a PPL company
220 West Main Street
Louisville, KY 40202

May 23, 2019

Kentucky Division of Water, Surface Water Permits Branch
300 Sower Boulevard, 3rd Floor
Frankfort, KY 40601

RE: KPDES No. KY0002020 E. W. Brown Generating Station, Mercer County, KY
Agency Interest # AI 3148

This letter and enclosures provide a complete technical update for the reissuance of the KPDES permit No. KY0002020 held by Kentucky Utilities Company (KU) for its E.W. Brown fossil-fuel fired steam electric generating station. This information updates previous KPDES permit renewal submissions on August 28, 2014. KPDES Form 1, Form C and other supporting documents have been updated with recent monitoring data and information on process changes, re-certified and are enclosed with other related support documents.

Significant process water management and ash pond-impoundment changes have been constructed or planned for construction at Brown Station to comply with Coal Combustion Residuals (CCR) federal regulatory rules recently finalized by the USEPA, Kentucky Water Quality Standards (KyWQS) for KPDES discharges, and in anticipation of requirements for the USEPA ELG (Effluent Limitations Guidelines) final rule (under reconsideration by USEPA. Generally, these changes are required for:

- Wet-to-dry conversion of coal ash handling systems for management in a landfill constructed on-site. Fly ash is pneumatically collected in silos and moist-pugmilled for management to the landfill; bottom ash (including mill rejects/pyrites) is sluiced to remote submerged conveyors, dewatered and moist solids subsequently conveyed to the landfill (i.e., dry handling);
- Construction upgrades to Flue Gas Desulfurization (FGD) gypsum dewatering equipment to accommodate marketing, on-site landfilling, with extensive re-piping work to segregate, recycle and minimize FGD process wastewaters for treatment;
- Construction of a FGD Process Waters Treatment System (PWS: Physical-Chemical precipitation equipment including potential/future biological system final treatment) and filtration/sludge handling equipment for dewatering treatment solids for management into the landfill;
- Construction of a new physical/chemical treatment system for the closed Main Ash Pond Toe Drain and Coal Pile Runoff Treatment System (TDCPRTS) flows (the toe drain collection system was installed previously), which will discharge to the Process Pond;
- Efforts to dewater, close, cap, vegetate and install cap runoff monitoring controls for the Auxiliary Ash Pond – scheduled completion by 2022;

- Construction of a new Process Pond to replace ash pond treatment of plant process flows including treated FGD wastewater; plant sumps, coal/limestone piles runoff waters, landfill leachate/CCR-contact runoff flow, incidental fractions of bottom ash recycle water flows, and other low volume wastewaters currently treated in one (1) large CCR-impoundment which is being closed per the USEPA CCR Rule requirements;
- Construction of a high-rate, multiport diffuser for process water discharges from Outfall 006 to Herrington Lake, which accommodates KU's request for establishment of a mixing zone and zone of initial dilution for the process flows of outfall 001 with same flows relocated to new Outfall 006;

As required by the ELG regulations, and further described in **Attachment 11** of this submission, KU is providing information to determine compliance applicability dates for first-time-KyWQS limits and the as soon as possible compliance deadline for ELG rule requirements that are not under reconsideration. EPA recently granted a petition to reconsider the new 2015 Steam-Electric ELG (Effluent Limitations Guidelines) regulations for FGD wastewaters and bottom ash transport water (scheduled for finalization in 2019/2020), and revised applicability dates for the ELG discharge limits. However, nearly the same treatment technologies (as required for compliance with the ELG regulations) are being installed to assure that plant discharges meet anticipated KyWQS discharge limits (e.g. mercury, arsenic, etc.). Permittees are required to provide information 'for regulators to consider to determining the compliance deadlines, including time to expeditiously plan (including to raise capital), design, procure, and install equipment to comply with the requirements of the final rule'. Other information to be supplied includes impacts from CCR regulations, needs for initial commissioning periods for FGD wastewaters treatment equipment, and other factors as appropriate, such as EPA's ongoing reconsideration of the standards themselves.

Due to the Brown plant size, inter-related systems complexity, construction sequence challenges, and procurement of equipment/systems based upon still-developing technologies; KU requests an implementation schedule for compliance with any first-time KyWQS based limits that also best positions the plant to meet future ELG requirements when the reconsideration of FGD standards is completed and the revised compliance deadlines are finalized. This construction work will:

- Segregate, recycle and treat FGD (Flue Gas Desulfurization) wastewaters with dedicated physical-chemical systems to ensure in-lake compliance with the KyWQS by mid-2020 and ELG technology-based limits on two internal wastestreams (bottom ash transport water and FGD wastewater) by a compliance date of December 31, 2023 (which will be revisited upon finalization of the USEPA reconsideration of these treatment requirements for these wastewaters);
- Install dry handling for all fly ash systems to eliminate the discharge of fly ash sluice waters (this work has already been completed);
- Install a recirculation system to recycle all bottom ash sluice waters and prevent the discharge of bottom ash sluice waters by December 31, 2023 (redesign/modification work on-going to resolve reliability issues and assure 100% flows recycling, to the extent that is required by the reconsidered ELGs).

Accordingly, this work will be performed in Phases defined here for identifying changes to plant KPDES outfall 001 (external), and new proposed external outfalls 006-008 and new proposed internal outfall 007. Generally, most changes will ultimately occur associated with flows currently contributing to outfall 001 which, upon construction of a multiport diffuser expected by Q3-2019, will discharge as Outfall 006 to Herrington Lake.

Contributing flows to these outfalls will vary according to three proposed phases of Plant flow configurations:

1. **EXISTING Operations** (current *to anticipated Permit Effective date ~July/August 2019*)

   Continued/temporary use of the existing Auxiliary Ash Pond (to be closed/capped by 2021). Contributing process flows to Outfall 001 from the existing pond include:

   a. Bottom Ash Sluice Flows (blowdown from Remote SFC-Submerged Flight Conveyors recycled sluice flows, etc.);
   b. FGD-Gypsum Wastewaters – from Dewatering/filtration and inert fines FGD blowdowns (until future Process Water Treatment System (PWS) constructed);
   c. Plant sumps & other low-volume wastewaters;
   d. Coal pile runoff;
   e. Landfill leachate & CCR-contact runoff flows;
   f. Auxiliary Ash Pond stormwater runoff flows;
   g. **<u>No</u>** dewatering flows from Auxiliary Ash Pond.

2. **TRANSITION Operations** (Permit Effective date ~*August 2019 until Future Op's*)

   Process Pond Wastewater and Auxiliary Ash Pond Closure/Dewatering Flows Begin with Discharges to Outfall 006/Diffuser; Landfill Stormwater Discharges Continue thru Existing Outfall 001 to Herrington Lake/Curds Inlet.

   KU requests a compliance schedule for application of Kentucky Water Quality Standards to Outfall 006 flows until July 1, 2020.

   Transition flows to New Outfall 006/Diffuser include:

   a. Bottom Ash Sluice Flows -same as existing flows described above;
   b. FGD-Gypsum Wastewaters – same as existing described above until Q4-2019 when PWS operations begin startup, optimization/testing, and reliable/commercial operations by mid-2020;
   c. Plant sumps & other low-volume wastewaters – same as existing;
   d. Coal pile runoff – same as existing;
   e. Landfill leachate & CCR-contact runoff flows- same as existing;
   f. Auxiliary Ash Ponds Direct Precipitation Stormwater flows;
   g. Auxiliary Ash Pond Closure/Capping Work Begins with Initial Dewatering Flows - *ash ponds work to begin for final-grade, liner installed, dirt/vegetation capped, and stormwater runoff management controls/monitoring for completion by 2021.*

Transition flows to Existing Outfall 001 include:

a. Landfill Stormwater Runoff Flows from Inactive Areas (deminimis CCR-contact);
b. Uncontaminated Stormwater Runoff flows from Outfall Channel adjacent areas;
c. Misc. Landfill Liner Monitoring System Drains

3. **FUTURE Operations (*starting July 1, 2020*)**
Herrington Lake Diffuser for Outfall 006 Process Pond Discharges, Auxiliary Ash Pond Dewatering Flows Planned Cessation, PWS-FGD Wastewaters Treatment System Optimized and Ponds Clean Purge Completed to Meet KyWQS for Discharges.

Future flows to Outfall 006 Include*:*

a. Herrington Lake Diffuser (multiport, high-rate) discharges all plant process flows described above under Transition flows (*except Auxiliary Ash Pond Dewatering Flows Cease and except for Outfall 003 cooling tower blowdown flows*) and Outfall 006 flows are expected to meet KyWQS limits;
b. Bottom Ash Sluice Waters (10% of water separated from solids) pumped to plant sumps/Process Pond but transport waters discharge elimination and conformance to ELG requirements planned by December 31, 2023;
c. FGD-Gypsum Wastewaters – from Dewatering/filtration and inert fines FGD blowdowns with PWS operations constructed/optimized but discharges conformance to ELG requirements planned by December 31, 2023 and when Internal Outfall 007 for PWS monitoring established *(until USEPA ELG reconsideration announcement, on-going analysis of installing a biological treatment system following the physical-chemical system under construction, will be communicated with KPDES staff).*
d. Auxiliary Ash Pond Closure/Capping work progresses until cap stormwater runoff flows diverted to Outfall 001 (*rather than collection to Process Pond/Outfall 00*6).

Future flows to Existing Outfall 001 include:

a. Landfill Stormwater Runoff Flows from Inactive Areas (deminimis CCR-contact);
b. Uncontaminated Stormwater Runoff flows from Outfall Channel adjacent areas;
c. Misc. Landfill Liner Monitoring System Drains;
d. Uncontaminated Stormwater Runoff Flows from Closed/Capped Auxiliary Ash Pond.

We request a mixing zone for any pollutant where a mixing zone is deemed appropriate as a result of the reasonable potential analysis that is conducted with the new data.

We also request a mixing zone/variance with respect to ORSANCO's water quality standard for mercury. Pursuant to ORSANCO's revised 2015 Pollution Control Standards, a mixing zone for mercury for existing sources is authorized where compliance with the standard is not economically or technically feasible. At a minimum, compliance with the 12 ng/L (ppt) ORSANCO standard cannot be ascertained until after the ash ponds dewatering flows are assessed, and the new wastewater treatment system is designed, installed and operational. Even then, it is not certain whether such systems are capable of attaining reductions sufficient to assure the ORSANCO standard is achieved at all times.

Lastly, we request a compliance schedule for meeting the Kentucky Water Quality Standard for mercury of 51 ng/L (ppt) for plant discharges. Outfall 006 will consist of flows directed to the existing Auxiliary Ash Pond including ash sluice-related flows, FGD dewatering flows, and pond dewatering flows with initiating closure efforts. Although this permit renewal Form C data indicates a current discharge with a 18.8 ppt mercury content, process/seasonal/sampling variability aside, reconfiguration of FGD flows to minimize discharges may elevate concentrations where reliably complying with 51 ppt may currently be difficult at times. While the new PWTS-FGD wastewaters treatment system will begin to operate by late 2019 to reduce mercury concentrations below 51 ppt of new flows, the large volume of legacy wastewater will require a significant amount of time to manage. The Process Ponds store 5-10 million gallons and may require 6+ months to gradually comingle these legacy flows with treated wastewaters, while remaining in compliance with the limit for the blended flows. Therefore, KU-Brown requests a compliance schedule until July 1, 2020 to achieve the 51 ppt standard for mercury at outfall 006.

As you are aware, KU-Brown have already conducted the required 316(b) studies to assess impacts of cooling intake flows and those studies were submitted to your office in September 2018. Those studies confirm the current cooling tower use meets BTA for impingement and entrainment for the intake and KU requests that be confirmed in the Fact Sheet of the renewal permit.

Enclosed is a $7,000.00 check for the application filing fee (major industry). As discussed with KPDES staff, this technical update to the KPDES permit renewal application includes 1 set of Priority Pollutant Analyses recently sampled and analyzed during January-April 2019.

The total supporting documents enclosed include 12 attachments:

Attachment 1	KPDES Permit Application Synopsis;
Attachment 2	KPDES Form 1;
Attachment 3	Check to Kentucky State Treasurer for KPDES application filing fee;
Attachment 4	Copy of the USGS Topographic Map (noting the facility site and Outfalls);
Attachment 5	KPDES Form C;
Attachment 6	Sample results for the priority pollutant analysis required for Form C from the contracted commercial laboratory;
Attachment 7	Quarterly Metals Analyses Summarized for Two (2) Recent Years for KPDES monitored outfalls and as reported on Monthly DMRs;
Attachment 8	Stormwater Runoff Calculations;
Attachment 9	Stormwater Runoff Diagram(s);
Attachment 10	Water Balance Diagram(s): 30-Day Peak Monthly Process and Annual Daily **Average Rainfall** Conditions • *(E) Existing Conditions Diagram;* • *(T) Transition Conditions Diagram* • *(F) Future Conditions Diagram*
Attachment 11	Construction Activities Required at KU-Brown Generating Station Impacting the Schedule of Compliance with KY Water Quality Standards, USEPA CCR Rule and USEPA ELG Rule;

Attachment 12 Design Document for a High-Rate, Multiport Diffuser for Outfall 006 Discharges to Herrington Lake.

If I may be of assistance or you have any questions concerning the attached information, please feel free to contact me at (502) 627-2997 (or my email is roger.medina@lge-ku.com).

Sincerely,

Roger J. Medina
Environmental Affairs, Sr. Chemical Engineer

Attachments (12)
cc: internal distribution list
file

ATTACHMENT 1

KU – Brown Plant

KPDES Permit Application Synopsis

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

Name and Address of Applicant

(Corporate)
Kentucky Utilities Company KPDES No. KY0002020 Agency Interest # AI 3148
P.O. Box 32010
Louisville, Kentucky 40232
c/o Roger J. Medina

(Facility)
Brown Generating Station
815 Dix Dam Road
Harrodsburg, Kentucky 40330-9282
c/o Tamara Powell

Description of Applicants' Operation

Fossil fuel fired steam electric power plant for the generation, transmission and distribution of electricity (SIC Code 4911 NAICS Code 221112).
Located on a 1,185+ acre site along the Herrington Lake/Dix River at mile mark 3.4 (the Dix River confluence into Kentucky River nearby at Mile Mark 118).

Production Capacity of Facility

Generation of electric power from fossil fuel-fired units with the following nameplate generating capacity:
(Retired March 1, 2019) Unit 1 – 114 MW (coal)
(Retired March 1, 2019) Unit 2 – 180 MW (coal)
Unit 3 – 464 MW (coal)
Total Coal: 464 MW

Combustion Turbines, Natural Gas or Fuel Oil Fired
Unit 5 – 123 MW
Units 6-7 – 177 MW/each,
Units 8-11 – 126 MW/each
Total Combustion Turbines: 981 MW

Solar Facility - Universal Solar Facility, 44,000 panels, 50 acres – 10 MW
Dix Dam Hydroelectric Facility, 3 Turbines, - 33 MW

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

Description of Submitted Outfalls

Note: See attached flow diagrams and rainfall runoff calculations for flow and acreage information

At the KU-Brown plant, recent/current construction activities to comply with the USEPA CCR regulations final rule, Kentucky Water Quality Standards, and in accordance with the ELG final rule, include:

- Final conversion of handling systems from wet-to-dry solids management in the Coal Combustion Residuals Transport (CCRT) facility to manage fly ash, bottom ash, and gypsum for transport to the landfill or marketing/trucking these CCR materials off-site for beneficial reuse. This includes significant tank/piping modifications of FGD wastewaters and systems associated with the gypsum dewatering vacuum belts (2). Bottom ash sluice waters management includes redesign/repairs to Submerged Flight Conveyors (SFC) constructed to dewater sluice flows and facilitate ’dry‘ solids-truck handling to the landfill (reliability problems currently being addressed);
- A Process Water System (PWS) to treat FGD wastewaters (by physical-chemical and potential/future biological technology) including piping to segregate and manage FGD blowdown, gypsum dewatering, reclaim, and other related process flows - scheduled to be operational by mid-2020;
- Construction of a new physical/chemical treatment system for the closed Main Ash Pond Toe Drain and Coal Pile Runoff Treatment System (TDCPRTS) flows (the toe drain dedicated/closed system installed previously) which will discharge to the process pond – scheduled to be operational by mid-2020;
- Closure/capping/vegetation of the Auxiliary Ash Pond – scheduled completion by 2022;
- Expand the existing CCR-Landfill for Phase 1/Cell 2 operations and close/cap the Phase 3 phase of the landfill (not-needed following recent retirement of coal-fired Units 1-2 units);
- A New Process Pond (North and South cells) to settle/mix/neutralize all plant wastewaters (adjacent/north of the future closed/capped Auxiliary Ash Pond);
- A multiport, high-rate diffuser for enhanced mixing zone/ZID discharge of outfall 006 treated process wastewaters to Herrington Lake – completion date expected by 3rd quarter 2019;
- Installing three (3) new outfall monitoring/sample structures for flows associated with the process pond/Diffuser, FGD-PWS, and railway stormwater/wick-drain high flow events.

Accordingly, this work will be performed in Phases defined here for purposes of identifying changes to plant KPDES outfall 001 and new proposed outfalls 006 thru 008. Contributing flows to these outfalls will vary according to three (3) proposed phases of plant flow configurations:

- **Phase 1 – *Existing***: *Auxiliary Ash Pond or New Process Pond Treat Plant Process Flows and Combine with Landfill Stormwater Pond Discharge to Herrington Lake/Curds Inlet thru existing Outfall 001;*
- **Phase 2 – *Transition***: *Dewatering of Auxiliary Ash Pond Begins and Plant Process Flows Treated by Process Pond Flows are Collectively Discharged thru New Diffuser (and New Outfall 006) to Herrington Lake; Landfill Stormwater Pond Continues to Discharge thru*

existing Outfall 001 to Herrington Lake/Curds Inlet; FGD-Process Wastewater Chemical Treatment Facilities Still Under Construction (per Requested Compliance Schedule);

- **Phase 3 – *Future***: *Process Wastewaters Treatment Facilities Completed and Treated Flows Discharged to Diffuser/Outfall 006; Ash Pond Dewatering Completed and Stormwater Runoff with Landfill Stormwater Discharged thru Outfall 001 (Note: ELG Compliance Dates for FGD and Bottom Ash Sluice Wastewaters Dates requested for December 31, 2023).*

<u>Outfall #001 – Auxiliary Ash Pond and Landfill Flows</u>

EXISTING OPERATIONS (Phase 1):

The Auxiliary Ash Pond (and/or Process Pond planned to start May 2019) receives plant process wastewaters and treated discharges combine with flows from the Landfill Stormwater Runoff Pond to the external Outfall 001 (to Herrington Lake). Stormwater runoff from areas adjacent the Outfall 001 channel and a landfill liner underdrain system also contribute to the flows monitored by Outfall 001. Specifically, wastewater flows to Outfall 001 currently include:

- Unit 3 FGD wastewater flows including FGD-inerts/fines wastewaters (*FGD-PWS under construction)* and CCRT gypsum dewatering/filtration wastewaters;
- Unit 3 bottom ash sluice waters blowdown (~10%) from recirculated sluice waters associated with submerged flight conveyor bottom ash handling systems (*percentage blowdown of sluiced bottom ash flows may continue until troubleshooting-optimization work is completed and reliability established*);
- **<u>No</u>** dewatering flows from Auxiliary Ash Pond (*closure activities begin after KPDES renewal permit effective date when such flows will be directed to Outfall 006 and with commencement of Phase 2*);
- Landfill active area leachate/runoff flows *(flows pumped to Auxiliary Ash Pond and in Phase 2 the Process Pond);*
- Units 1-3 basement/plant sumps including non-chemical air heater washwaters;
- Coal pile runoff and Closed Main Ash Pond Toe Drain sump flows (temporary treatment until future permanent system constructed)*;*
- Treated Boiler chemical cleaning wastewaters (Internal Outfall 004);
- Demineralized-Boiler water treatment wastewaters (filter backwash & reverse osmosis reject waters);
- Boiler blowdown wastewaters;
- Railway area stormwater/wick-drain sump flows;
- Stormwater runoff from Landfill Stormwater Runoff Pond (*from Perimeter Haul Road & Inactive/Capped Runoff Areas: deminimis CCR-Contact*) and plant Stormwater Runoff Areas 1.a-h and 6.c-6.k including stormwaters runoff contacting CCRs or process materials;
- Landfill Liner Underdrain System (*i.e., for emergency/monitoring/potential flows*);
- Direct precipitation upon the Auxiliary Ash Pond/Process Pond areas (including associated perimeter areas draining inward).

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

The existing Auxiliary Ash Pond settles/mixes/neutralizes plant wastewaters; discharges are controlled thru a decant/stop-log structure which is equipped with floating skimmer-equipment. These flows are piped to a channel to combine with landfill stormwater runoff pond flows; the combined flows are monitored at Outfall 001 sampling/monitoring structure and subsequently discharge to Herrington Lake (via Curds Inlet).

When constructed, the Process Pond is designed to flow as two-cells-in-series with the first cell for primary settling and coupled with a secondary/polishing cell; these cells allow settling, mixing, and neutralization of flows to occur. If maintenance were required, either cell can be used separately. Both cells have decant structures equipped with skimmer-baffles to prevent the discharge of floating materials.

The existing Outfall 001 sampling/monitoring structure provides sampling access and measures flow by a cipoleti-type weir and level-staff gauge in the outfall channel prior to discharge to Herrington Lake.

<u>Outfall #001</u> –cont'd

NEW: TRANSITION OPERATIONS (Phase 2)

External Outfall 001 discharges to Herrington Lake/Curds Inlet and primarily includes many of the same landfill-stormwater flows as during Phase I; however, Plant process flows will be redirected to the Process Pond configured to discharge to external Outfall 006. Specifically, Phase 2 flows to Outfall 001 will include:

- *Stormwater runoff from Landfill Stormwater Runoff Pond (for Perimeter Haul Road & Inactive/Capped Runoff Areas: deminimis CCR-Contact) and plant Stormwater Runoff Areas 1.a-h (note: plant stormwaters runoff contacting CCRs or process materials ultimately directed to Outfall 006);*
- *Landfill Liner Underdrain System (i.e., for emergency/monitoring/potential flows);*
- ***<u>No</u>** wastewater flows from Process Pond or plant process wastewaters such as FGD, bottom ash sluice, plant sumps, coal pile runoff, toe drains, etc. will be directed to Outfall 001 during the Transition Phase 2 Operations. These process flows will be re-directed to the New Diffuser/Outfall 006.*
- ***<u>No</u>** Auxiliary Ash Pond Dewatering flows will be directed to Outfall 001. Such dewatering flows will be directed to the Diffuser/Outfall 006.*
- ***No** coal pile runoff or toe/abutment drain collection system waters, which will be directed to the New Diffuser/Outfall 006.*
- ***<u>No</u>** flows of direct precipitation upon the Auxiliary Ash Pond areas, including associated perimeter areas draining inward, will flow to Outfall 001; these flows will ultimately be pumped to the Process Pond and to the Diffuser/Outfall 006.*

The landfill stormwater runoff pond treats/settles runoff flows from non-CCR portions of the landfill already inactive/capped which may contain total suspended solids from cover soils prior to establishing vegetation. This pond will also receive stormwater runoff flows from the landfill perimeter haul road which may include incidental TSS from the tire treads of truck traffic around/into/out of the landfill. These flows are piped to the channel and joined by *stormwater runoff from adjacent areas and the landfill liner underdrain/system-monitoring pipe, prior to discharge through the Outfall 001 monitoring/sampling structure with final entry into Herrington Lake/Curds Inlet.*

Drainage from the Landfill Stormwater Pond occurs through a passive fabric-filtration system. The existing Outfall 001 monitoring/sampling structure will be used for Transition Phase 2 (and Future Phase 3) operational discharges to Herrington Lake.

Outfall #001 –cont'd
NEW: FUTURE OPERATIONS (Phase 3)

Upon Auxiliary Ash Pond closure, all dewatering flows or potential process wastewaters from the Auxiliary pond will stop (which were directed to Process Ponds/Outfall 006). Stormwater runoff from the closed/capped Auxiliary Ash Pond will be directed to Outfall 001. Future Phase 3 flows, similar to Phase 2 flows, will include:

- *The Landfill Stormwater Runoff Pond flows;*
- *Landfill liner underdrain/system-monitoring pipe;*
- *Adjacent/contributing areas stormwater runoff.*
- *Uncontaminated non-CCR-contact stormwater runoff from the closed/capped/vegetated Auxiliary Ash Pond will be directed to Outfall 001*

The Outfall 001 discharge monitoring structure specifics remain the same for Future Phase 3 operations as for the Transition Operations (Phase 2).

Outfall #002 – RETIRED Units 1-2 Cooling Tower Blowdown Flows

EXISTING: External Outfall 002 discharges to Herrington Lake, and previously included the Cooling Tower Blowdown flows from the currently-RETIRED Units 1-2 (*Retired as of March 1, 2019*); direct precipitation upon the Units 1-2 building roofs also drain to this outfall. All flows pass through an oil-water separator prior to monitoring/sampling and discharge.

Outfall #002

NEW: FUTURE (Phases 2-3) *Current operations and into the future will include drainage from the Units 1-2 building rooftop direct precipitation flows which will continue to flow through the oil-water separator prior to discharge past the existing Outfall 002 sampling-monitoring structure. For this reason, KU requests this outfall sampling and monitoring conditions be changed to require BMP-monitoring and inspections only.*

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

Outfall #003 – Unit 3 Cooling Tower Blowdown Flows

EXISTING/FUTURE: External Outfall 003 discharges to Herrington Lake, and primarily includes the Cooling Tower Blowdown flows from Unit 3 as well as misc. areas stormwater flows. Specifically, flows include:

- Unit 3 Cooling Tower Blowdown flows;
- Unit 3 Cooling Tower(s) direct precipitation (upon east/west cooling towers);
- Unit 3 Building roof direct precipitation.

All flows pass through an oil-water separator prior to monitoring/sampling and discharge. The cooling tower recirculating waters are periodically brominated to control bio-fouling of the condenser as provided for in the current permit.

Outfall #004 – Boiler Chemical Metal-Cleaning Flows

EXISTING/FUTURE: Treated Internal Outfall 004 will discharges to the Process Pond/Outfall 006 in Phase 2 and 3 (*currently to Auxiliary Ash Pond/Outfall 001*) and is an intermittent flow (potentially once or twice per 5-yr period) of wastewater generated during the chemical cleaning of the boiler tubes from the units.

Outfall #005 – Plant Intake

EXISTING/FUTURE: External Outfall 005 from Herrington Lake is the plant intake water used to supply the service water, cooling water, fire protection, and other systems.

Outfall #006 – Process Pond Flows To Diffuser

PROPOSED: *Not applicable for existing operations, the outfall is currently under construction and will not discharge process flows until Phase 2 of new KPDES permit.*

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

Outfall #006 – Process Pond Flows To Diffuser
NEW: TRANSITION OPERATIONS (Phase 2)

External Outfall 006 will discharge to Herrington Lake through a multi-port, high-rate diffuser at a location southeast of Curds Inlet at a wide area of the lake. Flows will generally include Plant-Process Pond flows and stormwater runoff from some areas. Specifically, Phase 2 Outfall 006 flows include:

- *Unit 3 FGD wastewater flows including FGD-inerts/fines wastewaters (FGD-PWS under construction until late-2019) and CCRT gypsum dewatering/filtration wastewaters;*
- *Unit 3 bottom ash sluice waters blowdown (~10%) from recirculated sluice waters associated with submerged flight conveyor bottom ash handling systems (percentage blowdown of sluiced bottom ash flows may continue until troubleshooting-optimization work is completed and reliability established);*
  SEE BELOW – FOOTNOTE 1. Bottom Ash Transport Water ELG Compliance Schedule (at this document bottom)
- *Dewatering flows from Auxiliary Ash Pond for closure activities; these flows would commence with Phase 2/KPDES permit effective date following appropriate advance notice to KDOW;*
- *Landfill active area leachate/runoff flows pumped to Process Pond);*
- *Units 1-3 basement/plant sumps including non-chemical air heater washwaters (treated through oil/water separators before pumping to Process Pond);*
- *Coal pile runoff (temporary treatment provided prior to late-2019 completion of TDCPRTS (Toe Drain and Coal Pile Runoff Treatment System);*
- *Closed Main Ash Pond Toe Drain sump flows (temporary treatment provided prior to late-2019 completion of TDCPRTS (Toe Drain and Coal Pile Runoff Treatment System);*
- *Treated boiler chemical cleaning wastewaters (Internal Outfall 004);*
- *Demineralized-Boiler water treatment wastewaters (filter backwash & reverse osmosis system reject waters);*
- *Boiler blowdown wastewaters;*
- *Railway area stormwater/wick-drain sump flows;*
- *Stormwater runoff from plant Stormwater Runoff Areas 6.a-k including stormwaters runoff contacting CCRs or process materials;*
- *Direct precipitation upon the Process Pond areas (including associated perimeter areas draining inward).*

The Process Pond is designed to flow in series for primary settling, coupled with a secondary/polishing cell, to allow settling, mixing, and neutralization of flows to occur. If maintenance were required, either cell can be used separately. Both cells have decant structures equipped with skimmer-baffles to prevent the discharge of floating materials.

Flows are piped to the multi-port, high-rate Diffuser and the Outfall 006 monitoring/sampling structure is located along the pipeline mid-way before entry into Herrington Lake.

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

Outfall #006 –cont'd

NEW: FUTURE OPERATIONS (Phase 3)

Upon Auxiliary Ash Pond closure, all dewatering flows or potential process wastewaters from the Auxiliary pond to Outfall 006 will stop; thus, only Process Pond flows will be directed to Outfall 006. Except for exclusion of Auxiliary Pond flows, all wastewater flows streams, treatment/configuration of combined flows, and discharge monitoring structure specifics remain the same for Future Phase 3 operations as for the Transition Operations (Phase 2).

Upon startup, troubleshooting, testing and optimization of the PWS and TDCPRTS treatment systems(anticipated to occur during Phase 2 in first half of 2020), the accumulated water volume within the Process Pond will likely require at least 3-6 months to purge of non-chemically treated flows. KU requests a compliance schedule for application of Kentucky Water Quality Standards to Outfall 001 (during Phase 1) and Outfall 006 flows until July 31, 2020.

Outfall #007 – Process Water System (PWS) for FGD-Wastewaters Treatment

PROPOSED *(By End-of Year 2019):* *Internal Outfall 007 to the Process Pond/Outfall 006 will designate the monitoring/sample point of discharges from the Process Water Treatment System (PWTS) Treated Wastewater Effluent Tank; treated wastewaters will be subsequently pumped to the New Process Pond and discharged with combined wastewaters to Herrington Lake.*

The PWS treatment trains startup is planned for late-2019, commercial operations are expected to begin 1st quarter 2020, and a 3-6 month troubleshooting and optimizing period is expected to establish reliable operations to reduce mercury and arsenic concentrations. ELG reconsideration rules may change treatment requirements or limits, and are expected to affect whether biological technology is potentially needed for selenium. Because of the reconsideration, an additional 36-42 months of design-procurement-installation-troubleshooting will be required (following the anticipated November 20, 2020 USEPA Reconsideration/finalization date), so an applicability date of December 31, 2023 is requested for setting limits and conditions for this outfall and meeting the ELGs for FGD wastewater, unless additional time and considerations are included in the final rule.

