



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

VALLEY REGIONAL OFFICE

4411 Early Road, P.O. Box 3000, Harrisonburg, Virginia 22801

(540) 574-7800 Fax (540) 574-7878

www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

Amy Thatcher Owens
Regional Director

March 31, 2016

By Email (cathy.c.taylor@dom.com)

Ms. Cathy C. Taylor
Director, Electric Environmental Services
Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Re: Concept Engineering Report – Centralized Source Water Treatment System
Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004138
Dominion –Bremo Power Station

Dear Ms. Taylor:

The Concept Engineering Report (CER) received under cover letter dated March 30, 2016, for the above referenced project is approved. This action is in accordance with a memorandum dated March 31, 2016, a copy of which is enclosed for your information. As stipulated in Part I.G.5 of the facility's VPDES permit, noncompliance with the CER shall be deemed a violation of the permit.

The Department of Environmental Quality (DEQ) approval does not relieve you of your responsibility to:

1. Construct the treatment system in accordance with the approved CER;
2. Operate the treatment system in a manner to consistently meet the facility's performance requirements;
3. Correct design and/or operation deficiencies; or
4. Comply with all other applicable laws and regulations.

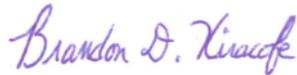
Part I.G.5 of the facility's VPDES permit requires that no later than 14 days following completion of construction of any project for which a CER has been approved, written notification shall be submitted to the DEQ -Valley Regional Office certifying, that based on an inspection of the project, construction was completed in accordance with the approved CER.

Nothing in this CER approval preempts, modifies, or otherwise alters any effluent limitations or monitoring requirements in VPDES Permit No. VA0004138.

DEQ is aware of the separate settlement agreement entered into by Dominion Virginia Power and the James River Association on March 7, 2016, to which DEQ is not a party. However, DEQ recognizes that this agreement is enforceable by the parties who entered it. Although this agreement requires Dominion to “treat all coal ash wastewaters... by making use of enhanced treatment as set forth in the CER” it also imposes monitoring, reporting and other requirements between the parties beyond the requirements contained in the approved CER and VPDES permit.

If you have any questions, please contact Bev Carver at beverley.carver@deq.virginia.gov or (540) 574-7805.

Sincerely,



Brandon D. Kiracofe
Regional Water Permits & Compliance Manager

Enc.: Concept Engineering Report Memo

cc: Ken Roller (kenneth.roller@dom.com)
Jason Williams (jason.e.williams@dom.com)
Oula Shehab-Dandan (oula.k.shehab-dandan@dom.com)
Taylor L. Engen (taylor.l.engen@dom.com)
Correspondence File

MEMORANDUM
DEPARTMENT OF ENVIRONMENTAL QUALITY
VALLEY REGIONAL OFFICE

4411 Early Rd., P.O. Box 3000

Harrisonburg, VA 22801

SUBJECT: Concept Engineering Report
Centralized Source Water Treatment System (CSWTS)
Dominion – Bremo Power Station, VPDES Permit No. VA0004138

TO: Brandon D. Kiracofe, Regional Water Permits & Compliance Manager

FROM: Bev Carver

DATE: March 31, 2016

COPIES: Correspondence File

Project Name: Concept Engineering Report – Centralized Source Water Treatment System

Project Owner: Virginia Electric and Power Company

Project Scope: Wastewater generated during the closure of the East Ash Ponds, West Ash Pond, North Ash Pond, and Metal Waste Cleaning Basin will be directed to the Centralized Source Water Treatment System (CSWTS) which will discharge through internal Outfall 504. The CSWTS has been designed to treat a maximum design flow of 1,500 gallons per minute and to ensure compliance with the applicable effluent limits in VPDES Permit No. VA0004138. The treatment system components and additional details are included in the Concept Engineering Report.

The Concept Engineering Report received under cover letter dated March 30, 2016, supersedes the Concept Engineering Report approved on February 8, 2016, and the Concept Engineering Report Addendum approved on March 2, 2016.

Staff Comments: The staff has no objections to the facilities as proposed in Dominion's submittal dated March 30, 2016.

STAFF RECOMMENDATIONS:

The staff recommends that the Concept Engineering Report be approved.

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
dom.com



Overnight Mail
Return Receipt Requested

March 30, 2016

Ms. Beverly Carver
Senior Water Permit Writer
Virginia Department of Environmental Quality
Valley Regional Office
4411 Early Road, Harrisonburg, VA 22801

**RE: Dominion-Bremo Power Station VPDES Permit No. VA0004138:
Revised CER for Centralized Source Water Treatment System**

Dear Ms. Carver:

Enclosed is a revised copy of the Concept Engineering Report (CER) for the Centralized Source Water Treatment System (CSWTS) that Dominion is planning to utilize to treat wastewaters generated during the ash pond closure project at the Bremo Power Station. This revision should supersede the CER submitted March 24, 2016. This document incorporates the following revision:

1. Page 11, Section 4.3.1, first paragraph, fourth sentence revised to include the in line process sampling frequency.

Please contact Ken Roller of my staff at (804) 273-3494 or by email at kenneth.roller@dom.com should you have any questions or require additional information about this transmittal.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jason Williams", with a long, sweeping underline.

Jason Williams
Manager, Electric Environmental Services



Concept Engineering Report
Source Water Treatment System

CONCEPT ENGINEERING REPORT

CENTRALIZED SOURCE WATER TREATMENT SYSTEM

Bremo Power Station



Dominion

Submitted To: Virginia Electric and Power Company
1038 Bremo Road
Bremo Bluff, VA 23022

Submitted By: Golder Associates Inc.
2108 W. Laburnum Avenue
Suite 200
Richmond, VA 23227



January 2016
Revised March 2016 (Rev. 3)

1520-347.300

A world of
capabilities
delivered locally



Table of Contents

1.0	INTRODUCTION.....	1
1.1	Site Description	1
2.0	WASTEWATER SOURCES.....	2
2.1	Metals Pond Pumped Decant Water.....	2
2.2	Metals Pond Contact Stormwater	2
2.3	Metals Pond Material Dewatering Water	2
2.4	Impoundment Decant Water	3
2.5	Ash Pond Contact Stormwater.....	3
2.6	Ash Pond Ash Dewatering Water.....	3
3.0	WASTEWATER CHARACTERISTICS	3
4.0	TREATABILITY	5
4.1	Collection System	5
4.2	Treatment System Components	5
4.3	Treatment Process.....	6
4.3.1	Enhanced Treatment (if necessary).....	11
5.0	EFFLUENT STORAGE TANKS.....	13

Tables

Table 1	Summary of Constituents in Expected Process Water
Table 2	Statistical Summary of Constituents in Process Water
Table 3	North Ash Pond Pre-permit Water Sampling Results

Drawings

Drawing 1	– Site Location Map
Drawing 2	– Site Plan
Drawing 3	– Process Flow Diagram
Drawing 4	– Equipment and Process Lay-out (Rev. 2)
Drawing 5	– Effluent Storage Tank Plan (Rev. 2)

Appendices

Appendix A	– Bench-scale Testing Guidelines for the Reduction of Sediment and Colloidal Particles
Appendix B	– Treatability Studies
Appendix C	– Safety Data Sheets

1.0 INTRODUCTION

This Concept Engineering Report (CER) has been prepared for the proposed Centralized Source Water Treatment System (CSWTS) at Dominion's Brema Power Station (Station), located in Fluvanna County, Virginia. The Station converted from a coal-fired power plant to a natural gas-fired power plant in 2013. Coal Combustion Residuals (CCR) from historical coal-fired operations are stored in three impoundments on-site (North Ash Pond, West Ash Pond, and East Ash Pond). Process water from these ponds and other Station activities has historically been discharged with contact stormwater to the James River pursuant to the authorization, limits, and conditions of Virginia Department of Environmental Quality (DEQ) Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA0004138 (Permit).

Dominion is preparing to close these three inactive CCR surface impoundments in accordance with the U.S. Environmental Protection Agency's (EPA's) final CCR rule, which is codified at 40 CFR 257, and which has also been adopted by reference into the Virginia Solid Waste Management Regulations (VSWMR) at 9VAC20-81-10 *et seq.* Closure of the West Ash Pond will be accomplished by removing the CCR, and repurposing the eastern portion of the impoundment as the new West Treatment Pond. Closure of the North and East Ash Ponds will be accomplished by dewatering the CCR and capping it in place. In concert with closure of these three CCR impoundments, Dominion will also close the Metals Pond by dewatering and removing accumulated solids. During the closure activities, wastewater will be generated and will require treatment to ensure compliance with the limitations and conditions in the Permit, which was reissued by the State Water Control Board on January 19, 2016. Wastewater generated during the closure of the East, West, and North Ash Ponds, as well as wastewater associated with closure of the station's Metals Pond, will be directed to the CSWTS, which will be monitored at outfall 504. Dominion has prepared this CER to provide a description of the proposed CSWTS, which has been specifically designed to comply with the numeric effluent limitations in Part I.A.9 of the Permit. The CSWTS will be brought on-line following DEQ approval of this CER.

The conceptual engineering systems and processes presented herein reflect the planned conceptual approach for the CSWTS and may not reflect the specific details of the final design system configuration. Prior to system operation, a certification will be provided in writing that based on inspection of the project, the CSWTS construction was completed in general accordance and intent with this CER.

1.1 Site Description

The Brema Power Station is owned and operated by Virginia Electric and Power Company doing business as Dominion Power (Dominion) in Fluvanna County, Virginia, at 1038 Brema Road, just east of Route 15 (James Madison Highway) and north of the James River. The location of the Station is illustrated on the inset United States Geological Survey (USGS) topographic map on Drawing 1. A Site Plan is presented on an aerial photograph as Drawing 2. The Station property consists of wooded, open, and developed land

just north of the James River. The Station's northern, eastern, and western boundaries are bordered by primarily undeveloped parcels, and the Station is bordered to the south by a CSX rail line and the James River. Land use surrounding the Station is classified as "A-1 Agricultural," and consists of undeveloped wooded and agricultural properties within a rural residential setting.

2.0 WASTEWATER SOURCES

The Process Flow Diagram on Drawing 3 depicts the wastewater sources to the proposed CSWTS during the closure activities for the West, North, and East Ash Ponds, and the Metals Pond. These wastewater sources are described below.

2.1 Metals Pond Pumped Decant Water

Metals Pond Pumped Decant Water is surface water that has accumulated in the Metals Pond and needs to be removed as an initial step to facilitate closure. In the past, this water was periodically pumped to the West Ash Pond via internal outfall 202 for ultimate discharge to the James River via outfall 002.

Decanting shall be accomplished by pumping decant water either to the West Ash Pond (after monitoring for compliance with the Permit Part I.A.4 limits for internal outfall 202), or to the CSWTS for treatment prior to discharge via internal outfall 504. Alternatively, the Metals Pond Pumped Decant Water may be transported off-site for treatment and/or disposal at a permitted facility. If routed to the West Ash Pond, decanting will continue until the limits and conditions in Part I.A.9 are triggered pursuant to Part I.G.19, at which time the Metals Pond Pumped Decant Water will be routed to the CSWTS for treatment prior to discharge.

2.2 Metals Pond Contact Stormwater

Metals Pond Contact Stormwater is stormwater that, following removal of the decant water, has contacted the accumulated material in the Metals Pond during closure of the Metals Pond. Metals Pond Contact Stormwater will need to be removed from the Metals Pond to facilitate closure. The Metals Pond Contact Stormwater will be routed to the CSWTS for treatment prior to discharge via internal outfall 504. Alternatively, the Metals Pond Contact Stormwater may be transported off-site for treatment and/or disposal at a permitted facility.

2.3 Metals Pond Material Dewatering Water

Metals Pond Material Dewatering Water is the water that will be produced from dewatering the accumulated material in the Metals Pond to allow for its removal and off-site disposal. This waste stream will be directed to the CSWTS for treatment prior to discharge through internal outfall 504.

2.4 Impoundment Decant Water

Impoundment decant water (IDW) includes surface waters that result from the commingling of a number of wastewater types, including but not necessarily limited to: stormwater, low volume wastewater, sewage treatment plant (STP) discharges, ash dewatering water, and waters that are used to convey CCR to an impoundment through sluicing or dredging. As an initial step in the process leading to closure of the North Ash Pond, it will be necessary to remove the IDW in order to dewater the ash enough to allow for preparation of a stable surface on which to construct the closure cap. IDW from the North Pond will be routed to the CSWTS for treatment and discharge through internal outfall 504. Stormwater collected in the ponded area at the east end of the East Ash Pond will be routed to the CSWTS upon initiation of drawdown of this water for closure of the East Ash Pond.

2.5 Ash Pond Contact Stormwater

Ash Pond Contact Stormwater is stormwater that has contacted the CCR in the North, East, and West Ash Ponds, and is considered process wastewater. This waste stream will be directed to the CSWTS for treatment prior to discharge through internal outfall 504.

2.6 Ash Pond Ash Dewatering Water

Ash Pond Ash Dewatering Water is considered to be the pore water within the CCR mass in the West, North, and East Ash Ponds. This wastewater refers to the water that is produced from dewatering the CCR to stabilize the CCR and allow for its removal by mechanical dredging or excavation (West Ash Pond), or to support the closure cap system (North and East Ash Ponds). It is generated from the CCR dewatering process through mechanical means (*e.g.*, vacuum wells, sump pumps, or other *in situ* withdrawal methods) and from cutting drainage ditches or rim ditches into the CCR mass. Ash Pond Ash Dewatering Water will be directed to the CSWTS for treatment prior to discharge through internal outfall 504.

3.0 WASTEWATER CHARACTERISTICS

To characterize the expected quality of most wastewater sources to be treated in the CSWTS, a series of sampling events was conducted between March and June 2015 by an independent consultant. During these events, samples were collected from representative locations within the source streams for various analyses as shown on the Site Plan (Drawing 2).

During each sampling event for each source water, representative samples were collected using appropriate equipment by qualified sample technicians following EPA surface water sampling protocols and industry standards for groundwater (*i.e.*, piezometer) sampling. Samples collected for dissolved analysis were laboratory-filtered with a 0.45-micron filter.

The samples were collected in laboratory-provided, pre-preserved (laboratory-filtered metals containers were preserved by the laboratory after filtering), pre-labeled sample containers and placed on ice in a cooler

under chain-of-custody control pending delivery to the laboratory for analysis. Samples for analysis by Environmental Conservation Laboratories, Inc. (ENCO) of Cary, North Carolina were shipped to ENCO via commercial overnight courier under chain-of-custody control, and samples for analysis by Air, Water and Soils Laboratories, Inc. (AWS) of Richmond, Virginia, were delivered to AWS under chain-of-custody control. Both AWS and ENCO and their subcontractor laboratories are Virginia Environmental Laboratory Accreditation Program (VELAP) accredited laboratories. The results of the laboratory analyses for those constituents subject to numeric effluent limitations in the Permit are presented in Table 1 and are summarized in Table 2.

The samples collected from PZ-1 (North Ash Pond CCR) and PZ-2 (East Ash Pond CCR) are representative of the expected ash dewatering water quality prior to any additional treatment. The sample results indicate elevated metals concentrations (total and dissolved) for certain metals, particularly in the PZ-2 samples collected from the East Ash Pond. In general, these elements are: antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, nickel, thallium, vanadium, and zinc. In addition, the ash dewatering water samples have elevated total suspended solids (TSS) concentrations in comparison to the other source waters, contributing to the elevated total metals concentrations. In general, the dissolved metals concentrations in the ash dewatering water samples (PZ-1 and PZ-2) are substantially lower than the total metals concentrations, indicating the attenuating effect of filtration on the metals concentrations, with the exceptions of boron and molybdenum.

The elevated metals concentrations are expected to be attenuated significantly with TSS controls, and thus, the CSWTS is designed to remove TSS with provisions for metals recovery using pH buffering, aeration, and other oxidative processes combined with hydraulic retention time and solids recovery (see Section 4.0 for treatability study results).

The North Pond Toe Drain sample had elevated concentrations of TSS and iron, when compared to other effluents; however, for the majority of parameters, concentrations in the North Pond Toe Drain were lower than those measured in the other sources.

To characterize the North Ash Pond IDW, a series of sampling events was conducted from late October 2015 to present. During each event, three representative water samples were obtained for analysis of the constituents subject to numeric effluent limitations in the Permit. The catwalk over the North Ash Pond was used to obtain water samples from the North Ash Pond at depths of 1 foot and 4 feet below the surface near the weir structure. These "NP Catwalk" samples are intended to represent surface water and mid-column water (*i.e.*, IDW). A third sample was collected at the inlet pipe to the North Pond Pool ("NP Pool," near the East Ash Pond). Table 3 presents the analytical results, as compared to the Permit limits. As shown, the North Ash Pond IDW samples meet the Permit limits.

4.0 TREATABILITY

To determine the effectiveness of chemical precipitation and filtration in treating the wastewater to meet the discharge limitations specified in the Permit, Golder commissioned Ground/Water Treatment & Technology, LLC (GWTT) to perform treatability studies. GWTT followed the protocol provided by Adegas Chemical Company (see Appendix A – *Bench-scale Testing Guidelines for the Reduction of Sediment and Colloidal Particles*). Three treatability studies were performed, two in a laboratory and one on-site. The reports are presented in Appendix B. The results of the studies indicate that a treatment process involving aeration, hydroxide precipitation, followed by coagulation / flocculation / settling will reduce the contaminants of concern to below the discharge limits in the Permit. Note that two of the treatability studies were performed prior to reissuance of the VPDES permit and, therefore, comparisons in the tables associated with these study reports were made between treated effluent concentrations and draft permit limits. The limitations in the final permit are consistent with the draft permit limitations referenced in the treatability studies. It is also noted that the quantitation limits (QLs) used by the laboratory during the treatability studies differ somewhat from those specified in the reissued permit; however, the QLs achieved by the laboratory have no adverse bearing on the results or reliability of the treatability studies in designing the CSWTS.

