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
located at 4411 Early Road, Harrisonburg, VA
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

Amy Thatcher Owens
Regional Director

February 8, 2016

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
Dominion – Bremo Power Station, VPDES Permit No. VA0004138

Dear Ms. Taylor:

The Concept Engineering Report (CER) for the above referenced project is approved. This action is in accordance with a memorandum dated February 8, 2016, a copy of which is enclosed for your information.

The Department of Environmental Quality 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.

The CER indicates that storage capacity for the effluent from the Centralized Source Water Treatment System may be added if necessary to effectively manage the wastewater. If storage capacity for the effluent is to be added, an addendum to the Concept Engineering Report that addresses the storage shall be submitted to the DEQ-Valley Regional Office. DEQ approval shall be secured prior to adding the effluent storage.

Part I.G.5 of VPDES Permit No. VA0004138 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.

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

Sincerely,

Brandon D. Kiracofe

Brandon D. Kiracofe
Regional Water Permits & Compliance Manager

cc: Ken Roller
Oula Shehab-Dandan
Taylor L. Engen
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
Dominion – Bremo Power Station, VPDES Permit No. VA0004138

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

FROM: Bev Carver

DATE: February 8, 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.

Previous Agency Action: None

Staff Comments: The staff has no objections to the CSWTS as proposed in Dominion's submittal received on February 5, 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

Dominion

Overnight Mail
Return Receipt Requested

February 5, 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 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. The CER submitted by my cover January 27, 2016 cover letter has been updated to address DEQ comments as follows :

1. Revised Drawing 4 to show the return water line from the "Filter Press Trailer" press back to the "pH Adjustment Tank", and include language in Section 4.3 specifically stating that routing;
2. Revised Drawing 4 to show the Decant Tank mentioned in Section 4.3;
3. Revised Drawing 4 to show the return water line from the "Decant Tank" back to the "pH Adjustment Tank", and include language in Section 4.3 specifically stating that routing;
4. Revised Drawing 4 to re-label the "Cone Bottom Tanks" to "sludge holding tanks" to match the text in Section 4.3, and;
5. Revised the bullet list of system component in Section 4.2 to match the labels on Drawing 4 relative to the 3 different filter units.
6. Revised the bullet list of system components in Section 4.2 to match the exact title of the third and final filter unit as shown on Drawing 4 (i.e., the bullet was revised to read "Three (3) duplex 36-cartridge filtration system").

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,

Cathy C. Taylor

Cathy C. Taylor
Director, 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

COMMONWEALTH OF VIRGINIA
JAMES R. DIFRANCESCO
Lic. No. 025260
2-4-16
PROFESSIONAL ENGINEER

January 2016
Revised February 2016

1520-347.300

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1.0 INTRODUCTION

This Concept Engineering Report (CER) has been prepared for the proposed Centralized Source Water Treatment System (CSWTS) at Dominion's Bremo 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 re-purposing 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 14, 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 Bremo Power Station is owned and operated by Virginia Electric and Power Company doing business as Dominion Power (Dominion) in Fluvanna County, Virginia, at 1038 Bremo 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 Adega Chemical Company (see Appendix A – *Bench-scale Testing Guidelines for the Reduction of Sediment and Colloidal Particles*). Two treatability studies were performed, one 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 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 "frac" tank;
- 12-inch high density polyethylene (HDPE) piping from the source pumps to the "frac" 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, frac 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 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 Adega 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 Adega 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 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 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 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 two duplex bag filter skids will consist of two 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 third set of bag filter skids will consist of two 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 duplex cartridge filter skids will each consist of two 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 pH adjustment tank is an 18,000-gallon (nominal), open-top, frac 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 secondary 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 desired outfall using a diesel transfer pump. The diesel transfer pump is capable of 1,800 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 may be added if necessary to effectively manage the wastewater. If such storage capacity is utilized, effluent monitoring for compliance with Part I.A.9 limits will be performed on the effluent from the storage vessel. 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, as a precaution, provisions for enhanced treatment are provided in this CER in the event additional treatment is necessary for a particular waste stream to meet the limits. As shown on the Equipment and Process Lay-out diagram (Drawing 4), an area (approximately 40 feet by 75 feet) is designated for an optional metals treatment module consisting of resin / ion exchange vessels in between the cartridge filters and the pH adjustment tank.

From the cartridge filter skid, water can be diverted under pressure to the ion exchange resin units plumbed in series. Each treatment train will consist of four ion exchange resin vessels, two cationic resin units, and two anionic resin units for the reduction of the dissolved metals concentrations in the waste stream. Each treatment train is designed for a flow rate of 500 gpm. A total of 12 ion exchange resin vessels, six cationic resin units, and six anionic resin units will be installed to treat for a maximum design flow rate of 1,500 gpm.

The cationic resin units will each contain 300 cubic feet (cf) of CGS ion exchange resin provided by Resin Tech, Inc., which is designed to remove most of the dissolved metals prior to discharge. At the design flow rate of 500 gpm, the loading rate is 1.67 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 resin will be removed from the lead unit and will be replaced with 300 cf of CGS ion exchange resin. The spent resin will be sampled to determine RCRA waste characteristics, and will be disposed of accordingly. Periodic sampling of the effluent of cationic resin unit #1 will determine if dissolved metals breakthrough is occurring, and will alert the operator as to when to replace the resin unit.

The anionic resin units will each contain 300 cf of SBG1 ion exchange resin provided by Resin Tech, Inc., which is designed to reduce dissolved arsenic and selenium prior to discharge. At the design flow rate of 500 gpm, the loading rate is 1.67 gpm/cf of resin. If breakthrough of dissolved arsenic or selenium occurs on the lead resin unit, the water will be treated through the lag unit temporarily. The spent resin will be removed from the lead unit and will be replaced with 300 cf of SBG1 ion exchange resin. The spent resin will be sampled to determine RCRA waste characteristics, and will be disposed of accordingly. Periodic sampling of the effluent of anionic resin unit #1 will determine if dissolved arsenic or selenium breakthrough is occurring, and will alert the operator as to when to replace the resin unit.