KENTUCKY UTILITIES COMPANY
E. W. BROWN STATION

<u>Outfall #008 – Railway Area Stormwater/Wick-Drain High Rainfall Flows</u>

PROPOSED *(By Mid-Year 2020):* *Railway area stormwater/wick-drain sump flows are pumped to Process Pond (existing flows to Auxiliary Ash Pond before closure). During high rainfall flow events, sump pump flow capabilities may be exceeded so the excess flows will be directed to a Outfall Sampling-monitoring structure to allow monitoring of these flows (of typically short duration). This external Outfall 008 discharge will combine into the Unit 3 cooling tower blowdown channel to Herrington Lake/Curds Inlet.*

<u>FOOTNOTE 1. Bottom Ash Transport Water ELG Compliance Schedule</u>

As noted above (in Outfall 006/Transition Operations), ongoing Bottom ash sluice waters management includes redesign/repairs to Submerged Flight Conveyors (SFC) constructed to dewater sluice flows and facilitate 'dry' solids-truck handling to the landfill (reliability problems currently being addressed). EPA is currently reconsidering the requirements in the ELGs for bottom ash transport waters and may authorize limited carry over/blowdown waters, which could affect the design or operation of KU's current system. In the September 18, 2017 final rule preamble, EPA explained that the earliest as soon as possible date for bottom ash transport water is extended to November 1, 2020, to accommodate the rule reconsideration. Given the likelihood that the rule reconsideration will not be completed until that date, KU requests until December 31, 2023, to design and install any required changes to its bottom ash handling system to comply with the ELGs, , unless additional time and considerations are included in the final rule.

.

ATTACHMENT 2

Kentucky Division of Water

KPDES – Form 1

Form 1	KENTUCKY POLLUTION DISCHARGE ELIMINATION SYSTEM Permit Application	Division of Water

NAME OF FACILITY:	AGENCY USE ONLY
PERMIT NO.:	COUNTY:

This is an application to: (check one)

☐ Apply for a new permit.
☒ Apply for reissuance of expiring permit.
☐ Modify an existing permit.* (Give reason for modification under Section III)

A complete application consists of this form (Form 1), and one or more of the following: Form A, Form B, Form C, Form F, or Form SC.

I. FACILITY AND CONTACT INFORMATION

Name of business, municipality, company, etc. requesting permit:	E.W. Brown Generating Station
Owner Name (and Title if applicable):	Kentucky Utilities Company, Attn: Gary H. Revlett (Director Environmental Affairs)
Owner Mailing Address (Street, etc.):	P.O Box 32010
Owner City, State, Zip:	Louisville, KY 40232
Owner Telephone Number:	502-627-4621
Owner Email Address:	gary.revlett@lge-ku.com

Type of Ownership:	☐ Publicly Owned	☒ Privately Owned	☐ State Owned	☐ Both Publicly and Privately Owned	☐ Federally Owned

Contact Name and Title (if different):	Roger Medina, Senior Environmental Engineer
Contact Mailing Address (if different):	P.O Box 32010
Contact City, State, Zip (if different):	Louisville, KY 40232
Contact Telephone Number (if different):	502-627-2997
Contact Email Address (if different):	roger.medina@lge-ku.com
NetDMR Official Contact for Facility:	William Michael Winkler
NetDMR Official Contact Telephone Number:	502-627-2338
NetDMR Official Contact Email Address:	Michael.winkler@lge-ku.com

II. FACILITY LOCATION

Facility Location (street, road, highway, etc.):	815 Dix Dam Road
Facility City, State, Zip:	Harrodsburg, KY 40330-9282
Facility Latitude (Decimal Degrees):	37 47' 17"
Facility Longitude (Decimal Degrees):	84 42' 44"

☒ Attach a site location map with the facility and outfalls clearly marked. Provide either an aerial map, topographic map, or other map that identifies the site location and significant features.

III. FACILITY DESCRIPTION	
Provide a brief description of activities, products, etc.: Fossil-fuel fired steam electric generating station	
* Reason for modifying existing permit, if applicable:	
Principal SIC Code and description: 4911	
Other SIC Codes:	
IV. OPERATOR INFORMATION	
Treatment Plant Operator Name: NA	
Operator Mailing Address (Street, etc.):	
Operator City, State, Zip:	
Operator Telephone Number:	
Operator Email Address:	
Operator Certification Class:	Operator Certification Number:
V. ENVIRONMENTAL PERMITS/REGISTRATIONS FOR THIS FACILITY	
KPDES Permit Number: KY 0002020	Issue Date of Current Permit: March 1, 2010
Expiration Date of Current Permit: Feb 28, 2015	Date of Original Permit Issuance: Dec 31, 1974
☐ Other DOW Permits (list):	
☐ Sludge Disposal Permit Number:	
☐ Air Emission Source Control Permit Number: KYDAQ Title V Permit V-10-004 R2	
☐ Solid Waste or Special Waste Permit Number: KYDWM 084-00010 S.W. Landfill	
☐ Hazardous Waste Registration or Permit Number: KYD-000-622-951 CESQG/SQG	
☐ Surface Mine or Underground Mine Permit Number:	
☐ Other (specify):	
VI. PERMIT FEE (See instructions)	
Select the type of permit being requested. See instructions for applicable fees and methods of payment. Additional information can be found in "General Instructions" at Water.Ky.Gov/Permitting/WastewaterDischarge	
☒ Major Industry	☐ Large Non-POTW
☐ Minor Industry	☐ Intermediate Non-POTW
☐ Non-Process Industry	☐ Small Non-POTW
☐ Surface Mining Operation	☐ 501(c)(3)

☐ Agriculture	☐ Exempt Publicly Owned Facility
☐ Total Amount Enclosed $	

IX. CERTIFICATION	
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.	
PRINTED NAME AND TITLE: Donald Ralph Bowling, Vice President Power Production	
SIGNATURE: Ralph Bowling	DATE: 5-22-19
TELEPHONE NO. 502-627-4121	EMAIL: ralph.bowling@lge-ku.com

Return completed application form and attachments to:
Division of Water
Surface Water Permits Branch
300 Sower Boulevard, 3rd Floor
Frankfort, KY 40601

Direct questions to: Surface Water Permits Branch at (502) 564-3410.

KPDES FORM 1 – INSTRUCTIONS

Section A: GENERAL INSTRUCTIONS

The facility name should be the official or legal name by which the facility is commonly known and/or uniquely identified. Do not use a colloquial name. List the county where the facility is located.

With the exceptions described in Section C of these instructions, Federal and State laws prohibit you from the discharge of pollutants into the waters of the United States or waters of the Commonwealth.

Where to File:	Return completed application form and attachments to: Division of Water Surface Water Permits Branch 300 Sower Boulevard, 3rd Floor Frankfort, KY 40601
When to File:	File the application at least 180 days prior to expiration of your current KPDES permit or at least 180 days prior to startup of a new facility.
Fees:	Permit Fees are listed in Section B of these instructions.
Completion of Form:	Unless otherwise specified in the detailed instructions, you must answer each item in the form. To indicate that you have considered each item, enter "NA," for not applicable, if a particular item does not fit the circumstances of your facility or activity. If more space is necessary to answer a question, attach a separate sheet entitled "Additional Information."

Section B: COMPLETING FORM 1

Listed below are explanations of select Form 1 questions. If further information is needed concerning any section, **please contact Division of Water, Surface Water Permits Branch at (502) 564-3410.**

I. Facility and Contact Information

Use the official or legal name of the business, company, municipality, etc. requesting permit. Do not use a colloquial name. Give the name, as it is legally referred to, of the person, firm, public organization, or any other entity that operates the facility described in this application. This may or may not be the same name as the facility. The operator of the facility is the legal entity which controls the facility's operation rather than the plant or site manager. This use of "operator" in many cases is not the same as the treatment plant Certified Operator.

The owner mailing address should be the legal permittee of record and is the address where correspondence regarding the application, permit, etc. for the facility will be sent unless otherwise indicated. This often is not the address used to designate the location of the facility or activity. Give the name, title, and work telephone number of a person who is thoroughly familiar with the operation of the facility and with the facts reported in this application and who can be contacted by reviewing offices if necessary. The contact mailing address is to be provided if different from the owner mailing address. The name, telephone number, and email address of the facility's official contact for netDMR (Discharge Monitoring Reports) is to be provided.

II. Facility Location

The facility location should be for the actual location of the facility (i.e. road name, highway number, not the P.O. Box address). If there is no street address, identify the facility by the most accurate alternative geographic information such as direction and distance to the nearest intersection or permanent landmark (e.g., ½ mile east of intersection of KY 70 and US 127).

List the latitude and longitude for the facility site. The latitude/longitude reading for the site should be taken at the influent to the wastewater treatment plant, if applicable.

Attach a site location map with the facility and outfalls clearly marked. Provide either an aerial map, topographic map, or other map that identifies the site location and significant features including the facility's intake and discharge structures. Also mark the locations of those wells, springs, surface water bodies, and drinking water wells listed in public records or otherwise known to the applicant within one-quarter mile of the facility property boundary.

III. Facility Description

Briefly describe the nature of the business and the activities being conducted that require a KPDES permit.

Identify the principal 4-digit standard industrial classification (SIC) code and other applicable SIC codes that best describe your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words. These classifications may differ from the SIC codes describing the operation generating the discharge. The SIC codes are numbers and descriptions of activities classified by the Executive Office of the President, Office of Management and Budget. These are found in the latest edition of the Standard Industrial Classification (SIC) Manual.

If the application is for the modification of an existing permit, please provide the specific reason(s) for modifying the existing permit.

IV. Operator Information

For those facilities that require a Certified Operator, enter the name of a Certified Operator who will operate the treatment plant, or enter the name of an operator who will be certified before commencement of discharge. The operator of the treatment plant is often someone other than the operator of the facility identified in Section I.

List the Certified Operator's mailing address, telephone number, and email address. Also, provide the Certified Operator's Certification Class and Certification Number.

The operator must be currently certified with the Division of Water. For information concerning those requirements, please contact the Division of Compliance Assistance at (502) 564-0323.

V. Environmental Permits/Registrations for This Facility

List any existing environmental permits for this facility and identify any permits for which the facility will apply. KPDES permits use an NPDES generated number.

VI. Permit Fee

The payment of the permit fee, as listed below, must accompany the application for a new KPDES Permit or for reissuance of an expiring KPDES Permit in order for the permit application to be processed. For an application to modify an existing permit, the Division of Water will notify the applicant of the required permit fee to be paid prior to issuance of the permit modification. Your check must be made payable to "Kentucky State Treasurer." For permit renewals, to ensure proper credit to your account, please include the KPDES permit number on the check. The permit fee is not refundable if the application is withdrawn or the permit is denied. Listed below are the facility categories and associated base five-year permit fees. (See the separate "General Instructions" for definitions of facility categories.)

Facility Category	Five-Year Permit Fee
Major Industry	$7,000
Minor Industry	$4,500
Non-Process Industry	$2,200
Large Non-POTW	$3,700
Intermediate Non-POTW	$3,200
Small Non-POTW	$2,200
Agriculture	$1,200
Surface Mining Operation	$3,300
501(c)(3)	$100

If this application is for a new project, see separate General Instructions for the applicable Construction Permit fee.

VII. Certification

The permit application must be signed as follows:

- **Corporation:** by a principal executive officer of at least the level of vice president.
- **Partnership or sole proprietorship:** by a general partner or the proprietor respectively.

- **Municipality, state, federal, or other public agency:** by either a principal executive officer or ranking elected official.

Section C: ACTIVITIES WHICH DO NOT REQUIRE KPDES PERMITS

You are not required to obtain a KPDES permit if your discharge is one of the following categories, as provided by the Clean Water Act (CWA) and KPDES regulations (401 KAR Chapter 5).

1. Dredged or Fill Material: Discharges of dredged or fill material as defined at 33 CFR 323.2 into waters of the Commonwealth do not need KPDES permits if the dredging or filling is authorized by a permit issued by the U.S. Army Corp of Engineers.

2. Discharges into Publicly Owned Treatment Works (POTW): The introduction of sewage, industrial wastes, or other pollutants into a POTW does not need a KPDES permit. You must comply with all applicable pretreatment standards promulgated under Section 307 (b) of the CWA, which may be included in the permit issued to the POTW. If you have a plan or an agreement to switch to a POTW in the future, this does not relieve you of the obligation to apply for and receive a KPDES permit until you have stopped discharging pollutants into waters of the Commonwealth.

3. Dischargers into Privately Owned Treatment Works: Dischargers into privately owned treatment works do not have to apply for or obtain KPDES permits except as otherwise required by the Cabinet. The owner or operator of the treatment works itself, however, must apply for a permit and identify all users in its application.

4. Discharges from Agricultural and Silvicultural Activities: Most discharges from agricultural and silvicultural activities to waters of the Commonwealth do not require KPDES permits. These include runoff from orchards, cultivated crops, pastures, range lands, and forest lands. However, the discharge listed below DO require KPDES permits.
   a. Discharges from Concentrated Animal Feeding Operations.
   b. Discharges from Concentrated Aquatic Animal Production Facilities.
   c. Discharges associated with approved Aquaculture Projects.
   d. Discharges from Silvicultural Point Sources. Nonpoint source silvicultural activities are excluded from KPDES permit requirements. However, some of these activities, such as stream crossings for roads, may involve point source discharge of dredged or fill material which may require a Section 404 permit. See 33 CFR 209.120.

5. Underground Injection Control Permits Under the Safe Drinking Water Act

ATTACHMENT 3

Kentucky Division of Water

KPDES

Application Filing Fee Check to State Treasurer

VENDOR NO: 15166

ENDORSEMENT OF ATTACHED CHECK WILL ACKNOWLEDGE PAYMENT IN FULL OF ITEMS SET FORTH BELOW
KENTUCKY UTILITIES COMPANY

NO: 610216
DATE: 19-Feb-19

INVOICE NUMBER	INVOICE DATE	DESCRIPTION	DISCOUNT	NET AMOUNT
KENTUC021419	14-Feb-2019	RTN TO CONNIE YORK LGE 4	0.00	7,000.00
TOTALS			0.00	7,000.00

PLEASE DETACH BEFORE PRESENTING CHECK

REMOVE DOCUMENT ALONG THIS PERFORATION

THIS DOCUMENT IS PRINTED IN TWO COLORS. DO NOT ACCEPT UNLESS BLUE AND GREEN ARE PRESENT.

KENTUCKY UTILITIES COMPANY
P.O. Box 32030
Louisville, KY 40232

CHECK DATE: 19-Feb-19

VOID 6 MONTHS AFTER THIS DATE

BANK OF AMERICA, N.A.
Controlled Disbursement
Atlanta, Dekalb County, Georgia

NO: 610216

64-1278
611 GA

PAY Seven Thousand and 00/100 Dollars

CHECK AMOUNT: ****$7,000.00

TO THE ORDER OF:
KENTUCKY STATE TREASURER
SURFACE WATER PERMITS BRANCH
DIVISION OF WATER
300 SOWER BLVD
FRANKFORT KY 40601

MANUAL COUNTER SIGNATURE REQUIRED OVER $300,000

⑈00610216⑈ ⑆061112788⑆ 329 902 7583⑈

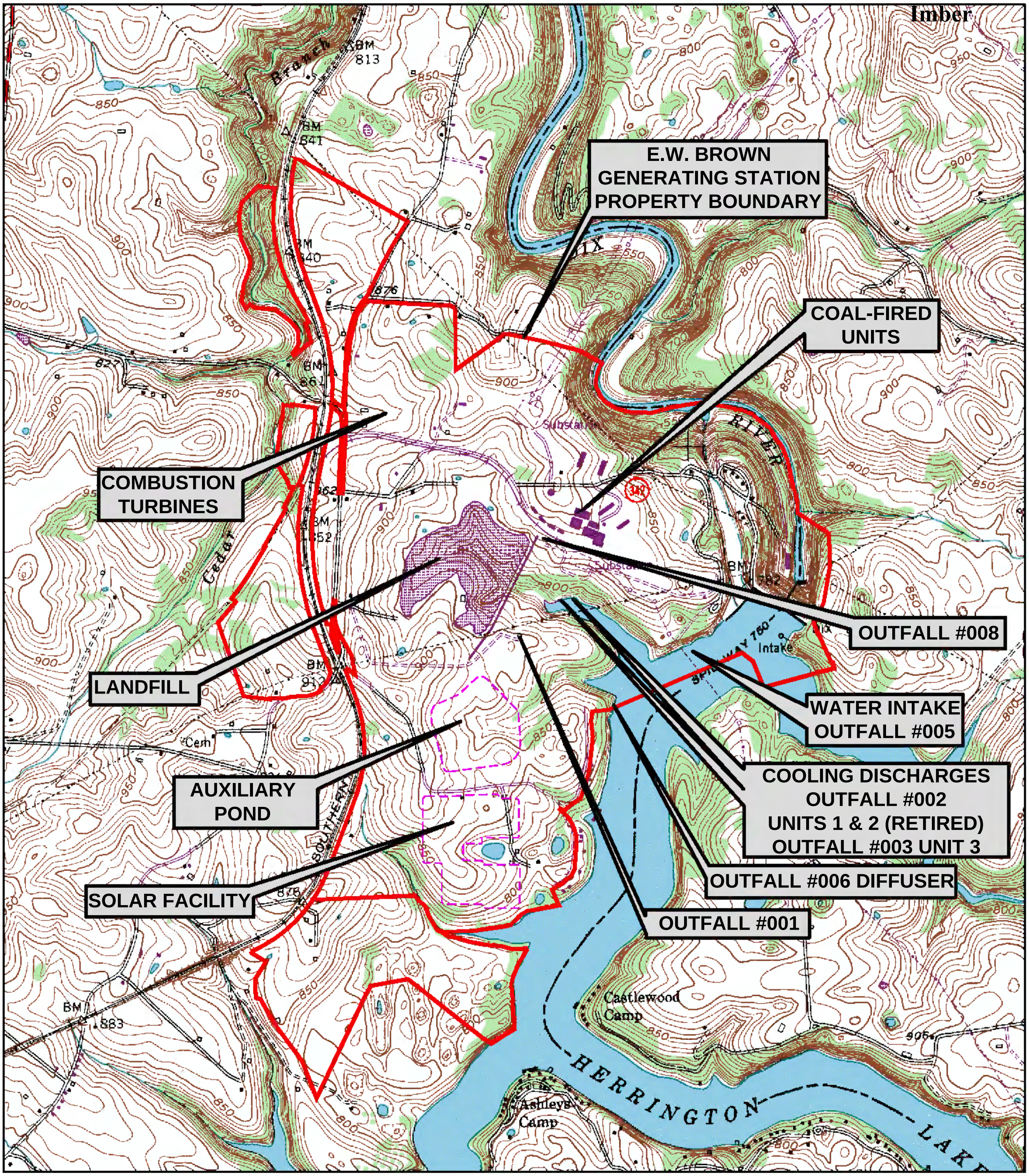
KENTUCKY UTILITIES COMPANY
P.O. Box 32030
Louisville, KY 40232

KENTUCKY STATE TREASURER
SURFACE WATER PERMITS BRANCH
DIVISION OF WATER 300 SOWER BLVD
FRANKFORT KY US 40601

SEE REVERSE SIDE FOR OPENING INSTRUCTIONS

ATTACHMENT 4

USGS TOPOGRAPHIC MAP



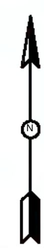
E.W. BROWN GENERATING STATION

KENTUCKY UTILITIES CO.

HARRODSBURG, MERCER COUNTY, KENTUCKY

WILMORE, KENTUCKY, USGS QUADRANGLE MAP

Scale: 1"=2000'



ATTACHMENT 5

Kentucky Division of Water

KPDES – Form C

Form C

KENTUCKY POLLUTION DISCHARGE ELIMINATION SYSTEM

Permit Application

Division of Water

NAME OF FACILITY: E.W. Brown Generating Station	AGENCY USE ONLY
PERMIT NO.: KY 0002020	COUNTY: Mercer

I. OUTFALL LOCATION

☒ For each outfall, list the latitude and longitude of its location to five decimal points.

OUTFALL NUMBER	LATITUDE In Decimal Degrees	LONGITUDE In Decimal Degrees	RECEIVING WATER (name)
001	37.784741	-84.715331	Herrington Lake
002	37.786910	-84.712715	Herrington Lake
003	37.787529	-84.714465	Herrington Lake
005	37.783567	-84.709256	Herrington Lake
006	37.782714	-84.715321	Herrington Lake
007	37.787328	-84.716126	Internal to 006
008	37.787492	-84.714583	Herrington Lake

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES

A. Attach a line drawing showing the water flow through the facility. Indicate sources of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item B. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfall. If a water balance cannot be determined (e.g., for certain mining activities), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.

B. For each outfall, provide a description of: (1) all operations contributing wastewater to the effluent, including process wastewater, sanitary wastewater, cooling water, and stormwater runoff; (2) the average flow contributed by each operation; and (3) the treatment received by the wastewater. Continue on additional sheets if necessary.

OUTFALL NUMBER	SOURCES OF WASTEWATER			TREATMENT DESCRIPTION (from Table C-1)
	Operations Contributing to Flow	Avg. Flow (include units)	Design Flow (include units)	
Existing Operations – *Outfalls 001 to 005 per current permit (which change with Transition Operations)*				
001	Flue Gas Desulfurization (FGD) Inert Fines + Dewatering+Flush Flows	0.0864 MGD		Settling, Mixing, Neutralization
	Bottom Ash Sluice + Flush Waters (Approx 10% of Recycled Flows)	0.1206 MGD		
	Landfill Leachate (Precipitation, CCR-Contact)	0.1193 MGD		
	Plant Sumps including Air Heater Washwaters, Boiler Blowdowns, Demineralizer Wastes, Seal Waters, filter/backwashes, etc.	0.5531 MGD		
	Coal Pile/Yard Runoff & Washdowns	0.2079 MGD		
	Metal Cleaning Wastes (***Outfall 004***)	0.0038 MGD		
	Abutment & Wick-Drain Sumps Flows	0.1044 MGD		

	Closed Main Ash Pond Toe Drain, Sump Flows	0.5205 MGD		
	Precipitation, on Limestone Pile	0.0031 MGD		
	Precipitation, to Oil/Water Separators (misc. plant process areas)	0.0176 MGD		
	Precipitation, Direct Aux-Ash Pond *and newly Construct. Process Ponds*	0.0495 MGD		
	Precipitation, Landfill Inactive Areas Perimeter Access Areas Stormwater Runoff	0.0948 MGD		
	Precipitation, Landfill Liner Underdrain-Monitoring System	0 MGD		
002	Precipitation, Units 1-2 Building Roof Drains (thru O/W Separator)	0.0038 MGD		Discharge to Surface Water
	*Previously Cooling Tower Blowdown but now-**RETIRED Units 1-2***	0 MGD	0	
003	Cooling Tower Blowdown Unit 3	1.9728 MGD		Disinfection (Other), Discharge to Surface Water
	Precipitation, Direct to Cooling Tower(s) and Unit 3 Building Roof Drains (thru O/W Separator)	0.0086 MGD		
004 (Internal)	Boiler-Metal Cleaning Wastewaters	See above 001		Chemical Precipitation
005	Plant Intake	6.2875 MGD		

AVERAGE & MAXIMUM FLOWS = 30 day Composite of 29 days Maximum Flows & 1 day Maintenance Max Flows

Transition Operations – *Outfalls 001 to 005, New 006-008 per new permit (to continue into Future Operations), Auxiliary Ash Pond Dewatering Flows Begin to New Outfall 006 Multiport, High-Rate Diffuser to Herrington Lake*

001	Precipitation, Landfill Inactive Areas Perimeter Access & Adjacent Drainage Areas Stormwater Runoff	0.0948 MGD		Settling, Mixing, Neutralization
	Precipitation, Landfill Liner Underdrain-Monitoring System	0 MGD		
002	Precipitation, Units 1-2 Building Roof Drains (thru O/W Separator)	0.0038 MGD		Discharge to Surface Water
	*Previously Cooling Tower Blowdown from now-**RETIRED Units 1-2***	0 MGD		
003	Cooling Tower Blowdown Unit 3	1.9728 MGD		Disinfection (Other), Discharge to Surface Water
	Precipitation, Direct to Cooling Tower(s) and Unit 3 Building Roof Drains (thru O/W Separator)	0.0086 MGD		
004 (Internal)	Boiler-Metal Cleaning Wastewaters	See Outfall 006		Chemical Precipitation
005	Plant Intake	6.2875 MGD		
006 (NEW, to Multiport, High-Rate Diffuser)	Auxiliary Ash Pond Dewatering Flows	0.325 MGD		Settling, Mixing, Neutralization
	Flue Gas Desulfurization (FGD) Inert Fines + Dewatering+Flush Flows (***Outfall 007** after Optimization*)	0.0086 MGD		
	Bottom Ash Sluice + Flush Waters (Approx 10% of Recycled Flows)	0.1206 MGD		
	Landfill Leachate (Precipitation, CCR-Contact)	0.1193 MGD		

	Plant Sumps including Air Heater Washwaters, Boiler Blowdowns, Demineralizer Wastes, Seal Waters, filter/backwashes, etc.	0.5531 MGD		
	Coal Pile/Yard Runoff & Washdowns	0.2079 MGD		
	Metal Cleaning Wastes (***Outfall 004***)	0.0038 MGD		
	Abutment and Wick-Drain Sumps Flows	0.1044 MGD		
	Closed Main Ash Pond Toe Drain Sump Flows	0.5205 MGD		
	Precipitation, on Limestone Pile	0.0031 MGD		
	Precipitation, to Oil/Water Separators (misc. plant process areas)	0.0176 MGD		
	Precipitation, Direct Aux-Ash Pond *and newly Construct. Process Ponds*	0.0082 MGD		
007 (NEW, Internal)	Flue Gas Desulfurization (FGD) Inert Fines + Dewatering+Flush Flows (*after Optimization Period*)	0.0043 MGD		Chemical Precipitation
008 (NEW)	Railway Area/Wick-Drin Stormwater High Rainfall Flow Events (*Fraction of Flow not pumped to Process Pond/Outfall 006*)	0.0558 MGD		Discharge to Surface Water
AVERAGE & MAXIMUM FLOWS = 30 day Composite of 29 days Maximum Flows & 1 day Maintenance Max Flows				
Future Operations – *Outfalls 001 to 008 continue per new permit, Auxiliary Ash Pond Dewatering Flows Nearly Complete/Stopped, PWS-FGD Wastewaters Treatment Optimized, All Process Flows (except Cooling Tower Blowdowns) to New Outfall 006 Multiport, High-Rate Diffuser to Herrington Lake*				
001	Precipitation, Landfill Inactive Areas Perimeter Access & Adjacent Drainage Areas Stormwater Runoff	0.0948 MGD		Settling, Mixing, Neutralization
	Precipitation, Landfill Liner Underdrain-Monitoring System	0 MGD		
	Precipitation, Closed/Capped Auxiliary Ash Pond Stormwater Runoff Flows	0.0413 MGD		
002	Same Flows as Transition Operations			Discharge to Surface Water
	Precipitation, Units 1-2 Building Roof Drains (thru O/W Separator)	0.0038 MGD		
	*Previously Cooling Tower Blowdown from now-**RETIRED Units 1-2***	0 MGD		
003	Same Flows as Transition Operations			
	Cooling Tower Blowdown Unit 3	1.9728 MGD		
	Precipitation, Direct to Cooling Tower(s) and Unit 3 Building Roof Drains (thru O/W Separator)	0.0086 MGD		
004	Boiler-Metal Cleaning Wastewaters	See Outfall 006		Chemical Precipitation
005	Plant Intake	6.2875 MGD		
006 (NEW, to Multiport, High-Rate Diffuser)	Auxiliary Ash Pond Dewatering Flows **(STOPPED)**	0 MGD		Settling, Mixing, Neutralization
	Flue Gas Desulfurization (FGD) Inert Fines + Dewatering+Flush Flows (***Outfall 007** Optimization Complete*)	0.0086 MGD		
	Bottom Ash Sluice + Flush Waters (Approx 10% of Recycled Flows)	0.1206 MGD		

	Landfill Leachate (Precipitation, CCR-Contact)	0.1193 MGD		
	Plant Sumps including Air Heater Washwaters, Boiler Blowdowns, Demineralizer Wastes, Seal Waters, filter/backwashes, etc.	0.5531 MGD		
	Coal Pile/Yard Runoff & Washdowns	0.2079 MGD		
	Metal Cleaning Wastes (***Outfall 004***)	0.0038 MGD		
	Abutment & Wick-Drain Sumps Flows	0.1044 MGD		
	Closed Main Ash Pond Toe Drain Sump Flows	0.5205 MGD		
	Precipitation, on Limestone Pile	0.0031 MGD		
	Precipitation, to Oil/Water Separators (misc. plant process areas)	0.0176 MGD		
	Precipitation, Direct to *newly Construct. Process Ponds*	0.0082 MGD		
007 (NEW, Internal)	Flue Gas Desulfurization (FGD) Inert Fines + Dewatering+Flush Flows *(Optimization Completed*)	0.0086 MGD		Chemical Precipitation
008 (NEW)	Railway Area/Wick-Drin Stormwater High Rainfall Flow Events (*Fraction of Flow not pumped to Process Pond/Outfall 006*)	0.0558 MGD		Discharge to Surface Water
AVERAGE & MAXIMUM FLOWS = 30 day Composite of 29 days Maximum Flows & 1 day Maintenance Max Flows				

II. FLOWS, SOURCES OF POLLUTION, AND TREATMENT TECHNOLOGIES (Continued)

C. Except for stormwater runoff, leaks, or spills, are any of the discharges described in Items II-A or B intermittent or seasonal?

☐ Yes. If yes then complete the following table.

☒ No. If no then go to Section III.

OUTFALL NUMBER	OPERATIONS CONTRIBUTING TO FLOW	DAYS PER WEEK (specify avg.)	MONTHS PER YEAR (specify avg.)	FLOW RATE (MGD)		TOTAL VOLUME (include units)		DURATION (days)
				Long-Term Avg.	Max Daily	Long-Term Avg.	Max Daily	

III. PRODUCTION

A. Does an effluent limitation guideline promulgated by EPA under Section 304 of the Clean Water Act apply to your facility? (40 CFR 401 – 471)

☒ Yes. Complete Item III-B and list the effluent limitation guideline category(ies): 40 CFR Part 423

☐ No. Go to Section IV.

B. Are the limitations in the applicable effluent limitations guideline expressed in terms of production or other measures of operation? (40 CFR 401 – 471)

☐ Yes. Complete Item III-C.

☒ No. Go to Section IV.

C. If you answered "Yes" to Item III-B, list the quantity which represents the actual measurement of your level of production, expressed in the terms and units used in the applicable effluent limitation guideline, and indicate the affected outfalls

AVERAGE DAILY PRODUCTION			Affected Outfalls (list outfall numbers)
Quantity Per Day	Units of Measure	Operation, Product, Material, Etc. (specify)	

IV. IMPROVEMENTS

A. Are you now required by any federal, state or local authority to meet any implementation schedule for the construction, upgrading, or operation of wastewater equipment or practices or any other environmental programs which may affect the discharges described in this application? This includes, but is not limited to, permit conditions, administrative or enforcement orders, enforcement compliance schedule letters, stipulations, court orders and grant or loan conditions

☐ Yes. Complete the following table.

☒ No. Go to Section IV-B.

INDENTIFICATION OF CONDITION AGREEMENT, ETC.	AFFECTED OUTFALLS		BRIEF DESCRIPTION OF PROJECT	FINAL COMPLIANCE DATE	
	No.	Source of Discharge		Required	Projected

B. **OPTIONAL:** You may attach additional sheets describing any additional water pollution control programs (or other environmental projects which may affect your discharges) you now have under way or which you plan. Indicate whether each program is now under way or planned, and indicate your actual or planned schedules for construction

V. INTAKE AND EFFLUENT CHARACTERISTICS

A. Tables A, B, and C of this section are included on separate sheets numbered 5-18.
B. See instructions before proceeding.
Complete one set of tables for each outfall.
C. Place the outfall number in the space provided on each table.

