the file that acted as addendum to the individual permit equivalency (October 17, 2016 Ashland/NSP Superfund Site WPDES Permit

Equivalency Addendum, attached). Further discussion of this is documented in Jennifer Jerich's September 28, 2016 email thread, also attached. Note that the site is in the EPA Superfund program, timelines for permits are waived and only the substantive requirements need to be met.

2016 Pilot Study Results

Alum was applied on October 20, 2016 and drastically reduced turbidity and increased water clarity within 24-hours of application, as shown in the photos and monitoring results below:

Before Alum

After Alum

Alum Status	Date	Turbidity (NTU)			TSS (mg/l)			Alkalinity (mg/l)			Aluminum (mg/l)			COCs[1]	
		01	02	03	01	02	03	01	02	03	01	02	03	VOCs	PAHs
Pre	10/20	44	44	44	22	21	19	49	49	50	0.46	0.52	0.53	>	>
Post	10/20	15	16	15											
	10/21	2	2	2	2.1	1.9	1.5	41	43	41	0.18	0.17	0.17	<	<
	10/22	1	1	1											

[1] Relative to project water quality standards

Sediment samples of the settled floc indicated that the floc was contaminated with site related COCs. The total aluminum concentration a sample of the floc was 110,000 mg/kg. The background concentration of aluminum is unknown without further research. The background concentration would have to be subtracted out of this to determine the relative alum contribution to this concentration.

2017 Full Scale

Based on the success of the alum and Pilot test, in general, operations went full scale in 2017. The WPDES permit equivalency was amended to include alum application (attached). In addition, permit conditions were added to the Chapter 30 Permit Equivalency that flocculated material from alum application must be hydraulically dredged, because of the elevated site COCs.

The contractors used alum extensively in 2017. In total, 38,695 gallons of alum at a concentration of 50 ppm were applied between the barrier systems. Midway through the 2017, the contractor switched from spraying alum from boats to applying pumping through a series of perforated piles along the barrier systems to more uniformity and consistently apply alum. Due to the quantity of alum being applied, we requested a round of sample of sampling for aluminum at the monitoring locations, below:

September 1, 2017 Sentinel Monitoring Locations, water samples, in mg/L

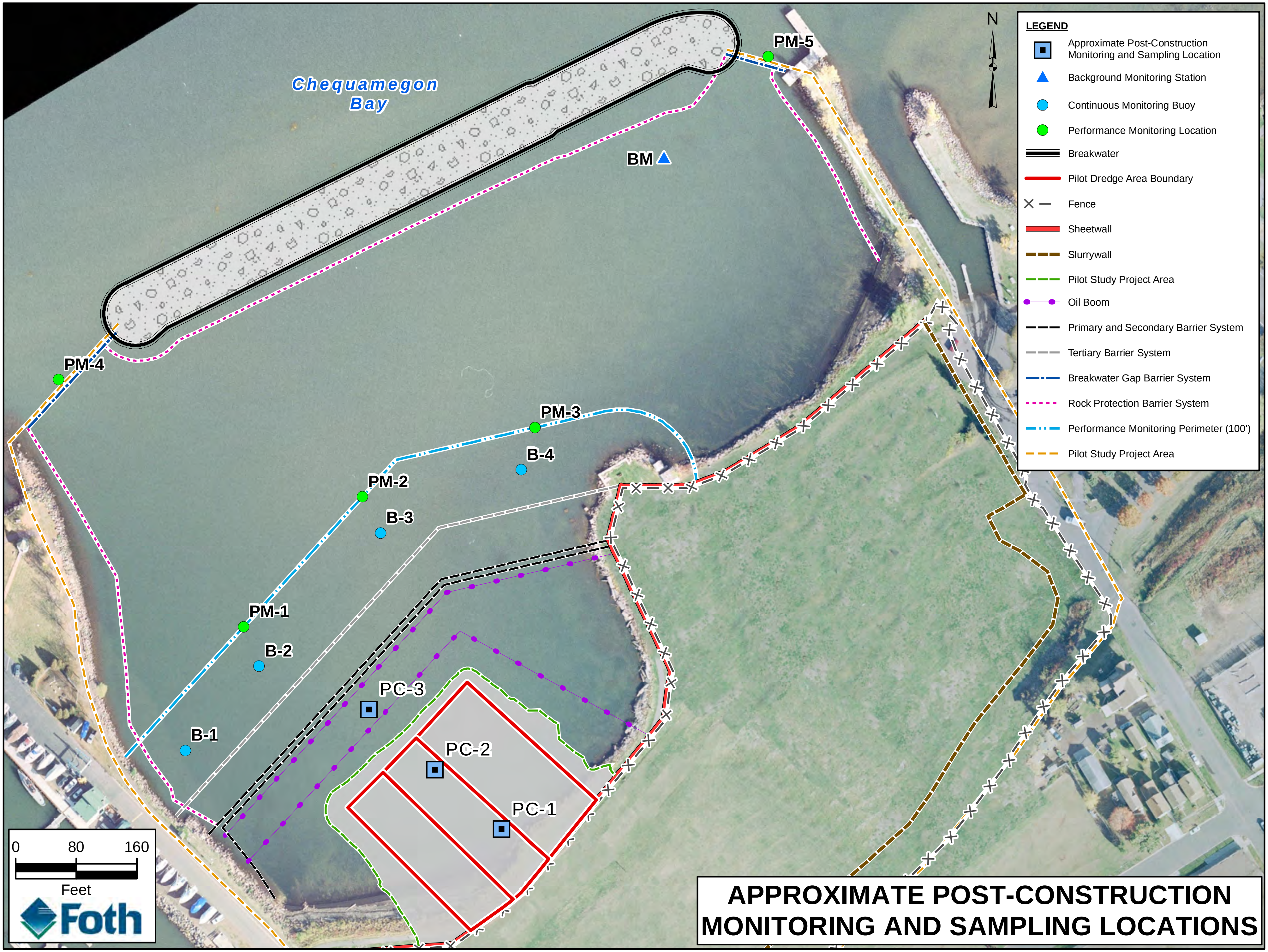
	SL2		SL3	
Analyte	a	b	a	b
Calcium	14	22	21	22
Magnesium	3	3.9	3.7	3.7
Aluminum	0.039	0.065	0.041	0.075
Hardness as calcium carbonate	46	71	69	70
Dissolved Organic Carbon	3.7	3.2	2.3	2.6

Inspection of the daily turbidity monitoring, which also monitors pH, shows that pH was 6.5 inside the bay during the highest alum application day and the pH at the background location was 7.7.

In summary, alum application at the Ashland site helped control the release of site related COCs. The project would not have meet water quality standards without the use of alum or more drastic measures, such as sheet piling off the entire bay. Pictures showing the effectiveness of the alum and barrier system during full scale dredging are below:

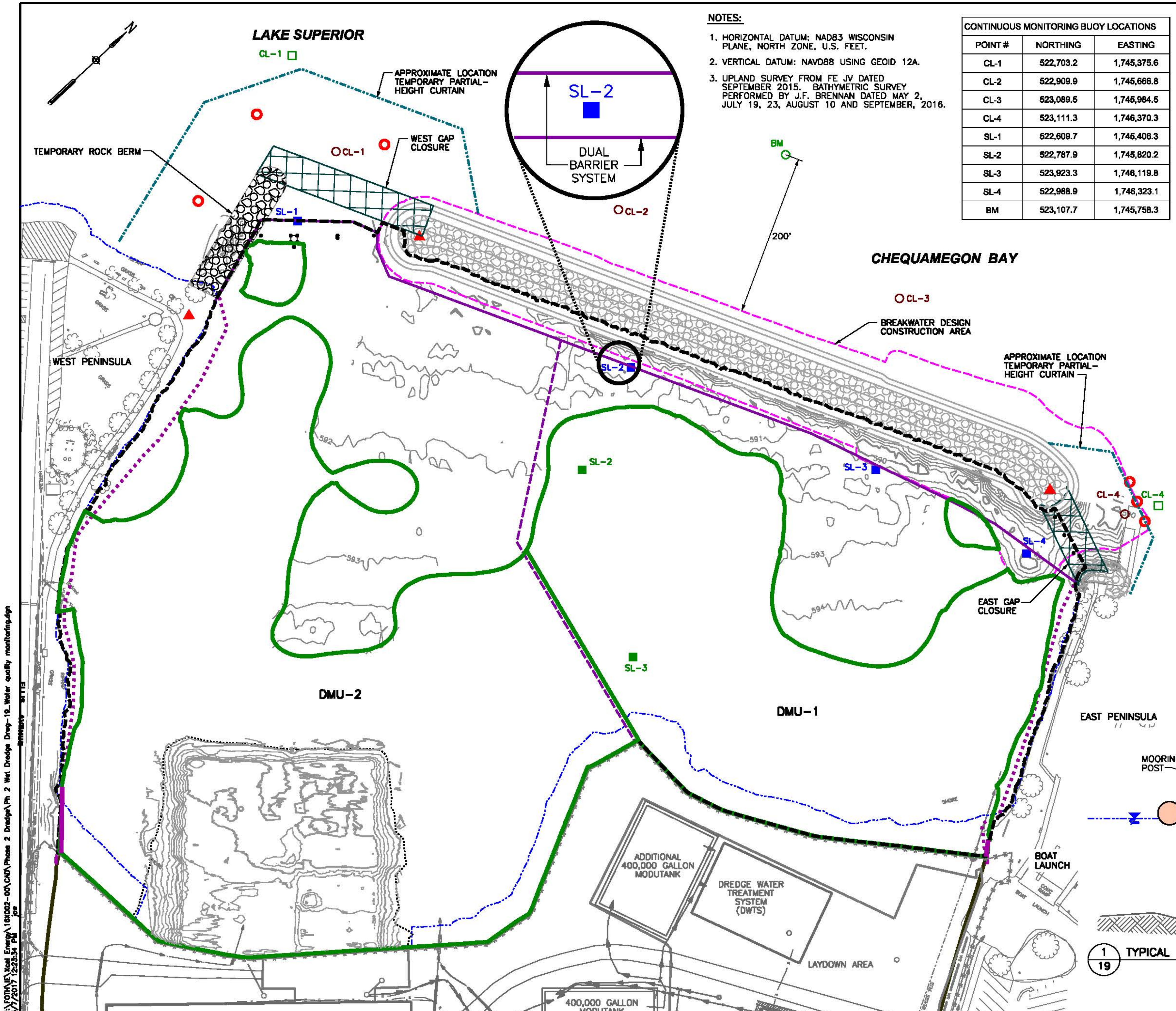
Attachments

- Pilot Map
- Full Scale Map
- Project Water Quality Standards
- Jennifer Jerich September 28, 2016 email thread
- WPDES Permit Equivalency No. WI-0065382-01-0 (2016 Version)
- October 17, 2016 Ashland/NSP Superfund Site WPDES Permit Equivalency Addendum
- WPDES Permit Equivalency No. WI-0065382-01-0 (2017 Version)
- Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study
- Technical Memorandum #16-4 Bench Test Results from the Water Quality Management
- Technical Memorandum #16-5 Colum Settling Results and Recommendations
- Denis Roznowski October 24, 2016 email results



APPROXIMATE POST-CONSTRUCTION MONITORING AND SAMPLING LOCATIONS

Path: X:\FOTH\IE\Xcel Energy\15X002-00\GIS\mxd\Field Maps\Post Construction Monitoring and Sampling Locations Map.mxd Date: 6/8/2016



NOTES:

1. HORIZONTAL DATUM: NAD83 WISCONSIN PLANE, NORTH ZONE, U.S. FEET.
2. VERTICAL DATUM: NAVD88 USING GEOID 12A.
3. UPLAND SURVEY FROM FE JV DATED SEPTEMBER 2015. BATHYMETRIC SURVEY PERFORMED BY J.F. BRENNAN DATED MAY 2, JULY 19, 23, AUGUST 10 AND SEPTEMBER, 2016.

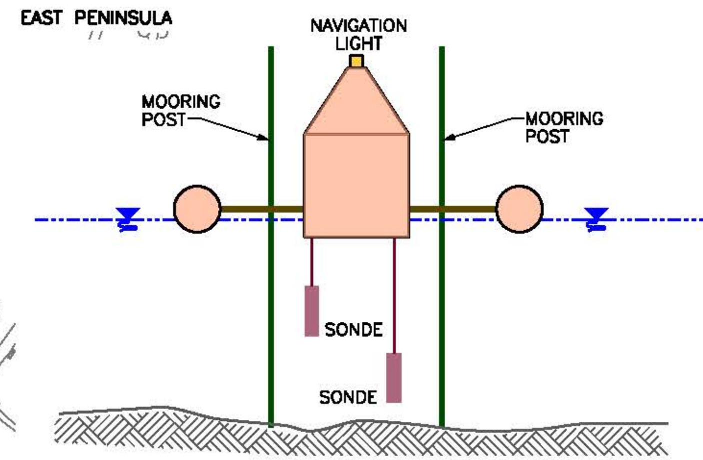
CONTINUOUS MONITORING BUOY LOCATIONS		
POINT #	NORTHING	EASTING
CL-1	522,703.2	1,745,375.6
CL-2	522,909.9	1,745,666.8
CL-3	523,089.5	1,745,984.5
CL-4	523,111.3	1,746,370.3
SL-1	522,609.7	1,745,406.3
SL-2	522,787.9	1,745,820.2
SL-3	523,923.3	1,746,119.8
SL-4	522,988.9	1,746,323.1
BM	523,107.7	1,745,758.3

LEGEND

- PHASE 2 WET DREDGE AREA
- EXISTING LAKE BED CONTOURS (1 FT INTERVALS)
- APPROXIMATE SHORELINE (602 FT)
- SHORELINE BULKHEAD WALL
- EXTENT OF PILOT STUDY DREDGING
- BREAKWATER DESIGN CONSTRUCTION AREA
- WARNING BUOY
- NAVIGATIONAL AID LIGHTS
- APPROXIMATE DMU BOUNDARY/ DAYLIGHT LIMIT
- ROCK PROTECTION BARRIER
- BREAKWATER/GAP BARRIER CURTAIN SYSTEM
- ISOLATION CURTAIN
- APPROXIMATE LOCATION TEMPORARY PARTIAL-HEIGHT CURTAIN
- CL-2 PROPOSED COMPLIANCE LOCATION (SEE DETAIL 1/19)
- SL-2 PROPOSED SENTINEL LOCATION
- BM PROPOSED BACKGROUND LOCATION (SEE DETAIL 1/19)
- SL-2 PROPOSED SENTINEL LOCATION AFTER INSTALLATION OF ISOLATION BARRIER
- CL-4 PROPOSED MANUAL COMPLIANCE LOCATION DURING GAP CLOSURE CONSTRUCTION/DECOMISSIONING

MONITORING NOTES:

1. MONITORING WILL BE CONDUCTED IN ACCORDANCE WITH MONITORING PLAN.
2. MOORING POST TO BE INSTALLED PRIOR TO ON-THE-WATER OPERATIONS. MOORING POST WILL BE USED TO HOLD THE VESSEL AND MONITORING BUOYS IN POSITION DURING MONITORING ACTIVITIES.
3. CL-1 AND CL-4 TO BE INSTALLED FOLLOWING GAP CLOSURE CONSTRUCTION AND REMOVED JUST PRIOR TO GAP CLOSURE DECOMMISSIONING. DURING GAP CLOSURE CONSTRUCTION/DECOMMISSIONING IN LIEU OF REAL TIME MEASUREMENTS, MANUAL ON-SITE MEASUREMENT WILL BE COLLECTED THREE TIMES PER DAY AT LOCATIONS OUTSIDE THE TEMPORARY PARTIAL-HEIGHT CURTAINS. COC SAMPLING WILL BE PERFORMED IN ACCORDANCE WITH THE MONITORING PLAN AT THE MANUAL IN-SITU MEASUREMENT LOCATIONS.



1/19 TYPICAL CONTINUOUS MONITORING BUOY

Foth | Envirocon
Joint Venture
Foth Infrastructure & Environment, LLC
2121 Innovation Court, Suite 300
P.O. Box 5126
De Pere, WI 54115-5126
Phone: 920-497-2500 Fax: 920-497-8516

ASHLAND/NSP LAKEFRONT SITE
FINAL (100%) REMEDIAL DESIGN FOR
PHASE 2 WET DREDGE

NORTHERN STATES POWER COMPANY

ASHLAND COUNTY | WISCONSIN

REVISIONS			
NO.	BY	DATE	DESCRIPTION
1			
2			
3			
4			

RECORD DRAWING OF COMPLETED CONSTRUCTION BY:
RECORD DRAWINGS OF COMPLETED CONSTRUCTION CONFORMING TO CONTRACTOR AND/OR OWNERS RECORDS.
BY / DATE

DATE OF PREPARATION	BY	DATE
SURVEYED		
DRAWN	JOW	MARCH 2017
DESIGNED		
CHECKED	DMR	MARCH 2017

SURFACE WATER QUALITY MONITORING PLAN AND NAVIGATIONAL SIGNAGE

HORIZONTAL SCALE: 0 60' 120'

PROJECT ID: 16X002

19

X:\FOTH\E\Xcel Energy\16X002-00\CAD\Phase 2 Dredge\Ph 2 Wet Dredge Dreg-19_Water quality monitoring.dgn
3/7/2017 12:23:34 PM
joe

5 Analytical Chemistry

5.1 Surface Water Chemistry

Surface water will be analyzed for the constituents listed in Table 5-1 by TestAmerica. Surface water COC sample analyses will have turn-around times as specified in Section 2. All analytical methods used will follow EPA or American Public Health Association (APHA) protocols. Sample containers, preservation, and hold times for the analytes below are listed in *QAPP* (see Appendix F of the *Final Design*). Measurement performance criteria for the analytes are listed in Table 5-1.

Table 5-1

Surface Water Quality Sampling Laboratory Analyses

Analyte	Method	Project Water Quality Standard	Reporting Limit[a]	Laboratory-Specific Method Detection Limit[a]
General Chemistry (mg/L) – Compliance and Sentinel Locations COC Sampling				
TSS	SM 2540D		1.0	0.7
Volatile Organics (µg/L) – Compliance Location COC Sampling				
1,2,4-Trimethylbenzene	8260B	12.3	1	0.17
1,3,5-Trimethylbenzene	8260B	12.3	1	0.17
Benzene	8260B	0.34	1	0.2
Ethylbenzene	8260B	14	1	0.19
Toluene	8260B	--	1	0.17
m+p,xylene	8260B			
Xylenes (Total)	8260B	27	3	0.58
PAHs (µg/L) – Compliance and Sentinel Locations COC Sampling				
1-Methylnaphthalene	8270D SIM	433	0.1	0.02
2-Methylnaphthalene	8270D SIM	24.3	0.1	0.03
Acenaphthene	8270D SIM	38	0.1	0.02
Acenaphthylene	8270D SIM	--	0.1	0.03
Anthracene	8270D SIM	0.035	0.1	0.03
Fluorene	8270D SIM	--	0.1	0.02
Naphthalene	8270D SIM	6.2	0.1	0.02
Phenanthrene	8270D SIM	3.6	0.1	0.03
Benzo[a]anthracene	8270D SIM	0.025	0.1	0.02
Benzo[a]pyrene	8270D SIM	0.003[*]	0.1[c]	0.02[c]
Benzo[b]fluoranthene	8270D SIM	0.003[*]	0.1[c]	0.02[c]
Benzo[e]pyrene	8270D SIM	--	0.1	0.05
Benzo[g,h,i]perylene	8270D SIM	7.64	0.1	0.02
Benzo[k]fluoranthene	8270D SIM	0.14	0.1	0.02
Chrysene	8270D SIM	0.07	0.1	0.02
Dibenzo[a,h]anthracene	8270D SIM	0.003[*]	0.1 [c]	0.02[c]

Analyte	Method	Project Water Quality Standard	Reporting Limit[a]	Laboratory-Specific Method Detection Limit[a]
Dibenzofuran [b]	8270D SIM	--	--	--
Fluoranthene	8270D SIM	1.9	0.1	0.03
Indeno[1,2,3-c,d]-pyrene	8270D SIM	0.03	0.1	0.02
Pyrene	8270D SIM	0.3	0.1	0.02
Total PAHs[b]	--	--	--	--

a. Achievable method detection limits (MDL) and reporting limits (RL) are limits that the selected laboratory can achieve when performing the analytical methods specified in Worksheet #23 with nominal sample volumes in the absence of interferences. Actual MDLs and RLs will vary based on sample-specific factors. Samples must report to the detection limits per Wisconsin requirements. For data sets used to assess compliance with water quality standards, detection limits must not exceed the standard except as identified in the table (*).

b. Total PAHs will be the sum of 18 of the 20 individual listed PAHs. 1-methylnapthalene and dibenzofuran results will not be included in the total PAH calculation. Totals will be summed using 1/2 MDL value for results below detection.

c. May be revised in discussions with the laboratory.

mg/L milligrams per liter

µg/L micrograms per liter

Prepared by: KDA1
Checked by: KRG1

5.2 Wastewater Chemistry

Wastewater collected for WPDES Permit Equivalency will be analyzed for the constituents listed in Tables 5-2 by TestAmerica. Wastewater COC sample analyses will have turn-around times as specified in Section 3. Sample containers, preservation, and hold times for the analytes below are listed in *QAPP* (see Appendix F of the *Final Design*). Measurement performance criteria for the analytes are listed in Table 5-2.

Inman, Scott T - DNR

From: Jerich, Jennifer K - DNR
Sent: Wednesday, September 28, 2016 1:02 PM
To: Dunn, James R - DNR; Provost, Scott M - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Cc: Snowbank, Sheri A - DNR; Fleming, Kari L - DNR; Weigel, Brian M - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency
Attachments: RE: Ashland Extended Pilot Turbidity Control Contingency

Hi all
I had a chance to talk to a number of folks on this. It sounds like Jamie and Sheri had already talked and came to the same conclusion I did.

Summary:

1- An 'addendum' or modification to the WPDES equivalency WI-0065382-01 should be issued to cover this new part of the project.
   a. Addition of a new outfall
   b. Required dosage restriction to the minimum needed.
   c. Require dosage and effective concentrations be recorded and maintained in a report on site.
   d. Reference that the use of these specific products in this way is a unique situation.
2- A full additives review is **not required** given the unique situation and current toxicity levels in the water at this time. Instead the work being done to determine the minimum effective dose will meet our toxicity requirements.
3- Section 2.2.1.2 of the substantive requirements of a WPDES permit document allows for changes to monitoring and/or limits based on the data being reviewed. I would include in the file a discussion that the current in-water levels exceed the requirements and therefore additional treatment is needed. In this case the additional treatment is ______, and final treatment will be _______.
4- Based on the limited research I did today I would say that this project is purely for turbidity and therefore the addendum to the WPDES equivalency WI-0065382-01 is sufficient to communicate WPDES requirements with a limit on the effective dose to the minimum required to settle the turbidity.

Feel free to add as I wrote this up pretty quick and it sounded like Sheri and Jamie already had a lot of this worked out.

Please note that the wastewater statewide is next week. Sheri will be largely not available to complete the paperwork next week.

Thanks all – I know I learned a lot!
Jen
We are committed to service excellence.
Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Jennifer Jerich
Phone: (920) 387-7886
Jennifer.Jerich@wisconsin.gov
Please be aware that I work on Tuesdays and Wednesdays.

From: Dunn, James R - DNR
Sent: Wednesday, September 28, 2016 11:08 AM
To: Provost, Scott M - DNR; Jerich, Jennifer K - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Subject: Re: Ashland Extended Pilot Turbidity Control Contingency

No local wastewater involvement. The Alum will be dissolved in water and then sprayed out on the surface of the embayment. This will floc out the turbidity to settle on the floor of the bay.

From: Provost, Scott M - DNR
Sent: Wednesday, September 28, 2016 10:27 AM
To: Jerich, Jennifer K - DNR; Dunn, James R - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

They need to meet discharge limits, could it be wrapped up there?

From: Jerich, Jennifer K - DNR
Sent: Wednesday, September 28, 2016 10:21 AM
To: Provost, Scott M - DNR; Dunn, James R - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

I'm guessing they are getting a Ch. 30 permit and have had local wastewater involved but not sure…..

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Jennifer Jerich
Phone: (920) 387-7886
Jennifer.Jerich@wisconsin.gov
Please be aware that I work on Tuesdays and Wednesdays.

From: Provost, Scott M - DNR
Sent: Wednesday, September 28, 2016 10:17 AM
To: Jerich, Jennifer K - DNR; Dunn, James R - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

If it's for turbidity control due to dredging then let's keep it there.

From: Jerich, Jennifer K - DNR
Sent: Wednesday, September 28, 2016 10:14 AM
To: Provost, Scott M - DNR; Dunn, James R - DNR; Inman, Scott T - DNR; Van Egeren, Scott J - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

The way the GP is written even for nutrient deactivation we might be able to use the pesticide GP. But this project is purely turbidity control so we need to put our heads together for what other GP might work.

Will we be issuing a NR107 permit for this alum treatment? If yes, then it's just a matter of deciding how to cover any alum that might get outside the treatment areas (very simplified statement) so that WPDES is covered. It would take way too long to do a specific WPDES permit to meet the project's needs. The fact that it is a superfund site and there is dredging makes me wonder if we already did some review and permitting of this project. I could search for that but I'd need to know more possible names of applicants to search our database.

Scott or Jim – Did you have a wastewater person you were working with when you started the dredging planning? That might be the key to the best answer here.

I'm available until 1:30 today. Next week is our statewide but I'll make a point of checking emails to help keep this moving forward. It sounds like timing is critical for this.

Jen

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Jennifer Jerich
Phone: (920) 387-7886
Jennifer.Jerich@wisconsin.gov
Please be aware that I work on Tuesdays and Wednesdays.

From: Provost, Scott M - DNR
Sent: Wednesday, September 28, 2016 10:01 AM
To: Dunn, James R - DNR; Inman, Scott T - DNR; Jerich, Jennifer K - DNR; Van Egeren, Scott J - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

This is the only alum permit I wrote. I don't believe we considered WPDES back then for this. It was for nutrient deactivation not herbicide (plant control) application.

Scott

From: Dunn, James R - DNR
Sent: Wednesday, September 28, 2016 8:55 AM
To: Inman, Scott T - DNR; Jerich, Jennifer K - DNR; Van Egeren, Scott J - DNR
Cc: Provost, Scott M - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

Any chance that there is a completed WPDES permit out there for the application of Alum?

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Jamie Dunn
Hydrogeologist – Remediation & Redevelopment
Wisconsin Department of Natural Resources
810 W. Maple, Spooner, WI
Phone: 715 635-4049
james.dunn@wisconsin.gov

dnr.wi.gov

From: Inman, Scott T - DNR
Sent: Tuesday, September 27, 2016 4:24 PM
To: Jerich, Jennifer K - DNR; Van Egeren, Scott J - DNR
Cc: Provost, Scott M - DNR; Dunn, James R - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

Jennifer,

This has not yet happened and we were thinking about drafting up a WDPES equivalency today as this is a superfund site, everything is substantive requirements but not the process. We have requested additional information from NSP. NSP is proposing this for turbidity/total suspended solids, and contaminates of concern (PAHs and VOCs) exceeding water quality standards within the active dredge area. The pictures are worth 1000 words in this scenario, see attached.

The thought process is that the fines from the clay are not going to settle out before winter and additional management activities are required to meet water quality standards before pulling the contaminate barriers. Right now they are pumping water from the active dredge area at 150 gpm, the maximum capacity of their onsite system, to treat the contaminated water.

We had a call with the contractor today, they are amendable to leaving the bed load baffle (one of the five barriers, a silt curtain from the bottom to ¾ water column) in place over the winter. Attached are two memorandums on the testing they have performed.

It is important to note that the entire area that they are talking about applying the alum and or powdered activated carbon will be dredged next year as part of a full scale project.

Anybody know anything about alum contributing to the methylation of mercury, it was a concern Karrie Fleming had.

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Scott T. Inman
Office: (608) 264-9201
Cell: (608) 576-4912

Scott.Inman@Wisconsin.gov

From: Jerich, Jennifer K - DNR
Sent: Tuesday, September 27, 2016 4:08 PM
To: Van Egeren, Scott J - DNR; Inman, Scott T - DNR
Cc: Provost, Scott M - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

HI all,
I have asked to get access to Jeff Brauer's files on his computer to see if he already researched this. My inclination would be that it requires a WPDES permit for many alum treatments as it is a discharge to a water of the state (note the attachment says a WPDES is not required is from 2002 – pre court case).

In GP WI-0064556-1 see Section 3. Now having said that – are they only doing this for turbidity? That would change my analysis. I might need more info. Has this already happened?

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Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Jennifer Jerich
Phone: (920) 387-7886
Jennifer.Jerich@wisconsin.gov
Please be aware that I work on Tuesdays and Wednesdays.

From: Van Egeren, Scott J - DNR
Sent: Thursday, September 22, 2016 3:53 PM
To: Inman, Scott T - DNR
Cc: Provost, Scott M - DNR; Jerich, Jennifer K - DNR
Subject: RE: Ashland Extended Pilot Turbidity Control Contingency

Hi Scott,

Thanks for stopping by to ask about alum applications the other day.

As I explained, DNR has authority under s.s. 23.24 to authorize treatments of water with alum. See the attached email for reference. We issue these authorizations/permits through our aquatic plant management (APM) program.

I am copying Scott Provost, Statewide APM Coordinator, here so that he is aware of the proposed application (see email below). Scott will have advice on how this type of application would need to be permitted (if we decide we will permit it).

They also likely will need a WPDES permit to discharge alum to waters of the state, but I'm not exactly sure with general permit or individual permit would be applicable. I have copied Jen Jerich here as she would have advice on any need wastewater permits.

Again, it is one thing to permit this use of alum if we determine it will not have non-target impacts. You also will want to think about whether this is the most effective way to control the turbidity issue. I will connect you with Dr. Bill James in a separate email. Bill worked most of his career for the Army Corps of Engineers in Wisconsin and did a lot of work on the efficacy of alum treatments for nutrient inactivation. He knows a lot about alum treatment and would be a good reference for technical questions about this management technique.

Let us know how we can help you.

Cheers,
scott

Scott Van Egeren
Phone: (608)264-8895
scott.vanegeren@wi.gov

From: Inman, Scott T - DNR
Sent: Tuesday, September 20, 2016 2:06 PM
To: Van Egeren, Scott J - DNR
Subject: FW: Ashland Extended Pilot Turbidity Control Contingency

FYI

Scott T. Inman
Office: (608) 264-9201
Cell: (608) 576-4912

Scott.Inman@Wisconsin.gov

From: Dunn, James R - DNR
Sent: Tuesday, September 20, 2016 1:13 PM
To: Inman, Scott T - DNR
Cc: Robinson, John H - DNR
Subject: FW: Ashland Extended Pilot Turbidity Control Contingency

Scott

I have concerns about the addition of Alum to an open surface water. I think at a minimum a WPDES EQ would be required. Can you ask someone in Wastewater about it?

We are committed to service excellence.
Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Jamie Dunn
Hydrogeologist – Remediation & Redevelopment
Wisconsin Department of Natural Resources
810 W. Maple, Spooner, WI
Phone: 715 635-4049
james.dunn@wisconsin.gov

dnr.wi.gov

From: Roznowski, Denis M [mailto:Denis.Roznowski@Foth.com]
Sent: Tuesday, September 20, 2016 12:56 PM
To: Dunn, James R - DNR; 'hansen.scott@epa.gov'
Cc: Ealy, Eric J; Coss, Terry E (terry.e.coss@xcelenergy.com); Carney, Kristen S; Jennifer.Casler@lw.com; Garbaciak Jr., Steve; Aukerman, Ken; Laszewski, Steve; Brad Hay; Alan Buell; Brian Bell (bbell@envirocon.com); Kozicki, Sharon V F; Laszewski, Steve
Subject: Ashland Extended Pilot Turbidity Control Contingency

Jamie/Scott

NSPW is contemplating use of alum addition to the water column as a contingency in the event turbidity levels stay above Alert levels outside of the tertiary barrier for an extended period of time.