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

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	**6.06**
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	**0.189**	**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

			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
Nickel	01/20/2015	SM3113B	--	--	--	--
Nickel	03/31/2015	SW6010C	**40.5**	**430**	--	--
Nickel	04/15/2015	SW6010C	**30.3**	**135**	**7.55**	**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	**1.78**	**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

			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**	**24000000**	--	--
Total Suspended Solids	04/15/2015	SM2540D	**750000**	**13000000**	**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
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	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	3.08
Chromium (III)	66	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	5.36	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
pH	Field	10/30/2015	S.U.	0.1	0.1	None	6.0	9.0	8.17	8.02	--
	Field	11/2/2015	S.U.	0.1	0.1	None	6.0	9.0	8.43	--	8.34
	Field	11/3/2015	S.U.	0.1	0.1	None	6.0	9.0	8.44	--	8.22
	Field	11/5/2015	S.U.	0.1	0.1	None	6.0	9.0	8.1	--	8.4
	Field	11/17/2015	S.U.	0.1	0.1	None	6.0	9.0	7.65	7.83	7.86
	Field	12/1/2015	S.U.	0.1	0.1	None	6.0	9.0	8.5	8.4	8.6
	Field	12/2/2015	S.U.	0.1	0.1	None	6.0	9.0	8.2	--	8.1
	Field	12/4/2015	S.U.	0.1	0.1	None	6.0	9 0	8.5	--	8.4
	Field	1/6/2015	S.U.	0.1	0.1	None	6.0	9.0	--	--	8.2
Oil and Grease	HEM	10/30/2015	mg/L	1.1	5.0	15.0	No Limit	20.0	ND	ND	--
	HEM	11/2/2015	mg/L	1.1	5.0	15.0	No Limit	20.0	--	--	ND
	HEM	11/17/2015	mg/L	1.1	5.0	15.0	No Limit	20.0	ND	ND	ND
	HEM	12/1/2015	mg/L	1.1	5.0	15.0	No Limit	20.0	ND	ND	ND
	HEM	1/6/2015	mg/L	1.1	5.0	15.0	No Limit	20.0	--	--	ND
Antimony	200.7	10/30/2015	ug/L	3.9	5.0	2,100	No Limit	2,100	5.7	6.2	--
	200.7	11/2/2015	ug/L	3.9	5.0	2,100	No Limit	2,100	--	--	5.9
	200.7	11/17/2015	ug/L	3.9	5.0	2,100	No Limit	2,100	4.3, J	4.8, J	4.0, J
	200.7	12/1/2015	ug/L	3.9	5.0	2,100	No Limit	2,100	5.4	5.0, J	4.3, J
	200.7	1/6/2015	ug/L	3.9	5.0	2,100	No Limit	2,100	--	--	ND
Arsenic	200.7	10/30/2015	ug/L	5.0	10.0	290	No Limit	530	64.8	65.2	--
	200.7	11/2/2015	ug/L	5.0	10.0	290	No Limit	530	--	--	58.7
	200.7	11/17/2015	ug/L	5.0	10.0	290	No Limit	530	48.4	43.7	48.9
	200.7	12/1/2015	ug/L	5.0	10.0	290	No Limit	530	39.8	41.3	38
	200.7	1/6/2015	ug/L	5.0	10.0	290	No Limit	530	--	--	30.8
Cadmium	200.7	10/30/2015	ug/L	0.50	1.0	1 8	No Limit	3.2	ND	ND	--
	200.7	11/2/2015	ug/L	0.50	1.0	1 8	No Limit	3.2	--	--	ND
	200.7	11/17/2015	ug/L	0.50	1.0	1 8	No Limit	3.2	ND	ND	ND
	200.7	12/1/2015	ug/L	0.50	1.0	1 8	No Limit	3.2	ND	ND	ND
	200.7	1/6/2015	ug/L	0.50	1.0	1 8	No Limit	3.2	--	--	ND
Chromium, total	200.7	10/30/2015	ug/L	2.5	5.0	No Limit	No Limit	No Limit	ND	ND	--
	200.7	11/2/2015	ug/L	2.5	5.0	No Limit	No Limit	No Limit	--	--	ND
	200.7	11/17/2015	ug/L	2.5	5.0	No Limit	No Limit	No Limit	ND	ND	ND
	200.7	12/1/2015	ug/L	2.5	5.0	No Limit	No Limit	No Limit	ND	ND	ND
	200.7	1/6/2015	ug/L	2.5	5.0	No Limit	No Limit	No Limit	--	--	ND
Chromium, trivalent	calculated	10/30/2015	ug/L	NA	NA	120	No Limit	220	ND	ND	--
	calculated	11/2/2015	ug/L	NA	NA	120	No Limit	220	--	--	ND
	calculated	11/17/2015	ug/L	NA	NA	120	No Limit	220	ND	ND	ND
	calculated	12/1/2015	ug/L	NA	NA	120	No Limit	220	ND	ND	ND
	calculated	1/6/2015	ug/L	NA	NA	120	No Limit	220	--	--	ND

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
	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