D. Use the space below to list any of the pollutants (refer to SARA Title III, Section 313) listed in TABLE C-3 of the instructions which you know or have reason to believe is discharged or may be discharged from any outfall. For every pollutant you list, briefly describe the reasons you believe it to be present and report any analytical data in your possession

POLLUTANT	SOURCE	POLLUTANT	SOURCE
Ammonium Hydroxide	Boiler/Feedwater System pH Control & Buffering	Sodium Hypochlorite	Feedwater Pre-Treatment System Conditoning Agent
Sodium Hydroxide & Sulfuric Acid	Demineralizer Regenerant Chemicals	Sodium BiSulfite	Reverse Osmosis (RO) System Dechlorination-Pre-Treatment
Sodium Bisulfite	Demineralizer Water Treatment Dechlorination	Phosphoric Acid	RO System Membrane Cleaner
Sodium Molybdate	Closed Cooling Inhibitor	Quat-DIMAC Ammonium Chloride	Cooling System Zebra Mussel Biocide Periodic Treatments
Sodium Hydroxide, Organo-Sulfide & Polymer Coagulant	Toe Drain & Coal Pile Runoff Flows Metals Precipitation	Sodium Hydroxide, Organo-Sulfide & Polymer Coagulant	FGD & Gypsum Dewatering Flows Metals Precipitation

VI. POTENTIAL DISCHARGES NOT COVERED BY ANALYSIS

A. Is any pollutant listed in Table C of this section a substance or a component of a substance which you currently use or manufacture as an intermediate or final product or byproduct?

☐ Yes. List all such pollutants in the space provided below.

☒ No. Go to Section VII.

VII. BIOLOGICAL TOXICITY TESTING DATA

Do you have any knowledge of or reason to believe that any biological test for acute or chronic toxicity has been made on any of your discharges or on a receiving water in relation to your discharge within the last 3 years?

☒ Yes. Identify the test(s) and describe their purposes below.

☐ No. Go to Section VIII.

Toxicity Control & Biomonitoring Program Testing was incorporated into the current KPDES for Outfall 001 discharge including:
1. a 48-hour static toxicity test with Ceriodaphnia sp.;
2. a 48-hour static toxicity test with fathead minnow

These tests were performed at least annually and indicated full compliance with the KPDES toxicity limits.

VIII. CONTRACT ANALYSIS INFORMATION

Applicants that discharge pollutants to waters of the Commonwealth must provide analytical data for the parameters shown on this Form. The analysis must be performed by a laboratory that is certified in accordance with 401 KAR 5:320
All information reported must be based on data collected through analysis conducted using 40 CFR Part 136 methods. In addition, this data must comply with QA/QC requirements of 40 CFR Part 136 and other appropriate QA/QC requirements for standard methods for analytes not addressed by 40 CFR Part 136.
Below please list any analyses reported in Section V that were performed by a contract laboratory or consulting firm.

NAME	ADDRESS	TELEPHONE	POLLUTANTS ANALYZED
Microbac-Laboratories Kentucky Testing Laboratory Division	3323 Gilmore Industrial Blvd Louisville, KY 40213 (or) 2520 Regency Road Lexington, KY 40503	502-962-6400 859-276-3506	Biomonitoring and chemical composition analyses

IX. CERTIFICATION.

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.

PRINTED NAME AND TITLE: Donald Ralph Bowling, Vice President Power Production

SIGNATURE: Ralph Bowling | DATE: 5-22-19

TELEPHONE NO. 502-627-4121 | EMAIL: ralph.bowling@lge-ku.com

Return completed application form and attachments to:
Division of Water
Surface Water Permits Branch
300 Sower Boulevard, 3rd Floor
Frankfort, KY 40601

Direct questions to: Surface Water Permits Branch at (502) 564-3410.

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued from Section V. INTAKE AND EFFLUENT CHARACTERISTICS)

PART A.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE A.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.
You must provide the results of at least one analysis for every pollutant in this table.

TABLE A Page 1 of 1 — **OUTFALL NO.** 001 (E.W. Brown – Auxiliary Pond)

1. POLLUTANT	2. EFFLUENT							3. UNITS (specify if blank)		4. INTAKE (optional)		
	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Biochemical Oxygen Demand $(BOD)_5$	BDL				BDL		1	mg/L				
2. Chemical Oxygen Demand (COD)	BDL				BDL		1	mg/L				
3. Total Organic Carbon (TOC)	4.14				4.14		1	mg/L				
4. Total Suspended Solids (TSS)	27				27		1	mg/L				
5. Ammonia (as N)	BDL				BDL		1	mg/L				
6. Flow (MGD)	0.403		VALUE		0.403		1	MGD		VALUE		
7. Temperature (winter)	8.6		VALUE		8.6		1	°C		VALUE		
8. Temperature (summer)	VALUE		VALUE		VALUE			°C		VALUE		
9. pH	MINIMUM 7.77	MAXIMUM	MINIMUM	MAXIMUM			1	STANDARD UNITS				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART B.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE B.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

In column "2. MARK X", place an "X" in either the **Believed Present** column (2.a) for each pollutant you know or have reason to believe is present; or place an "X" in the **Believed Absent** column (2.b) for each pollutant you believe to be absent.
If you mark the **Believed Present** column for any pollutant, you must provide the results of at least one analysis for that pollutant.
Complete one table for each outfall. See the instructions for additional details and requirements.

TABLE B Page 1 of 2 — **OUTFALL NO.** 001 (E.W. Brown – Auxiliary Pond)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
			(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Bromide (24959-67-9)	X		2.2						1	mg/L				
2. Chloride	X		79						1	mg/L				
3. Chlorine, Total Residual	X		BDL						1	mg/L				
4. Color	X		20						1	ADMI				
5. E.coli	X		20.3						1	MPN/100 ml				
6. Fluoride (16984-48-8)	X		2.3						1	mg/L				
7. Hardness ($CaCO_3$)	X		980						1	mg/L				
8.Nitrate–Nitrite (as N)	X		2.0						1	mg/L				
9. Nitrogen, Total Organic (as N)	X		0.86						1	mg/L				
10. Oil and Grease	X		BDL						1	mg/L				
11. Phosphorous (as P), Total (7723-14-0)	X		0.21						1	mg/L				
12. Radioactivity														
(1) Alpha, Total	X		2.64						1	pCi/L		BDL		1
(2) Beta, Total	X		7.87						1	pCi/L		2.92		1
(3) Radium, Total	X		0.706						1	pCi/L		0.562		1

TABLE B Page 2 of 2	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)												
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value (1) Concentration	a. Maximum Daily Value (2) Mass	b. Maximum 30-Day Avg. Value (if available) (1) Concentration	b. Maximum 30-Day Avg. Value (if available) (2) Mass	c. Long-Term Avg. Value (if available) (1) Concentration	c. Long-Term Avg. Value (if available) (2) Mass	d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value (1) Concentration	a. Long-Term Avg. Value (2) Mass	b. No of Analyses
(4) Radium, 226, Total	X		0.567						1	pCi/L		0.182		1
(5) Strontium-90, Total	X		0.772						1	pCi/L		BDL		1
(6) Uranium	X		3.67						1	ug/L		0.359		1
13. Sulfate (asSO_4) (14808-79-8)	X		740						1	mg/L				
14. Sulfide (as S)	X		BDL						1	mg/L				
15. Sulfite (asSO4) (14286-46-3)	X		BDL						1	mg/L				
16. Surfactants	X		BDL						1	mg/L MBAS				
17.Aluminum,Total (7429-90)	X		470						1	ug/L				
18. Barium, Total (7440-39-3)	X		43						1	ug/L				
19. Boron, Total (7440-42-8)	X		9.1						1	mg/L				
20. Cobalt, Total (7440-48-4)	X		6.2						1	ug/L				
21. Iron, Total (7439-89-6)	X		700						1	ug/L				
22. Magnesium, Total (7439-96-4)	X		71						1	mg/L				
23. Molybdenum, Total (7439-98-7)	X		450						1	ug/L				
24. Manganese, Total (7439-96-6)	X		1,400						1	ug/L				
25. Tin, Total (7440-31-5)	X		BDL						1	mg/L				
26. Titanium, Total (7440-32-6)	X		BDL						1	mg/L				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART C.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE C.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

If you are a primary industry and this outfall contains process wastewater, refer to the instructions (Table C-2) to determine which of the GC/MS fractions you must test for.
Mark "X" in the **Testing Required** column for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols.
If you are not required to mark this column (secondary industries, nonprocess wastewater outfalls, and non-required GC/MS fractions), mark "X" in the **Believed Present** column for each pollutant you know or have reason to believe is present.
Mark "X: in the **Believed Absent** column for each pollutant you believe to be absent.
If you mark either the **Testing Required** or **Believed Present** columns for any pollutant, you must provide the result of at least one analysis for that pollutant. Note that there are eight pages to this part; please review each carefully. Complete one table (all eight pages) for each outfall.
See the instructions for additional details and requirements

TABLE C Page 1 of 8 — **OUTFALL NO.** 001 (E.W. Brown – Auxiliary Pond)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS															
1M. Antimony, Total (7440-36-0)	X			2.0						1	ug/L				
2M. Arsenic, Total (7440-38-2)	X			6.2						1	ug/L				
3M. Beryllium, Total (7440-41-7)	X			BDL						1	ug/L				
4M. Cadmium, Total (7440-43-9)	X			1.6						1	ug/L				
5M. Chromium, Total (7440-43-9)	X			1.9						1	ug/L				
6M. Copper, Total (7550-50-8)	X			6.6						1	ug/L				
7M. Lead, Total (7439-92-1)	X			1.2						1	ug/L				
8M. Mercury, Total (7439-97-6)	X			18.8						1	**ng/L**				
9M. Nickel, Total (7440-02-0)	X			29						1	ug/L				
10M. Selenium, Total (7782-49-2)	X			22						1	ug/L				
11M. Silver, Total (7440-28-0)	X			BDL						1	ug/L				

TABLE C Page 2 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS continued															
12M Thallium, Total (7440-28-0)	X			BDL						1	ug/L				
13M. Zinc, Total (7440-66-6)	X			17						1	ug/L				
14M. Cyanide, Total (57-12-5)	X			BDL						1	mg/L				
15M. Phenols, Total	X			BDL						1	mg/L				
DIOXIN															
2,3,7,8 Tetra-chlorodibenzo-P-Dioxin (1784-01-6)			X	DESCRIBE RESULTS:											
GC/MS FRACTION – VOLATILE COMPOUNDS															
1V. Acrolein (107-02-8)	X			BDL						1	mg/L				
2V. Acrylonitrile (107-13-1)	X			BDL						1	mg/L				
3V. Benzene (71-43-2)	X			BDL						1	mg/L				
4V. Bis (Chloromethyl) Ether (542-88-1)	X			BDL*						1	mg/L				
5V. Bromoform (75-25-2)	X			BDL						1	mg/L				
6V. Carbon Tetrachloride (56-23-5)	X			BDL						1	mg/L				
7V. Chlorobenzene (108-90-7)	X			BDL						1	mg/L				
8V. Chlorodibromomethane (124-48-1)	X			BDL						1	mg/L				
9V. Chloroethane (74-00-3)	X			BDL						1	mg/L				
10V. 2-Chloroethylvinyl Ether (110-75-8)	X			BDL						1	mg/L				
11V. Chloroform (67-66-3)	X			BDL						1	mg/L				

TABLE C Page 3 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)													
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
12V. Dichloro-bromomethane (75-71-8)	X			BDL						1	mg/L				
13V. Dichloro-difluoromethane (75-71-8)	X			BDL						1	mg/L				
14V. 1,1-Dichloroethane (75-34-3)	X			BDL						1	mg/L				
15V. 1,2-Dichloroethane (107-06-2)	X			BDL						1	mg/L				
16V. 1,1-Dichlorethylene (75-35-4)	X			BDL						1	mg/L				
17V. 1,2-Dichloropropane (78-87-5)	X			BDL						1	mg/L				
18V. 1,3-Dichloropropylene (452-75-6)	X			BDL						1	mg/L				
19V. Ethylbenzene (100-41-4)	X			BDL						1	mg/L				
20V. Methyl Bromide (74-83-9)	X			BDL						1	mg/L				
21V. Methyl Chloride (74-87-3)	X			BDL						1	mg/L				
22V. Methylene Chloride (75-00-2)	X			BDL						1	mg/L				
23V. 1,1,2,2-Tetrachloroethane (79-34-5)	X			BDL						1	mg/L				
24V. Tetra-chloroethylene (127-18-4)	X			BDL						1	mg/L				
25V. Toluene (108-88-3)	X			BDL						1	mg/L				
26V. 1,2-Trans-Dichloroethylene (156-60-5)	X			BDL						1	mg/L				
27V. 1,1,1-Trichloroethane (71-55-6)	X			BDL						1	mg/L				

TABLE C Page 4 of 8 | **OUTFALL NO.** 001 (E.W. Brown – Auxiliary Pond)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
28V. 1,1,2-Trichloroethane (79-00-5)	X			BDL						1	mg/L				
29V. Tri-chloroethylene (79-01-6)	X			BDL						1	mg/L				
30V. Trichloro-fluoromethane (75-69-4)	X			BDL						1	mg/L				
31V. Vinyl Chloride (75-01-4)	X			BDL						1	mg/L				
GC/MS FRACTION – ACID COMPOUNDS															
1A. 2-Chlorophenol (95-57-8)	X			BDL						1	mg/L				
2A. 2,4-Dichlorophenol (120-83-2)	X			BDL						1	mg/L				
3A. 2,4-Dimethylphenol (105-67-9)	X			BDL						1	mg/L				
4A. 4,6-Dinitro-O-Cresol (534-52-1)	X			BDL						1	mg/L				
5A. 2,4-Dinitrophenol (51-28-5)	X			BDL						1	mg/L				
6A. 2-Nitrophenol (88-75-5)	X			BDL						1	mg/L				
7A. 4-Nitrophenol (100-02-7)	X			BDL						1	mg/L				
8A. P-Chloro-M-Cresol (59-50-7)	X			BDL						1	mg/L				
9A. Pentachloro-phenol (87-88-5)	X			BDL						1	mg/L				
10A. Phenol (108-05-2)	X			BDL						1	mg/L				
11A. 2,4,6-Trichloro-phenol (88-06-2)	X			BDL						1	mg/L				

TABLE C Page 5 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS															
1B. Acenaphthene (83-32-9)	X			BDL						1	mg/L				
2B. Acenaphtylene (208-96-8)	X			BDL						1	mg/L				
3B. Anthracene (120-12-7)	X			BDL						1	mg/L				
4B. Benzidine (92-87-5)	X			BDL						1	mg/L				
5B . Benzo (a) Anthracene (56-55-3)	X			BDL						1	mg/L				
6B. Benzo (a) Pyrene (50-32-8)	X			BDL						1	mg/L				
7B. 3,4-Benzo-fluoranthene (205-99-2)	X			BDL						1	mg/L				
8B. .Benzo (ghi) perylene (191-24-2)	X			BDL						1	mg/L				
9B. .Benzo (k)-fluoranthene (207-08-9)	X			BDL						1	mg/L				
10B. Bis (2-chloroethoxy) Methane (111-91-1)	X			BDL						1	mg/L				
11B. Bis (2-chloroethel) Ether (111-44-4)	X			BDL						1	mg/L				
12B. Bis (2-chloroisopropyl)-Ether (102-80-1)	X			BDL						1	mg/L				
13B. Bis (2-ethyl-hexyl) Phthalate (117-81-7)	X			BDL						1	mg/L				
14B. 4-Bromophenyl Phenyl Ether (101-55-3)	X			BDL						1	mg/L				
15B. Butyl Benzyl Phthalate (85-68-7)	X			BDL						1	mg/L				
16B. 2-Chloro-Naphthalene (7005-72-3)	X			BDL						1	mg/L				
17B. 4-Chlorophenyl Phenyl Ether (7005-72-3)	X			BDL						1	mg/L				

TABLE C Page 6 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
18B. Chrysene (218-01-9)	X			BDL						1	mg/L				
19B. Dibenzo (a,h) Anthracene (53-70-3)	X			BDL						1	mg/L				
20B. 1,2-Dichloro-benzene (95-50-1)	X			BDL						1	mg/L				
21B. 1,3-Dichloro-Benzene (541-73-1)	X			BDL						1	mg/L				
22B. 1,4-Dichloro-benzene (106-46-7)	X			BDL						1	mg/L				
23B. 3,3-Dichloro-benzidene (91-94-1)	X			BDL						1	mg/L				
24B. Diethyl Phthalate (84-66-2)	X			BDL						1	mg/L				
25B. Dimethyl Phthalate (131-11-3)	X			BDL						1	mg/L				
26B. Di-N-Butyl Phthalate (84-74-2)	X			BDL						1	mg/L				
27B. 2,4-Dinitro-toluene (121-14-2)	X			BDL						1	mg/L				
28B. 2,6-Dinitro-toluene (606-20-2)	X			BDL						1	mg/L				
29B. Di-N-Octyl Phthalate (117-84-0)	X			BDL						1	mg/L				
30B. 1,2-Diphenyl-hydrazine (as Azo-benzene) (122-66-7)	X			BDL						1	mg/L				
31B. Fluoranthene (208-44-0)	X			BDL						1	mg/L				
32B. Fluorene (86-73-7)	X			BDL						1	mg/L				
33B. Hexachloro-benzene (118-71-1)	X			BDL						1	mg/L				
34B. Hexachloro-butadiene (87-68-3)	X			BDL						1	mg/L				
35B. Hexachloro-cyclopentadiene (77-47-4)	X			BDL						1	mg/L				

TABLE C Page 7 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)															
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
36B. Hexachloro-ethane (67-72-1)	X			BDL						1	mg/L				
37B. Indeno (1,2,3-cd) Pyrene (193-39-5)	X			BDL						1	mg/L				
38B. Isophorone (78-59-1)	X			BDL						1	mg/L				
39B. Napthalene (91-20-3)	X			BDL						1	mg/L				
40B. Nitrobenzene (98-95-3)	X			BDL						1	mg/L				
41B. N-Nitro-sodimethylamine (62-75-9)	X			BDL						1	mg/L				
42B. N-Nitrosodi-N-Propylamine (621-64-7)	X			BDL						1	mg/L				
43B. N-Nitro-sodiphenylamine (86-30-6)	X			BDL						1	mg/L				
44B. Phenanthrene (85-01-8)	X			BDL						1	mg/L				
45B. Pyrene (129-00-0)	X			BDL						1	mg/L				
46B. 1,2,4-Trichloro-benzene (120-82-1)	X			BDL						1	mg/L				
GC/MS FRACTION - PESTICIDES															
1P. Aldrin (309-00-2)			X												
2P. α-BHC (319-84-6)			X												
3P. β-BHC (319-85-7)			X												
4P. γ-BHC (58-89-9)			X												
5P. δ-BHC (319-86-8)			X												
6P. Chlordane (57-74-9)			X												

TABLE C Page 8 of 8	OUTFALL NO. 001 (E.W. Brown – Auxiliary Pond)															
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)			
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses	
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass		
GC/MS FRACTION – PESTICIDES continued																
7P. 4,4'-DDT (50-29-3)			X													
8P. 4,4'-DDE (72-55-9)			X													
9P. 4,4'-DDD (72-54-8)			X													
10P. Dieldrin (60-57-1)			X													
11P. α-Endosulfan (115-29-7)			X													
12P. β-Endosulfan (115-29-7)			X													
13P. Endosulfan Sulfate (1031-07-8)			X													
14P. Endrin (72-20-8)			X													
15P. Endrin Aldehyde (7421-93-4)			X													
16P Heptachlor (76-44-8)			X													
17P. Heptaclor Epoxide (1024-57-3)			X													
18P. PCB-1242 (53469-21-9)			X													
19P. PCB-1254 (11097-69-1)			X													
20P. PCB-1221 (11104-28-2)			X													
21P. PCB-1232 (11141-16-5)			X													
22P. PCB-1248 (12672-29-6)			X													
23P. PCB-1260 (11096-82-5)			X													
24P. PCB-1016 (12674-11-2)			X													
25P. Toxaphene (8001-35-2)			X													

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued from Section V. INTAKE AND EFFLUENT CHARACTERISTICS)

PART A.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE A.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.
You must provide the results of at least one analysis for every pollutant in this table.

TABLE A Page 1 of 1 — **OUTFALL NO.** 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)

1. POLLUTANT	2. EFFLUENT							3. UNITS (specify if blank)		4. INTAKE (optional)		
	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Biochemical Oxygen Demand $(BOD)_5$	BDL				BDL		1	mg/L				
2. Chemical Oxygen Demand (COD)	BDL				BDL		1	mg/L				
3. Total Organic Carbon (TOC)	6.88				6.88		1	mg/L				
4. Total Suspended Solids (TSS)	3				3		1	mg/L				
5. Ammonia (as N)	BDL				BDL		1	mg/L				
6. Flow (MGD)	0.007		VALUE		0.007		1	MGD		VALUE		
7. Temperature (winter)	20.7		VALUE		20.7		1	°C		VALUE		
8. Temperature (summer)	VALUE		VALUE		VALUE			°C		VALUE		
9. pH	MINIMUM 8.24	MAXIMUM	MINIMUM	MAXIMUM			1	STANDARD UNITS				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART B.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE B.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

In column "2. MARK X", place an "X" in either the **Believed Present** column (2.a) for each pollutant you know or have reason to believe is present; or place an "X" in the **Believed Absent** column (2.b) for each pollutant you believe to be absent.
If you mark the **Believed Present** column for any pollutant, you must provide the results of at least one analysis for that pollutant.
Complete one table for each outfall. See the instructions for additional details and requirements.

TABLE B Page 1 of 2

OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
			(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Bromide (24959-67-9)	X		BDL						1	mg/L				
2. Chloride	X		9.8						1	mg/L				
3. Chlorine, Total Residual	X		BDL						1	mg/L				
4. Color	X		25						1	ADMI				
5. E.coli	X		26.5						1	MPN/100 ml				
6. Fluoride (16984-48-8)	X		BDL						1	mg/L				
7. Hardness ($CaCO_3$)	X		260						1	mg/L				
8.Nitrate–Nitrite (as N)	X		1.9						1	mg/L				
9. Nitrogen, Total Organic (as N)	X		0.60						1	mg/L				
10. Oil and Grease	X		BDL						1	mg/L				
11. Phosphorous (as P), Total (7723-14-0)	X		0.36						1	mg/L				
12. Radioactivity														
(1) Alpha, Total	X		1.21						1	pCi/L				
(2) Beta, Total	X		5.52						1	pCi/L				
(3) Radium, Total	X		0.451						1	pCi/L				

TABLE B Page 2 of 2	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)													
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
			(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
(4) Radium, 226, Total	X		BDL						1	pCi/L				
(5) Strontium-90, Total	X		BDL						1	pCi/L				
(6) Uranium	X		0.582						1	ug/L				
13. Sulfate (asSO_4) (14808-79-8)	X		38						1	mg/L				
14. Sulfide (as S)	X		BDL						1	mg/L				
15. Sulfite (asSO4) (14286-46-3)	X		BDL						1	mg/L				
16. Surfactants	X		BDL						1	mg/L MBAS				
17.Aluminum,Total (7429-90)	X		59						1	ug/L				
18. Barium, Total (7440-39-3)	X		39						1	ug/L				
19. Boron, Total (7440-42-8)	X		0.24						1	mg/L				
20. Cobalt, Total (7440-48-4)	X		0.10						1	ug/L				
21. Iron, Total (7439-89-6)	X		62						1	ug/L				
22. Magnesium, Total (7439-96-4)	X		13						1	mg/L				
23. Molybdenum, Total (7439-98-7)	X		58						1	ug/L				
24. Manganese, Total (7439-96-6)	X		19						1	ug/L				
25. Tin, Total (7440-31-5)	X		BDL						1	mg/L				
26. Titanium, Total (7440-32-6)	X		BDL						1	mg/L				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART C.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE C**.**
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

If you are a primary industry and this outfall contains process wastewater, refer to the instructions (Table C-2) to determine which of the GC/MS fractions you must test for.
Mark "X" in the **Testing Required** column for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols.
If you are not required to mark this column (secondary industries, nonprocess wastewater outfalls, and non-required GC/MS fractions), mark "X" in the **Believed Present** column for each pollutant you know or have reason to believe is present.
Mark "X: in the **Believed Absent** column for each pollutant you believe to be absent.
If you mark either the **Testing Required** or **Believed Present** columns for any pollutant, you must provide the result of at least one analysis for that pollutant. Note that there are eight pages to this part; please review each carefully. Complete one table (all eight pages) for each outfall.
See the instructions for additional details and requirements

TABLE C Page 1 of 8 — **OUTFALL NO.** 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS															
1M. Antimony, Total (7440-36-0)	X			0.56						1	ug/L				
2M. Arsenic, Total (7440-38-2)	X			3.3						1	ug/L				
3M. Beryllium, Total (7440-41-7)	X			BDL						1	ug/L				
4M. Cadmium, Total (7440-43-9)	X			BDL						1	ug/L				
5M. Chromium, Total (7440-43-9)	X			0.91						1	ug/L				
6M. Copper, Total (7550-50-8)	X			44						1	ug/L				
7M. Lead, Total (7439-92-1)	X			BDL						1	ug/L				
8M. Mercury, Total (7439-97-6)	X			BDL						1	**ng/L**				
9M. Nickel, Total (7440-02-0)	X			4.9						1	ug/L				
10M. Selenium, Total (7782-49-2)	X			0.66						1	ug/L				
11M. Silver, Total (7440-28-0)	X			BDL						1	ug/L				

TABLE C Page 2 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS continued															
12M Thallium, Total (7440-28-0)	X			0.11						1	ug/L				
13M. Zinc, Total (7440-66-6)	X			5.8						1	ug/L				
14M. Cyanide, Total (57-12-5)	X			BDL						1	mg/L				
15M. Phenols, Total	X			0.011						1	mg/L				
DIOXIN															
2,3,7,8 Tetra-chlorodibenzo-P-Dioxin (1784-01-6)			X	DESCRIBE RESULTS:											
GC/MS FRACTION – VOLATILE COMPOUNDS															
1V. Acrolein (107-02-8)	X			BDL						1	mg/L				
2V. Acrylonitrile (107-13-1)	X			BDL						1	mg/L				
3V. Benzene (71-43-2)	X			BDL						1	mg/L				
4V. Bis (Chloromethyl) Ether (542-88-1)	X			BDL*						1	mg/L				
5V. Bromoform (75-25-2)	X			BDL						1	mg/L				
6V. Carbon Tetrachloride (56-23-5)	X			BDL						1	mg/L				
7V. Chlorobenzene (108-90-7)	X			BDL						1	mg/L				
8V. Chlorodibromomethane (124-48-1)	X			BDL						1	mg/L				
9V. Chloroethane (74-00-3)	X			BDL						1	mg/L				
10V. 2-Chloroethylvinyl Ether (110-75-8)	X			BDL						1	mg/L				
11V. Chloroform (67-66-3)	X			BDL						1	mg/L				

TABLE C Page 3 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
12V. Dichloro-bromomethane (75-71-8)	X			BDL						1	mg/L				
13V. Dichloro-difluoromethane (75-71-8)	X			BDL						1	mg/L				
14V. 1,1-Dichloroethane (75-34-3)	X			BDL						1	mg/L				
15V. 1,2-Dichloroethane (107-06-2)	X			BDL						1	mg/L				
16V. 1,1-Dichlorethylene (75-35-4)	X			BDL						1	mg/L				
17V. 1,2-Dichloropropane (78-87-5)	X			BDL						1	mg/L				
18V. 1,3-Dichloropropylene (452-75-6)	X			BDL						1	mg/L				
19V. Ethylbenzene (100-41-4)	X			BDL						1	mg/L				
20V. Methyl Bromide (74-83-9)	X			BDL						1	mg/L				
21V. Methyl Chloride (74-87-3)	X			BDL						1	mg/L				
22V. Methylene Chloride (75-00-2)	X			BDL						1	mg/L				
23V. 1,1,2,2-Tetrachloroethane (79-34-5)	X			BDL						1	mg/L				
24V. Tetra-chloroethylene (127-18-4)	X			BDL						1	mg/L				
25V. Toluene (108-88-3)	X			BDL						1	mg/L				
26V. 1,2-Trans-Dichloroethylene (156-60-5)	X			BDL						1	mg/L				
27V. 1,1,1-Trichloroethane (71-55-6)	X			BDL						1	mg/L				

TABLE C Page 4 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
28V. 1,1,2-Trichloroethane (79-00-5)	X			BDL						1	mg/L				
29V. Tri-chloroethylene (79-01-6)	X			BDL						1	mg/L				
30V. Trichloro-fluoromethane (75-69-4)	X			BDL						1	mg/L				
31V. Vinyl Chloride (75-01-4)	X			BDL						1	mg/L				
GC/MS FRACTION – ACID COMPOUNDS															
1A. 2-Chlorophenol (95-57-8)	X			BDL						1	mg/L				
2A. 2,4-Dichlorophenol (120-83-2)	X			BDL						1	mg/L				
3A. 2,4-Dimethylphenol (105-67-9)	X			BDL						1	mg/L				
4A. 4,6-Dinitro-O-Cresol (534-52-1)	X			BDL						1	mg/L				
5A. 2,4-Dinitrophenol (51-28-5)	X			BDL						1	mg/L				
6A. 2-Nitrophenol (88-75-5)	X			BDL						1	mg/L				
7A. 4-Nitrophenol (100-02-7)	X			BDL						1	mg/L				
8A. P-Chloro-M-Cresol (59-50-7)	X			BDL						1	mg/L				
9A. Pentachloro-phenol (87-88-5)	X			BDL						1	mg/L				
10A. Phenol (108-05-2)	X			BDL						1	mg/L				
11A. 2,4,6-Trichloro-phenol (88-06-2)	X			BDL						1	mg/L				

TABLE C Page 5 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS															
1B. Acenaphthene (83-32-9)	X			BDL						1	mg/L				
2B. Acenaphtylene (208-96-8)	X			BDL						1	mg/L				
3B. Anthracene (120-12-7)	X			BDL						1	mg/L				
4B. Benzidine (92-87-5)	X			BDL						1	mg/L				
5B . Benzo (a) Anthracene (56-55-3)	X			BDL						1	mg/L				
6B. Benzo (a) Pyrene (50-32-8)	X			BDL						1	mg/L				
7B. 3,4-Benzo-fluoranthene (205-99-2)	X			BDL						1	mg/L				
8B. .Benzo (ghi) perylene (191-24-2)	X			BDL						1	mg/L				
9B. .Benzo (k)-fluoranthene (207-08-9)	X			BDL						1	mg/L				
10B. Bis (2-chloroethoxy) Methane (111-91-1)	X			BDL						1	mg/L				
11B. Bis (2-chloroethel) Ether (111-44-4)	X			BDL						1	mg/L				
12B. Bis (2-chloroisopropyl)-Ether (102-80-1)	X			BDL						1	mg/L				
13B. Bis (2-ethyl-hexyl) Phthalate (117-81-7)	X			BDL						1	mg/L				
14B. 4-Bromophenyl Phenyl Ether (101-55-3)	X			BDL						1	mg/L				
15B. Butyl Benzyl Phthalate (85-68-7)	X			BDL						1	mg/L				
16B. 2-Chloro-Naphthalene (7005-72-3)	X			BDL						1	mg/L				
17B. 4-Chlorophenyl Phenyl Ether (7005-72-3)	X			BDL						1	mg/L				