The higher turbidity levels currently being experienced are from the dredging of clay as we perform clean-up pass dredging in Ext Pilot DMUs E-1 and E-2. While turbidity is being knocked down considerably by the barrier systems it is higher than previously experienced outside the tertiary barrier in some locations.

Despite the higher turbidity, the COC monitoring at the compliance points is fine (results from 9/12 and 9/15 well below standards), likely due to very low levels of COCs in the clay material being dredged.

FE JV is also pumping water out of the area confined by the primary barrier at a slow rate of approximately 170 gpm and treating that water through the STWTS to help control turbidity.

Since the turbidity being caused by the clay dredging is not anticipated to become a COC issue in the water column, we are presently monitoring the situation and anticipate levels will drop when we initiate hydraulic dredging later this week.

In the event we need to control turbidity to get back below Alert levels this week, or next, can the Agencies give us approval to apply alum to the water column? Based on our preliminary water quality contingencies test work, we anticipate a dosage of between 10 and 50 mg/l would be required to be effective.

Thanks

Denis

Denis Roznowski, P.E. (WI, MN, MI, OH, NY, OR, IN)

Project Director
Foth Infrastructure & Environment, LLC
2121 Innovation Court, Suite 300
P.O. Box 5126
De Pere, WI 54115-5126
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Joint Venture

SUBSTANTIVE REQUIREMENTS OF A WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

Ashland/NSP Lakefront Superfund Site

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located on the south shore of Chequamegon Bay within the City of Ashland WI

to

CHEQUAMEGON BAY WITHIN THE FISH CREEK WATERSHED IN THE LAKE SUPERIOR DRAINAGE BASIN, ASHLAND COUNTY

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

EFFECTIVE DATE - July 01, 2014
EXPIRATION DATE - June 30, 2024

TABLE OF CONTENTS

1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Contaminated groundwater, surface water, contact water and sediment de-watering influent to the treatment system.

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - Influent Sample Point

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Measure	
COD		mg/L	Weekly	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	Weekly	24-Hr Flow Prop Comp	
pH Field		su	Weekly	Grab	
Acenaphthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Acenaphthylene		µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Arsenic, Total Recoverable		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzene		µg/L	Weekly	Grab	
Benzo(a)anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(a)pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(e)Pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(b)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(k)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(ghi)perylene		µg/L	Weekly	24-Hr Flow Prop Comp	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
BETX, Total		μg/L	Weekly	Calculated	Refer to footnote 2.2.1.5 for sampling information.
Chrysene		μg/L	Weekly	24-Hr Flow Prop Comp	
Cyanide, Total		μg/L	Weekly	Grab	
Dibenzo(a,h)-anthracene		μg/L	Weekly	24-Hr Flow Prop Comp	
Ethylbenzene		μg/L	Weekly	Grab	
Fluoranthene		μg/L	Weekly	24-Hr Flow Prop Comp	
Fluorene		μg/L	Weekly	24-Hr Flow Prop Comp	
Indeno(1,2,3-cd)-pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
1-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
4-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
Naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
PAHs		μg/L	Weekly	Calculated	Refer to footnote 2.2.1.4 for sampling information.
Phenanthrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Phenol		μg/L	Weekly	24-Hr Flow Prop Comp	
Pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Styrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Toluene		μg/L	Weekly	Grab	
1,2,4-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	
1,3,5-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	
Xylene		μg/L	Weekly	Grab	

2 Surface Water Requirements

2.1 Sampling Point(s)

The discharge(s) shall be limited to the waste type(s) designated for the listed sampling point(s).

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent samples shall be taken after the water treatment system prior to discharge to Chequamegon Bay of Lake Superior.

2.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point (Outfall) 001 - Effluent

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Measure	
COD		mg/L	Weekly	24-Hr Flow Prop Comp	
Suspended Solids, Total	Daily Max	40 mg/L	Weekly	24-Hr Flow Prop Comp	
pH Field	Daily Max	9.0 su	Weekly	Grab	
pH Field	Daily Min	6.0 su	Weekly	Grab	
Acenaphthene	Monthly Avg	220 µg/L	Weekly	24-Hr Flow Prop Comp	
Acenaphthylene		µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene	Daily Max	0.71 µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene	Weekly Avg	0.21 µg/L	Weekly	24-Hr Flow Prop Comp	
Arsenic, Total Recoverable		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzene	Monthly Avg	55 µg/L	Weekly	Grab	
Benzo(a)anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(b)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(k)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(ghi)perylene		µg/L	Weekly	24-Hr Flow Prop Comp	

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Benzo(a)pyrene	Monthly Avg	0.054 μg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(a)pyrene	Weekly Avg	0.24 μg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(e)Pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
BETX, Total	Monthly Avg	750 μg/L	Weekly	Calculated	Refer to footnote 2.2.1.5 for sampling information.
Chrysene		μg/L	Weekly	24-Hr Flow Prop Comp	
Cyanide, Total	Daily Max	45 μg/L	Weekly	Grab	
Dibenzo(a,h)-anthracene		μg/L	Weekly	24-Hr Flow Prop Comp	
Ethylbenzene		μg/L	Weekly	Grab	
Fluoranthene		μg/L	Weekly	24-Hr Flow Prop Comp	
Fluorene	Weekly Avg	36 μg/L	Weekly	24-Hr Flow Prop Comp	
Indeno(1,2,3-cd)-pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
1-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
4-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
Naphthalene	Monthly Avg	70 μg/L	Weekly	24-Hr Flow Prop Comp	
PAHs	Monthly Avg	0.1 μg/L	Weekly	Calculated	Refer to footnote 2.2.1.4 for sampling information.
Phenanthrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Phenol	Monthly Avg	3,300 μg/L	Weekly	24-Hr Flow Prop Comp	
Pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Styrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Toluene		μg/L	Weekly	Grab	
1,2,4-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	
1,3,5-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	
Xylene		μg/L	Weekly	Grab	

2.2.1.1 Additional Monitoring During Startup

During startup of the treatment system more frequent monitoring than specified in Tables 1.2.1 and 2.2.1 above shall be performed during startup as follows:

Monitoring must be performed initially upon startup of the treatment system at 3 times per week for four weeks or until continuing compliance is adequately documented. Initial intensive monitoring is needed to document compliance with effluent limits and requirements as soon as possible after initiating discharge.

Results of monitoring during startup shall be reported to the Department and the U.S. EPA Region 5 project manager as soon as possible after the results are available, on a daily basis. The routine monitoring frequency specified in the table and submittal of electronic discharge forms may be initiated upon obtaining approval from the Department and/or U.S. EPA based on review of all startup monitoring data.

2.2.1.2 Continuing Evaluation of Monitoring Data and the Need to Modify Effluent Limits

The Department and U.S. EPA will review information submitted to determine satisfaction with discharge monitoring requirements. If it is determined that additional monitoring and/or limits are required to protect the waters of the state, the Department will propose appropriate changes to effluent limits and monitoring requirements in consultation with U.S. EPA.

The frequency of monitoring after startup is specified in the tables above unless otherwise approved in a letter from the Department in consultation with U.S. EPA. A reduction in the frequency of monitoring (a frequency no less than monthly) may be requested by submittal of a report presenting the complete rationale and documentation for a reduced monitoring frequency including but not limited to: documentation of pollutant levels in the discharge well below effluent limits; limited potential for breakthrough of influent pollutants through the treatment units; influent pollutant levels below levels of analytical detection; and consideration of variability of influent and effluent quality.

2.2.1.3 Evaluation of Discharge Requirements for Reported Noncompliance

Requirements for reporting noncompliance to the Department's Northern Region and U.S. EPA Region 5 Project Manager within 24 hours of becoming aware of noncompliance are specified in the standard requirements of the document. Upon receipt of documentation of noncompliance with effluent limits, the Department in consultation with U.S. EPA, will review all relevant submitted information to determine whether these requirements for discharge should be modified to include one or more of the following:

- a revision to the monitoring frequencies established; and/or
- a modification of the limits in the Table above; and/or
- an order under the Superfund Program to reduce or cease discharge to Lake Superior; and/or
- a schedule of compliance for actions needed to evaluate and implement measures to satisfy these limits; and/or other appropriate actions as determined by U.S. EPA, in consultation with the Department

2.2.1.4 Polynuclear Aromatic Hydrocarbons Group

The polynuclear aromatic hydrocarbons (PAH) group regulated by this permit shall include a summation of the following individual compounds: benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. Compliance with the monthly average PAH group limit can be demonstrated by using EPA method 610 or 8310 HPLC and reporting no detect of any of these PAH compounds, or by reporting the sum of the PAH group detected amounts equal to or less than 0.1 ug/L.

2.2.1.5 Total BETX

Total BETX shall include the summation of the following compounds: benzene, ethylbenzene, toluene and total xylenes.

2.2.1.6 Total Metal Analyses

Measurements of total metals and total recoverable metals shall be considered as equivalent.

3 Standard Requirements

Note: Standard requirements apply as substantive requirements of a WPDES permit even though references to permit and permittee and statues and administrative codes have not been changed.

NR 205, Wisconsin Administrative Code (Conditions for Industrial Dischargers): The conditions in ss. NR 205.07(1) and NR 205.07(3), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(3).

3.1 Reporting and Monitoring Requirements

3.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report. The report may require reporting of any or all of the information specified below under 'Recording of Results'. This report is to be returned to the Department no later than the date indicated on the form. A copy of the Wastewater Discharge Monitoring Report Form or an electronic file of the report shall be retained by the permittee.

Monitoring results shall be reported on an electronic discharge monitoring report (eDMR). The eDMR shall be certified electronically by a principal executive officer, a ranking elected official or other duly authorized representative. The 'eReport Certify' page certifies that the electronic report form is true, accurate and complete.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included on the Wastewater Discharge Monitoring Report.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

3.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

3.1.3 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;
- the individual who performed the sampling or measurements;
- the date the analysis was performed;
- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

3.1.4 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

3.1.5 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application, except for sludge management forms and records, which shall be kept for a period of at least 5 years.

3.1.6 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

3.2 System Operating Requirements

3.2.1 Noncompliance Reporting

The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:

- any noncompliance which may endanger health or the environment;
- any violation of an effluent limitation resulting from an unscheduled bypass;
- any violation of an effluent limitation resulting from an upset; and
- any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

A written report describing the noncompliance shall also be submitted to the Department as directed at the end of this permit within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

A scheduled bypass approved by the Department under the 'Scheduled Bypass' section of this permit shall not be subject to the reporting required under this section.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. **The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at 1-800-943-0003.**

3.2.2 Bypass

Except for a controlled diversion as provided in the 'Controlled Diversions' section of this permit, any bypass is prohibited and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats. The Department may approve an unscheduled bypass provided all the following conditions are met:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities or adequate back-up equipment, retention of untreated wastes, reduction of inflow and infiltration, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance. When evaluating feasibility of alternatives, the department may consider factors such as technical achievability, costs and affordability of implementation and risks to public health, the environment and, where the permittee is a municipality, the welfare of the community served; and
- The bypass was reported in accordance with the 'Noncompliance Reporting' section of this permit.

3.2.3 Scheduled Bypass

Whenever the permittee anticipates the need to bypass for purposes of efficient operations and maintenance and the permittee may not meet the conditions for controlled diversions in the 'Controlled Diversions' section of this permit, the permittee shall obtain prior written approval from the Department for the scheduled bypass. A permittee's written request for Department approval of a scheduled bypass shall demonstrate that the conditions for unscheduled bypassing are met and include the proposed date and reason for the bypass, estimated volume and duration of the bypass, alternatives to bypassing and measures to mitigate environmental harm caused by the bypass. The department may require the permittee to provide public notification for a scheduled bypass if it is determined there is significant public interest in the proposed action and may recommend mitigation measures to minimize the impact of such bypass.

3.2.4 Controlled Diversions

Controlled diversions are allowed only when necessary for essential maintenance to assure efficient operation provided the following requirements are met:

- Effluent from the wastewater treatment facility shall meet the effluent limitations established in the permit. Wastewater that is diverted around a treatment unit or treatment process during a controlled diversion shall be recombined with wastewater that is not diverted prior to the effluent sampling location and prior to effluent discharge;
- A controlled diversion may not occur during periods of excessive flow or other abnormal wastewater characteristics;
- A controlled diversion may not result in a wastewater treatment facility overflow; and
- All instances of controlled diversions shall be documented in wastewater treatment facility records and such records shall be available to the department on request.

3.2.5 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

3.2.6 Spill Reporting

The permittee shall notify the Department in accordance with ch. NR 706 (formerly NR 158), Wis. Adm. Code, in the event that a spill or accidental release of any material or substance results in the discharge of pollutants to the waters of the state at a rate or concentration greater than the effluent limitations established in this permit, or the spill or accidental release of the material is unregulated in this permit, unless the spill or release of pollutants has been reported to the Department in accordance with s. NR 205.07 (1)(s), Wis. Adm. Code.

3.2.7 Planned Changes

In accordance with ss. 283.31(4)(b) and 283.59, Stats., the permittee shall report to the Department any facility expansion, production increase or process modifications which will result in new, different or increased discharges of pollutants. The report shall either be a new permit application, or if the new discharge will not violate the effluent limitations of this permit, a written notice of the new, different or increased discharge. The notice shall contain a description of the new activities, an estimate of the new, different or increased discharge of pollutants and a description of the effect of the new or increased discharge on existing waste treatment facilities. Following receipt of this report, the Department may modify this permit to specify and limit any pollutants not previously regulated in the permit.

3.2.8 Duty to Halt or Reduce Activity

Upon failure or impairment of treatment facility operation, the permittee shall, to the extent necessary to maintain compliance with its permit, curtail production or wastewater discharges or both until the treatment facility operations are restored or an alternative method of treatment is provided.

3.3 Surface Water Requirements

3.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantitation (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

3.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average concentration limits and mass limits and total load limits:

Weekly/Monthly/Six-Month/Annual Average Concentration = the sum of all daily results for that week/month/six-month/year, divided by the number of results during that time period. [Note: When a six-month average effluent limit is specified for Total Phosphorus the applicable periods are May through October and November through April.]

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

Six-Month Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the six-month period. [Note: When a six-month average effluent limit is specified for Total Phosphorus the applicable periods are May through October and November through April.]

Annual Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the entire year.

Total Monthly Discharge: = monthly average concentration (mg/L) x total flow for the month (MG/month) x 8.34.

Total Annual Discharge: = sum of total monthly discharges for the calendar year.

12-Month Rolling Sum of Total Monthly Discharge: = the sum of the most recent 12 consecutive months of Total Monthly Discharges.

3.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

3.3.4 Surface Water Uses and Criteria

In accordance with NR 102.04, Wis. Adm. Code, surface water uses and criteria are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all surface waters including the mixing zone meet the following conditions at all times and under all flow and water level conditions:

a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state.

b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the state.

c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state.

d) Substances in concentrations or in combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life.

4 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	Date	Page
Wastewater Discharge Monitoring Report	no later than the date indicated on the form	7

Report forms shall be submitted electronically in accordance with the reporting requirements herein. All other submittals required by this permit shall be submitted to:
Northern Region - Rhinelander, 107 Sutliff Ave., Rhinelander, WI 54501 and
U.S. EPA Region 5 (site project manager).

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Northern Region Headquarters
810 W. Maple Street
Spooner, WI 54801-1255

Scott Walker, Governor
Cathy Stepp, Secretary
John Gozdzialski, Regional Director
Telephone (715) 635-2101
FAX (715) 635-4105
TDD (715) 635-4001

March 9, 2016

Eric Ealy
Environmental Analyst V
414 Nicollet Mall, # MP-4
Minneapolis, MN 55401-1993

SUBJECT: Typographical Error(s) in the Substantive Requirements of a WPDES Permit No. WI-0065382-01-0

Greetings:

A typographical error in the Substantive Requirements of a WPDES Permit No. WI-0065382-01-0 issued to Ashland/NSP Lakefront Superfund Site on July 01, 2014 has been discovered.

The permit equivalency inadvertently identified using a 24 hour flow proportional composite as the collection method for 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene and Styrene. These Volatile Organic Compounds (VOCs) should have been identified as Grab samples

All discharges from this facility and actions or reports relating thereto shall be in accordance with the terms and conditions of the original substantive requirements as amended by this letter.

Sincerely,

Sheri A. Snowbank
Wastewater Specialist

cc: Permit File – Region & Central Office
Donalea Dinsmore – WNDR Central Office
Jamie Dunn – WDNR Spooner
Eric DeVenecia – WDNR Superior
U.S. Fish and Wildlife Service (Electronic Copy via Email)

State of Wisconsin

CORRESPONDENCE/MEMORANDUM

DATE: October 17, 2016 FILE REF: 02-02-000013

TO: File

FROM: Jamie Dunn

SUBJECT: Ashland/NSP Superfund Site WPDES Permit Equivalency Addendum

On October 6, 2016, Northern States Power of Wisconsin (NSPW) submitted the Implementation of Water Quality Contingency plan (Plan) for the above referenced site. The plan includes the operations that may take place post restorative layer placement if water quality does not meet standards to allow the removal of the barrier system installed to support the Wet Dredge Pilot Test.

The Plan includes the addition of Alum and potentially powdered activated carbon to the surface water of Chequamegon Bay of Lake Superior. Current wastewater discharges from the Superfund Site are covered under a WPDES equivalency under Superfund Authority administered by USEPA.

This memo will act as an addendum to that WPDES equivalency for the addition of another discharge point (addition of Alum) to the receiving water. Additional requirements are requested due to this addition. Prior to the addition of Alum and/or Carbon, Water quality samples will be collected and analyzed for:

- Total Suspended Solids (TSS)
- Total Aluminum
- pH
- Alkalinity

Post application and after the settling process is complete, “floc” samples will be collected and analyzed for:

- PAHs/VOCs
- Total Aluminum

Due to the presence of the “floc” material on the floor of the bay and it potential to migrate, the removal of the at a minimum, the bed load baffle portion of the tertiary barrier will be set back until spring when the full scale wet dredge water quality controls are in place.

cc: Sheri Snowbank

SUBSTANTIVE REQUIREMENTS OF A WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

Ashland/NSP Lakefront Superfund Site

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located on the south shore of Chequamegon Bay within the City of Ashland WI

to

CHEQUAMEGON BAY WITHIN THE FISH CREEK WATERSHED IN THE LAKE SUPERIOR DRAINAGE BASIN, ASHLAND COUNTY

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

EFFECTIVE DATE - July 01, 2014
MODIFICATION DATE – March 1, 2017
EXPIRATION DATE - June 30, 2024

TABLE OF CONTENTS

1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Influent flows consist primarily of contaminated groundwater sent to the Long-Term Water Treatment System.
702	Influent flows consist of carriage water from hydraulic and mechanical dredging as well as contact water associated with dredging activities and stormwater sent to the Phase II Wet Dredging Water Treatment System.

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - LTWTS Influent and 702- Phase II Influent

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Measure	
COD		mg/L	Weekly	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	Weekly	24-Hr Flow Prop Comp	
pH Field		su	Weekly	Grab	
Acenaphthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Acenaphthylene		µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Arsenic, Total Recoverable		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzene		µg/L	Weekly	Grab	
Benzo(a)anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(a)pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(e)Pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(b)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(k)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Benzo(ghi)perylene		µg/L	Weekly	24-Hr Flow Prop Comp	
BETX, Total		µg/L	Weekly	Calculated	Refer to footnote 3.2.1.5 for sampling information.
Chrysene		µg/L	Weekly	24-Hr Flow Prop Comp	
Cyanide, Total		µg/L	Weekly	Grab	
Dibenzo(a,h)-anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Ethylbenzene		µg/L	Weekly	Grab	
Fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Fluorene		µg/L	Weekly	24-Hr Flow Prop Comp	
Indeno(1,2,3-cd)-pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
1-Methyl-naphthalene		µg/L	Weekly	24-Hr Flow Prop Comp	
2-Methyl-naphthalene		µg/L	Weekly	24-Hr Flow Prop Comp	
2-Methylphenol		µg/L	Weekly	24-Hr Flow Prop Comp	
4-Methylphenol		µg/L	Weekly	24-Hr Flow Prop Comp	
Naphthalene		µg/L	Weekly	24-Hr Flow Prop Comp	
PAHs		µg/L	Weekly	Calculated	Refer to footnote 3.2.1.4 for sampling information.
Phenanthrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Phenol		µg/L	Weekly	24-Hr Flow Prop Comp	
Pyrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Styrene		µg/L	Weekly	24-Hr Flow Prop Comp	
Toluene		µg/L	Weekly	Grab	
1,2,4-Trimethyl-benzene		µg/L	Weekly	24-Hr Flow Prop Comp	
1,3,5-Trimethyl-benzene		µg/L	Weekly	24-Hr Flow Prop Comp	
Xylene		µg/L	Weekly	Grab	

2 In-Plant Requirements

2.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
101	The permittee is authorized to add alum to the surface water of Chequamegon Bay as needed to control total suspended solids as a result of Phase II dredging.

2.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point 101 - Turbidity Control

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Additive - Alum		lbs	Daily	Measure	

2.2.1.1 Alum Treatment

Only days with alum treatment are required to be recorded. The use of alum to precipitate suspended solids as a result of Phase II dredging shall follow the protocols developed in the 2016 pilot study. Additional best management practices may be imposed by the Department as needed to protect water quality.

3 Surface Water Requirements

3.1 Sampling Point(s)

The discharge(s) shall be limited to the waste type(s) designated for the listed sampling point(s).

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent samples shall be taken after the Long-Term Water Treatment System prior to discharge to Chequamegon Bay of Lake Superior.
002	Effluent samples shall be taken after the Phase II Water Treatment System prior to discharge to Chequamegon Bay of Lake Superior.

3.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

3.2.1 Sampling Point (Outfall) 001 - LTWTS Effluent and 002- Phase II Effluent

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Daily	Measure	
COD		mg/L	Weekly	24-Hr Flow Prop Comp	
Suspended Solids, Total	Daily Max	40 mg/L	Weekly	24-Hr Flow Prop Comp	
pH Field	Daily Max	9.0 su	Weekly	Grab	
pH Field	Daily Min	6.0 su	Weekly	Grab	
Acenaphthene	Monthly Avg	220 µg/L	Weekly	24-Hr Flow Prop Comp	
Acenaphthylene		µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene	Daily Max	0.71 µg/L	Weekly	24-Hr Flow Prop Comp	
Anthracene	Weekly Avg	0.21 µg/L	Weekly	24-Hr Flow Prop Comp	
Arsenic, Total Recoverable		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzene	Monthly Avg	55 µg/L	Weekly	Grab	
Benzo(a)anthracene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(b)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(k)fluoranthene		µg/L	Weekly	24-Hr Flow Prop Comp	

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Benzo(ghi)perylene		μg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(a)pyrene	Monthly Avg	0.054 μg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(a)pyrene	Weekly Avg	0.24 μg/L	Weekly	24-Hr Flow Prop Comp	
Benzo(e)Pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
BETX, Total	Monthly Avg	750 μg/L	Weekly	Calculated	Refer to footnote 3.2.1.5 for sampling information.
Chrysene		μg/L	Weekly	24-Hr Flow Prop Comp	
Cyanide, Total	Daily Max	45 μg/L	Weekly	Grab	
Dibenzo(a,h)-anthracene		μg/L	Weekly	24-Hr Flow Prop Comp	
Ethylbenzene		μg/L	Weekly	Grab	
Fluoranthene		μg/L	Weekly	24-Hr Flow Prop Comp	
Fluorene	Weekly Avg	36 μg/L	Weekly	24-Hr Flow Prop Comp	
Indeno(1,2,3-cd)-pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
1-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methyl-naphthalene		μg/L	Weekly	24-Hr Flow Prop Comp	
2-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
4-Methylphenol		μg/L	Weekly	24-Hr Flow Prop Comp	
Naphthalene	Monthly Avg	70 μg/L	Weekly	24-Hr Flow Prop Comp	
PAHs	Monthly Avg	0.1 μg/L	Weekly	Calculated	Refer to footnote 3.2.1.4 for sampling information.
Phenanthrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Phenol	Monthly Avg	3,300 μg/L	Weekly	24-Hr Flow Prop Comp	
Pyrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Styrene		μg/L	Weekly	24-Hr Flow Prop Comp	
Toluene		μg/L	Weekly	Grab	
1,2,4-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
1,3,5-Trimethyl-benzene		μg/L	Weekly	24-Hr Flow Prop Comp	
Xylene		μg/L	Weekly	Grab	

3.2.1.1 Additional Monitoring During Startup

During startup of a treatment system more frequent monitoring than specified in Tables 1.2.1 and 2.2.1 above shall be performed during startup as follows:

Monitoring must be performed initially upon startup of the treatment system at 3 times per week for four weeks or until continuing compliance is adequately documented. Initial intensive monitoring is needed to document compliance with effluent limits and requirements as soon as possible after initiating discharge.

Results of monitoring during startup shall be reported to the Department and the U.S. EPA Region 5 project manager as soon as possible after the results are available, on a daily basis. The routine monitoring frequency specified in the table and submittal of electronic discharge forms may be initiated upon obtaining approval from the Department and/or U.S. EPA based on review of all startup monitoring data.

3.2.1.2 Continuing Evaluation of Monitoring Data and the Need to Modify Effluent Limits

The Department and U.S. EPA will review information submitted to determine satisfaction with discharge monitoring requirements. If it is determined that additional monitoring and/or limits are required to protect the waters of the state, the Department will propose appropriate changes to effluent limits and monitoring requirements in consultation with U.S. EPA.

The frequency of monitoring after startup is specified in the tables above unless otherwise approved in a letter from the Department in consultation with U.S. EPA. A reduction in the frequency of monitoring (a frequency no less than monthly) may be requested by submittal of a report presenting the complete rationale and documentation for a reduced monitoring frequency including but not limited to: documentation of pollutant levels in the discharge well below effluent limits; limited potential for breakthrough of influent pollutants through the treatment units; influent pollutant levels below levels of analytical detection; and consideration of variability of influent and effluent quality.

3.2.1.3 Evaluation of Discharge Requirements for Reported Noncompliance

Requirements for reporting noncompliance to the Department's Northern Region and U.S. EPA Region 5 Project Manager within 24 hours of becoming aware of noncompliance are specified in the standard requirements of the document. Upon receipt of documentation of noncompliance with effluent limits, the Department in consultation with U.S. EPA, will review all relevant submitted information to determine whether these requirements for discharge should be modified to include one or more of the following:

- a revision to the monitoring frequencies established; and/or
- a modification of the limits in the Table above; and/or
- an order under the Superfund Program to reduce or cease discharge to Lake Superior; and/or
- a schedule of compliance for actions needed to evaluate and implement measures to satisfy these limits; and/or other appropriate actions as determined by U.S. EPA, in consultation with the Department

3.2.1.4 Polynuclear Aromatic Hydrocarbons Group

The polynuclear aromatic hydrocarbons (PAH) group regulated by this permit shall include a summation of the following individual compounds: benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. Compliance with the monthly average PAH group limit can be demonstrated by using EPA method 610 or 8310 HPLC and reporting no detect of any of these PAH compounds, or by reporting the sum of the PAH group detected amounts equal to or less than 0.1 ug/L.

3.2.1.5 Total BETX

Total BETX shall include the summation of the following compounds: benzene, ethylbenzene, toluene and total xylenes.

3.2.1.6 Total Metal Analyses

Measurements of total metals and total recoverable metals shall be considered as equivalent.

4 Standard Requirements

Note: Standard requirements apply as substantive requirements of a WPDES permit even though references to permit and permittee and statues and administrative codes have not been changed.

NR 205, Wisconsin Administrative Code (Conditions for Industrial Dischargers): The conditions in ss. NR 205.07(1) and NR 205.07(3), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(3).

4.1 Reporting and Monitoring Requirements

4.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report. The report may require reporting of any or all of the information specified below under 'Recording of Results'. This report is to be returned to the Department no later than the date indicated on the form. A copy of the Wastewater Discharge Monitoring Report Form or an electronic file of the report shall be retained by the permittee.

Monitoring results shall be reported on an electronic discharge monitoring report (eDMR). The eDMR shall be certified electronically by a principal executive officer, a ranking elected official or other duly authorized representative. The 'eReport Certify' page certifies that the electronic report form is true, accurate and complete.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included on the Wastewater Discharge Monitoring Report.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

4.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

4.1.3 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;
- the individual who performed the sampling or measurements;
- the date the analysis was performed;
- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

4.1.4 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

4.1.5 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application, except for sludge management forms and records, which shall be kept for a period of at least 5 years.

4.1.6 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

4.2 System Operating Requirements

4.2.1 Noncompliance Reporting

The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:

- any noncompliance which may endanger health or the environment;
- any violation of an effluent limitation resulting from an unscheduled bypass;
- any violation of an effluent limitation resulting from an upset; and
- any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

A written report describing the noncompliance shall also be submitted to the Department as directed at the end of this permit within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

A scheduled bypass approved by the Department under the 'Scheduled Bypass' section of this permit shall not be subject to the reporting required under this section.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. **The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at 1-800-943-0003**.

4.2.2 Bypass

Except for a controlled diversion as provided in the 'Controlled Diversions' section of this permit, any bypass is prohibited and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats. The Department may approve an unscheduled bypass provided all the following conditions are met:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities or adequate back-up equipment, retention of untreated wastes, reduction of inflow and infiltration, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance. When evaluating feasibility of alternatives, the department may consider factors such as technical achievability, costs and affordability of implementation and risks to public health, the environment and, where the permittee is a municipality, the welfare of the community served; and
- The bypass was reported in accordance with the 'Noncompliance Reporting' section of this permit.

4.2.3 Scheduled Bypass

Whenever the permittee anticipates the need to bypass for purposes of efficient operations and maintenance and the permittee may not meet the conditions for controlled diversions in the 'Controlled Diversions' section of this permit, the permittee shall obtain prior written approval from the Department for the scheduled bypass. A permittee's written request for Department approval of a scheduled bypass shall demonstrate that the conditions for unscheduled bypassing are met and include the proposed date and reason for the bypass, estimated volume and duration of the bypass, alternatives to bypassing and measures to mitigate environmental harm caused by the bypass. The department may require the permittee to provide public notification for a scheduled bypass if it is determined there is significant public interest in the proposed action and may recommend mitigation measures to minimize the impact of such bypass.

4.2.4 Controlled Diversions

Controlled diversions are allowed only when necessary for essential maintenance to assure efficient operation provided the following requirements are met:

- Effluent from the wastewater treatment facility shall meet the effluent limitations established in the permit. Wastewater that is diverted around a treatment unit or treatment process during a controlled diversion shall be recombined with wastewater that is not diverted prior to the effluent sampling location and prior to effluent discharge;
- A controlled diversion may not occur during periods of excessive flow or other abnormal wastewater characteristics;
- A controlled diversion may not result in a wastewater treatment facility overflow; and
- All instances of controlled diversions shall be documented in wastewater treatment facility records and such records shall be available to the department on request.

4.2.5 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

4.2.6 Spill Reporting

The permittee shall notify the Department in accordance with ch. NR 706 (formerly NR 158), Wis. Adm. Code, in the event that a spill or accidental release of any material or substance results in the discharge of pollutants to the waters of the state at a rate or concentration greater than the effluent limitations established in this permit, or the spill or accidental release of the material is unregulated in this permit, unless the spill or release of pollutants has been reported to the Department in accordance with s. NR 205.07 (1)(s), Wis. Adm. Code.