The proposed CSWTS is designed based on the results of these treatability studies. The proposed CSWTS consists of a source water collection system from which the source waters may be commingled, and then conveyed to the water treatment components for treatment, effluent sampling, and discharge. Drawing 4 depicts the equipment and process lay-out of the CSWTS.

4.1 Collection System

At each pond location undergoing closure, a spill containment area (approximately 100 feet by 60 feet) will be constructed to house equipment to collect and transfer the source waters from the pond decanting/dewatering activities to the CSWTS. The equipment components of each collection and transfer system will generally include at a minimum:

- One (1) 21,000-gallon, closed-top tank;
- 12-inch high density polyethylene (HDPE) piping from the source pumps to the tank;
- One (1) diesel pump capable of 1,500 gallons per minute (gpm);
- Integral fuel tank (estimated to be 200 gallons);
- Hoses, pipes, and fittings as required within the spill containment area;
- Alarm panel and overflow protection system, and;
- Small generator, control wiring, and power cables as required.

4.2 Treatment System Components

The source waters from the collection systems will be conveyed for treatment to the CSWTS, which is a modular, integrated treatment system. Temporary equalization/storage capacity for the raw source water influent to the CSWTS may be utilized as necessary for effective wastewater management. The CSWTS

will be located in a spill containment area (approximately 240 feet by 80 feet). The CSWTS equipment will consist of the following components:

- 8-inch HDPE piping into the equalization/aeration tank;
- One (1) 18,000-gallon, open-top equalization/aeration tank supplied with a pressure blower and diffuser nozzles;
- One (1) 18,000-gallon, open-top pH adjustment tank supplied with a pH adjustment system;
- Three (3) open-top, chemical mix tanks each supplied with electric mixers;
- Five (5) v-bottom clarifiers plumbed in parallel, each supplied with removable settling tube media;
- Three (3) chemical feed systems for the introduction of liquid coagulant and powdered flocculent to each chemical mix tank;
- One (1) sludge handling system consisting of an electric sludge pump, poly cone bottom tanks, and pumps feeding a mobile filter press;
- One (1) mobile filter press to convey filter cake;
- Two (2) diesel transfer pumps, one (1) primary and one (1) back-up, each capable of 1,500 gpm;
- Two (2) duplex 23-bag filtration systems;
- Three (3) duplex 6-bag filtration systems;
- Three (3) duplex 36-cartridge filtration system;
- One (1) mechanical process flow meter with totalizer;
- One (1) 18,000-gallon open-top effluent holding tank/pH adjustment tank supplied with a pH adjustment system and electric mixers;
- One (1) primary generator, one (1) back-up generator, one (1) manual transfer switch, and one (1) fuel holding tank;
- One (1) 480-volt (V), 3-phase main distribution panel;
- Control wiring and power cables from the generators to the main electrical distribution panel, and from the main electrical distribution panel to the individual equipment skids;
- Alarm panel and overflow protection are incorporated in several areas of the CSWTS, and;
- Hoses, pipes, and fittings as required between the treatment system components within the spill containment berm.

4.3 Treatment Process

Raw source water will be conveyed through an influent flow meter to the aeration tank. The aeration tank is an 18,000-gallon (nominal), open-top, tank. Air will be injected into the influent chamber of the aeration tank via an electric blower piped to air diffuser nozzles.

Water from the aeration tank will be pumped to the initial pH adjustment tank via a duplex, 25-horsepower (Hp) submersible transfer pump skid consisting of a primary pump and a secondary pump to achieve a maximum flow rate of 1,500 gpm. Each of the submersible transfer pumps is capable of 750 gpm at approximately 80-foot total dynamic head (TDH), and is equipped with a 25-HP, 460-V, 3-phase, 60-hertz (Hz) electric motor.

The submersible transfer pump skids will be provided with a local control system consisting of two pump motor starters and four float controls – Pump 1 On, Pump 2 On, Pump 1 Off, and Pump 2 Off. The high level and high-high level alarms in the aeration tank will each activate an indicator light on the alarm panel, and activate a strobe light to alert the operator of a high level or a high-high level condition in the aeration

and pH adjustment tanks. The high-high level alarm float will also have the ability to shut off the raw water feed pump to discontinue the forward flow to the treatment system.

A pH probe will be submerged in a downstream chamber of the pH adjustment tank. The probe will be wired to a pH controller that will communicate with the sodium hydroxide feed pumps and inject sodium hydroxide, if necessary, to increase the pH of the incoming water to approximately 9.5 standard units. Electric mixers will be installed in the pH adjustment tank to ensure proper mixing of the water and sodium hydroxide.

Water from the pH adjustment tank will be pumped to three chemical mix tanks via a triplex, 10-Hp submersible transfer pump skid consisting of a primary pump and two secondary pumps to allow for 500 gpm of flow to each treatment train. Each of the submersible transfer pumps is capable of 500 gpm at approximately 50-foot TDH, and is equipped with a 10 HP, 460-V, 3-phase, 60-Hz electric motor. Water will pass through a 6-inch magnetic meter and a throttling valve to monitor and control the amount of water being pumped from the pH adjustment tank to each chemical mix tank. The 6-inch magnetic meter will also be used to pace the amount of coagulant and flocculent injected into each chemical mix tank.

The submersible transfer pump skids will be provided with a local control system consisting of three pump motor starters and six float controls – Pump 1 On, Pump 2 On, Pump 3 On, Pump 1 Off, Pump 2 Off, and Pump 3 Off. The high level and high-high level alarms in the pH adjustment tank will each activate an indicator light on the alarm panel, and activate a strobe light to alert the operator of a high level or a high-high level condition in the pH adjustment tank. The high-high level alarm float will also have the ability to shut off the raw water feed pump to discontinue the forward flow to the treatment system.

Prior to entering the chemical mix tanks, water will flow through an in-line static mixer where a coagulant, such as Adegas WC-500, will be injected via a chemical metering pump. The Safety Data Sheet for this coagulant is provided in Appendix C. The coagulant is used to change the electrical charge of the fine particles and to cause a destabilization of the particles. A spare coagulant feed pump will be provided in case the primary coagulant feed pump needs to be serviced or replaced.

Water will then enter the chemical mix tanks. The chemical mix tanks are 11,000-gallon (nominal), open-top, steel tanks equipped with weirs and baffles. Flocculent will be added to the chemical mix tanks using a chemical metering pump. Flocculent is used to bring the charged particles together and to make them heavier, which will allow for better settling in the downstream clarifier. The actual flocculent used will be determined based on jar testing performed using representative water during on-site start-up. It is anticipated that an anionic polymer such as Adegas AP-210 will be utilized. The Safety Data Sheet for this polymer is provided in Appendix C. A spare flocculent feed pump will be provided in case the primary flocculent feed pump needs to be serviced or replaced. The flocculent will be provided in powdered form. Solutions of liquid flocculent will be mixed using a return line of the effluent water stream.

The chemical mix tank will be equipped with low-speed electric mixers to further mix the coagulant into the water stream and to ensure proper mixing of the water and flocculent. Flow pacing for the chemical feed pumps feeding the coagulant and flocculent will be achieved using the 6-inch magnetic meter installed upstream of the chemical mix tanks. The chemical mix tanks will be elevated on dunnage to allow the water to flow by gravity from the chemical mix tanks to the clarifiers to minimize the shearing of any floc particles prior to entering the clarifiers.

The chemical mix tanks will be equipped with a high level alarm and a high-high level alarm. The high level alarm will activate an indicator light on the alarm panel, and activate a strobe light to alert the operator of a high level condition in a chemical mix tank. The high-high level alarm will activate an indicator light on the alarm panel, and activate a strobe light to alert the operator of a high-high level condition in the chemical mix tanks, and also send a signal to shut down the transfer pumps pumping water from the pH adjustment tank to the chemical mix tanks.

Water will flow by gravity from the chemical mix tanks to the clarifiers. The clarifiers are equipped with a number of features that will facilitate both the settling of solids and routine maintenance of the units. Water to the clarifiers is directed to an influent chamber. A weir plate extending from the top of the unit forces the water underneath removable settling tube media. Treated water flows upward through the settling tubes while solids collect and fall to the bottom of the bulk settling clarifier. Tube settlers capture the settled fine floc that escapes the clarification zone beneath the tube settlers, and allow the larger floc to travel to the tank bottom in a more settled form. The tube settler's channel collects solids into a compact mass that allows the solids to slide down the tube channel.

Solids and/or sludge that have settled to the bottom of the clarifiers will need to be periodically removed and pumped to two sludge holding tanks plumbed in parallel. The sludge holding tanks are cone bottom poly tanks each with a nominal capacity of 2,600 gallons. Sludge should be removed from the clarifiers when solids begin passing through the clarification zone and into the effluent portion of the clarifiers. The sludge removal system for each of the clarifiers consists of an electric auger plumbed to a sludge pump. Sludge is removed from each chamber and pumped to the sludge holding tank where sludge can be condensed, and free water can be decanted back to the initial pH adjustment tank via a decant tank and an electric decant pump. The remaining solids in the sludge holding tank will then be pumped via a second sludge pump to a trailer-mounted filter press. Filter cake from the filter press will be dropped onto a conveyor that will direct the filter cake to a lined 20-cubic-yard roll-off dumpster. The contained filter cake will be managed as a special waste under the VSWMR, and will be characterized as required by the VSWMR and the permitted disposal facility selected to receive the waste. The filtrate generated from dewatering will gravity-feed into a filtrate holding tank and be decanted back to the initial pH adjustment tank via an electric decant pump.

The sludge holding tanks will each be equipped with a high level alarm float. The high level alarm will activate an indicator light on the alarm panel, and activate the strobe light to alert the operator of a high level condition in the sludge holding tanks, and also send a signal to shut down the electric sludge pump feeding the sludge holding tank.

Clarified water will rise above the settling tube media and flow over a final weir plate into an effluent chamber. Water in the effluent chamber of the clarifiers will flow by gravity from the clarifier to the pump suction tank. The effluent chamber of the clarifier will be equipped with a high level alarm and a high-high level alarm. The high level alarm will activate an indicator light on the alarm panel, and activate the strobe light to alert the operator of a high level condition in the clarifier. The high-high level alarm will activate an indicator light on the alarm panel, and activate the strobe light to alert the designated team members of a high-high level condition in the clarifiers, and also send a signal to shut down the centrifugal pumps pumping water from the pH adjustment tank to the chemical mix tank.

Water in the pump suction tank will be pumped through the filtration step, which consists of three sets of bag filter housings and one cartridge filtration housing, to the final pH adjustment tank containing electric mixers. Each of the diesel transfer pumps is capable of 1,500 gpm at approximately 120-foot TDH. The diesel transfer pumps will process water through the duplex multi-bag filter skids as well as the cartridge filtration skid. The first set of bag filters will consist of two duplex 23-bag filter housings plumbed in parallel. The inlet and outlet of the bag filter skid will be equipped with manifolds complete with isolation valves. Each of the filter housings will contain 23 #2 filter bags designed to remove TSS, sediment, and filterable metals from the process water prior to discharge. The micron rating of the filter bags will be 5-25 microns depending on water quality and discharge requirements. The inlet and outlet of each of the bag filter housings will also be equipped with pressure gauges to monitor the differential pressure across the filter housing. The bag filters should be changed once the differential pressure across the housing reaches 15 to 20 pounds per square inch (psi). The bag filter housings will be plumbed in parallel such that the bags in one filter housing can be changed while the remaining filter housing continues to process water at the maximum design water flow rate of 1,500 gpm.

The second set of bag filters will consist of three duplex 6-bag filter housings plumbed in parallel. The inlet and outlet of the bag filter skid will be equipped with manifolds complete with isolation valves. Each of the filter housings will contain six #2 filter bags designed to remove TSS, sediment, and filterable metals from the process water prior to discharge. The micron rating of the filter bags will be 1-5 microns depending on water quality and discharge requirements. The inlet and outlet of each of the bag filter housings will also be equipped with pressure gauges to monitor the differential pressure across the filter housing. The bag filters should be changed once the differential pressure across the housing reaches 15 to 20 psi. The bag filter housings will be plumbed in parallel such that the bags in one filter housing can be changed while the

remaining filter housing continues to process water at the maximum design water flow rate of 500 gpm per 6-bag filtration skid.

The third set of filters will consist of three duplex 36-cartridge filter housings plumbed in parallel. The inlet and outlet of the cartridge filter skids will be equipped with manifolds complete with isolation valves. Each of the filter housings will contain 36 30-inch cartridges designed to remove TSS, sediment, and filterable metals from the process water prior to discharge. The micron rating of the filter bags will be 0.5-1 micron depending on water quality and discharge requirements. The inlet and outlet of each of the cartridge filter housings will also be equipped with pressure gauges to monitor the differential pressure across the filter housing. The cartridge filters should be changed once the differential pressure across the housing reaches 15 to 20 psi. The cartridge filter housings will be plumbed in parallel such that the cartridges in one filter housing can be changed while the remaining filter housing continues to process water at the design water flow rate of 500 gpm per duplex skid. The spent cartridge filters will be disposed of as solid waste at a permitted solid waste disposal facility.

If the bag/cartridge filters are not properly operated and maintained, the differential pressure across the filter housings can rise to the point that the diesel pumps cannot pump water from the pump suction tank faster than water is introduced into the pump suction tank. The water level in the pump suction tank will rise and eventually activate the high level and high-high level alarm light. An adjustable differential pressure switch will be installed across the duplex bag/cartridge filter skids to alert the Operator that the filter(s) needs to be changed immediately. The adjustable differential pressure switch will be set at approximately 15 psi. When this pressure is reached, the differential pressure switch will illuminate a strobe light as well as an indicator light on the alarm panel to alert the Operator of a high differential pressure condition across the duplex bag/cartridge filter skids.

The final pH adjustment tank is an 18,000-gallon (nominal), open-top, tank. Two pH probes will be submerged in two chambers of the pH adjustment tank. The pH probes will be wired to a pH controller that will communicate with the hydrochloric acid feed pumps and inject concentrated hydrochloric acid (or sodium hydroxide if operating the enhanced metals treatment), if necessary, to decrease the pH of the water within a preset range. Electric mixers will be installed in the final pH adjustment tank to ensure proper mixing of the water and hydrochloric acid.

Water in the pH adjustment tank effluent chamber will be pumped to effluent storage tanks using a diesel transfer pump. The diesel transfer pump is capable of 1,500 gpm at approximately 110-foot TDH. A 12-inch diameter mechanical flow meter with a totalizer will be provided at the end of the treatment system to indicate the flow rate and to record the total gallons of water treated and discharged. The flow meter has an acceptable flow range of 150 to 2000 gpm. Flow readings should be recorded daily in a log book.

The effluent piping will be equipped with an in-line pH sensor with a local readout. If the pH sensor detects a pH value outside of the pre-set desirable range, it will illuminate a strobe light as well as an indicator light on the alarm panel to alert the operator that the effluent pH is out of range. An in-line turbidity monitor will also be installed to monitor the effluent turbidity of the water treatment system.

A return line with a valve will be provided in the effluent piping to pump water to the chemical storage box to provide a clean water source to make periodic solutions of liquid flocculent.

The individual components of the CSWTS will be skid-mounted to the greatest extent possible, and will be interconnected using HDPE piping, polyvinyl chloride (PVC) piping, and suction hose. Pressure gauges, flow meters, and sample taps will be located throughout the CSWTS to monitor system performance. Sampling of the final CSWTS effluent will be conducted in accordance with the Permit to comply with Parts I.A.9 and I.C. Storage capacity for the effluent from the CSWTS will be provided to effectively manage the wastewater, as described in Section 5.0. Effluent monitoring for compliance with Part I.A.9 limits will be performed on the effluent from the storage vessel(s). Butterfly valves will be provided on the inlet and outlet of each of the major units to isolate them for maintenance.

An indicator/alarm panel will be mounted within the CSWTS area, with indicator lights for the various alarm conditions. A 480-V, 3-phase, 600-ampere (amp) main disconnect will also be mounted within the CSWTS area to distribute power to the various pump control panels, and the indicator/alarm panel.

4.3.1 Enhanced Treatment (if necessary)

The treatability studies indicate that the proposed CSWTS as described above can achieve the discharge limits specified in the Permit. However, to further improve the quality of the final effluent, provisions for enhanced treatment are provided in this CER. As shown on the Equipment and Process Lay-out diagram (Drawing 4), an area (approximately 40 feet by 75 feet) is designated for an additional metals treatment module consisting of a chemical reducing agent addition in the aeration tank followed by pH adjustment (hydrochloric acid) and adsorptive media vessels in between the cartridge filters and the final pH adjustment tank. In-line process samples will be collected at a minimum frequency of once every four (4) hours from a location prior to the enhanced treatment module(s) (S1 sampling location on Drawing 4), and analytical results will be returned within one (1) hour after sample collection. If effluent from the treatment system exceeds any of the pollutant concentration triggers presented below, as determined by in-line process sampling, then the effluent will be routed through enhanced treatment:

- Arsenic – 100 ug/L
- Antimony – 640 ug/L
- Selenium – 5.0 ug/L
- Thallium – 0.47 ug/L
- Lead – 7.4 ug/L

■ Copper – 6 ug/L

The enhanced treatment can likewise be turned off should in-line process sampling determine that pollutant concentrations prior to the enhanced treatment system are below the trigger limits. Dominion reserves the right to operate the enhanced treatment system at any time, even if trigger limits have not been exceeded.

A monthly report will be submitted to the DEQ, which will provide dates when enhanced treatment was turned on or off. Process samples will be grab samples and will be analyzed using methods that will achieve the Quantification Levels (QLs) specified in the VPDES permit.

Raw source water conveyed through an influent flow meter will be dosed with a chemical reducing agent (ferrous sulfate) prior to introduction to the aeration tank. The reducing agent will then be slowly mixed in the aeration tank by the use of slow mixers prior to aeration. The purpose of the chemical reducing agent will be to reduce soluble forms of dissolved metals into a more insoluble form so that the majority of metals reduction will occur in the chemical precipitation process. The raw source water will be treated as described in the treatment process before being conveyed through the adsorptive media vessels.