TABLE C Page 6 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
18B. Chrysene (218-01-9)	X			BDL						1	mg/L				
19B. Dibenzo (a,h) Anthracene (53-70-3)	X			BDL						1	mg/L				
20B. 1,2-Dichloro-benzene (95-50-1)	X			BDL						1	mg/L				
21B. 1,3-Dichloro-Benzene (541-73-1)	X			BDL						1	mg/L				
22B. 1,4-Dichloro-benzene (106-46-7)	X			BDL						1	mg/L				
23B. 3,3-Dichloro-benzidene (91-94-1)	X			BDL						1	mg/L				
24B. Diethyl Phthalate (84-66-2)	X			BDL						1	mg/L				
25B. Dimethyl Phthalate (131-11-3)	X			BDL						1	mg/L				
26B. Di-N-Butyl Phthalate (84-74-2)	X			BDL						1	mg/L				
27B. 2,4-Dinitro-toluene (121-14-2)	X			BDL						1	mg/L				
28B. 2,6-Dinitro-toluene (606-20-2)	X			BDL						1	mg/L				
29B. Di-N-Octyl Phthalate (117-84-0)	X			BDL						1	mg/L				
30B. 1,2-Diphenyl-hydrazine (as Azo-benzene) (122-66-7)	X			BDL						1	mg/L				
31B. Fluoranthene (208-44-0)	X			BDL						1	mg/L				
32B. Fluorene (86-73-7)	X			BDL						1	mg/L				
33B. Hexachloro-benzene (118-71-1)	X			BDL						1	mg/L				
34B. Hexachloro-butadiene (87-68-3)	X			BDL						1	mg/L				
35B. Hexachloro-cyclopentadiene (77-47-4)	X			BDL						1	mg/L				

TABLE C Page 7 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
36B. Hexachloro-ethane (67-72-1)	X			BDL						1	mg/L				
37B. Indeno (1,2,3-cd) Pyrene (193-39-5)	X			BDL						1	mg/L				
38B. Isophorone (78-59-1)	X			BDL						1	mg/L				
39B. Napthalene (91-20-3)	X			BDL						1	mg/L				
40B. Nitrobenzene (98-95-3)	X			BDL						1	mg/L				
41B. N-Nitro-sodimethylamine (62-75-9)	X			BDL						1	mg/L				
42B. N-Nitrosodi-N-Propylamine (621-64-7)	X			BDL						1	mg/L				
43B. N-Nitro-sodiphenylamine (86-30-6)	X			BDL						1	mg/L				
44B. Phenanthrene (85-01-8)	X			BDL						1	mg/L				
45B. Pyrene (129-00-0)	X			BDL						1	mg/L				
46B. 1,2,4-Trichloro-benzene (120-82-1)	X			BDL						1	mg/L				
GC/MS FRACTION - PESTICIDES															
1P. Aldrin (309-00-2)			X												
2P. α-BHC (319-84-6)			X												
3P. β-BHC (319-85-7)			X												
4P. γ-BHC (58-89-9)			X												
5P. δ-BHC (319-86-8)			X												
6P. Chlordane (57-74-9)			X												

TABLE C Page 8 of 8	OUTFALL NO. 002 (E.W. Brown – Units 1-2 Cooling Tower Blowdown & Misc.)															
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)			
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – PESTICIDES continued															
7P. 4,4'-DDT (50-29-3)			X												
8P. 4,4'-DDE (72-55-9)			X												
9P. 4,4'-DDD (72-54-8)			X												
10P. Dieldrin (60-57-1)			X												
11P. α-Endosulfan (115-29-7)			X												
12P. β-Endosulfan (115-29-7)			X												
13P. Endosulfan Sulfate (1031-07-8)			X												
14P. Endrin (72-20-8)			X												
15P. Endrin Aldehyde (7421-93-4)			X												
16P Heptachlor (76-44-8)			X												
17P. Heptaclor Epoxide (1024-57-3)			X												
18P. PCB-1242 (53469-21-9)			X												
19P. PCB-1254 (11097-69-1)			X												
20P. PCB-1221 (11104-28-2)			X												
21P. PCB-1232 (11141-16-5)			X												
22P. PCB-1248 (12672-29-6)			X												
23P. PCB-1260 (11096-82-5)			X												
24P. PCB-1016 (12674-11-2)			X												
25P. Toxaphene (8001-35-2)			X												

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued from Section V. INTAKE AND EFFLUENT CHARACTERISTICS)

PART A.	PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE A. See instructions before proceeding. Complete one set of tables for each outfall. Place the outfall number in the space provided on each table. You must provide the results of at least one analysis for every pollutant in this table.
TABLE A Page 1 of 1	**OUTFALL NO.** 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)

1. POLLUTANT	2. EFFLUENT							3. UNITS (specify if blank)		4. INTAKE (optional)		
	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Biochemical Oxygen Demand $(BOD)_5$	BDL				BDL		1	mg/L				
2. Chemical Oxygen Demand (COD)	BDL				BDL		1	mg/L				
3. Total Organic Carbon (TOC)	6.07				6.07		1	mg/L				
4. Total Suspended Solids (TSS)	BDL				BDL		1	mg/L				
5. Ammonia (as N)	BDL				BDL		1	mg/L				
6. Flow (MGD)	0.432		VALUE		0.432		1	MGD		VALUE		
7. Temperature (winter)	13.2		VALUE		13.2		1	°C		VALUE		
8. Temperature (summer)	VALUE		VALUE		VALUE			°C		VALUE		
9. pH	MINIMUM 7.51	MAXIMUM	MINIMUM	MAXIMUM			1	STANDARD UNITS				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART B.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE B.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

In column "2. MARK X", place an "X" in either the **Believed Present** column (2.a) for each pollutant you know or have reason to believe is present; or place an "X" in the **Believed Absent** column (2.b) for each pollutant you believe to be absent.
If you mark the **Believed Present** column for any pollutant, you must provide the results of at least one analysis for that pollutant.
Complete one table for each outfall. See the instructions for additional details and requirements.

TABLE B Page 1 of 2

OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
			(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
1. Bromide (24959-67-9)	X		BDL						1	mg/L				
2. Chloride	X		7.7						1	mg/L				
3. Chlorine, Total Residual	X		BDL						1	mg/L				
4. Color	X		20						1	ADMI				
5. E.coli	X		6.3						1	MPN/100 ml				
6. Fluoride (16984-48-8)	X		BDL						1	mg/L				
7. Hardness ($CaCO_3$)	X		190						1	mg/L				
8.Nitrate–Nitrite (as N)	X		1.5						1	mg/L				
9. Nitrogen, Total Organic (as N)	X		0.76						1	mg/L				
10. Oil and Grease	X		BDL						1	mg/L				
11. Phosphorous (as P), Total (7723-14-0)	X		0.16						1	mg/L				
12. Radioactivity														
(1) Alpha, Total	X		BDL						1	pCi/L				
(2) Beta, Total	X		1.64						1	pCi/L				
(3) Radium, Total	X		1.433						1	pCi/L				

TABLE B Page 2 of 2	OUTFALL NO003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)													
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"		3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Believed Present	b. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
			(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
(4) Radium, 226, Total	X		0.880						1	pCi/L				
(5) Strontium-90, Total	X		0.735						1	pCi/L				
(6) Uranium	X		0.453						1	ug/L				
13. Sulfate (asSO_4) (14808-79-8)	X		27						1	mg/L				
14. Sulfide (as S)	X		BDL						1	mg/L				
15. Sulfite (asSO4) (14286-46-3)	X		BDL						1	mg/L				
16. Surfactants	X		BDL						1	mg/L MBAS				
17.Aluminum,Total (7429-90)	X		48						1	ug/L				
18. Barium, Total (7440-39-3)	X		31						1	ug/L				
19. Boron, Total (7440-42-8)	X		0.17						1	mg/L				
20. Cobalt, Total (7440-48-4)	X		BDL						1	ug/L				
21. Iron, Total (7439-89-6)	X		66						1	ug/L				
22. Magnesium, Total (7439-96-4)	X		9.3						1	mg/L				
23. Molybdenum, Total (7439-98-7)	X		7.6						1	ug/L				
24. Manganese, Total (7439-96-6)	X		14						1	ug/L				
25. Tin, Total (7440-31-5)	X		BDL						1	mg/L				
26. Titanium, Total (7440-32-6)	X		BDL						1	mg/L				

V. INTAKE AND EFFLUENT CHARACTERISTICS (Continued)

PART C.

PLEASE PRINT OR TYPE IN THE UNSHADED AREAS ONLY OF TABLE C.
See instructions before proceeding.
Complete one set of tables for each outfall. Place the outfall number in the space provided on each table.

If you are a primary industry and this outfall contains process wastewater, refer to the instructions (Table C-2) to determine which of the GC/MS fractions you must test for.
Mark "X" in the **Testing Required** column for all such GC/MS fractions that apply to your industry and for ALL toxic metals, cyanides, and total phenols.
If you are not required to mark this column (secondary industries, nonprocess wastewater outfalls, and non-required GC/MS fractions), mark "X" in the **Believed Present** column for each pollutant you know or have reason to believe is present.
Mark "X: in the **Believed Absent** column for each pollutant you believe to be absent.
If you mark either the **Testing Required** or **Believed Present** columns for any pollutant, you must provide the result of at least one analysis for that pollutant. Note that there are eight pages to this part; please review each carefully. Complete one table (all eight pages) for each outfall.
See the instructions for additional details and requirements

TABLE C Page 1 of 8 — **OUTFALL NO.** 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS															
1M. Antimony, Total (7440-36-0)	X			1.2						1	ug/L				
2M. Arsenic, Total (7440-38-2)	X			1.1						1	ug/L				
3M. Beryllium, Total (7440-41-7)	X			BDL						1	ug/L				
4M. Cadmium, Total (7440-43-9)	X			BDL						1	ug/L				
5M. Chromium, Total (7440-43-9)	X			0.32						1	ug/L				
6M. Copper, Total (7550-50-8)	X			4.0						1	ug/L				
7M. Lead, Total (7439-92-1)	X			BDL						1	ug/L				
8M. Mercury, Total (7439-97-6)	X			BDL						1	**ng/L**				
9M. Nickel, Total (7440-02-0)	X			1.4						1	ug/L				
10M. Selenium, Total (7782-49-2)	X			BDL						1	ug/L				
11M. Silver, Total (7440-28-0)	X			BDL						1	ug/L				

TABLE C Page 2 of 8	OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
METALS, CYANIDE AND TOTAL PHENOLS continued															
12M Thallium, Total (7440-28-0)	X			BDL						1	ug/L				
13M. Zinc, Total (7440-66-6)	X			2.7						1	ug/L				
14M. Cyanide, Total (57-12-5)	X			BDL						1	mg/L				
15M. Phenols, Total	X			0.013						1	mg/L				
DIOXIN															
2,3,7,8 Tetra-chlorodibenzo-P-Dioxin (1784-01-6)			X	DESCRIBE RESULTS:											
GC/MS FRACTION – VOLATILE COMPOUNDS															
1V. Acrolein (107-02-8)	X			BDL						1	mg/L				
2V. Acrylonitrile (107-13-1)	X			BDL						1	mg/L				
3V. Benzene (71-43-2)	X			BDL						1	mg/L				
4V. Bis (Chloromethyl) Ether (542-88-1)	X			BDL*						1	mg/L				
5V. Bromoform (75-25-2)	X			BDL						1	mg/L				
6V. Carbon Tetrachloride (56-23-5)	X			BDL						1	mg/L				
7V. Chlorobenzene (108-90-7)	X			BDL						1	mg/L				
8V. Chlorodibromomethane (124-48-1)	X			BDL						1	mg/L				
9V. Chloroethane (74-00-3)	X			BDL						1	mg/L				
10V. 2-Chloroethylvinyl Ether (110-75-8)	X			BDL						1	mg/L				
11V. Chloroform (67-66-3)	X			BDL						1	mg/L				

TABLE C Page 3 of 8	OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
12V. Dichloro-bromomethane (75-71-8)	X			BDL						1	mg/L				
13V. Dichloro-difluoromethane (75-71-8)	X			BDL						1	mg/L				
14V. 1,1-Dichloroethane (75-34-3)	X			BDL						1	mg/L				
15V. 1,2-Dichloroethane (107-06-2)	X			BDL						1	mg/L				
16V. 1,1-Dichlorethylene (75-35-4)	X			BDL						1	mg/L				
17V. 1,2-Dichloropropane (78-87-5)	X			BDL						1	mg/L				
18V. 1,3-Dichloropropylene (452-75-6)	X			BDL						1	mg/L				
19V. Ethylbenzene (100-41-4)	X			BDL						1	mg/L				
20V. Methyl Bromide (74-83-9)	X			BDL						1	mg/L				
21V. Methyl Chloride (74-87-3)	X			BDL						1	mg/L				
22V. Methylene Chloride (75-00-2)	X			BDL						1	mg/L				
23V. 1,1,2,2-Tetrachloroethane (79-34-5)	X			BDL						1	mg/L				
24V. Tetra-chloroethylene (127-18-4)	X			BDL						1	mg/L				
25V. Toluene (108-88-3)	X			BDL						1	mg/L				
26V. 1,2-Trans-Dichloroethylene (156-60-5)	X			BDL						1	mg/L				
27V. 1,1,1-Trichloroethane (71-55-6)	X			BDL						1	mg/L				

TABLE C Page 4 of 8 — **OUTFALL NO.** 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – VOLATILE COMPOUNDS continued															
28V. 1,1,2-Trichloroethane (79-00-5)	X			BDL						1	mg/L				
29V. Tri-chloroethylene (79-01-6)	X			BDL						1	mg/L				
30V. Trichloro-fluoromethane (75-69-4)	X			BDL						1	mg/L				
31V. Vinyl Chloride (75-01-4)	X			BDL						1	mg/L				
GC/MS FRACTION – ACID COMPOUNDS															
1A. 2-Chlorophenol (95-57-8)	X			BDL						1	mg/L				
2A. 2,4-Dichlorophenol (120-83-2)	X			BDL						1	mg/L				
3A. 2,4-Dimethylphenol (105-67-9)	X			BDL						1	mg/L				
4A. 4,6-Dinitro-O-Cresol (534-52-1)	X			BDL						1	mg/L				
5A. 2,4-Dinitrophenol (51-28-5)	X			BDL						1	mg/L				
6A. 2-Nitrophenol (88-75-5)	X			BDL						1	mg/L				
7A. 4-Nitrophenol (100-02-7)	X			BDL						1	mg/L				
8A. P-Chloro-M-Cresol (59-50-7)	X			BDL						1	mg/L				
9A. Pentachloro-phenol (87-88-5)	X			BDL						1	mg/L				
10A. Phenol (108-05-2)	X			BDL						1	mg/L				
11A. 2,4,6-Trichloro-phenol (88-06-2)	X			BDL						1	mg/L				

TABLE C Page 5 of 8	OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS															
1B. Acenaphthene (83-32-9)	X			BDL						1	mg/L				
2B. Acenaphtylene (208-96-8)	X			BDL						1	mg/L				
3B. Anthracene (120-12-7)	X			BDL						1	mg/L				
4B. Benzidine (92-87-5)	X			BDL						1	mg/L				
5B . Benzo (a) Anthracene (56-55-3)	X			BDL						1	mg/L				
6B. Benzo (a) Pyrene (50-32-8)	X			BDL						1	mg/L				
7B. 3,4-Benzo-fluoranthene (205-99-2)	X			BDL						1	mg/L				
8B. .Benzo (ghi) perylene (191-24-2)	X			BDL						1	mg/L				
9B. .Benzo (k)-fluoranthene (207-08-9)	X			BDL						1	mg/L				
10B. Bis (2-chloroethoxy) Methane (111-91-1)	X			BDL						1	mg/L				
11B. Bis (2-chloroethel) Ether (111-44-4)	X			BDL						1	mg/L				
12B. Bis (2-chloroisopropyl)-Ether (102-80-1)	X			BDL						1	mg/L				
13B. Bis (2-ethyl-hexyl) Phthalate (117-81-7)	X			BDL						1	mg/L				
14B. 4-Bromophenyl Phenyl Ether (101-55-3)	X			BDL						1	mg/L				
15B. Butyl Benzyl Phthalate (85-68-7)	X			BDL						1	mg/L				
16B. 2-Chloro-Naphthalene (7005-72-3)	X			BDL						1	mg/L				
17B. 4-Chlorophenyl Phenyl Ether (7005-72-3)	X			BDL						1	mg/L				

TABLE C Page 6 of 8	OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)														
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
18B. Chrysene (218-01-9)	X			BDL						1	mg/L				
19B. Dibenzo (a,h) Anthracene (53-70-3)	X			BDL						1	mg/L				
20B. 1,2-Dichloro-benzene (95-50-1)	X			BDL						1	mg/L				
21B. 1,3-Dichloro-Benzene (541-73-1)	X			BDL						1	mg/L				
22B. 1,4-Dichloro-benzene (106-46-7)	X			BDL						1	mg/L				
23B. 3,3-Dichloro-benzidene (91-94-1)	X			BDL						1	mg/L				
24B. Diethyl Phthalate (84-66-2)	X			BDL						1	mg/L				
25B. Dimethyl Phthalate (131-11-3)	X			BDL						1	mg/L				
26B. Di-N-Butyl Phthalate (84-74-2)	X			BDL						1	mg/L				
27B. 2,4-Dinitro-toluene (121-14-2)	X			BDL						1	mg/L				
28B. 2,6-Dinitro-toluene (606-20-2)	X			BDL						1	mg/L				
29B. Di-N-Octyl Phthalate (117-84-0)	X			BDL						1	mg/L				
30B. 1,2-Diphenyl-hydrazine (as Azo-benzene) (122-66-7)	X			BDL						1	mg/L				
31B. Fluoranthene (208-44-0)	X			BDL						1	mg/L				
32B. Fluorene (86-73-7)	X			BDL						1	mg/L				
33B. Hexachloro-benzene (118-71-1)	X			BDL						1	mg/L				
34B. Hexachloro-butadiene (87-68-3)	X			BDL						1	mg/L				
35B. Hexachloro-cyclopentadiene (77-47-4)	X			BDL						1	mg/L				

TABLE C Page 7 of 8 | **OUTFALL NO.** 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)

1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)		
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – BASE/NEUTRAL COMPOUNDS continued															
36B. Hexachloro-ethane (67-72-1)	X			BDL						1	mg/L				
37B. Indeno (1,2,3-cd) Pyrene (193-39-5)	X			BDL						1	mg/L				
38B. Isophorone (78-59-1)	X			BDL						1	mg/L				
39B. Napthalene (91-20-3)	X			BDL						1	mg/L				
40B. Nitrobenzene (98-95-3)	X			BDL						1	mg/L				
41B. N-Nitro-sodimethylamine (62-75-9)	X			BDL						1	mg/L				
42B. N-Nitrosodi-N-Propylamine (621-64-7)	X			BDL						1	mg/L				
43B. N-Nitro-sodiphenylamine (86-30-6)	X			BDL						1	mg/L				
44B. Phenanthrene (85-01-8)	X			BDL						1	mg/L				
45B. Pyrene (129-00-0)	X			BDL						1	mg/L				
46B. 1,2,4-Trichloro-benzene (120-82-1)	X			BDL						1	mg/L				
GC/MS FRACTION - PESTICIDES															
1P. Aldrin (309-00-2)			X												
2P. α-BHC (319-84-6)			X												
3P. β-BHC (319-85-7)			X												
4P. γ-BHC (58-89-9)			X												
5P. δ-BHC (319-86-8)			X												
6P. Chlordane (57-74-9)			X												

TABLE C Page 8 of 8	OUTFALL NO. 003 (E.W. Brown – Unit 3 Cooling Tower Blowdown & Misc.)															
1. POLLUTANT and CAS NO. (if available)	2. MARK "X"			3. EFFLUENT							4. UNITS		5. INTAKE (optional)			
	a. Testing Required	b. Believed Present	c. Believed Absent	a. Maximum Daily Value		b. Maximum 30-Day Avg. Value (if available)		c. Long-Term Avg. Value (if available)		d. No. of Analyses	a. Concentration	b. Mass	a. Long-Term Avg. Value		b. No of Analyses
				(1) Concentration	(2) Mass	(1) Concentration	(2) Mass	(1) Concentration	(2) Mass				(1) Concentration	(2) Mass	
GC/MS FRACTION – PESTICIDES continued																
7P. 4,4'-DDT (50-29-3)			X												
8P. 4,4'-DDE (72-55-9)			X												
9P. 4,4'-DDD (72-54-8)			X												
10P. Dieldrin (60-57-1)			X												
11P. α-Endosulfan (115-29-7)			X												
12P. β-Endosulfan (115-29-7)			X												
13P. Endosulfan Sulfate (1031-07-8)			X												
14P. Endrin (72-20-8)			X												
15P. Endrin Aldehyde (7421-93-4)			X												
16P Heptachlor (76-44-8)			X												
17P. Heptaclor Epoxide (1024-57-3)			X												
18P. PCB-1242 (53469-21-9)			X												
19P. PCB-1254 (11097-69-1)			X												
20P. PCB-1221 (11104-28-2)			X												
21P. PCB-1232 (11141-16-5)			X												
22P. PCB-1248 (12672-29-6)			X												
23P. PCB-1260 (11096-82-5)			X												
24P. PCB-1016 (12674-11-2)			X												
25P. Toxaphene (8001-35-2)			X												

KPDES FORM C – INSTRUCTIONS

Listed below are explanations of select Form C questions. If further information is needed concerning any questions, please contact the Division of Water, at (502) 564-3410.

Section I: Outfall Location
Use the map you provided for Item II of Form 1 to determine the latitude and longitude of each of your outfalls and the name of the receiving water.

Section II: Flows, Sources of Pollution, and Treatment Technologies

A. The line drawing should show generally the route taken by water in your facility from intake to discharge. Show all operations contributing wastewater, including process and production areas, sanitary flows, cooling water, and storm water runoff. Group similar operations into a single unit and label to correspond to the more detailed listing in Item II.B. The water balance should show average flows. Show all significant losses of water to products, atmosphere, and discharge. Use actual measurements whenever available. Otherwise, use your best estimate.

B. List all sources of wastewater to each outfall. Operations may be described in general terms (for example, "dye-making reactor" or "distillation tower"). Estimate the flow contributed by each source if no data are available. For storm water, use any reasonable measure of duration, volume, or frequency. For each treatment unit, indicate its size, flow rate, and retention time; and describe the ultimate disposal of any solid or liquid wastes not discharged. Treatment units should be listed in order. Select the proper code from Table C-1 to fill in the treatment code for each treatment unit. Insert "XX" for the treatment code if no code corresponds to a treatment unit you have listed.

   If the permit application is for a privately-owned treatment works, you must also identify all of your contributors in an attached listing.

C. A discharge is intermittent unless it occurs without interruption during the operating hours of the facility, except for shutdowns for maintenance, process changes, or other similar activities. A discharge is seasonal if it occurs during certain parts of the year. Fill in every applicable column in this item for each source of intermittent or seasonal discharge. Base your answers on actual data whenever available, otherwise, provide your best estimate. Report the highest daily for flow rate and total volume in the "Maximum Daily" columns. Report the average of all daily values measured during days when discharge occurred within the last year in the "Long Term Average" columns.

Section III: Production

A. All effluent guidelines promulgated by EPA appear in the Federal Register and are published annually in 40 CFR Subchapter N. A guideline applies to you if you have any operations contributing process wastewater in any subcategory covered by a BPT, BCT, or BAT guideline. If you are unsure whether you are covered by a promulgated effluent guideline, check with the Department for Environmental Protection, Division of Water. You must check "yes" if an applicable effluent guideline has been promulgated, even if the guideline limitations are being contested in court. If you believe that promulgated effluent guideline has been remanded for reconsideration by a court and does not apply to your operation, you may check "no."

B. An effluent guideline is expressed in terms of production (or other measure of operation) if the limitation is expressed as mass of pollutant per operational parameter, for example, "pounds of BOD per cubic foot of logs from which bark is removed," or "pounds of TSS per megawatt hour of electrical energy consumed by smelting furnace." An example of a guideline not expressed in terms of a measure of operation is one that limits the concentration of pollutants.

C. This item must be completed only if you check "yes" to Item III.B. The production information requested here is necessary to apply effluent guidelines to your facility and you may not claim it as confidential. However, you do not have to indicate how the reported information was calculated.

Report quantities in the units of measurements used in the applicable effluent guidelines. The figures provided must be a measure of actual operation over a one month period, such as the production for the highest month during the last twelve months, or the monthly average production for the highest year of the last five years, or other reasonable measure of actual operation. But these figures may not be based on design capacity or on predictions of future increases in operation.

If you have two or more substantially identical outfalls, request permission from the Division of Water to sample and analyze only one outfall and submit the results of the analysis for other substantially identical outfalls. If your request is granted, identify on a separate sheet attached to the application form the outfall tested, and describe why the outfalls not tested are substantially identical to the tested outfall.

Section IV: Improvements

A. If you check "yes" to this question, complete all parts of the chart or attach a copy of any previous submission you have made to the Department for Environmental Protection containing the same information.

Section V: Intake and Effluent Characteristics

This item requires you to collect and report data on the pollutants discharged for each of your outfalls. Each part of this item addresses a different set of pollutants and must be completed in accordance with the specific instructions for that part. The following general instructions apply to the entire item.

GENERAL INSTRUCTIONS

In the "Mark X" columns of Parts B and C mark only one box per pollutant. Part D requires you to list any of a group of pollutants which you believe to be present, with a brief explanation of why you believe it to be present. See specific instruction on the form and below for Parts A through D.

Base your determination that a pollutant is present in or absent from your discharge on your knowledge of your raw materials, maintenance chemicals, intermediate and final products and byproducts, and any previous analyses known to you of your effluent or of any similar effluent. (For example, if you manufacture pesticides, you should expect those pesticides to be present in contaminated storm water runoff.) If you would expect a pollutant to be present solely as a result of its presence in your intake water, you must mark "Believed Present" but "X" in that "Intake" column.

REPORTING

All levels must be reported as concentration and as total mass. Use the following abbreviations in the columns headed "Units" (column 3, Part A, and column 4, Parts B and C).

CONCENTRATIONS		MASS	
ppm	parts per million	lbs.	Pounds
mg/l	milligrams per liter	ton	Tons (english tons)
ppb	parts per billion	mg	Milligrams
µg/l	micrograms per liter	g	Grams
		kg	Kilograms
		T	Tonnes (metric tons)
		MGD	Million Gallons Per Day

If you measure only one daily value, complete only the "Maximum Daily Values" columns and insert "1" into the "Number of Analyses" columns (columns 2-a and 2-d, Part A, and columns 3-a and 3-d, Parts B and C).

For composite samples, the daily value is the total mass or average concentration found in a composite sample taken over the operating hours of the facility during a 24-hour period. For grab samples, the daily value is the arithmetic or flow-weighted total mass or average concentration found in a series of at least four grab samples taken over the operating hours of the facility during a 24-hour period.

If you measure more than one daily value for a pollutant, determine the average of all values within the last year and report the concentration and mass under the "Long-Term Average Values" columns (column 2-c, Part A, and column 3-c, Parts B and C). Also report the total number of daily values under the "Number of Analyses" columns (column 2-d, Part A, and column 3-d, Parts B and C). Determine the average of all daily values taken during each calendar month, and report the highest average under the "Maximum 30-Day Values" columns (2-b, Part A, and column 3-b, Parts B and C).

SAMPLING

The collection of the samples for the reported analyses should be supervised by a person experienced in performing sampling of industrial wastewater. You may contact the Department for Environmental Protection or appropriate regional office for detailed guidance on sampling techniques and for answers to specific questions. Any specific requirements contained in the applicable analytical methods should be followed for sample containers, sample preservation, holding times, the collection of duplicate samples, etc. The time when you sample should be representative of your normal operation, to the extent feasible, with all processes which contribute wastewater in normal operation, and with your treatment system operating properly with no system upsets.

ANALYSIS

Use test methods promulgated in 40 CFR Part 136; however, if none have been promulgated for a particular pollutant, use any suitable methods for measuring the level of the pollutant in your discharge provided that you submit a description of the methods or a reference to a published method. Your description should include the sample holding times, preservation techniques, and the quality control measures used.

REPORTING OF INTAKE DATA

You are not required to report data under the "Intake" columns unless you wish to demonstrate your eligibility for a "net" effluent limitation for one or more pollutants, that is, effluent limitations adjusted by subtracting the average level of the pollutant(s) present in your intake water. 401 KAR 5:065, Section 3(7), allows net limitations only in certain circumstances. To demonstrate your eligibility, report the average of the results of analysis on your intake water in the "Intake" columns (if your water is treated before use, test the water after it is treated), and attach a separate sheet containing the following for each pollutant:

1. A statement that the intake and discharge are from the same water body (Otherwise, you are not eligible for net limitations);
2. A statement of the extent to which the level of the pollutant is reduced by treatment of your wastewater (Your limitations will be adjusted only to the extent that the pollutant is not removed);
3. When applicable (for example, when the pollutant represents a class of compounds), a demonstration of the extent to which the pollutants in the intake vary physically, chemically, or biologically from the pollutants contained in your discharge. (Your limitations will be adjusted only to the extent that the intake pollutants do not vary from the discharged pollutants.)

SPECIFIC INSTRUCTIONS

A. This part must be completed by all applicants for all outfalls, including outfalls containing only noncontact cooling water or storm runoff. However, at your request, the Division of Water may waive the requirements to test for one or more of these pollutants upon a determination that testing for the pollutant(s) is not appropriate for your effluents.

   Use grab samples for pH and temperature. Use composite samples for all pollutants in this part. See discussion in General Instructions to Item V for definitions of the columns in Part A. The "Long-Term

Average Values" column (column 2-c) and "Maximum 30-Day Values" column (column 2-b) are not compulsory but should be filled out if data are available.

B. This part must be completed by all applicants for all outfalls including those containing only noncontact cooling water or storm runoff.

Use composite samples for all pollutants you analyze in this part, except use grab samples for residual chlorine, oil and grease, fecal coliform, and E.coli. The "Long-Term Average Values" column (column 3-b) are not compulsory but should be filled out if data are available.

C. Table C-2 lists the 34 "primary" industry categories in the left-hand column. For each outfall, if any of your processes which contribute wastewater falls into one of those categories, you must mark "X" in "Testing Required" column (column 2-a) and test for: (A) all of the toxic metals, cyanide, and total phenols; and (B) the organic toxic pollutants contained in the gas chromatography/mass spectrometry (GC/MS) fractions indicated in Table C-2 as applicable to your category, unless you qualify as a small business (see below). The organic toxic pollutants are listed by GC/MS fractions on pages V-4 through V-10 in Part V-C. For example, the Organic Chemical industry has an "X" in all four fractions; therefore, applicants in this category must test for all organic toxic pollutants in Part V-C. If you are applying for a permit for a privately owned treatment works, determine your testing contributors. The industry category you use for testing requirements is not used to categorize you for any other purpose.

For all other cases (secondary industries, non-process wastewater outfalls, and non-required GC/MS fractions), you must mark "X" in either the "Believed Present" column (column 2-b) or the "Believed Absent" column (column 2-c) for each pollutant, and test for those you believe present (those marked "X" in column 2-b). If you qualify as a small business (see below) you are exempt from testing for the organic toxic pollutants listed on page V-4 through V-10 in Part C. For pollutants in intake water, see discussion in General Instructions to this item. The "Long-Term Average Values" column (column 3-c) and "Maximum 30-Day Values" column (column 3-b) are not compulsory but should be filled out if data are available.

Use grab samples for total phenols and cyanide. Use composite samples for all other pollutants in this part.

Mark "Testing Required" for dioxin if you use or manufacture one of the following compounds:

A. 2,4,5-trichlorophenoxy acetic acid (2,4,5-T);
B. 2-(2,4,5-trichlorophenoxy) propanoic acid (Silvex, 2,4,5,-TP);
C. 2-(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate (Erbon);
D. 0, 0-dimethyl 0-(2,4,5-trichlorophenyl) phosphorothioate (Ronnel);
E. 2,4,5-trichlorophenol (TCP); or
F. Hexachlorophene (HCP)

If you mark "Testing Required" or "Believed Present" you must perform a screening analysis for dioxins, using gas chromotography with an electron capture detector. A TCDD standard for quantification is not required. Describe the results of this analysis in the space provided, for example, "no measurable baseline deflection at the retention time of TCDD" or "a measurable peak within the tolerances of the retention time of TCDD." You may be required to perform a quantitative analysis if you report a positive result.