4.2.7 Planned Changes

In accordance with ss. 283.31(4)(b) and 283.59, Stats., the permittee shall report to the Department any facility expansion, production increase or process modifications which will result in new, different or increased discharges of pollutants. The report shall either be a new permit application, or if the new discharge will not violate the effluent limitations of this permit, a written notice of the new, different or increased discharge. The notice shall contain a description of the new activities, an estimate of the new, different or increased discharge of pollutants and a description of the effect of the new or increased discharge on existing waste treatment facilities. Following receipt of this report, the Department may modify this permit to specify and limit any pollutants not previously regulated in the permit.

4.2.8 Duty to Halt or Reduce Activity

Upon failure or impairment of treatment facility operation, the permittee shall, to the extent necessary to maintain compliance with its permit, curtail production or wastewater discharges or both until the treatment facility operations are restored or an alternative method of treatment is provided.

4.3 Surface Water Requirements

4.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantitation (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

4.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average concentration limits and mass limits and total load limits:

Weekly/Monthly/Six-Month/Annual Average Concentration = the sum of all daily results for that week/month/six-month/year, divided by the number of results during that time period. [Note: When a six-month average effluent limit is specified for Total Phosphorus the applicable periods are May through October and November through April.]

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

Six-Month Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the six-month period. [Note: When a six-month average effluent limit is specified for Total Phosphorus the applicable periods are May through October and November through April.]

Annual Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the entire year.

Total Monthly Discharge: = monthly average concentration (mg/L) x total flow for the month (MG/month) x 8.34.

Total Annual Discharge: = sum of total monthly discharges for the calendar year.

12-Month Rolling Sum of Total Monthly Discharge: = the sum of the most recent 12 consecutive months of Total Monthly Discharges.

4.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

4.3.4 Surface Water Uses and Criteria

In accordance with NR 102.04, Wis. Adm. Code, surface water uses and criteria are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all surface waters including the mixing zone meet the following conditions at all times and under all flow and water level conditions:

a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state.

b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the state.

c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state.

d) Substances in concentrations or in combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life.

5 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	Date	Page
Wastewater Discharge Monitoring Report	no later than the date indicated on the form	8

Report forms shall be submitted electronically in accordance with the reporting requirements herein. All other submittals required by this permit shall be submitted to:
WDNR Northern Region – Spooner, 810 West Maple, Spooner, WI 54801 and
U.S. EPA Region 5 (site project manager).

Report

Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study

Ashland/NSP Lakefront Site

Project I.D.: 15X002

NSPW
Eau Claire, Wisconsin

April 2016

Foth | Envirocon
Joint Venture

Foth | Envirocon
Joint Venture

101 International Drive, P.O. Box 16655
Missoula, MT 59808

April 29, 2016

Mr. Eric Ealy
Project Manager
Xcel Energy, Inc., on behalf of NSPW
414 Nicollet Mall
Minneapolis MN 55401

Dear Mr. Ealy:

RE: *Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study* – Ashland/NSP Lakefront Site

On behalf of Foth Infrastructure & Environment/Envirocon Joint Venture (FE JV), the *Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study* (*WQ Work Plan*) for the Ashland/NSP Lakefront Site is enclosed. The document has also been posted to the FE JV Ashland Phase 2 SharePoint site for Agency review and approval.

If you have any questions concerning this report, please contact either of the undersigned at (920) 497-2500.

Sincerely,

Foth Infrastructure & Environment/Envirocon Joint Venture

Steve J. Laszewski, Ph.D.
Management Committee Member

Denis Roznowski, P.E.
Project Manager

Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study

Distribution

No. of Copies	Sent To
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1	Alan Buell Deputy Project Manager Foth Infrastructure & Environment/ Envirocon Joint Venture 7878 Wadsworth Blvd, Suite 340 Arvada CO 80003
1	Master Project Files Foth Infrastructure & Environment/Envirocon Joint Venture

No. of Copies	Sent To
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Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study

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Contents

Tables

Appendices

List of Abbreviations, Acronyms, and Symbols

Agencies	U.S. Environmental Protection Agency and Wisconsin Department of Natural Resources
Bay	Chequamegon Bay
COC	contaminants of concern
EPA	Environmental Protection Agency
FE JV	Foth Infrastructure & Environment/Envirocon Joint Venture
Final Design	*Final Design for Phase 2 Wet Dredge Pilot Study*
GAC	granular activated carbon
gpm	gallons per minute
mg/kg	milligrams per kilograms
Monitoring Plan	*Monitoring Plan for Phase 2 Wet Dredge Pilot Study*
NAPL	non-aqueous phase liquid
NSP	Northern States Power Company
NSPW	Northern States Power Company, a Wisconsin Corporation
PAH	polynuclear aromatic hydrocarbon
Phase 1 Final Design	*Final Design for Phase 1 Remedial Action*
Pilot Study	Phase 2 Wet Dredge Pilot Study
QAPP Addendum 2	*Quality Assurance Project Plan for Phase 2 Wet Dredge Pilot Study Addendum 2*
ROD	*Record of Decision*
SAP	*Pre-Dredge Sediment Sampling and Analysis Plan for Phase 2 Wet Dredge Pilot Study*
Site	Ashland/NSP Lakefront Site
STWTS	Short-Term Water Treatment System
tPAH	total polynuclear aromatic hydrocarbon
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WDNR	Wisconsin Department of Natural Resources
WQ Work Plan	*Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study*
WTS	water treatment system

1 Introduction

On February 25, 2016, the Foth Infrastructure & Environment/Envirocon Joint Venture (FE JV) submitted the *Final Design for Phase 2 Wet Dredge Pilot* Study (*Final Design*) (FE JV, 2016a). The *Final Design* presents design details, plans and specifications, and accompanying support documents related to implementing the Wet Dredge Pilot Study (Pilot Study) at the Ashland/NSP Lakefront Site (Site). The Pilot Study is being performed to evaluate whether wet dredging can be used to successfully remediate the nearshore sediments at the Site.

The water quality barrier system that will be deployed during the Pilot Study cannot be demobilized and removed from the Site until the water quality is acceptable, as detailed in the *Final Design*. While it is expected that the required water quality standards can eventually be attained through natural processes, the barrier system must be removed prior to winter to prevent severe damage/destruction from ice. The *Final Design* recognizes that contingencies may be required to accelerate water quality improvement by actively managing total suspended solids (TSS) and concentrations of chemical contaminants that remain above the project standards and are preventing the timely removal of the barrier system.

The FE JV has prepared this *Water Quality Management Contingencies Work Plan* **(***WQ Work Plan*) for submittal and approval by the U.S. Environmental Protection Agency (USEPA/EPA) and the Wisconsin Department of Natural Resources (WDNR) (collectively referred to as the "Agencies") to ensure that all parties are in agreement with the approach to identifying, testing, and selecting water quality contingency measures that may be employed during the Pilot Study. Upon approval of the *WQ Work Plan*, the outlined work will be completed and a technical memorandum will be prepared describing the results of the efforts and the specific recommendations for contingency implementation.

This *WQ Work Plan* reviews and identifies potential contingency measures that will be further evaluated through a series of bench scale tests. Successful contingency options that are identified through bench scale testing will be identified and recommendations for options to be implemented in the field will be submitted in a technical memorandum. After review and approval of the recommended options, the appropriate procurement steps will be taken to make the necessary materials and equipment available to be implemented, if needed.

- Section 1 provides background information regarding the project and Pilot Study, the performance standards for the Pilot Study, the results of a previous dredge elutriate test (DRET) (FE JV, 2016a), and potential contingency technologies that were reviewed.

- Section 2 presents the results of a literature review.

- Section 3 presents the experimental design including bench-scale testing of in-situ and ex-situ technologies.

- Section 4 presents the work schedule and planned reporting.

1.1 Site Description

The Site is located in the city of Ashland, Wisconsin, along the southeast shoreline of Chequamegon Bay (Bay), which is part of southwestern Lake Superior. The Site was historically industrialized and encompasses several upland properties, including the sites of a former manufactured gas plant, former lumber operations, a former wastewater treatment plant, and several acres of impacted sediment offshore. The Site has known contamination of upland soils, groundwater, and Bay sediments, and has been divided into two remedial areas: the Phase 1 upland area, which is currently being addressed; and the Phase 2 sediment area, which is further divided into nearshore and offshore areas.

1.2 Project Background

In September 2010, the USEPA published a *Record of Decision* (*ROD*) (USEPA, 2010) documenting the cleanup approach for soils, groundwater, and sediments impacted by non-aqueous phase liquid (NAPL) and/or polynuclear aromatic hydrocarbons (PAH) at the Site. The *ROD* permits a wet-dredge-only remedy to be implemented for both offshore and nearshore sediments upon successful completion of a Pilot Study and EPA approval. The *Final Design* was submitted to the USEPA to advance the Pilot Study and gain concurrence from USEPA on project approach on February 25, 2016, and an *Amended and Restated Administrative Settlement Agreement and Order on Consent for Wet Dredge Pilot Study* (USEPA, 2016) was issued for the Wet Dredge Pilot Study on March 18, 2016. The Pilot Study will begin in April 2016.

The Pilot Study Dredge Area focuses on an approximate 40,000 square foot portion of the Phase 2 remedial area that was selected to provide a combination of elements and conditions to allow for a representative, meaningful, and implementable wet dredging program. This area has PAH and volatile organic compound (VOC) concentrations that are representative of contaminated sediments throughout the Site.

The purpose of this *WQ Work Plan* is to present a plan to test potential technologies that could be used as contingency measures if surface water TSS or concentrations of PAHs or certain volatile organic compounds (contaminants of concern [COCs]) are present in the water column in the Pilot Study area above the performance standards for the project. The contingent measures would be implemented, if necessary, prior to the removal of the barrier systems upon completion of the Pilot Study during the fall of 2016. The sequence of events leading up to the removal of the barrier systems is detailed in the *Final Design* and the *Monitoring Plan for Phase 2 Wet Dredge Pilot Study* (*Monitoring Plan*) (FE JV, 2016b) (Appendix D in the *Final Design*).

1.3 Performance Standards

The *ROD* defines a number of surface water performance standards that need to be met during dredging activities. These standards are incorporated by reference and are presented in Table 4-1 in the *Monitoring Plan*.

As defined in the *Monitoring Plan*, before the primary, secondary, tertiary, breakwater gap, and rock protection barriers can be removed, the following criteria must be met, subject to adaptive approach discussions with the Agencies:

- For removal of the primary and secondary barriers surface water quality in-situ measurements must not exceed the agreed upon turbidity Alert Level (turbidity is a surrogate for TSS).

- For removal of the tertiary, breakwater gap, and rock protection barriers, surface water COC sampling results must not exceed the surface water quality standards established for the Pilot Study. COC samples will be generated by compositing samples collected from the surface and two-thirds water column interval at each of three locations.

- No visible sheens may be present prior to removing the primary, secondary, or tertiary, breakwater gap, and rock protection barriers.

If the surface water quality sample results exceed the criteria, the barriers will be left in place until further surface water quality sampling confirms removal is acceptable or until such time that the Agencies agree the barriers can be removed because surface water quality reductions have reached sufficiently low levels and/or winter weather conditions become a factor in Site decision making.

Water quality standards set for the project include the parameters in Table 1-1. Surface water quality results obtained during the baseline monitoring event, that will be performed immediately prior to the initiation of any on-the-water operations within the Pilot Study Project Area, will be utilized to the extent possible to develop site specific water quality standards for the Pilot Study.

Table 1-1

Surface Water Quality Sampling Laboratory Analyses and Standards

Analyte	Unit	Method	Project Water Quality Standard
General Chemistry			
Total Suspended Solids	mg/L	SM 2540D	
Dissolved Organic Carbon	mg/L	9060A	--
Sulfide	mg/L	SM 4500S2D	
Volatile Organics			
1,2,4-Trimethylbenzene	µg/L	8260B	12.3
1,3,5-Trimethylbenzene	µg/L	8260B	12.3
Benzene	µg/L	8260B	0.34
Ethylbenzene	µg/L	8260B	14
Toluene	µg/L	8260B	--
m+p,xylene	µg/L	8260B	
Xylenes (Total)	µg/L	8260B	27

Analyte	Unit	Method	Project Water Quality Standard
Polynuclear Aromatic Hydrocarbons (PAH)			
1-Methylnaphthalene	µg/L	8270D SIM	433
2-Methylnaphthalene	µg/L	8270D SIM	24.3
Acenaphthene	µg/L	8270D SIM	38
Acenaphthylene	µg/L	8270D SIM	--
Anthracene	µg/L	8270D SIM	0.035
Fluorene	µg/L	8270D SIM	--
Naphthalene	µg/L	8270D SIM	6.2
Phenanthrene	µg/L	8270D SIM	3.6
Benzo[a]anthracene	µg/L	8270D SIM	0.025
Benzo[a]pyrene	µg/L	8270D SIM	0.003
Benzo[b]fluoranthene	µg/L	8270D SIM	0.003
Benzo[e]pyrene	µg/L	8270D SIM	--
Benzo[g,h,i]perylene	µg/L	8270D SIM	7.64
Benzo[k]fluoranthene	µg/L	8270D SIM	0.14
Chrysene	µg/L	8270D SIM	0.07
Dibenzo[a,h]anthracene	µg/L	8270D SIM	0.003
Dibenzofuran [a]	µg/L	8270D SIM	--
Fluoranthene	µg/L	8270D SIM	1.9
Indeno[1,2,3-c,d]-pyrene	µg/L	8270D SIM	0.03
Pyrene	µg/L	8270D SIM	0.3

Prepared by: SVF
Checked by: SDG

1.4 Conditions Requiring Contingent Measures

Water quality impacts expected from dredging were previously estimated through a dredge elutriate test (DRET) (see Appendix B-1 of the *Final Design* (FE JV, 2016a)). (The DRET results provide an indication of water quality associated with resuspended sediment resulting from dredging. The DRET data for a representative sample from the Pilot Study area are summarized and compared to performance standards in Table 1-2.

Table 1-2

Dredge Elutriate Test Summary

Parameter	Unit	Project Water Quality Standard[a]	Dredge Elutriate Sample 060514_401
General Chemistry			
Turbidity	NTU	Alert Level (17)	350
Volatile Organics			
1,2,4-Trimethylbenzene	µg/L	12.3	**21**
1,3,5-Trimethylbenzene	µg/L	12.3	5.8
Benzene	µg/L	0.34	**2.3**
Ethylbenzene	µg/L	14	**25**
Toluene	µg/L	--	6.5
m+p-xylene	µg/L	--	17
Xylenes (Total)	µg/L	27	**27**
Polynuclear Aromatic Hydrocarbons (PAH)			
1-Methylnaphthalene	µg/L	433	120
2-Methylnaphthalene	µg/L	24.3	**180**
Acenaphthene	µg/L	38	**80**
Acenaphthylene	µg/L	--	3.8
Anthracene	µg/L	0.035	**13**
Fluorene	µg/L	--	24
Naphthalene	µg/L	6.2	**270**
Phenanthrene	µg/L	3.6	**50**
Benzo[a]anthracene	µg/L	0.025	**2.7**
Benzo[a]pyrene	µg/L	0.003	**1.6**
Benzo[b]fluoranthene	µg/L	0.003	**1.4**
Benzo[e]pyrene	µg/L	--	1
Benzo[g,h,i]perylene	µg/L	7.64	0.65
Benzo[k]fluoranthene	µg/L	0.14	**0.55**
Chrysene	µg/L	0.07	**2.4**
Dibenzo[a,h]anthracene	µg/L	0.003	**0.16**
Dibenzofuran	µg/L	--	9
Fluoranthene	µg/L	1.9	**9**
Indeno[1,2,3-c,d]-pyrene	µg/L	0.03	**0.52**
Pyrene	µg/L	0.3	**10**

Table adapted from Table 6 in Appendix B-1 of the *Final Design* (FE JV, 2016a).

a. May be modified following completion of Baseline sampling May 2016.
Bold = Detected result is equal to or is above the project water quality standard.
-- = not applicable
µg/L = micrograms per liter

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Water quality sampling conducted during installation of the breakwater at Ashland in 2015 also provides an indication of potential water quality impacts associated with on-the-water activities. Breakwater sediment removal and stone placement water quality sampling results are provided in the *Construction Documentation Report for Ashland Breakwater* (FE JV, 2016d) and are included herein as Appendix A.

The barrier systems are designed to contain dredging impacted water within the containment area. Passive settling will be the primary method used to improve water quality within the barrier systems after on-the-water activities are completed. The barrier systems will be left in place until water quality in-situ measurement and COC sampling within the containment areas indicate standards listed in Table 1-2 have been met (or until such time that the Agencies agree the barriers can be removed because surface water quality reductions have reached sufficiently low levels and/or winter weather conditions become a factor in Site decision making).

If passive settling is determined to not be sufficiently improving water quality, contingency measures may need to be utilized to actively improve water quality to the point at which the barrier system can be removed.

The DRET results, which are a conservative predictor of water column concentrations that may be observed immediately following dredging in the Pilot Study area, indicate that additional measures beyond primary settling may be required to reduce concentrations to levels below the project performance standards. This *WQ Work Plan* summarizes the various technologies that may be applied to achieve this reduction and provides an experimental approach for demonstrating the effectiveness of these techniques.

2 Literature Review

As part of this *WQ Work Plan* a literature review was completed. A number of references were reviewed to understand the technologies available and the application of those technologies. This section presents the results of that review. (Note: Due to the volume of the case studies reviewed, specific case studies of interest will be provided upon request.)

During the review, no applications of in situ water treatment processes, physical or chemical, to the surface waters at a dredging project were identified. The most similar applications dealt with the treatment of small lakes for nutrient control (primarily through precipitation of phosphorus) and the clarification of dredged material carriage water as it enters an on-shore water treatment system. Based on the literature review presented herein and experience at similar sites, it was concluded that activated carbon and organoclay are the most promising candidates for reducing total and dissolved COC concentrations in the water column following dredging, as discussed below.

2.1 Experience at Similar Sites

Cases involving ponds and lakes, active dredging treatments, in-situ water and sediment slurry treatments and oil spill remediation references were reviewed. The pertinent information from this review is summarized below.

2.1.1 Pond and Lake Treatments

Projects that addressed water quality issues in ponds and small lakes provided information regarding the use of water treatment technologies in a similar environment to the Pilot Study. Various coagulants and flocculants used at these projects may be appropriate for use as a water quality contingency at the Pilot Study. Coagulant usage during active dredging is not common but is widely used for settling of solids during treatment of sludge materials.

Materials such as organoclay and activated carbon are efficient and effective at removing polychlorinated biphenyls (PCB), PAHs, and dissolved metals (Fabre, 2000; Rosinka and Dabrowska, 2015) from the water column. When combined with a coagulant such as alum, enhanced reduction of COCs and turbidity maybe achieved.

Coagulants and flocculants can cause toxicological effects to aquatic biota if not properly tested to establish safe dosages before application. Not all coagulants are toxic, however, and those that are may be balanced with other materials, such as hydrated lime used with an alum treatment to minimize pH decrease in soft water.

Organic matter such as chopped hay or cottonseed meal can also reduce turbidity, although large amounts of material must be added which may deplete dissolved oxygen (DO) levels as the organic matter decomposes (Hargreaves, 1999). The effectiveness of hay and cottonseed meal is fairly unpredictable in this type of application and often takes several weeks before a treatment may be declared a success or failure (Boyd, 1979). Also, transporting and deploying hay or cottonseed meal can be costly due to the quantity needed for effective treatment.

Another form of organic control of turbidity is through the use of *Moringa oleifera* seeds. *Moringa oleifera* is an indigenous tree to northern India and Pakistan (Kavitha, 2012), and is currently found in Florida where it is cultivated for various purposes. Recently, studies have used *Moringa oleifera* to treat water in third world countries with high turbidities to produce acceptable drinking water due to its high efficiency in coagulation. Sarpong and Richardson (2010) found removal of turbidity was on the order of 95% or greater and did not affect pH or conductivity of the treated water. Even though *Moringa oleifera* is efficient at turbidity removal, little is known about the toxicity to aquatic communities. Kavitha et al. (2012) found that the 96 hour LC50 value of *Moringa oleifera* seed extract for the freshwater fish *C. carpio* (Common carp) was found to be 124.0 mg/L. Common carp are tolerant to poor water quality conditions and with little known about the effects of *Moringa oleifera* on intolerant species, more studies are needed before the material could be considered for applications such as at the Site.

Besides organic treatments for ponds and lakes, other coagulants have been used to treat turbidity for aquaculture systems and for phosphorous treatments in lakes around the U.S. In a study by Wu and Boyd (1990), turbidity removal was accomplished during the first day after a gypsum treatment and the efficiency was no more than other additives, but the application concentration compared to other additives was much greater and pH levels could have a delayed decline due to phytoplankton reduction. Hargreaves (1999) found that gypsum can be used to control turbidity but only at high concentration rates of 1,000 to 2,000 pounds per acre.

Alum is one of the most effective coagulants and an application concentration of 15-25 mg/L should be sufficient to remove turbidity from most waters (Hargreaves, 1999). In a study by Boyd (1979), alum applications reduced turbidity values by 89 to 97% within 48 hours. While being efficient in reducing turbidity, alum may have negative side effects including; decreased pH and total alkalinity. However, these negative side effects can be countered with hydrated lime.

In a study by McKee and Wolf (1963), alum was shown to be nontoxic to fish in treatments of 10-30 mg/L except in water with low alkalinity. Boyd (1979) found the floc formed by alum treatment of turbid water was nontoxic to fathead minnows, but in soft water (< 20 mg/L total alkalinity), alum treatment may depress pH to the point that fish are adversely affected. A 2003 article by the WDNR, "Alum Treatments to Control Phosphorus in Lakes," states that, fish related problems have been primarily documented in soft water lakes; however, soft water lakes have been successfully treated.

In 2004, a full scale treatment with alum occurred at Big Bear Lake (1,550 acres) in California. During the treatment, alum was applied twice per day for one month. During that time, a total of 700,850 gallons of alum were applied. According to Godwin-Saad (2005), no fish mortality occurred and pH and alkalinity readings did not decrease.

2.1.2 Active Dredging Treatments

Literature information is limited in the treatment of turbidity during active dredging by addition of materials to the surface waters in the area being dredged. Turbidity treatment with the use of a coagulant or flocculant has been documented during treatment of carriage water removed from dredged materials. In the publication, *Case Studies of Environmental Dredging Projects,* prepared for the U.S. Army Corps of Engineers (USACE) by Malcom Pirnie, Inc. and TAMS Consultants, Inc. (USEPA, 2003), numerous contaminated sediment dredging projects were analyzed. Most projects reviewed in the publication include information on turbidity monitoring during active dredging, both next to the dredge and outside silt curtains, sheet pile, or other turbidity containment systems. No examples were found of in-situ addition of coagulants or flocculants to reduce turbidity at the dredging site.

2.1.3 Carriage Water Slurry and Sediment Treatment

The use of coagulants and flocculants to aid in settling of solids in dredged material slurries and carriage waters at dredged material dewatering sites is an established practice. Polymers to treat turbidity can be cationic or anionic. Water-soluble cationic polymers are used as coagulants/ flocculants in processes that include clarification of drinking water, sludge dewatering and as coating resins (Goodrich et al., 1991). In the 2013 article, *Polymer Flocculation* (USEPA, 2013), cationic polymers are found to be effective flocculants and reduce turbidity as the positively charged polymer binds with negatively charged soil particles producing floc having sufficient mass to reduce turbidity. Due to negatively charged gill filaments of fish, positively charged cationic polymers can bind to gill lamellae causing a decrease in oxygen diffusion making cationic polymers toxic. Goodrich et al. (1991) found the toxicity of a cationic polymer can be reduced when humic acid is used to offset the binding of the polymer to gill filaments. In a study conducted by Kerr et al. (2014), anionic polymer products commonly used to remove suspended materials may produce short term irritant effects on fish lamellae, but gill morphology was largely unaffected by exposure to concentrations up to 300 mg/L. By adding calcium ions to an anionic polymer, flocculation can reduce turbidity without effects on aquatic communities (USEPA, 2013).

In addition to polymers, organoclay and activated carbon have been used as additives for sediment capping, turbidity treatment and contaminant removal. Unlike other turbidity coagulants commonly used in pond and lake treatments, organoclay and activated carbon have the ability to adsorb dissolved contaminants and remove them from the water column.

Organoclays are manufactured by modifying bentonite with quaternary amines. Montmorillonite constitutes 90% of the composition of an industrial grade bentonite, and quaternary amines are surfactants which have a water loving hydrophilic and oil loving lipophilic end (Fabre, 2000). According to Fabre, organoclays can remove 50% or more of their dry weight in oil, PAHs, PCBs and other chlorinated hydrocarbons. Organoclay can remove seven times the amount of oil as activated carbon, but when combined with activated carbon non-detect levels of most organics is achievable (Fabre, 2000). Organoclay can be used as a granular, as seen in carbon vessels, or as a powder. Case studies using organoclay as a treatment include: wastewater, refinery wastewater, steel mill wastewater and as an active treatment in capping after dredging.

Activated carbon, organic material with high carbon content, is an effective absorbent because it is a highly porous material and provides a large surface area to which contaminants may absorb. Activated carbon can be administered as a granular (GAC) or as a powder (PAC). In a study by Hatt et al. (2013), GAC achieved a minimum of 80% turbidity removal and noted that GACs have a significantly lower carbon usage rate than PACs when removing organics. Rosinska and Dabrowska (2015) found when using a coagulant, such as alum, the coagulation process is enhanced with PAC with a reduction of heavy metal concentrations and PCBs.

2.1.4 Oil Spill Remediation

During the Exxon Valdez oil spill and multiple oil spills in the Gulf of Mexico, dispersants were used, primarily to address oil slicks. A dispersant, a mixture of solvents, additives, and surfactants, is used to break up an oil slick into smaller oil droplets. The small oil droplets become submerged in the water column and become subject to transport by wind and currents. The purpose of breaking up the oil slick into small droplets is to make the oil more manageable for biodegradation by bacteria, which can naturally biodegrade many hydrocarbons.

In the Gulf of Mexico, besides dispersants, other forms of treatment were used to control oil movement. Dependent on concentrations and environmental factors such as wind, oil was burned from the surface, corralled by oil booms and skimmed off the water, or absorbed using various oil absorbent materials. No examples were found of techniques to remove oil from the water column that were directly applicable to potential applications at the Site for water quality contingency measures.

2.2 Contingency Measures to be Considered for the Site

Coagulants, flocculants or other additives are used in many applications with the primary function of reducing turbidity of water. Turbidity is a general term that describes the “cloudiness” or “muddiness” of water and can be caused by a variety or combination of substances (Hargreaves, 1999). Since the COCs at the Site are largely hydrophobic compounds, the removal of turbidity-causing suspended solids is an important mechanism in the reduction of water column COC concentrations. Dissolved concentrations of COCs may remain, however, following the successful removal of suspended solids. The ability of solids removal techniques to sufficiently reduce total and dissolved COC concentrations will be a key metric of overall effectiveness.

Numerous constituents have been used to decrease turbidity dependent on an array of circumstances and objectives. Coagulants can be an organic, chemical, or a mix of organic and chemical components. Through the research summarized above, the FE JV has constructed a list of possible approaches along with pros and cons to control turbidity, enhance particle settling, or promote adsorption of COCs onto treatment media to assist in meeting appropriate water quality standards, allowing the removal of barrier systems.

Each additive listed in Table 2-1 has a unique purpose for application and function. In Sections 2.1 and 2.2, case studies of dredging, pond and lake treatments, toxicology, and results from specific studies are reviewed to identify which additives may provide efficient and effective turbidity and COC reduction following dredging with the least amount of possible ecological effects.

Table 2-1

Summary of Technologies Reviewed

Treatment	Pros	Cons
Organic		
1. Chopped Hay	♦ No chemical additive	♦ Could lead to reduced DO levels caused by decomposition ♦ Transportation and deployment could be costly due to volume needed ♦ Not highly predictable and several weeks could elapse before results evident
2. Cottonseed Meal	♦ No chemical additive	♦ Not highly predictable and several weeks could elapse before results evident ♦ Could lead to reduced DO levels caused by decomposition
3. Manure	♦ No chemical additive	♦ Rich organic matter could lead to reduced DO levels caused by decomposition
4. Moringa oleifera seeds	♦ Highly effective/efficient (95% turbidity reduction) ♦ Does not affect pH or conductivity	♦ 96 Hour LC 50 of Common carp 124 mg/L ♦ No studies to determine effects on intolerant fish species
5. Organic Carbon - powdered or granular	♦ Effective/efficient absorbent of COCs ♦ When paired with coagulant (alum) enhanced reductions in metals and PCBs ♦ No impact to macro-invertebrates ♦ Can achieve high percentage of turbidity reduction	♦ Dosing through large water surface areas not an established practice
6. Organoclay	♦ High capacity for low soluble organics and removes NAPL and oils ♦ Pairing with coagulant (alum) enhances reductions ♦ Can remove 50% or more of their dry weight in oil, PCBs, etc.	♦ Dosing through large water surface areas not an established practice
Physical In-situ		
1. Fabric - Filter tow behind	♦ Can be readily available on site if oil sheen is visible ♦ Efficient at removing free oil located on surface ♦ Can be linked to provide encircled protection of an area	♦ If towed behind boat, boat speed effects adsorption rate ♦ Will not remove dissolved oil located throughout water column ♦ Dimensions of netting and effectiveness maybe compromised while under tow

Treatment	Pros	Cons
Chemical Additives		
1. Gypsum (Calcium sulfate)	♦ Turbidity removal accomplished in 24 hours ♦ Low cost	♦ Application concentration amount greater than other chemical additives (1,000-2,000 lbs/ acre) ♦ pH levels could have a delayed decline due to phytoplankton reduction
2. Alum	♦ Highly effective/efficient ♦ Application rates 15-20 mg/L (150-250 lbs/ acre) ♦ Floc formed not toxic to fish ♦ Used to control phosphorous in lake wide applications ♦ Low Cost ♦ Floc visible after 10 minutes with up to 97% turbidity reduction in 48 hours ♦ Aquatic invertebrates are not sensitive to aluminum	♦ In systems with low alkalinity, alum may depress pH causing adverse effects to fish (aluminum toxic to fish if pH decreases below 4.5) ♦ The use of hydrated lime may be needed to offset alum pH decrease ♦ 96 Hour LC 50 of fathead minnows at an alkalinity of 14.5 mg/L is 60 mg/L of Alum
3. Cationic Polymer	♦ Highly effective/efficient ♦ Toxicity may be offset with humic acid addition	♦ Toxic to fish due to positive charged polymer binding to negative fish gill filaments
4. Anionic Polymer	♦ Nontoxic to slight irritant to fish	♦ Positively charged ion such as calcium is needed to be an effective coagulant if not already combined with product
Ex-Situ		
1. Pump and Treat - Walnut based – 5,000 gallons per minute (gpm)	♦ Relatively higher processing flow rate	♦ Requires upland infrastructure not provided by Short-Term Water Treatment System (STWTS)

Prepared by: JPW
Checked by: SDG

3 Experimental Design

Based on results of the literature review and experience at similar sites, activated carbon and organoclay are the most promising candidates for application to the water column at the Site following dredging for reducing total and dissolved COC concentrations. Activated carbon, a highly porous material having a large surface area, has been shown to remove dissolved oil-associated constituents including: benzene, phenols, toluene, and xylene. Organoclays can remove 50% or more of their dry weight in oil, diesel fuel, PAHs, PCBs, along with other chlorinated hydrocarbons and have been shown to remove seven times the amount of oil as activated carbon. Research has shown alum to be an effective and efficient coagulant to control turbidity. In addition to use individually, combinations of alum and activated carbon or alum with organoclay should be investigated to remove both turbidity and COCs.