From the cartridge filter skid, water can be diverted under pressure to a metals pH adjustment tank prior to being pumped through the adsorptive media trains plumbed in series. The pH adjustment tank is an 18,000-gallon (nominal), open-top, tank. Two pH probes will be submerged in two chambers of the pH adjustment tank. The pH probes will be wired to a pH controller that will communicate with the hydrochloric acid feed pumps and inject concentrated hydrochloric acid, if necessary, to decrease the pH of the water within a preset range. Electric mixers will be installed in the pH adjustment tank to ensure proper mixing of the water and hydrochloric acid. Water in the pH adjustment tank effluent chamber will be pumped to the adsorptive vessels treatment trains using a diesel transfer pump. The diesel transfer pump is capable of 1,500 gpm at approximately 110-foot TDH.

Each treatment train will consist of two adsorptive media vessels for the reduction of the dissolved metals concentrations in the waste stream. Each treatment train is designed for a flow rate of 250 gpm to allow for an empty bed contact time (EBCT) of 10 minutes adsorption per lead vessel. A total of 12 adsorptive media vessels (six trains of lead and lag vessels at a design flow rate of 250 gpm per vessel train) will be installed to treat for a maximum design flow rate of 1,500 gpm.

The adsorptive media vessels will each contain 300 cubic feet (cf) of a mixture of crushed limestone and activated alumina, which is designed to reduce the dissolved metals prior to discharge. At the design flow rate of 250 gpm, the loading rate is 0.83 gpm/cf of resin. If breakthrough of dissolved metals occurs on the lead resin unit, the water will be treated through the lag unit temporarily. The spent media will be removed from the lead unit and will be replaced with 300 cf of adsorptive media. The spent media will be sampled to determine RCRA waste characteristics, and will be disposed of accordingly. Periodic sampling of the

effluent of adsorptive media unit #1 (S2 sampling locations on Drawing 4) will determine if dissolved metals breakthrough is occurring, and will alert the operator as to when to replace the media in the lead vessel. In addition, the operator will maintain a regular schedule for replacement of media in the resin units based on the expected life of the media in order to prevent any metals breakthrough.

The inlet and outlet of each adsorptive media vessel will be equipped with a pressure gauge to monitor the differential pressure across the media. The differential pressure across each adsorptive media vessel will be recorded in a log book on a daily basis. If the differential pressure across a particular adsorptive media vessel rises to the point that water flow is restricted (as measured by the effluent flow meter), that adsorptive media vessel will be taken off-line, and the media will be either replaced or backwashed (to the aeration tank) in an attempt to reduce the pressure in the unit due to excessive pressure drop.

5.0 EFFLUENT STORAGE TANKS

Temporary effluent storage tanks will be used to provide hydraulic retention of treated effluent prior to release. Four 950,000-gallon temporary aboveground storage tanks will be erected to provide a storage capacity of up to 3,800,000 gallons. The storage tanks will be erected on top of the former closed coal yard and set on a compacted aggregate base (Drawing 5). The inside of the tanks will be lined with a geomembrane liner for water-tight containment, and the prepared area will be provided with spill containment.

The temporary storage tanks will be used in conjunction with the CSWTS. The tanks will be operated in rotation to hold approximately 12 hours of treated effluent at an operating rate of up to 1,500 gallons per minute. As identified on Drawing 5, internal outfall 504 will be located on the effluent side of the tanks. Outfall 504 will be the metered outfall compliance sampling location. Effluent discharge from the storage tanks will be up to 1,500 gallons per minute.

Process monitoring may be performed within the tanks (S3 sampling locations on Drawing 5) at various times to confirm the CSWTS is operating as designed to meet the permitted effluent limits prior to discharge. In the unlikely event that the process monitoring indicates the designed level of treatment is not being achieved, the stored effluent can then be recirculated through the system for additional treatment prior to discharge. This recirculation will be accomplished through a series of valves and piping (Drawing 5).

TABLES

**Table 1
Summary of Constituents in Expected Process Water
Bremo Power Station**

			PZ-1 (North Pond)	PZ-2 (East Pond)	North Pond Toe Drain	Metals Pond
Source Water Type			Ash Dewatering Water		Toe Drain	Commingled Process and Stormwater
Parameter	Sample Date	Method				
Total Metals (ug/L)						
Aluminum	01/20/2015	SM3111D	--	--	--	--
Aluminum	03/31/2015	SW6010C	22200	249000	--	--
Aluminum	04/15/2015	SW6010C	9220	65100	244	--
Aluminum	05/21/2015	E200.7	76300	120000	--	76.1
Aluminum	06/04/2015	E200.7	24700	123000	< 20.0	334
Aluminum	06/16/2015	E200.7	--	--	< 20.0	--
Antimony	01/20/2015	SM3113B	--	--	--	--
Antimony	03/31/2015	SW6020A	11.7	13.4	--	--
Antimony	04/15/2015	SW6020A	13.5	8.79	0.715	0.355
Antimony	05/21/2015	E200.8	4.77	9.50	--	0.157
Antimony	06/04/2015	E200.8	4.73	7.97	< 0.110	0.247
Antimony	06/16/2015	E200.8	--	--	< 0.110	--
Arsenic	01/20/2015	SM3113B	--	--	--	--
Arsenic	03/31/2015	SW6010C	173	813	--	--
Arsenic	04/15/2015	SW6010C	265	425	< 6.80	--
Arsenic	05/21/2015	E200.8	1020	838	--	3.59
Arsenic	05/21/2015	E200.9	--	544	--	--
Arsenic	06/04/2015	E200.8	485	1460	< 0.610	8.57
Arsenic	06/04/2015	E200.9	--	511	--	--
Arsenic	06/16/2015	E200.8	--	--	< 0.610	--
Barium	01/20/2015	SM3113B	--	--	--	--
Barium	03/31/2015	SW6010C	758	9370	--	--
Barium	04/15/2015	SW6010C	844	2620	114	--
Barium	05/21/2015	E200.7	2510	3680	--	58.9
Barium	06/04/2015	E200.7	1260	3540	14.5	59.9
Barium	06/16/2015	E200.7	--	--	13.4	--
Beryllium	01/20/2015	SM3113B	--	--	--	--
Beryllium	03/31/2015	SW6010C	5.54	87.7	--	--
Beryllium	04/15/2015	SW6010C	3.14	31.9	< 0.100	--
Beryllium	05/21/2015	E200.7	22.6	57.0	--	< 2.0
Beryllium	06/04/2015	E200.7	6.8	64.9	< 2.0	< 2.0
Beryllium	06/16/2015	E200.7	--	--	< 2.0	--
Boron	03/31/2015	SW6010C	1320	2190	--	--
Boron	04/15/2015	SW6010C	2790	2190	396	230
Boron	05/21/2015	E200.7	1630	1750	--	217
Boron	06/04/2015	E200.7	1740	1890	774	238
Boron	06/16/2015	E200.7	--	--	777	--
Cadmium	01/20/2015	SM3113B	--	--	--	--
Cadmium	03/31/2015	SW6010C	< 0.360	1.36	--	--
Cadmium	04/15/2015	SW6010C	< 0.360	1.33	< 0.360	< 0.360
Cadmium	05/21/2015	E200.8	2.26	9.41	--	< 0.110
Cadmium	06/04/2015	E200.8	0.636	11.5	< 0.110	< 0.110
Cadmium	06/16/2015	E200.8	--	--	< 0.110	--
Chromium	01/20/2015	SM3113B	--	--	--	--
Chromium	03/31/2015	SW6010C	32.3	366	--	--
Chromium	04/15/2015	SW6010C	20.5	150	< 1.40	< 1.40
Chromium	05/21/2015	E200.8	112	342	--	0.498
Chromium	06/04/2015	E200.8	23.6	557	< 0.450	3.08
Chromium	06/16/2015	E200.8	--	--	< 0.450	--

**Table 1
Summary of Constituents in Expected Process Water
Bremo Power Station**

			PZ-1 (North Pond)	PZ-2 (East Pond)	North Pond Toe Drain	Metals Pond
Source Water Type			Ash Dewatering Water		Toe Drain	Commingled Process and Stormwater
Chromium (III)	05/21/2015	CALC	112	342	--	< 5
Chromium (III)	06/04/2015	CALC	24	557	< 5	< 5
Chromium (III)	06/16/2015	CALC	--	--	< 5	--
Cobalt	01/20/2015	SM3113B	--	--	--	--
Cobalt	03/31/2015	SW6010C	25.5	265	--	--
Cobalt	04/15/2015	SW6010C	13.6	79.7	< 1.10	--
Cobalt	05/21/2015	E200.7	77.6	167	--	< 2.0
Cobalt	06/04/2015	E200.7	29.4	174	< 2.0	5.5
Cobalt	06/16/2015	E200.7	--	--	< 2.0	--
Copper	01/20/2015	SM3113B	--	--	--	--
Copper	03/31/2015	SW6010C	86.6	1050	--	--
Copper	04/15/2015	SW6010C	57.7	404	2.81	4.04
Copper	05/21/2015	E200.8	363	1110	--	1.63
Copper	05/21/2015	E200.9	--	806	--	--
Copper	06/04/2015	E200.8	70.3	1780	< 0.220	6.05
Copper	06/04/2015	E200.9	--	853	--	--
Copper	06/16/2015	E200.8	--	--	0.681	--
Hexavalent Chromium	04/15/2015	SM3500-CR-B	< 8.8	16	17	< 8.8
Hexavalent Chromium	05/21/2015	SM3500-CR-B	< 50	< 25	--	< 5
Hexavalent Chromium	06/04/2015	SM3500-CR-B	< 25	< 100	< 5	< 5
Hexavalent Chromium	06/16/2015	SM3500-CR-B	--	--	< 5	--
Iron	01/20/2015	SM3111B	--	--	--	--
Iron	03/31/2015	SW6010C	10700	103000	--	--
Iron	04/15/2015	SW6010C	4070	22600	1030	142
Iron	05/21/2015	E200.7	27800	29800	--	548
Iron	06/04/2015	E200.7	8930	30600	12.7	1410
Iron	06/16/2015	E200.7	--	--	3.6	--
Lead	01/20/2015	SM3113B	--	--	--	--
Lead	03/31/2015	SW6010C	28.8	336	--	--
Lead	04/15/2015	SW6010C	15.9	77.2	< 3.10	< 3.10
Lead	05/21/2015	E200.8	152	244	--	< 0.160
Lead	06/04/2015	E200.8	35.6	579	< 0.160	1.47
Lead	06/16/2015	E200.8	--	--	< 0.160	--
Mercury	01/20/2015	SM3112B	--	--	--	--
Mercury	03/31/2015	SW7470A	< 0.170	0.862	--	--
Mercury	04/15/2015	SW7470A	< 0.170	0.361	< 0.170	< 0.170
Mercury	05/21/2015	E245.1	0.109	1.86	--	< 0.023
Mercury	06/04/2015	E245.1	< 0.023	5.39	0.147	< 0.023
Mercury	06/16/2015	E245.1	--	--	< 0.023	--
Molybdenum	01/20/2015	SM3113B	--	--	--	--
Molybdenum	03/31/2015	SW6010C	226	64.9	--	--
Molybdenum	04/15/2015	SW6010C	305	32.6	< 2.50	--
Molybdenum	05/21/2015	E200.7	52.6	< 50.0	--	< 50.0
Molybdenum	06/04/2015	E200.7	92.5	< 50.0	< 50.0	< 50.0
Molybdenum	06/16/2015	E200.7	--	--	< 50.0	--

**Table 1
Summary of Constituents in Expected Process Water
Bremo Power Station**

Source Water Type			PZ-1 (North Pond)	PZ-2 (East Pond)	North Pond Toe Drain	Metals Pond
			Ash Dewatering Water		Toe Drain	Commingled Process and Stormwater
Nickel	01/20/2015	SM3113B	--	--	--	--
Nickel	03/31/2015	SW6010C	40.5	430	--	--
Nickel	04/15/2015	SW6010C	30.3	135	7.56	15.1
Nickel	05/21/2015	E200.8	126	332	--	11.4
Nickel	06/04/2015	E200.8	31.0	625	0.403	20.3
Nickel	06/16/2015	E200.8	--	--	0.527	--
Selenium	01/20/2015	SM3113B	--	--	--	--
Selenium	03/31/2015	SW6010C	< 5.00	90.0	--	--
Selenium	04/15/2015	SW6010C	< 5.00	15.1	< 5.00	< 5.00
Selenium	05/21/2015	E200.8	< 13.0	35.3	--	5.48
Selenium	06/04/2015	E200.8	< 3.25	144	< 0.650	10.6
Selenium	06/16/2015	E200.8	--	--	< 0.650	--
Silver	01/20/2015	SM3113B	--	--	--	--
Silver	03/31/2015	SW6020A	< 0.500	< 1.00	--	--
Silver	04/15/2015	SW6010C	< 1.90	< 1.90	< 1.90	< 1.90
Silver	05/21/2015	E200.8	< 0.580	< 0.870	--	< 0.029
Silver	06/04/2015	E200.8	< 0.145	< 0.870	< 0.029	< 0.029
Silver	06/16/2015	E200.8	--	--	< 0.029	--
Thallium	01/20/2015	E279.2	--	--	--	--
Thallium	03/31/2015	SW6020A	1.91	11.4	--	--
Thallium	04/15/2015	SW6020A	0.818	9.12	< 0.110	0.141
Thallium	05/21/2015	E200.8	7.96	26.4	--	< 0.058
Thallium	06/04/2015	E200.8	1.75	46.4	< 0.058	0.096
Thallium	06/16/2015	E200.8	--	--	< 0.058	--
Vanadium	03/31/2015	SW6010C	176	1420	--	--
Vanadium	04/15/2015	SW6010C	159	796	< 1.40	--
Vanadium	05/21/2015	E200.7	407	718	--	< 2.0
Vanadium	06/04/2015	E200.7	131	1080	< 2.0	< 2.0
Vanadium	06/16/2015	E200.7	--	--	< 2.0	--
Zinc	01/20/2015	SM3111B	--	--	--	--
Zinc	03/31/2015	SW6010C	58.1	447	--	--
Zinc	04/15/2015	SW6010C	35.5	167	< 3.80	< 3.80
Zinc	05/21/2015	E200.8	228	491	--	16.9
Zinc	06/04/2015	E200.8	47.2	943	< 1.60	9.35
Zinc	06/16/2015	E200.8	--	--	5.50	--
WQ/Other (ug/L)						
Ammonia	03/31/2015	E350.1	220	280	--	--
Ammonia	04/15/2015	E350.1	330	310	< 45	< 45
Ammonia Nitrogen	01/20/2015	SM4500-NH3-D	--	--	--	--
Ammonia Nitrogen	05/21/2015	E350.1	460	210	--	90
Ammonia Nitrogen	06/04/2015	E350.1	--	--	< 50	--
Ammonia Nitrogen	06/16/2015	E350.1	--	--	< 50	--
Chloride	01/20/2015	E300	--	--	--	--
Chloride	03/31/2015	E300	15000	5500	--	--
Chloride	04/15/2015	E300	17000	4100	9700	3800
Chloride	05/21/2015	E300.0A	12300	2900	--	< 1000
Chloride	06/04/2015	E300.0A	--	--	11800	--
Chloride	06/16/2015	E300.0A	--	--	11600	--

**Table 1
Summary of Constituents in Expected Process Water
Bremo Power Station**

Source Water Type			PZ-1 (North Pond)	PZ-2 (East Pond)	North Pond Toe Drain	Metals Pond
Source Water Type			Ash Dewatering Water		Toe Drain	Commingled Process and Stormwater
Cyanide	01/20/2015	SM4500-CN-E	--	--	--	--
Cyanide	05/21/2015	SM4500-CN-E	< 10	< 10	--	12
Cyanide	06/04/2015	SM4500-CN-E	< 10	< 10	< 10	< 10
Cyanide	06/16/2015	SM4500-CN-E	--	--	< 10	--
Hardness	04/15/2015	SM2340B	450000	570000	130000	--
Hardness	05/21/2015	SM2340B	476000	628000	--	313000
Hardness	06/04/2015	SM2340B	438000	764000	80000	330000
Hardness	06/16/2015	SM2340B	--	--	78300	--
Oil & Grease, Total Rec	01/20/2015	E1664B	--	--	--	--
Oil & Grease, Total Rec	03/31/2015	E1664B	< 2400	< 2400	--	--
Oil & Grease, Total Rec	04/15/2015	E1664B	< 2400	< 2400	< 2400	< 2400
Oil & Grease, Total Rec	05/21/2015	E1664A	< 5000	< 5000	--	< 5000
Oil & Grease, Total Rec	06/04/2015	E1664A	--	--	< 5200	--
Oil & Grease, Total Rec	06/16/2015	E1664A	--	--	< 5000	--
Total Suspended Solids	01/20/2015	SM4500-P-E	--	--	--	--
Total Suspended Solids	03/31/2015	SM2540D	1100000	2400000	--	--
Total Suspended Solids	04/15/2015	SM2540D	750000	1300000	4300	< 2500
Total Suspended Solids	05/21/2015	SM2540D	5640000	5120000	--	3000
Total Suspended Solids	06/04/2015	SM2540B	--	--	175000	--
Total Suspended Solids	06/04/2015	SM2540D	--	--	< 1000	--
Total Suspended Solids	06/16/2015	SM2540D	--	--	< 1000	--