The Engineering and Analysis Division of EPA has collected and analyzed samples from some facilities for the pollutants listed in Part C in the course of its BAT guidelines development program. If your effluents were sampled and analyzed as part of this program in the last three years, you may use this data to answer Part C. This may be done provided that no process change or change in raw materials, process or operating practices has occurred since the samples were taken which would make the analyses unrepresentative of your current discharge.

Small Business Exemption

If you qualify as a "small business," under 401 KAR 5:060, Section 2(8) you are exempt from the reporting requirements for the organic toxic pollutants listed on pages 9 through 18 in Part C. If your facility is a coal mine with a probable total annual production of less than 100,000 tons, you may submit past production data or estimated future production (such as a schedule of estimated total production under 30 CFR Section 795.14(c)) instead of conducting analyses for the organic toxic pollutants. If your facility is not a coal mine, and if your gross total annual sales for the most recent three years average less than $100,000 per year (in second quarter 1980 dollars), you may submit sales data for those years instead of conducting analyses for the organic toxic pollutants.

The production or sales data must be for the facility that is the source of the discharge. The data should not be limited to production or sales for the process or processes that contribute to the discharge, unless those are the only processes of your facility. For sales data, in situations involving intra-corporate transfers of goods and services, the transfer price per unit should approximate market prices for those goods and services as closely as possible. Sales figures for years after 1980 should be indexed to the second quarter of 1980 by using the gross national product prices deflator (second quarter of 1980 = 100). This index is available in "National Income and Product Accounts of the United States" (U.S. Department of Commerce, Bureau of Economic Analysis).

D. List any pollutants in Table C-3 that you believe to be present and explain why you believe them to be present. No analysis is required, but if you have analytical data, you must report it also.

NOTE: Under 40 CFR 117.12(a)(2), certain discharges of hazardous substances (listed in Table C-3 of these instructions) may be exempted from the requirements of Section 311 of the Clean Water Act (33 USC Section 1321), which establishes reporting requirements, civil penalties, and liability for cleanup costs for spills of oil and hazardous substances. A discharge of a particular substance may be exempted if the origin, source, and amount of the discharged substance are identified in the KPDES permit application or in the permit, if the permit contains a requirement for treatment of the discharge, and if the treatment is in place. To apply for an exclusion of the discharge of any hazardous substance from the requirement of Section 311, attach additional sheets of paper to your form, setting forth the following information:

A. the substance and the amount of each substance which may be discharged;
B. the origin and source of the discharge of the substance;
C. the treatment which is provided or to be provided for the discharge by:

1. an on-site treatment system separate from any treatment system treating your normal discharge;
2. a treatment system designed to treat your normal discharge and which is additionally capable of treating the amount of the substance identified under paragraph 1 above; or
3. any combination of the above.

See 40 CFR Section 117.12(a)(2) and (c), published on August 29, 1979, or contact the Division of Water for further information on exclusions from Section 311.

<u>Section VI. Potential Discharges Not covered by Analysis</u>

A. You may not claim this information as confidential. However, you do not have to distinguish between use of production of the pollutants or list the amounts. Under KPDES regulations, your permit will contain limits to control all pollutants you report in answer to this question, as well as pollutants reported in Item V and VI.B at levels exceeding the technology-based limits appropriate to your facility. Your permit will also require you to report to the Department for Environmental Protection if you begin or expect to begin to use or manufacture any toxic pollutant as an immediate or final product or byproduct which you did not report here. Your permit may be modified at that time if necessary to control that pollutant.

B. Consider only those variations which may result in the concentrations of pollutants in effluents which exceed twice the maximum values you reported in Item V. These variations may be part of your routing operations, or part of your regular cleaning cycles.

Under KPDES regulations, your permit will contain limits to control any pollutant that you report in this item at levels exceeding the technology-based limits appropriate to your facility. Your permit will also require you to report to the Department for Environmental Protection if you know or have reason to believe that any toxic pollutant two times the maximum values reported in Item V-C or in this item. Your permit may be modified at that time if necessary to control the pollutant.

Do not consider variations that are the result of bypasses or upsets. Increased levels of pollutants that are discharged as a result of bypasses or upsets are regulated separately under KPDES regulations.

C. Variation exemptions to be described here include:

Changes in raw or intermediate materials
Changes in process equipment or materials;
Changes in product lines;
Significant chemical reactions among pollutants in waste streams; and
Significant variation in removal efficiencies of pollution control equipment.

You may indicate other types of variations as well, except those that are the result of bypasses or upsets. You may be required to further investigate or document variations you report here.

Base your prediction on expected levels of these pollutants upon your knowledge of your processes, raw materials, past and projected product ranges, etc., or upon any testing of your effluent which indicates the range of variability that can be expected over the next five years.

EXAMPLE: Outfall 001 discharges water used to clean six 500-gallon tanks. These tanks are used for formulation of dispersions of synthetic resins in water (adhesives). Use of toxic pollutants which can be expected in the next 5 years is:

1. copper acetate inhibitor, 1/2 lb. per tank;
2. dibutyl phthalate, 50 lbs. per tank;
3. toluene, 5 lbs. per tank; and
4. antimony oxide, 1 lb. per tank.

Based on normal cleaning, an average of 1% and a maximum of 3% of the contents of each tank is collected and discharged once every two weeks in the 150 gallons of water used for cleaning. Treatment (pH adjustment, flocculation, filtration) removes 85% of metals and 50% of organic compounds.

Section IX: Certification

The permit application must be signed as follows:

- **Corporation:** by a principal executive officer of at least the level of vice president.
- **Partnership or sole proprietorship:** by a general partner or the proprietor respectively.
- **Municipality, state, federal, or other public agency:** by either a principal executive officer or ranking elected official.

TABLE C-1
CODES FOR TREATMENT UNITS
(For use with Form C, Item II, Part B)

PHYSICAL TREATMENT PROCESSES

1-A	Ammonia Stripping	1-M	Grit Removal
1-B	Dialysis	1-N	Microstraining
1-C	Diatomaceous Earth Filtration	1-O	Mixing
1-D	Distillation	1-P	Moving Bed Filters
1-E	Electrodialysis	1-Q	Multimedia Filtration
1-F	Evaporation	1-R	Rapid Sand Filtration
1-G	Flocculation	1-S	Reverse Osmosis (Hyperfiltration)
1-H	Flotation	1-T	Screening
1-I	Foam Fractionation	1-U	Sedimentation (Settling)
1-J	Freezing	1-V	Slow Sand Filtration
1-K	Gas-Phase Separation	1-W	Solvent Extraction
1-L	Grinding (Comminutors)	1-X	Sorption

CHEMICAL TREATMENT PROCESSES

2-A	Carbon Adsorption	2-G	Disinfection (Ozone)
2-B	Chemical Oxidation	2-H	Disinfection (Other)
2-C	Chemical Precipitation	2-I	Electrochemical Treatment
2-D	Coagulation	2-J	Ion Exchange
2-E	Dechlorination	2-K	Neutralization
2-F	Disinfection (Chlorine)	2-L	Reduction

BIOLOGICAL TREATMENT PROCESSES

3-A	Activated Sludge	3-E	Pre-Aeration
3-B	Aerated Lagoons	3-F	Spray Irrigation/Land Application
3-C	Anaerobic Treatment	3-G	Stabilization Ponds
3-D	Nitrification-Denitrification	3-H	Trickling Filtration

OTHER PROCESSES

4-A	Discharge to Surface Water	4-C	Reuse/Recycle of Treated Effluent
4-B	Ocean Discharge Through Outfall	4-D	Underground Injection

SLUDGE TREATMENT AND DISPOSAL PROCESSES

5-A	Aerobic Digestion	5-M	Heat Drying
5-B	Anaerobic Digestion	5-N	Heat Treatment
5-C	Belt Filtration	5-O	Incineration
5-D	Centrifugation	5-P	Land Application
5-E	Chemical Conditioning	5-Q	Landfill
5-F	Chlorine Treatment	5-R	Pressure Filtration
5-G	Composting	5-S	Pyrolysis
5-H	Drying Beds	5-T	Sludge Lagoons
5-I	Elutriation	5-U	Vacuum Filtration
5-J	Flotation Thickening	5-V	Vibration
5-K	Freezing	5-W	Wet Oxidation
5-L	Gravity Thickening		

TABLE C-2
TESTING REQUIREMENTS FOR ORGANIC TOXIC POLLUTANTS BY INDUSTRY CATEGORY*
(For use with Form C, Item V, Part C)

INDUSTRY CATEGORY	GC/MS FRACTION[1]			
	Volatile	Acid	Base/Neutral	Pesticide
Adhesives and sealants	x	x	x	-
Aluminum forming	x	x	x	-
Auto and other laundries	x	x	x	x
Battery manufacturing	x	-	x	-
Coal mining	-*	-*	-*	-*
Coil coating	x	x	x	-
Copper forming	x	x	x	-
Electric and electronic compounds	x	x	x	x
Electroplating	x	x	x	-
Explosives manufacturing	-	x	x	-
Foundries	x	x	x	-
Gum and wood chemicals	x	x	x	-
Inorganic chemicals manufacturing	x	x	x	-
Iron and steel manufacturing	x	x	x	-
Leather tanning and finishing	x	x	x	-*
Mechanical products manufacturing	x	x	x	-
Nonferrous metals manufacturing	x	x	x	x
Ore mining	x	x	x	x
Organic chemicals manufacturing	x	x	x	x
Paint and ink formulation	x	x	x	-*
Pesticides	x	x	x	x
Petroleum refining	x	-	-	-
Pharmaceutical preparation	x	x	x	-
hotographic equipment and supplies	x	x	x	-*
Plastic and synthetic materials manufacturing	x	x	x	x
Plastic processing	x	-	-	-
Porcelain enameling	-*	-*	-*	-*
Printing and publishing	x	x	x	x
Pulp and paperboard mills	x	x	x	x
Rubber Processing	x	x	x	-
Soap and detergent manufacturing	x	x	x	-
Steam electric power plants	x	x	x	-
Textile mills	x	x	x	x
Timber products processing	x	x	x	x

***See note at conclusion of 40 CFR Part 122, Appendix D (1983) for explanation of effect of suspensions on testing requirements for primary industry categories. See Note 1 at 46 FR 2045, Jan. 8, 1981; Note 2 at 46 FR22585, Apr. 20, 1981; and Note 3 at FR 35090, July 1, 1981.**

[1] The pollutants in each fraction are listed in item V-C.

x = Testing required.

- = Testing not required.

TOXIC POLLUTANTS AND HAZARDOUS SUBSTANCES REQUIRED TO BE IDENTIFIED BY APPLICANTS IF EXPECTED TO BE PRESENT

(For use with Form C, Item V, Part D)

TOXIC POLLUTANT

Asbestos

HAZARDOUS SUBSTANCES

1.	Acetaldehyde	35.	Ammonium thiocyanate	69.	Calcium chromate
2.	Acetic Acid	36.	Ammonium thiosulfate	70.	Calcium cyanide
3.	Acetic anhydride	37.	Amyl acetate	71.	Calcium dodecylbenzenesulfonate
4.	Acetone cyanohydrin	38.	Aniline	72.	Calcium hypochlorite
5.	Acetyl bromide	39.	Antimony pentachloride	73.	Captan
6.	Acetyl chloride	40.	Antimony potassium tartrate	74.	Carbaryl
7.	Acrolein	41.	Antimony tribromide	75.	Carbofuran
8.	Acrylonitrile	42.	Antimony trichloride	76.	Carbon disulfide
9.	Adipic acid	43.	Antimony trifluoride	77.	Carbon tetrachloride
10.	Aldrin	44.	Antimony trioxide	78.	Chlordane
11.	Allyl alcohol	45.	Arsenic disulfide	79.	Chlorine
12.	Allyl chloride	46.	Arsenic pentoxide	80.	Chlorobenzene
13.	Aluminum sulfate	47.	Arsenic trichloride	81.	Chloroform
14.	Ammonia	48.	Arsenic trioxide	82.	Chloropyrifos
15.	Ammonium acetate	49.	Arsenic trisulfide	83.	Chlorosulfonic acid
16.	Ammonium benzoate	50.	Barium cyanide	84.	Chromic acetate
17.	Ammonium bicarbonate	51.	Benzene	85.	Chromic acid
18.	Ammonium bichromate	52.	Benzoic acid	86.	Chromic sulfate
19.	Ammonium bifluoride	53.	Benzonitrile	87.	Chromous chloride
20.	Ammonium bisulfite	54.	Benzoyl chloride	88.	Cobaltous bromide
21.	Ammonium carbamate	55.	Benzyl chloride	89.	Cobaltous formate
22.	Ammonium carbonate	56.	Beryllium chloride	90.	Cobaltous sulfamate
23.	Ammonium chloride	57.	Beryllium fluoride	91.	Coumaphos
24.	Ammonium chromate	58.	Beryllium nitrate	92.	Cresol
25.	Ammonium citrate	59.	Butylacetate	93.	Crotonaldehyde
26.	Ammonium fluoroborate	60.	n-Butylphthalate	94.	Cupric acetate
27.	Ammonium fluoride	61.	Butylamine	95.	Cupric acetoarsenite
28.	Ammonium hydroxide	62.	Butyric acid	96.	Cupric chloride
29.	Ammonium oxalate	63.	Cadmium acetate	97.	Cupric nitrate
30.	Ammonium silicofluoride	64.	Cadmium bromide	98.	Cupric oxalate
31.	Ammonium sulfamate	65.	Cadmium chloride	99.	Cupric sulfate
32.	Ammonium sulfide	66.	Cadmium arsenate	100.	Cupric sulfate ammoniated
33.	Ammonium sulfite	67.	Calcium arsenite	101.	Cupric tartrate
34.	Ammonium tartrate	68.	Calcium carbide	102.	Cyanogen chloride

HAZARDOUS SUBSTANCES (continued)

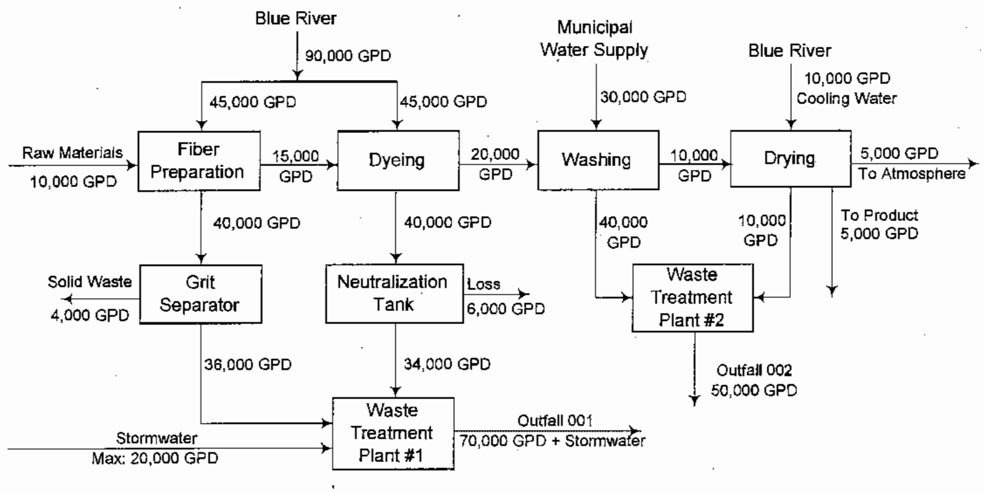
103.	Cyclohexane	134.	Ethylene dichloride	165.	Lead iodide
104.	2,4-D acid (2,4-Dichlorophenoxyacetic acid)	135.	Ethylene diaminetetracetic acid (EDTA)	166.	Lead nitrate
105.	2,4-D esters (2,4-Dichlorophenoxyacetic acid esters)	136.	Ferric ammonium citrate	167.	Lead stearate
106.	DDT	137.	Ferric ammonium oxalate	168.	Lead sulfate
107.	Diazinon	138.	Ferric chloride	169.	Lead sulfide
108.	Dicamba	139.	Ferric fluoride	170.	Lead thiocyanate
109.	Dichlobenil	140.	Ferric nitrate	171.	Lindane
110.	Dichlone	141.	Ferric sulfate	172.	Lithium chromate
111.	Dichlorobenzene	142.	Ferrous ammonium sulfate	173.	Malathion
112.	Dichloropropane	143.	Ferrous chloride	174.	Maleic acid
113.	Dichloropropene	144.	Ferrous sulfate	175.	Maleic anhydride
114.	Dichloropropene-dichloropropane mix	145.	Formaldehyde	176.	Mercaptodimethur
115.	2,2-Dichloropropionic acid	146.	Formic acid	177.	Mercuric cyanide
116.	Dichlorvos	147.	Fumaric acid	178.	Mercuric nitrate
117.	Dieldrin	148.	Furfural	179.	Mercuric sulfate
118.	Diethylamine	149.	Guthion	180.	Mercuric thiocyanate
119.	Dimethylamine	150.	Heptachlor	181.	Mercurous nitrate
120.	Dinitrobenzene	151.	Hexachlorocyclopentadiene	182.	Methoxychlor
121.	Dinitrophenol	152.	Hydrochloric acid	183.	Methyl mercaptan
122.	Dinitrotoluene	153.	Hydrofluoric acid	184.	Methyl methacrylate
123.	Diquat	154.	Hydrogen cyanide	185.	Methyl parathion
124.	Disulfoton	155.	Hydrogen sulfite	186.	Mevinphos
125.	Diuron	156.	Isoprene	187.	Mexacarbate
126.	Dodecylbenzesulfonic acid	157.	Isopropanolamine dodecylbenzenesulfonate	188.	Monoethylamine
127.	Endosulfan	158.	Kelthane	189.	Monomethylamine
128.	Endrin	159.	Kepone	190.	Naled
129.	Epichlorohydrin	160.	Lead acetate	191.	Naphthalene
130.	Ethion	161.	Lead arsenate	192.	Naphthenic acid
131.	Ethylbenzene	162.	Lead chloride	193.	Nickel ammonium sulfate
132.	Ethylenediamine	163.	Lead fluoborate	194.	Nickel chloride
133.	Ethylene dibromide	164.	Lead fluorite	195.	Nickel hydroxide

HAZARDOUS SUBSTANCES (continued)

196.	Nickel nitrate	221.	Propargite	246.	Sodium phosphate (tribasic)
197.	Nickel sulfate	222.	Propionic acid	247.	Sodium selenite
198.	Nitric acid	223.	Propionic anhydride	248.	Strontium choromate
199.	Nitrobenzene	224.	Propylene oxide	249.	Strychnine
200.	Nitrogen dioxide	225.	Pyrethrins	250.	Styrene
201.	Nitrophenol	226.	Quinoline	251.	Sulfuric acid
202.	Nitrotoluene	227.	Resorcinol	252.	Sulfur monochloride
203.	Paraformaldehyde	228.	Selenium oxide	253.	2,4,5-T acid (2,4,5-Trichlorophenoxy acetic acid)
204.	Parathion	229.	Silver nitrate	254.	2,4,5-T amines (2,4,5-Trichlorophenoxy acetic acid amines)
205.	Pentachlorophenol	230.	Sodium	255.	2,4,5-T esters (2,4,5-Trichlorophenoxy acetic acid esters)
206.	Phenol	231.	Sodium arsenate	256.	2,4,5-salts (2,4,5-Trichlorophenoxy acetic acid salts)
207.	Phosgene	232.	Sodium arsenite	257.	2,4,5-TP acid (2,4,5-Trichlorophenoxy propanoic acid)
208.	Phosphoric acid	233.	Sodium bichromate	258.	2,4,5-TP acid esters (2,4,5-Trichlorophenoxy propanoic acid esters)
209.	Phosphorus	234.	Sodium bifluoride	259.	TDE (Tetrachlorodiphenyl ethane)
210.	Phosphorus oxychloride	235.	Sodium bisulfite	260.	Tetraethyl lead
211.	Phosphorus pentasulfide	236.	Sodium chromate	261.	Tetraethyl pyrophosphate
212.	Phosphorus trichloride	237.	Sodium cyanide	262.	Thallium sulfate
213.	Polychlorinated biphenyls (PCB)	238.	Sodium dodecylbenzenesulfonate	263.	Toluene
214.	Potassium arsenate	239.	Sodium fluoride	264.	Toxaphene
215.	Potassium arsenite	240.	Sodium hydrosulfide	265.	Trichlorofon
216.	Potassium bichromate	241.	Sodium hydroxide	266.	Trichloroethylene
217.	Potassium chromate	242.	Sodium hypochlorite	267.	Trichlorophenol
218.	Potassium cyanide	243.	Sodium methylate	268.	Triethanolamine dodecylbenzenesulfonate
219.	Potassium hydroxide	244.	Sodium nitrate	269.	Triethylamine
220.	Potassium permanganate	245.	Sodium phosphate (dibasic)	270.	Trimethylamine
271.	Uranyl acetate	280.	Zinc ammonium chloride	289.	Zinc nitrate
272.	Uranyl nitrate	281.	Zinc borate	290.	Zinc phenolsulfonate
273.	Vanadium pentoxide	282.	Zinc bromide	291.	Zinc phosphate
274.	Vanadyl sulfate	283.	Zinc carbonate	292.	Zinc silicofluoride
275.	Vinyl acetate	284.	Zinc chloride	293.	Zinc sulfate
276.	Vinylidene chloride	285.	Zinc cyanide	294.	Zirconium nitrate
277.	Xylene	286.	Zinc fluoride	295.	Zirconium potassium fluoride
278.	Xylenol	287.	Zinc formate	296.	Zirconium sulfate
279.	Zinc acetate	288.	Zinc hydrosulfonate	297.	Zirconium tetrachloride

EXAMPLE

LINE DRAWING



Schematic of Water Flow
Brown Mills, Inc.
City, County, State

ATTACHMENT 6

LABORATORY RESULTS

(FORM C SUPPORT DATA)

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

LG&E - KU ENERGY LLC.

Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

Project Name: EW Brown - Form C - KPDES Renewal
Project / PO Number: 620758
Received: 01/23/2019
Reported: 02/04/2019

Analytical Testing Parameters

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 600							
Flow by Measurement & Calc.	**0.403**	0	MGD			01/23/19 1415	BZT
Method: SM 2550B							
Temperature	**8.6**		deg C			01/23/19 1415	BZT

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: Calculated							
Total Organic Nitrogen	**0.86**	0.40	mg/L		01/28/19 0948	01/29/19 1346	EES
Method: EPA 1664B							
Oil & Grease	<5.7	5.7	mg/L		01/25/19 1419	01/25/19 1443	AXJ
Method: EPA 365.1							
Phosphorus	**0.21**	0.050	mg/L		01/24/19 1716	01/25/19 1146	EES
Method: SM 2120B							
Color, Pt-Co (Apparent)	**20**	5	CU		01/24/19 0926	01/24/19 1350	CJL
pH at Color	**6**	1	SU		01/24/19 0926	01/24/19 1350	CJL
Method: SM 4500 NH3 G							
Nitrogen, Ammonia	<0.25	0.25	mg/L		01/25/19 1243	01/26/19 1719	EES
Nitrogen, Total Kjeldahl	**0.86**	0.40	mg/L		01/28/19 0948	01/29/19 1346	EES
Method: SM 4500 S2 D							
Sulfide	<0.20	0.20	mg/L		01/26/19 1009	01/26/19 1015	CJL
Method: SM 4500 SO3 B							
Sulfite	<2.0	2.0	mg/L	**H1**	01/24/19 0844	01/24/19 1100	MGM
Method: SM 5210 B							
BOD, 5 Day	<5.0	5.0	mg/L			01/24/19 1136	BWS
Method: SM 5220D							
COD	<25	25	mg/L		01/28/19 1329	01/28/19 1517	NWW

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM 5540C							
MBAS (as LAS MW 340)	<0.20	0.20	mg/L			01/24/19 1330	EES
Method: USGS I-3765-85							
Solids, Total Suspended	**27**	2	mg/L		01/27/19 1401	01/28/19 1352	BWS

Anions by Ion Chromatography	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 300.0							
Bromide	**2.2**	0.50	mg/L		01/25/19 1605	01/25/19 1605	LJC
Chloride	**79**	0.50	mg/L		01/25/19 1605	01/25/19 1605	LJC
Fluoride	**2.3**	0.50	mg/L		01/25/19 1605	01/25/19 1605	LJC
Nitrogen, Nitrate + Nitrite	**2.0**	0.75	mg/L		01/25/19 1805	01/25/19 1805	LJC
Sulfate	**740**	7.0	mg/L		01/26/19 0906	01/26/19 0906	LJC

Metals, Total by EPA 200/6000/7000 Series Methods	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.7							
Calcium	**280**	5.0	mg/L		01/24/19 1110	01/30/19 0230	JSW
Magnesium	**69**	0.50	mg/L		01/24/19 1110	01/28/19 2252	JSW
Method: SM 2340B							
Hardness, Total as CaCO3	**980**	12	mg/L		01/24/19 1110	01/30/19 0230	JSW

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 624							
Vinyl Chloride	<0.0020	0.0020	mg/L			01/25/19 2007	LJC
Chloromethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Bromomethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Chloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Trichlorofluoromethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,1-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Methylene Chloride	<0.010	0.010	mg/L			01/25/19 2007	LJC
Acrolein	<0.025	0.025	mg/L	**L4**		01/25/19 2007	LJC
Acrylonitrile	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
trans-1,2-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,1-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Chloroform	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,1,1-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Carbon Tetrachloride	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Benzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,2-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Trichloroethene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,2-Dichloropropane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Dichlorobromomethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
2-Chloroethyl Vinyl Ether	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
cis-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Toluene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
trans-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,1,2-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Dibromochloromethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Tetrachloroethene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Chlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Ethylbenzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Bromoform	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,1,2,2-Tetrachloroethane	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,3-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,4-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
1,2-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2007	LJC
Surrogate: SR / BFB	101	Limit: 86-115	% Rec			01/25/19 2007	LJC
Surrogate: SR / DBFM	98.5	Limit: 86-118	% Rec			01/25/19 2007	LJC
Surrogate: SR / DCA	97.4	Limit: 80-120	% Rec			01/25/19 2007	LJC
Surrogate: SR / Tol-D8	97.8	Limit: 88-110	% Rec			01/25/19 2007	LJC

Analyses Performed by: Microbac Laboratories, Inc., Lexington

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: HACH 8167							
Chlorine, Total Residual	<0.02	0.02	mg/L			01/23/19 1415	BZT
Method: SM 4500 H+ B							
pH	**7.77**	1.00	SU			01/23/19 1415	BZT

Microbiology	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM9223B (Colilert-18)							
E. coli	**20.3**	1.0	MPN/100mL		01/23/19 1735	01/23/19 1746	CDW

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 625 Rev 7/95							
1,2,4-Trichlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
1,2-Diphenylhydrazine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,2´-oxybis(1-chloropropane)	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
2,4,5-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,4,6-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,4-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,4-Dimethylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,4-Dinitrophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,4-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,6-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2,6-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Chloronaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Chlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Methylnaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
2-Nitrophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
3,3´-Dichlorobenzidine	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0125	CLR
3/4-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
3-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
4,6-Dinitro-2-methylphenol	<0.025	0.025	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Bromophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Chloro-3-methylphenol	<0.020	0.020	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Chloroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Chlorophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
4-Nitrophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0125	CLR
Acenaphthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Acenaphthylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Acetophenone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Aniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzidine	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzo[a]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzo[a]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzo[b]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzo[g,h,i]perylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzo[k]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzoic acid	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Benzyl alcohol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Bis(2-chloroethoxy)methane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Bis(2-chloroethyl)ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Bis(2-ethylhexyl)phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Butyl benzyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Carbazole	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Chrysene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Dibenz[a,h]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Dibenzofuran	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Diethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Dimethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Di-n-butyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Di-n-octyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Fluorene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Hexachlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Hexachlorobutadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Hexachlorocyclopentadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Hexachloroethane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Indeno[1,2,3cd]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Isophorone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Naphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Nitrobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
N-Nitrosodimethylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
N-Nitrosodi-n-propylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
N-Nitrosodiphenylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Pentachlorophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0125	CLR
Phenanthrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Phenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Pyridine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0125	CLR
Surrogate: 2,4,6-Tribromophenol	75.7	Limit: 47.8-138	% Rec		01/28/19 1136	01/30/19 0125	CLR
Surrogate: 2-Fluorobiphenyl	54.6	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0125	CLR
Surrogate: 2-Fluorophenol	34.0	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0125	CLR
Surrogate: Nitrobenzene-d5	55.7	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0125	CLR
Surrogate: Phenol-d5	24.4	Limit: 10-60.8	% Rec		01/28/19 1136	01/30/19 0125	CLR
Surrogate: Terphenyl-d14	65.5	Limit: 16.8-110	% Rec		01/28/19 1136	01/30/19 0125	CLR

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8 Rev 5.4							
Aluminum	**470**	5.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Antimony	**2.0**	1.0	µg/L		01/28/19 1042	01/31/19 1646	RPL
Arsenic	**6.2**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Barium	**43**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Beryllium	<1.0	1.0	µg/L	**J**	01/28/19 1042	01/28/19 1728	RPL
Boron	**9.1**	0.50	mg/L		01/28/19 1042	01/29/19 1459	RPL
Cadmium	**1.6**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Chromium	**1.9**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Cobalt	**6.2**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Copper	**6.6**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Iron	**700**	100	µg/L		01/28/19 1042	01/29/19 1526	RPL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-01	**Collection Date:**	01/23/2019 14:15

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Lead	**1.2**	1.0	µg/L		01/28/19 1042	01/29/19 1526	RPL
Magnesium	**71**	10	mg/L		01/28/19 1042	01/29/19 1459	RPL
Manganese	**1400**	5.0	µg/L		01/31/19 0900	01/31/19 1351	RPL
Molybdenum	**450**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Nickel	**29**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Selenium	**22**	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Silver	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1728	RPL
Thallium	<1.0	1.0	µg/L	**J**	01/28/19 1042	01/28/19 1728	RPL
Tin	<0.0010	0.0010	mg/L		01/28/19 1042	01/28/19 1728	RPL
Titanium	<0.030	0.030	mg/L	**J**	01/28/19 1042	01/28/19 1728	RPL
Zinc	**17**	2.0	µg/L		01/28/19 1042	01/28/19 1728	RPL

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 420.4 Rev 1.0							
Phenolics, Total Recoverable	<0.010	0.010	mg/L		01/29/19 1319	02/01/19 1424	ABG
Method: SM 4500-CN C/E-1999							
Cyanide, Total	<0.0050	0.0050	mg/L		01/29/19 0825	01/29/19 1416	ABG

Analyses Subcontracted to: Microbac Laboratories, Inc. - Ohio Valley

Total Organic Carbon	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM5310-C-2000							
Total Organic Carbon	**4.14**	1.00	mg/L			01/29/19 1509	EPT

Client Sample ID:	001 - Site Auxiliary / Ash Pond - Low Level Mercury		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-02	**Collection Date:**	01/23/2019 14:20

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	**18.8**	5.00	ng/L		01/29/19 1243	01/31/19 0937	/FXE1 gs

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	001 - Site Auxiliary / Ash Pond - Low Level Mercury Blank		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-03	**Collection Date:**	01/23/2019 14:20

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<0.500	0.500	ng/L		01/29/19 1243	01/31/19 0944	/FXE1 gs