3.1.1 Data Quality Objectives

To assess the effectiveness of potential water quality contingency measures, experimental bench-scale laboratory tests will be designed and implemented. The goals and objectives of bench-scale testing design and implementation are as follows:

- Collect representative samples of water and sediment from the site;
- Conduct column settling tests to identify how resuspended sediments in the water column will behave during passive settling;
- Measure the impact of resuspended sediment settling in the column settling tests from the addition of alum, activated carbon, and organoclay;
- Measure the reduction in water column concentration of COCs through passive settling and the addition of alum, activated carbon, and organoclay, and;
- Generate, validate, and manage data in a manner consistent with the *Quality Assurance Project Plan for Phase 2 Wet Dredge Pilot Study Addendum 2 (QAPP Addendum 2)* (FE JV, 2016d).

3.1.2 Sample Locations

Sediment and water samples for bench-scale treatment and analysis will be collected in early May 2016 and composited from the three offshore full depth of contamination locations as designated and described in the *Pre-Dredge Sediment Sampling and Analysis Plan for Wet Dredge Pilot Study* (FE JV, 2016e) and also shown on Figure 1 of that plan.

3.2 In-Situ Contingency Measures – Bench-Scale Testing

The effectiveness of potential in-situ contingency measures will be evaluated through bench-scale testing. Bench-scale testing will be conducted in two phases that will initially narrow the range of candidate measures by conducting a series of tests using impacted water generated from sediment and water samples collected prior to the initiation of dredging activities. The second phase will focus on the most promising techniques and utilize impacted water samples collected from the site during active dredging operations. The two phases are discussed in additional detail in the following sections.

3.2.1 First Phase Testing

Column settling tests will be conducted during the first phase to determine the settling behavior of suspended solids and COCs with and without the use of in-situ contingency measures. In total, four column settling tests will be completed with one test being a control and each of the other three tests being dosed with either alum, organoclay, or activated carbon. All column settling tests will be conducted following the procedures summarized below, which have been adapted from the column settling test procedures presented in the USACE's *Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities – Testing Manual* (USACE, 2003).

- Characterize Site sediment and surface water obtained, as described in Section 3.1.2, for all sediment and water analytes described in Tables 3-1 and 3-2. Then mix Site sediment and surface water to form a slurry with a ratio of sediment to surface water of 10 grams per liter (g/L) on a dry weight basis. Adjust water temperature to represent conditions at anticipated time of contingency implementation (October to November).

- Fill the test columns with the generated slurry and completely mix slurry in column. Following mixing, removed samples from each sampling port for analysis of TSS. This begins the start of the column testing procedure.

- Obtain one sample from the sampling port closest to air/water interface and one sample from the sampling port closest to two-thirds water column depth at the following sampling time intervals: 1, 2, 4, 6, 12, 24, 48, 72, 96, 120, 144, and 168 hours. The height of the water surface and water/sediment interface shall be measured and recorded at the start of each sampling time interval.

- Each sample collected during all sampling intervals will be analyzed for turbidity and TSS.

- Samples collected at the 1, 24, 48, 72, 96, 120, 144, and 168 hour time intervals will undergo analytical testing for the parameters defined in Section 3.4.

- Immediately following the collection of the 24-hour time interval sample, alum, organoclay, and activated carbon are added to three of the columns, so that one column contains alum, one contains organoclay, and one contains activated carbon.

- Water within the columns are lightly stirred to mix the alum, organoclay, and activated carbon into the column water.

- After alum, organoclay, and activated carbon addition, the columns are allowed to continue to settle with sampling and analyses continuing at the frequency identified above.

Dosage rates used for alum during the first phase of bench-scale testing will be 0.25 g/L. The alum dosage rate is based on results of bench treatability testing for STWTS dissolved air floatation, completed by Salt Creek Technologies, Inc. Dosage rates for organoclay and activated carbon will be determined through consultation with material suppliers. However, it is currently anticipated the dosage rate for organoclay and activated carbon will be approximately 0.5 g/L.

A sample naming convention will be developed during the column settling test experimental setup. It is anticipated that the sample naming convention will follow elements of the sample naming convention described in the *Monitoring Plan,* where appropriate.

3.2.2 Second Phase Testing

The second phase of bench-scale testing will be completed using site surface water collected during active dredging. Second phase testing methodologies will be developed following the analysis of the first phase column settling test results. This will allow the second phase of bench-scale testing to be tailored using information gained from the first phase, with focus on the most promising additive or combination of additives. The second phase of testing is anticipated to use an approach similar to jar testing, using smaller volumes of water and a range of application dosages in order to optimize the amount of material to be added to the water column.

3.3 Ex-Situ Contingency Measures

In addition to the in-situ options described above, testing of an ex-situ technology is viewed to be a promising option. The STWTS on-site contains multiple unit processes designed to address the expected worst-case influent dredging contact water during Pilot Study operations. The STWTS is sized, however, to treat a maximum of 200 gpm, and with approximately 6 million gallons of water enclosed by the tertiary barrier system, the STWTS would have to operate for close to 17 days to treat the entire volume of impacted water. Therefore, use of the STWTS as a contingency measure is not being considered.

Walnut shell filtration systems have been used in the oil and gas industry and chemical, petrochemical, metal working, and power generation industries to filter oil and suspended solids from water. Walnut shell filters utilize black walnuts as the filter material. In these types of filters, influent typically is pumped into the bottom of the filter canister and flow upward through the media where the walnut shells separate the oil and suspended solids. Clean effluent then flows from a valve at the top of the canister. Walnut filter systems can be set up to treat an estimated 5,000 gpm (7,200,000 gallons per day) and it is anticipated that the system could treat the entire volume of water from the Pilot Study Dredge Area in approximately 1 day.

As part of the evaluation, a walnut filter vendor, such as Filtra-Systems, will be contracted to conduct bench scale testing on a sample of water using the same mixing procedures as for the influent water used in the column settling tests described in Section 3.2.1. It is anticipated that water and sediment will be shipped to the vendor for mixing and to conduct the testing.

3.4 Analytes

Sediment used in the bench-scale tests described in Sections 3.2 and 3.3 to generate elutriate will be analyzed for general chemistry, VOCs, and PAHs, as defined in Table 3-1. All collected elutriate and water samples resulting from bench-scale testing will be analyzed for general chemistry, VOC, and PAH parameters, as defined in Table 3-2. Analytical methods, reporting limits, and method detection limits are also summarized in Tables 3-1 and 3-2. The parameters and analytical methods presented in Tables 3-1 and 3-2 are consistent with the sediment and water quality monitoring that will be conducted during and after completion of on-the-water activities as described in the *Monitoring Plan*. All analytical testing will be conducted by TestAmerica, and all analyses will be requested with a normal (10 day) turnaround time. Sample containers, preservation, and hold times for the parameters listed in Tables 3-1 and 3-2 are listed in the *QAPP Addendum 2*. All data generated during bench-scale testing will be subjected to all quality assurance/quality control (QA/QC) procedures provided in the *QAPP Addendum 2*.

Table 3-1

Bench Testing Sediment Analytical Parameters

Parameter	Unit	Method	Reporting Limit[a]	Laboratory-Specific Method Detection Limit[a]
General Chemistry				
Total Organic Carbon	mg/kg	9060M	1000	600
Total Solids	%	8000C - Modified	0.1	0.1
Polynuclear Aromatic Hydrocarbons (PAH)				
2-Methylnaphthalene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.6/16
Acenaphthene	µg/kg	8270D SIM / 8270D	3.33 / 67	0.5/10
Acenaphthylene	µg/kg	8270D SIM / 8270D	3.33 / 67	0.7 / 9
Anthracene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.2 / 9
Fluorene	µg/kg	8270D SIM / 8270D	3.33 / 67	0.7 / 12
Naphthalene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.2 / 9
Phenanthrene	µg/kg	8270D SIM / 8270D	3.33 / 67	1 / 9
Benzo[a]anthracene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.2 / 15
Benzo[a]pyrene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.8 / 12
Benzo[e]pyrene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.5 / 12
Benzo[b]fluoranthene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.5 / 12
Benzo[k]fluoranthene	µg/kg	8270D SIM / 8270D	3.33 / 67	1 / 14
Benzo[g,h,i]perylene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.9 / 9
Chrysene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.8 / 9
Dibenzo[a,h]anthracene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.9 / 7
Dibenzofuran	µg/kg	8270D SIM / 8270D	3.33 / 333	1.5 / 41
Fluoranthene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.8 / 9
Indeno[1,2,3-c,d]-pyrene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.8 / 10
Pyrene	µg/kg	8270D SIM / 8270D	3.33 / 67	1.8 / 12

Notes for Table 3-1 are on following page.

a. Actual report limits and method detection limits may vary based on sample-specific factors. If a methods with higher reporting limits is used (e.g., EPA 8270D) and there are no detected results, the analytical laboratory must reanalyze using a method with lower detection limits (e.g., EPA 8270D SIM).
-- = not applicable
% = percent
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram

Prepared by: MCC2
Checked by: SVF

Table 3-2

Bench Testing Water Quality Parameters

Parameter	Unit	Method	Reporting Limit[a]	Laboratory-Specific Method Detection Limit[a]
General Chemistry				
Alkalinity[b]	mg/L	2320B	10.0	5.0
Dissolved Oxygen	mg/L	Field Method	--	--
Oil and Grease	mg/L	1664A	4.0	1.4
pH	S.U.	Field Method	--	--
Specific Conductance	µS/cm	Field Method	--	--
Temperature	°C	Field Method	--	--
Turbidity	NTU	Field Method	--	--
Total Suspended Solids	mg/L	SM 2540D	1.0	0.7
Dissolved Organic Carbon	mg/L	9060A	1.0	0.5
Total Organic Carbon	mg/L	9060A	1.0	0.5
Sulfide	mg/L	SM 4500S2D	0.1	0.05
Metals				
Aluminum[b]	µg/L	200.8	20	9.6
Volatile Organic Carbons (VOC)				
1,2,4-Trimethylbenzene	µg/L	8260B	1.0	0.17
1,3,5-Trimethylbenzene	µg/L	8260B	1.0	0.17
Benzene	µg/L	8260B	1.0	0.2
Ethylbenzene	µg/L	8260B	1.0	0.19
Toluene	µg/L	8260B	1.0	0.17
m+p-xylene	µg/L	8260B		
Xylenes (Total)	µg/L	8260B	3.0	0.58
Polynuclear Aromatic Hydrocarbons (PAH)				
1-Methylnaphthalene	µg/L	8270D SIM	0.1	0.02
2-Methylnaphthalene	µg/L	8270D SIM	0.1	0.03
Acenaphthene	µg/L	8270D SIM	0.1	0.02
Acenaphthylene	µg/L	8270D SIM	0.1	0.03
Anthracene	µg/L	8270D SIM	0.1	0.03
Fluorene	µg/L	8270D SIM	0.1	0.02
Naphthalene	µg/L	8270D SIM	0.1	0.02
Phenanthrene	µg/L	8270D SIM	0.1	0.03

Parameter	Unit	Method	Reporting Limit[a]	Laboratory-Specific Method Detection Limit[a]
Benzo[a]anthracene	µg/L	8270D SIM	0.1	0.02
Benzo[a]pyrene	µg/L	8270D SIM	0.1	0.02
Benzo[b]fluoranthene	µg/L	8270D SIM	0.1	0.02
Benzo[e]pyrene	µg/L	8270D SIM	0.1	0.05
Benzo[g,h,i]perylene	µg/L	8270D SIM	0.1	0.02
Benzo[k]fluoranthene	µg/L	8270D SIM	0.1	0.02
Chrysene	µg/L	8270D SIM	0.1	0.02
Dibenzo[a,h]anthracene	µg/L	8270D SIM	0.1	0.02
Dibenzofuran	µg/L	8270D SIM	--	--
Fluoranthene	µg/L	8270D SIM	0.1	0.03
Indeno[1,2,3-c,d]-pyrene	µg/L	8270D SIM	0.1	0.02
Pyrene	µg/L	8270D SIM	0.1	0.02

a. Actual report limits and method detection limits may vary based on sample-specific factors.
b. Alkalinity and aluminum analysis will only be conducted on a limited basis.

°C = degrees Celsius
-- = not applicable
µg/L = micrograms per liter
µS/cm = microSiemens per centimeter
CDOM/FDOM = colored dissolved organic matter/fluorescent dissolved organic matter
mg/L = milligrams per liter
NTU = nephelometric turbidity units
S.U. = standard units

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Checked by: SVF

4 Schedule and Reporting

4.1 Schedule

The schedule for implementing the *WQ Work Plan* is as follows:

May 2016	Samples Collected (Phase 1 early May, Phase 2 late May)
June 2016	Bench Testing/Jar Testing Complete
July 2016	Laboratory Reports Received
August 2016	Technical Memorandum Summarizing Findings and Recommendations Submitted to Agencies

4.2 Reporting

All analytical bench-scale testing results will be reported in a technical memorandum after experimental treatments are completed and results from TestAmerica Laboratories are received. Within the document, protocols and possible deviations during sample collection or treatment will be stated. Results for each treatment will be presented in a table format along with the project water quality standards and reporting limit values for evaluation. A review and discussion will identify water quality contingency options with the most efficacy for the Site based on the test results with operational considerations given equal weight. The costs associated with the probable contingency options, and the permitting requirements to be met prior to their implementation, will also be discussed.

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Appendix A

Water Quality Sampling Results – Sediment Removal and Stone Placement

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	R1_SW_N_150707	R2_SW_N_150709	Bma_SW_N_150709	Bmb_SW_N_150709	Bmc_SW_N_150709	M1a_SW_N_150709
		Date	7/7/2015	7/9/2015	7/9/2015	7/9/2015	7/9/2015	7/9/2015
		Sample Type	N	N	N	N	N	N
		Sample Interval (ft below surface)	7	0-2	0-2	4	9	0-2
Analyte	**Project Screening/Action Criteria**	**Units**	Turbidity "Action Level"	Sheen "Action Level"				
Total Organic Carbon	--	mg/L	2.1	1.9	2.8	3	2.9	2.2
Total Suspended Solids	--	mg/L	67	5.4	3.4	2.4	2.8	7.4 J
Sulfide	--	mg/L	< 0.1	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	< 0.094	0.67	< 0.095	< 0.095	< 0.093	< 0.093
2-Methylnaphthalene	24.3	µg/L	< 0.094	0.73	< 0.095	< 0.095	< 0.093	< 0.093
Acenaphthene	38	µg/L	< 0.094	0.44	< 0.095	< 0.095	< 0.093	< 0.093
Acenaphthylene	--	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Anthracene	0.035	µg/L	< 0.094	***0.17***	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(a)anthracene	0.025	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(a)pyrene	0.003	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(b)fluoranthene	0.03	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(e)pyrene	--	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Chrysene	0.07	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Dibenzofuran	--	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Fluoranthene	1.9	µg/L	< 0.094	0.13	< 0.095	< 0.095	< 0.093	< 0.093
Fluorene	--	µg/L	< 0.094	0.19	< 0.095	< 0.095	< 0.093	< 0.093
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.094	< 0.1	< 0.095	< 0.095	< 0.093	< 0.093
Naphthalene	6.2	µg/L	0.1	1.3	< 0.095	< 0.095	< 0.093	< 0.093
Phenanthrene	3.6	µg/L	< 0.094	0.55	< 0.095	< 0.095	< 0.093	< 0.093
Pyrene	0.3	µg/L	< 0.094	0.18	< 0.095	< 0.095	< 0.093	< 0.093

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

R - Unusable data due to serious deficiencies in meeting QC criteria (i.e., analyte may or may not be present in the sample).

UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	FD01_SW_FD_150709	M1b_SW_N_150709	M1c_SW_N_150709	M2a_SW_N_150709	M2b_SW_N_150709	M2c_SW_N_150709
		Date	7/9/2015	7/9/2015	7/9/2015	7/9/2015	7/9/2015	7/9/2015
		Sample Type	FD	N	N	N	N	N
		Sample Interval (ft below surface)	0-2	4	7	0-2	3	7
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	2.3	2.3	2.2	2.2	2.2	2.2
Total Suspended Solids	--	mg/L	13 J	13	15	6.4	6.5	20
Sulfide	--	mg/L	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
2-Methylnaphthalene	24.3	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Acenaphthene	38	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Acenaphthylene	--	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Anthracene	0.035	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(a)anthracene	0.025	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(a)pyrene	0.003	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(b)fluoranthene	0.03	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(e)pyrene	--	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Chrysene	0.07	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Fluoranthene	1.9	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Fluorene	--	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Phenanthrene	3.6	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Pyrene	0.3	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

R - Unusable data due to serious deficiencies in meeting QC criteria (i.e., analyte may or may not be present in the sample).

UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	**M3a_SW_N_150709**	**M3b_SW_N_150709**	**M3c_SW_N_150709**	**R3_SW_N_150711**	**R4_SW_N_150711**	**R5_SW_N_150711**
		Date	**7/9/2015**	**7/9/2015**	**7/9/2015**	**7/10/2015**	**7/10/2015**	**7/11/2015**
		Sample Type	**N**	**N**	**N**	**N**	**N**	**N**
		Sample Interval (ft below surface)	**0-2**	**4**	**7**	**0-2**	**0-2**	**0-2**
Analyte	**Project Screening/Action Criteria**	**Units**				Sheen "Action Level"	Sheen "Action Level"	Sheen "Action Level"
Total Organic Carbon	--	mg/L	2.9	2.2	2.2	1.8	3	1.8
Total Suspended Solids	--	mg/L	5.7	7.7	12	6.6	5.6	5.7
Sulfide	--	mg/L	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1 R	< 0.1	< 0.1 R
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	0.21	0.84	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1	0.28	0.56	< 1
Toluene	--	µg/L	< 1	< 1	< 1	< 1	0.23	0.24
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	0.58	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	0.91	< 3
1-Methylnaphthalene	433	µg/L	< 0.093	< 0.093	< 0.095	0.42	9.9	0.12
2-Methylnaphthalene	24.3	µg/L	< 0.093	< 0.093	< 0.095	0.45	11	0.14
Acenaphthene	38	µg/L	< 0.093	< 0.093	< 0.095	0.23	7.7	0.14
Acenaphthylene	--	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	0.57	< 0.098
Anthracene	0.035	µg/L	< 0.093	< 0.093	< 0.095	***0.055***	***2.5***	***0.085***
Benzo(a)anthracene	0.025	µg/L	< 0.093	< 0.093	< 0.095	***0.037***	***1.6***	***0.12***
Benzo(a)pyrene	0.003	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	***1.4***	***0.1***
Benzo(b)fluoranthene	0.03	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	***1.2***	***0.11***
Benzo(e)pyrene	--	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	0.83	0.079
Benzo(ghi)perylene	7.64	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	0.65	0.06
Benzo(k)fluoranthene	0.14	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	***0.45***	0.049
Chrysene	0.07	µg/L	< 0.093	< 0.093	< 0.095	0.042	***1.6***	***0.16***
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	< 0.093	< 0.098
Dibenzofuran	--	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	0.77	< 0.098
Fluoranthene	1.9	µg/L	< 0.093	< 0.093	< 0.095	0.1	***4.6***	0.32
Fluorene	--	µg/L	< 0.093	< 0.093	< 0.095	0.088	3.6	0.087
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.093	< 0.093	< 0.095	< 0.094	***0.48***	< 0.098
Naphthalene	6.2	µg/L	< 0.093	< 0.093	< 0.095	1	***15***	0.22
Phenanthrene	3.6	µg/L	< 0.093	< 0.093	< 0.095	0.29	***14***	0.55
Pyrene	0.3	µg/L	< 0.093	< 0.093	< 0.095	0.15	***6.4***	***0.45***

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

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UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Prepared by: TSB
Checked by: KRG1

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	Bma_SW_N_150712	Bmb_SW_N_150712	Bmc_SW_N_150712	M1a_SW_N_150712	FD02_SW_FD_150712	M1b_SW_N_150712
		Date	7/12/2015	7/12/2015	7/12/2015	7/12/2015	7/12/2015	7/12/2015
		Sample Type	N	N	N	N	FD	N
		Sample Interval (ft below surface)	0-2	5	9	0-2	0-2	3
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	1.9	1.9	1.9	1.9	1.9	1.9
Total Suspended Solids	--	mg/L	1.7	2.7	2.6	2.8	3.4	5
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	0.34	< 1	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	< 0.093	< 0.094	< 0.094	0.032 J	0.14 J	0.12
2-Methylnaphthalene	24.3	µg/L	< 0.093	< 0.094	< 0.094	0.039 J	0.17 J	0.14
Acenaphthene	38	µg/L	< 0.093	< 0.094	< 0.094	< 0.093 UJ	0.11 J	0.079
Acenaphthylene	--	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Anthracene	0.035	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	***0.041***	***0.035***
Benzo(a)anthracene	0.025	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Benzo(a)pyrene	0.003	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Benzo(b)fluoranthene	0.03	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Benzo(e)pyrene	--	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Benzo(ghi)perylene	7.64	µg/L	< 0.093	< 0.094 UJ	< 0.094	< 0.093	< 0.097	< 0.095
Benzo(k)fluoranthene	0.14	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Chrysene	0.07	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.094 UJ	< 0.094	< 0.093	< 0.097	< 0.095
Dibenzofuran	--	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	< 0.097	< 0.095
Fluoranthene	1.9	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	0.053	0.038
Fluorene	--	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	0.049	< 0.095
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.093	< 0.094 UJ	< 0.094	< 0.093	< 0.097	< 0.095
Naphthalene	6.2	µg/L	< 0.093	< 0.094	< 0.094	0.097 J	0.37 J	0.29
Phenanthrene	3.6	µg/L	< 0.093	< 0.094	< 0.094	< 0.093 UJ	0.19 J	0.12
Pyrene	0.3	µg/L	< 0.093	< 0.094	< 0.094	< 0.093	0.07	0.051

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	M1c_SW_N_150712	M2a_SW_N_150712	M2b_SW_N_150712	M2c_SW_N_150712	M3a_SW_N_150712	M3b_SW_N_150712
		Date	7/12/2015	7/12/2015	7/12/2015	7/12/2015	7/12/2015	7/12/2015
		Sample Type	N	N	N	N	N	N
		Sample Interval (ft below surface)	7	0-2	3	6	0-2	3
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	1.9	1.9	1.9	1.9	2	1.9
Total Suspended Solids	--	mg/L	3.7	4.3	4.8	4.3	4.2	5.8
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	0.2	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	0.2	< 1
Ethylbenzene	14	µg/L	< 1	0.26	< 1	< 1	< 1	< 1
Toluene	--	µg/L	< 1	0.18	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	0.039	0.29	0.13	0.16	0.33	0.46
2-Methylnaphthalene	24.3	µg/L	0.046	0.34	0.16	0.19	0.4	0.53
Acenaphthene	38	µg/L	< 0.096	0.17	0.095	0.11	0.19	0.24
Acenaphthylene	--	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Anthracene	0.035	µg/L	< 0.096	***0.051***	***0.039***	***0.04***	***0.047***	***0.046***
Benzo(a)anthracene	0.025	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Benzo(a)pyrene	0.003	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Benzo(b)fluoranthene	0.03	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Benzo(e)pyrene	--	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Benzo(ghi)perylene	7.64	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Benzo(k)fluoranthene	0.14	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Chrysene	0.07	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Dibenzofuran	--	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Fluoranthene	1.9	µg/L	< 0.096	0.06	0.043	0.045	0.046	0.042
Fluorene	--	µg/L	< 0.096	0.059	< 0.093	< 0.093	0.058	0.073
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.096	< 0.093	< 0.093	< 0.093	< 0.094	< 0.095
Naphthalene	6.2	µg/L	0.1	0.72	0.28	0.35	0.94	1.4
Phenanthrene	3.6	µg/L	< 0.096	0.19	0.12	0.13	0.17	0.18
Pyrene	0.3	µg/L	< 0.096	0.086	0.056	0.064	0.062	0.051

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

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UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Prepared by: TSB
Checked by: KRG1

Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

Sample ID			M3c_SW_N_150712	Bma_SW_N_150715	Bmb_SW_N_150715	Bmc_SW_N_150715	M1a_SW_N_150715	FD03_SW_FD_150715
Date			7/12/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
Sample Type			N	N	N	N	N	FD
Sample Interval (ft below surface)			7	0-2	4	8	0-2	0-2
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	1.8	2.3	2.2	2.1	2.2	2.1
Total Suspended Solids	--	mg/L	16	4.5	4.3	5.5	32 J	4.7 J
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	1.6	1.6	0.2	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	0.58	0.61	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	2.6	< 1	< 1	< 1	< 1	< 1
Toluene	--	µg/L	0.41	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	2.3	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	3.5	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	2.5	4.8	0.044	0.043	0.097	0.071
2-Methylnaphthalene	24.3	µg/L	2.8	5.7	0.049	0.048	0.097	0.071
Acenaphthene	38	µg/L	1.2	0.93	< 0.093	< 0.093	0.074	0.05
Acenaphthylene	--	µg/L	0.044	0.2	< 0.093	< 0.093	< 0.093	< 0.093
Anthracene	0.035	µg/L	***0.25***	***0.29***	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(a)anthracene	0.025	µg/L	***0.054***	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(a)pyrene	0.003	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(b)fluoranthene	0.03	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(e)pyrene	--	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Chrysene	0.07	µg/L	0.055	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	µg/L	0.11	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Fluoranthene	1.9	µg/L	0.17	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Fluorene	--	µg/L	0.37	0.54	< 0.093	< 0.093	< 0.093	< 0.093
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	µg/L	7.1	0.18	0.065	0.083	0.13	0.18
Phenanthrene	3.6	µg/L	0.8	1.7	< 0.093	< 0.093	0.079	0.046
Pyrene	0.3	µg/L	0.24	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

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Checked by: KRG1

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	M1b_SW_N_150715	M1c_SW_N_150715	M2a_SW_N_150715	M2b_SW_N_150715	M2c_SW_N_150715	M3a_SW_N_150715
		Date	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015	7/15/2015
		Sample Type	N	N	N	N	N	N
		Sample Interval (ft below surface)	3	6	0-2	3	6	0-2
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	2.1	2.1	2.1	2.1	2.1	2
Total Suspended Solids	--	mg/L	24	28	73	17	6.8	30
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	μg/L	< 1	< 1	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	μg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	μg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	μg/L	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	--	μg/L	< 1	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	μg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	μg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	μg/L	0.084	0.19	0.9	0.1	0.15	0.29
2-Methylnaphthalene	24.3	μg/L	0.09	0.18	1.1	0.11	0.14	0.24
Acenaphthene	38	μg/L	0.054	0.15	0.38	0.084	0.1	0.22
Acenaphthylene	--	μg/L	< 0.094	< 0.093	0.047	< 0.093	< 0.093	< 0.093
Anthracene	0.035	μg/L	< 0.094	0.034	***0.067***	< 0.093	0.028	***0.051***
Benzo(a)anthracene	0.025	μg/L	< 0.094	***0.03***	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(a)pyrene	0.003	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(b)fluoranthene	0.03	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(e)pyrene	--	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Chrysene	0.07	μg/L	< 0.094	0.04	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzo(a,h)anthracene	0.003	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	μg/L	< 0.094	< 0.093	0.077	< 0.093	< 0.093	< 0.093
Fluoranthene	1.9	μg/L	< 0.094	0.099	0.11	0.046	0.053	0.086
Fluorene	--	μg/L	< 0.094	0.053	0.15	< 0.093	< 0.093	0.062
Indeno(1,2,3-cd)pyrene	0.03	μg/L	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	μg/L	0.13	0.21	0.37	0.13	0.16	0.28
Phenanthrene	3.6	μg/L	0.057	0.13	0.32	0.082	0.092	0.14
Pyrene	0.3	μg/L	< 0.094	0.11	0.14	0.056	0.063	0.11

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

R - Unusable data due to serious deficiencies in meeting QC criteria (i.e., analyte may or may not be present in the sample).

UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

Sample ID			M3b_SW_N_150715	M3c_SW_N_150715	Bma_SW_N_150723	Bmb_SW_N_150723	Bmc_SW_N_150723	M1a_SW_N_150723
Date			7/15/2015	7/15/2015	7/23/2015	7/23/2015	7/23/2015	7/23/2015
Sample Type			N	N	N	N	N	N
Sample Interval (ft below surface)			3	7	0-2	4	8	0-2
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	2.1	2.1	1.9	2	2	2
Total Suspended Solids	--	mg/L	33	16	1.8	1.7	2.2	9.8
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	0.18	0.11	< 0.093	< 0.093	0.39	0.8 J
2-Methylnaphthalene	24.3	µg/L	0.17	0.11	< 0.093	< 0.093	0.42	0.89 J
Acenaphthene	38	µg/L	0.13	0.098	< 0.093	< 0.093	0.24	0.53 J
Acenaphthylene	--	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Anthracene	0.035	µg/L	0.032	***0.092***	< 0.093	< 0.093	***0.075***	***0.17*** J
Benzo(a)anthracene	0.025	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	***0.047*** J
Benzo(a)pyrene	0.003	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093 UJ
Benzo(b)fluoranthene	0.03	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093 UJ
Benzo(e)pyrene	--	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Chrysene	0.07	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	0.04 J
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	0.062
Fluoranthene	1.9	µg/L	0.067	< 0.094	< 0.093	< 0.093	0.05	0.14 J
Fluorene	--	µg/L	0.044	< 0.094	< 0.093	< 0.093	0.075	0.19 J
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.093	< 0.094	< 0.093	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	µg/L	0.21	0.16	< 0.093	< 0.093	0.59	1.1 J
Phenanthrene	3.6	µg/L	0.12	< 0.094	< 0.093	< 0.093	0.23	0.49 J
Pyrene	0.3	µg/L	0.075	< 0.094	< 0.093	< 0.093	0.063	0.19 J

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

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Prepared by: TSB
Checked by: KRG1

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Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	FD04_SW_FD_150723	M1b_SW_N_150723	M1c_SW_N_150723	M2a_SW_N_150723	M2b_SW_N_150723	M2c_SW_N_150723
		Date	7/23/2015	7/23/2015	7/23/2015	7/23/2015	7/23/2015	7/23/2015
		Sample Type	FD	N	N	N	N	N
		Sample Interval (ft below surface)	0-2	4	8	0-2	5	9
Analyte	Project Screening/Action Criteria	Units						
Total Organic Carbon	--	mg/L	1.9	2	1.9	1.9	1.9	1.9
Total Suspended Solids	--	mg/L	8.2	14	13	15	11	21
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	0.24	0.19	0.28	0.33
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	0.2	< 1	0.21	0.24
Toluene	--	µg/L	0.17	< 1	< 1	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	1.5 J	0.81	1.3	1.1	1.3	1.6
2-Methylnaphthalene	24.3	µg/L	1.5 J	0.81	1.2	1.2	1.2	1.6
Acenaphthene	38	µg/L	1 J	0.51	0.83	0.7	0.71	0.91
Acenaphthylene	--	µg/L	0.081	< 0.093	0.042	< 0.093	< 0.093	0.052
Anthracene	0.035	µg/L	***0.35*** J	***0.14***	***0.27***	***0.21***	***0.22***	***0.26***
Benzo(a)anthracene	0.025	µg/L	***0.17*** J	***0.038***	***0.072***	***0.038***	< 0.093	***0.038***
Benzo(a)pyrene	0.003	µg/L	***0.14*** J	< 0.093	***0.059***	< 0.093	< 0.093	< 0.093
Benzo(b)fluoranthene	0.03	µg/L	***0.14*** J	< 0.093	***0.055***	< 0.093	< 0.093	< 0.093
Benzo(e)pyrene	--	µg/L	0.098	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(ghi)perylene	7.64	µg/L	0.079	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	0.076	< 0.093	0.024	< 0.093	< 0.093	< 0.093
Chrysene	0.07	µg/L	***0.2*** J	0.043	***0.073***	< 0.093	< 0.093	0.043
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	µg/L	0.1	0.058	0.085	0.08	0.076	0.091
Fluoranthene	1.9	µg/L	0.45 J	0.13	0.22	0.15	0.14	0.17
Fluorene	--	µg/L	0.35 J	0.16	0.28	0.24	0.21	0.31
Indeno(1,2,3-cd)pyrene	0.03	µg/L	***0.051***	< 0.093	< 0.093	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	µg/L	1.6 J	1	1.3	1.6	1.5	2
Phenanthrene	3.6	µg/L	1 J	0.43	0.67	0.6	0.58	0.71
Pyrene	0.3	µg/L	***0.69*** J	0.18	***0.32***	0.2	0.2	0.25

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

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Prepared by: TSB
Checked by: KRG1

Table 2
Water Quality Sampling Results
Sediment Removal Routine and Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	M3a_SW_N_150723	M3b_SW_N_150723	M3c_SW_N_150723
		Date	7/23/2015	7/23/2015	7/23/2015
		Sample Type	N	N	N
		Sample Interval (ft below surface)	0-2	5	9
Analyte	Project Screening/Action Criteria	Units			
Total Organic Carbon	--	mg/L	1.9	1.8	1.9
Total Suspended Solids	--	mg/L	6.5	6.8	5.8
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	0.19	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1
Ethylbenzene	14	µg/L	0.2	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	0.9	1.4	0.47
2-Methylnaphthalene	24.3	µg/L	1	1.5	0.54
Acenaphthene	38	µg/L	0.55	0.87	0.31
Acenaphthylene	--	µg/L	< 0.093	0.047	< 0.093
Anthracene	0.035	µg/L	***0.19***	***0.31***	***0.13***
Benzo(a)anthracene	0.025	µg/L	***0.048***	***0.085***	< 0.093
Benzo(a)pyrene	0.003	µg/L	< 0.093	***0.076***	< 0.093
Benzo(b)fluoranthene	0.03	µg/L	< 0.093	***0.077***	< 0.093
Benzo(e)pyrene	--	µg/L	< 0.093	0.048	< 0.093
Benzo(ghi)perylene	7.64	µg/L	< 0.093	< 0.093	< 0.093
Benzo(k)fluoranthene	0.14	µg/L	< 0.093	0.038	< 0.093
Chrysene	0.07	µg/L	0.046	***0.1***	< 0.093
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.093	< 0.093	< 0.093
Dibenzofuran	--	µg/L	0.062	0.089	< 0.093
Fluoranthene	1.9	µg/L	0.15	0.27	0.1
Fluorene	--	µg/L	0.19	0.3	0.11
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.093	< 0.093	< 0.093
Naphthalene	6.2	µg/L	1.4	1.9	0.76
Phenanthrene	3.6	µg/L	0.56	0.89	0.34
Pyrene	0.3	µg/L	0.21	***0.39***	0.14

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

R - Unusable data due to serious deficiencies in meeting QC criteria (i.e., analyte may or may not be present in the sample).