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
Thallium	200.8	10/30/2015	ug/L	0.50	1.0	1.4	No Limit	1.4	ND	ND	--
	200.8	11/2/2015	ug/L	0.50	1.0	1.4	No Limit	1.4	--	--	ND
	200.8	11/17/2015	ug/L	0.50	1.0	1.4	No Limit	1.4	ND	ND	ND
	200.8	12/1/2015	ug/L	0.50	1.0	1.4	No Limit	1.4	ND	ND	ND
	200.8	1/6/2015	ug/L	0.50	1.0	1.4	No Limit	1.4	--	--	ND
Zinc	200.7	10/30/2015	ug/L	2.5	10.0	110	No Limit	210	2.8, J	11.5	--
	200.7	11/2/2015	ug/L	2.5	10.0	110	No Limit	210	--	--	ND
	200.7	11/17/2015	ug/L	2.5	10.0	110	No Limit	210	9.2, J	5.8, J	3.9, J
	200.7	12/1/2015	ug/L	2.5	10.0	110	No Limit	210	7.3, J	ND	ND
	200.7	1/6/2015	ug/L	2.5	10.0	110	No Limit	210	--	--	9.8, J
Hardness as CaCO3	SM-2340B	10/30/2015	ug/L	662	662	No Limit	No Limit	No Limit	84,000	82,600	--
	SM-2340B	11/2/2015	ug/L	662	662	No Limit	No Limit	No Limit	--	--	91,300
	SM-2340B	11/17/2015	ug/L	662	662	No Limit	No Limit	No Limit	83,300	83,700	82,700
	SM-2340B	12/1/2015	ug/L	662	662	No Limit	No Limit	No Limit	85,900	87,200	84,900
	SM-2340B	1/6/2015	ug/L	662	662	No Limit	No Limit	No Limit	--	--	82,600
Turbidity	180.1	10/30/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	1.9	3.0	--
	180.1	11/2/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	--	--	1.9
	180.1	11/17/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	28.0	30.0	25.0
	180.1	12/1/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	5.56	6.49	5.69
	180.1	12/2/2015	NTU	0.05	1.0	No Limit	No Limit	No Limit	10.5	--	15.5
	180.1	12/4/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	10.3	--	9.37
	180.1	1/6/2015	NTU	0.50	1.0	No Limit	No Limit	No Limit	--	--	5.20
Total Suspended Solids	SM-2540D	10/30/2015	mg/L	1.2	1.2	30.0	No Limit	100.0	4.1	5.7	--
	SM-2540D	11/2/2015	mg/L	1.0	1.0	30.0	No Limit	100.0	--	--	2.7
	SM-2540D	11/17/2015	mg/L	1.0	1.0	30.0	No Limit	100.0	9.8	8.7	7.1
	SM-2540D	12/1/2015	mg/L	1.0	1.0	30.0	No Limit	100.0	ND	2.1	2.9
	SM-2540D	1/6/2015	mg/L	2.0	2.0	30.0	No Limit	100.0	--	--	ND
Ammonia - N	350.1	10/30/2015	mg/L	0.0050	0.010	9.6	No Limit	14	ND	ND	--
	350.1	11/2/2015	mg/L	0.0050	0.010	9.6	No Limit	14	--	--	0.0070, J
	350.1	11/17/2015	mg/L	0.0050	0.010	9.6	No Limit	14	0.19	0.28	0.25
	350.1	12/1/2015	mg/L	0.0050	0.010	9.6	No Limit	14	0.031	0.041	0.089
	350.1	1/6/2015	mg/L	0.0050	0.010	9.6	No Limit	14	--	--	ND

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
Chloride	SM-4500-CL-E	10/30/2015	mg/L	0.50	1.0	450	No Limit	820	12.3	11.9	--
	SM-4500-CL-E	11/2/2015	mg/L	0.50	1.0	450	No Limit	820	--	--	11.9
	SM-4500-CL-E	11/17/2015	mg/L	0.50	1.0	450	No Limit	820	10.8	10.9	11.0
	SM-4500-CL-E	12/1/2015	mg/L	0.50	1.0	450	No Limit	820	10.2	10.6	11.3
	SM-4500-CL-E	1/6/2015	mg/L	0.50	1.0	450	No Limit	820	--	--	9.3
Acute WET *(Ceridaphnia dubia)*	2002.0	11/2/2015	$\%^{C}$	--	--	No Limit	100	No Limit	100	--	100
(Daphnid)	2002.0	12/1/2015	$\%^{C}$	--	--	No Limit	100	No Limit	100	--	100
Chronic WET *(Ceridaphnia dubia)*	1002.0	11/2/2015	TU_c	--	--	No Limit	No Limit	6.25	1.00	--	1.00
(Daphnid)	1002.0	12/1/2015	TU_c	--	--	No Limit	No Limit	6.25	1.00	--	1.00
Acute WET *(Pimephales promelas)*	2000.0	11/2/2015	$\%^{C}$	--	--	No Limit	100	No Limit	100	--	100
(Fathead Minnow)	2000.0	12/1/2015	$\%^{C}$	--	--	No Limit	100	No Limit	100	--	100
Chronic WET *(Pimephales promelas)*	1000.0	11/2/2015	TU_c	--	--	No Limit	No Limit	6.25	1.00	--	1.00
(Fathead Minnow)	1000.0	12/1/2015	TU_c	--	--	No Limit	No Limit	6.25	1.00	--	1.00

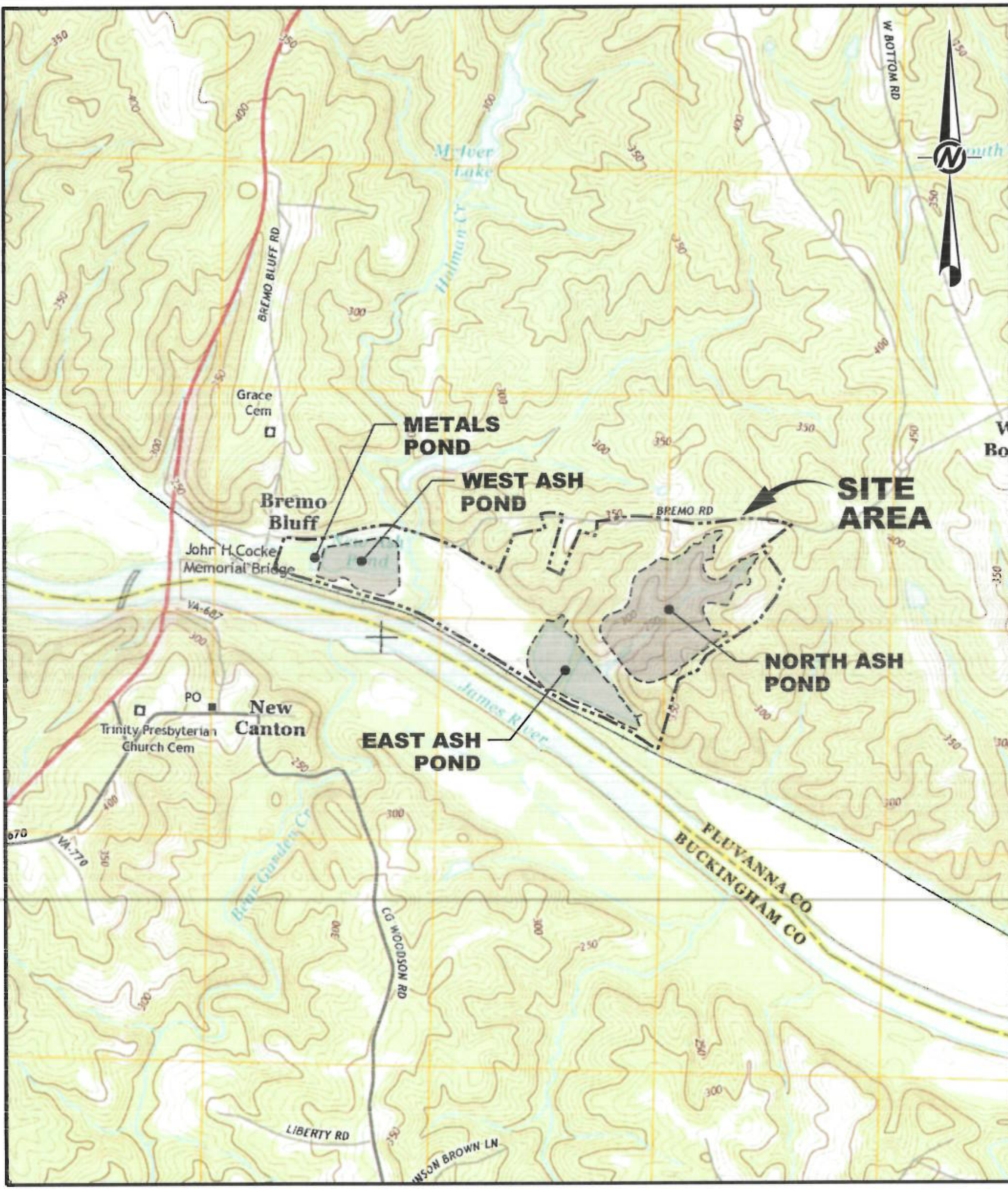
Notes:

ug/L = micrograms per liter   mg/L = milligrams per liter   SU = Standard Units   "--" = No Data   ND = Not Detected at the indicated detection limit

TU_c = Toxicity Units (the relative toxicity of an effluent, the larger the T.U. value the more toxic the effluent) (100/NOEC)

$\%^{C}$ = The highest concentration of sample in an acute test at which organisms exhibit no significant reduction in any of the test end points (e.g growth, survival, reproduction) (NOAEC)

DRAWINGS



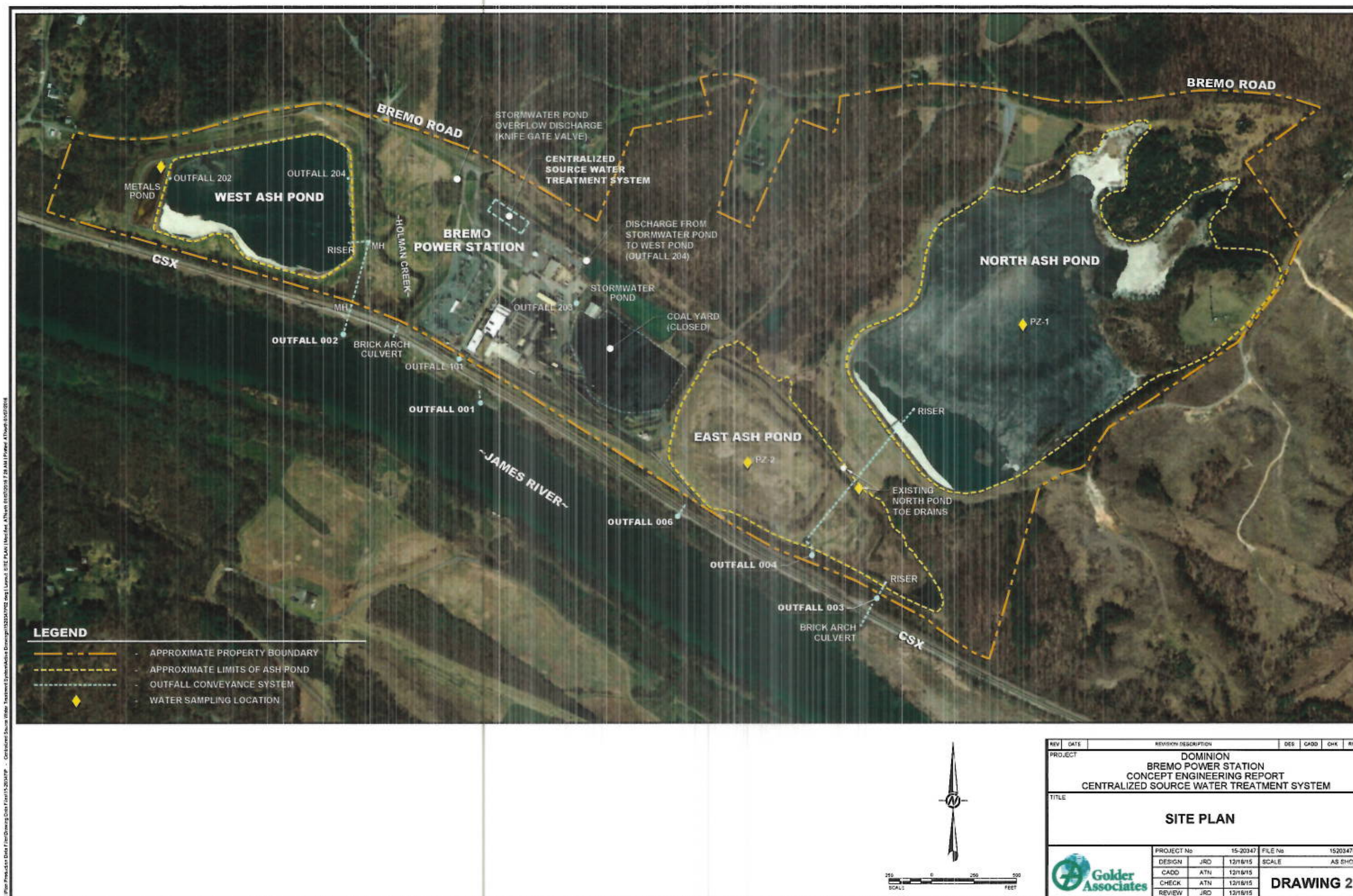
REFERENCE

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

2000 0 2000
SCALE FEET

Golder Associates, Richmond, Virginia		DATE 12/18/15	TITLE	
		DESIGN JRD	SITE LOCATION MAP	
		CADD BPG		
PROJECT No. 15-20347		CHECK DPM		
SCALE AS SHOWN	REV. 0	REVIEW JRD	DOMINION - BREMO POWER STATION	DRAWING 1