ug/L - microgram per liter

**Table 2
Statistical Summary of Constituents in Process Water
Brema Power Station**

	PZ-1 (North Pond)		PZ-2 (East Pond)		North Pond Toe Drain		Metals Pond	
Source Water Type	Ash Dewatering Water				Toe Drain		Commingled Process and Stormwater	
Parameter	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Total Metals (ug/L)								
Aluminum	33100	76300	139000	249000	81.3	244	205	334
Antimony	8.68	13.5	9.92	13.4	0.238	0.715	0.253	0.355
Arsenic	486	1020	765	1460	0	0	6.08	8.57
Barium	1340	2510	4800	9370	47.3	114	59.4	59.9
Beryllium	9.52	22.6	60.4	87.7	0	0	0	0
Boron	1870	2790	2010	2190	649	777	228	238
Cadmium	0.724	2.26	5.9	11.5	0	0	0	0
Chromium	47.1	112	354	557	0	0	1.19	3.09
Chromium (III)	68	112	450	557	0	0	0	0
Cobalt	36.5	77.6	171	265	0	0	2.8	5.5
Copper	144	363	1000	1780	1.16	2.81	3.91	6.05
Hexavalent Chromium	0	0	5.3	16	5.7	17	0	0
Iron	12900	27800	46500	103000	349	1030	700	1410
Lead	58.1	152	309	579	0	0	0.49	1.47
Mercury	0.0473	0.189	2.12	5.39	0.049	0.147	0	0
Molybdenum	169	305	24.4	64.9	0	0	0	0
Nickel	57	126	381	625	2.83	7.55	15.6	20.3
Selenium	0	0	71.1	144	0	0	5.38	10.6
Silver	0	0	0	0	0	0	0	0
Thallium	3.12	7.96	23.3	46.4	0	0	0.079	0.141
Vanadium	218	407	1000	1420	0	0	0	0
Zinc	92.2	228	512	943	1.83	5.5	8.75	16.9
WQ/Other (ug/L)								
Ammonia	280	330	300	310	0	0	0	0
Ammonia Nitrogen	460	460	210	210	0	0	90	90
Chloride	14800	17000	4200	5500	11000	11800	1900	3800
Cyanide	0	0	0	0	0	0	6	12
Hardness	455000	476000	654000	764000	96100	130000	322000	330000
Oil & Grease, Total Rec	0	0	0	0	0	0	0	0
Total Suspended Solids	2500000	5640000	14000000	24000000	44800	175000	2000	3000

ug/L - microgram per liter

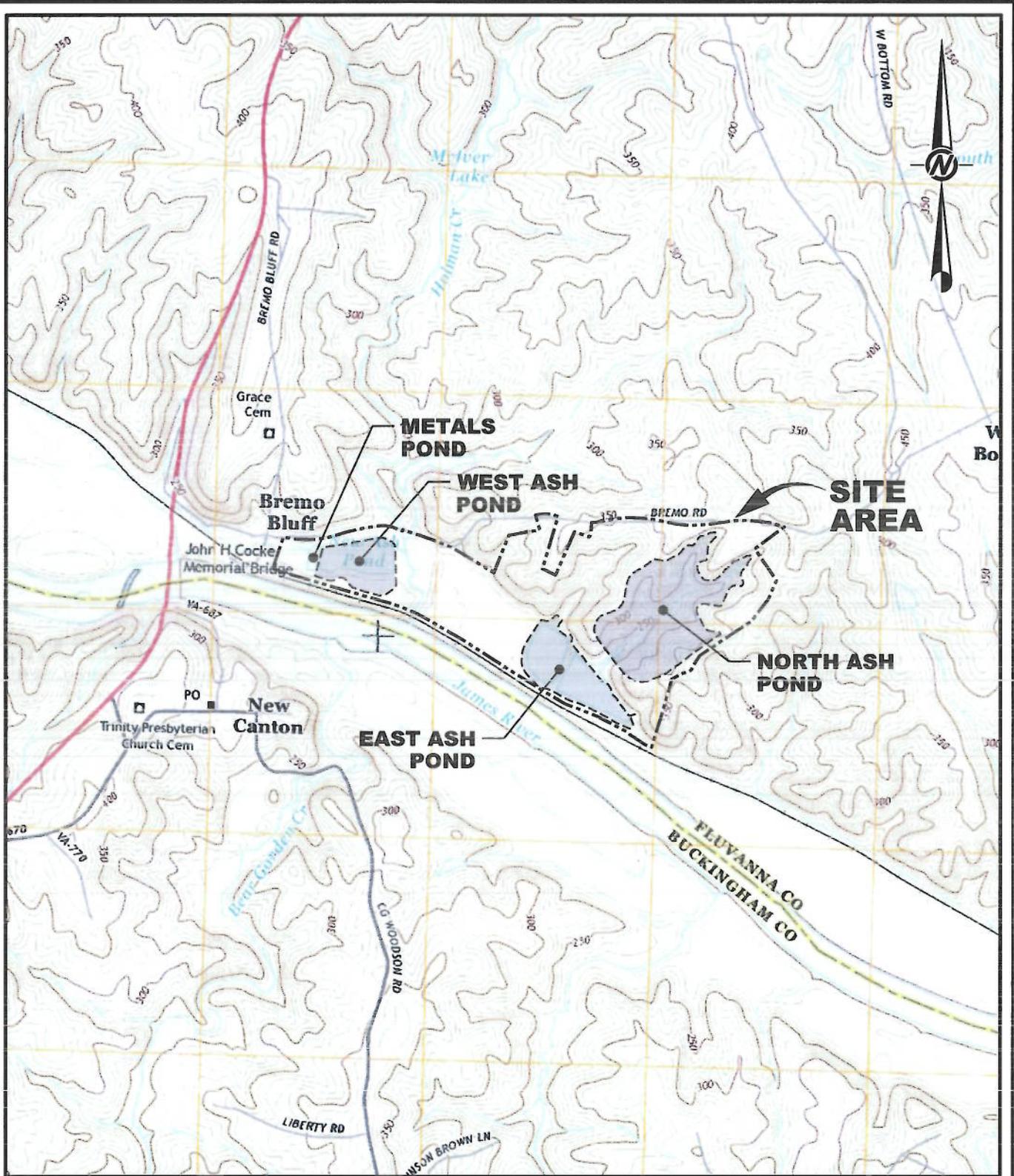
Zero value used in place of all non-detected parameters

Table 3 - Summary of Pre-Permit North Pond Water Sampling Results
Bremo Power Station, Fluvanna, Virginia

Analyte	Method	Date	Units	Detection Limit	Reporting Limit	Outfall 500's Monthly Average	Outfall 500's Monthly Minimum	Outfall 500's Monthly Maximum	NP Catwalk 1' Depth' Results	NP Catwalk 4' Depth Results	NP Pool Results
Chromium, Hexavalent	SM-3500-Cr-B	10/30/2015	ug/L	5.0	10.0	18	No Limit	34	ND	ND	--
	SM-3500-Cr-B	11/2/2015	ug/L	5.0	10.0	18	No Limit	34	--	--	ND
	SM-3500-Cr-B	11/17/2015	ug/L	5.0	10.0	18	No Limit	34	ND	ND	ND
	SM-3500-Cr-B	12/1/2015	ug/L	5.0	10.0	18	No Limit	34	ND	ND	ND
	SM-3500-Cr-B	1/6/2015	ug/L	5.0	10.0	18	No Limit	34	--	--	ND
Copper	200.8	10/30/2015	ug/L	0.50	1.0	12	No Limit	23	7.1	1.5	--
	200.8	11/2/2015	ug/L	0.50	1.0	12	No Limit	23	--	--	1.4
	200.8	11/17/2015	ug/L	0.50	1.0	12	No Limit	23	2.5	2.8	2.2
	200.8	12/1/2015	ug/L	0.50	1.0	12	No Limit	23	1.4	1.4	1.4
	200.8	1/6/2015	ug/L	0.50	1.0	12	No Limit	23	--	--	1.8
Lead	200.7	10/30/2015	ug/L	2.5	5.0	19	No Limit	35	ND	ND	--
	200.7	11/2/2015	ug/L	2.5	5.0	19	No Limit	35	ND	ND	ND
	200.7	11/17/2015	ug/L	2.5	5.0	19	No Limit	35	ND	ND	ND
	200.7	12/1/2015	ug/L	2.5	5.0	19	No Limit	35	ND	ND	ND
	200.7	1/6/2015	ug/L	2.5	5.0	19	No Limit	35	--	--	ND
Mercury	245.1	10/30/2015	ug/L	0.070	0.20	1.5	No Limit	2.8	ND	ND	--
	245.1	11/2/2015	ug/L	0.070	0.20	1.5	No Limit	2.8	--	--	ND
	245.1	11/17/2015	ug/L	0.070	0.20	1.5	No Limit	2.8	ND	ND	ND
	245.1	12/1/2015	ug/L	0.070	0.20	1.5	No Limit	2.8	ND	ND	ND
	245.1	1/6/2015	ug/L	0.070	0.20	1.5	No Limit	2.8	--	--	ND
Nickel	200.7	10/30/2015	ug/L	2.5	5.0	31	No Limit	57	ND	ND	--
	200.7	11/2/2015	ug/L	2.5	5.0	31	No Limit	57	--	--	ND
	200.7	11/17/2015	ug/L	2.5	5.0	31	No Limit	57	ND	ND	2.5, J
	200.7	12/1/2015	ug/L	2.5	5.0	31	No Limit	57	ND	ND	ND
	200.7	1/6/2015	ug/L	2.5	5.0	31	No Limit	57	--	--	ND
Selenium	200.7	10/30/2015	ug/L	5.0	10.0	9.6	No Limit	18	ND	ND	--
	200.7	11/2/2015	ug/L	5.0	10.0	9.6	No Limit	18	--	--	ND
	200.7	11/17/2015	ug/L	5.0	10.0	9.6	No Limit	18	ND	ND	ND
	200.7	12/1/2015	ug/L	5.0	10.0	9.6	No Limit	18	ND	ND	ND
	200.7	1/6/2015	ug/L	5.0	10.0	9.6	No Limit	18	--	--	ND
Silver	200.8	10/30/2015	ug/L	0.050	0.10	2.7	No Limit	5.0	ND	ND	--
	200.8	11/2/2015	ug/L	0.050	0.10	2.7	No Limit	5.0	--	--	ND
	200.8	11/17/2015	ug/L	0.050	0.10	2.7	No Limit	5.0	ND	ND	ND
	200.8	12/1/2015	ug/L	0.050	0.10	2.7	No Limit	5.0	ND	ND	ND
	200.8	1/6/2015	ug/L	0.050	0.10	2.7	No Limit	5.0	--	--	ND

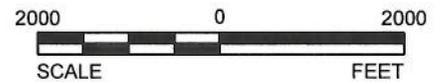
DRAWINGS

G:\Plan Production Data Files\Drawing Data Files\15-20347N - CER Water Treatment\Active Drawings\1520347N01.dwg

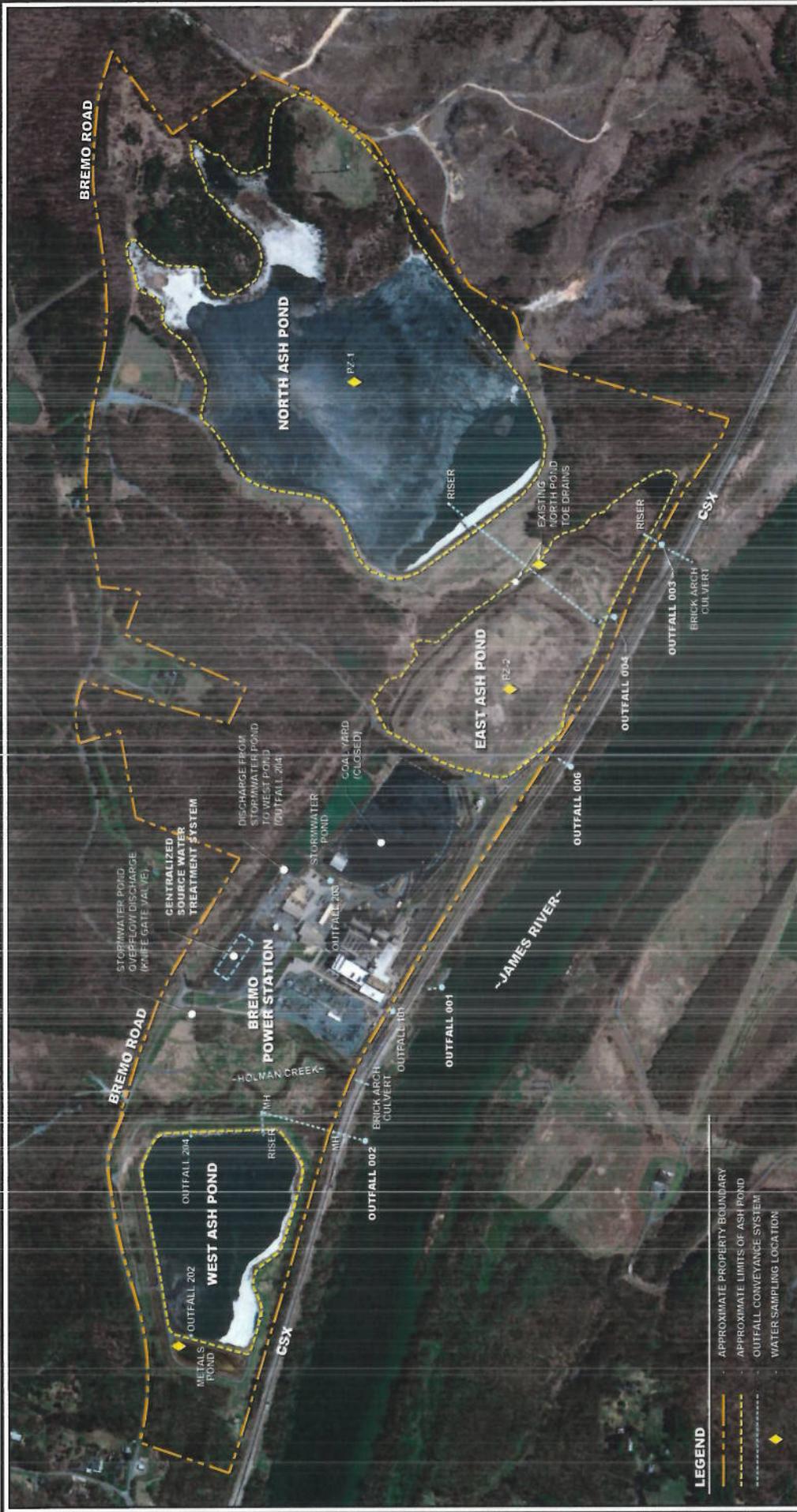


REFERENCE

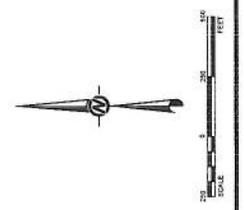
BASE MAP CONSISTS OF 7.5-MINUTE USGS TOPOGRAPHIC QUADRANGLE NAMED ARVONIA, VIRGINIA, DATED 2013.



 Golder Associates Richmond, Virginia	DATE	12/18/15	TITLE	<h2>SITE LOCATION MAP</h2>
	DESIGN	JRD		
PROJECT No.	15-20347	CADD	BPG	<h3>DOMINION - BREMO POWER STATION</h3>
SCALE	AS SHOWN	CHECK	DPM	
REV.	0	REVIEW	JRD	



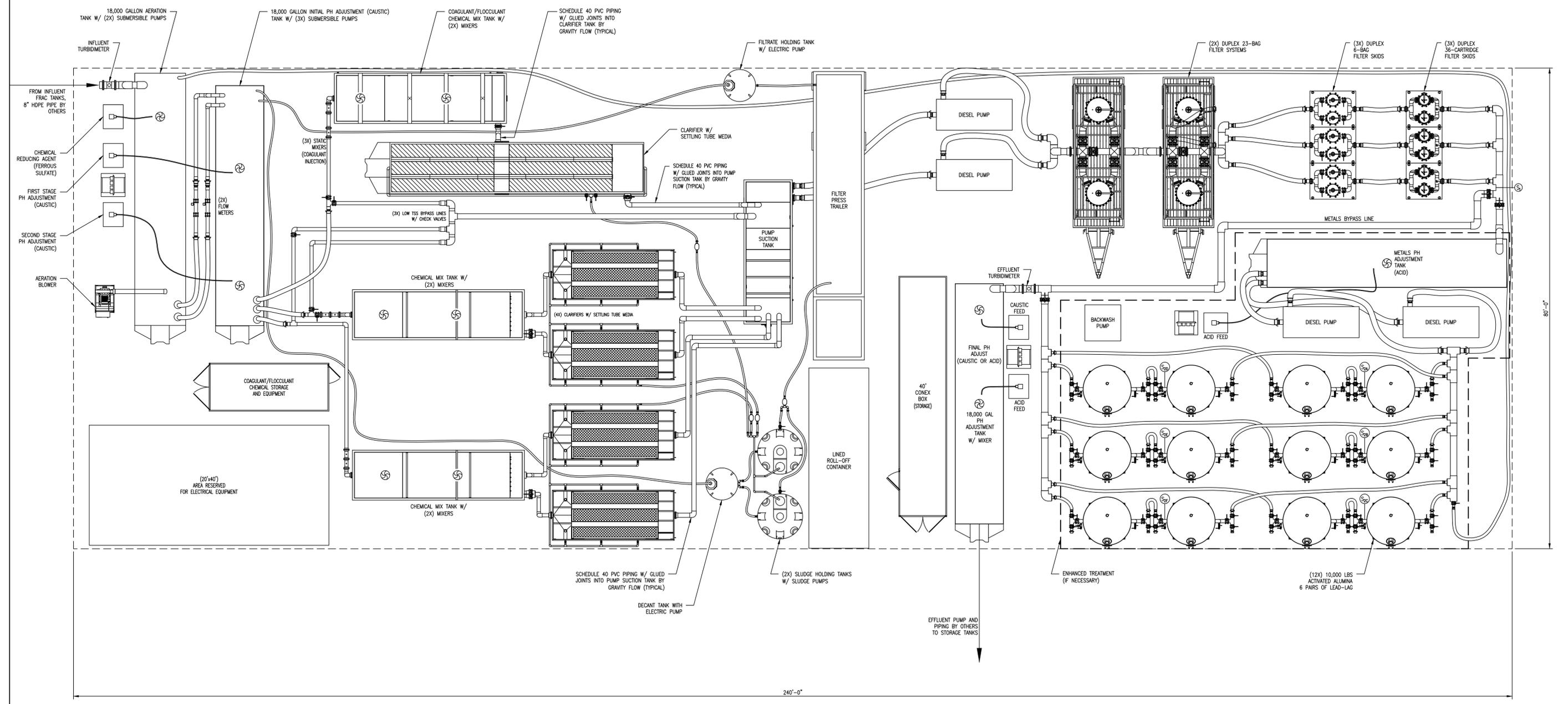
NO.	DATE	PROJECT	DESIGN	ISSUED	CHK.	REV.
BREOMO POWER STATION CONCEPT ENGINEERING REPORT CENTRALIZED SOURCE WATER TREATMENT SYSTEM						
TITLE SITE PLAN						
PROJECT No. 15-2047		FILE No. 152047P02		SCALE		AS SHOWN
DESIGN	JRD	12/18/15	12/18/15	12/18/15	12/18/15	
CADD	ATN	12/18/15	12/18/15	12/18/15	12/18/15	
CHECK	ATN	12/18/15	12/18/15	12/18/15	12/18/15	
REVIEW	JRD	12/18/15	12/18/15	12/18/15	12/18/15	



- LEGEND**
- APPROXIMATE PROPERTY BOUNDARY
 - - - APPROXIMATE LIMITS OF ASH POND
 - - - - - OUTFALL CONVEYANCE SYSTEM
 - ◆ WATER SAMPLING LOCATION

- NOTES:**
- DESIGN FLOW RATE: 1500 GPM
 - SYSTEM FOOTPRINT APPROXIMATELY 80'x240' (PARKING LOT LOCATION)
 - NOT ALL VALVES, CONNECTIONS, ETC. SHOWN FOR CLARITY
 - PVC PIPING TO BE SCHEDULE 40 PVC WITH GLUED JOINTS
 - ⊙ DENOTES SAMPLING LOCATIONS

TEMPORARY CENTRALIZED SOURCE WATER TREATMENT SYSTEM
1500 GPM EQUIPMENT AND PROCESS LAYOUT



ID - C:\Cad Files\QUOTES\Q-6400s\Q-6453 Dominion\Working CAD\QT-146453-LYT09(4)_r032116.dwg - Wed, 23 Mar 2016 - 14:41

THIS DRAWING IS THE PROPERTY OF GROUND/WATER TREATMENT & TECHNOLOGIES, LLC. IT IS NOT TO BE USED FOR ANY PURPOSES DETRIMENTAL TO THE INTEREST OF THIS COMPANY AND IS SUBJECT TO RETURN UPON REQUEST.