UJ - Analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Prepared by: TSB
Checked by: KRG1

Table 3
Water Quality Sampling Results
Stone Placement Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	**R6_SW_N_150908 (5+00 Basin Side)**	**R7_SW_N_151001 (8+00 - 9+00 Basin Side)**	**R8_SW_N_151004 (8+00 - 9+00 Basin Side)**	**R9_SW_N_151008 (2+00 Basin Side)**
		Date	**9/8/2015**	**10/1/2015**	**10/4/2015**	**10/8/2015**
		Sample Type	**N**	**N**	**N**	**N**
		Sample Interval (ft below surface)	**0-2**	**0-2**	**0-2**	**0-2**
Analyte	**Project Screening/Action Criteria**	**Units**	Sheen "Action Level"	Sheen "Action Level"	Sheen "Action Level"	Sheen "Action Level"
Total Organic Carbon	--	mg/L	3.7	1.8	1.9	2
Total Suspended Solids	--	mg/L	3	9.3	7.7	8
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	0.5	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	0.24	< 1
Toluene	--	µg/L	0.18	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	110	0.087	0.52	4.6
2-Methylnaphthalene	24.3	µg/L	***140***	0.11	0.56	5.1
Acenaphthene	38	µg/L	***90***	0.055	1.2	7.2
Acenaphthylene	--	µg/L	3.1	0.17	0.87	1.5
Anthracene	0.035	µg/L	***12***	***0.39***	***6***	***7.3***
Benzo(a)anthracene	0.025	µg/L	***0.74***	***0.8***	***3.7***	***5***
Benzo(a)pyrene	0.003	µg/L	***0.33***	***0.57***	***2.8***	***4.4***
Benzo(b)fluoranthene	0.03	µg/L	***0.3***	***0.52***	***2.5***	***3.6***
Benzo(e)pyrene	--	µg/L	0.19	0.32	1.5	2.4
Benzo(ghi)perylene	7.64	µg/L	0.15	0.27	1.2	***2.1***
Benzo(k)fluoranthene	0.14	µg/L	***0.16***	***0.24***	***1.3***	***1.8***
Chrysene	0.07	µg/L	***0.62***	***0.64***	***3.2***	***4.2***
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.095	0.076	***0.34***	***0.5***
Dibenzofuran	--	µg/L	8.4	< 0.094	0.21	0.87
Fluoranthene	1.9	µg/L	***5.7***	***1.4***	***8.2***	***14***
Fluorene	--	µg/L	33	0.068	2.4	6
Indeno(1,2,3-cd)pyrene	0.03	µg/L	***0.12***	***0.22***	***1***	***1.6***
Naphthalene	6.2	µg/L	***58***	0.25	1	2.2
Phenanthrene	3.6	µg/L	***52***	0.9	***16***	***31***
Pyrene	0.3	µg/L	***6.5***	***1.8***	***11***	***17***

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

J - Analyte result is an estimated quantity and represents an approximate concentration of the analyte in the sample.

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Prepared by: TSB
Checked by: KRG1

Foth | Envirocon Joint Venture

Table 3
Water Quality Sampling Results
Stone Placement Response Samples
Ashland/NSP Lakefront Site - Breakwater

		Sample ID	R10_SW_N_151009 (6+50 Basin Side)	R11_SW_N_151014 (6+50 Basin Side)	R12_SW_N_151019 (8+00 Basin Side)
		Date	10/9/2015	10/14/2015	10/19/2015
		Sample Type	N	N	N
		Sample Interval (ft below surface)	0-2	0-2	0-2
Analyte	Project Screening/Action Criteria	Units	Sheen "Action Level"	Sheen "Action Level"	Sheen "Action Level"
Total Organic Carbon	--	mg/L	1.9	1.8	1.8
Total Suspended Solids	--	mg/L	10	5.1	3.7
Sulfide	--	mg/L	< 0.1	< 0.1	< 0.1
1,2,4-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1
1,3,5-Trimethylbenzene	12.3	µg/L	< 1	< 1	< 1
Benzene	0.34	µg/L	< 1	< 1	< 1
Ethylbenzene	14	µg/L	< 1	< 1	< 1
Toluene	--	µg/L	< 1	< 1	< 1
Xylene, m & p	--	µg/L	< 2	< 2	< 2
Xylenes, Total	27	µg/L	< 3	< 3	< 3
1-Methylnaphthalene	433	µg/L	0.56	0.59	0.99
2-Methylnaphthalene	24.3	µg/L	0.57	0.51	1.2
Acenaphthene	38	µg/L	2.1	3.3	3.2
Acenaphthylene	--	µg/L	0.084	0.18	1.7
Anthracene	0.035	µg/L	***0.6***	***1.2***	***1.9***
Benzo(a)anthracene	0.025	µg/L	***0.12***	***0.26***	***5***
Benzo(a)pyrene	0.003	µg/L	***0.047***	***0.11***	***4.1***
Benzo(b)fluoranthene	0.03	µg/L	***0.049***	***0.11***	***4.7***
Benzo(e)pyrene	--	µg/L	< 0.097	0.066	3
Benzo(ghi)perylene	7.64	µg/L	< 0.097	0.044	2.5
Benzo(k)fluoranthene	0.14	µg/L	0.022	0.045	***2.3***
Chrysene	0.07	µg/L	***0.097***	***0.23***	***6.1***
Dibenzo(a,h)anthracene	0.003	µg/L	< 0.097	< 0.093	***0.2***
Dibenzofuran	--	µg/L	0.26	< 0.093	0.55
Fluoranthene	1.9	µg/L	0.45	1	***15***
Fluorene	--	µg/L	1.5	1.8	5.8
Indeno(1,2,3-cd)pyrene	0.03	µg/L	< 0.097	< 0.093	***2***
Naphthalene	6.2	µg/L	0.84	0.26	0.89
Phenanthrene	3.6	µg/L	2.2	***4***	***39***
Pyrene	0.3	µg/L	***0.54***	***1.2***	***18***

Bold, shaded, and italicized values exceed Project Screening/Action Criteria.

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UJ - Analyte was analyzed for, but was not detected. The reported quantitation

Prepared by: TSB
Checked by: KRG1

101 International Drive, P.O. Box 16655
Missoula, MT 59808

July 28, 2016

TO: Scott Hansen and Jamie Dunn

CC: Scott Inman, Eric Ealy, Terry Coss, Tom Perry, Alan Buell, Brad Hay, Steve Laszewski, Denis Roznowski, Steve Garbaciak

FR: Richard Onderko, P.E. and Rob Brillhart, P.E.

RE: Bench Test Results from the *Water Quality Management Contingencies Work Plan*
Ashland/NSP Lakefront Site

Introduction

The *Water Quality Management Contingencies Work Plan (WQ Work Plan)* (FE JV, 2016) was prepared to set a plan including identifying, testing, and selecting water quality contingency measures that may be employed during the Pilot Study. The *WQ Work Plan* identifies and reviews potential contingency measures that were to be further evaluated through a series of bench scale tests. Final comments to the *WQ Work Plan* (most related to the testing approach) were received from the U.S. Environmental Protection Agency [USEPA] on July 25, 2016 and are being addressed by Foth Infrastructure & Environment/Envirocon Joint Venture (FE JV)

The purpose of the bench scale jar testing was to identify potential contingency measures to accelerate improvements in water quality, following completion of dredging operations, by actively managing total suspended solids (TSS) and contaminant concentrations. A water quality barrier system has been installed to mitigate and contain suspended solids and contaminants of concern (COC) within the area of dredging operations. At the completion of the Pilot Study, COC levels may be above project water quality standards, which may prevent the removal of the water quality barrier system prior to freeze-up. Jar testing was performed to identify options to accelerate improvements in water quality following dredging activities.

A previous literature review indicted that activated carbon or organoclay addition would likely be the most viable options to reduce soluble concentrations for COCs and that alum addition would enhance solids settling and removal of adsorbed COCs. Jar testing was conducted at the Foth Infrastructure & Environment, LLC (Foth) laboratory located in

Green Bay, Wisconsin, the week of July 4, 2016, to determine the removal efficiencies of activated carbon, organoclay, alum, and combinations of these additives as well as approximate dosages required to achieve project water quality standards. The results of that testing are presented in this memo along with recommendations for the second phase column testing.

Settleability Testing

Settleability testing was completed to determine the settleability of granular activated carbon (GAC), powdered activated carbon (PAC), granular organoclay (GOC), and powdered organoclay (POC). The test consisted of adding a known weight of each material to a 1,000 milliliter (mL) graduated cylinder filled with deionized (DI) water. Following addition of the material, the time was measured and recorded for the material to settle to the bottom of the graduated cylinder.

The settling test was performed to identify products having settling characteristics thought to be advantageous. It is assumed that material that settles too quickly would limit the contact time between the selected adsorbent and the COCs dissolved in the water column. The contact time is expected to have a direct effect on the removal rate of the COCs.

The following summary provides the results of the settleability tests performed on the GAC, PAC, POC, and GOC.

Settleability Testing of Selected Additives

Material	Settle Time (second)	Liquid Depth (feet)	Settling Velocity (feet/second)
GAC[1]	326	1.14	0.0035
PAC[2]	720	1.14	0.0016
GOC	5	1.14	0.23
POC[3]	1,800	1.14	0.00063

1. A small amount of residual carbon remained at the liquid surface at the end of the recorded settle time.
2. The settling test was conducted on both wetted and non-wetted PAC. The wetted PAC settling time is presented in the time above as the PAC would likely be spread a slurry. An insignificant amount of PAC remained at the surface at the end of the settling test.
3. The settling test was conducted on both wetted and non-wetted POC. None of the non-wetted POC settled in the first 10 minutes of the test and the test was stopped. Approximately 60% of the wetted POC settled within 30 minutes. However, larger clumps of the wetted POC had settling characteristics similar to the GOC. Approximately 40% of the material remained at the liquid surface at the end of 30 minutes.

Based on the settling tests, jar tests were performed utilizing GAC, PAC, and POC. No further testing of the GOC was conducted due to the high settling velocity observed.

Jar Testing

GAC, PAC, POC, and alum were jar tested at various doses to determine the effectiveness in reducing the COCs to the required project water quality standards.

Six representative samples of dredging-impacted water were collected in 5-gallon pails from the site and shipped to Foth's Green Bay office for jar testing. The samples were transferred into a 30-gallon drum equipped with a mechanical mixer to obtain a single homogeneous composite sample. The composite was sampled for the COCs and turbidity for use as a base line in evaluating the jar tests.

The following summary provides the analytical data of the composite base line sample.

Composite Sample Analytical Results

Contaminants of Concern		Result (units)
VOC	1,2,4-Trimethylbenzene	<0.17
	1,3,5-Trimethylbenzene	<0.17
	Benzene	<0.20
	Ethylbenzene	<0.19
	Toluene	<0.17
	Xylene, m & p	<0.38
	Xylenes (Total)	<0.58
SVOCs	1-Methylnaphthalene	<0.048
	2-Methylnaphthalene	<0.048
	Acenaphthene	0.2
	Acenaphthylene	0.19
	Anthracene	<0.048
	Benzo(a)anthracene	**0.52**
	Benzo(a)pyrene	**0.53**
	Benzo(b)fluoranthene	**0.51**
	Benzo(e) pyrene	0.47
	Benzo(g,h,i)perylene	0.43
	Benzo(k)fluoranthene	**0.27**
	Chrysene	**0.47**
	Dibenzo(a,h)anthracene	<0.024
	Dibenzofuran	<0.019
	Fluoranthene	1.0
	Fluorene	<0.048
	Indeno(1,2,3-cd)pyrene	**0.35**
	Naphthalene	<0.048
	Phenanthrene	<0.048
	Pyrene	**0.86**
	Turbidity (NTU)	**95.1**

[shaded] Value is above project water quality standards.

Prepared by: RGB2
Checked by: SVF

Tables 1 to 8 (see Table's tab) present a summary of the analytical results from the jar tests performed. The tables include the COCs analyzed, the analytical results, a comparison to the water quality standard and percent removal for each of the jar tests. The sample results are also presented in each of the tables. The following COCs that were above the standards in the baseline sample: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Indeno(1,2,3-cd)pyrene, Pyrene.

GAC Jar Test

1.5 liter (L) samples were collected from the composite sample and poured into one of six 2,000-mL Erlenmeyer flasks. Each flask was dosed with a measured weight of GAC to achieve the following dose rates:

- 100 mg/L
- 200 mg/L
- 400 mg/L
- 800 mg/L
- 1,200 mg/L
- 1,600 mg/L

The Erlenmeyer flasks were then placed on an orbital shaker table and allowed to mix with the granular activated carbon for 60 minutes. The shaker table speed was set to 150 rotations per minute (rpm) for the duration of the test. Following the 60-minute mix time, the Erlenmeyer flasks were removed from the table and allowed to settle for two hours. Samples were then decanted and collected from each of the six flasks for laboratory analysis of the COCs. One sample was also collected from each of the tests for on-site analysis of turbidity (as a surrogate for TSS).

Results and Discussion

The turbidity results of the GAC samples are included in the following summary:

GAC Turbidity Results[1]

Sample No.	Additive	Dose (mg/L)	Turbidity (NTU)
GC-0100-SW-N_20160706	GAC	100	66.1
GC-0200-SW-N_20160706	GAC	200	65.2
GC-0400-SW-N_20160706	GAC	400	69.9
GC-0800-SW-N_20160706	GAC	800	61.5
GC-1200-SW-N_20160706	GAC	1,200	70.9
GC-1600-SW-N_20160706	GAC	1,600	66.3

1. Results after two-hours settling. Initial turbidity value at time “0” was 95.1 nephelometric turbidity unit (NTU).

Prepared by: RGB2
Checked by: SVF

The analytical results for the baseline sample and the GAC testing are provided in Table 1. COC concentrations were reduced from 11 to >93%. However, the analytical results indicate that GAC was not effective in reducing the COCs to meet the project water quality standards. This is likely due to GAC settling to the bottom of the Erlenmeyer flask within a few minutes of mixing. In addition, the orbital mixer was unable to keep the GAC in suspension throughout the mixing cycle limiting the contact time of the GAC with the entire water column. No further testing with granular activated carbon was conducted.

PAC Jar Tests

The procedure described above was repeated utilizing PAC.

The following summary provides the results of the turbidity testing from the PAC.

PAC Turbidity Results[1]

Sample No.	Additive	Dose (mg/L)	Turbidity (NTU)
PC-0100-SW-N_20160706	PAC	100	60.9
PC-0200-SW-N_20160706	PAC	200	54.6
PC-0400-SW-N_20160706	PAC	400	42.0
PC-0800-SW-N_20160706	PAC	800	27.8
PC-1200-SW-N_20160706	PAC	1,200	19.0
PC-1600-SW-N_20160706	PAC	1,600	13.2

1. Results after two-hours settling. Initial turbidity value at time “0” was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the baseline sample and the PAC testing are provided in Table 2. The analytical results indicate that PAC has the potential to be effective in reducing the COCs to meet the project water quality standards at dosage of 800 mg/L or greater. Unlike the GAC jar test, the PAC remained in suspension throughout the entire mixing cycle providing adequate contact time between the PAC and the liquid medium. COC concentrations were reduced from40 to 92% at PAC dosage rates of 100 and 200 mg/L to more than 95% for dosage rates above 800 mg/L.

POC Jar Tests

The procedure described above was repeated utilizing POC to determine the effectiveness of POC.

The following summary provides the results of the turbidity testing from the POC.

POC Turbidity Results[1]

Sample No.	Additive	Dose (mg/L)	Turbidity (NTU)
OC-0100-SW-N_20160706	POC	100	83.9
OC-0200-SW-N_20160706	POC	200	73.4
OC-0400-SW-N_20160706	POC	400	86.6
OC-0800-SW-N_20160706	POC	800	87.7
OC-1200-SW-N_20160706	POC	1,200	71.3
OC-1600-SW-N_20160706	POC	1,600	72.2

1. Results after two-hours settling. Initial turbidity value at time "0" was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the base line sample and the POC testing are provided in Table 3. The analytical results indicate that PAC has the potential to be effective in reducing the COCs to meet the project water quality standards at dosage levels equal to or greater than 1,600 mg/L. The dispersion of POC throughout the water column may have contributed to the lower removal rates when compared to the PAC. The POC had the tendency to either remain at the surface of the flask or clump which limited the dispersion of the material evenly throughout the beaker potentially reducing contact between the POC and chemicals in the sample. Larger clumps had the tendency to settle to the bottom of the flask while smaller clumps were able to remain in suspension during mixing. This may provide an explanation as to the higher dosage rates being required to meet the project water quality standards. COC concentrations were reduced from less than 10% at POC dosage rates equal to and less than 1,200 mg/L. COC concentrations were reduced more than 76% at a dosage rates of 1,600 mg/L.

Alum Jar Test

1.0 L samples were collected from the composite sample and poured into one of three 2,000-mL graduated beakers. Alum was added to each of the three composite samples at the following dosages:

- 25 ppm
- 50 ppm
- 100 ppm

The samples were then mixed for two minutes using a bench top four-station mechanical paddle mixer. The samples were then allowed to settle for two hours. Samples were then decanted and collected from each of the three beakers for off-site analytical analysis of the COCs. Turbidity samples were also collected for on-site analysis.

The following summary provides the results of the turbidity testing from the alum addition.

Alum Turbidity Results[1]

Sample No.	Additive	Dose (ppm)	Turbidity (NTU)
AL-25-SW-N_20160706	Alum	25	23.5
AL-50-SW-N_20160706	Alum	50	18.9
AL-100-SW-N_20160706	Alum	100	8.91

1. Results after two-hours settling. Initial turbidity value at time “0” was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the base line sample and the alum tests are provided in Table 4. COC concentrations were reduced from 59 to over 95% at an alum dosage of 25 ppm. The analytical results indicate that alum has the potential to be effective in reducing the COCs to meet the project water quality standards at a dosage level of 25 ppm. As the alum dose was increased to 50 ppm, the removal of rates of the COCs ranged from 38 to 93%. The analytical results indicate lower removal rates at increased alum dosage even as the turbidity improved at increased alum dosage levels. However; in each of the three alum samples tested, alum was unable to remove pyrene to concentrations to meet the project water quality standards.

Simultaneous PAC/Alum Addition Jar Tests

Based on the turbidity reductions obtained during the alum testing, combinations of PAC and alum were tested to determine if there were dosage efficiencies that could be realized. 1.5 L samples were collected from the composite sample and poured into one of six 2,000-mL Erlenmeyer flasks. The flasks were dosed with a measured weight of GAC to achieve the following dose rates:

- Two (2) flasks at 400 mg/L
- Two (2) flasks at 800 mg/L
- Two (2) flasks at 1,200 mg/L

Alum was dosed at 25 ppm into one of the two flasks at the various concentrations of carbon. The other three flasks were dosed at 50 ppm alum. The Erlenmeyer flasks were then placed on an orbital shaker table and allowed to mix for 60 minutes. The shaker table speed was set to 150 rpm for the duration of the test. Following the 60-minute mix time, the Erlenmeyer flasks were removed from the table and allowed to settle for two hours. Samples were then decanted and collected from each of the six flasks for off-site analytical analysis of selected chemical constituents. One sample was also collected from each of the jar tests for on-site analysis of turbidity.

The following summary provides the results of the turbidity testing from the simultaneous addition of PAC and alum.

Simultaneous PAC/Alum Addition Turbidity Results[1]

Sample No.	PAC/Dose (mg/L)	Alum/Dose (ppm)	Turbidity (NTU)
CA-0425-SW-N_20160707	400	25	13.42
CA-0825-SW-N_20160707	800	25	14.28
CA-1225-SW-N_20160707	1,200	25	7.78
CA-0450-SW-N_20160707	400	50	0.45
CA-0850-SW-N_20160707	800	50	0.65
CA-1250-SW-N_20160707	1,200	50	0.63

1. Results after two-hours settling. Initial turbidity value at time "0" was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the combination PAC and alum testing are provided in Table 5. In each of the tests performed, the COC concentrations were reduced to levels less than the limit of detection. The analytical results indicate that combining PAC and alum can reduce the COCs to levels consistent with the project water quality standards at dosage levels lower than adding PAC or alum alone.

PAC with Delayed Alum Addition Jar Tests

A second round of testing was performed with the PAC and alum with the exception that the alum was dosed 30 minutes following the PAC dose. The delayed alum dose was performed to determine if there would be any observable difference in settling as well as COC reduction.

1.5 L samples were collected from the composite sample and poured into one of six 2,000-mL Erlenmeyer flasks. The flasks were dosed with a measured weight of GAC to achieve the following dose rates:

- Two (2) flasks at 400 mg/L
- Two (2) flasks at 800 mg/L
- Two (2) flasks at 1,200 mg/L

Alum was dosed at 25 ppm into one of the two flasks at the various concentrations of carbon. The other three flasks were dosed at 50-ppm alum. The Erlenmeyer flasks dosed with PAC were then placed on an orbital shaker table and allowed to mix for 30 minutes. The shaker table speed was set to 150 rpm for the duration of the test. After 30 minutes of mix time, alum was dosed at 25 ppm into one of the two flasks at the various concentrations of carbon with the other three flasks being dosed at 50-ppm alum. The flasks were then allowed to mix for an additional 30 minutes. Following the final 30-minute mix time, the Erlenmeyer flasks were removed from the table and allowed to settle for two hours. Samples were then decanted and collected from each of the six flasks for off-site analytical analysis of COCs. One sample was also collected from each of the jar tests for on-site analysis of turbidity.

The following summary provides the results of the turbidity testing from the addition of PAC with the delayed addition of alum.

PAC with Delayed Alum Addition Turbidity Results[1]

Sample No.	PAC/Dose (mg/L)	Alum/Dose (ppm)	Turbidity (NTU)
C30A-0425-SW-N_20160707	400	25	0.75
C30A-0825-SW-N_20160707	800	25	0.72
C30A-1225-SW-N_20160707	1,200	25	3.83
C30A-0450-SW-N_20160707	400	50	0.58
C30A-0850-SW-N_20160707	800	50	1.40
C30A-1250-SW-N_20160707	1,200	50	1.28

1. Results after two-hours settling. Initial turbidity value at time "0" was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the combination PAC and delayed alum addition testing are provided in Table 6. Similar to the simultaneous PAC and alum dosing tests, the COC concentrations were also reduced to levels less than the limit of detection with the delayed dosing of alum. However; the turbidity results indicate that delaying the dosing of alum into the sample improves the settling characteristics of the solids. At a delayed alum addition of 25 ppm, the turbidity results improved by more than 85% compared to the same PAC and alum dosages added simultaneously.

Simultaneous POC/Alum Addition Jar Tests

For comparison, the simultaneous PAC/alum addition procedure was repeated utilizing POC and alum.

The following summary provides the results of the turbidity testing from the simultaneous addition of POC and alum.

Simultaneous POC/Alum Addition Turbidity Results[1]

Sample No.	POC/Dose (mg/L)	Alum/Dose (ppm)	Turbidity (NTU)
OA-0425-SW-N_20160707	400	25	25.4
OA-0825-SW-N_20160707	800	25	21.8
OA-1225-SW-N_20160707	1,200	25	7.17
OA-0450-SW-N_20160707	400	50	6.85
OA-0850-SW-N_20160707	800	50	2.78
OA-1250-SW-N_20160707	1,200	50	15.15

1. Results after two-hours settling. Initial turbidity value at time "0" was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the simultaneous addition of POC and alum testing are provided in Table 7. The analytical results indicate that the simultaneous addition of POC and alum may not consistently achieve the project water quality standards at the lower POC and alum dosages. At POC dosages less than 800 mg/L and an alum dosage of 25 ppm, the COC concentrations were reduced from 55 to over 95%. However, several of the COCs analyzed remained above the water quality standards for the project. At alum dosages of 50 ppm and similar POC dosages, COC concentrations were reduced to less than the limit of detection. The analytical results show that increasing the dosage of alum in combination with POC addition can achieve the project water quality standards.

POC with Delayed Alum Addition Jar Tests

For comparison, the PAC with delayed alum addition procedure was repeated utilizing POC and alum. The following summary provides the results of the turbidity testing from the combination POC with delayed alum addition.

POC with Delayed Alum Addition Turbidity Results[1]

Sample No.	POC/Dose (mg/L)	Alum/Dose (ppm)	Turbidity (NTU)
O30A-0425-SW-N_20160707	400	25	11.94
O30A-0825-SW-N_20160707	800	25	31.8
O30A-1225-SW-N_20160707	1,200	25	27.1
O30A-0450-SW-N_20160707	400	50	5.66
O30A-0850-SW-N_20160707	800	50	9.09
O30A-1250-SW-N_20160707	1,200	50	10.96

1. Results after two-hours settling. Initial turbidity value at time “0” was 95.1 NTU.

Prepared by: RGB2
Checked by: SVF

The analytical results for the combination POC delayed alum addition testing are provided in Table 8. Similar to the simultaneous POC and 25-ppm alum dosing tests, several COC concentrations remained above the water quality standards for the project. At an alum dosage of 25 ppm and 1,200 mg of POC, the COC concentrations were reduced to below limits of detection.

Recommendations

Based on preliminary settleability and jar testing, column settling testing is not recommended with GAC, POC, or alum as standalone water quality improvement measures. Although the combination of POC and alum addition indicate that the project water quality standards could be achieved, the required dosages of POC and alum are significantly higher than the combined dosages required for effective adsorption of the COCs and solids settling using PAC and alum. In addition, POC is expected to be more difficult to apply and is a higher cost material than PAC.

Therefore, column settling tests are recommended using PAC as well as PAC with delayed addition of alum. The proposed column settling tests will include a control (untreated) sample as well as column tests performed using PAC as well as varying concentrations of PAC with delayed alum addition. The initial round of tests, which includes the control condition, will be conducted for a period of seven days to provide sufficient time for settling and obtaining adequate samples for evaluating the removal and settling rates of the recommended water quality improvement options. The data collected from the control sample will be used as a base line for evaluating the potential impact the proposed improvement options may have on water quality.

The objectives of the column settling tests will be to:

- Evaluate the effectives and efficiencies of the PAC dosages and PAC/alum combination dosages as potential water quality improvement options.

- Perform column settling tests at temperatures less than 10 degree F to simulate the anticipated water temperatures expected during the time when contingency measures may be implemented to improve water quality prior to removal of the water quality barrier system.

- Determine the effect, if any, alum addition may have on the alkalinity of the source water that could impact water quality.

- Assess the presence of any nepheloid layer resulting from the above water quality improvement options.

Based on conversations with contractors that perform dredging and similar operations, the most likely scenario for PAC/alum distribution in the Pilot Study area would be to dose the PAC in the impacted area followed the next day with alum addition. To replicate the PAC with delayed alum addition in the settling tests, the recommended testing procedure will be to dose the columns with PAC and allowing the column to settle for one day. No samples would be collected until the columns are dosed with the predetermined alum dose. The day following PAC addition, the columns will be dosed with alum and mixed. The settleability test and sample collection would start once the alum has been dosed into the column.

Based on jar testing, PAC with delayed alum addition would require significantly less than seven days for absorption of the COCs and solids settling. The testing period is anticipated to be complete within 48 hours. However, the testing period may be extended up to seven days based on the results of the initial round of column settling tests or observations during subsequent column settling tests (primarily limited solids settling) necessitating subsequent tests to be extended up to seven days.

The following PAC and delayed alum dosages are proposed:

Test	PAC Dose (mg/L)	Alum Dose (ppm)[1]	Proposed Test Period (days)[2]	Proposed Sample Interval (hours)										
1	0	0	7	0			24				48	72	120	168
2	800	0	7	0	1	3	24				48			168
3	400	10	7				24	24.5	25	27	48			168
4	200	10	2				24	24.5	25	27	48			
5	200	25	2				24	24.5	25	27	48			
6	100	25	2				24	24.5	25	27	48			

1 Alum to be added to the column the day following PAC dose

2 Testing period for column settling tests 4, 5, and 6 may be extended based on initial column settling tests results or other observations during testing period.