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



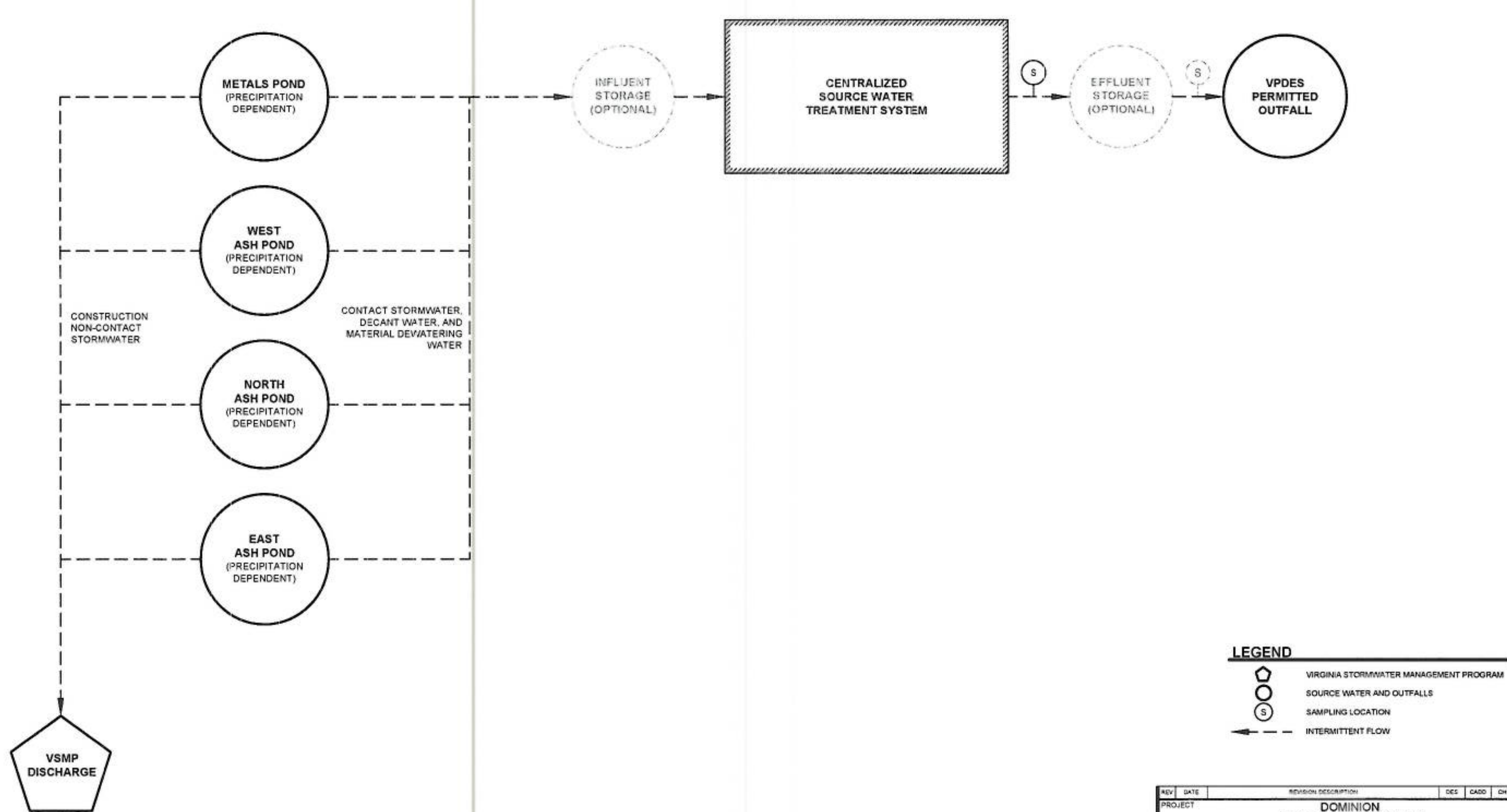
REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW

PROJECT
DOMINION
BREMO POWER STATION
CONCEPT ENGINEERING REPORT
CENTRALIZED SOURCE WATER TREATMENT SYSTEM

TITLE
SITE PLAN

Golder Associates

PROJECT No		15-20347	FILE No	1520347P02
DESIGN	JRD	12/18/15	SCALE	AS SHOWN
CADD	ATN	12/18/15		
CHECK	ATN	12/18/15	**DRAWING 2**	
REVIEW	JRD	12/18/15		