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 600							
Flow by Measurement & Calc.	**0.007**	0	MGD			01/23/19 1230	BZT
Method: SM 2550B							
Temperature	**20.7**		deg C			01/23/19 1230	BZT

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: Calculated							
Total Organic Nitrogen	**0.60**	0.40	mg/L		01/28/19 0948	01/29/19 1348	EES
Method: EPA 1664B							
Oil & Grease	<6.0	6.0	mg/L		01/25/19 1419	01/25/19 1443	AXJ
Method: EPA 365.1							
Phosphorus	**0.36**	0.050	mg/L		01/24/19 1716	01/25/19 1148	EES
Method: SM 2120B							
Color, Pt-Co (Apparent)	**25**	5	CU		01/24/19 0926	01/24/19 1350	CJL
pH at Color	**6**	1	SU		01/24/19 0926	01/24/19 1350	CJL
Method: SM 4500 NH3 G							
Nitrogen, Ammonia	<0.25	0.25	mg/L		01/25/19 1243	01/26/19 1721	EES
Nitrogen, Total Kjeldahl	**0.60**	0.40	mg/L		01/28/19 0948	01/29/19 1348	EES
Method: SM 4500 S2 D							
Sulfide	<0.20	0.20	mg/L		01/26/19 1009	01/26/19 1015	CJL
Method: SM 4500 SO3 B							
Sulfite	<2.0	2.0	mg/L	**H1**	01/24/19 0844	01/24/19 1100	MGM
Method: SM 5210 B							
BOD, 5 Day	<5.0	5.0	mg/L			01/24/19 1136	BWS
Method: SM 5220D							
COD	<25	25	mg/L		01/28/19 1329	01/28/19 1517	NWW
Method: SM 5540C							
MBAS (as LAS MW 340)	<0.20	0.20	mg/L			01/24/19 1330	EES
Method: USGS I-3765-85							
Solids, Total Suspended	**3**	3	mg/L		01/27/19 1401	01/28/19 1352	BWS

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

Anions by Ion Chromatography	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 300.0							
Bromide	<0.50	0.50	mg/L		01/25/19 1620	01/25/19 1620	LJC
Chloride	**9.8**	0.50	mg/L		01/25/19 1620	01/25/19 1620	LJC
Fluoride	<0.50	0.50	mg/L		01/25/19 1620	01/25/19 1620	LJC
Nitrogen, Nitrate + Nitrite	**1.9**	0.75	mg/L		01/25/19 1820	01/25/19 1820	LJC
Sulfate	**38**	0.50	mg/L		01/25/19 1620	01/25/19 1620	LJC

Metals, Total by EPA 200/6000/7000 Series Methods	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.7							
Calcium	**81**	0.50	mg/L		01/24/19 1110	01/28/19 2258	JSW
Magnesium	**14**	0.50	mg/L		01/24/19 1110	01/28/19 2258	JSW
Method: SM 2340B							
Hardness, Total as CaCO3	**260**	2.1	mg/L		01/24/19 1110	01/28/19 2258	JSW

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 624							
Vinyl Chloride	<0.0020	0.0020	mg/L			01/25/19 2033	LJC
Chloromethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Bromomethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Chloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Trichlorofluoromethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,1-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Methylene Chloride	<0.010	0.010	mg/L			01/25/19 2033	LJC
Acrolein	<0.025	0.025	mg/L	**L4**		01/25/19 2033	LJC
Acrylonitrile	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
trans-1,2-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,1-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Chloroform	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,1,1-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Carbon Tetrachloride	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Benzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,2-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Trichloroethene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,2-Dichloropropane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Dichlorobromomethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
2-Chloroethyl Vinyl Ether	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
cis-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Toluene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
trans-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,1,2-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

Volatile Organics	**Result**	**RL**	**Units**	**Note**	**Prepared**	**Analyzed**	**Analyst**
Dibromochloromethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Tetrachloroethene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Chlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Ethylbenzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Bromoform	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,1,2,2-Tetrachloroethane	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,3-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,4-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
1,2-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2033	LJC
Surrogate: SR / BFB	96.6	Limit: 86-115	% Rec			01/25/19 2033	LJC
Surrogate: SR / DBFM	102	Limit: 86-118	% Rec			01/25/19 2033	LJC
Surrogate: SR / DCA	105	Limit: 80-120	% Rec			01/25/19 2033	LJC
Surrogate: SR / Tol-D8	97.3	Limit: 88-110	% Rec			01/25/19 2033	LJC

Analyses Performed by: Microbac Laboratories, Inc., Lexington

Field Parameters	**Result**	**RL**	**Units**	**Note**	**Prepared**	**Analyzed**	**Analyst**
Method: HACH 8167							
Chlorine, Total Residual	<0.02	0.02	mg/L			01/23/19 1230	BZT
Method: SM 4500 H+ B							
pH	**8.24**	1.00	SU			01/23/19 1230	BZT

Microbiology	**Result**	**RL**	**Units**	**Note**	**Prepared**	**Analyzed**	**Analyst**
Method: SM9223B (Colilert-18)							
E. coli	**26.5**	1.0	MPN/100mL		01/23/19 1735	01/23/19 1746	CDW

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	**Result**	**RL**	**Units**	**Note**	**Prepared**	**Analyzed**	**Analyst**
Method: EPA 625 Rev 7/95							
1,2,4-Trichlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
1,2-Diphenylhydrazine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,2´-oxybis(1-chloropropane)	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4,5-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4,6-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4-Dimethylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4-Dinitrophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,4-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,6-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2,6-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
2-Chloronaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2-Chlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2-Methylnaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
2-Nitrophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
3,3´-Dichlorobenzidine	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0146	CLR
3/4-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
3-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
4,6-Dinitro-2-methylphenol	<0.025	0.025	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Bromophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Chloro-3-methylphenol	<0.020	0.020	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Chloroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Chlorophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
4-Nitrophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0146	CLR
Acenaphthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Acenaphthylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Acetophenone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Aniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzidine	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzo[a]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzo[a]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzo[b]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzo[g,h,i]perylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzo[k]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzoic acid	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Benzyl alcohol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Bis(2-chloroethoxy)methane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Bis(2-chloroethyl)ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Bis(2-ethylhexyl)phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Butyl benzyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Carbazole	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Chrysene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Dibenz[a,h]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Dibenzofuran	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Diethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Dimethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Di-n-butyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Di-n-octyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Fluorene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Hexachlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Hexachlorobutadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Hexachlorocyclopentadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Hexachloroethane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Indeno[1,2,3cd]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Isophorone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Naphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Nitrobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
N-Nitrosodimethylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
N-Nitrosodi-n-propylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
N-Nitrosodiphenylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Pentachlorophenol	<0.051	0.051	mg/L		01/28/19 1136	01/30/19 0146	CLR
Phenanthrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Phenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Pyridine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0146	CLR
Surrogate: 2,4,6-Tribromophenol	52.5	Limit: 47.8-138	% Rec		01/28/19 1136	01/30/19 0146	CLR
Surrogate: 2-Fluorobiphenyl	38.8	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0146	CLR
Surrogate: 2-Fluorophenol	26.8	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0146	CLR
Surrogate: Nitrobenzene-d5	40.3	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0146	CLR
Surrogate: Phenol-d5	18.9	Limit: 10-60.8	% Rec		01/28/19 1136	01/30/19 0146	CLR
Surrogate: Terphenyl-d14	58.2	Limit: 16.8-110	% Rec		01/28/19 1136	01/30/19 0146	CLR

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8 Rev 5.4							
Aluminum	**59**	5.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Antimony	<1.0	1.0	µg/L	J	01/28/19 1042	01/29/19 1530	RPL
Arsenic	**3.3**	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Barium	**39**	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Beryllium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Boron	**0.24**	0.050	mg/L		01/28/19 1042	01/29/19 1503	RPL
Cadmium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Chromium	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1751	RPL
Cobalt	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1751	RPL
Copper	**44**	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Iron	<100	100	µg/L	J	01/28/19 1042	01/29/19 1530	RPL
Lead	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Magnesium	**13**	1.0	mg/L		01/28/19 1042	01/29/19 1503	RPL
Manganese	**19**	1.0	µg/L		02/01/19 0819	02/01/19 1307	RPL
Molybdenum	**58**	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Nickel	**4.9**	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Selenium	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1751	RPL
Silver	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1751	RPL
Thallium	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1751	RPL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-04	**Collection Date:**	01/23/2019 12:30

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Tin	<0.0010	0.0010	mg/L	**J**	01/28/19 1042	01/28/19 1751	RPL
Titanium	<0.030	0.030	mg/L		01/28/19 1042	01/28/19 1751	RPL
Zinc	**5.8**	2.0	µg/L		01/28/19 1042	01/28/19 1751	RPL

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 420.4 Rev 1.0							
Phenolics, Total Recoverable	**0.011**	0.010	mg/L		01/29/19 1319	02/01/19 1426	ABG
Method: SM 4500-CN C/E-1999							
Cyanide, Total	<0.0050	0.0050	mg/L		01/29/19 0825	01/29/19 1418	ABG

Analyses Subcontracted to: Microbac Laboratories, Inc. - Ohio Valley

Total Organic Carbon	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM5310-C-2000							
Total Organic Carbon	**6.88**	1.00	mg/L			01/29/19 1531	EPT

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown - Low Level Mercury		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-05	**Collection Date:**	01/23/2019 12:40

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<5.00	5.00	ng/L		01/29/19 1243	01/31/19 0946	BTM

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown - Low Level Mercury Blank		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-06	**Collection Date:**	01/23/2019 12:40

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<0.500	0.500	ng/L		01/29/19 1243	01/31/19 0953	/FXE1 g

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 600							
Flow by Measurement & Calc.	**0.432**	0	MGD			01/23/19 1325	BZT
Method: SM 2550B							
Temperature	**13.2**		deg C			01/23/19 1325	BZT

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: Calculated							
Total Organic Nitrogen	**0.76**	0.40	mg/L		01/28/19 0948	01/29/19 1350	EES
Method: EPA 1664B							
Oil & Grease	<5.9	5.9	mg/L		01/25/19 1419	01/25/19 1443	AXJ
Method: EPA 365.1							
Phosphorus	**0.16**	0.050	mg/L		01/24/19 1719	01/25/19 1212	EES
Method: SM 2120B							
Color, Pt-Co (Apparent)	**20**	5	CU		01/24/19 0926	01/24/19 1350	CJL
pH at Color	**6**	1	SU		01/24/19 0926	01/24/19 1350	CJL
Method: SM 4500 NH3 G							
Nitrogen, Ammonia	<0.25	0.25	mg/L		01/25/19 1243	01/26/19 1723	EES
Nitrogen, Total Kjeldahl	**0.76**	0.40	mg/L		01/28/19 0948	01/29/19 1350	EES
Method: SM 4500 S2 D							
Sulfide	<0.20	0.20	mg/L		01/26/19 1009	01/26/19 1015	CJL
Method: SM 4500 SO3 B							
Sulfite	<2.0	2.0	mg/L	**H1**	01/24/19 0844	01/24/19 1100	MGM
Method: SM 5210 B							
BOD, 5 Day	<5.0	5.0	mg/L			01/24/19 1136	BWS
Method: SM 5220D							
COD	<25	25	mg/L		01/28/19 1329	01/28/19 1517	NWW
Method: SM 5540C							
MBAS (as LAS MW 340)	<0.20	0.20	mg/L			01/24/19 1330	EES
Method: USGS I-3765-85							
Solids, Total Suspended	<2	2	mg/L		01/27/19 1401	01/28/19 1352	BWS

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

Anions by Ion Chromatography	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 300.0							
Bromide	<0.50	0.50	mg/L		01/25/19 1735	01/25/19 1735	LJC
Chloride	**7.7**	0.50	mg/L		01/25/19 1735	01/25/19 1735	LJC
Fluoride	<0.50	0.50	mg/L		01/25/19 1735	01/25/19 1735	LJC
Nitrogen, Nitrate + Nitrite	**1.5**	0.75	mg/L		01/25/19 1835	01/25/19 1835	LJC
Sulfate	**27**	0.50	mg/L		01/25/19 1735	01/25/19 1735	LJC

Metals, Total by EPA 200/6000/7000 Series Methods	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.7							
Calcium	**60**	0.50	mg/L		01/24/19 1110	01/28/19 2303	JSW
Magnesium	**11**	0.50	mg/L		01/24/19 1110	01/28/19 2303	JSW
Method: SM 2340B							
Hardness, Total as CaCO3	**190**	2.1	mg/L		01/24/19 1110	01/28/19 2303	JSW

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 624							
Vinyl Chloride	<0.0020	0.0020	mg/L			01/25/19 2100	LJC
Chloromethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Bromomethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Chloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Trichlorofluoromethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,1-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Methylene Chloride	<0.010	0.010	mg/L			01/25/19 2100	LJC
Acrolein	<0.025	0.025	mg/L	**L4**		01/25/19 2100	LJC
Acrylonitrile	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
trans-1,2-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,1-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Chloroform	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,1,1-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Carbon Tetrachloride	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Benzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,2-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Trichloroethene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,2-Dichloropropane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Dichlorobromomethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
2-Chloroethyl Vinyl Ether	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
cis-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Toluene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
trans-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,1,2-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Dibromochloromethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Tetrachloroethene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Chlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Ethylbenzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Bromoform	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,1,2,2-Tetrachloroethane	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,3-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,4-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
1,2-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2100	LJC
Surrogate: SR / BFB	94.3	Limit: 86-115	% Rec			01/25/19 2100	LJC
Surrogate: SR / DBFM	101	Limit: 86-118	% Rec			01/25/19 2100	LJC
Surrogate: SR / DCA	99.2	Limit: 80-120	% Rec			01/25/19 2100	LJC
Surrogate: SR / Tol-D8	101	Limit: 88-110	% Rec			01/25/19 2100	LJC

Analyses Performed by: Microbac Laboratories, Inc., Lexington

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: HACH 8167							
Chlorine, Total Residual	<0.02	0.02	mg/L			01/23/19 1325	BZT
Method: SM 4500 H+ B							
pH	**7.51**	1.00	SU			01/23/19 1325	BZT

Microbiology	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM9223B (Colilert-18)							
E. coli	**6.3**	1.0	MPN/100mL		01/23/19 1735	01/23/19 1746	CDW

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 625 Rev 7/95							
1,2,4-Trichlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
1,2-Diphenylhydrazine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,2´-oxybis(1-chloropropane)	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4,5-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4,6-Trichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4-Dimethylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4-Dinitrophenol	<0.052	0.052	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,4-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,6-Dichlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2,6-Dinitrotoluene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
2-Chloronaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2-Chlorophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2-Methylnaphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
2-Nitrophenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
3,3´-Dichlorobenzidine	<0.052	0.052	mg/L		01/28/19 1136	01/30/19 0208	CLR
3/4-Methylphenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
3-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
4,6-Dinitro-2-methylphenol	<0.026	0.026	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Bromophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Chloro-3-methylphenol	<0.021	0.021	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Chloroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Chlorophenyl phenyl ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Nitroaniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
4-Nitrophenol	<0.052	0.052	mg/L		01/28/19 1136	01/30/19 0208	CLR
Acenaphthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Acenaphthylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Acetophenone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Aniline	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzidine	<0.052	0.052	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzo[a]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzo[a]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzo[b]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzo[g,h,i]perylene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzo[k]fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzoic acid	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Benzyl alcohol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Bis(2-chloroethoxy)methane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Bis(2-chloroethyl)ether	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Bis(2-ethylhexyl)phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Butyl benzyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Carbazole	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Chrysene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Dibenz[a,h]anthracene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Dibenzofuran	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Diethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Dimethyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Di-n-butyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Di-n-octyl phthalate	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Fluoranthene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Fluorene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Hexachlorobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Hexachlorobutadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Hexachlorocyclopentadiene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Hexachloroethane	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Indeno[1,2,3cd]pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Isophorone	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Naphthalene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Nitrobenzene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
N-Nitrosodimethylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
N-Nitrosodi-n-propylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
N-Nitrosodiphenylamine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Pentachlorophenol	<0.052	0.052	mg/L		01/28/19 1136	01/30/19 0208	CLR
Phenanthrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Phenol	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Pyrene	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Pyridine	<0.010	0.010	mg/L		01/28/19 1136	01/30/19 0208	CLR
Surrogate: 2,4,6-Tribromophenol	70.0	Limit: 47.8-138	% Rec		01/28/19 1136	01/30/19 0208	CLR
Surrogate: 2-Fluorobiphenyl	52.1	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0208	CLR
Surrogate: 2-Fluorophenol	36.1	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0208	CLR
Surrogate: Nitrobenzene-d5	54.8	Limit: 10-110	% Rec		01/28/19 1136	01/30/19 0208	CLR
Surrogate: Phenol-d5	25.9	Limit: 10-60.8	% Rec		01/28/19 1136	01/30/19 0208	CLR
Surrogate: Terphenyl-d14	64.8	Limit: 16.8-110	% Rec		01/28/19 1136	01/30/19 0208	CLR

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8 Rev 5.4							
Aluminum	**48**	5.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Antimony	**1.2**	1.0	µg/L		01/28/19 1042	01/31/19 1650	RPL
Arsenic	**1.1**	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Barium	**31**	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Beryllium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Boron	**0.17**	0.025	mg/L		01/28/19 1042	01/29/19 1508	RPL
Cadmium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Chromium	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1755	RPL
Cobalt	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1755	RPL
Copper	**4.0**	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Iron	<100	100	µg/L	J	01/28/19 1042	01/29/19 1535	RPL
Lead	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Magnesium	**9.3**	0.10	mg/L		01/28/19 1042	01/28/19 1755	RPL
Manganese	**14**	1.0	µg/L		01/31/19 0900	01/31/19 1355	RPL
Molybdenum	**7.6**	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Nickel	**1.4**	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Selenium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Silver	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL
Thallium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1755	RPL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-07	**Collection Date:**	01/23/2019 13:25

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Tin	<0.0010	0.0010	mg/L		01/28/19 1042	01/28/19 1755	RPL
Titanium	<0.030	0.030	mg/L		01/28/19 1042	01/28/19 1755	RPL
Zinc	**2.7**	2.0	µg/L		01/28/19 1042	01/28/19 1755	RPL

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 420.4 Rev 1.0							
Phenolics, Total Recoverable	**0.013**	0.010	mg/L		01/29/19 1319	02/01/19 1427	ABG
Method: SM 4500-CN C/E-1999							
Cyanide, Total	<0.0050	0.0050	mg/L		01/29/19 0825	01/29/19 1420	ABG

Analyses Subcontracted to: Microbac Laboratories, Inc. - Ohio Valley

Total Organic Carbon	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM5310-C-2000							
Total Organic Carbon	**6.07**	1.00	mg/L			01/29/19 1553	EPT

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown - Low Level Mercury		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-08	**Collection Date:**	01/23/2019 13:30

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<5.00	5.00	ng/L		01/29/19 1243	01/31/19 0955	BTM

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown - Low Level Mercury Blank		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-09	**Collection Date:**	01/23/2019 13:30

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<0.500	0.500	ng/L		01/29/19 1243	01/31/19 0958	/FXE1 g

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 600							
Flow by Measurement & Calc.	**0.001**	0	MGD			01/23/19 1130	BZT
Method: SM 2550B							
Temperature	**10.9**		deg C			01/23/19 1130	BZT

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: Calculated							
Total Organic Nitrogen	**0.64**	0.40	mg/L		01/28/19 0948	01/29/19 1355	EES
Method: EPA 1664B							
Oil & Grease	<5.6	5.6	mg/L		01/25/19 1419	01/25/19 1443	AXJ
Method: EPA 365.1							
Phosphorus	**0.11**	0.050	mg/L		01/24/19 1719	01/25/19 1213	EES
Method: SM 2120B							
Color, Pt-Co (Apparent)	**25**	5	CU		01/24/19 0926	01/24/19 1350	CJL
pH at Color	**6**	1	SU		01/24/19 0926	01/24/19 1350	CJL
Method: SM 4500 NH3 G							
Nitrogen, Ammonia	<0.25	0.25	mg/L		01/25/19 1243	01/26/19 1724	EES
Nitrogen, Total Kjeldahl	**0.64**	0.40	mg/L		01/28/19 0948	01/29/19 1355	EES
Method: SM 4500 S2 D							
Sulfide	<0.20	0.20	mg/L		01/26/19 1009	01/26/19 1015	CJL
Method: SM 4500 SO3 B							
Sulfite	**3.1**	2.0	mg/L	**H1**	01/24/19 0844	01/24/19 1100	MGM
Method: SM 5210 B							
BOD, 5 Day	<5.0	5.0	mg/L			01/24/19 1136	BWS
Method: SM 5220D							
COD	<25	25	mg/L		01/28/19 1329	01/28/19 1517	NWW
Method: SM 5540C							
MBAS (as LAS MW 340)	<0.20	0.20	mg/L			01/24/19 1330	EES
Method: USGS I-3765-85							
Solids, Total Suspended	<3	3	mg/L		01/27/19 1204	01/28/19 1352	BWS

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

Anions by Ion Chromatography	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 300.0							
Bromide	<0.50	0.50	mg/L		01/25/19 1750	01/25/19 1750	LJC
Chloride	**5.9**	0.50	mg/L		01/25/19 1750	01/25/19 1750	LJC
Fluoride	<0.50	0.50	mg/L		01/25/19 1750	01/25/19 1750	LJC
Nitrogen, Nitrate + Nitrite	**1.2**	0.75	mg/L		01/25/19 1850	01/25/19 1850	LJC
Sulfate	**21**	0.50	mg/L		01/25/19 1750	01/25/19 1750	LJC

Metals, Total by EPA 200/6000/7000 Series Methods	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.7							
Calcium	**52**	0.50	mg/L		01/24/19 1110	01/28/19 2308	JSW
Magnesium	**8.8**	0.50	mg/L		01/24/19 1110	01/28/19 2308	JSW
Method: SM 2340B							
Hardness, Total as CaCO3	**170**	2.1	mg/L		01/24/19 1110	01/28/19 2308	JSW

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 624							
Vinyl Chloride	<0.0020	0.0020	mg/L			01/25/19 2126	LJC
Chloromethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Bromomethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Chloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Trichlorofluoromethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,1-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Methylene Chloride	<0.010	0.010	mg/L			01/25/19 2126	LJC
Acrolein	<0.025	0.025	mg/L	**L4**		01/25/19 2126	LJC
Acrylonitrile	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
trans-1,2-Dichloroethene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,1-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Chloroform	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,1,1-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Carbon Tetrachloride	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Benzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,2-Dichloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Trichloroethene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,2-Dichloropropane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Dichlorobromomethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
2-Chloroethyl Vinyl Ether	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
cis-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Toluene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
trans-1,3-Dichloropropene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,1,2-Trichloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Dibromochloromethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Tetrachloroethene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Chlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Ethylbenzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Bromoform	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,1,2,2-Tetrachloroethane	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,3-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,4-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
1,2-Dichlorobenzene	<0.0050	0.0050	mg/L			01/25/19 2126	LJC
Surrogate: SR / BFB	98.2	Limit: 86-115	% Rec			01/25/19 2126	LJC
Surrogate: SR / DBFM	105	Limit: 86-118	% Rec			01/25/19 2126	LJC
Surrogate: SR / DCA	117	Limit: 80-120	% Rec			01/25/19 2126	LJC
Surrogate: SR / Tol-D8	102	Limit: 88-110	% Rec			01/25/19 2126	LJC

Analyses Performed by: Microbac Laboratories, Inc., Lexington

Field Parameters	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: HACH 8167							
Chlorine, Total Residual	<0.02	0.02	mg/L			01/23/19 1130	BZT
Method: SM 4500 H+ B							
pH	**7.38**	1.00	SU			01/23/19 1130	BZT

Microbiology	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM9223B (Colilert-18)							
E. coli	**5.2**	1.0	MPN/100mL		01/23/19 1735	01/23/19 1746	CDW

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 625 Rev 7/95							
1,2,4-Trichlorobenzene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
1,2-Diphenylhydrazine	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,2´-oxybis(1-chloropropane)	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4,5-Trichlorophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4,6-Trichlorophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4-Dichlorophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4-Dimethylphenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4-Dinitrophenol	<0.050	0.050	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,4-Dinitrotoluene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,6-Dichlorophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2,6-Dinitrotoluene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
2-Chloronaphthalene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2-Chlorophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2-Methylnaphthalene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2-Methylphenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2-Nitroaniline	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
2-Nitrophenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
3,3´-Dichlorobenzidine	<0.050	0.050	mg/L		01/29/19 0924	01/29/19 2038	CLR
3/4-Methylphenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
3-Nitroaniline	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
4,6-Dinitro-2-methylphenol	<0.025	0.025	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Bromophenyl phenyl ether	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Chloro-3-methylphenol	<0.020	0.020	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Chloroaniline	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Chlorophenyl phenyl ether	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Nitroaniline	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
4-Nitrophenol	<0.050	0.050	mg/L		01/29/19 0924	01/29/19 2038	CLR
Acenaphthene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Acenaphthylene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Acetophenone	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Aniline	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Anthracene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzidine	<0.050	0.050	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzo[a]anthracene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzo[a]pyrene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzo[b]fluoranthene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzo[g,h,i]perylene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzo[k]fluoranthene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzoic acid	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Benzyl alcohol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Bis(2-chloroethoxy)methane	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Bis(2-chloroethyl)ether	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Bis(2-ethylhexyl)phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Butyl benzyl phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Carbazole	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Chrysene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Dibenz[a,h]anthracene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Dibenzofuran	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Diethyl phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Dimethyl phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Di-n-butyl phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Di-n-octyl phthalate	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Fluoranthene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Fluorene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Hexachlorobenzene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Hexachlorobutadiene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Hexachlorocyclopentadiene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Hexachloroethane	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Indeno[1,2,3cd]pyrene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Isophorone	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Naphthalene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Nitrobenzene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
N-Nitrosodimethylamine	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
N-Nitrosodi-n-propylamine	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
N-Nitrosodiphenylamine	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Pentachlorophenol	<0.050	0.050	mg/L		01/29/19 0924	01/29/19 2038	CLR
Phenanthrene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Phenol	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Pyrene	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Pyridine	<0.010	0.010	mg/L		01/29/19 0924	01/29/19 2038	CLR
Surrogate: 2,4,6-Tribromophenol	73.8	Limit: 47.8-138	% Rec		01/29/19 0924	01/29/19 2038	CLR
Surrogate: 2-Fluorobiphenyl	50.0	Limit: 10-110	% Rec		01/29/19 0924	01/29/19 2038	CLR
Surrogate: 2-Fluorophenol	33.9	Limit: 10-110	% Rec		01/29/19 0924	01/29/19 2038	CLR
Surrogate: Nitrobenzene-d5	56.2	Limit: 10-110	% Rec		01/29/19 0924	01/29/19 2038	CLR
Surrogate: Phenol-d5	24.4	Limit: 10-60.8	% Rec		01/29/19 0924	01/29/19 2038	CLR
Surrogate: Terphenyl-d14	64.1	Limit: 16.8-110	% Rec		01/29/19 0924	01/29/19 2038	CLR

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8 Rev 5.4							
Aluminum	**45**	5.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Antimony	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Arsenic	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1800	RPL
Barium	**26**	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Beryllium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Boron	**0.14**	0.025	mg/L		01/28/19 1042	01/29/19 1512	RPL
Cadmium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Chromium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Cobalt	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1800	RPL
Copper	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1800	RPL
Iron	<100	100	µg/L	J	01/28/19 1042	01/29/19 1539	RPL
Lead	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Magnesium	**8.0**	0.10	mg/L		01/28/19 1042	01/28/19 1800	RPL
Manganese	**11**	1.0	µg/L		01/31/19 0900	01/31/19 1400	RPL
Molybdenum	**5.0**	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Nickel	<1.0	1.0	µg/L	J	01/28/19 1042	01/28/19 1800	RPL
Selenium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Silver	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL
Thallium	<1.0	1.0	µg/L		01/28/19 1042	01/28/19 1800	RPL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-10	**Collection Date:**	01/23/2019 11:30

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Tin	<0.0010	0.0010	mg/L		01/28/19 1042	01/28/19 1800	RPL
Titanium	<0.030	0.030	mg/L		01/28/19 1042	01/28/19 1800	RPL
Zinc	**2.6**	2.0	µg/L		01/28/19 1042	01/28/19 1800	RPL

Wet Chemistry	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 420.4 Rev 1.0							
Phenolics, Total Recoverable	**0.014**	0.010	mg/L		01/29/19 1319	02/01/19 1438	ABG
Method: SM 4500-CN C/E-1999							
Cyanide, Total	<0.0050	0.0050	mg/L		01/29/19 0825	01/29/19 1421	ABG

Analyses Subcontracted to: Microbac Laboratories, Inc. - Ohio Valley

Total Organic Carbon	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM5310-C-2000							
Total Organic Carbon	**5.86**	1.00	mg/L			01/29/19 1615	EPT

Client Sample ID:	005 - Plant Intake - Herrington Lake - Low Level Mercury		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-11	**Collection Date:**	01/23/2019 11:40

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<5.00	5.00	ng/L		01/29/19 1243	01/31/19 1000	BTM

Client Sample ID:	005 - Plant Intake - Herrington Lake - Low Level Mercury Blank		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1312-12	**Collection Date:**	01/23/2019 11:40

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

Metals	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 1631E							
Mercury	<0.500	0.500	ng/L		01/29/19 1243	01/31/19 1002	/FXE1 g

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1312

Definitions

H1:	Sample received outside of holding time for these analytes.
J:	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
L4:	Lab Control Sample (LCS) recovery below lower Control Limit, analyte not detected.
MDL:	Minimum Detection Limit
RL:	Reporting Limit

Project Requested Certification(s)

Microbac Laboratories, Inc. - Chicagoland

75	Kentucky EPPC analysis Underground Storage Tanks (k)
90147	Kentucky Wastewater Laboratory Certification Program (j)

Report Comments

Samples were received in proper condition and the reported results conform to applicable accreditation standard unless otherwise noted.

The data and information on this, and other accompanying documents, represents only the sample(s) analyzed. This report is incomplete unless all pages indicated in the footnote are present and an authorized signature is included.