Prepared by: RGB2
Checked by: SVF

Tables

Table 1

Analytical Results Granular Activated Carbon

Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	GC-0100-SW-N_20160706		GC-0200-SW-N_20160706		GC-0400-SW-N_20160706		GC-0800-SW-N_20160706		GC-1200-SW-N_20160706		GC-1600-SW-N_20160706	
Carbon concentration (mg/L):			NA	100		200		400		800		1200		1600	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
Carbon Dose (mg):			NA	150		300		600		1200		1800		2400	
Alum Dose (ppm):			NA	0		0		0		0		0		0	
Alum Mix Time (min):			NA	0		0		0		0		0		0	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	NA
	Acenaphthene	µg/L	0.20	<0.050	>75%	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	>77%
	Acenaphthylene	µg/L	0.19	<0.050	>73%	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	>76%
	Anthracene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	**0.13**	NA
	Benzo(a)anthracene	µg/L	**0.52**	**0.44**	15.4%	**0.36**	30.8%	**0.38**	26.9%	**0.28**	46.2%	**0.26**	50.0%	**0.29**	44.2%
	Benzo(a)pyrene	µg/L	**0.53**	**0.46**	13.2%	**0.39**	26.4%	**0.45**	15.1%	**0.45**	15.1%	**0.34**	35.8%	**0.38**	28.3%
	Benzo(b)fluoranthene	µg/L	**0.51**	**0.43**	15.7%	**0.39**	23.5%	**0.44**	13.7%	**0.45**	11.8%	**0.32**	37.3%	**0.33**	35.3%
	Benzo(e) pyrene	µg/L	0.47	0.40	14.9%	0.34	27.7%	0.37	21.3%	0.36	23.4%	0.28	40.4%	0.34	27.7%
	Benzo(g,h,i)perylene	µg/L	0.43	0.33	23.3%	0.35	18.6%	0.38	11.6%	<0.048	>88%	0.28	34.9%	0.35	18.6%
	Benzo(k)fluoranthene	µg/L	**0.27**	**0.21**	22.2%	**0.18**	33.3%	**0.19**	29.6%	**0.17**	37.0%	0.10	63.0%	**0.20**	25.9%
	Chrysene	µg/L	**0.47**	**0.43**	8.5%	**0.35**	25.5%	**0.37**	21.3%	**0.42**	10.6%	**0.28**	40.4%	**0.33**	29.8%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.025	NA	<0.023	NA	<0.024	NA	<0.024	NA	<0.024	NA	<0.022	NA
	Dibenzofuran	µg/L	<0.019	<0.020	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.018	NA
	Fluoranthene	µg/L	1.0	0.89	11.0%	0.75	25.0%	0.71	29.0%	0.64	36.0%	0.49	51.0%	0.57	43.0%
	Fluorene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	**0.28**	20.0%	**0.25**	28.6%	**0.24**	31.4%	<0.024	>93%	**0.25**	28.6%	**0.25**	28.6%
	Naphthalene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.045	NA
	Phenanthrene	µg/L	<0.048	<0.050	NA	<0.046	NA	<0.048	NA	<0.048	NA	<0.048	NA	0.20	NA
	Pyrene	µg/L	**0.86**	**0.81**	5.8%	**0.63**	26.7%	**0.66**	23.3%	**0.65**	24.4%	**0.47**	45.3%	**0.58**	32.6%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	66.1		65.2		69.9		61.5		70.9		66.3	

Yellow highlighted and bold values indicate exceedance

Prepared by: RBG2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 2
Analytical Results Powdered Activated Carbon
Phase 2 Contingency Testing - Initial Jar Tests

Sample ID:			SW-N_20160706	PC-0100-SW-N_20160706		PC-0200-SW-N_20160706		PC-0400-SW-N_20160706		PC-0800-SW-N_20160706		PC-1200-SW-N_20160706		PC-1600-SW-N_20160706	
Carbon concentration (mg/L):			NA	100		200		400		80		1200		1600	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
Carbon Dose (mg):			NA	150		300		600		1200		1800		2400	
Alum Dose (ppm):			NA	0		0		0		0		0		0	
Alum Mix Time (min):			NA	0		0		0		0		0		0	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	Acenaphthene	µg/L	0.20	<0.045	>77%	<0.050	>75%	<0.046	>75%	<0.046	>75%	<0.050	>75%	<0.048	>76%
	Acenaphthylene	µg/L	0.19	<0.045	>76%	<0.050	>73%	<0.046	>73%	<0.046	>73%	<0.050	>73%	<0.048	>74%
	Anthracene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	Benzo(a)anthracene	µg/L	**0.52**	**0.17**	67.3%	**0.14**	73.1%	<0.023	>95%	<0.023	>95%	<0.025	>95%	<0.024	>95%
	Benzo(a)pyrene	µg/L	**0.53**	**0.28**	47.2%	**0.27**	49.1%	**0.13**	75.5%	<0.023	>95%	<0.025	>95%	<0.024	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	**0.23**	54.9%	**0.21**	58.8%	**0.13**	74.5%	<0.023	>95%	<0.025	>95%	<0.024	>95%
	Benzo(e) pyrene	µg/L	0.47	0.22	53.2%	0.23	51.1%	0.10	78.7%	<0.046	>90%	<0.050	>89%	<0.048	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	0.26	39.5%	0.27	37.2%	<0.046	>89%	<0.046	>89%	<0.050	>88%	<0.048	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	0.095	64.8%	0.083 J	69.3%	0.06 J	77.8%	<0.046	>82%	<0.050	>81%	<0.048	>82%
	Chrysene	µg/L	**0.47**	**0.22**	53.2%	**0.18**	61.7%	<0.046	>90%	<0.046	>90%	<0.050	>89%	<0.048	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.022	NA	<0.025	NA	<0.023	NA	<0.023	NA	<0.025	NA	<0.024	NA
	Dibenzofuran	µg/L	<0.019	<0.018	NA	<0.020	NA	<0.019	NA	<0.019	NA	<0.020	NA	<0.019	NA
	Fluoranthene	µg/L	1.0	0.26	74.0%	0.25	75.0%	<0.046	>95%	<0.046	>95%	<0.050	>95%	<0.048	>95%
	Fluorene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.022	>93%	<0.025	>93%	<0.023	>93%	<0.023	>93%	<0.025	>92%	<0.024	>93%
	Naphthalene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	Phenanthrene	µg/L	<0.048	<0.045	NA	<0.050	NA	<0.046	NA	<0.046	NA	<0.050	NA	<0.048	NA
	Pyrene	µg/L	**0.86**	0.28	67.4%	0.28	67.4%	<0.046	>94%	<0.046	>94%	<0.050	>94%	<0.048	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	60.9		54.6		42		27.8		19		13.2	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 3
Analytical Results Powdered Organoclay
Phase 2 Contingency Testing

Sample ID:			SW-N_20160706	OC-0100-SW-N_20160706		OC-0200-SW-N_20160706		OC-0400-SW-N_20160706		OC-0800-SW-N_20160706		OC-1200-SW-N_20160706		OC-1600-SW-N_20160706	
OrganoClay concentration (mg/L):			NA	100		200		400		800		1200		1600	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
OrganoClay Dose (mg):			NA	150		300		600		1200		1800		2400	
Alum Dose (ppm):			NA	0		0		0		0		0		0	
Alum Mix Time (min):			NA	0		0		0		0		0		0	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016		07/06/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.048	NA	0.19	NA	<0.048	NA	0.11	NA	<0.048	NA	<0.048	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.048	NA	0.19	NA	<0.048	NA	0.20	NA	<0.048	NA	<0.048	NA
	Acenaphthene	µg/L	0.2	<0.048	>76%	<0.048	>76%	<0.048	>76%	<0.048	>76%	<0.048	>76%	<0.048	>76%
	Acenaphthylene	µg/L	0.19	<0.048	>75%	<0.048	>75%	<0.048	>75%	<0.048	>75%	<0.048	>75%	<0.048	>75%
	Anthracene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA
	Benzo(a)anthracene	µg/L	0.52	**0.23**	55.8%	**0.33**	36.5%	<0.024	>95%	**0.26**	50.0%	<0.024	>95%	<0.024	>95%
	Benzo(a)pyrene	µg/L	0.530	**0.33**	37.7%	**0.55**	-3.8%	**0.22**	58.5%	**0.31**	41.5%	**0.24**	54.7%	<0.024	>95%
	Benzo(b)fluoranthene	µg/L	0.510	**0.31**	39.2%	**0.53**	-3.9%	**0.19**	62.7%	**0.31**	39.2%	**0.23**	54.9%	<0.024	>95%
	Benzo(e) pyrene	µg/L	0.5	0.30	36.2%	0.46	2.1%	0.20	57.4%	0.28	40.4%	0.20	57.4%	<0.048	>90%
	Benzo(g,h,i)perylene	µg/L	0.43	0.25	41.9%	0.49	-14.0%	<0.048	>88%	0.32	25.6%	<0.048	>88%	<0.048	>88%
	Benzo(k)fluoranthene	µg/L	0.27	0.14	48.1%	**0.21**	22.2%	0.094 J	65.2%	0.12	55.6%	0.094 J	65.2%	<0.048	>82%
	Chrysene	µg/L	0.47	**0.21**	55.3%	**0.46**	2.1%	<0.048	>89%	**0.25**	46.8%	<0.048	>89%	<0.048	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.024	NA	<0.024	NA	<0.024	NA	<0.024	NA	<0.024	NA	<0.024	NA
	Dibenzofuran	µg/L	<0.019	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA
	Fluoranthene	µg/L	1.0	0.31	69.0%	0.54	46.0%	0.25	75.0%	0.38	62.0%	0.27	73.0%	<0.048	>95%
	Fluorene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA
	Indeno(1,2,3-cd)pyrene	µg/L	0.35	<0.024	>93%	**0.34**	2.9%	<0.024	>93%	<0.024	>93%	<0.024	>93%	<0.024	>93%
	Naphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA
	Phenanthrene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA	<0.048	NA
	Pyrene	µg/L	0.86	**0.32**	62.8%	**0.58**	32.6%	<0.048	>94%	**0.38**	55.8%	<0.048	>94%	<0.048	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	83.9		73.4		86.6		87.7		71.3		72.2	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 4
Analytical Results Alum
Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	AL-25-SW-N_20160706		AL-50-SW-N_20160706		AL-100-SW-N_20160706	
Sample Size (mL):			NA	1000		1000		1000	
Carbon Dose (mg):			NONE	0		0		0	
Alum Dose (ppm):			NONE	25		50		100	
Alum Mix Time (min):			NONE	5		5		5	
Total Mix Time (min):			NONE	5		5		5	
Settle Time (min):			NONE	45		45		45	
Test Date:			07/06/2016	07/06/2016		07/06/2016		07/06/2016	
		Units			Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	Acenaphthene	µg/L	0.20	<0.048	>76%	<0.048	>76%	<0.048	>76%
	Acenaphthylene	µg/L	0.19	<0.048	>74%	<0.048	>74%	<0.048	>74%
	Anthracene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	Benzo(a)anthracene	µg/L	**0.52**	<0.024	>95%	**0.27**	48.1%	<0.024	>95%
	Benzo(a)pyrene	µg/L	**0.53**	<0.024	>95%	**0.25**	52.8%	<0.024	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	<0.024	>95%	**0.24**	52.9%	<0.024	>95%
	Benzo(e) pyrene	µg/L	0.47	<0.048	>89%	0.18	61.7%	<0.048	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	<0.048	>88%	<0.048	>88%	<0.048	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	<0.048	>82%	0.094 J	65.2%	<0.048	>82%
	Chrysene	µg/L	**0.47**	<0.048	>89%	**0.29**	38.3%	<0.048	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.024	NA	<0.024	NA	<0.024	NA
	Dibenzofuran	µg/L	<0.019	<0.019	NA	<0.019	NA	<0.019	NA
	Fluoranthene	µg/L	1.0	0.41	59.0%	0.57	43.0%	0.50	50.0%
	Fluorene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.024	>93%	<0.024	>93%	<0.024	>93%
	Naphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	Phenanthrene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA
	Pyrene	µg/L	**0.86**	**0.33**	61.6%	**0.52**	39.5%	**0.47**	45.3%
General Chemistry	Sulfide		NT	NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT	
	Turbidity	NTU	NT	23.5		18.9		8.91	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 5
Analytical Results Simultaneous Addition of Powdered Activated Carbon and Alum
Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	CA-0425-SW-N_20160707		CA-0825-SW-N_20160707		CA-1225-SW-N_20160707		CA-0450-SW-N_20160707		CA-0850-SW-N_20160707		CA-1250-SW-N_20160707	
Carbon concentration (mg/L):			NA	400		800		1200		400		800		1200	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
Carbon Dose (mg):			NA	600		1200		1800		600		1200		1800	
Alum Dose (ppm):			NA	25		25		25		50		50		50	
Alum Mix Time (min):			NA	60		60		60		60		60		60	
Total Mix Time (min)			NA	60		60		60		60		60		60	
Settle Time (min)			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.050	NA	<0.050	NA	<0.050	NA	0.23	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.050	NA	<0.050	NA	<0.050	NA	0.23	NA
	Acenaphthene	µg/L	0.20	<0.048	>76%	<0.048	>76%	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%
	Acenaphthylene	µg/L	0.19	<0.048	>74%	<0.048	>74%	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%
	Anthracene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Benzo(a)anthracene	µg/L	**0.52**	<0.024	>95%	<0.024	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(a)pyrene	µg/L	**0.53**	<0.024	>95%	<0.024	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	<0.024	>95%	<0.024	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(e) pyrene	µg/L	0.47	<0.048	>89%	<0.048	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	<0.048	>88%	<0.048	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	<0.048	>82%	<0.048	>82%	<0.050	>81%	<0.050	>81%	<0.050	>81%	<0.050	>81%
	Chrysene	µg/L	**0.47**	<0.048	>89%	<0.048	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.024	NA	<0.024	NA	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA
	Dibenzofuran	µg/L	<0.019	<0.019	NA	<0.019	NA	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA
	Fluoranthene	µg/L	1.0	<0.048	>95%	<0.048	>95%	<0.050	>95%	<0.050	>95%	<0.050	>95%	<0.050	>95%
	Fluorene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.024	>93%	<0.024	>93%	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%
	Naphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	0.23	NA	<0.050	NA	<0.050	NA	0.40	NA
	Phenanthrene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Pyrene	µg/L	**0.86**	<0.048	>94%	<0.048	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	13.42		14.28		7.78		0.45		0.65		0.63	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 6

Analytical Results Powdered Activated Carbon with Delayed Alum Addition

Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	C30A-0425-SW-N_20160707		C30A-0825-SW-N_20160707		C30A-1225-SW-N_20160707		C30A-0450-SW-N_20160707		C30A-0850-SW-N_20160707		C30A-1250-SW-N_20160707	
Carbon concentration (mg/L):			NA	400		800		1200		400		800		1200	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
Carbon Dose (mg):			NA	600		1200		1800		600		1200		1800	
Alum Dose (ppm):			NA	25		25		25		50		50		50	
Alum Mix Time (min):			NA	30		30		30		30		30		30	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	Acenaphthene	µg/L	0.20	<0.048	>76%	<0.048	>76%	<0.048	>76%	<0.046	>77%	<0.048	>76%	<0.048	>76%
	Acenaphthylene	µg/L	0.19	<0.048	>74%	<0.048	>74%	<0.048	>74%	<0.046	>75%	<0.048	>74%	<0.048	>74%
	Anthracene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	Benzo(a)anthracene	µg/L	**0.52**	<0.024	>95%	<0.024	>95%	<0.024	>95%	<0.023	>95%	<0.024	>95%	<0.024	>95%
	Benzo(a)pyrene	µg/L	**0.53**	<0.024	>95%	<0.024	>95%	<0.024	>95%	<0.023	>95%	<0.024	>95%	<0.024	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	<0.024	>95%	<0.024	>95%	<0.024	>95%	<0.023	>95%	<0.024	>95%	<0.024	>95%
	Benzo(e) pyrene	µg/L	0.47	<0.048	>89%	<0.048	>89%	<0.048	>89%	<0.046	>90%	<0.048	>89%	<0.048	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	<0.048	>88%	<0.048	>88%	<0.048	>88%	<0.046	>89%	<0.048	>88%	<0.048	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	<0.048	>82%	<0.048	>82%	<0.048	>82%	<0.046	>82%	<0.048	>82%	<0.048	>82%
	Chrysene	µg/L	**0.47**	<0.048	>89%	<0.048	>89%	<0.048	>89%	<0.046	>90%	<0.048	>89%	<0.048	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.024	NA	<0.024	NA	<0.024	NA	<0.023	NA	<0.024	NA	<0.024	NA
	Dibenzofuran	µg/L	<0.019	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA	<0.019	NA
	Fluoranthene	µg/L	1.0	<0.048	>95%	<0.048	>95%	<0.048	>95%	<0.046	>95%	<0.048	>95%	<0.048	>95%
	Fluorene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.024	>93%	<0.024	>93%	<0.024	>93%	<0.023	>93%	<0.024	>93%	<0.024	>93%
	Naphthalene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	Phenanthrene	µg/L	<0.048	<0.048	NA	<0.048	NA	<0.048	NA	<0.046	NA	<0.048	NA	<0.048	NA
	Pyrene	µg/L	**0.86**	<0.048	>94%	<0.048	>94%	<0.048	>94%	<0.046	>94%	<0.048	>94%	<0.048	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Tubidity	NTU	NT	0.75		0.72		3.83		0.58		1.40		1.28	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 7

Analytical Results Simultaneous Powdered Organoclay and Alum Addition

Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	OA-0425-SW-N_20160707		OA-0825-SW-N_20160707		OA-1225-SW-N_20160707		OA-0450-SW-N_20160707		OA-0850-SW-N_20160707		OA-1250-SW-N_20160707	
Carbon concentration (mg/L):			NA	400		800		1200		400		800		1200	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
OrganoClay Dose (mg):			NA	600		1200		1800		600		1200		1800	
Alum Dose (ppm):			NA	25		25		25		50		50		50	
Alum Mix Time (min):			NA	60		60		60		60		60		60	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Acenaphthene	µg/L	0.20	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%
	Acenaphthylene	µg/L	0.19	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%
	Anthracene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Benzo(a)anthracene	µg/L	**0.52**	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(a)pyrene	µg/L	**0.53**	**0.22**	58.5%	**0.24**	54.7%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	<0.025	>95%	**0.065**	87.3%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(e) pyrene	µg/L	0.47	0.077 J	83.6.%	0.06 J	87.2%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	<0.050	>81%	0.12	55.6%	<0.050	>81%	<0.050	>81%	<0.050	>81%	<0.050	>81%
	Chrysene	µg/L	**0.47**	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA
	Dibenzofuran	µg/L	<0.019	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA
	Fluoranthene	µg/L	1.0	0.21	79.0%	0.20	80.0%	<0.050	>95%	<0.050	>95%	<0.050	>95%	<0.050	>95%
	Fluorene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%
	Naphthalene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Phenanthrene	µg/L	<0.048	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Pyrene	µg/L	**0.86**	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	25.4		21.8		7.17		6.85		2.78		15.15	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Table 8
Analytical Results Powdered Organoclay with Delayed Alum Addition
Phase 2 Contingency Testing - Initial Jar Testing

Sample ID:			SW-N_20160706	O30A-0425-SW-N_20160707		O30A-0825-SW-N_20160707		O30A-1225-SW-N_20160707		O30A-0450-SW-N_20160707		O30A-0850-SW-N_20160707		O30A-1250-SW-N_20160707	
Carbon concentration (mg/L):			NA	400		800		1200		400		800		1200	
Sample Size (mL):			NA	1500		1500		1500		1500		1500		1500	
OrganoClay Dose (mg):			NA	600		1200		1800		600		1200		1800	
Alum Dose (ppm):			NA	25		25		25		50		50		50	
Alum Mix Time (min):			NA	30		30		30		30		30		30	
Total Mix Time (min):			NA	60		60		60		60		60		60	
Settle Time (min):			NA	120		120		120		120		120		120	
Test Date:			07/06/2016	07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016		07/07/2016	
		Units			Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal		Percent Removal
VOCs	1,2,4-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	1,3,5-Trimethylbenzene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Benzene	µg/L	<0.20	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA	<0.20	NA
	Ethylbenzene	µg/L	<0.19	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA	<0.19	NA
	Toluene	µg/L	<0.17	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA	<0.17	NA
	Xylene, m & p	µg/L	<0.38	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA	<0.38	NA
	Xylenes (Total)	µg/L	<0.58	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA	<0.58	NA
SVOCs	1-Methylnaphthalene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	2-Methylnaphthalene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Acenaphthene	µg/L	0.20	<0.052	>74%	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%	<0.050	>75%
	Acenaphthylene	µg/L	0.19	<0.052	>72%	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%	<0.050	>73%
	Anthracene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Benzo(a)anthracene	µg/L	**0.52**	<0.026	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(a)pyrene	µg/L	**0.53**	<0.026	>95%	**0.21**	60.4%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(b)fluoranthene	µg/L	**0.51**	<0.026	>94%	**0.088**	82.7%	<0.025	>95%	<0.025	>95%	<0.025	>95%	<0.025	>95%
	Benzo(e) pyrene	µg/L	0.47	<0.052	>88%	0.07 J	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Benzo(g,h,i)perylene	µg/L	0.43	<0.052	>87%	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%	<0.050	>88%
	Benzo(k)fluoranthene	µg/L	**0.27**	<0.052	>80%	0.11	59.3%	<0.050	>81%	<0.050	>81%	<0.050	>81%	<0.050	>81%
	Chrysene	µg/L	**0.47**	<0.052	>88%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%	<0.050	>89%
	Dibenzo(a,h)anthracene	µg/L	<0.024	<0.026	NA	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA	<0.025	NA
	Dibenzofuran	µg/L	<0.019	<0.021	NA	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA	<0.020	NA
	Fluoranthene	µg/L	1.0	<0.052	>94%	0.22	78.0%	<0.050	>95%	<0.050	>95%	<0.050	>95%	<0.050	>95%
	Fluorene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Indeno(1,2,3-cd)pyrene	µg/L	**0.35**	<0.026	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%	<0.025	>92%
	Naphthalene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Phenanthrene	µg/L	<0.048	<0.052	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA	<0.050	NA
	Pyrene	µg/L	**0.86**	<0.052	>93	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%	<0.050	>94%
General Chemistry	Sulfide		NT	NT		NT		NT		NT		NT		NT	
	Total Suspended Solids		NT	NT		NT		NT		NT		NT		NT	
	Dissolved Organic Carbon		NT	NT		NT		NT		NT		NT		NT	
	Turbidity	NTU	NT	11.94		31.8		27.1		5.66		9.09		10.96	

Yellow highlighted and bold values indicate exceedance

Prepared by: RGB2
Checked by: SVF

NT = not tested
µg/L = micrograms per liter
NTU = nephelometric turbidity unit
J = result is estimated
ppm = parts per million
mL = milliliter
min = minute
% = percent
VOC = volatile organic carbon
SVOC - semi-volatile organic carbon
mg = milligram

Foth | Envirocon
Joint Venture

Technical Memorandum #16-5

101 International Drive, P.O. Box 16655
Missoula, MT 59808

September 27, 2016

TO: Scott Hansen and Jamie Dunn

CC: Scott Inman, Eric Ealy, Terry Coss, Kristen Carney, Jennifer Casler, Tom Perry, Alan Buell, Brad Hay, Brian Bell, Steve Laszewski, Denis Roznowski, Steve Garbaciak,

FR: Richard Onderko, P.E. and Rob Brillhart, P.E.

RE: Water Quality Management Contingencies Column Settling Testing Results and Recommendations
Ashland/NSP Lakefront Site

Introduction

The *Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study (WQ Work Plan)* (FE JV, 2016a) was prepared to set a plan including identifying, testing, and selecting water quality contingency measures that may be employed during the Wet Dredge Pilot Study. The *WQ Work Plan* identified and reviewed potential contingency measures that were to be evaluated through a series of bench scale jar tests and column settling tests.

A water quality barrier system has been installed to mitigate and contain suspended solids and contaminants of concern (COC) within the area of dredging operations of the Ashland/NSP Lakefront Site Wet Dredge Pilot Study. At the completion of the Wet Dredge Pilot Study, COC levels within the containment area may be above project water quality standards. This may prevent the removal of the water quality barrier system prior to freeze-up. The purpose of the *WQ Work Plan* testing was to identify potential contingency measures which could accelerate improvements in water quality by actively managing total suspended solids (TSS) and contaminant concentrations.

Foth Infrastructure & Environment/Envirocon Joint Venture (FE JV) has prepared this memorandum to report the results of the column settling tests as described in the *WQ Work Plan* and provide contingency recommendations. Bench scale testing was previously reported in Technical Memorandum #16-4, "Bench Test Results from the Water Quality Management Contingencies Work Plan" (FE JV 2016b).

Granular activated carbon (GAC), powdered activated carbon (PAC), powdered organoclay (POC), and alum were jar tested at various doses to determine the effectiveness in reducing the TSS and COCs to the required project water quality standards. Based on results of the jar testing column settling testing was recommended to further evaluate PAC and PAC with delayed addition of alum as viable water quality contingency measures.

Three column settling tests were conducted at the TestAmerica, Inc. (TestAmerica) laboratory (Pittsburgh, Pennsylvania) to further evaluate:

- The effect and efficiency of the PAC and PAC/alum dosages;
- Settling rates at the pilot dredging operations at expected lake water temperatures; and
- The effect alum addition may have on the alkalinity of the source water that could negatively impact water quality.

Column Settling Tests

Three column settling tests were performed as part of this work. Representative samples were collected approximately 12 hours after cessation of second pass dredging operations by pumping water from within the primary water quality barrier surrounding the Pilot Study Dredge Area into three 55-gallon drums. The drums were shipped via a refrigerated truck to TestAmerica's facility for column testing.

An initial composite sample of the water was analyzed for the COCs and general chemistry parameters. The results of this test were used as a baseline in evaluating all column tests.

The COCs in the water collected for the column settling tests were compared to the COCs in the water collected for the earlier bench testing to determine if any significant differences in initial water quality existed between the two tests. Table 1 provides a comparison of the water quality used for the bench and column tests.

Table 1

Bench and Column Test Composite Sample Comparison

Contaminants of Concern		Units	Project Water Quality Standard (µg/L)	Bench Test Composite	Column Test Composite
Volatile Organic Compounds (VOC)	1,2,4-Trimethylbenzene	µg/L	12.3	<0.17	<0.17
	1,3,5-Trimethylbenzene	µg/L	12.3	<0.17	<0.17
	Benzene	µg/L	0.34	<0.20	0.48 JB*
	Ethylbenzene	µg/L	14	<0.19	<0.19
	Toluene	µg/L	N/A	<0.17	0.31 JB
	Xylene, m & p	µg/L	N/A	<0.38	<0.38
	Xylenes (Total)	µg/L	27	<0.58	<0.58
Semi-Volatile Organic Compounds (SVOC)	1-Methylnaphthalene	µg/L	433	<0.048	0.048 J
	2-Methylnaphthalene	µg/L	24.3	<0.048	0.90 J
	Acenaphthene	µg/L	38	0.20	0.064 J
	Acenaphthylene	µg/L	N/A	0.19	0.16
	Anthracene	µg/L	0.035	<0.048	**0.14**
	Benzo(a)anthracene	µg/L	0.025	**0.52**	**0.35**
	Benzo(a)pyrene	µg/L	0.003	**0.53**	**0.49**
	Benzo(b)fluoranthene	µg/L	0.003	**0.51**	**0.47**
	Benzo(e) pyrene	µg/L	N/A	0.47	0.4 O
	Benzo(g,h,i)perylene	µg/L	7.64	0.43	0.35
	Benzo(k)fluoranthene	µg/L	0.14	**0.27**	**0.22**
	Chrysene	µg/L	0.07	**0.47**	**0.25**
	Dibenzo(a,h)anthracene	µg/L	0.003	<0.024	<0.019
	Dibenzofuran	µg/L	N/A	<0.019	<0.048
	Fluoranthene	µg/L	1.9	1.0	0.31
	Fluorene	µg/L	N/A	<0.048	<0.019
	Indeno(1,2,3-cd)pyrene	µg/L	0.03	**0.35**	**0.24**
	Naphthalene	µg/L	6.2	<0.048	0.078 J
	Phenanthrene	µg/L	3.6	<0.048	0.14 B
	Pyrene	µg/L	0.3	**0.86**	**0.55**

[yellow box] Value is above water quality standards.

µg/L = micrograms per liter
J = Result is estimated.
B = Compound was found in the blank and in sample.
* = relative percent difference (RPD) of the laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) exceeds the control limits.
< = Analyte not detected above the method detection limit (MDL).
N/A = Not applicable

Prepared by: RGB2
Checked by: SVF

Both composite samples contained COCs that exceeded the project water quality standards. The composite sample collected for the column test included several COCs that not were detected in the bench test composite sample. These COCs included benzene, toluene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, naphthalene, and phenanthrene. Overall the results of the COCs observed in both composite samples compared well.

Tables A-1 through A-6 (see tables in Attachment 1) present a summary of the analytical results from the column tests performed. These tables include the COCs and general chemistry parameters analyzed, the analytical results, and a comparison to the project water quality standards for the COCs. The following COCs were above the project standards in the baseline composite column test sample and the composite bench test sample: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and pyrene. Anthracene was present at concentrations above the project water quality standards only in the composite sample used in the column settling tests.

Baseline Column Settling Test

The composite samples were mixed by initially rolling each drum on its side followed by mechanical mixing with a paddle blade mixer.

68 liters of sample were transferred from the mixed drum into an 8-foot column using a 5-gallon bucket. Coarse bubble air was introduced at the bottom of the column during the initial fill to prevent solids from settling prior to collecting the first set of samples (approximately one minute). Once the column was filled, the air flow was stopped and the first set of samples were collected starting the testing period.

Initial samples were collected at every 0.5 foot of water depth for TSS and at the surface and one half water depth for the COCs and general chemistry parameters. This procedure was repeated every 24 hours until the conclusion of the testing period at 168 hours. The overall water depth in the column decreased through the duration of the test as water samples were removed for analyses.

Lake water temperatures are expected to be approximately 10 degrees Celsius (°C) or less at the completion of the Wet Dredge Pilot Study in late October. Therefore, the column settling test was completed in a climate controlled environment to simulate the effect cold water temperatures may have on the settling rate of solids. The temperature of the baseline column was maintained between 8.4 and 11.2°C through the test periods.

Results and Discussion

The turbidity results of the baseline samples are included in the following summary:

Table 2

Column Settling Test Turbidity Results - Baseline

Sample	Additive	Dose (mg/L)	Turbidity (NTU) – surface	Turbidity (NTU) – ½ water column
WQC-0000-SW-N-20160802-0HR	None	None	91	72
WQC-0000-SW-N-20160803-24HR	None	None	51	61
WQC-0000-SW-N-20160804-48HR	None	None	54	55
WQC-0000-SW-N-20160805-72HR	None	None	53	52
WQC-0000-SW-N-20160807-120HR	None	None	39	39
WQC-0000-SW-N-20160809-168HR	None	None	37	38

mg/L = milligrams per liter
NTU = Nephelometric Turbidity Units

Prepared by: RGB2
Checked by: SVF

The COC's analytical results for the baseline sample testing are provided in Table A-1. The general chemistry analytical results for the baseline sample testing are provided in Table A-2.

The turbidity of the baseline water samples collected for the column testing was compared to the turbidity of water used during the bench tests to evaluate whether the water quality between the two tests were similar. No significant difference in turbidity was observed between the water samples used during bench and column testing activities. The initial turbidity reading from the bench testing was 95.1 NTU vs. 91 NTU for the column testing. Refer to Technical Memorandum #16-4, which provides a summary of the results of the bench testing performed.

Turbidity samples were collected every 24 hours from the baseline test column throughout the duration of the testing period. Following 168 hours of settling, the turbidity of the water decreased by approximately 54%. The observed reduction in turbidity was compared to the observed reduction of TSS. Over the course of the settling test, the baseline column TSS was observed to be reduced by over 89%.

As shown on Table A-1, within 72 hours, COC concentrations in the baseline column were observed to reduce from 76 to 83%. At the completion of the testing period, COC reductions over 88% were observed in the baseline column. A total of four COC compounds were detected in the 168-hour samples. This indicates these compounds may be dissolved in solution or adsorbed on very fine particles which require longer periods in order to settle. Benzo(a)pyrene and benzo(b)fluoranthene remained at levels above the project water quality standard throughout the entire test.

The analytical results indicate that settling times greater than 168 hours could be needed to settle very fine or colloidal solids without the addition of PAC or alum. In addition, COCs that may be dissolved or associated with non-settleable solids could remain in the water column above the project water quality standards for an extended period of time without the addition of PAC or alum.