REV	DATE	REVISION DESCRIPTION	DES	CADD	CHK	RVW

PROJECT
DOMINION
BREMO POWER STATION
CONCEPT ENGINEERING REPORT
CENTRALIZED SOURCE WATER TREATMENT SYSTEM

TITLE
PROCESS FLOW DIAGRAM
2016-2018 TIME FRAME

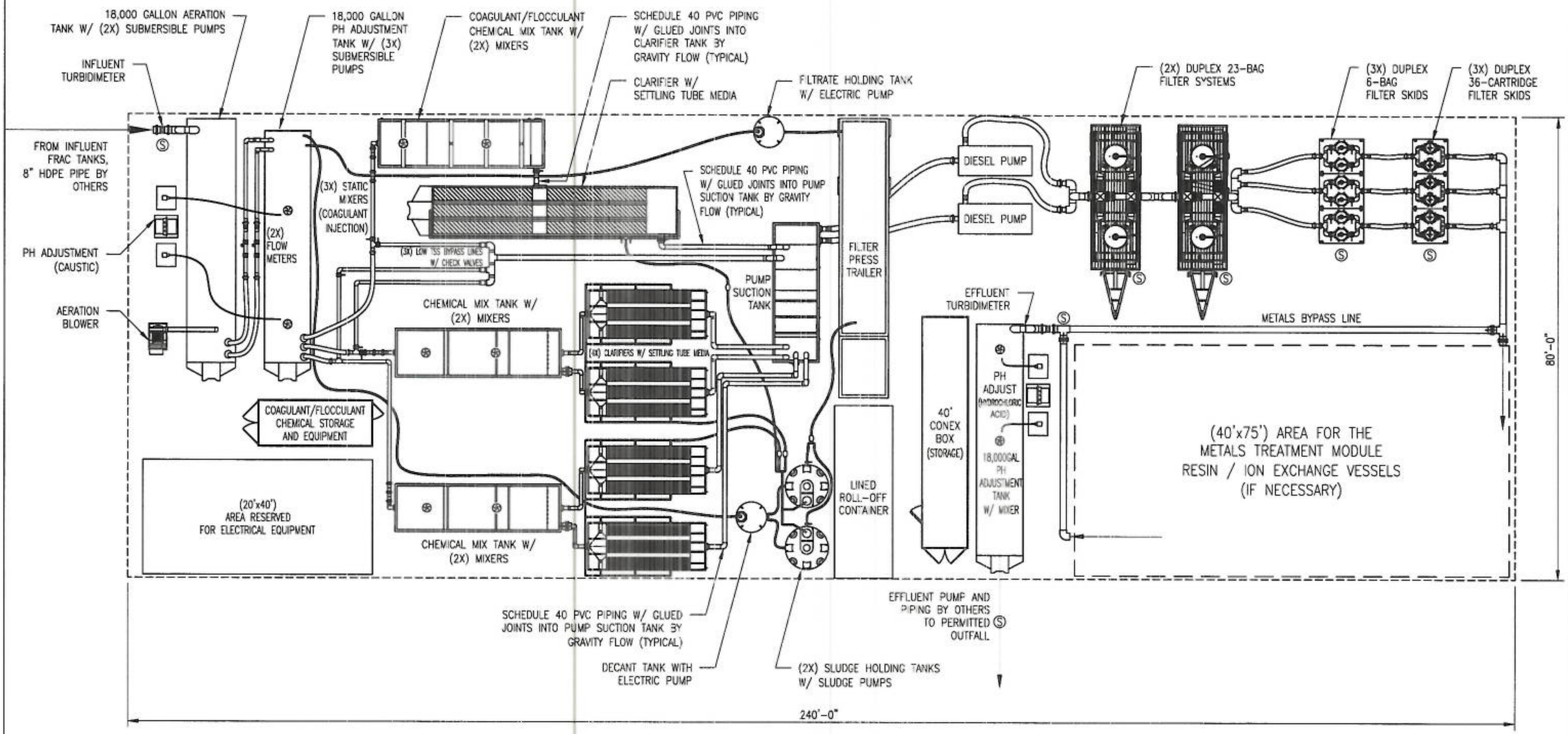
Golder Associates

PROJECT No		15-20347	FILE No	1520347P03
DESIGN	JRD	12/18/15	SCALE	AS SHOWN
CADD	ATN	12/18/15	DRAWING 3	
CHECK	ATN	12/18/15		
REVIEW	JRD	12/18/15		

TEMPORARY CENTRALIZED SOURCE WATER TREATMENT SYSTEM

1500 GPM EQUIPMENT AND PROCESS LAYOUT

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



D – C:\Cad Files\QUOTES\Q-6400s\Q-6453 Dominion\Working CAD\QT-146453-LYT09(4).dwg – Thu, 4 Feb 2016 – 14:22

REV.	DATE	BY	REMARKS
D	12/14/15	RJS	RE-ARRANGED EQUIPMENT
C	12/04/15	RJS	SMALLER FOOTPRINT DESIGN
B	12/01/15	RJS	SMALLER FOOTPRINT DESIGN
A	11/24/15	RJS	PRELIMINARY DESIGN.
4	12/18/15	RJS	ADDED SAMPLING LOCATIONS

CUSTOMER: DOMINION
SITE: BREMO, VA
TITLE: TEMPORARY TREATMENT SYSTEM 1500 GPM EQUIPMENT AND PROCESS LAYOUT
SCALE: NTS
DRAWN BY: RJS DATE: 11/24/15
APPROVED BY: MFP DATE: 12/14/15

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

DWG SIZE: B | SHEET: 1 OF 1 | DRAWING NO.: QT-146453-LYT09 | 4

APPENDICES

APPENDIX A

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

ADEGA
CHEMICAL COMPANY
NEW JERSEY • CALIFORNIA
877-ADEGA11 • 877-233-4211

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

Ground/Water Treatment & Technology, LLC

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(973) 983-0901
Fax: (973) 983-0903

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:	Bremo 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 Bremo 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

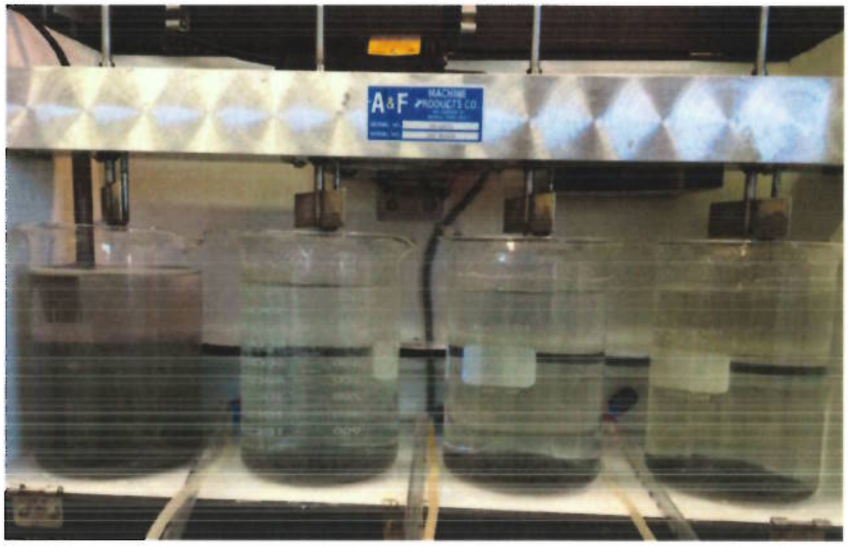
The following samples were collected and analyzed during the treatability study:

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.