SCALE: NTS
DRAWN BY: RJS DATE: 03/23/16
APPROVED BY: RO DATE: 03/23/16

TITLE: CENTRALIZED TREATMENT SYSTEM
1500 GPM
EQUIPMENT LAYOUT



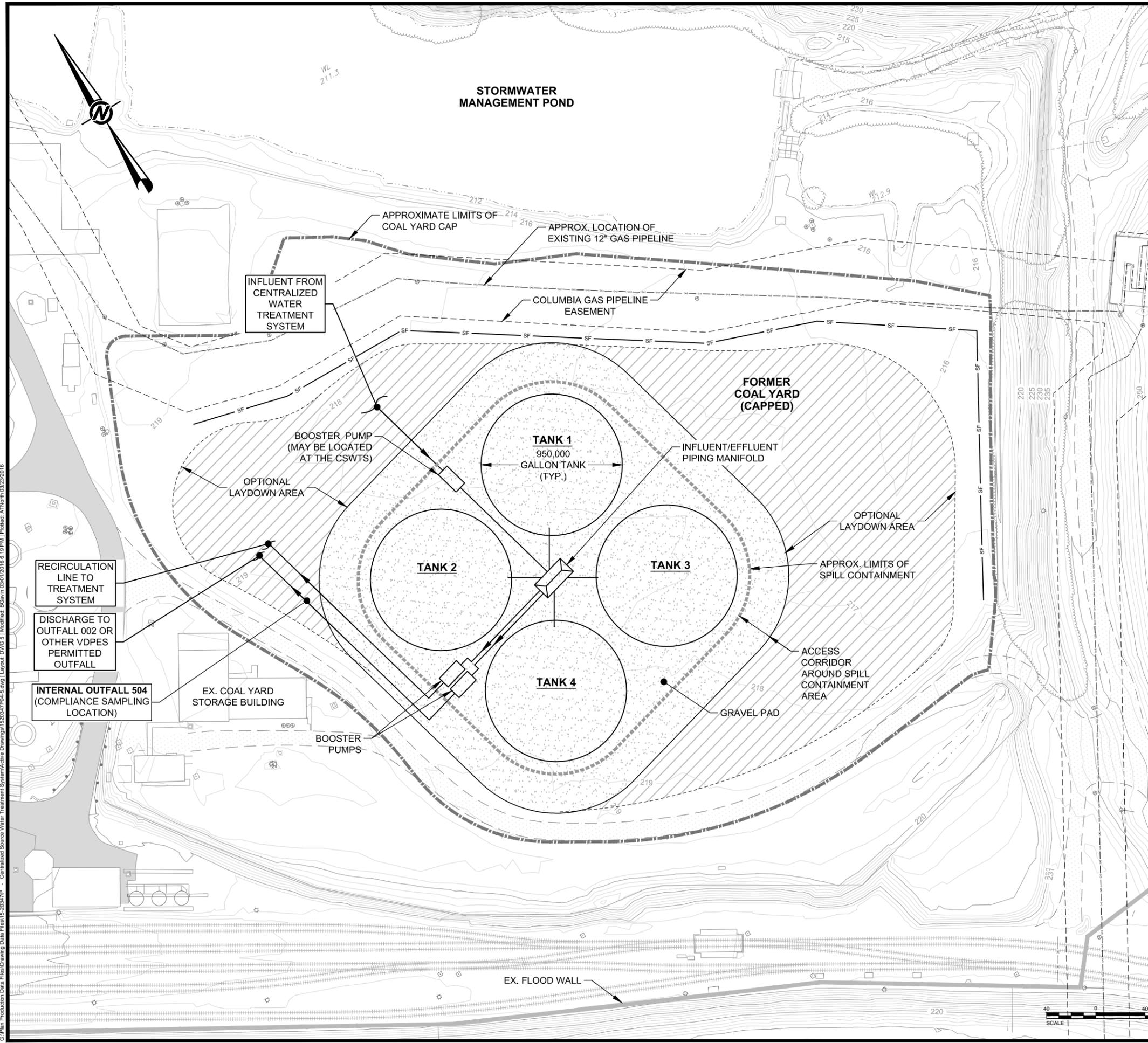
627 MOUNT HOPE ROAD
WHARTON, NJ 07885
PHONE: 973-983-0901
FAX: 973-983-0903
www.gwttllc.com

REV.	DATE	BY	REMARKS	REV.	DATE	BY	REMARKS
4	03/23/16	RJS	ADDED SAMPLE PORTS AND BACKWASH RETURN LINE				

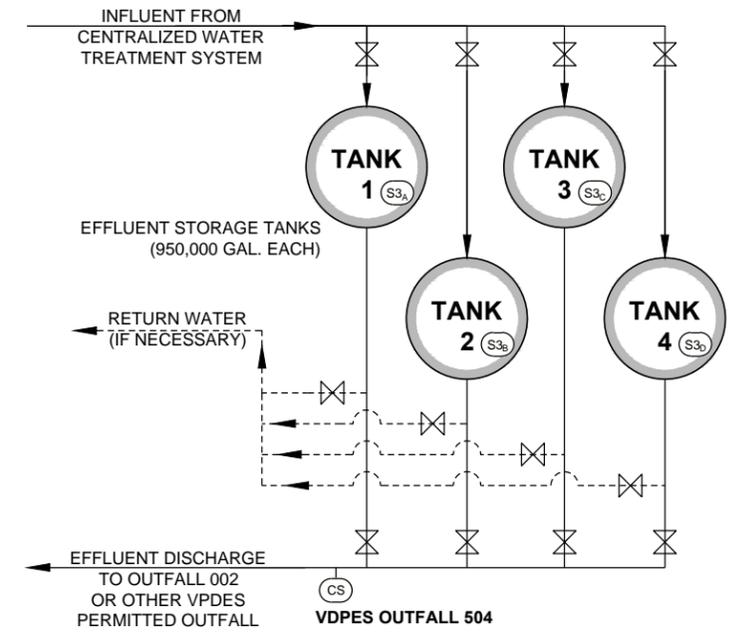
CUSTOMER: DOMINION

DWG. SIZE: D SHEET TOTAL 1 OF 1 DRAWING NO. QT-146453-LYT09 4

**STORMWATER
MANAGEMENT POND**



- NOTE:**
1. PIPING SHOWN FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY.
 2. SPACE BETWEEN TANKS TO BE GRADED TO DRAIN IN CONTAINMENT AREA.



TANK MANIFOLD SCHEMATIC

- (S_A) - DENOTES PROCESS TANK SAMPLE
- (CS) - DENOTES COMPLIANCE SAMPLE
- X - DENOTES VALVES

SHIFT	0	1	2	3	4	5	6	7
TOTAL HOURS	0	12	24	36	48	60	72	84
TANK 1		FILL	ANALYTICAL TESTS	DISCHARGE				
TANK 2			FILL	ANALYTICAL TESTS	DISCHARGE			
TANK 3				FILL	ANALYTICAL TESTS	DISCHARGE		
TANK 4					FILL	ANALYTICAL TESTS	DISCHARGE	
REPEAT PROCESS								

NOTE:
 1.) BASED ON 1,000 gpm
 2.) TANKS MAY BE DISCHARGED SIMULTANEOUSLY. TOTAL DISCHARGE NOT TO EXCEED 1,500 gpm

CONCEPTUAL TANK FILLING & DISCHARGE SEQUENCE

03/23/16	PER DEQ COMMENTS	JRD	ATN	ATN	JRD	
03/01/16	PER DEQ COMMENTS	JRD	ATN	ATN	JRD	
REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW
PROJECT DOMINION BREMO POWER STATION CONCEPT ENGINEERING REPORT CENTRALIZED SOURCE WATER TREATMENT SYSTEM						
TITLE EFFLUENT STORAGE PLAN						
PROJECT No.	15-20347	FILE No.	1520347P04-5			
DESIGN	JRD	02/09/16	SCALE	AS SHOWN		
CADD	ATN	02/06/16	DRAWING 5			
CHECK	ATN	02/11/16				
REVIEW	JRD	02/11/16				



C:\Plan Production Data Files\15-20347P - Centralized Source Water Treatment System\Active Drawings\1520347P04-5.dwg | Layout: DWG-5 | Modified: 03/01/2016 6:19 PM | Printer: ATNorth 03/23/2016



APPENDICES

APPENDIX A
BENCH-SCALE TESTING GUIDELINES FOR THE REDUCTION OF SEDIMENT AND COLLOIDAL PARTICLES



Bench-Scale Testing Guidelines

For the Reduction of Sediment and Colloidal Particles

Bench-scale testing is conducted to help develop and optimize chemical processes like coagulation and flocculation. Let's define coagulation and flocculation as the chemical reactions applied to enhance the agglomeration and filtration & settling characteristics of the insoluble particles to aid the removal of those particles from process water.

For the purposes of these testing procedures, we will consider coagulation as the reduction (i.e., neutralization) of electrostatic forces that cause particles to repel each other. By neutralizing the charge between particles, the forces that repel and keep particles in suspension are alleviated and the particles are allowed to settle out of solution. Flocculation will be generally considered the physical/chemical agglomeration of smaller precipitated particles into larger particles that have more favorable (i.e., faster) settling characteristics.

The most difficult suspended solids to remove from process water are the colloids (e.g., silts, pin floc). Due to their very small size and electrostatic forces, colloidal solids tend to remain suspended for excessively long periods of time; detrimental to both filtration and sedimentation processes. Coagulation (i.e., charge neutralization) is essential to effective colloid removal. Once the charge is reduced or eliminated, then repulsive forces are minimized and gentle agitation in a contact vessel can cause the colloidal solids to collide and form micro-flocs that continue to grow into visible floc particles that settle rapidly and filter easily.

The bench-scale testing is used to determine approximate process operating parameters and characteristics, for example; appropriate chemical reagent and dosage, optimum pH, reaction retention time, treatment volumes/ratios, temperature, mixing requirements, coagulant & flocculent selection, suspended solids, and sludge volume and characteristics.

Each site and project will have unique characteristics that will dictate the conceptual test planning and procedures. However, there are general guidelines and procedures that will enable good data collection and record keeping. **The first and most important guideline is good and comprehensive record-keeping. Write it down and make sure that it is clear for later referral.**

Testing Procedures

Bench-scale testing procedures will vary according to the site specific conditions and available samples. However, comprehensive advance planning including identification of the testing objectives and required testing equipment will enable the most useful testing results.

Below is an example procedure for evaluation of a coagulant and flocculent. The exact procedure should be pre-determined in a planning session that targets project specific objectives.

Examples of Some Important Bench-scale Testing Parameters:

- Initial solution pH
- Temperature
- Alkalinity
- Approximate amount of settleable, suspended/colloidal, dissolved solids
- Hazardous characteristics
- Neutralization chemicals characteristics and amount used to neutralize to a particular pH.

Example Testing Equipment

- pH meter with electrode to monitor pH (if available).
- **ADEGA Liter Containers**
- Eyedroppers & chemical syringes for adding chemical reagents.
- Filter paper and cone
- Turbidity meter (if available)
- Metals Test Kit or Spectrophotometer (if available).
- Timing device (e.g., stop watch, or equal)

Chemicals:

1. Sodium-Hydroxide (Caustic-Soda) solution for pH adjustment (if needed)
2. Sulfuric-Acid solution for pH adjustment (if needed)
3. ADEGA Coagulants & Flocculants

pH considerations

Generally, coagulation and flocculation is performed successfully over a relatively wide range of water pH. Typically, optimum results are achieved within a pH range of 5 to 10. On project sites, pH adjustment is sometimes required to achieve water pH within a target discharge compliance range. It is recommended that pH adjustment be performed prior to coagulation and flocculation testing.

ADEGA Coagulation/Flocculation Test Kit

ADEGA has developed a convenient and “easy-testing” kit for the purpose of on-site bench-scale testing. The testing kit is comprised of small plastic containers (approximately 1.5 liters) with lids that may be used for making 1 liter wastewater samples to perform coagulation, and flocculation bench-scale testing.

When using the easy-testing containers; you can stir the contents within the container or you can place the lid on the container and shake/stir/swirl the container and liquid contents within the container by hand. Shake/swirling should be performed to achieve the same objective as if you were stirring a mixture using a Jar Test mixing device:

- Fast Mix – using the easy-testing container should be considered vigorously swirled for up to a minute or even two. You are looking for signs that the chemical has been thoroughly mixed into the water. When fast mix is completed, let the container sit undisturbed for up to 5 minutes to observe the conditions:
 - If testing coagulation – see if signs of charge neutralization and settling and flocs are developing
- Slow Mix - using the easy-testing container should be considered less-vigorous swirling for up to a minute or even two. You are looking for signs that the chemical has been thoroughly mixed into the water and that larger flocs may be developing as the chemical is thoroughly mixed into the water. When slow mix is completed, let the container sit undisturbed for up to 5 minutes to observe the conditions:
 - If testing flocculation – see if larger flocs that may settle more quickly develop.

Coagulation/Flocculation Testing Procedure:

1. Take time to consider the testing objectives and plan the testing out in stages that will allow you to make reasonable and accurate conclusions. Do not try too many things at once as this strategy may inhibit your ability to establish reliable test results and draw accurate conclusions.
2. Measure the initial chemical/physical characteristics of the sample
3. Record chemical/physical observations regarding the sample
4. Pour a sample of untreated wastewater into a containers or group of containers (e.g., 1,000 ml size containers).
5. To the sample container(s) - add a prescribed (planned) amount of coagulant to the sample – amount depends on the target concentration. For example – a 50 % PAC product may only require 1 ml of product injected into a 1,000 mL sample to achieve a PAC concentration of greater than 500 mg/L in the sample. Typical coagulant doses vary with the amount of target metal to be removed from solution.
 - High initial solids concentrations will require less coagulant dose to aid the process.
 - Testing more than one sample concentration (at the same time) is a good way to compare results against each other – for example: in the 1st container you might add approximately 25 mg/L; in a 2nd container add 50 mg/L; 3rd container add 75 mg/L; 4th container add 100 mg/L – another example; in the 1st container you might add approximately 100 mg/L; in a 2nd container add 200 mg/L; 3rd

container add 400 mg/L; 4th container add 600 mg/L. It is your choice to help you focus in on the best dose for the specific application.

- In coagulation more is not always better.
 - After evaluating the first set of results, one would typically test various concentrations closer to the best results from the first set. For example; let's say that the jar test results in the range of 100 to 200 mg/L appeared to show better results than other ranges. Then you might try another set; in the 1st container you might add approximately 100 mg/L; in a 2nd container add 125 mg/L; 3rd container add 150 mg/L; 4th container add 200 mg/L. The idea is to narrow down your range of concentrations to select a desired treatment dosage.
 - Various concentrations can be as narrow a range or as wide a range as desired.
 - i. Could be a preliminary range to get an idea of what is working - like 100 mg/L, 200 mg/L, 300 mg/L, 400 mg/L.
 - ii. Could be a tight range to determine exactly what dose you want to use – like 1mg/L, 2 mg/L, 3 mg/L, 4 mg/L
 - The range of concentrations depends on the treatment application:
 - i. WC-500 coagulant typical dosage requirements can range from as little as 10 to 20 mg/L to greater than 100 to 300 mg/L.
 - ii. Organic Polymer Coagulants (cationic) typical dosage requirements can range from as little as 5 to 10 to 20 mg/L (for coagulation aid) to 50 to 100 mg/L (for sludge dewatering).
 - iii. Organic Polymer Flocculants (non-ionic & anionic) typical dosage requirements can range from 1 to 5 mg/L sometimes as high as 10 mg/L to 15 mg/L – you do not typically want to use more than a 3 to 5 mg/L of anionic polymer because it may adversely affect sludge conditioning and filter press performance.
6. Perform Fast Mix using the ADEGA liter containers for 1 to 2 minutes and observe the subsequent coagulation of the precipitated particles. Do they appear to be separating and/or creating larger flocs over time? If the particles appear to be coagulating but are perhaps very slowly settling, a flocculent may be beneficial to the process.
- Do not look at an experiment as being a success or failure – we need to look at this as being a test that informs you of how things are working. When something does not work; that can be just as informative (by showing what is not working) as when something is working.
 - Completed results will enable you to plan what your next move will be in terms of developing a process.
 - It is important to write down the results that you find so that you will be able to evaluate later and be able to make intelligent decisions based on the testing results that you have already completed.
7. If being evaluated, flocculent should be added to the solution followed by a Slow Mixing procedure for 2 to 3 minutes to allow for chemical contact to take place and floc building. Flocculent doses may vary but tend to be in a range of 1 to 5 mg/L (active). Higher doses of flocculent may be a bad sign for subsequent solids handling (e.g., sludge thickening, filter press operation).