PAC Column Settling Test

The initial column fill procedure used above was followed in preparing the PAC column test. However, once the column was filled with water approximately 51 grams (equivalent to 750 parts per million [ppm]) of PAC was added to the column. Following addition of PAC to the test column, the air used to maintain solids in suspension during the initial filling of the column was removed; and the first set of samples were collected starting the testing period.

Initial samples were collected at every 0.5 foot of water depth for TSS and at the surface and one half water depth for the COCs and general chemistry parameters. This procedure was repeated at 1, 3, 24, 48, and 168 hours.

This column settling test was also completed in a climate controlled environment to simulate the effect cold water temperatures may have on the settling rate of solids. The temperature of the PAC dosed column was maintained between 8.2 and 11.5°C throughout the test period.

Results and Discussion

The following summary provides the results of column water turbidity in the PAC dosed column throughout the testing period.

Table 3

Column Settling Test Turbidity Results - PAC

Sample	Additive	Dose (mg/L)	Turbidity (NTU) – surface	Turbidity (NTU) – ½ water column
WQC-PC-SW-N-20160802-0HR	PAC	750	600	420
WQC-PC-SW-N-20160802-1HR	PAC	750	110	110
WQC-PC-SW-N-20160802-3HR	PAC	750	74	79
WQC-PC-SW-N-20160803-24HR	PAC	750	62	64
WQC-PC-SW-N-20160804-48HR	PAC	750	54	54
WQC-PC-SW-N-20160809-168HR	PAC	750	39	54

Prepared by: RGB2
Checked by: SVF

The analytical results for the COCs in the PAC sample testing are provided in Table A-3. The general chemistry analytical results for the baseline sample testing are provided in Table A-4.

The addition of the PAC significantly increased the initial turbidity of the water when compared to the baseline sample. At test completion, the surface sample turbidity reading was similar to the surface sample turbidity reading of the baseline sample. However, the turbidity reading collected at the 1-foot level of the PAC column was approximately 1.4 times higher when compared to the turbidity reading collected at 1 foot in the baseline sample. This observation is likely a result of entrainment of PAC that had settled in the column during collection of the 1-hour sample.

Two initial samples for COC analysis were collected from the column including one sample from the sampling port closest to air/water interface and one sample from the sampling port closest to one half water column depth. No COCs were detected in the initial surface sample after PAC addition; however, as the sample collection depth increased from the water surface the number and concentrations of COC's detected increased. This may be due to the PAC not having settled through the water column or having time to adsorb COC's. However, only benzo(a)pyrene and benzo(k)fluoranthene were detected at levels that exceeded project water quality standards.

After 48-hours settling time, benzo(k)fluoranthene was the only COC detected at levels exceeding project water quality standards. No additional COC samples were analyzed until the completion of the 168-hour settling period. At the end of the 168-hour settling period, no COCs were detected in the sample.

The analytical results indicate that the addition of 750-ppm PAC will reduce COCs to meet the project water quality standards within 168 hours settling time.

PAC with Delayed Alum Column Settling Test

The initial column fill procedure used in preparing the PAC column test above was followed when preparing the PAC with delayed alum addition column. Approximately 26 grams (equivalent to 385 ppm) of PAC was added to the column. Following addition of PAC to the test column, the air used to maintain solids in suspension during the initial filling of the column was removed and the first set of TSS samples were collected starting the testing period. A 10-ppm dose of alum was added to the column 24 hours following the start of the test. Prior to the addition of alum, air was added to the column for approximately 15 seconds to provide mixing of the alum and the column water sample.

Initial samples were collected for TSS at the initial dose of PAC every 0.5 foot of water depth. Following alum addition, samples were collected at every 0.5-foot of water depth for TSS and at the surface and one half water depth for the COCs and general chemistry parameters. This procedure was repeated at 0.5, 1, 3, and 48 hours after alum addition to the column.

Similar to the previous column tests, the PAC with delayed alum addition column settling test was completed in a climate controlled environment to simulate the effect cold water temperatures may have on the settling rate of solids. The temperature of the PAC dosed column was maintained between 10 and 16.6°C throughout the test period.

Results and Discussion

The following summary provides the results of column water turbidity in the PAC with delayed alum dosed column throughout the testing period.

Table 4

Column Settling Test Turbidity Results – PAC with Alum

Sample	Additive	Dose (mg/L)	Turbidity (NTU) – surface	Turbidity (NTU) – ½ water column
WQC-MX-4010-SW-N-20160812-24HR	PAC Alum	385 10	34	51
WQC-MX-4010-SW-N-20160812-24.5HR	PAC Alum	385 10	17	23
WQC-MX-4010-SW-N-20160812-25HR	PAC Alum	385 10	8.2	12
WQC-MX-4010-SW-N-20160812-27HR	PAC Alum	385 10	5.9	7.3
WQC-MX-4010-SW-N-20160812-48HR	PAC Alum	385 10	2.8	2.8

Prepared by: RGB2
Checked by: SVF

The COC analytical results for the PAC/alum sample testing are provided in Table A-5. The general chemistry analytical results for the baseline sample testing are provided in Table A-6.

Turbidity results collected during the 24-hour settling time for the PAC test can be used as a baseline for turbidity prior to addition of alum Since it is expected that the initial turbidity results (prior to alum addition) would be similar to those observed during the first 24-hour PAC setting test. Turbidity results, following addition of alum, were similar to the observed turbidity readings at the completion of both the baseline and PAC column test. However, within 1 hour of alum addition, turbidity readings averaged less than 10 NTU. In comparison, the turbidity at the 168-hour settling time of the baseline and PAC settling tests were 37.5 NTU and 46.5 NTU, respectively.

1-methylnaphthalene, 2-methylnaphthalene, benzo(a)anthracene, benzo(k)fluoranthene, chrysene, naphthalene, and phenanthrene were detected during only one of the 24.5-hour sampling events. Of these, benzo(k)fluoranthene and chrysene exceeded project water quality standards. In all, ten samples were collected and analyzed for COCs over a 48-hour settling period. Only one additional sample detected any of the COCs. All COCs after the 24-hour sampling event were less than the level of detection or significantly below project water quality standards.

Alkalinity samples were collected at 24 hours, 24.5 hours, 25 hours, 27 hours, and 48 hours. The average alkalinity prior to the addition of alum was 51.5 mg/L, similar to the other previously described column tests. The addition of alum reduced the alkalinity to an average of 46 mg/L, or a reduction of only 10%.

The analytical results indicate that addition of 385-ppm PAC followed 24 hours later by addition of alum will reduce COCs to meet the project water quality standards within 48 hours settling time.

Ex-Situ Testing

In addition to the in-situ options described above, the *WQ Work Plan* identified walnut shell filtration as a potential ex-situ option for evaluation. FE JV discussed application of walnut shell filtration technology for the water contained within the water quality barrier system with two suppliers of these systems, Filtra Systems and Siemens. FE JV also reviewed published literature on the technology. The typical application for walnut shell filtration has been the removal of free oils. The removal mechanism is coalescence of free oil on the surface of the walnut shell. Walnut shells have a weak affinity for oil and the oil is effectively removed from the surface of walnut shells with backwashing. Walnut shells will also remove suspended solids, however, suspended solids removal is poor in the absence of free oil. Typical applications for the technology are where the free oil concentrations are in the 5 milligrams per liter (mg/L) to 100 mg/L range.

Expected water quality data was supplied to Siemens based on field data collected as part of the ongoing Wet Dredge Pilot Study. Both free oil (as non-aqueous phase liquid [NAPL]) and suspended solids concentrations are well below the concentration ranges cited previously. Siemens stated in an email received on July 26, 2016 that they expected that walnut shell filtration would have little affinity for PAH or benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds in the absence of NAPL. Therefore, it was concluded that further consideration of walnut shell filtration technology was not warranted as the technology would not be effective in addressing water quality COC reduction based on specific conditions present in the Wet Dredge Pilot Study.

Recommendations

Based on bench tests, column settling tests, and ex-situ treatment evaluation, in-situ water quality improvement contingency measures have shown to be effective in achieving project water quality standards.

The recommended in-situ water quality improvement option is a combination addition of PAC followed by a delayed addition of alum. Bench testing indicated that a 400-ppm dose of PAC followed by a delayed dose of 25-ppm alum would achieve the project water quality standards. This dosage was replicated in the subsequent column settling test with the addition of 385-ppm PAC followed 24 hours later with a 10-ppm dose of alum. In both cases, COC levels were reduced to levels less than the level of detection, or significantly below project water quality standards, and turbidity readings were less than 2.8 NTU within 48 hours settling time.

Bench and column settling tests indicate the addition of PAC alone may achieve project water quality standards. However, it does appear that the cooler water temperatures may have some negative impact in the settling rate of solids. The settling rate of the PAC dosed column was estimated by observing the amount of time the TSS concentrations exceeded the initial background TSS level recorded in the baseline column settling test composite sample. It was assumed that the increase in TSS concentration was a result of the PAC addition to the column. TSS concentrations were observed to equal the background concentrations following 24 hours of settling time. The settling time was then divided by the initial height of liquid in the column to obtain a settling rate of 0.000069 feet per second (ft/sec). This settling rate was compared to the settling results observed for PAC during bench testing. Bench test observations recorded a PAC settling rate of 0.0016 ft/sec. This would indicate a decrease in the rate of settling of over 95% due to the cooler water temperatures. A decreased settling rate may delay removal of the water quality barrier system installed to manage TSS and COC concentrations.

The addition of alum was shown to enhance the settleability of solids during bench testing. This observation was corroborated in the column tests by comparing the solids settling rates estimated from the PAC column test to the settling rates estimated following the addition of alum in the PAC with the delayed alum addition column test. The solid settling rate following addition of alum was estimated using the method used above to estimate the settling rate of solids from the PAC column test. TSS concentrations were less than background TSS levels within 1 hour. This resulted in an estimated settling rate of 0.0016 ft/sec which is a significant improvement to PAC addition alone.

Field conditions will not directly mimic lab column settling conditions, so it is expected that some variability in results will be encountered. Therefore, it is recommended that jar tests be performed at varying alum doses prior to alum application during any contingency implementation. It is recommended that approximately four jar tests be performed at 10, 15, 25, and 50 mg/L dosages. The jar tests should be allowed to settle for 1 hour and a turbidity sample taken from each test for field analysis. The dose determined to be the most effective should be the dose applied in the field.

The PAC and alum effectiveness in reducing TSS and COCs is clear and is expected to be a positive enhancement to the natural settling that is occurring at the site. The multi-barrier system will provide a relatively quiescent area as witnessed during the conduct of the Pilot Study work which should be similar to the column settling test environment.

Based on the results of the in-situ options evaluated as well as the lack of applicability to this project for walnut shell filtration technology, no further testing of walnut shell filtration is warranted.

Application

The Wet Dredge Pilot Study tertiary barrier encompasses an approximate 194,000 square foot portion of the Phase 2 remedial area. Water depth ranges from 0 (along the shoreline) to approximately 11 feet (post-dredge depth in the Pilot dredge areas).

PAC would be mixed with water and applied within the tertiary barrier areas a slurry behind a work boat. No direct mixing will be applied but the boat motor and wave action will provide some mixing. The PAC slurry would be allowed to mix and settle for at least 24 hours after application and then the process would be repeated with the alum.

References

Foth Infrastructure & Environment/Envirocon Joint Venture, 2016a. *Water Quality Management Contingencies Work Plan for Wet Dredge Pilot Study*. July 2016.

Foth Infrastructure & Environment/Envirocon Joint Venture, 2016b. Technical Memorandum #16-4, “Bench Test Results from the Water Quality Management Contingencies Work Plan.” July 2016.

Attachment 1

Tables

Table A-1

VOC/SVOC Analytical Results Control Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160802-0HR-6'	WQC-0000-SW-N-20160802-0HR-4'	WQC-0000-SW-N-20160803-24HR-5'	WQC-0000-SW-N-20160803-24HR-2.5'	WQC-0000-SW-N-20160804-48HR-4'	WQC-0000-SW-N-20160804-48HR-2'	WQC-0000-SW-N-20160805-72HR-3.5'	WQC-0000-SW-N-20160805-72HR-1.5'	WQC-0000-SW-N-20160807-120HR-2.5'	WQC-0000-SW-N-20160807-120HR-1'	WQC-0000-SW-N-20160809-168HR-2'	WQC-0000-SW-N-20160809-168HR-1'
Sample Collection Height (ft):				6	4	5	2.5	4	2	3.5	1.5	2.5	1	2	1
Settle Time (hr):				0	0	24	24	48	48	72	72	120	120	168	168
Test Date:				8/2/2016	8/2/2016	8/3/2016	8/3/2016	8/4/2016	8/4/2016	8/5/2016	8/5/2016	8/7/2016	8/7/2016	8/9/2016	8/9/2016
			Units												
VOCs	1,2,4-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	1,3,5-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Benzene	0.34	mg/L	0.48JB*	**0.55JB***	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Ethylbenzene	14	mg/L	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
	Toluene	N/A	mg/L	0.31JB	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Xylene, m & p	N/A	mg/L	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38
	Xylenes (Total)	27	mg/L	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58
SVOCs	1-Methylnaphthalene	433	mg/L	0.048J	0.049J	<0.019	0.041J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	2-Methylnaphthalene	24.3	mg/L	0.09J	0.089J	<0.029	0.055J	<0.028	<0.028	<0.029	<0.028	<0.028	<0.028	<0.028	<0.029
	Acenaphthene	38	mg/L	0.064J	0.051J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Acenaphthylene	N/A	mg/L	0.16	0.150	0.055J	0.075J	<0.028	0.047J	<0.029	<0.028	<0.028	<0.028	<0.028	<0.029
	Anthracene	0.035	mg/L	**0.14**	**0.095J**	**0.041J**	**0.06J**	**0.046J**	<0.028	<0.029	<0.028	<0.028	<0.028	<0.028	<0.029
	Benzo(a)anthracene	0.025	mg/L	**0.35**	**0.35**	<0.019	**0.098**	**0.05J**	**0.053J**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(a)pyrene	0.003	mg/L	**0.49**	**0.48**	**0.098**	**0.19**	**0.086J**	**0.097**	**0.083J**	**0.094**	**0.068J**	**0.083J**	**0.033J**	<0.019
	Benzo(b)fluoranthene	0.003	mg/L	**0.47**	**0.46**	**0.12**	**0.19**	**0.095**	**0.10**	**0.086J**	**0.096**	**0.063J**	**0.08J**	**0.053J**	**0.052J**
	Benzo(e) pyrene	N/A	mg/L	0.40	0.40	0.098	0.18	0.083J	0.094	0.086J	0.093	0.069J	0.081J	<0.047	<0.048
	Benzo(g,h,i)perylene	7.64	mg/L	0.35	0.34	0.07J	0.16	0.066J	0.068J	0.059J	0.059J	0.049J	0.055J	<0.019	<0.019
	Benzo(k)fluoranthene	0.14	mg/L	**0.22**	**0.22**	0.05J	**0.14**	0.057J	0.073J	0.044J	0.049J	0.037J	0.04J	0.025J	0.022J
	Chrysene	0.07	mg/L	**0.25**	**0.25**	<0.019	**0.12**	0.065J	**0.072J**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzo(a,h)anthracene	0.003	mg/L	<0.019	**0.074J**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzofuran	N/A	mg/L	<0.048	<0.048	<0.048	<0.048	<0.047	<0.047	<0.048*	<0.047*	<0.047*	<0.047*	<0.047	<0.048
	Fluoranthene	1.9	mg/L	0.31	0.31	0.12	0.12	0.092J	0.077J	0.069J	0.066J	0.047J	0.056J	<0.028	<0.029
	Fluorene	N/A	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Indeno(1,2,3-cd)pyrene	0.03	mg/L	**0.24**	**0.22**	**0.046J**	**0.10**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Naphthalene	6.2	mg/L	0.078J	0.099	0.043JB	0.05JB	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Phenanthrene	3.6	mg/L	0.14B	0.14B	0.047J	0.077J	0.051	0.044J	<0.029	<0.028	<0.028	<0.028	<0.028	<0.029
	Pyrene	0.3	mg/L	**0.55**	**0.58**	0.13	0.23	0.13	0.14	0.098	0.097	0.071J	0.077J	<0.019	0.044J

Yellow highlighted and bold values indicate exceedance

Prepared by: RBG2
Checked by: SVF

J = Result is < the Reporting Limit but ≥ the Method Detection Limit and the concentration is an approximate value
B = Compound was found in the blank and sample
* (VOC) = RPD of the LCS and LCSD exceeds the control limits
* (SVOC) = LCS or LCSC is outside acceptance limits
µg/L = micrograms per liter
ft = feet
hr = hour
VOC = volatile organic compounds
SVOC = semi-volatile organic compounds
mg/L = milligrams per liter

Table A-2
General Chemistry Analytical Results - Control Sample
Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160802-0HR-6'	WQC-0000-SW-N-20160802-0HR-5.5'	WQC-0000-SW-N-20160802-0HR-5'	WQC-0000-SW-N-20160802-0HR-4.5'	WQC-0000-SW-N-20160802-0HR-4'	WQC-0000-SW-N-20160802-0HR-3.5'	WQC-0000-SW-N-20160802-0HR-3'	WQC-0000-SW-N-20160802-0HR-2.5'	WQC-0000-SW-N-20160802-0HR-2'
Sample Collection Height (ft):				6	5.5	5	4.5	4	3.5	3	2.5	2
Settle Time (hr):				0	0	0	0	0	0	0	0	0
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016
			Units									
General Chemistry	Aluminum	N/A	mg/L	1.0				0.94				
	Temperature, Field	N/A	°C	11.2				10.3				
	HEM	N/A	mg/L	<1.4				<1.4				
	Turbidity	N/A	NTU	91				72				
	Sulfide	N/A	mg/L	<0.70				<0.70				
	Organic Carbon, Dissolved	N/A	mg/L	3.2				3.1				
	Organic Carbon, Total	N/A	mg/L	2.7				2.6				
	Alkalinity	N/A	mg/L	53				50				
	Specific Conductance	N/A	µmhos-cm	120				130				
	Total Suspended Solids	N/A	mg/L	25	29	52	21	35	27	32	48	22
	pH	N/A	S.U.	7.53HF				7.76HF				
	Oxygen, Dissolved	N/A	mg/L	9.3				9.5				

Table A-2

General Chemistry Analytical Results - Control Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160802-0HR-1.5'	WQC-0000-SW-N-20160802-0HR-1'	WQC-0000-SW-N-20160803-24HR-5.5'	WQC-0000-SW-N-20160803-24HR-5'	WQC-0000-SW-N-20160803-24HR-4.5'	WQC-0000-SW-N-20160803-24HR-4'	WQC-0000-SW-N-20160803-24HR-3.5'	WQC-0000-SW-N-20160803-24HR-3'	WQC-0000-SW-N-20160803-24HR-2.5'
Sample Collection Height (ft):				1.5	1	5.5	5	4.5	4	3.5	3	2.5
Settle Time (hr):				0	0	24	24	24	24	24	24	24
Test Date:				8/2/2016	8/2/2016	8/3/2016	8/3/2016	8/3/2016	8/3/2016	8/3/2016	8/3/2016	8/3/2016
			Units									
General Chemistry	Aluminum	N/A	mg/L				0.47^					0.67^
	Temperature, Field	N/A	°C				10.8					10.7
	HEM	N/A	mg/L				<1.5					<1.4
	Turbidity	N/A	NTU				51					61
	Sulfide	N/A	mg/L				<0.70					<0.70
	Organic Carbon, Dissolved	N/A	mg/L				3.4					3.4
	Organic Carbon, Total	N/A	mg/L				2.6					2.6
	Alkalinity	N/A	mg/L				48					48
	Specific Conductance	N/A	µmhos-cm				130					130
	Total Suspended Solids	N/A	mg/L	110	69	10	7.0	10	14	14	34	11
	pH	N/A	S.U.				7.76HF					7.79HF
	Oxygen, Dissolved	N/A	mg/L				9.3					9.4

Table A-2

General Chemistry Analytical Results - Control Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160803-24HR-2'	WQC-0000-SW-N-20160803-24HR-1.5'	WQC-0000-SW-N-20160803-24HR-1'	WQC-0000-SW-N-20160804-48HR-4.5'	WQC-0000-SW-N-20160804-48HR-4'	WQC-0000-SW-N-20160804-48HR-3.5'	WQC-0000-SW-N-20160804-48HR-3'	WQC-0000-SW-N-20160804-48HR-2.5'	WQC-0000-SW-N-20160804-48HR-2'
Sample Collection Height (ft):				2	1.5	1	4.5	4	3.5	3	2.5	2
Settle Time (hr):				24	24	24	48	48	48	48	48	48
Test Date:				8/3/2016	8/3/2016	8/3/2016	8/4/2016	8/4/2016	8/4/2016	8/4/2016	8/4/2016	8/4/2016
			Units									
General Chemistry	Aluminum	N/A	mg/L					0.53^				0.62^
	Temperature, Field	N/A	°C					9.2				8.5
	HEM	N/A	mg/L					<1.4				<1.4
	Turbidity	N/A	NTU					54				11
	Sulfide	N/A	mg/L					<0.70				<0.70
	Organic Carbon, Dissolved	N/A	mg/L					3.1				3.1
	Organic Carbon, Total	N/A	mg/L					2.6				2.6
	Alkalinity	N/A	mg/L					49				51
	Specific Conductance	N/A	µmhos-cm					130				130
	Total Suspended Solids	N/A	mg/L	20	14	16	10	11	11	11	9.0	8.5
	pH	N/A	S.U.					7.77HF				7.76HF
	Oxygen, Dissolved	N/A	mg/L					8.5				8.6

Table A-2

General Chemistry Analytical Results - Control Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160804-48HR-1.5'	WQC-0000-SW-N-20160804-48HR-1'	WQC-0000-SW-N-20160805-72HR-4'	WQC-0000-SW-N-20160805-72HR-3.5'	WQC-0000-SW-N-20160805-72HR-3'	WQC-0000-SW-N-20160805-72HR-2.5'	WQC-0000-SW-N-20160805-72HR-2'	WQC-0000-SW-N-20160805-72HR-1.5'	WQC-0000-SW-N-20160805-72HR-1'
Sample Collection Height (ft):				1.5	1	4	3.5	3	2.5	2	1.5	1
Settle Time (hr):				48	48	72	72	72	72	72	72	72
Test Date:				8/4/2016	8/4/2016	8/5/2016	8/5/2016	8/5/2016	8/5/2016	8/5/2016	8/5/2016	8/5/2016
			Units									
General Chemistry	Aluminum	N/A	mg/L				0.62^				0.63^	
	Temperature, Field	N/A	°C				9.9				10.7	
	HEM	N/A	mg/L				<1.4				<1.4	
	Turbidity	N/A	NTU				53				52	
	Sulfide	N/A	mg/L				<0.70				<0.70	
	Organic Carbon, Dissolved	N/A	mg/L				3.2				3.0	
	Organic Carbon, Total	N/A	mg/L				2.5				2.5	
	Alkalinity	N/A	mg/L				48				50	
	Specific Conductance	N/A	µmhos-cm				140				130	
	Total Suspended Solids	N/A	mg/L	15	14	<5.0	9.0	8.0	7.0	6.0	8.5	6.0
	pH	N/A	S.U.				7.58HF				7.71HF	
	Oxygen, Dissolved	N/A	mg/L				8.3HF				8.3HF	

Table A-2

General Chemistry Analytical Results - Control Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-0000-SW-N-20160807-120HR-3'	WQC-0000-SW-N-20160807-120HR-2.5'	WQC-0000-SW-N-20160807-120HR-2'	WQC-0000-SW-N-20160807-120HR-1.5'	WQC-0000-SW-N-20160807-120HR-1'	WQC-0000-SW-N-20160809-168HR-2.5'	WQC-0000-SW-N-20160809-168HR-2'	WQC-0000-SW-N-20160809-168HR-1.5'	WQC-0000-SW-N-20160809-168HR-1'
Sample Collection Height (ft):				3	2.5	2	1.5	1	2.5	2	1.5	1
Settle Time (hr):				120	120	120	120	120	168	168	168	168
Test Date:				8/7/2016	8/7/2016	8/7/2016	8/7/2016	8/7/2016	8/9/2016	8/9/2016	8/9/2016	8/9/2016
			Units									
General Chemistry	Aluminum	N/A	mg/L		0.51^			0.52^		0.36^		0.38^
	Temperature, Field	N/A	°C		9.1			8.4		9.1		8.5
	HEM	N/A	mg/L		<1.4			<1.4		<1.4		<1.4
	Turbidity	N/A	NTU		39			39		37		38
	Sulfide	N/A	mg/L		<0.70			<0.70		<0.70		<0.70
	Organic Carbon, Dissolved	N/A	mg/L		2.9			2.9		2.8		2.9
	Organic Carbon, Total	N/A	mg/L		2.6			2.6		2.7		2.6
	Alkalinity	N/A	mg/L		51			52		52		54
	Specific Conductance	N/A	µmhos-cm		140			140		140		140
	Total Suspended Solids	N/A	mg/L	5.0	5.5	7.0	<5.0	4.5	<5.0	4.5	<5.0	<2.5
	pH	N/A	S.U.		7.6HF			7.9HF		7.8HF		7.7HF
	Oxygen, Dissolved	N/A	mg/L		9.8			10		8.1		8.1

Prepared by: RBG2
Checked by: SVF

ft = feet
hr = hour
µg/L = micrograms per liter
NT = not tested
NTU = nephelometric turbidity unit
µmhos-cm = microhms - centimeter
S.U. = standard units
°C = degree centigrade
mg/L = milligram per liter
HF = Field parameter with a holding time of 15 minutes. Test performed by lab at client's request
^ = Instrument-related QC is outside acceptance limits

Table A-3

VOC/SVOC Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)	Units	WQC-PC-8000-SW-N-20160802-0HR-6'	WQC-PC-8000-SW-N-20160802-0HR-4'	WQC-PC-8000-SW-N-20160802-1HR-5'	WQC-PC-8000-SW-N-20160802-1HR-3.5'	WQC-PC-8000-SW-N-20160802-3HR-4.5'	WQC-PC-8000-SW-N-20160802-3HR-2.5'	WQC-PC-8000-SW-N-20160803-24HR-3.5'	WQC-PC-8000-SW-N-20160803-24HR-2'	WQC-PC-8000-SW-N-20160804-48HR-3'	WQC-PC-8000-SW-N-20160804-48HR-1.5'	WQC-PC-8000-SW-N-20160809-168HR-2.0'	WQC-PC-8000-SW-N-20160809-168HR-1.0'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800	800	800	800	800
Sample Collection Height (ft):				6	4	5	3.5	4.5	2.5	3.5	2	3	1.5	2	1
Settle Time (hr):				0	0	1	1	3	3	24	24	48	48	168	168
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/3/2016	8/3/2016	8/4/2016	8/4/2016	8/9/2016	8/9/2016
			Units												
VOCs	1,2,4-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	1,3,5-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Benzene	0.34	mg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Ethylbenzene	14	mg/L	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
	Toluene	N/A	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Xylene, m & p	N/A	mg/L	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38
	Xylenes (Total)	27	mg/L	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58
SVOCs	1-Methylnaphthalene	433	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	2-Methylnaphthalene	24.3	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.028	<0.029	<0.028	<0.028	<0.028
	Acenaphthene	38	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Acenaphthylene	N/A	mg/L	<0.029	0.057J	<0.029	<0.029	<0.029	<0.029	<0.029	<0.028	<0.029	<0.028	<0.029	<0.028
	Anthracene	0.035	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.028	<0.029	<0.028	<0.029	<0.028
	Benzo(a)anthracene	0.025	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(a)pyrene	0.003	mg/L	<0.019	<0.019	**0.036J**	**0.063J**	<0.019	**0.039J**	<0.019	**0.021J**	<0.019	<0.019	<0.019	<0.019
	Benzo(b)fluoranthene	0.003	mg/L	<0.019	**0.042J**	**0.061J**	**0.087J**	**0.053J**	**0.071J**	**0.04J**	**0.046J**	**0.037J**	<0.019	<0.019	<0.019
	Benzo(e) pyrene	N/A	mg/L	<0.048	<0.048	<0.048	0.06J	<0.048	<0.048	<0.048	<0.047	<0.048	<0.047	<0.048	<0.047
	Benzo(g,h,i)perylene	7.64	mg/L	<0.019	<0.019	<0.019	0.056J	<0.019	0.034J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(k)fluoranthene	0.14	mg/L	<0.019	<0.019	0.019J	0.038J	<0.019	0.024J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Chrysene	0.07	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzo(a,h)anthracene	0.003	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzofuran	N/A	mg/L	<0.048	<0.048	<0.048	<0.049	<0.048	<0.048	<0.048	<0.047	<0.048	<0.047	<0.048	<0.047
	Fluoranthene	1.9	mg/L	<0.029	<0.029	<0.029	0.048J	<0.029	<0.029	<0.029	0.046J	<0.029	<0.028	<0.029	<0.028
	Fluorene	N/A	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Indeno(1,2,3-cd)pyrene	0.03	mg/L	<0.019	<0.019	<0.019	**0.042J**	<0.019	0.029J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Naphthalene	6.2	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Phenanthrene	3.6	mg/L	<0.029	<0.029	0.092JB	0.035JB	<0.029	<0.029	<0.029	0.055J	0.073J	<0.028	<0.029	<0.028
	Pyrene	0.3	mg/L	<0.019	<0.019	0.052J	J	<0.019	<0.019	<0.019	0.045J	<0.019	<0.019	<0.019	<0.019

Yellow highlighted and bold values indicate exceedance

Prepared by: RBG2
Checked by: SVF

J = Result is < the Reporting Limit but ≥ the Method Detection Limit and the concentration is an approximate value
B = Compound was found in the blank and sample
* (VOC) = RPD of the LCS and LCSD exceeds the control limits
* (SVOC) = LCS or LCSC is outside acceptance limits
µg/L = micrograms per liter
ppm = parts per million
ft = feet
hr = hour
VOC = volatile organic compounds
SVOC = semi-volatile organic compounds
mg/L = milligrams per liter

Table A-4

VOC/SVOC General Chemistry Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000--SW-N-20160802-0HR-6'	WQC-PC-8000-SW-N-20160802-0HR-5.5'	WQC-PC-8000-SW-N-20160802-0HR-5'	WQC-PC-8000-SW-N-20160802-0HR-4.5'	WQC-PC--8000-SW-N-20160802-0HR-4'	WQC-PC-8000-SW-N-20160802-0HR-3.5'	WQC-PC-8000-SW-N-20160802-0HR-3'	WQC-PC-8000-SW-N-20160802-0HR-2.5'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800
Sample Collection Height (ft):				6	5.5	5	4.5	4	3.5	3	2.5
Settle Time (hr):				0	0	0	0	0	0	0	0
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L	12				7.3			
	Temperature, Field	N/A	°C	8.9				8.7			
	HEM	N/A	mg/L	<1.5				<1.5			
	Turbidity	N/A	NTU	600				420			
	Sulfide	N/A	mg/L	<0.70				<0.70			
	Organic Carbon, Dissolved	N/A	mg/L	0.78J				0.76J			
	Organic Carbon, Total	N/A	mg/L	<0.50				<0.50			
	Alkalinity	N/A	mg/L	59				54			
	Specific Conductance	N/A	µmhos-cm	140				130			
	Total Suspended Solids	N/A	mg/L	3300	1600	1200	1300	1700	1000	1100	660
	pH	N/A	S.U.	8.21HF				8.11HF			
	Oxygen, Dissolved	N/A	mg/L	8.3				8.9			