Beaker 1	Beakers 2,3 and 4
○ Untreated ○ Solids Settling	○ 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 Enginer

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GWTT
Ground/Water Treatment & Technology, LLC

Beyond Water Treatment

Table 1
Laboratory Bench Test Results - Bremo East Pond

PARAMETER	TREATABILITY TESTING RESULTS														BREMO PERMIT LIMITS		
	EAST POND PZ-2 070115		EAST POND PZ-2 112315														
	INFLUENT	Q	**INFLUENT**	Q	MDL	**CHEM PRECIP**	Q	MDL	**FILTRATION**	Q	MDL	**TREATED**	Q	MDL	MINIMUM	MONTHLY AVERAGE	DAILY MAXIMUM
Total Metals (mg/L)																	
Antimony	**0.007**		ND		0.008	**ND**		0.008	**ND**		0.008	**ND**		0.008	NL	2.1	2.1
Arsenic	**0.061**		**0.121**		0.002	**0.027**		0.002	**0.027**		0.002	**ND**		0.002	NL	0.29	0.53
Cadmium	**0.00072**	U	ND		0.001	**ND**		0.001	**ND**		0.001	**ND**		0.001	NL	0.0018	0.0032
Chromium	**0.02**		**0.02**		0.002	**ND**		0.002	**0.003**	J	0.002	**0.002**		0.002	NL	0.12	0.22
Copper	**0.051**		**0.055**		0.002	**0.004**	J	0.002	**0.004**	J	0.002	**0.005**		0.002	NL	0.012	0.023
Lead	**0.026**		**0.026**		0.002	**0.002**	J	0.002	**ND**		0.002	**ND**		0.002	NL	0.019	0.035
Mercury	**0.00014**	U	**0.00009**	J	0.00006	**ND**		0.00006	**ND**		0.00006	**ND**		0.00006	NL	0.0015	0.0028
Nickel	**0.046**		**0.029**		0.004	**ND**		0.004	**ND**		0.004	**ND**		0.004	NL	0.031	0.057
Selenium	**0.0037**	J	**0.005**	J	0.003	**0.005**	J	0.003	**ND**		0.003	**ND**		0.003	NL	0.0096	0.018
Silver	--		ND		0.002	**ND**		0.002	**ND**		0.002	**ND**		0.002	NL	0.0027	0.005
Thallium	--		ND		0.004	**ND**		0.004	**ND**		0.004	**ND**		0.004	NL	0.0014	0.0014
Zinc	**0.034**		**0.036**	J	0.007	**ND**		0.007	**0.023**	J	0.007	**0.013**	J	0.007	NL	0.11	0.21
General Chemistry (mg/L)																	
Total Suspended Solids	**24600**		**790**		NA	**ND**		NA	**ND**		NA	**ND**		NA	NL	30	100
Oil and Grease, Hem-Grav	**2.8**	U	ND			--			--			**ND**			NL	15	20
TPH, SGT-HEM	**2.8**	U	ND			--			--			**ND**			NL	NL	NL
Hexavalent Chromium	**0.0049**	U	ND		0.003	**ND**		0.003	**ND**		0.003	**ND**		0.003	NL	0.018	0.034
Ammonia-N	**0.08**	J	--			--			--			--			NL	9.6	14
Hardness (as $CaCO_3$)	--		--			--			--			--			NL	MONITOR	MONITOR
Ph (standard units)	**8.03**		**7.927**			--			--			--			6.0	NL	9.0
Anions (mg/L)																	
Chloride	**10.6**		**3.02**		0.054	**18.7**		0.054	**22.1**		0.054	**198**		0.054	NL	450	820
Sulfate	--		**45.6**		0.051	**44.8**		0.051	**46.3**		0.051	**0.352**	J	0.051	NL	NL	NL
Acute Whole Effluent Toxicity (%)																	
Ceriodaphnia Dubia	--		--			--			--			--			100	NL	NL
Pimephales promelas	--		--			--			--			--			100	NL	NL
Chronic Whole Effluent Toxicity (TU_c)																	
Ceriodaphnia Dubia	--		--			--			--			--			NL	NL	6.25
Pimephales promelas	--		--			--			--			--			NL	NL	6.25

NOTES
ND - Non Detect
Q - Qualifier
J - Estimated Concentration
U - Undetected
NL - No Limit
Highlighted Limits indicate that the untreated concentration is greater than effluent discharge limit for the specified constituent

Table 2

Laboratory Bench Test Results - Bremo East Pond Dissolved Metals

PARAMETER	EAST POND PZ-2 112315			BREMO		
	INFLUENT	Q	MDL	MINIMUM	AVERAGE	MAXIMUM
Dissolved Metals (mg/L)						
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

Ground/Water Treatment & Technology, LLC

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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:	Bremo 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 Bremo 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.

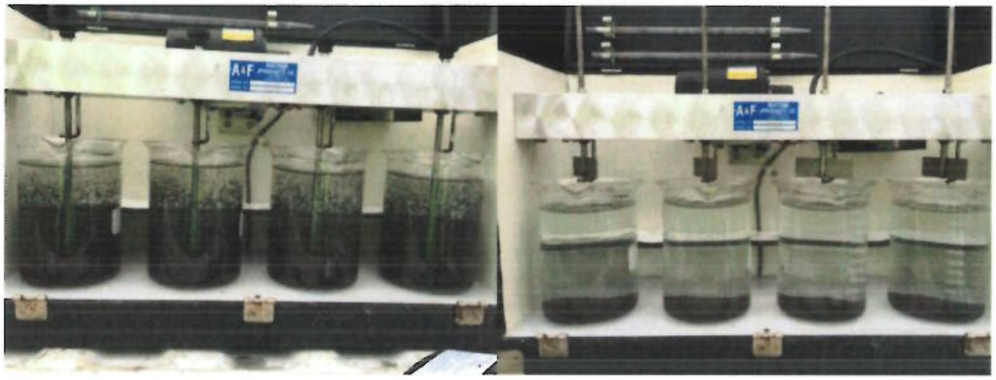
Samples Collected

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.

<u>Beakers 1, 2, 3 and 4</u>

- 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 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 Enginer
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GWTT
Ground/Water Treatment & Technology, LLC

Beyond Water Treatment

TABLE 1: Treatability Testing Results

Analyte	Method	Date	Units	Detection Limit	Reporting Limit	Final Draft Permit MA	Final Draft Permit DM	PZ2(INF) Results	PZ2(EFF) 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	PZ2(Mid1) Results	PZ2(Mid2) 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 **10** min		Design Time **15** min	
Full Scale Volume (Frac Tank)	18,000 gallons			
Working Volume (Frac Tank)	15,000 gallons			
Hydraulic Residence Time (HRT)				
Design Flow Rate (500 GPM)	15,000 gallons / 500 gallons/minute	=	30	min
Maximum Flow Rate (1,500 GPM)	15,000 gallons / 1,500 gallons/minute	=	10	min
Bench Scale Air Flow Rate (scfm)	**0.0075** scfm			
Dosage at Aeration Time	0.075 ft^3		0.113	ft^3
Full Scale Aeration Blower	500 scfm	@	100	" H_2O

NOTES:
$1\ ft^3 = 7.48$ 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 $\mathbf{0.155}\ \frac{\text{mL NaOH}}{\text{L } H_2O}$ to raise pH to 9.5 s.u.