- It is very important to make sure that you actually get the flocculant well mixed into the sample solution. Do not be shy about swirling the sample vigorously enough to get the mix.
 - Just as important -- after mixing, you need to allow the flocculant some time to affect the precipitated solids and develop larger flocs that will settle out of solution and create a clearer supernatant above the settled solids. The flocs will typically develop into large flocs within a few minutes.
8. If the settling action is too slow or incomplete, it may indicate a greater concentration of coagulant/flocculent needed. Performing several sample tests concurrently with varying levels of coagulant or flocculent may enable evaluation of optimum coagulant/flocculent concentration. Be careful to vary one chemical at a time -- when evaluating the relative performance of various doses of a coagulant -- apply the same flocculent dose to all the samples -- only vary the coagulant. The same rule applies when evaluating varying doses of flocculants.
 9. After a prescribed settling time period (5 to 15 minutes); a clear supernatant should be visible in the upper portion of the sample container. This supernatant may be collected for analytical evaluation. The collected sample should be filtered to remove specs and the filtered sample then analyzed.

1 drop = 0.05 ml

1 drop per liter = 50 mg/l (ppm)

Be sure to take time to observe results and record your testing results; including data like time for settling, visual observations, chemical doses amounts, pH, etc. for the purpose of later data review and system design.

APPENDIX B
TREATABILITY STUDIES

Date: December 18, 2015

Customer: Mr. Ron DiFrancesco
Associate and Senior Consultant
Golder Associates, Inc.
2108 W. Laburnum Ave., Suite 200
Richmond, Virginia 23277

Project Location: Bremono Bluff, VA

Project Scope: Treatability Study for Dominion's East Ash Pond

GWTT Ref#: 6410

Dear Mr. DiFrancesco:

Ground/Water Treatment & Technology, LLC (GWTT) is pleased to submit this report which has been prepared to detail the findings of a laboratory study in accordance with our proposal dated September 8, 2015.

Please find as follows:

Summary

Approximately 20 gallons of water from the Bremono East Ash Pond were collected on November 23, 2015 and received in the laboratory on November 25, 2015. The water represents what is called pore water from the East Ash Pond.

The purpose of this testing is to determine the effectiveness of chemical precipitation in treating the water to discharge standards laid out in the Virginia Department of Environmental Quality draft permit. The treatability process was performed to determine the degree of metals reduction through GWTT's chemical precipitation pre-treatment system.

When designing a treatment process it is required that the discharge standards are known. In this case they are yet to be finalized for this particular site. The discharge criteria in the draft permit are included in Table 1 containing the sampling results from the treatability study.

The sample received had a significant quantity of very fine particles that had settled at the bottom of the containers. Each of the containers was not mixed to simulate a well point system. The solids were black in color.

Samples Collected

The following samples were collected and analyzed during the treatability study:

1. Untreated water (INFLUENT)
2. Chemically precipitated effluent passed through a 5-micron (um) filter (CHEM PRECIP)
3. Chemically precipitated effluent passed through a 0.5-um cartridge filter (FILTRATION)
4. Ion exchange resin treated water (TREATED)

Five gallons split from the total volume of the sample (20 gallons) were mixed completely for the treatability testing process. A split sample for analyses was prepared for the laboratory, labelled INFLUENT. The untreated water was then aerated for 15 minutes to reduce the amount of dissolved metals in the waste stream. Following the aeration step, the pH of the aerated sample was increased to approximately 9.5 standard units (s.u.) using sodium hydroxide to decrease the solubility of the metals in the waste stream. After the pH was adjusted, a coagulant and a flocculent were added to begin the chemical precipitation process. After the precipitation chemicals were added and allowed to completely mix, the samples were allowed to settle for 10 minutes to simulate clarification.

The decanted effluent water was passed through a 5-um filter and a split sample was collected and analyzed by the laboratory, labelled CHEM PRECIP. The filtered sample was filtered again through a 0.5-um filter to determine the amount of dissolved metals remaining in the sample. A split sample of the sub-micron filtered water was collected for analysis by the laboratory, labelled FILTRATION.

Water that was filtered through a 0.5-um cartridge filter was collected for the next unit operation to reduce the dissolved metals concentrations that remain from the chemical precipitation process. Ion exchange resin was placed into vessels to simulate the required empty bed contact time (EBCT) of the full scale treatment plant. Two types of resins were tested in series; the first resin was a cationic resin to reduce metals such as copper, nickel, lead and zinc, followed by an anionic resin that will reduce metals such as arsenic, selenium and thallium. The filtered sample was pumped through both resin beds, and a sample was collected and analyzed by the laboratory, labelled TREATED.



<u>Beaker 1</u>	<u>Beakers 2,3 and 4</u>
<ul style="list-style-type: none"> ○ Untreated ○ Solids Settling 	<ul style="list-style-type: none"> ○ Aerated for 15 minutes ○ pH adjustment with hydroxide to pH of approximately 9.5 ○ Varying Coagulation Dosages ○ Varying Flocculation Dosages ○ Solids Settling

Treatability Results

The results of the analytical testing, along with the draft permit discharge limits for Bremo, are presented in Table 1. The untreated East Ash Pond sample had elevated levels of copper, lead and total suspended solids when compared to the limits in the draft permit, as shown by the highlighted yellow values. The nickel concentration is close the permitted discharge limit, and may be a contaminant of concern if the concentration increases slightly.

The untreated influent sample of East Ash Pond pore water from the previous treatability testing performed in July 2015 was also compared to the draft permit limits for Bremo. The untreated pore water sample from July 2015 had elevated levels of copper, lead, nickel and total suspended solids when compared to the proposed limits for Bremo in the draft permit, as shown by the highlighted yellow values presented in Table 1.

It should be noted that there was an elevated concentration of arsenic in the untreated East Ash Pond sample when compared to the concentration in the previous East Ash Pond pore water sample, but neither of these values were above the draft Bremo permit limit for arsenic.

A subsample of the East Ash Pond untreated influent was later analyzed for dissolved metals in order to determine if the metals concentrations were dissolved in the wastewater or could be attributed to the elevated total suspended solids in the sample. This step was performed to mimic the mechanical filtration that is currently on-site using bag and cartridge filters. The results are shown in Table 2. A majority of the metals of concern in the treatability testing were reduced to below permit limits through mechanical filtration. A notable exception is that the concentration of selenium in the filtered sample was higher than the draft permit limit.

The treatability study results indicate that the treatment process including aeration, hydroxide precipitation, followed by coagulation/flocculation/settling will reduce the contaminants of concern to below the Bremo discharge limits described in the draft permit.

We trust this report is fully responsive to your request. If you have any questions regarding this matter please contact me.

Best Regards,



Rob Orlando
Chief Engineer

www.gwttllc.com

627 Mt. Hope Road, Wharton, NJ 07885

Email: rorlando@gwttllc.com

Cell (973) 800 3531



Beyond Water Treatment

Table 2
Laboratory Bench Test Results - Breomo East Pond Dissolved Metals

PARAMETER	EAST POND PZ-2 112315			BREM0		
	INFLUENT	C _i	MDL	MINIMUM	AVERAGE	MAXIMUM
<i>Dissolved Metals (mg/L)</i>						
Antimony	0.102		0.008	NL	2.1	2.1
Arsenic	0.068		0.002	NL	0.29	0.53
Cadmium	ND		0.001	NL	0.0018	0.0032
Chromium	0.002	J	0.002	NL	0.12	0.22
Copper	0.004	J	0.002	NL	0.012	0.023
Lead	ND		0.002	NL	0.019	0.035
Mercury	--			NL	0.0015	0.0028
Nickel	0.004	J	0.004	NL	0.031	0.057
Selenium	0.011		0.003	NL	0.0096	0.018
Silver	ND		0.002	NL	0.0027	0.005
Thallium	ND		0.004	NL	0.0014	0.0014
Zinc	ND		0.007	NL	0.11	0.21
NOTES						
ND - Non Detect						
Q - Qualifier						
J - Estimated Concentration						
NL - No Limit						
Highlighted Limits indicate that the untreated concentration is greater than effluent discharge limit for the specified constituent						

Date: January 6, 2016

Customer: Mr. Ron DiFrancesco
Associate and Senior Consultant
Golder Associates, Inc.
2108 W. Laburnum Ave., Suite 200
Richmond, Virginia 23277

Project Location: Bremono Bluff, VA

Project Scope: Second Round of Treatability Study for Dominion's East Pond (On-site)

GWTT Ref#: 6410

Dear Mr. DiFrancesco:

Ground/Water Treatment & Technology, LLC (GWTT) is pleased to submit this report which has been prepared to detail the findings of an on-site laboratory scale study in accordance with our proposal dated September 8, 2015.

Please find as follows:

Summary

Approximately 5 gallons of water from the Bremono East Ash Pond were collected from Piezometer PZ-2 on December 27, 2015 by Golder and tested on-site by GWTT. The water represents what is called pore water from the East Ash Pond.

The purpose of this testing is to determine the effectiveness of chemical precipitation in treating the water to discharge standards laid out in the Virginia Department of Environmental Quality draft permit. The treatability process was performed to determine the degree of metals reduction through GWTT's chemical precipitation pre-treatment system.

When designing a treatment process, it is required that the discharge standards are known. In this case, the discharge limits are determined by the Virginia Department of Environmental Quality through

the draft permit being issued to Dominion. The discharge criteria included in Table 1 contain the sampling results from the treatability study as compared to the draft permit received from Golder on January 5, 2016.

The sample collected had a significant quantity of very fine grey suspended particles that were evident throughout the treatability testing. The sample had a pH of 7.3 standard units (s.u.). This sample had a different color than the samples received in Wharton, NJ by GWTT during the first treatability study (in the laboratory), which were black due to oxidation/mixing of the samples during transit.

Samples Collected

The following samples were collected and analyzed during the treatability study:

1. Untreated water (PZ2 INF)
2. Chemically precipitated effluent passed through a 5-micron (um) filter (PZ2 EFF)
3. Aerated effluent not filtered through a 5-um filter (PZ2 Mid 1)
4. Aerated and pH adjusted effluent not filtered through a 5-um filter (PZ2 Mid 2)

Five gallons collected from PZ2 were mixed completely for the treatability testing process. A split sample for analyses was prepared for the laboratory, labelled PZ2 INF. The remaining water was collected and set up in the treatability testing mobile laboratory.



The untreated water was aerated for 15 minutes to reduce the amount of dissolved metals in the waste stream. Following the aeration step, the pH of the aerated sample was increased to approximately 9.5 s.u. using sodium hydroxide to decrease the solubility of the metals in the waste stream. After the pH was adjusted, a coagulant and a flocculent were added to begin the chemical precipitation process. After the precipitation chemicals were added and allowed to completely mix, the samples were allowed to settle for 10 minutes to simulate clarification.



The decanted effluent water was passed through a 5-um filter, and a split sample was collected and analyzed by the laboratory, labelled PZ2 EFF. Each of the four sample jars tested had similar chemical additions from the previous testing, and were retested to determine the efficiency with the different water collected during this treatability test.

Beakers 1, 2, 3 and 4

- Aerated for 15 minutes
- pH adjustment with hydroxide to pH of approximately 9.5
- Single Coagulation Dosage (0.05 mL/L Water)
- Single Flocculation Dosage (1.0 mL/L Water)
- Solids Settling



A second treatability test was performed to determine the efficiency of total metals reduction at each step of the metals pre-treatment process. The sample from PZ-2 was aerated for 15 minutes and was collected for total metals analysis by the laboratory, labelled PZ2 Mid1. The sample was not filtered prior to collection, and the pH of the sample rose to 8.6 s.u.

The next process added sodium hydroxide to the aerated water to increase the pH to a value of 9.5 s.u., and the water was allowed to equalize prior to sample collection. The unfiltered sample was collected and analyzed by the laboratory, labelled PZ2 Mid2. The final pH of the sample was 9.6 s.u.

Treatability Results

The results of the analytical testing, along with the draft permit discharge limits for Bremo, are presented in Table 1 and Table 2. The untreated East Ash Pond sample had elevated levels of arsenic, cadmium, chromium (III), copper, lead, nickel, selenium, thallium, zinc and total suspended solids

when compared to the limits contained in the draft permit. The pre-treatment process reduced the elevated constituents to below the draft permitted limits, with the exception of pH, as shown in Table 1. Therefore, an additional pH adjustment step will be implemented prior to discharge, to meet the pH effluent limit.

The untreated influent sample of East Ash Pond pore water was also tested after each pre-treatment step to determine the extent of reduction of each process.

The aerated pore water sample had elevated levels of copper, lead, nickel, selenium, thallium and total suspended solids (based upon the turbidity measurement of the effluent sample) when compared to the proposed limits in the draft permit, as shown in Table 2. The sample was not filtered prior to total metals analysis.

The aerated pore water sample that was pH adjusted had elevated levels of copper, lead, nickel, selenium, thallium and total suspended solids (based upon the turbidity measurement of the effluent sample) when compared to the proposed limits in the draft permit, as shown in Table 2. The sample was not filtered prior to total metals analysis.

The treatability study results indicate that the treatment process including aeration, hydroxide precipitation, followed by coagulation/flocculation/settling will reduce the contaminants of concern to below the Bremono discharge limits described in the draft permit. These unit operations will need to be operated in conjunction with one another in order to reduce the contaminants to below the permitted discharge limits.

We trust this report is fully responsive to your request. If you have any questions regarding this matter please contact me.

Best Regards,



Rob Orlando

Chief Engineer

www.gwttllc.com

627 Mt. Hope Road, Wharton, NJ 07885

Email: rorlando@gwttllc.com

Cell (973) 800 3531



Beyond Water Treatment

gwttllc.com

TABLE 1: Treatability Testing Results

Analyte	Method	Date	Units	Detection Limit	Reporting Limit	Final Draft Permit MA	Final Draft Permit DM	P22(INF)	P22(EFF)
								Results	Results
pH (Minimum and Maximum)	Field	12/28/2015	S.U.	0.1	0.1	6.0	9.0	7.3	9.3
Oil and Grease	HEM	12/28/2015	mg/L	1.1	5.0	15	20	ND	ND
Antimony	200.7	12/28/2015	ug/L	3.9	5.0	2,100	2,100	11.1	9.0
Arsenic	200.7	12/28/2015	ug/L	5.0	10.0	290	530	328	25.7
Cadmium	200.7	12/28/2015	ug/L	0.50	1.0	1.8	3.2	2.4	ND
Chromium, total	200.7	12/28/2015	ug/L	2.5	5.0	No Limit	No Limit	119	ND
Chromium, trivalent	calculated	12/28/2015	ug/L	NA	NA	120	220	119	ND
Chromium, Hexavalent	SM-3500-Cr-B	12/28/2015	ug/L	0.005	0.010	18	34	ND	ND
Copper	200.8	12/28/2015	ug/L	2.5	5.0	12	23	227	0.6
Lead	200.7	12/28/2015	ug/L	2.5	5.0	19	35	103	ND
Mercury	245.1	12/28/2015	ug/L	0.070	0.20	1.5	2.8	1.2	ND
Nickel	200.7	12/28/2015	ug/L	2.5	5.0	31	57	170	6.4
Selenium	200.7	12/28/2015	ug/L	5.0	10.0	9.6	18	45.8	ND
Silver	200.8	12/28/2015	ug/L	0.050	0.10	2.7	5.0	0.31	ND
Thallium	200.8	12/28/2015	ug/L	0.50	1.0	1.4	1.4	2.6	0.56
Zinc	200.7	12/28/2015	ug/L	2.5	10.0	110	210	137	9.3
Hardness as CaCO3	SM-2340B	12/28/2015	ug/L	662	662	No Limit	No Limit	336,000	240,000
Turbidity	180.1	12/28/2015	NTU	0.50	1.0	No Limit	No Limit	over range	6.51
Total Suspended Solids	SM-2540D	12/28/2015	mg/L	13.3*	13.3*	30.0	100	1,940	ND
Ammonia - N	350.1	12/28/2015	mg/L	0.0050	0.010	9.6	14	0.15	0.20
Chloride	SM-4500-CL-E	12/28/2015	mg/L	0.50	1.0	450	820	3.4	13.3
Cyanide	SM-4500-CN-E	12/28/2015	mg/L	0.004	0.008	No Limit	No Limit	ND	ND

Notes:

ug/L = micrograms per liter mg/L = milligrams per liter SU - Standard Units "-" = No Data
 ND = Not Detected at the indicated detection limit MA = Monthly Average DM = Daily Maximum
 Result exceeds Final Draft Permit MA and/or DM limit
 Result is qualified with "J" as an estimated concentration above the Detection Limit and below the Reporting Limit
 * DL and RL are being verified by Pace