Table A-4

VOC/SVOC General Chemistry Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000-SW-N-20160802-0HR-2'	WQC-PC-8000-SW-N-20160802-0HR-1.5'	WQC-PC-8000-SW-N-20160802-0HR-1.0'	WQC-PC-8000-SW-N-20160802-1HR-5.5'	WQC-PC-8000-SW-N-20160802-1HR-5'	WQC-PC-8000-SW-N-20160802-1HR-4.5'	WQC-PC-8000-SW-N-20160802-1HR-4.0'	WQC-PC-8000-SW-N-20160802-1HR-3.5'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800
Sample Collection Height (ft):				2	1.5	1	5.5	5	4.5	4	3.5
Settle Time (hr):				0	0	0	1	1	1	1	1
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L					1.1			1.2
	Temperature, Field	N/A	°C					10.0			8.8
	HEM	N/A	mg/L					<1.4			<1.4
	Turbidity	N/A	NTU					110			110
	Sulfide	N/A	mg/L					<0.70			7.4
	Organic Carbon, Dissolved	N/A	mg/L					1.2			0.98J
	Organic Carbon, Total	N/A	mg/L					<0.50			<0.50
	Alkalinity	N/A	mg/L					50			53
	Specific Conductance	N/A	µmhos-cm					130			120
	Total Suspended Solids	N/A	mg/L	660	440	430	10	120	200	190	130
	pH	N/A	S.U.					7.89HF			7.93HF
	Oxygen, Dissolved	N/A	mg/L					10			9.9

Table A-4

VOC/SVOC General Chemistry Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000-SW-N-20160802-1HR-3.0'	WQC-PC-8000-SW-N-20160802-1HR-2.5'	WQC-PC-8000-SW-N-20160802-1HR-2.0'	WQC-PC-8000-SW-N-20160802-1HR-1.5'	WQC-PC-8000-SW-N-20160802-1HR-1.0'	WQC-PC-8000-SW-N-20160802-3HR-5.0'	WQC-PC-8000-SW-N-20160802-3HR-4.5'	WQC-PC-8000-SW-N-20160802-3HR-4.0'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800
Sample Collection Height (ft):				3	2.5	2	1.5	1	5	4.5	4
Settle Time (hr):				1	1	1	1	1	3	3	3
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L							0.62	
	Temperature, Field	N/A	°C							11.5	
	HEM	N/A	mg/L							<1.5	
	Turbidity	N/A	NTU							74	
	Sulfide	N/A	mg/L							<0.70	
	Organic Carbon, Dissolved	N/A	mg/L							0.95J	
	Organic Carbon, Total	N/A	mg/L							<0.50	
	Alkalinity	N/A	mg/L							50	
	Specific Conductance	N/A	µmhos-cm							130	
	Total Suspended Solids	N/A	mg/L	290	170	180	150	290	34	39	82
	pH	N/A	S.U.							7.97HF	
	Oxygen, Dissolved	N/A	mg/L							10	

Table A-4

VOC/SVOC General Chemistry Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000-SW-N-20160802-3HR-3.5'	WQC-PC-8000-SW-N-20160802-3HR-3.0'	WQC-PC-8000-SW-N-20160802-3HR-2.5'	WQC-PC-8000-SW-N-20160802-3HR-2.0'	WQC-PC-8000-SW-N-20160802-3HR-1.5'	WQC-PC-8000-SW-N-20160802-3HR-1'	WQC-PC-8000-SW-N-20160803-24HR-4'	WQC-PC-8000-SW-N-20160803-24HR-3.5'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800
Sample Collection Height (ft):				3.5	3	2.5	2	1.5	1	4	3.5
Settle Time (hr):				3	3	3	3	3	3	24	24
Test Date:				8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/2/2016	8/3/2016	8/3/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L			0.84					0.40^
	Temperature, Field	N/A	°C			11.4					9.8
	HEM	N/A	mg/L			<1.4					<1.4
	Turbidity	N/A	NTU			79					62
	Sulfide	N/A	mg/L			<0.70					<0.70
	Organic Carbon, Dissolved	N/A	mg/L			1.1					1.1
	Organic Carbon, Total	N/A	mg/L			<0.50					<0.50
	Alkalinity	N/A	mg/L			51					50
	Specific Conductance	N/A	µmhos-cm			130					120
	Total Suspended Solids	N/A	mg/L	68	120	69	92	78	96	30	23
	pH	N/A	S.U.			7.99HF					7.99HF
	Oxygen, Dissolved	N/A	mg/L			10					9.1

Table A-4
VOC/SVOC General Chemistry Analytical Results PAC Sample
Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000-SW-N-20160803-24HR-3'	WQC-PC-8000-SW-N-20160803-24HR-2.5'	WQC-PC-8000-SW-N-20160803-24HR-2'	WQC-PC-8000-SW-N-20160803-24HR-1.5'	WQC-PC-8000-SW-N-20160803-24HR-1'	WQC-PC-8000-SW-N-20160804-48HR-3.5'	WQC-PC-8000-SW-N-20160804-48HR-3'	WQC-PC-8000-SW-N-20160804-48HR-2.5'
Carbon Dose (ppm):				800	800	800	800	800	800	800	800
Sample Collection Height (ft):				3	2.5	2	1.5	1	3.5	3	2.5
Settle Time (hr):				24	24	24	24	24	48	48	48
Test Date:				8/3/2016	8/3/2016	8/3/2016	8/3/2016	8/3/2016	8/4/2016	8/4/2016	8/4/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L			0.45^				0.41^	
	Temperature, Field	N/A	°C			9.7				9.3	
	HEM	N/A	mg/L			<1.4				<1.4	
	Turbidity	N/A	NTU			64				54	
	Sulfide	N/A	mg/L			<0.70				<0.70	
	Organic Carbon, Dissolved	N/A	mg/L			1.2				0.96J	
	Organic Carbon, Total	N/A	mg/L			0.57J				<0.50	
	Alkalinity	N/A	mg/L			52				51	
	Specific Conductance	N/A	µmhos-cm			130				130	
	Total Suspended Solids	N/A	mg/L	50	24	26	20	36	9.0	15	12
	pH	N/A	S.U.			7.94HF				7.87HF	
	Oxygen, Dissolved	N/A	mg/L			9.1				8.1	

Table A-4

VOC/SVOC General Chemistry Analytical Results PAC Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-PC-8000-SW-N-20160804-48HR-2'	WQC-PC-8000-SW-N-20160804-48HR-1.5'	WQC-PC-8000-SW-N-20160804-48HR-1.5'	WQC-PC-8000-SW-N-20160809-168HR-2.5'	WQC-PC-8000-SW-N-20160809-168HR-2'	WQC-PC-8000-SW-N-20160809-168HR-1.5'	WQC-PC-8000-SW-N-20160809-168HR-1'
Carbon Dose (ppm):				800	800	800	800	800	800	800
Sample Collection Height (ft):				2	1.5	1.5	2.5	2	1.5	1
Settle Time (hr):				48	48	48	168	168	168	168
Test Date:				8/4/2016	8/4/2016	8/4/2016	8/9/2016	8/9/2016	8/9/2016	8/9/2016
			Units							
General Chemistry	Aluminum	N/A	mg/L		0.34^			0.26^		0.22^
	Temperature, Field	N/A	°C		8.7			8.3		8.2
	HEM	N/A	mg/L		<1.4			<1.4		<1.4
	Turbidity	N/A	NTU		54			39		54
	Sulfide	N/A	mg/L		<0.70			<0.70		<0.70F1
	Organic Carbon, Dissolved	N/A	mg/L		0.86J			1.0		0.84J
	Organic Carbon, Total	N/A	mg/L		<0.50			<0.50		<0.50
	Alkalinity	N/A	mg/L		52			52		52
	Specific Conductance	N/A	µmhos-cm		130			130		130
	Total Suspended Solids	N/A	mg/L	15	15	19	5.0	10	7.0	8.0
	pH	N/A	S.U.		7.94HF			7.7HF		7.6HF
	Oxygen, Dissolved	N/A	mg/L		8.1			8.0		8.1

Prepared by: RBG2
Checked by: SVF

ppm = parts per million
ft = feet
hr = hour
µg/L = micrograms per liter
J = Result is < the Reporting Limit but ≥ the Method Detection Limit and the concentration is an approximate value
NT = not tested
NTU = nephelometric turbidity unit
µmhos-cm = microhms - centimeter
S.U. = standard units
°C = degree centigrade
mg/L = milligram per liter
HF = Field parameter with a holding time of 15 minutes. Test performed by lab at client's request
^ = Instrument-related QC is outside acceptance limits

Table A-5
VOC/SVOC Analytical Results PAC/Alum Sample
Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160813-24HR-6'	WQC-MX-4010-SW-N-20160813-24HR-3'	WQC-MX-4010-SW-N-20160813-24.5HR-5'	WQC-MX-4010-SW-N-20160813-24.5HR-2.5'	WQC-MX-4010-SW-N-20160813-25HR-4.5'	WQC-MX-4010-SW-N-20160813-25HR-2.5'	WQC-MX-4010-SW-N-20160813-27HR-3.5'	WQC-MX-4010-SW-N-20160813-27HR-1.5'	WQC-MX-4010-SW-N-20160813-48HR-2.5'	WQC-MX-4010-SW-N-20160813-48HR-1'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100	100	100
Sample Collection Height (ft):				6	3	5	2.5	4.5	2.5	3.5	1.5	2.5	1
Settle Time (hr)[1]:				24	24	24	24.5	25	25	27	27	48	48
Test Date:				8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/14/2016	8/14/2016
			Units										
VOCs	1,2,4-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	1,3,5-Trimethylbenzene	12.3	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Benzene	0.34	mg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Ethylbenzene	14	mg/L	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
	Toluene	N/A	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17
	Xylene, m & p	N/A	mg/L	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38
	Xylenes (Total)	27	mg/L	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58
SVOCs	1-Methylnaphthalene	433	mg/L	<0.019	<0.019	<0.019	0.041J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	2-Methylnaphthalene	24.3	mg/L	<0.029	<0.029	<0.029	0.076J	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029
	Acenaphthene	38	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Acenaphthylene	N/A	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029
	Anthracene	0.035	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029
	Benzo(a)anthracene	0.025	mg/L	<0.019	<0.019	<0.019	0.021J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(a)pyrene	0.003	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(b)fluoranthene	0.003	mg/L	<0.019	<0.019	<0.019	**0.034J**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(e) pyrene	N/A	mg/L	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
	Benzo(g,h,i)perylene	7.64	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Benzo(k)fluoranthene	0.14	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Chrysene	0.07	mg/L	<0.019	<0.019	<0.019	**0.22J**	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzo(a,h)anthracene	0.003	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Dibenzofuran	N/A	mg/L	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
	Fluoranthene	1.9	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029
	Fluorene	N/A	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Indeno(1,2,3-cd)pyrene	0.03	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Naphthalene	6.2	mg/L	<0.019	<0.019	<0.019	0.087J	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
	Phenanthrene	3.6	mg/L	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	<0.029	0.065J	<0.029
	Pyrene	0.3	mg/L	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019

[1] Alum added 24 hours following initial setup and carbon dose.

Yellow highlighted and bold values indicate exceedance

Prepared by: RBG2
Checked by: SVF

J = Result is < the Reporting Limit but ≥ the Method Detection Limit and the concentration is an approximate value
B = Compound was found in the blank and sample
* (VOC) = RPD of the LCS and LCSD exceeds the control limits
* (SVOC) = LCS or LCSC is outside acceptance limits
µg/L = micrograms per liter
ppm = parts per million
ft = feet
hr = hour
VOC = volatile organic compounds
SVOC = semi-volatile organic compounds
mg/L = milligrams per liter

Table A-6

General Chemistry Analytical Results PAC with Delayed Alum Addition Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160812-0HR-6'	WQC-MX-4010-SW-N-20160812-0HR-5.5'	WQC-MX-4010-SW-N-20160812-0HR-5'	WQC-MX-4010-SW-N-20160812-0HR-4.5'	WQC-MX-4010-SW-N-20160812-0HR-4'	WQC-MX-4010-SW-N-20160812-0HR-3.5'	WQC-MX-4010-SW-N-20160812-0HR-3'	WQC-MX-4010-SW-N-20160812-0HR-2.5'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				6	5.5	5	4.5	4	3.5	3	2.5
Settle Time (hr)[1]:				0	0	0	0	0	0	0	0
Test Date:				8/12/2016	8/12/2016	8/12/2016	8/12/2016	8/12/2016	8/12/2016	8/12/2016	8/12/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L								
	Temperature, Field	N/A	°C								
	HEM	N/A	mg/L								
	Turbidity	N/A	NTU								
	Sulfide	N/A	mg/L								
	Organic Carbon, Dissolved	N/A	mg/L								
	Organic Carbon, Total	N/A	mg/L								
	Alkalinity	N/A	mg/L								
	Specific Conductance	N/A	mmhos-cm								
	Total Suspended Solids	N/A	mg/L	490	400	410	420	450	470	480	540
	pH	N/A	S.U.								
	Oxygen, Dissolved	N/A	mg/L								

[1] Alum added 24 hours following initial setup and carbon dose.

Table A-6

General Chemistry Analytical Results PAC with Delayed Alum Addition Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160812-0HR-2'	WQC-MX-4010-SW-N-20160812-0HR-1.5'	WQC-MX-4010-SW-N-20160812-0HR-1'	WQC-MX-4010-SW-N-20160813-24HR-6'	WQC-MX-4010-SW-N-20160813-24HR-5'	WQC-MX-4010-SW-N-20160813-24HR-4.5'	WQC-MX-4010-SW-N-20160813-24HR-4'	WQC-MX-4010-SW-N-20160813-24HR-3.5'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				2	1.5	1	6	5	4.5	4	3.5
Settle Time (hr)[1]:				0	0	0	24	24	24	24	24
Test Date:				8/12/2016	8/12/2016	8/12/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L				0.31				
	Temperature, Field	N/A	°C				16.6				
	HEM	N/A	mg/L				ND				
	Turbidity	N/A	NTU				34				
	Sulfide	N/A	mg/L				ND				
	Organic Carbon, Dissolved	N/A	mg/L				1.2				
	Organic Carbon, Total	N/A	mg/L				0.59J				
	Alkalinity	N/A	mg/L				51				
	Specific Conductance	N/A	mmhos-cm				130				
	Total Suspended Solids	N/A	mg/L	540	540	560	6.5	50	66	56	48
	pH	N/A	S.U.				7.8				
	Oxygen, Dissolved	N/A	mg/L				8.7				

[1] Alum added 24 hours following initial setup and carbon dose.

Table A-6
General Chemistry Analytical Results PAC with Delayed Alum Addition Sample
Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160813-24HR-3'	WQC-MX-4010-SW-N-20160813-24HR-2.5'	WQC-MX-4010-SW-N-20160813-24HR-2'	WQC-MX-4010-SW-N-20160813-24HR-1.5'	WQC-MX-4010-SW-N-20160813-24HR-1'	WQC-MX-4010-SW-N-20160813-24.5HR-5'	WQC-MX-4010-SW-N-20160813-24.5HR-4.5'	WQC-MX-4010-SW-N-20160813-24.5HR-4'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				3	2.5	2	1.5	1	5	4.5	4
Settle Time (hr)[1]:				24	24	24	24	24	24.5	24.5	24.5
Test Date:				8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L	0.57					0.59		
	Temperature, Field	N/A	°C	11.9					13		
	HEM	N/A	mg/L	ND					ND		
	Turbidity	N/A	NTU	51					17		
	Sulfide	N/A	mg/L	ND					ND		
	Organic Carbon, Dissolved	N/A	mg/L	1					0.98J		
	Organic Carbon, Total	N/A	mg/L	ND					ND		
	Alkalinity	N/A	mg/L	52					48		
	Specific Conductance	N/A	mmhos-cm	130					130		
	Total Suspended Solids	N/A	mg/L	25	70	110	100	60	30	78	68
	pH	N/A	S.U.	7.9					7.6		
	Oxygen, Dissolved	N/A	mg/L	8.9					8.8		

[1] Alum added 24 hours following initial setup and carbon dose.

Table A-6

General Chemistry Analytical Results PAC with Delayed Alum Addition Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160813-24.5HR-3.5'	WQC-MX-4010-SW-N-20160813-24.5HR-3'	WQC-MX-4010-SW-N-20160813-24.5HR-2.5'	WQC-MX-4010-SW-N-20160813-24.5HR-2'	WQC-MX-4010-SW-N-20160813-24.5HR-1.5'	WQC-MX-4010-SW-N-20160813-24.5HR-1'	WQC-MX-4010-SW-N-20160813-25HR-4.5'	WQC-MX-4010-SW-N-20160813-25HR-3.5'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				3.5	3	2.5	2	1.5	1	4.5	3.5
Settle Time (hr)[1]:				24.5	24.5	24.5	24.5	24.5	24.5	25	25
Test Date:				8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L			0.71				0.38	
	Temperature, Field	N/A	°C			11.6				12.6	
	HEM	N/A	mg/L			ND				ND	
	Turbidity	N/A	NTU			23				8.2	
	Sulfide	N/A	mg/L			ND				ND	
	Organic Carbon, Dissolved	N/A	mg/L			0.92J				1.7	
	Organic Carbon, Total	N/A	mg/L			ND				ND	
	Alkalinity	N/A	mg/L			45				42	
	Specific Conductance	N/A	mmhos-cm			130				130	
	Total Suspended Solids	N/A	mg/L	78	84	54	110	64	130	9.5	18
	pH	N/A	S.U.			7.6				7.6	
	Oxygen, Dissolved	N/A	mg/L			8.7				8.6	

[1] Alum added 24 hours following initial setup and carbon dose.

Table A-6

General Chemistry Analytical Results PAC with Delayed Alum Addition Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160813-25HR-3'	WQC-MX-4010-SW-N-20160813-25HR-2.5'	WQC-MX-4010-SW-N-20160813-25HR-2'	WQC-MX-4010-SW-N-20160813-25HR-1.5'	WQC-MX-4010-SW-N-20160813-25HR-1'	WQC-MX-4010-SW-N-20160813-27HR-3.5'	WQC-MX-4010-SW-N-20160813-27HR-3.0'	WQC-MX-4010-SW-N-20160813-27HR-2.5'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				3	2.5	2	1.5	1	3.5	3	2.5
Settle Time (hr)[1]:				25	25	25	25	25	27	27	27
Test Date:				8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016	8/13/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L		0.48				0.33		
	Temperature, Field	N/A	°C		11.8				12.5		
	HEM	N/A	mg/L		ND				ND		
	Turbidity	N/A	NTU		12				5.9		
	Sulfide	N/A	mg/L		ND				ND		
	Organic Carbon, Dissolved	N/A	mg/L		1.1				1.1		
	Organic Carbon, Total	N/A	mg/L		ND				ND		
	Alkalinity	N/A	mg/L		47				45		
	Specific Conductance	N/A	mmhos-cm		130				130		
	Total Suspended Solids	N/A	mg/L	20	20	23	26	26	4.5	7	5
	pH	N/A	S.U.		7.6				7.5		
	Oxygen, Dissolved	N/A	mg/L		8.4				8.7		

[1] Alum added 24 hours following initial setup and carbon dose.

Table A-6

General Chemistry Analytical Results PAC with Delayed Alum Addition Sample

Phase 2 Contingency Testing - Column Settling Testing

Sample ID:		Project Water Quality Standard (µg/L)		WQC-MX-4010-SW-N-20160813-27HR-2'	WQC-MX-4010-SW-N-20160813-27HR-1.5'	WQC-MX-4010-SW-N-20160813-27HR-1'	WQC-MX-4010-SW-N-20160813-48HR-3'	WQC-MX-4010-SW-N-20160813-48HR-2.5'	WQC-MX-4010-SW-N-20160813-48HR-2'	WQC-MX-4010-SW-N-20160813-48HR-1.5'	WQC-MX-4010-SW-N-20160813-48HR-1'
Carbon Dose (ppm):				400	400	400	400	400	400	400	400
Alum Dose (ppm):				100	100	100	100	100	100	100	100
Sample Collection Height (ft):				2	1.5	1	3	2.5	2	1.5	1
Settle Time (hr)[1]:				27	27	27	48	48	48	48	48
Test Date:				8/13/2016	8/13/2016	8/13/2016	8/14/2016	8/14/2016	8/14/2016	8/14/2016	8/14/2016
			Units								
General Chemistry	Aluminum	N/A	mg/L		0.37			0.25			0.25
	Temperature, Field	N/A	°C		11.8			10			10.2
	HEM	N/A	mg/L		ND			ND			ND
	Turbidity	N/A	NTU		7.3			2.8			2.8
	Sulfide	N/A	mg/L		ND			ND			ND
	Organic Carbon, Dissolved	N/A	mg/L		1.2			1			0.98J
	Organic Carbon, Total	N/A	mg/L		ND			ND			ND
	Alkalinity	N/A	mg/L		47			45			47
	Specific Conductance	N/A	mmhos-cm		130			130			130
	Total Suspended Solids	N/A	mg/L	10	11	7	ND	3.6	ND	ND	2.3
	pH	N/A	S.U.		7.6			7.4			7.6
	Oxygen, Dissolved	N/A	mg/L		8.9			8.5			8.3

[1] Alum added 24 hours following initial setup and carbon dose.

Prepared by: RBG2
Checked by: SVF

ppm = parts per million
ft = feet
hr = hour
µg/L = micrograms per liter
J = Result is < the Reporting Limit but ≥ the Method Detection Limit and the concentration is an approximate value
NT = not tested
NTU = nephelometric turbidity unit
µmhos-cm = microhms - centimeter
S.U. = standard units
°C = degree centigrade
mg/L = milligram per liter
HF = Field parameter with a holding time of 15 minutes. Test performed by lab at client's request
^ = Instrument-related QC is outside acceptance limits

Inman, Scott T - DNR

From: Roznowski, Denis M <Denis.Roznowski@Foth.com>
Sent: Monday, October 24, 2016 8:32 AM
To: Hansen, Scott; Dunn, James R - DNR
Cc: Inman, Scott T - DNR; Brown, Adam; Ealy, Eric J; Aukerman, Ken; Laszewski, Steve; Alan Buell; Brad Hay; Brian Bell (bbell@envirocon.com); Summers, Keith J; Van Hoof, Tara M; Garbaciak Jr., Steve; Kozicki, Sharon V F; Onderko, Richard R; Core, Alyssa M - DNR; Burton, Jim; Schuh, Beth M; Coss, Terry E (terry.e.coss@xcelenergy.com); Carney, Kristen S; Jennifer.Casler@lw.com; Laszewski, Steve; Mike Palmer (mpalmer@demaximis.com) (mpalmer@demaximis.com) (mpalmer@demaximis.com)
Subject: RE: Implementation of Water Quality Management Contingency
Attachments: Post Construction Monitoring and Sampling Locations Map.pdf; 490-114255-1Ashland_PhaseIIW.XLSX; 490-114482-1Ashland_PhaseIIW.XLSX

Scott/Jamie,

Alum addition within the primary barrier system occurred on October 20. The reduction in turbidity resulting from the alum treatment was consistent with the lab testing work, and turbidity within the primary curtain has dropped to single digits, with values typically equal to or lower than our background monitoring location. See table of results. PC-1, PC-2 and PC-3 locations are inside the primary barrier as described in *Monitoring Plan* Section 2.8.2, and as shown on the attached figure.

	AVERAGE TURBIDITY RESULTS (NTU)						
DATE/TIME	**BM**	**PC-1**	**DELTA**	**PC-2**	**DELTA**	**PC-3**	**DELTA**
10/20/16 (PRE-ALUM)	6.1	43.9	**37.8**	44.3	**38.2**	43.5	**37.4**
10/20/16 (POST-ALUM)	5.3	15.4	10.1	15.5	10.2	14.6	9.3
10/21/16	4.2	1.8		2.1		1.7	
10/22/16	3.6	1.1		1.0		1.1	

We will perform another round of in-situ measurements within the primary barrier system this morning to confirm site conditions.

Based on these result, FE JV will commence removing the primary and secondary barriers on October 24 and complete that activity by October 26, consistent with the approved *Monitoring Plan*.

Following removal of the primary and secondary barriers, FE JV also proposes to immediately remove the rock protection barriers. We will continue to monitor visually for sheens during on the water activities and mop up any sheens in accordance with the *Monitoring Plan.*

As another point of information, Performance Monitoring results for COCs collected outside the tertiary barrier and at the gaps (PM 1 thru 5) on Oct 18 and 20 (final lab report, not yet validated) show no COCs above water quality standards (see attached draft tables).

FE JV has decided to keep the full tertiary barrier system in place through winter to address the Agencies request in the Permit Equivalency Amendment for the alum addition.

We will collect post-construction water quality samples from within the tertiary barrier late this week (Thursday Oct 27 planned). Upon receipt of those results we will discuss them with the Agencies and take appropriate actions consistent with the *Monitoring Plan,* removing the gap barriers when COC levels within the tertiary barrier reach acceptable levels.

Thanks

Denis

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From: Roznowski, Denis M
Sent: Friday, October 14, 2016 2:11 PM
To: 'Hansen, Scott'; Dunn, James R - DNR (James.Dunn@wisconsin.gov)
Cc: Cc: Inman, Scott T - DNR; Dinsmore, Donalea - DNR; Brown, Adam; Ealy, Eric J; Aukerman, Ken; Laszewski, Steve; Alan Buell; Brad Hay; Brian Bell (bbell@envirocon.com); Summers, Keith J; Van Hoof, Tara M; Garbaciak Jr., Steve; Kozicki, Sharon V F; Onderko, Richard R; Alyssa.Core@wisconsin.gov; Burton, Jim; Schuh, Beth M; Coss, Terry E (terry.e.coss@xcelenergy.com); Carney, Kristen S; Jennifer.Casler@lw.com; Laszewski, Steve; Mike Palmer (mpalmer@demaximis.com) (mpalmer@demaximis.com) (mpalmer@demaximis.com)
Subject: RE: Implementation of Water Quality Management Contingency

Thanks Scott.

We will review the contingencies and will have some clarifying questions early next week.

Our current plan is to apply the contingency measures, if needed, on or shortly after Oct 19. We then are looking to monitor turbidity and make decisions on removal of the primary and secondary barriers based on the turbidity results. If turbidity meets requirements, without the addition of the contingency measures, we will remove those curtains per the approved plan. We would then proceed with COC monitoring and again assess the need for the contingency measures prior to tertiary curtain removal. Of note is that on 10/11/16 all performance monitoring water quality locations met project standards.

On a related note, we are scheduled to remove the anchor cables on the primary and secondary curtains on Oct 24 with the aid of divers. The divers are on a strict schedule so we do not want to vary on that work getting done on the 24th. In the event that turbidity results are not yet at levels allowing the removal of those barriers on the 24th, we would propose to disconnect the anchors and use the fence posts to hold the barriers in place until such time that the turbidity levels fall to acceptable levels, or the onset of freezing temperatures dictates removal, with Agency input. The gap barriers and tertiary barriers would remain fully anchored until a later date.

The fence posts have worked well in keeping the additional primary barrier and the optional full depth curtain that FE JV deployed for additional turbidity control earlier this fall.

We look forward to discussing/clarifying the contingencies you have laid out below and completing the barrier removal work in October while the weather is in our favor.

Thanks

Denis

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Joint Venture

From: Hansen, Scott [mailto:hansen.scott@epa.gov]
Sent: Friday, October 14, 2016 11:38 AM
To: Roznowski, Denis M; Dunn, James R - DNR (James.Dunn@wisconsin.gov)
Cc: Cc: Inman, Scott T - DNR; Dinsmore, Donalea - DNR; Brown, Adam; Ealy, Eric J; Aukerman, Ken; Laszewski, Steve; Alan Buell; Brad Hay; Brian Bell (bbell@envirocon.com); Summers, Keith J; Van Hoof, Tara M; Garbaciak Jr., Steve; Kozicki, Sharon V F; Onderko, Richard R; Alyssa.Core@wisconsin.gov; Burton, Jim; Schuh, Beth M
Subject: RE: Implementation of Water Quality Management Contingency

Denis,

The Agencies have reviewed the Tech Memo and feel the approach is acceptable with some contingencies. Since this is a pilot test and the idea is to assess approaches for the potential application to the full scale project some additional information should be collected. Water quality data prior to and after the application of Alum should include dissolved aluminum, pH and Alkalinity. Also, post application of the "floc" should be collected for visual, and chemical analysis (PAHs/VOCs) and Aluminum.

The plan includes the removal of the tertiary barrier. Due to the mobility of the floc, we would like to see the tertiary barrier left in place through the winter, being removed after the gap barriers have been installed.

If carbon is also used, the same process should be followed.

As this will be a discharge to the waters of the State, we will consider this and addendum to the WPDES permit equivalency (under ss. 283.31 Wisconsin State Stats.) as outfall #2.

If you have any questions, please let us know.

Scott

From: Roznowski, Denis M [mailto:Denis.Roznowski@Foth.com]
Sent: Thursday, October 06, 2016 8:47 PM
To: Hansen, Scott <hansen.scott@epa.gov>; Dunn, James R - DNR (James.Dunn@wisconsin.gov) <James.Dunn@wisconsin.gov>
Cc: Cc: Inman, Scott T - DNR <Scott.Inman@wisconsin.gov>; Dinsmore, Donalea - DNR <Donalea.Dinsmore@wisconsin.gov>; Craig Melodia ('melodia.craig@epa.gov') <'melodia.craig@epa.gov'>; Brown, Adam <Adam.Brown@WestonSolutions.com>; Benson, Thomas (ENRD <Thomas.Benson@usdoj.gov>; Ealy, Eric J <Eric.J.Ealy@xcelenergy.com>; Coss, Terry E (terry.e.coss@xcelenergy.com) <terry.e.coss@xcelenergy.com>; 'Carney, Kristen S' <Kristen.S.Carney@xcelenergy.com>; Aukerman, Ken <Ken.Aukerman@foth.com>; Laszewski, Steve <Steve.Laszewski@Foth.com>; Alan Buell <ABuell@envirocon.com>; Brad Hay <bhay@envirocon.com>; Brian Bell (bbell@envirocon.com) <bbell@envirocon.com>; Jennifer.Casler@lw.com; Summers, Keith J <Keith.Summers@Foth.com>; 'Voigt, John A' <John.Voigt@xcelenergy.com>; 'Leon Christion' <leon@demaximis.com>; Mike Palmer (mpalmer@demaximis.com) (mpalmer@demaximis.com) (mpalmer@demaximis.com) <mpalmer@demaximis.com>; Van Hoof, Tara M <Tara.VanHoof@Foth.com>; Garbaciak Jr., Steve <Steve.Garbaciak@foth.com>; Kozicki, Sharon V F <Sharon.Kozicki@Foth.com>; Onderko, Richard R <Richard.Onderko@foth.com>; Alyssa.Core@wisconsin.gov; Burton, Jim <James.Burton@WestonSolutions.com>; Carr, Patrick E <Patrick.Carr@xcelenergy.com>; Schuh, Beth M <Beth.Schuh@Foth.com>
Subject: Implementation of Water Quality Management Contingency

Jamie/Scott,

Below please find the link to the Ashland/NSP Lakefront Site *Implementation of Water Quality Management Contingency Technical Memorandum #16-8*:

https://clientsecured.foth.com/NSP/phase2agency/Documents%20for%20Agency%20Review/Forms/AllItems.aspx?RootFolder=%2fNSP%2fphase2agency%2fDocuments%20for%20Agency%20Review%2fTech%20Memo%2016%2d8%20%2d%20Implementation%20of%20Water%20Quality%20Contingencies&FolderCTID=&View=%7bCBF3798C%2dA0CC%2d4EA5%2d8DD7%2d10748C142D37%7d

This Tech Memo, including the referenced documents and completed application forms, represents the complete Work Plan to implement a water quality contingencies plan, if needed, as the Extended Pilot work draws to completion in early October.

If the post dredge confirmation samples collected 10-4-16 meet performance standards, it could be necessary to implement the water quality contingencies plan as soon as late next week, or early the following week, at the completion of restorative layer placement.

We therefore respectfully request approval of the plan by October 12, 2016.

Please let us know if you have any questions.

Thanks

Denis

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