Full Scale Flow Rate (Design Flow)

$$\frac{0.155 \text{ mL NaOH}}{\text{L } H_2O} \times \frac{3.785 \text{ L } H_2O}{\text{gal } H_2O} \times \frac{500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal NaOH}}{3{,}785 \text{ mL NaOH}} = \frac{4.7 \text{ gal NaOH}}{\text{hour}}$$

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)

$$\frac{0.155 \text{ mL NaOH}}{\text{L } H_2O} \times \frac{3.785 \text{ L } H_2O}{\text{gal } H_2O} \times \frac{1{,}500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal NaOH}}{3{,}785 \text{ mL NaOH}} = \frac{14 \text{ gal NaOH}}{\text{hour}}$$

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 ft^3 = 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: $\frac{\mathbf{0.050}\ \text{mL WC-500}}{\text{L } H_2O}$

Full Scale Flow Rate (Design Flow):

$$\frac{0.050\ \text{mL WC-500}}{\text{L } H_2O} \times \frac{3.785\ \text{L } H_2O}{\text{gal } H_2O} \times \frac{500\ \text{gallons}}{\text{min}} \times \frac{60\ \text{min}}{\text{hour}} \times \frac{\text{gal WC-500}}{3{,}785\ \text{mL WC-500}} = \frac{1.5\ \text{gal WC-500}}{\text{hour}}$$

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):

$$\frac{0.050\ \text{mL WC-500}}{\text{L } H_2O} \times \frac{3.785\ \text{L } H_2O}{\text{gal } H_2O} \times \frac{1{,}500\ \text{gallons}}{\text{min}} \times \frac{60\ \text{min}}{\text{hour}} \times \frac{\text{gal WC-500}}{3{,}785\ \text{mL WC-500}} = \frac{4.5\ \text{gal WC-500}}{\text{hour}}$$

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 ft^3 = 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

$$\frac{1.000 \text{ mL AP-210}}{\text{L } H_2O}$$

Full Scale Flow Rate (Design Flow)

$$\frac{1.000 \text{ mL AP-210}}{\text{L } H_2O} \times \frac{3.785 \text{ L } H_2O}{\text{gal } H_2O} \times \frac{500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal AP-210}}{3{,}785 \text{ mL AP-210}} = \frac{30 \text{ gal AP-210}}{\text{hour}}$$

Full Scale Mass Loading (Design Flow)

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

Full Scale Flow Rate (Maximum Flow)

$$\frac{1.000 \text{ mL AP-210}}{\text{L } H_2O} \times \frac{3.785 \text{ L } H_2O}{\text{gal } H_2O} \times \frac{1{,}500 \text{ gallons}}{\text{min}} \times \frac{60 \text{ min}}{\text{hour}} \times \frac{\text{gal AP-210}}{3{,}785 \text{ mL AP-210}} = \frac{90 \text{ gal AP-210}}{\text{hour}}$$

Full Scale Mass Loading (Maximum Flow)

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

NOTES:
1 ft^3 = 7.48 gallons
60 min/hr
3,785 mL/gallon
GPM - gallons per minute

Full-Scale Media Treatment Specifications:

Media: CGS, 50 lb/ft^3

Media Vessel: Siemens, Model PV-10000

V_D, Media Fill Volume = 330 ft^3

Q_D, Design Flow Rate = 500 gal/min

EBCT, Empty Bed Contact Time = $\frac{V_D}{Q_D/7.48}$ = 4.94 min = **5** min

Bench-Scale Media Treatment Specifications:

V_B, Media Fill Volume = 0.08722 ft^3 = 0.087 ft^3 2" column diameter, 12 inch media fill height

X_B Media Weight = 4.36111 lbs

Q_B, Design Flow Rate = $\frac{V_B}{EBCT}$ x 7.48 = 0.132 gal/min = 7.9 gal/hr

500 mL/min

Conversions:

1 ft^3 = 7.48 gallons

60 min/hr

Full-Scale Media Treatment Specifications:

Media: SBG-1, 50 lb/ft^3

Media Vessel: Siemens, Model PV-10000

V_D, Media Fill Volume = 330 ft^3

Q_D, Design Flow Rate = 500 gal/min

EBCT, Empty Bed Contact Time = $\frac{V_D}{Q_D/7.48}$ = 4.94 min = **5** min

Bench-Scale Media Treatment Specifications:

V_B, Media Fill Volume = 0.08722 ft^3 = 0.087 ft^3 2" column diameter, 12 inch media fill height

X_B Media Weight = 4.36111 lbs

Q_B, Design Flow Rate = $\frac{V_B}{EBCT}$ x 7.48 = 0.132 gal/min = 7.9 gal/hr

500 mL/min

Conversions:
1 ft^3 = 7.48 gallons
60 min/hr

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 IDENTIFACATION
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:	**Ingredient:**	**Exposure Limits:**
12042-91-0 **EC No:** 234-933-1	Dialuminum Chloride Pentahydroxide	OSHA PEL and ACGIH TLV for Aluminum, Soluble Salts: 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.

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

VAPOR PRESSURE (AT 77 DEB 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

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

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 Al^{3+}) and Aluminum Citrate one year developmental and chronic neurotoxicity study (oral, rat).

SECTION 12 – ECOLOGICAL INFORMATION

Aquatic Toxicity:
P. Promelas LC_{50} (72h) > 1000 mg/L, LC_{50} (96h) 720 mg/L; EC_{50} (72h) 316 mg/L, EC_{50} (96h) 40 mg/L
C. Dubia LC_{50} (24h) > 1000 mg/L, LC_{50} (48h) 0.32 mg/L; EC_{50} (24h) 316 mg/L, EC_{50} (48h) < 0.1 mg/L
Zebra fish LC_{50} (96h) 100 – 500 mg/l (OECD 203), Daphnia Magna EC_{50} (48h) 397mg/l,
EC_{50} (bactéria) > 1000 mg/l Fermentation tube test.

Mobility
Not classified based on rapid hydrolysis and precipitation.

Persistance 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 (C02), 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.

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/m'

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.

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 (NOx), carbon oxides C(Ox)

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

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.

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.