TABLE 2: Treatability Testing Midpoint Results

Analyte	Method	Date	Units	Detection Limit	Reporting Limit	Final Draft Permit MA	Final Draft Permit DM	P22(Mid1)	P22(Mid2)
								Results	Results
pH (Minimum and Maximum)	Field	12/28/2015	S.U.	0.1	0.1	6.0	9.0	8.6	9.6
Oil and Grease	HEM	12/28/2015	mg/L	1.1	5.0	15	20	--	--
Antimony	200.7	12/28/2015	ug/L	3.9	5.0	2,100	2,100	12.6	10.5
Arsenic	200.7	12/28/2015	ug/L	5.0	10.0	290	530	200	178
Cadmium	200.7	12/28/2015	ug/L	0.50	1.0	1.8	3.2	1.2	1.0
Chromium, total	200.7	12/28/2015	ug/L	2.5	5.0	No Limit	No Limit	46.2	54.0
Chromium, trivalent	calculated	12/28/2015	ug/L	NA	NA	120	220	46.2	54.0
Chromium, Hexavalent	SM-3500-Cr-B	12/28/2015	ug/L	0.005	0.010	18	34	ND	ND
Copper	200.8	12/28/2015	ug/L	2.5	5.0	12	23	67.6	82.4
Lead	200.7	12/28/2015	ug/L	2.5	5.0	19	35	35.1	40.9
Mercury	245.1	12/28/2015	ug/L	0.070	0.20	1.5	2.8	0.45	0.40
Nickel	200.7	12/28/2015	ug/L	2.5	5.0	31	57	64.7	74.8
Selenium	200.7	12/28/2015	ug/L	5.0	10.0	9.6	18	10.8	15.3
Silver	200.8	12/28/2015	ug/L	0.050	0.10	2.7	5.0	0.076	0.14
Thallium	200.8	12/28/2015	ug/L	0.50	1.0	1.4	1.4	2.2	1.8
Zinc	200.7	12/28/2015	ug/L	2.5	10.0	110	210	56.8	67.9
Hardness as CaCO3	SM-2340B	12/28/2015	ug/L	662	662	No Limit	No Limit	319,000	309,000
Turbidity	180.1	12/28/2015	NTU	0.50	1.0	No Limit	No Limit	over range	over range
Total Suspended Solids	SM-2540D	12/28/2015	mg/L	13.3*	13.3*	30.0	100	--	--
Ammonia - N	350.1	12/28/2015	mg/L	0.0050	0.010	9.6	14	--	--
Chloride	SM-4500-CL-E	12/28/2015	mg/L	0.50	1.0	450	820	--	--
Cyanide	SM-4500-CN-E	12/28/2015	mg/L	0.004	0.008	No Limit	No Limit	--	--

Notes:

ug/L = micrograms per liter mg/L = milligrams per liter SU = Standard Units "--" = No Data
 ND = Not Detected at the indicated detection limit MA = Monthly Average DM = Daily Maximum
 Result exceeds Final Draft Permit MA and/or DM limit
 Result is qualified with "J" as an estimated concentration above the Detection Limit and below the Reporting Limit
 * DL and RL are being verified by Pace

Aeration Calculations

Design Recommendations for Aeration

Minimum Time	Design Time
10 min	15 min

Full Scale Volume (Frac Tank)
Working Volume (Frac Tank)

18,000 gallons
15,000 gallons

Hydraulic Residence Time (HRT)

Design Flow Rate (500 GPM)

$$\frac{15,000 \text{ gallons}}{500 \text{ gallons/minute}} = 30 \text{ min}$$

Maximum Flow Rate (1,500 GPM)

$$\frac{15,000 \text{ gallons}}{1,500 \text{ gallons/minute}} = 10 \text{ min}$$

Bench Scale Air Flow Rate (scfm)

0.0075 scfm

Dosage at Aeration Time

0.075 ft³ 0.113 ft³

Full Scale Aeration Blower

500 scfm @ 100 " H₂O

NOTES:

1 ft³ = 7.48 gallons

60 min/hr

GPM - gallons per minute

scfm - standard cubic feet per minute

pH Adjustment Calculations

Influent pH (Bench Scale Testing)

7.3 s.u.

Flow Rate (GPM)

Design Flow	Maximum Flow
500 GPM	1,500 GPM

Chemical Used for pH Adjustment

25% NaOH

From Bench Scale Testing

0.155 $\frac{\text{mL NaOH}}{\text{L H}_2\text{O}}$ to raise pH to 9.5 s.u.

Full Scale Flow Rate (Design Flow)

$$\frac{0.155 \text{ mL NaOH}}{\text{L H}_2\text{O}} \times \frac{3.785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal NaOH}}{3.785 \text{ mL NaOH}} = \frac{4.7 \text{ gal NaOH}}{\text{hour}}$$

Full Scale Mass Loading (Design Flow)

$$\frac{4.65 \text{ gal NaOH}}{\text{hour}} \times \frac{10.7 \text{ lbs NaOH}}{\text{gal NaOH}} = \frac{49.755 \text{ lbs NaOH}}{\text{hour}}$$

Full Scale Flow Rate (Maximum Flow)

$$\frac{0.155 \text{ mL NaOH}}{\text{L H}_2\text{O}} \times \frac{3.785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{1,500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal NaOH}}{3.785 \text{ mL NaOH}} = \frac{14 \text{ gal NaOH}}{\text{hour}}$$

Full Scale Mass Loading (Maximum Flow)

$$\frac{13.95 \text{ gal NaOH}}{\text{hour}} \times \frac{10.7 \text{ lbs NaOH}}{\text{gal NaOH}} = \frac{149.27 \text{ lbs NaOH}}{\text{hour}}$$

Hydraulic Residence Time (HRT)

Design Flow Rate (500 GPM)

$$\frac{15,000 \text{ gallons}}{500 \text{ gallons/minute}} = 30 \text{ min}$$

Maximum Flow Rate (1,500 GPM)

$$\frac{15,000 \text{ gallons}}{1,500 \text{ gallons/minute}} = 10 \text{ min}$$

NOTES:

1 ft³ = 7.48 gallons

60 min/hr

3.785 mL/gallon

GPM - gallons per minute

Coagulation Calculations

Coagulant

WC-500 (polyaluminum chloride)

Flow Rate (GPM)

Design Flow	Maximum Flow
500 GPM	1,500 GPM

From Bench Scale Testing

$$\frac{0.050 \text{ mL WC-500}}{\text{L H}_2\text{O}}$$

Full Scale Flow Rate (Design Flow)

$$\frac{0.050 \text{ mL WC-500}}{\text{L H}_2\text{O}} \times \frac{3.785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal WC-500}}{3.785 \text{ mL WC-500}} = \frac{1.5 \text{ gal WC-500}}{\text{hour}}$$

Full Scale Mass Loading (Design Flow)

$$\frac{1.5 \text{ gal WC-500}}{\text{hour}} \times \frac{11.18 \text{ lbs WC-500}}{\text{gal WC-500}} = \frac{16.8 \text{ lbs WC-500}}{\text{hour}}$$

Full Scale Flow Rate (Maximum Flow)

$$\frac{0.050 \text{ mL WC-500}}{\text{L H}_2\text{O}} \times \frac{3.785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{1,500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal WC-500}}{3.785 \text{ mL WC-500}} = \frac{4.5 \text{ gal WC-500}}{\text{hour}}$$

Full Scale Mass Loading (Maximum Flow)

$$\frac{4.5 \text{ gal WC-500}}{\text{hour}} \times \frac{11.18 \text{ lbs WC-500}}{\text{gal WC-500}} = \frac{50.3 \text{ lbs WC-500}}{\text{hour}}$$

NOTES:

1 ft³ = 7.48 gallons

60 min/hr

3.785 mL/gallon

GPM - gallons per minute

Flocculation Calculations

Flocculant AP-210 (0.2% by Mass)

Flow Rate (GPM)

Design Flow	Maximum Flow
500 GPM	1,500 GPM

From Bench Scale Testing

$$1,000 \frac{\text{mL AP-210}}{\text{L H}_2\text{O}}$$

Full Scale Flow Rate (Design Flow)

$$1,000 \frac{\text{mL AP-210}}{\text{L H}_2\text{O}} \times \frac{3,785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} = \frac{30 \text{ gal AP-210}}{\text{hour}}$$

Full Scale Mass Loading (Design Flow)

$$30 \frac{\text{gal AP-210}}{\text{hour}} \times \frac{8.34 \text{ lbs AP-210}}{\text{gal AP-210}} \times \frac{1,000 \text{ lb AP-210}}{2 \text{ lbs AP-210 (ACTIVE)}} = \frac{0.5 \text{ lbs AP-210}}{\text{hour}}$$

Full Scale Flow Rate (Maximum Flow)

$$1,000 \frac{\text{mL AP-210}}{\text{L H}_2\text{O}} \times \frac{3,785 \text{ L H}_2\text{O}}{\text{gal H}_2\text{O}} \times \frac{1,500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} = \frac{90 \text{ gal AP-210}}{\text{hour}}$$

Full Scale Mass Loading (Maximum Flow)

$$90 \frac{\text{gal AP-210}}{\text{hour}} \times \frac{8.34 \text{ lbs AP-210}}{\text{gal AP-210}} \times \frac{1,000 \text{ lb AP-210}}{2 \text{ lbs AP-210 (ACTIVE)}} = \frac{1.5 \text{ lbs AP-210}}{\text{hour}}$$

NOTES:

- 1 ft³ = 7.48 gallons
- 60 min/hr
- 3,785 mL/gallon
- GPM - gallons per minute

Full-Scale Media Treatment Specifications:

Media: CGS, 50 lb/ft³

Media Vessel: Siemens, Model PV-10000

V_b, Media Fill Volume = 330 ft³

Q_b, Design Flow Rate = 500 gal/min

EBCT, Empty Bed Contact Time = $\frac{V_b}{Q_b}$ = 4.94 min = 5 min

Bench-Scale Media Treatment Specifications:

V_b, Media Fill Volume = 0.08722 ft³ = 0.087 ft³ 2" column diameter, 12 inch media fill height

X_B Media Weight = 4.36111 lbs

Q_B, Design Flow Rate = $\frac{V_b \times 7.48}{EBCT}$ = 0.132 gal/min = 7.9 gal/hr
500 mL/min

Conversions:

1 ft³ = 7.48 gallons

60 min/hr

Full-Scale Media Treatment Specifications:

Media: SBG-1, 50 lb/ft³

Media Vessel: Siemens, Model PV-10000

V_D, Media Fill Volume = 330 ft³

Q_D, Design Flow Rate = 500 gal/min

$$\text{EBCT, Empty Bed Contact Time} = \frac{V_D}{Q_D} = \frac{330 \text{ ft}^3}{500 \text{ gal/min}} = 4.94 \text{ min} = 5 \text{ min}$$

Bench-Scale Media Treatment Specifications:

V_B, Media Fill Volume = 0.08722 ft³ = 0.087 ft³ 2" column diameter, 12 inch media fill height

X_B Media Weight = 4.36111 lbs

$$Q_B, \text{ Design Flow Rate} = \frac{V_B \times 7.48}{\text{EBCT}} = \frac{0.087 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3}{500 \text{ mL/min}} = 0.132 \text{ gal/min} = 7.9 \text{ gal/hr}$$

Conversions:

1 ft³ = 7.48 gallons

60 min/hr

Date: February 29, 2016

Customer: Mr. Ron DiFrancesco
Associate and Senior Consultant
Golder Associates, Inc.
2108 W. Laburnum Ave., Suite 200
Richmond, Virginia 23277

Project Location: Bremono Bluff, VA

Project Scope: Treatability Study for Dominion's East Pond Spiked Sample

GWTT Ref#: 6410

Dear Mr. DiFrancesco:

Ground/Water Treatment & Technology, LLC (GWTT) is pleased to submit this report which has been prepared to detail the findings of an on-site laboratory scale study of elevated concentrations of metal.

Summary

Approximately 25 gallons of water from the Bremono East Ash Pond were collected from Piezometer PZ-2 by Golder and tested by GWTT at their treatability lab in Wharton, NJ. The water represents what is called pore water from the East Ash Pond.

The Centralized Treatment System currently installed at the Bremono site will successfully reduce all the metals (at the concentrations reported in the actual data) to below the discharge limits (VPDES Permit No. VA0004138, Dominion – Bremono Power Station). This is based upon previous treatability tests performed in both our lab and on-site, using East pond contact pore water.

However, it is understood that there is a concern for the need of a final polishing unit to address the potential for a higher than normal level of metals (Enhanced Metals Treatment Module) to protect the effluent discharge from a potential "metals spike" that may not be fully captured by the existing treatment system. In order to perform treatability testing for the

higher than normal level of metals, the East Pond pore water sample was “spiked” with a known concentration of total and dissolved metals to simulate this spike in metals in the Pore Water.

The purpose of this testing is to determine the effectiveness of the Enhanced Metals Treatment Module in treating the water to discharge standards laid out in the Virginia Department of Environmental Quality draft permit. The treatability process was performed to determine the degree of metals reduction through GWTT’s chemical precipitation pre-treatment system followed by the use of adsorptive media (fine grain limestone in conjunction with Activated Alumina).

When designing a treatment process, it is required that the discharge standards are known. In this case, the discharge limits are determined by the Virginia Department of Environmental Quality through the draft permit being issued to Dominion. The discharge criteria included in Table 1 contain the sampling results from the treatability study as compared to the draft permit received from Golder on February 19, 2016 through February 22, 2016.

The sample collected had a significant quantity of very fine grey/black suspended particles that were evident throughout the treatability testing. The sample had a pH of 7.3 standard units (s.u.).

Samples Collected

The following samples were collected and analyzed during the treatability study:

1. Untreated spiked wastewater (SPIKED)
2. Chemically precipitated effluent passed through a 0.5-micron (um) filter (FILTER PRECIP)
3. Three liters of chemically precipitate effluent passed through a fine grain limestone and activate alumina column (LIME 3L and AA 3L)
4. Six liters of chemically precipitate effluent passed through a fine grain limestone and activate alumina column (LIME 6L and AA 6L)
5. Twenty four liters of chemically precipitate effluent passed through a fine grain limestone and activate alumina column (LIME 24L and AA 24L)
6. Twenty nine liters of chemically precipitate effluent passed through a fine grain limestone and activate alumina column (LIME 29L and AA 29L)
7. Sixty seven liters of chemically precipitate effluent passed through a fine grain limestone and activate alumina column (LIME 67L and AA 67L)

Twenty-five gallons collected from PZ2 and the spiked metals solution were mixed completely for the treatability testing process. A split sample for analyses was prepared for the laboratory, labelled SPIKED, and analyzed for total and dissolved metals. The remaining water was collected and set up in the treatability laboratory.

The untreated water was treated with a chemical reducing agent (ferrous sulfate) and allowed to mix for 15 minutes to react with the soluble metals in the waste stream. The sample was aerated for 15 minutes to further reduce the amount of dissolved metals in the waste stream. Following the aeration step, the pH of the aerated sample was increased to approximately 9.0 s.u. using sodium hydroxide to decrease the solubility of the metals in the waste stream. After the pH was adjusted, a coagulant and a flocculent were added to begin the chemical precipitation process. After the precipitation chemicals were added and allowed to completely mix, the samples were allowed to settle for 10 minutes to simulate clarification.

Drum Composite Sample

- Ferrous Sulfate Dose (65 mL/L of a 0.0050% solution)
- Aerated for 15 minutes
- pH adjustment with hydroxide to pH of approximately 9.0
- Single Coagulation Dosage (0.05 mL/L Water)
- Single Flocculation Dosage (1.0 mL/L Water)
- Solids Settling



The decanted effluent water was passed through a 0.5-um filter, and a split sample was collected and analyzed by the laboratory, labelled FILTER PRECIP. Filtered effluent was then pumped through testing columns containing adsorptive media (fine grain limestone and activated alumina) at a rate of 30 mL/min. The testing columns contained 24" of adsorptive media per column with a column diameter of 1". Samples were collected from the effluent of each column at given volumes to determine the number of bed volumes pumped through the column:

Volume pumped through Column (L)	Bed Volumes
3 Liters	10
6 Liters	20
24 Liters	78
29 Liters	95
67 Liters	218

Treatability Results

The results of the analytical testing, along with the draft permit discharge limits for Bremono, are presented in Table 1. The untreated spiked East Ash Pond sample had elevated levels of arsenic, cadmium, chromium (III), copper, lead, nickel, selenium, thallium and zinc. The pre-treatment process reduced the elevated constituents to below the draft permitted limits, with the exception of selenium and thallium, as shown in Table 1. The untreated spiked sample contained two times the historical concentration of dissolved selenium and thallium when compared to the historical data.

The effluent of the pre-treatment process which contained the elevated selenium and thallium was further treated through the use of adsorptive media. The limestone reduced the remaining cationic compounds to below effluent permitted limits. The selenium and thallium were reduced through the use of activated alumina. Activated alumina has been proven to be the best available technology by the EPA for reducing anionic compounds such as arsenic, selenium and thallium in wastewater as demonstrated in this treatability testing. Activated alumina is a proven technology to reduce these compounds detected in trace levels in wastewater effluent streams.

Sample analysis shows that thallium breakthrough occurred between a total volume of 6 liters and 24 liters passed through the activated alumina test column. The activated alumina media became saturated with dissolved metals and was unable to adsorb any other metals in the wastewater. Replacement of the media once breakthrough occurs will be determined by inline process sampling.

Certain samples were re-analyzed using lower reporting limits to determine if the non-detect values found in Table 1 were below the effluent permitted limits. Thallium had a lower discharge limit than what the analytical method's reporting limit provided, so samples were rerun using EPA Method 200.8 with lower detection limits to determine the value of the non-

detect contaminants. The results in Table 2 show that the non-detect thallium values were detected at the lower detection limit, but they still met effluent discharge limits.

The treatability study results indicate that the treatment process including aeration, hydroxide precipitation, followed by coagulation/flocculation/settling followed by the use of adsorptive media will reduce the contaminants of concern to below the Bremo discharge limits described in the draft permit. These unit operations will need to be operated in conjunction with one another in order to reduce the contaminants to below the permitted discharge limits.

We trust this report is fully responsive to your request. If you have any questions regarding this matter please contact me.