Reviewed and Approved By:

JOAN HEINSOHN
Account Manager
Reported: 02/04/2019 12:41

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

JOAN HEINSOHN

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN

Project EW Brown - Form C Renew
Cust. P.O. 620758
Permit #

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max

Instructions

01 001 - Site Auxiliary / Ash Pond — Sample Date/Time/Field Results/Meter ID: 1-23-19 1415 P-98 TRC-FL

Type Grab

Analysis	Method	Containers/Preservative	Units	Field Result
Semi-Volatile Organics - 625	EPA 625	A-1 LITER AMBER-4°C	mg/L	
BOD, 5 Day	SM 5210 B	A-1 LITER PLASTIC - GEN CHEM-4°C	mg/L	
Solids, Total Suspended	USGS I-3765-85	A-1 LITER PLASTIC - GEN CHEM-4°C	mg/L	
Surfactants, MBAS	SM 5540C	A-1 LITER PLASTIC - GEN CHEM-4°C	mg/L	
Bromide	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C	mg/L	
Chloride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C	mg/L	
Fluoride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C	mg/L	
Sulfate	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C	mg/L	
Chlorine, Total Residual	HACH 8167	A-FIELD PARAMETERS	mg/L	0.00
Flow by Calculation	EPA 600	A-FIELD PARAMETERS	MGD	0.403
Sampling Labor - Hourly	NA	A-FIELD PARAMETERS	Hours	
Aluminum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Antimony	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Arsenic	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Barium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Beryllium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Boron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	mg/L	
Cadmium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Chromium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Cobalt	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Copper	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Iron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Lead	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Magnesium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	mg/L	
Manganese	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Molybdenum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Nickel	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Selenium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Silver	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Thallium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Tin	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	mg/L	
Titanium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	mg/L	
Zinc	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3	ug/L	
Oil and Grease, Total	EPA 1664B	C-1 LITER O&G-H2SO4	mg/L	
Phenolics, Tot. Recoverable	EPA 420.4	C-250 ML AMBER GLASS-H2SO4	mg/L	
COD	SM 5220D	C-250 ML PLASTIC - H2SO4	mg/L	

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. #	EL056	**Project**	EW Brown - Form C Renew
Phone	(502) 627-2997		
Fax	(502) 627-2550	**Cust. P.O.**	620758
Email	roger.medina@lge-ku.com	**Permit #**	
Acct. Mgr.	JOAN HEINSOHN		

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Instructions							
01 001 - Site Auxiliary / Ash Pond Type Grab ...continued			Sample Date/Time/Field Results/Meter ID [illegible]				
Nitrogen, Nitrate + Nitrite	EPA 300.0	C-250 ML PLASTIC - H2SO4			mg/L		
Phosphorus, Total	EPA 365.1	C-250 ML PLASTIC - H2SO4			mg/L		
Total Organic Carbon	SM 5310C	C-40 ML AMBER VOA VIALS-H2SO4			mg/L		
E. coli	SM9223B (Colilert-18)	D-STERILE BAC-T CUP-NA2S2O3			MPN/100mL		
Color, Platinum-Cobalt	SM 2120B	A-1 LITER AMBER-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER AMBER-4°C					
Color, Platinum-Cobalt	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
Calcium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Hardness Pkg. By ICP	SM 2340B	B-250 ML PLASTIC-METALS-HNO3					
Magnesium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Nitrogen, Ammonia	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Nitrogen, Total Kjeldahl	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Environmental Fee	NA	NA			---		
pH - Field	SM 4500 H+ B	NA			SU 7.77		
Temperature at pH - Field	SM 2550B	NA			deg C 8.6		
Volatile Organic Compounds - 62	EPA 624	O-40 ML VOA VIALS-HCL			mg/L		
Cyanide, Total	SM 4500 CN E	O-CYANIDE-NAOH 250 ML			mg/L		
Sulfide	SM 4500 S2 D	O-SULFIDE-NAOH/ZNC4H6O4			mg/L		
Sulfite	SM 4500 SO3 B	O-SULFITE-EDTA-ZERO HEADSPACE			mg/L		
02 001 - Site Auxiliary / Ash Pond - Low Level Mercury **Type** Grab			Sample Date/Time/Field Results/Meter ID 1-23-19 1420				
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		
03 001 - Site Auxiliary / Ash Pond - Low Level Mercury Blank **Type** Grab			Sample Date/Time/Field Results/Meter ID 1-23-19 1420				
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		
04 002 - Units 1-2 Cooling Towers Blowdown **Type** Grab			Sample Date/Time/Field Results/Meter ID 1-23-19 1230 7.78 TRC-F2				
Semi-Volatile Organics - 625	EPA 625	A-1 LITER AMBER-4°C			mg/L		
BOD, 5 Day	SM 5210 B	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Solids, Total Suspended	USGS I-3765-85	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Surfactants, MBAS	SM 5540C	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232
EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN

Project EW Brown - Form C Renew
Cust. P.O. 620758
Permit #

Instructions

[illegible]

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Bromide	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Chloride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Fluoride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Sulfate	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Chlorine, Total Residual	HACH 8167	A-FIELD PARAMETERS			mg/L	0.00	
Flow by Calculation	EPA 600	A-FIELD PARAMETERS			MGD	0.007	
Aluminum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Antimony	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Arsenic	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Barium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Beryllium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Boron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Cadmium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Chromium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Cobalt	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Copper	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Iron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Lead	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Magnesium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Manganese	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Molybdenum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Nickel	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Selenium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Silver	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Thallium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Tin	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Titanium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Zinc	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Oil and Grease, Total	EPA 1664B	C-1 LITER O&G-H2SO4			mg/L		
Phenolics, Tot. Recoverable	EPA 420.4	C-250 ML AMBER GLASS-H2SO4			mg/L		
COD	SM 5220D	C-250 ML PLASTIC - H2SO4			mg/L		
Nitrogen, Nitrate + Nitrite	EPA 300.0	C-250 ML PLASTIC - H2SO4			mg/L		
Phosphorus, Total	EPA 365.1	C-250 ML PLASTIC - H2SO4			mg/L		
Total Organic Carbon	SM 5310C	C-40 ML AMBER VOA VIALS-H2SO4			mg/L		
E. coli	SM9223B (Colilert-18)	D-STERILE BAC-T CUP-NA2S2O3			MPN/100mL		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN
Project EW Brown - Form C Renew
Cust. P.O. 620758
Permit #

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max

Instructions

04 002 - Units 1-2 Cooling Towers Blowdown — Sample Date/Time/Field Results/Meter ID
Type Grab
continued
1-23-19 1230

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Color, Platinum-Cobalt	SM 2120B	A-1 LITER AMBER-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER AMBER-4°C					
Color, Platinum-Cobalt	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
Calcium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Hardness Pkg. By ICP	SM 2340B	B-250 ML PLASTIC-METALS-HNO3					
Magnesium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Nitrogen, Ammonia	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Nitrogen, Total Kjeldahl	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Environmental Fee	NA	NA			----		
pH - Field	SM 4500 H+ B	NA			SU 8.24		
Temperature at pH - Field	SM 2550B	NA			deg C 20.7°		
Volatile Organic Compounds - 62‹	EPA 624	O-40 ML VOA VIALS-HCL			mg/L		
Cyanide, Total	SM 4500 CN E	O-CYANIDE-NAOH 250 ML			mg/L		
Sulfide	SM 4500 S2 D	O-SULFIDE-NAOH/ZNC4H6O4			mg/L		
Sulfite	SM 4500 SO3 B	O-SULFITE-EDTA-ZERO HEADSPACE			mg/L		

05 002 - Units 1-2 Cooling Towers Blowdown - Low Level Mercury — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1240

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		

06 002 - Units 1-2 Cooling Towers Blowdown - Low Level Mercury Blank — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1240

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		

07 003 - Unit 3 Cooling Tower Blowdown — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1325 TRC-F2 7.78

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Semi-Volatile Organics - 625	EPA 625	A-1 LITER AMBER-4°C			mg/L		
BOD, 5 Day	SM 5210 B	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Solids, Total Suspended	USGS I-3765-85	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Surfactants, MBAS	SM 5540C	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Bromide	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Chloride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Fluoride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Sulfate	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route **Freq.**

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056 **Project** EW Brown - Form C Renew
Phone (502) 627-2997
Fax (502) 627-2550 **Cust. P.O.** 620758
Email roger.medina@lge-ku.com **Permit #**
Acct. Mgr. JOAN HEINSOHN

Instructions

07 003 - Unit 3 Cooling Tower Blowdown
Type Grab
.....continued

Sample Date/Time/Field Results/Meter ID 1-23-19 1325

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Sample Date/Time/Field Results/Meter ID	Units	Min	Max
Chlorine, Total Residual	HACH 8167	A-FIELD PARAMETERS			0.00	mg/L		
Flow by Calculation	EPA 600	A-FIELD PARAMETERS			0.432	MGD	~~0.0??~~ DZF 1-23-19	
Aluminum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Antimony	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Arsenic	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Barium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Beryllium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Boron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				mg/L		
Cadmium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Chromium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Cobalt	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Copper	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Iron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Lead	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Magnesium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				mg/L		
Manganese	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Molybdenum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Nickel	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Selenium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Silver	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Thallium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Tin	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				mg/L		
Titanium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				mg/L		
Zinc	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3				ug/L		
Oil and Grease, Total	EPA 1664B	C-1 LITER O&G-H2SO4				mg/L		
Phenolics, Tot. Recoverable	EPA 420.4	C-250 ML AMBER GLASS-H2SO4				mg/L		
COD	SM 5220D	C-250 ML PLASTIC - H2SO4				mg/L		
Nitrogen, Nitrate + Nitrite	EPA 300.0	C-250 ML PLASTIC - H2SO4				mg/L		
Phosphorus, Total	EPA 365.1	C-250 ML PLASTIC - H2SO4				mg/L		
Total Organic Carbon	SM 5310C	C-40 ML AMBER VOA VIALS-H2SO4				mg/L		
E. coli	SM9223B (Colilert-18)	D-STERILE BAC-T CUP-NA2S2O3				MPN/100mL		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN

Project EW Brown - Form C Renew
Cust. P.O. 620758
Permit #

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Instructions							
[illegible] 003 - Unit 3 Cooling Tower Blowdown					Sample Date/Time/Field Results/Meter ID		
Type Grab							
continued		[illegible]					
Color, Platinum-Cobalt	SM 2120B	A-1 LITER AMBER-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER AMBER-4°C					
Color, Platinum-Cobalt	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
Calcium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Hardness Pkg. By ICP	SM 2340B	B-250 ML PLASTIC-METALS-HNO3					
Magnesium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Nitrogen, Ammonia	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Nitrogen, Total Kjeldahl	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Environmental Fee	NA	NA			---		
pH - Field	SM 4500 H+ B	NA			SU	7.51	
Temperature at pH - Field	SM 2550B	NA			deg C	13.2°	
Volatile Organic Compounds - 62	EPA 624	O-40 ML VOA VIALS-HCL			mg/L		
Cyanide, Total	SM 4500 CN E	O-CYANIDE-NAOH 250 ML			mg/L		
Sulfide	SM 4500 S2 D	O-SULFIDE-NAOH/ZNC4H6O4			mg/L		
Sulfite	SM 4500 SO3 B	O-SULFITE-EDTA-ZERO HEADSPACE			mg/L		
08 003 - Unit 3 Cooling Tower Blowdown - Low Level Mercury					Sample Date/Time/Field Results/Meter ID		
Type Grab					1-23-19 1330		
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		
09 003 - Unit 3 Cooling Tower Blowdown - Low Level Mercury Blank					Sample Date/Time/Field Results/Meter ID		
Type Grab					1-23-19 1330		
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN			ng/L		
10 005 - Plant Intake - Herrington Lake					Sample Date/Time/Field Results/Meter ID		
Type Grab					1-23-19 1130		
Semi-Volatile Organics - 625	EPA 625	A-1 LITER AMBER-4°C			mg/L		
BOD, 5 Day	SM 5210 B	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Solids, Total Suspended	USGS I-3765-85	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Surfactants, MBAS	SM 5540C	A-1 LITER PLASTIC - GEN CHEM-4°C			mg/L		
Bromide	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Chloride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Fluoride	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		
Sulfate	EPA 300.0	A-50 ML PLASTIC DIGITUBE-4°C			mg/L		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN

Project EW Brown - Form C Renew
Cust. P.O. 620758
Permit #

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max

Instructions

[illegible]

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Chlorine, Total Residual	HACH 8167	A-FIELD PARAMETERS			mg/L	0.00	
Flow by Calculation	EPA 600	A-FIELD PARAMETERS			MGD	0.001	
Aluminum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Antimony	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Arsenic	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Barium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Beryllium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Boron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Cadmium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Chromium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Cobalt	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Copper	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Iron	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Lead	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Magnesium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Manganese	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Molybdenum	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Nickel	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Selenium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Silver	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Thallium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Tin	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Titanium	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			mg/L		
Zinc	EPA 200.8	B-250 ML PLASTIC-METALS-HNO3			ug/L		
Oil and Grease, Total	EPA 1664B	C-1 LITER O&G-H2SO4			mg/L		
Phenolics, Tot. Recoverable	EPA 420.4	C-250 ML AMBER GLASS-H2SO4			mg/L		
COD	SM 5220D	C-250 ML PLASTIC - H2SO4			mg/L		
Nitrogen, Nitrate + Nitrite	EPA 300.0	C-250 ML PLASTIC - H2SO4			mg/L		
Phosphorus, Total	EPA 365.1	C-250 ML PLASTIC - H2SO4			mg/L		
Total Organic Carbon	SM 5310C	C-40 ML AMBER VOA VIALS-H2SO4			mg/L		
E. coli	SM9223B (Colilert-18)	D-STERILE BAC-T CUP-NA2S2O3			MPN/100mL		

MICROBAC
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. #	EL056	Project	EW Brown - Form C Renew
Phone	(502) 627-2997		
Fax	(502) 627-2550	Cust. P.O.	620758
Email	roger.medina@lge-ku.com	Permit #	
Acct. Mgr.	JOAN HEINSOHN		

Instructions

[illegible]

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Color, Platinum-Cobalt	SM 2120B	A-1 LITER AMBER-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER AMBER-4°C					
Color, Platinum-Cobalt	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
pH (at Color determination)	SM 2120B	A-1 LITER PLASTIC - GEN CHEM-4°C					
Calcium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Hardness Pkg. By ICP	SM 2340B	B-250 ML PLASTIC-METALS-HNO3					
Magnesium	EPA 200.7	B-250 ML PLASTIC-METALS-HNO3					
Nitrogen, Ammonia	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Nitrogen, Total Kjeldahl	SM 4500 NH3 G	C-250 ML PLASTIC - H2SO4					
Environmental Fee	NA	NA			---		
pH - Field	SM 4500 H+ B	NA			SU	7.38	
Temperature at pH - Field	SM 2550B	NA			deg C	10.9°	
Volatile Organic Compounds - 62	EPA 624	O-40 ML VOA VIALS-HCL			mg/L		
Cyanide, Total	SM 4500 CN E	O-CYANIDE-NAOH 250 ML			mg/L		
Sulfide	SM 4500 S2 D	O-SULFIDE-NAOH/ZNC4H6O4			mg/L		
Sulfite	SM 4500 SO3 B	O-SULFITE-EDTA-ZERO HEADSPACE			mg/L		

11 005 - Plant Intake - Herrington Lake - Low Level Mercury — Sample Date/Time/Field Results/Meter ID: 1-23-19 1140
Type Grab

Analysis	Method	Containers/Preservative	Units
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN	ng/L

12 005 - Plant Intake - Herrington Lake - Low Level Mercury Blank — Sample Date/Time/Field Results/Meter ID: 1-23-19 1150
Type Grab

Analysis	Method	Containers/Preservative	Units
Mercury	EPA 1631E	A-MERCURY LOW LEVEL-ULTRA CLEAN	ng/L

SETUP:________ Deg C Sunny/Cloudy/Ptly Cloudy/Rain **REC:**________ Deg C Sunny/Cloudy/Ptly Cloudy/Rain **Rain During Event: YES / NO**

NOTES:

Sampled By: [signature]

Relinq. Date/Time/Sign: [signature] 1-23-19 1550	Rec'd Date/Time/Sign: [signature] 1-23-19 1550
Relinq. Date/Time/Sign:	Rec'd Date/Time/Sign:
Relinq. Date/Time/Sign:	Rec'd Date/Time/Sign:

MICROBAC®
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Relinq. Date/Time/Sign: Rec'd Date/Time/Sign:

SAMPLE RECEIPT DOCUMENTATION Cooler/Sample Temp (Deg C): LEX 11°C EVV____ PAD____ LOU____ HAZ____

COC & proper paperwork provided & complete / COC, samples, & bottles are in agreement: YES / NO (YES circled)

Appropriate bottles provided intact with sufficient volume / Samples are within hold time / Samples properly preserved : YES / NO (YES marked)

Chain of Custody seal intact? N/A Samples on Ice? Yes Number of bottles 92 ? Thermometer ID L-10

Notes, Correspondence, Subcontracting, & Non-Conformance Documentation (All Non-Conformances must be documented & client notified) :

001	002	003	005
pH 7.76	pH 8.24	pH 7.54	pH 7.37
Tem 8.7°	Tem 20.6°	Tem 13.1°	Tem 11.0

TRC 0.01

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1314

LG&E - KU ENERGY LLC.

Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

Project Name: EW Brown - Form C - Radiologicals

Project / PO Number: 620758
Received: 01/23/2019
Reported: 02/27/2019

Analytical Testing Parameters

Client Sample ID:	001 - Site Auxiliary / Ash Pond		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1314-01	**Collection Date:**	01/23/2019 14:15

Gross Alpha & Beta	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM 7110B							
Gross Alpha	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Gross Beta	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL

Radionuclides	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8							
Uranium	See attached		mg/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-B							
Radium 226	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-D							
Radium 228	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500-SR B (Modified)							
Strontium	**See attached**		pCi/g		02/27/19 1518	02/26/19 1520	GEL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1314

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1314-02	**Collection Date:**	01/23/2019 12:30

Gross Alpha & Beta	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM 7110B							
Gross Alpha	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Gross Beta	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL

Radionuclides	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8							
Uranium	See attached		mg/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-B							
Radium 226	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-D							
Radium 228	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500-SR B (Modified)							
Strontium	**See attached**		pCi/g		02/27/19 1518	02/26/19 1520	GEL

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1314-03	**Collection Date:**	01/23/2019 13:25

Gross Alpha & Beta	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM 7110B							
Gross Alpha	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Gross Beta	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL

Radionuclides	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8							
Uranium	See attached		mg/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-B							
Radium 226	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-D							
Radium 228	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500-SR B (Modified)							
Strontium	**See attached**		pCi/g		02/27/19 1518	02/26/19 1520	GEL

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9A1314

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	Brandon Thorpe
Lab Sample ID:	L9A1314-04	**Collection Date:**	01/23/2019 11:30

Gross Alpha & Beta	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SM 7110B							
Gross Alpha	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Gross Beta	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL

Radionuclides	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: EPA 200.8							
Uranium	See attached		mg/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-B							
Radium 226	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500 RA-D							
Radium 228	See attached		pCi/L		02/27/19 1518	02/26/19 1520	GEL
Method: SM 7500-SR B (Modified)							
Strontium	**See attached**		pCi/g		02/27/19 1518	02/26/19 1520	GEL

Definitions

RL: Reporting Limit

Report Comments

The data and information on this, and other accompanying documents, represents only the sample(s) analyzed. This report is incomplete unless all pages indicated in the footnote are present and an authorized signature is included.

Reviewed and Approved By:

JOAN HEINSOHN
Account Manager
Reported: 02/27/2019 15:35

MICROBAC

Kentucky Testing Divison

3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411

Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - Radiologicals

Cust. #	EL056	Project	EW Brown - Form C Rads
Phone	(502) 627-2997		
Fax	(502) 627-2550	Cust. P.O.	620758
Email	roger.medina@lge-ku.com	Permit #	
Acct. Mgr.	JOAN HEINSOHN		

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max

Instructions

01 001 - Site Auxiliary / Ash Pond — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1415

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Gross Alpha	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Gross Beta	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 226	SM 7500 RA-B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 228	SM 7500 RA-D	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Strontium - 90	SM 7500-SR B (Modified)	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/g		
Uranium	EPA 200.8	B-1 LITER PLASTIC - DW METALS-HNO3			mg/L		

02 002 - Units 1-2 Cooling Towers Blowdown — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1230

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Gross Alpha	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Gross Beta	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 226	SM 7500 RA-B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 228	SM 7500 RA-D	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Strontium - 90	SM 7500-SR B (Modified)	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/g		
Uranium	EPA 200.8	B-1 LITER PLASTIC - DW METALS-HNO3			mg/L		

03 003 - Unit 3 Cooling Tower Blowdown — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1325

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Gross Alpha	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Gross Beta	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 226	SM 7500 RA-B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 228	SM 7500 RA-D	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Strontium - 90	SM 7500-SR B (Modified)	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/g		
Uranium	EPA 200.8	B-1 LITER PLASTIC - DW METALS-HNO3			mg/L		

04 005 - Plant Intake - Herrington Lake — Sample Date/Time/Field Results/Meter ID
Type Grab — 1-23-19 1130

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Gross Alpha	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Gross Beta	SM 7110B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 226	SM 7500 RA-B	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Radium 228	SM 7500 RA-D	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/L		
Strontium - 90	SM 7500-SR B (Modified)	B-1 LITER PLASTIC - DW METALS-HNO3			pCi/g		
Uranium	EPA 200.8	B-1 LITER PLASTIC - DW METALS-HNO3			mg/L		

SETUP:________ **Deg C Sunny/Cloudy/Ptly Cloudy/Rain** **REC:**________ **Deg C Sunny/Cloudy/Ptly Cloudy/Rain** **Rain During Event: YES / NC**

NOTES:

Brandon Thorpe **Sampled By**

GEL Laboratories LLC
a member of The GEL Group INC

PO Box 30712 Charleston, SC 29417
2040 Savage Road Charleston, SC 29407
P 843.556.8171
F 843.766.1178

gel.com

February 25, 2019

Ms. Joan Heinsohn
Company: Microbac Laboratories, Inc Kentucky Division
3323 Gilmore Industrial Boulevard
Louisville, Kentucky 40213

Re: Radiochemistry Analysis-Kentucky
Work Order: 469928
SDG: L9A1314

Dear Ms. Heinsohn:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on January 28, 2019. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 4778.

Sincerely,

PM_SIGN_HERE

Hope Taylor
Project Manager

Purchase Order: GELP16-0258
Enclosures

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 − (843) 556−8171 − www.gel.com

Certificate of Analysis Report
for

MBAC001 Microbac Laboratories

Client SDG: L9A1314 GEL Work Order: 469928

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria
** Analyte is a Tracer compound
** Analyte is a surrogate compound
U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Hope Taylor.

Reviewed by ______________________

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Company: Microbac Laboratories, Inc Kentucky Division
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Ms. Joan Heinsohn
Project: Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-01	Project:	MBAC00116
Sample ID:	469928001	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 14:15		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		3.67	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2026	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Company: Microbac Laboratories, Inc Kentucky Division
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Ms. Joan Heinsohn
Project: Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-02	Project:	MBAC00116
Sample ID:	469928002	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 12:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.582	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2039	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Company: Microbac Laboratories, Inc Kentucky Division
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Ms. Joan Heinsohn
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-03	Project:	MBAC00116
Sample ID:	469928003	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 13:25		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.453	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2042	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Company: Microbac Laboratories, Inc Kentucky Division
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Ms. Joan Heinsohn
Project: Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-04	Project:	MBAC00116
Sample ID:	469928004	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 11:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.359	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2046	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Microbac Laboratries, Inc.
Address :	3323 Gilmore Industrial Boulevard
	Louisville, Kentucky 40213
Contact:	Mr. David Lester
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-01	Project:	MBAC00116
Sample ID:	469928001	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 14:15		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		3.67	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2026	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Microbac Laboratries, Inc.
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Mr. David Lester
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-02	Project:	MBAC00116
Sample ID:	469928002	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 12:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.582	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2039	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Microbac Laboratries, Inc.
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Mr. David Lester
Project: Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-03		Project:	MBAC00116
Sample ID:	469928003		Client ID:	MBAC001
Matrix:	Water			
Collect Date:	23-JAN-19 13:25			
Receive Date:	28-JAN-19			
Collector:	Client			

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.453	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2042	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Microbac Laboratries, Inc.
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Mr. David Lester
Project: Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-04	Project:	MBAC00116
Sample ID:	469928004	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 11:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Metals Analysis-ICP-MS												
200.2/200.8 Uranium "As Received"												
Uranium		0.359	0.067	0.200	ug/L	1.00	1	BAJ	01/29/19	2046	1843974	1

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
EPA 200.2	ICP-MS 200.2 PREP	JXM8	01/28/19	1600	1843973

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 200.8	

Notes:

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Report Date: February 25, 2019

Company: Microbac Laboratories, Inc Kentucky Division
3323 Gilmore Industrial Boulevard
Louisville, Kentucky

Contact: Ms. Joan Heinsohn

Workorder: 469928

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Metals Analysis - ICPMS										
Batch 1843974										
QC1204207139 469928001 DUP										
Uranium		3.67		3.81	ug/L	3.64		(0%-20%)	BAJ	01/29/19 20:30
QC1204207138 LCS										
Uranium	50.0			50.1	ug/L		100	(85%-115%)		01/29/19 20:23
QC1204207137 MB										
Uranium			U	ND	ug/L					01/29/19 20:20
QC1204207140 469928001 MS										
Uranium	50.0	3.67		55.2	ug/L		103	(75%-125%)		01/29/19 20:33
QC1204207141 469928001 SDILT										
Uranium		3.67		0.747	ug/L	1.72		(0%-10%)		01/29/19 20:36

Notes:

The Qualifiers in this report are defined as follows:

- < Result is less than value reported
- > Result is greater than value reported
- E %difference of sample and SD is >10%. Sample concentration must meet flagging criteria
- FB Mercury was found present at quantifiable concentrations in field blanks received with these samples. Data associated with the blank are deemed invalid for reporting to regulatory agencies
- H Analytical holding time was exceeded
- J Value is estimated
- N Metals--The Matrix spike sample recovery is not within specified control limits
- N/A RPD or %Recovery limits do not apply.
- N1 See case narrative
- ND Analyte concentration is not detected above the detection limit
- NJ Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Q One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
- R Sample results are rejected
- U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 469928

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier

Y Other specific qualifiers were required to properly define the results. Consult case narrative.

^ RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.

h Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Report Date: February 25, 2019

Microbac Laboratries, Inc.
3323 Gilmore Industrial Boulevard
Louisville, Kentucky
Contact: **Mr. David Lester**

Workorder: **469928**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Metals Analysis - ICPMS										
Batch 1843974										
QC1204207139 469928001 DUP										
Uranium		3.67		3.81	ug/L	3.64		(0%-20%)	BAJ	01/29/19 20:30
QC1204207138 LCS										
Uranium	50.0			50.1	ug/L		100	(85%-115%)		01/29/19 20:23
QC1204207137 MB										
Uranium			U	ND	ug/L					01/29/19 20:20
QC1204207140 469928001 MS										
Uranium	50.0	3.67		55.2	ug/L		103	(75%-125%)		01/29/19 20:33
QC1204207141 469928001 SDILT										
Uranium		3.67		0.747	ug/L	1.72		(0%-10%)		01/29/19 20:36

Notes:

The Qualifiers in this report are defined as follows:

<	Result is less than value reported
>	Result is greater than value reported
E	%difference of sample and SD is >10%. Sample concentration must meet flagging criteria
FB	Mercury was found present at quantifiable concentrations in field blanks received with these samples. Data associated with the blank are deemed invalid for reporting to regulatory agencies
H	Analytical holding time was exceeded
J	Value is estimated
N	Metals--The Matrix spike sample recovery is not within specified control limits
N/A	RPD or %Recovery limits do not apply.
N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: **469928**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier

Y Other specific qualifiers were required to properly define the results. Consult case narrative.

^ RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.

h Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

Technical Case Narrative
Microbac Laboratories (MBAC)
SDG #: L9A1314
Work Order #: 469928

Metals

Product: Determination of Metals by ICP-MS
Analytical Method: EPA 200.8
Analytical Procedure: GL-MA-E-014 REV# 33
Analytical Batch: 1843974

Preparation Method: EPA 200.2
Preparation Procedure: GL-MA-E-016 REV# 18
Preparation Batch: 1843973

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
469928001	L9A1314-01
469928002	L9A1314-02
469928003	L9A1314-03
469928004	L9A1314-04
1204207137	Method Blank (MB)**ICP-MS**
1204207138	Laboratory Control Sample (LCS)
1204207141	469928001(L9A1314-01L) Serial Dilution (SD)
1204207139	469928001(L9A1314-01D) Sample Duplicate (DUP)
1204207140	469928001(L9A1314-01S) Matrix Spike (MS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable, with the following exceptions.

Calibration Information

ICSA/ICSAB Statement
For the ICP-MS analysis, the ICSA solution contains analyte concentrations which are verified trace impurities indigenous to the purchased standard.

Radiochemistry

Product: GFPC, Ra228, Liquid
Analytical Method: EPA 904.0/SW846 9320 Modified
Analytical Procedure: GL-RAD-A-063 REV# 3
Analytical Batch: 1844202

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
469928001	L9A1314-01
469928002	L9A1314-02
469928003	L9A1314-03
469928004	L9A1314-04
1204207743	Method Blank (MB)
1204207744	469671002(NonSDG) Sample Duplicate (DUP)
1204207745	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable, with the following exceptions.

Technical Information

Recounts
Samples were re-eluted and recounted due to a low recovery. The recounts are reported.

Product: **GFPC, Gross A/B, liquid**
Analytical Method: EPA 900.0/SW846 9310
Analytical Procedure: GL-RAD-A-001 REV# 20
Analytical Batch: 1845944

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
469928001	L9A1314-01
469928002	L9A1314-02
469928003	L9A1314-03
469928004	L9A1314-04
1204211483	Method Blank (MB)
1204211484	470317003(NonSDG) Sample Duplicate (DUP)
1204211485	470317003(NonSDG) Matrix Spike (MS)
1204211486	470317003(NonSDG) Matrix Spike Duplicate (MSD)
1204211487	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable, with the following exceptions.

Preparation Information

Aliquot Reduced
Aliquot volume was reduced due to the sample matrix. 469928001 (L9A1314-01).

Quality Control (QC) Information

Duplication Criteria between QC Sample and Duplicate Sample
The Sample and the Duplicate, (See Below), did not meet the relative percent difference requirement; however, they do meet the relative error ratio requirement with the value listed below.

Sample	Analyte	Value
1204211484 (Non SDG 470317003DUP)	BETA	RPD 28.6* (0.00%-20.00%) RER 1.68 (0-3)

Technical Information

Gross Alpha/Beta Preparation Information
High hygroscopic salt content in evaporated samples can cause the sample mass to fluctuate due to moisture absorption. To minimize this interference, the salts are converted to oxides by heating the sample under a flame until a dull red color is obtained. The conversion to oxides stabilizes the sample weight and ensures that proper alpha/beta efficiencies are assigned for each sample. Volatile radioisotopes of carbon, hydrogen, technetium, polonium and cesium may be lost during sample heating.

Miscellaneous Information

Additional Comments
The matrix spike and matrix spike duplicate, 1204211485 (Non SDG 470317003MS) and 1204211486 (Non SDG 470317003MSD), aliquots were reduced to conserve sample volume.

Product: **GFPC, Sr90, liquid**
Analytical Method: EPA 905.0 Modified/DOE RP501 Rev. 1 Modified
Analytical Procedure: GL-RAD-A-004 REV# 20
Analytical Batch: 1845973

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
469928001	L9A1314-01
469928002	L9A1314-02
469928003	L9A1314-03
469928004	L9A1314-04
1204211568	Method Blank (MB)
1204211569	469928004(L9A1314-04) Sample Duplicate (DUP)
1204211570	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

There are no exceptions, anomalies or deviations from the specified methods. All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable.

Product: **Lucas Cell, Ra226, liquid**
Analytical Method: EPA 903.1 Modified
Analytical Procedure: GL-RAD-A-008 REV# 15
Analytical Batch: 1843819

The following samples were analyzed using the above methods and analytical procedure(s).

GEL Sample ID#	Client Sample Identification
469928001	L9A1314-01
469928002	L9A1314-02
469928003	L9A1314-03
469928004	L9A1314-04
1204206745	Method Blank (MB)
1204206746	469893010(NonSDG) Sample Duplicate (DUP)
1204206747	469893010(NonSDG) Matrix Spike (MS)
1204206748	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on an "as received" basis.

Data Summary:

All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable, with the following exceptions.

Miscellaneous Information

Additional Comments
The matrix spike, 1204206747 (Non SDG 469893010MS), aliquot was reduced to conserve sample volume.

Certification Statement

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless otherwise noted in the analytical case narrative.