Best Regards,



Rob Orlando

Chief Engineer

www.gwttllc.com

627 Mt. Hope Road, Wharton, NJ 07885

Email: rorlando@gwttllc.com

Cell (973) 800 3531



Beyond Water Treatment

Table 2
Bremo East Pond PZ-2 Spiked Sample Treatability Testing Reruns

PARAMETER	EAST POND PZ-2 SPIKED SAMPLE FOR METALS REDUCTION																	BREM PERMIT LIMITS					
	SPIKED SAMPLE		TOTAL	Q	DISSOLVED	Q	FILTER PRECIP	Q	LIME 3L	Q	LIME 6L	Q	LIME 24L	Q	LIME 29L	Q	LIME 67L	Q	RL	MDL	MONTHLY AVERAGE	DAILY MAXIMUM	
	Q	Q																					
Total Metals (ug/L)																							
Antimony	6.48		2.6	J	5.44		5.17	9	J	13	63	5.21	11	11	45			3	0.1	2100	2100		
Selenium	16		14		9.6	J	9	J	13	13	13	13	11	11	9.7			J	10	3	9.6	18	
Silver	ND		ND		ND		ND	ND	ND	ND	ND	ND	ND	ND	ND			1	0.1	2.7	5		
Thallium	74		40		39		29	J	34	34	34	43	39	39	40			1	0.03	1.4	1.4		
Total Metals (ug/L)																							
Antimony							1.92	J	11	J	3.88	6	6	6	3.76	20		3	0.1	2100	2100		
Selenium							ND	ND	ND	6	6	6	6	6	7			J	10	3	9.6	18	
Silver							ND	ND	ND	ND	ND	ND	ND	ND	ND			1	0.1	2.7	5		
Thallium							0.32	J	0.86	J	7	7	8	8	12			1	0.03	1.4	1.4		

NOTES

ND - Non Detect
NS - Not Sampled

Q - Qualifier
RL - Reporting Limit

U - Undetected
NL - No Limit

J - Estimated Concentration [Estimated Concentration is defined as less than the reporting limit (RL) but greater than the method

Highlighted Limits indicate that the concentration is greater than effluent discharge limit for the specified constituent.

SPIKED is water from PZ-2 in which Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Thallium and Zinc were added to create a water sample that approximated historically and abnormally high concentrations of these constituents.

FILTER PRECIP is water that represents the effluent from the current treatment process. The current treatment process consists of chemical precipitation followed by mechanical filtration to 0.5 micron.

APPENDIX C
SAFETY DATA SHEETS

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET**

Material Name: WC 500

October 9, 2014

SECTION 1 – GENERAL INFORMATION

Manufacturer/Supplier's Name: ADEGA CHEMICAL
25411 NE 53rd Street
Vancouver, Wa, 98682

PRODUCT AND TECHNICAL INFORMATION NUMBER: (949) 275-7208

Proper Shipping Name	(49CFR 172.101):	None
D.O.T. Hazard Name	(49CFR 172.101):	None
D.O.T. ID Number	(49CFR 172.101):	None
D.O.T. Hazard Class	(49CFR 172.101):	None
RCRA Hazard Class	(40CFR 261) (IF DISCARDED):	None
E.P.A. Priority Pollutants	(40 CFR 122.53):	None

U.S. NFPA: Health: 2; Flammability: 0; Reactivity: 0

US HMIS: Health Hazard: 2; Fire Hazard: 0; Physical Hazard: 0; Personal Protection: B

Generic Description: contains water soluble Dialuminum Chloride Pentahydroxide (Aluminum Chlorohydrate) in a 50 % w/w solution in water

**SECTION 2 – HAZARDS IDENTIFICATION
HAZARDOUS INGREDIENTS AS DEFINED IN 29 CFR 1910 1200**

Classification: Not Regulated, No Hazard
Label Elements: Not Regulated, No Hazard
Other Hazards: Not Regulated, No Hazard

CAS No: 12042-91-0	Ingredient: Dialuminum Chloride	Exposure Limits: OSHA PEL and ACGIH TLV for Aluminum, Soluble Salts:
EC No: 234-933-1	Pentahydroxide	TWA 2 MG/M3 as aluminum

Purity: 50 % Aluminum Chlorohydrate w/w Other Constituent: water
impurities: None Additives: none
Hazard Ingredients: none

SECTION 3 – EFFECTS OF OVEREXPOSURE

EYES: Direct contact irritates slightly to moderately with redness and swelling

SKIN: A single relatively short exposure causes no known adverse effect.
Repeated exposures may irritate.

INHALATION: Inhaling dust or mist created during use may injure the respiratory system and cause an adverse lung reaction.

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET**

Material Name: WC 500

October 9, 2014

ORAL: Small amounts transferred to the mouth by fingers during use, etc., should not injure. Swallowing large amounts may cause injury.

COMMENTS: This product, as with any chemical, may enhance allergic conditions on certain people.

SECTION 4 – EMERGENCY AND FIRST AID PROCEDURES

General Information: Immediate medical attention is typically not necessary unless ingested or in eyes

EYES: Immediately flush with lukewarm water, including under eyelids for 15 min. If symptoms persist, get immediate medical attention.

SKIN: Wipe off and flush with water, then wash with soap and water. If symptoms persist, get immediate medical attention

INHALATION: Supply fresh air. Rinse wouth and nose with water. Get medical attention if there is any discomfort.

ORAL: Never give anything by mouth to an unconscious person. Do not induce vomiting. Rinse mouth with water. Drink 1 or 2 glasses of water or milk. Get medical attention if large amount swallowed or there is any discomfort

SECTION 5 – FIRE AND EXPLOSION DATA

FLASH POINT (METHOD USED): NONE; NOT FLAMMABLE

EXTINGUISHING MEDIA: Cool containers with water fog

SPECIAL FIRE FIGHTING PROCEDURES:

Self-contained breathing apparatus and protective clothing should be worn in fighting fires involving chemicals.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Excessive heating (after water evaporation) for long periods of time can result in the evolution of HCl.

SECTION 6 – PHYSICAL DATA

pH (20 °C): ≈ 3.5 (neat), ≈ 4 in a 15 % w/w solution

BOILING POINT (AT 760 MM HG):

Approx 212°F/100°C

SPECIFIC GRAVITY (AT 77 DEG. F / 25 DEG. C)

1.34

MELTING POINT:

Approx. 32°F / 0°C

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET**

Material Name: WC 500

October 9, 2014

VAPOR PRESSURE (AT 77 DEG F / 25 DEG C): 24 MM (water)

VAPOR DENSITY (AIR = 1 AT 77 DEG F / 25 DEG C): That of moist air

PERCENT VOLATILE BY WEIGHT (%): 50 (water)

EVAPORATION RATE (ETHER = 1): As water

SOLUBILITY IN WATER (%): Approx. 100

ODOR, APPEARANCE, COLOR: Clear (colorless to slight yellowish tint) liquid, with slight characteristic odor

NOTE: The above information is not intended for use in preparing product specifications, contact manufacturer before writing specifications.

SECTION 7 – STABILITY and REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY (MATERIAL TO AVOID):
Will react with caustics will precipitate Aluminum Hydroxide.
Can corrode ordinary grades of steel

CONDITIONS TO AVOID: Exposure to above and continuous high temperatures.

HAZARDOUS DECOMPOSITION PRODUCTS: Excessive heating for long periods of time can result in the evolution of HCl.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 8 – SPILL, LEAK, MAINTENANCE / REPAIR AND DISPOSAL PROCEDURES

Steps to be taken in case material is released or spilled: Use absorbent material to collect and contain. Wash with clear water only

PERSONAL PROTECTIVE EQUIPMENT:

EYES: Safety glasses, as a minimum, goggles if splashing should occur.

SKIN: Washing at mealtime and end of shift is adequate.

INHALATION: No respiratory protection should be needed.

WASTE DISPOSAL METHOD:

Material is not a hazardous waste; manufacturer suggests that all Local, State and Federal Regulations concerning Health and pollution be reviewed to determine approved disposal procedures. Contact supplier/manufacturer if there are any Disposal questions.

D.O.T. (49CFR 171.8)/E.P.A (40CFR 117) SPILL REPORTING INFORMATION:

HAZARDOUS SUBSTANCE: None

REPORTABLE QUANTITY: Not Applicable

CONCENTRATION OF HAZARDOUS SUBSTANCE: Not Applicable

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET**

Material Name: WC 500

October 9, 2014

REPORTABLE QUANTITY OF PRODUCT: Not Applicable

COMMENTS: Product contains no ingredient subject to D.O.T. or E.P.A.
CERCLA/SARA environmental release reporting regulations.
See SEC. 11. For additional SARA compliance information.

SECTION 9 – ROUTINE HANDLING PRECAUTIONS

PERSONAL PROTECTIVE EQUIPMENT:

EYES: Safety glasses, as a minimum, goggles if splashing should occur.

SKIN*: Washing at mealtime and end of shift is adequate.

INHALATION: No respiratory protection should be needed unless mists are created.

VENTILATION: LOCAL EXHAUST: None should be needed.

MECHANICAL (GENERAL): Recommended

SUITABLE RESPIRATOR: Dust/Mist type

These precautions are for room temperature handling. Use at elevated temperatures, or aerosol / spray applications may require added precautions.

* Good practice requires that gross amount of any chemical be removed from the skin as soon as practical, especially before eating or smoking

COMMENTS: Avoid eye contact.

SECTION 10 – SPECIAL PRECAUTIONS

Use reasonable care and caution in handling and storage. Store between 32° F/0°C and 120°F/49°C.

SECTION 11 – TOXICOLOGICAL INFORMATION

This product is not classified under either the Dangerous Substance Directive or the GHS/CLP Regulation.

Acute Toxicity

Oral; Not classified – rat ingestion study, OECD 401, LD50 (rat) indicates > 2,000 mg/kg

Dermal; Not classified – rat dermal toxicity study, OECD 402, LD50 (rat) indicates > 2,000 mg/kg

Irritant or Corrosive Effects

Primary irritation to skin; Not classified - negative results rabbit skin, OECD 404

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET**

Material Name: WC 500

October 9, 2014

Irritation to eyes; Not classified - negative results rabbit eye, OECD 405

Sensitization

Not classified. Negative result for Aluminum Hydroxy Chloride, CAS 1327-41-9

Specific Target Organ Toxicity (STOT)

Not classified. No STOT identified in animal studies. Human effects can be related to systemic toxicity

Repeated Dose Toxicity

Not classified. Read across from chronic (1 year) toxicity study (oral, rat) with Al Citrate, OECD 426, and OECD 452. Read across from short term repeat dose toxicity study (rat) with Aluminum Hydroxy Chloride, CAS 1327-41-9.

Carcinogenicity

Not classified. No studies; none expected

Mutagenicity/Genotoxicity

Not classified. Negative results for in-vitro mutagenicity testing

Toxicity for Reproduction

Not classified. Read across from Aluminum Hydroxy Chloride reproductive/developmental toxicity screening test. NOEL 1000 mg/kg/day (equivalent to 90 mg/kg bw/day Al³⁺) and Aluminum Citrate one year developmental and chronic neurotoxicity study (oral, rat).

SECTION 12 – ECOLOGICAL INFORMATION

Aquatic Toxicity:

P. Promelas LC₅₀ (72h) > 1000 mg/L, LC₅₀ (96h) 720 mg/L; EC₅₀ (72h) 316 mg/L, EC₅₀ (96h) 40 mg/L
C. Dubia LC₅₀ (24h) > 1000 mg/L, LC₅₀ (48h) 0.32 mg/L; EC₅₀ (24h) 316 mg/L, EC₅₀ (48h) < 0.1 mg/L
Zebra fish LC₅₀ (96h) 100 – 500 mg/l (OECD 203), Daphnia Magna EC₅₀ (48h) 397mg/l,
EC₅₀ (bacteria) > 1000 mg/l Fermentation tube test.

Mobility

Not classified based on rapid hydrolysis and precipitation.

Persistence and Degradability

Inorganic product, not degradable. Cannot be eliminated from water by biological purification processes.

Results of PBT Assessment

Substance is not toxic.

SECTION 11 – COMMENTS

Additional SARA regulatory compliance information

SEC. 312 HAZARD CLASS: Immediate

SEC. 313 NOTIFICATION: Not Applicable; either none present or none present
in regulated quantities.

These data are offered in good faith as typical values and not as a product specification. No warranty, either expressed or implied, is hereby made. The recommended industrial hygiene and safe handling procedures are believed to be generally applicable. However, each user should review these recommendations in the specific context of the intended use and determine whether they are appropriate.

ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET
Material Name: AP-210

SECTION 1 – GENERAL INFORMATION

Manufacturer/Supplier's Name: ADEGA CHEMICAL
25411 NE 53rd Street
Vancouver, Wa 98682

PRODUCT AND TECHNICAL INFORMATION NUMBER: (949) 275-7208

SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS

IDENTIFICATION OF THE PREPARATION: Anionic Water-Soluble Polymer
(polyacrylamide; CAS No. 9003-05-8)

SECTION 3 – HAZARDS IDENTIFICATION

Aqueous solutions or powders that become wet render surfaces extremely slippery

SECTION 4 – FIRST AID MEASURES

INHALATION: Move to fresh air.

SKIN CONTACT: Wash with water and soap as a precaution. In case of persistent skin irritation, consult physician.

EYE CONTACT: Rinse thoroughly with plenty of water, also under the eyelids. In case of persistent eye irritation, consult a physician.

INGESTION: The product is not considered toxic based on studies on laboratory animals.

SECTION 5 – FIRE-FIGHTING MEASURES

SUITABLE EXTINGUISHING MEDIA: Water, water spray, foam, carbon dioxide (CO₂), dry powder.

SPECIAL FIRE-FIGHTING PRECAUTIONS: Aqueous solutions or powders that become wet render surfaces extremely slippery.

PROTECTIVE EQUIPMENT FOR FIREFIGHTERS: No special protective equipment required.

ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET
Material Name: AP-210

SECTION 6 – ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS: No special precautions required.

ENVIRONMENTAL PRECAUTIONS: Do not contaminate water

METHODS FOR CLEANING UP: Do not flush with water. Clean Up promptly by sweeping or vacuum. Keep in suitable and closed containers for disposal. After cleaning, flush away traces with water.

SECTION 7 – HANDLING AND STORAGE

HANDLING: Avoid contact with skin and eyes. Avoid dust formation. Do not breathe dust. Wash hands before breaks and at the end of workday.

STORAGE: Keep in a dry, cool place (0-35°C).

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS: Use local exhaust if dusting occurs. Natural ventilation is adequate in absence of dusts.

PERSONAL PROTECTION EQUIPMENT

RESPIRATORY PROTECTION: Dust safety masks are recommended where concentration of total dust is more than 10 mg/m³

HAND PROTECTION: Rubber gloves

EYE PROTECTION: Safety glasses with side-shields. Do not wear contact lenses

SKIN PROTECTION: Chemical resistant apron or protective suit if splashing or contact with solution is likely.

HYGIENE MEASURES: Wash hands before breaks and at the end of the workday. Handle in accordance with good industrial hygiene and safety practice.

ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET
Material Name: AP-210

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

FORM:	Granular solid
COLOR:	White
ODOR:	None
PH:	5-9@5g/l
MELTING POINT (C):	Not Applicable
FLASH POINT(C):	Not Applicable
AUTOIGNITION TEMPERATURE (C):	Not Applicable
VAPOUR PRESSURE (MM HG):	Not Applicable
BULK DENSITY:	0.6 to 0.9
MAX CONCENTRATION:	10 g/L
VISCOSITY (MPA S):	@ 20 °C; 1 g/L ≈ 170 cps; 5 g/L ≈ 1200 cps

SECTION 10 – STABILITY AND REACTIVITY

STABILITY: Product is stable. No hazardous polymerization will occur

CONDITIONS TO AVOID: Oxidizing agents may cause exothermic reactions.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition may produce nitrogen oxides (NO_x), carbon oxides C(O_x)

SECTION 11 – TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

ORAL:	LD50/Oral/Rat>5000mg/kg
DERMAL:	LD50/Oral/Rat>5000mg/kg
INHALATION:	The product is not expected to be toxic by inhalation.

IRRITATION

SKIN:	Not irritating
EYES:	Not irritating
RESPIRATORY SYSTEM:	Not a respiratory irritant
SENSITIZATION:	No sensitizing
CARCINOGENICITY:	Not carcinogenic
CHRONIC TOXICITY:	No Chronic effects

ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET
Material Name: AP-210

SECTION 12 – ECOLOGICAL INFORMATION

FISH: LC50/Fathead minnow/96 hr>100 mg/L (OECD 203)

ALGAE: LC50/Scenedesmus subspicatus/72hr>100 mg/L (OECD 201)

DAPHNIDS: EC50/C. Dubia/48 hr>100 mg/L (OECD 202)

BIOACCUMULATION: Does not bioaccumulate.

PERSISTENCE / DEGRADABILITY: Not readily biodegradable.

SECTION 13 – DISPOSAL CONSIDERATIONS

WASTE FROM RESIDUES / UNUSED PRODUCTS: In accordance with Federal, State, and Local Regulations.

CONTAMINATED PACKAGING: Rinse empty containers with water and use the rinse water to prepare the working solution. Can be landfilled or incinerated, when in compliance with local regulations.

SECTION 14 – TRANSPORT INFORMATION

NOT REGULATED BY D.O.T.

**ADEGA CHEMICAL COMPANY
MATERIAL SAFETY DATA SHEET
Material Name: AP-210**

SECTION 15 – REGULATORY INFORMATION

**ALL COMPONENTS OF THIS PRODUCT ARE ON THE
TSCA AND DSL INVENTORIES**

RCRA STATUS: Not a hazardous waste.

HAZARDOUS WASTE NUMBER: Not Applicable

REPORTABLE QUANTITY (40 CFR 302): Not Applicable

THRESHOLD PLANNING QUANTITY (40 CFR 355): Not Applicable

CALIFORNIA PROPOSITION 65 INFORMATION:

The following statement is made in order to comply with the ca safe drinking water and toxic enforcement act of 1986: this product contains a chemical known to the state of california to cause cancer: residual acrylamide

HMIS & NFPA RATINGS:

	HMIS	NFPA
HEALTH	1	1
FLAMMABILITY:	1	1
REACTIVITY:	0	0

SECTION 16 – OTHER INFORMATION

PERSON TO CONTACT: Regulatory Affairs Manager

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of it's publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release, and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process unless specified in the text.