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Company: Microbac Laboratories, Inc Kentucky Division
Address :	3323 Gilmore Industrial Boulevard
	Louisville, Kentucky 40213
Contact:	Ms. Joan Heinsohn
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-01	Project:	MBAC00116
Sample ID:	469928001	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 14:15		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha		2.64	+/-0.974	1.12	3.00	pCi/L			LXB3	02/11/19	1759	1845944	1
Beta		7.87	+/-1.02	1.39	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.139	+/-0.367	0.649	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	0.772	+/-1.11	1.90	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226		0.567	+/-0.355	0.465	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			86.3	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			95.1	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Company: Microbac Laboratories, Inc Kentucky Division
Address :	3323 Gilmore Industrial Boulevard
	Louisville, Kentucky 40213
Contact:	Ms. Joan Heinsohn
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-02	Project:	MBAC00116
Sample ID:	469928002	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 12:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	1.21	+/-1.71	2.97	3.00	pCi/L			LXB3	02/11/19	1411	1845944	1
Beta		5.52	+/-1.56	2.18	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.451	+/-0.350	0.547	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	-0.742	+/-0.877	1.98	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226	U	-0.0388	+/-0.252	0.558	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			65.1	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			67	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Company: Microbac Laboratories, Inc Kentucky Division
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Ms. Joan Heinsohn
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-03	Project:	MBAC00116
Sample ID:	469928003	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 13:25		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	-0.28	+/-1.35	2.93	3.00	pCi/L			LXB3	02/11/19	1405	1845944	1
Beta	U	1.64	+/-1.72	2.88	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.553	+/-0.444	0.710	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	0.735	+/-1.06	1.83	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226		0.880	+/-0.583	0.836	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			63.7	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			64.9	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Company: Microbac Laboratories, Inc Kentucky Division
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Ms. Joan Heinsohn
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-04	Project:	MBAC00116
Sample ID:	469928004	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 11:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	-0.0202	+/-1.22	2.57	3.00	pCi/L			LXB3	02/11/19	1407	1845944	1
Beta		2.92	+/-1.48	2.32	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.380	+/-0.389	0.645	1.00	pCi/L			JXC9	02/14/19	0912	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	-0.48	+/-0.815	1.77	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226	U	0.182	+/-0.253	0.437	1.00	pCi/L			PCW	02/08/19	1020	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			75	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			73.5	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Microbac Laboratries, Inc.
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Mr. David Lester
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-01	Project:	MBAC00116
Sample ID:	469928001	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 14:15		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha		2.64	+/-0.974	1.12	3.00	pCi/L			LXB3	02/11/19	1759	1845944	1
Beta		7.87	+/-1.02	1.39	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.139	+/-0.367	0.649	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	0.772	+/-1.11	1.90	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226		0.567	+/-0.355	0.465	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			86.3	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			95.1	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company : Microbac Laboratries, Inc.
Address : 3323 Gilmore Industrial Boulevard

Louisville, Kentucky 40213
Contact: Mr. David Lester
Project: Radiochemistry Analysis-Kentucky

Client Sample ID: L9A1314-02 Project: MBAC00116
Sample ID: 469928002 Client ID: MBAC001
Matrix: Water
Collect Date: 23-JAN-19 12:30
Receive Date: 28-JAN-19
Collector: Client

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	1.21	+/-1.71	2.97	3.00	pCi/L			LXB3	02/11/19	1411	1845944	1
Beta		5.52	+/-1.56	2.18	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.451	+/-0.350	0.547	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	-0.742	+/-0.877	1.98	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226	U	-0.0388	+/-0.252	0.558	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			65.1	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			67	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Microbac Laboratries, Inc.
Address :	3323 Gilmore Industrial Boulevard Louisville, Kentucky 40213
Contact:	Mr. David Lester
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-03	Project:	MBAC00116
Sample ID:	469928003	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 13:25		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	-0.28	+/-1.35	2.93	3.00	pCi/L			LXB3	02/11/19	1405	1845944	1
Beta	U	1.64	+/-1.72	2.88	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.553	+/-0.444	0.710	1.00	pCi/L			JXC9	02/14/19	0908	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	0.735	+/-1.06	1.83	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226		0.880	+/-0.583	0.836	1.00	pCi/L			PCW	02/08/19	0735	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			63.7	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			64.9	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor
DL: Detection Limit
MDA: Minimum Detectable Activity
MDC: Minimum Detectable Concentration
Lc/LC: Critical Level
PF: Prep Factor
RL: Reporting Limit
SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: February 25, 2019

Company :	Microbac Laboratries, Inc.
Address :	3323 Gilmore Industrial Boulevard
	Louisville, Kentucky 40213
Contact:	Mr. David Lester
Project:	Radiochemistry Analysis-Kentucky

Client Sample ID:	L9A1314-04	Project:	MBAC00116
Sample ID:	469928004	Client ID:	MBAC001
Matrix:	Water		
Collect Date:	23-JAN-19 11:30		
Receive Date:	28-JAN-19		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gas Flow Proportional Counting													
GFPC, Gross A/B, liquid "As Received"													
Alpha	U	-0.0202	+/-1.22	2.57	3.00	pCi/L			LXB3	02/11/19	1407	1845944	1
Beta		2.92	+/-1.48	2.32	4.00	pCi/L							
GFPC, Ra228, Liquid "As Received"													
Radium-228	U	0.380	+/-0.389	0.645	1.00	pCi/L			JXC9	02/14/19	0912	1844202	2
GFPC, Sr90, liquid "As Received"													
Strontium-90	U	-0.48	+/-0.815	1.77	2.00	pCi/L			JXK3	02/11/19	1308	1845973	3
Rad Radium-226													
Lucas Cell, Ra226, liquid "As Received"													
Radium-226	U	0.182	+/-0.253	0.437	1.00	pCi/L			PCW	02/08/19	1020	1843819	4

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	EPA 900.0/SW846 9310	
2	EPA 904.0/SW846 9320 Modified	
3	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
4	EPA 903.1 Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Barium-133 Tracer	GFPC, Ra228, Liquid "As Received"			75	(15%-125%)
Strontium Carrier	GFPC, Sr90, liquid "As Received"			73.5	(25%-125%)

Notes:
Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Report Date: February 25, 2019

Company: Microbac Laboratories, Inc Kentucky Division
3323 Gilmore Industrial Boulevard
Louisville, Kentucky
Contact: **Ms. Joan Heinsohn**

Workorder: **469928**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gas Flow										
Batch 1844202										
QC1204207744 469671002 DUP										
Radium-228	U	1.92		4.67	pCi/L	83.5		(0% - 100%)	JXC9	02/14/19 09:12
	Uncertainty	+/-2.14		+/-2.63						
QC1204207745 LCS										
Radium-228	5.52			5.24	pCi/L		95.1	(75%-125%)		02/14/19 09:12
	Uncertainty			+/-0.612						
QC1204207743 MB										
Radium-228			U	0.0459	pCi/L					02/14/19 09:12
	Uncertainty			+/-0.305						
Batch 1845944										
QC1204211484 470317003 DUP										
Alpha		7.64		14.5	pCi/L	62.2		(0% - 100%)	LXB3	02/11/19 14:11
	Uncertainty	+/-3.90		+/-4.92						
Beta		15.4		20.6	pCi/L	28.6*		(0%-20%)		
	Uncertainty	+/-2.91		+/-3.06						
QC1204211487 LCS										
Alpha	80.5			97.4	pCi/L		121	(75%-125%)		02/11/19 14:05
	Uncertainty			+/-9.49						
Beta	309			296	pCi/L		95.9	(75%-125%)		
	Uncertainty			+/-11.4						
QC1204211483 MB										
Alpha			U	-0.948	pCi/L					02/11/19 14:05
	Uncertainty			+/-0.713						
Beta			U	1.18	pCi/L					
	Uncertainty			+/-1.21						
QC1204211485 470317003 MS										
Alpha	483	7.64		571	pCi/L		117	(75%-125%)		02/11/19 14:05
	Uncertainty	+/-3.90		+/-63.4						
Beta	1850	15.4		1810	pCi/L		97.2	(75%-125%)		
	Uncertainty	+/-2.91		+/-65.9						

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 469928

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gas Flow										
Batch 1845944										
QC1204211486 470317003 MSD										
Alpha	483	7.64		594	pCi/L	4	121	(0%-20%)	LXB3	02/11/19 14:05
	Uncertainty	+/-3.90		+/-66.7						
Beta	1850	15.4		1900	pCi/L	4.46	102	(0%-20%)		
	Uncertainty	+/-2.91		+/-66.8						
Batch 1845973										
QC1204211569 469928004 DUP										
Strontium-90	U	-0.48	U	-0.0948	pCi/L	N/A		N/A	JXK3	02/11/19 13:07
	Uncertainty	+/-0.815		+/-1.01						
QC1204211570 LCS										
Strontium-90	77.1			87.7	pCi/L		114	(75%-125%)		02/11/19 13:07
	Uncertainty			+/-6.11						
QC1204211568 MB										
Strontium-90			U	0.412	pCi/L					02/11/19 13:07
	Uncertainty			+/-1.05						
Rad Ra-226										
Batch 1843819										
QC1204206746 469893010 DUP										
Radium-226	U	0.229		0.509	pCi/L	75.9		(0% - 100%)	PCW	02/08/19 08:05
	Uncertainty	+/-0.280		+/-0.334						
QC1204206748 LCS										
Radium-226	26.0			23.7	pCi/L		91.4	(75%-125%)		02/08/19 08:05
	Uncertainty			+/-1.90						
QC1204206745 MB										
Radium-226			U	0.339	pCi/L					02/08/19 08:05
	Uncertainty			+/-0.287						
QC1204206747 469893010 MS										
Radium-226	130 U	0.229		136	pCi/L		104	(75%-125%)		02/08/19 08:05
	Uncertainty	+/-0.280		+/-10.7						

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

The Qualifiers in this report are defined as follows:

- ** Analyte is a Tracer compound
- < Result is less than value reported
- > Result is greater than value reported

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 469928

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

BD	Results are either below the MDC or tracer recovery is low
FA	Failed analysis.
H	Analytical holding time was exceeded
J	Value is estimated
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
M	M if above MDC and less than LLD
M	REMP Result > MDC/CL and < RDL
N/A	RPD or %Recovery limits do not apply.
N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
UI	Gamma Spectroscopy--Uncertain identification
UJ	Gamma Spectroscopy--Uncertain identification
UL	Not considered detected. The associated number is the reported concentration, which may be inaccurate due to a low bias.
X	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Y	Other specific qualifiers were required to properly define the results. Consult case narrative.
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
h	Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Report Date: February 25, 2019

Microbac Laboratries, Inc.
3323 Gilmore Industrial Boulevard
Louisville, Kentucky
Contact: **Mr. David Lester**

Workorder: **469928**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gas Flow										
Batch 1844202										
QC1204207744 469671002 DUP										
Radium-228	U	1.92		4.67	pCi/L	83.5		(0% - 100%)	JXC9	02/14/19 09:12
	Uncertainty	+/-2.14		+/-2.63						
QC1204207745 LCS										
Radium-228	5.52			5.24	pCi/L		95.1	(75%-125%)		02/14/19 09:12
	Uncertainty			+/-0.612						
QC1204207743 MB										
Radium-228			U	0.0459	pCi/L					02/14/19 09:12
	Uncertainty			+/-0.305						
Batch 1845944										
QC1204211484 470317003 DUP										
Alpha		7.64		14.5	pCi/L	62.2		(0% - 100%)	LXB3	02/11/19 14:11
	Uncertainty	+/-3.90		+/-4.92						
Beta		15.4		20.6	pCi/L	28.6*		(0%-20%)		
	Uncertainty	+/-2.91		+/-3.06						
QC1204211487 LCS										
Alpha	80.5			97.4	pCi/L		121	(75%-125%)		02/11/19 14:05
	Uncertainty			+/-9.49						
Beta	309			296	pCi/L		95.9	(75%-125%)		
	Uncertainty			+/-11.4						
QC1204211483 MB										
Alpha			U	-0.948	pCi/L					02/11/19 14:05
	Uncertainty			+/-0.713						
Beta			U	1.18	pCi/L					
	Uncertainty			+/-1.21						
QC1204211485 470317003 MS										
Alpha	483	7.64		571	pCi/L		117	(75%-125%)		02/11/19 14:05
	Uncertainty	+/-3.90		+/-63.4						
Beta	1850	15.4		1810	pCi/L		97.2	(75%-125%)		
	Uncertainty	+/-2.91		+/-65.9						

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 469928

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Gas Flow										
Batch 1845944										
QC1204211486 470317003 MSD										
Alpha	483	7.64		594	pCi/L	4	121	(0%-20%)	LXB3	02/11/19 14:05
	Uncertainty	+/-3.90		+/-66.7						
Beta	1850	15.4		1900	pCi/L	4.46	102	(0%-20%)		
	Uncertainty	+/-2.91		+/-66.8						
Batch 1845973										
QC1204211569 469928004 DUP										
Strontium-90	U	-0.48	U	-0.0948	pCi/L	N/A		N/A	JXK3	02/11/19 13:07
	Uncertainty	+/-0.815		+/-1.01						
QC1204211570 LCS										
Strontium-90	77.1			87.7	pCi/L		114	(75%-125%)		02/11/19 13:07
	Uncertainty			+/-6.11						
QC1204211568 MB										
Strontium-90			U	0.412	pCi/L					02/11/19 13:07
	Uncertainty			+/-1.05						
Rad Ra-226										
Batch 1843819										
QC1204206746 469893010 DUP										
Radium-226	U	0.229		0.509	pCi/L	75.9		(0% - 100%)	PCW	02/08/19 08:05
	Uncertainty	+/-0.280		+/-0.334						
QC1204206748 LCS										
Radium-226	26.0			23.7	pCi/L		91.4	(75%-125%)		02/08/19 08:05
	Uncertainty			+/-1.90						
QC1204206745 MB										
Radium-226			U	0.339	pCi/L					02/08/19 08:05
	Uncertainty			+/-0.287						
QC1204206747 469893010 MS										
Radium-226	130 U	0.229		136	pCi/L		104	(75%-125%)		02/08/19 08:05
	Uncertainty	+/-0.280		+/-10.7						

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

The Qualifiers in this report are defined as follows:

- ** Analyte is a Tracer compound
- < Result is less than value reported
- > Result is greater than value reported

GEL LABORATORIES LLC
2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: **469928**

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time

BD	Results are either below the MDC or tracer recovery is low
FA	Failed analysis.
H	Analytical holding time was exceeded
J	Value is estimated
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
M	M if above MDC and less than LLD
M	REMP Result > MDC/CL and < RDL
N/A	RPD or %Recovery limits do not apply.
N1	See case narrative
ND	Analyte concentration is not detected above the detection limit
NJ	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Q	One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
R	Sample results are rejected
U	Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
UI	Gamma Spectroscopy--Uncertain identification
UJ	Gamma Spectroscopy--Uncertain identification
UL	Not considered detected. The associated number is the reported concentration, which may be inaccurate due to a low bias.
X	Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
Y	Other specific qualifiers were required to properly define the results. Consult case narrative.
^	RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
h	Preparation or preservation holding time was exceeded

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.
^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.
* Indicates that a Quality Control parameter was not within specifications.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

409928

MICROBAC®

KENTUCKY TESTING LABORATORY DIVISION
3323 Gilmore Industrial Boulevard Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville, IN 812.464.9000 | Lexington, KY 859.276.3506 | Paducah, KY 270.898.3637| Hazard 606.487.0511

INTERLABORATORY CHAIN OF CUSTODY

Please E-mail all results to:
KENTUCKY.INBOX@MICROBAC.COM

Ship To GEL LABORATORIES, LLC 2040 Savage Road Charleston, SC 29407 Phone :(843) 556-8171 Fax: (843) 766-1178

Samp #	Sample Description	Test	Matrix	Method	Units	Analyte	Requested RL	Samp Date	Due Date
L9A1314-01	001 - Site Auxiliary / Ash Pond							01/23/2019	01/30/2019
		Uranium	WATER	EPA 200.8	mg/L	Uranium	0.00100		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Alpha	WATER	SM 7110B	pCi/L	Gross Alpha	3.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Beta	WATER	SM 7110B	pCi/L	Gross Beta	4.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 226	WATER	SM 7500 RA-B	pCi/L	Radium 226	1.0		
		Designator: B	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 228	WATER	SM 7500 RA-D	pCi/L	Radium 228	1.0		
		Designator: C	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Strontium - 90	WATER	SM 7500-SR B (Mo	pCi/g	Strontium - 90			
		Designator: D	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
L9A1314-02	002 - Units 1-2 Cooling Towers Blowdown							01/23/2019	01/30/2019
		Uranium	WATER	EPA 200.8	mg/L	Uranium	0.00100		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Alpha	WATER	SM 7110B	pCi/L	Gross Alpha	3.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Beta	WATER	SM 7110B	pCi/L	Gross Beta	4.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 226	WATER	SM 7500 RA-B	pCi/L	Radium 226	1.0		
		Designator: B	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 228	WATER	SM 7500 RA-D	pCi/L	Radium 228	1.0		
		Designator: C	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Strontium - 90	WATER	SM 7500-SR B (Mo	pCi/g	Strontium - 90			
		Designator: D	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						

MICROBAC®
KENTUCKY TESTING LABORATORY DIVISION
3323 Gilmore Industrial Boulevard Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville, IN 812.464.9000 | Lexington, KY 859.276.3506 | Paducah, KY 270.898.3637| Hazard 606.487.0511

INTERLABORATORY CHAIN OF CUSTODY

Please E-mail all results to:
KENTUCKY.INBOX@MICROBAC.COM

Ship To GEL LABORATORIES, LLC 2040 Savage Road Charleston, SC 29407 Phone (843) 556-8171 Fax: (843) 766-1178

Samp #	Sample Description	Test	Matrix	Method	Units	Analyte	Requested RL	Samp Date	Due Date
L9A1314-03	003 - Unit 3 Cooling Tower Blowdown							01/23/2019	01/30/2019
		Uranium	WATER	EPA 200.8	mg/L	Uranium	0.00100		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Alpha	WATER	SM 7110B	pCi/L	Gross Alpha	3.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Beta	WATER	SM 7110B	pCi/L	Gross Beta	4.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 226	WATER	SM 7500 RA-B	pCi/L	Radium 226	1.0		
		Designator: B	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 228	WATER	SM 7500 RA-D	pCi/L	Radium 228	1.0		
		Designator: C	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Strontium - 90	WATER	SM 7500-SR B (Mo	pCi/g	Strontium - 90			
		Designator: D	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
L9A1314-04	005 - Plant Intake - Herrington Lake							01/23/2019	01/30/2019
		Uranium	WATER	EPA 200.8	mg/L	Uranium	0.00100		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Alpha	WATER	SM 7110B	pCi/L	Gross Alpha	3.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Gross Beta	WATER	SM 7110B	pCi/L	Gross Beta	4.0		
		Designator: A	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 226	WATER	SM 7500 RA-B	pCi/L	Radium 226	1.0		
		Designator: B	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Radium 228	WATER	SM 7500 RA-D	pCi/L	Radium 228	1.0		
		Designator: C	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						
		Strontium - 90	WATER	SM 7500-SR B (Mo	pCi/g	Strontium - 90			
		Designator: D	*Container: B-1 LITER PLASTIC - DW METALS-HNO3*						

MICROBAC®

KENTUCKY TESTING LABORATORY DIVISION

3323 Gilmore Industrial Boulevard Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville, IN 812.464.9000 | Lexington, KY 859.276.3506 | Paducah, KY 270.898.3637| Hazard 606.487.0511

INTERLABORATORY CHAIN OF CUSTODY

Please E-mail all results to:
KENTUCKY.INBOX@MICROBAC.COM

SENDING LAB

Courier UPS ___ Zip ___ FedEx ✓ Other___

Number of Bottles Sent: 16

Auto-log Sent: N/A

Sub COC Scanned into Element: ✓ Custody Assigned: ✓

Special Instructions: ______

Relinquished By: [signature] Date: 1/24/19

RECEIVING LAB

Received By: [signature] Date: 1/28/19 8:55

Cooler Temperature Upon Receipt: ___°C

GEL Laboratories

HT

SAMPLE RECEIPT & REVIEW FORM

Client: MBAC	SDG/AR/COC/Work Order: 469928
Received By: AJA	Date Received: 1/28/19
Carrier and Tracking Number	Circle Applicable: FedEx Express (FedEx Ground circled) UPS Field Services Courier Other 7743 0461 2222 7743 0457 8223

Suspected Hazard Information	Yes	No	*If Net Counts > 100cpm on samples not marked "radioactive", contact the Radiation Safety Group for further investigation.
A) Shipped as a DOT Hazardous?		✓	Hazard Class Shipped: UN#: If UN2910, Is the Radioactive Shipment Survey Compliant? Yes___ No___
B) Did the client designate the samples are to be received as radioactive?		✓	COC notation or radioactive stickers on containers equal client designation.
C) Did the RSO classify the samples as radioactive?		✓	Maximum Net Counts Observed* (Observed Counts - Area Background Counts): 0 CPM / mR/Hr Classified as: Rad 1 Rad 2 Rad 3
D) Did the client designate samples are hazardous?		✓	COC notation or hazard labels on containers equal client designation.
E) Did the RSO identify possible hazards?		✓	If D or E is yes, select Hazards below. PCB's Flammable Foreign Soil RCRA Asbestos Beryllium Other:

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
2	Chain of custody documents included with shipment?	✓			Circle Applicable: Client contacted and provided COC COC created upon receipt
3	Samples requiring cold preservation within (0 ≤ 6 deg. C)?*		✓		Preservation Method: Wet Ice Ice Packs Dry ice (None circled) Other: *all temperatures are recorded in Celsius TEMP: 18°
4	Daily check performed and passed on IR temperature gun?	✓			Temperature Device Serial #: IR2-18 Secondary Temperature Device Serial # (If Applicable):
5	Sample containers intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
6	Samples requiring chemical preservation at proper pH?	✓			Sample ID's and Containers Affected: If Preservation added, Lot#:
7	Do any samples require Volatile Analysis?			✓	If Yes, are Encores or Soil Kits present for solids? Yes___ No___ NA___(If yes, take to VOA Freezer) Do liquid VOA vials contain acid preservation? Yes___ No___ NA___(If unknown, select No) Are liquid VOA vials free of headspace? Yes___ No___ NA___ Sample ID's and containers affected:
8	Samples received within holding time?	✓			ID's and tests affected:
9	Sample ID's on COC match ID's on bottles?	✓			ID's and containers affected:
10	Date & time on COC match date & time on bottles?			✓	Circle Applicable: No dates on containers No times on containers (COC missing info circled) Other (describe) -01 14:15, -02 12:30, -03 13:25, -04 11:30
11	Number of containers received match number indicated on COC?	✓			Circle Applicable: No container count on COC Other (describe)
12	Are sample containers identifiable as GEL provided?			✓	
13	COC form is properly signed in relinquished/received sections?	✓			Circle Applicable: Not relinquished Other (describe)

Comments (Use Continuation Form if needed):

PM (or PMA) review: Initials KG Date 1/29/19 Page 1 of 1

GL-CHL-SR-001 Rev 6

List of current GEL Certifications as of 25 February 2019

State	Certification
Alaska	17−018
Arkansas	88−0651
CLIA	42D0904046
California	2940
Colorado	SC00012
Connecticut	PH−0169
DoD ELAP/ ISO17025 A2LA	2567.01
Florida NELAP	E87156
Foreign Soils Permit	P330−15−00283, P330−15−00253
Georgia	SC00012
Georgia SDWA	967
Hawaii	SC00012
Idaho	SC00012
Illinois NELAP	200029
Indiana	C−SC−01
Kansas NELAP	E−10332
Kentucky SDWA	90129
Kentucky Wastewater	90129
Louisiana NELAP	03046 (AI33904)
Louisiana SDWA	LA024
Maryland	270
Massachusetts	M−SC012
Michigan	9976
Mississippi	SC00012
Nebraska	NE−OS−26−13
Nevada	SC000122019−1
New Hampshire NELAP	2054
New Jersey NELAP	SC002
New Mexico	SC00012
New York NELAP	11501
North Carolina	233
North Carolina SDWA	45709
North Dakota	R−158
Oklahoma	9904
Pennsylvania NELAP	68−00485
Puerto Rico	SC00012
S. Carolina Radiochem	10120002
South Carolina Chemistry	10120001
Tennessee	TN 02934
Texas NELAP	T104704235−19−14
Utah NELAP	SC000122018−27
Vermont	VT87156
Virginia NELAP	460202
Washington	C780

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9D1108

LG&E - KU ENERGY LLC.

Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

Project Name: EW Brown - Form C - KPDES Renewal
Project / PO Number: N/A
Received: 04/18/2019
Reported: 04/30/2019

Analytical Testing Parameters

Client Sample ID: 001 - Site Auxiliary / Ash Pond
Sample Matrix: WATER
Lab Sample ID: L9D1108-01
Collected By: JAROD ROOP
Collection Date: 04/18/2019 11:35

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW846 8260B							
Dichlorodifluoromethane	<0.0050	0.0050	mg/L			04/24/19 1951	LJC
Surrogate: SR / BFB	99.1	Limit: 86-115	% Rec			04/24/19 1951	LJC
Surrogate: SR / DBFM	104	Limit: 86-118	% Rec			04/24/19 1951	LJC
Surrogate: SR / DCA	107	Limit: 80-120	% Rec			04/24/19 1951	LJC
Surrogate: SR / Tol-D8	101	Limit: 88-110	% Rec			04/24/19 1951	LJC

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW-846 8270C							
Bis(chloromethyl)ether	<0.052	0.052	mg/L		04/22/19 1043	04/25/19 2229	CLR
Surrogate: 2,4,6-Tribromophenol	79.9	Limit: 47.8-138	% Rec		04/22/19 1043	04/25/19 2229	CLR
Surrogate: 2-Fluorobiphenyl	63.0	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2229	CLR
Surrogate: 2-Fluorophenol	36.9	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2229	CLR
Surrogate: Nitrobenzene-d5	64.3	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2229	CLR
Surrogate: Phenol-d5	29.0	Limit: 10-60.8	% Rec		04/22/19 1043	04/25/19 2229	CLR
Surrogate: Terphenyl-d14	66.1	Limit: 16.8-110	% Rec		04/22/19 1043	04/25/19 2229	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9D1108

Client Sample ID:	002 - Units 1-2 Cooling Towers Blowdown		
Sample Matrix:	WATER	**Collected By:**	JAROD ROOP
Lab Sample ID:	L9D1108-02	**Collection Date:**	04/18/2019 11:16

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW846 8260B							
Dichlorodifluoromethane	<0.0050	0.0050	mg/L			04/24/19 2017	LJC
Surrogate: SR / BFB	96.5	Limit: 86-115	% Rec			04/24/19 2017	LJC
Surrogate: SR / DBFM	105	Limit: 86-118	% Rec			04/24/19 2017	LJC
Surrogate: SR / DCA	114	Limit: 80-120	% Rec			04/24/19 2017	LJC
Surrogate: SR / Tol-D8	103	Limit: 88-110	% Rec			04/24/19 2017	LJC

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW-846 8270C							
Bis(chloromethyl)ether	<0.052	0.052	mg/L		04/22/19 1043	04/25/19 2251	CLR
Surrogate: 2,4,6-Tribromophenol	80.0	Limit: 47.8-138	% Rec		04/22/19 1043	04/25/19 2251	CLR
Surrogate: 2-Fluorobiphenyl	59.4	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2251	CLR
Surrogate: 2-Fluorophenol	31.9	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2251	CLR
Surrogate: Nitrobenzene-d5	60.1	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2251	CLR
Surrogate: Phenol-d5	25.0	Limit: 10-60.8	% Rec		04/22/19 1043	04/25/19 2251	CLR
Surrogate: Terphenyl-d14	73.9	Limit: 16.8-110	% Rec		04/22/19 1043	04/25/19 2251	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9D1108

Client Sample ID:	003 - Unit 3 Cooling Tower Blowdown		
Sample Matrix:	WATER	**Collected By:**	JAROD ROOP
Lab Sample ID:	L9D1108-03	**Collection Date:**	04/18/2019 11:23

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW846 8260B							
Dichlorodifluoromethane	<0.0050	0.0050	mg/L			04/24/19 2044	LJC
Surrogate: SR / BFB	97.0	Limit: 86-115	% Rec			04/24/19 2044	LJC
Surrogate: SR / DBFM	102	Limit: 86-118	% Rec			04/24/19 2044	LJC
Surrogate: SR / DCA	112	Limit: 80-120	% Rec			04/24/19 2044	LJC
Surrogate: SR / Tol-D8	101	Limit: 88-110	% Rec			04/24/19 2044	LJC

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW-846 8270C							
Bis(chloromethyl)ether	<0.051	0.051	mg/L		04/22/19 1043	04/25/19 2313	CLR
Surrogate: 2,4,6-Tribromophenol	74.9	Limit: 47.8-138	% Rec		04/22/19 1043	04/25/19 2313	CLR
Surrogate: 2-Fluorobiphenyl	57.7	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2313	CLR
Surrogate: 2-Fluorophenol	28.5	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2313	CLR
Surrogate: Nitrobenzene-d5	56.4	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2313	CLR
Surrogate: Phenol-d5	23.1	Limit: 10-60.8	% Rec		04/22/19 1043	04/25/19 2313	CLR
Surrogate: Terphenyl-d14	72.9	Limit: 16.8-110	% Rec		04/22/19 1043	04/25/19 2313	CLR

MICROBAC®

Microbac Laboratories, Inc., Louisville

CERTIFICATE OF ANALYSIS

L9D1108

Client Sample ID:	005 - Plant Intake - Herrington Lake		
Sample Matrix:	WATER	**Collected By:**	JAROD ROOP
Lab Sample ID:	L9D1108-04	**Collection Date:**	04/18/2019 11:05

Volatile Organics	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW846 8260B							
Dichlorodifluoromethane	<0.0050	0.0050	mg/L			04/24/19 2110	LJC
Surrogate: SR / BFB	96.2	Limit: 86-115	% Rec			04/24/19 2110	LJC
Surrogate: SR / DBFM	105	Limit: 86-118	% Rec			04/24/19 2110	LJC
Surrogate: SR / DCA	116	Limit: 80-120	% Rec			04/24/19 2110	LJC
Surrogate: SR / Tol-D8	102	Limit: 88-110	% Rec			04/24/19 2110	LJC

Analyses Subcontracted to: Microbac Laboratories, Inc. - Chicagoland

GCMS Semivolatiles	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: SW-846 8270C							
Bis(chloromethyl)ether	<0.052	0.052	mg/L		04/22/19 1043	04/25/19 2335	CLR
Surrogate: 2,4,6-Tribromophenol	76.1	Limit: 47.8-138	% Rec		04/22/19 1043	04/25/19 2335	CLR
Surrogate: 2-Fluorobiphenyl	61.4	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2335	CLR
Surrogate: 2-Fluorophenol	31.4	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2335	CLR
Surrogate: Nitrobenzene-d5	59.6	Limit: 10-110	% Rec		04/22/19 1043	04/25/19 2335	CLR
Surrogate: Phenol-d5	25.3	Limit: 10-60.8	% Rec		04/22/19 1043	04/25/19 2335	CLR
Surrogate: Terphenyl-d14	69.0	Limit: 16.8-110	% Rec		04/22/19 1043	04/25/19 2335	CLR

Definitions

RL: Reporting Limit

Project Requested Certification(s)

Microbac Laboratories, Inc. - Chicagoland

75	Kentucky EPPC analysis Underground Storage Tanks (k)
90147	Kentucky Wastewater Laboratory Certification Program (j)

Report Comments

Samples were received in proper condition and the reported results conform to applicable accreditation standard unless otherwise noted.

The data and information on this, and other accompanying documents, represents only the sample(s) analyzed. This report is incomplete unless all pages indicated in the footnote are present and an authorized signature is included.

Reviewed and Approved By:

Lisa Martin

LISA MARTIN
Customer Relationship Specialist
Reported: 04/30/2019 08:35

McCoy & McCoy
Kentucky Testing Divison
3323 Gilmore Industrial Blvd. Louisville, KY 40213 502.962.6400 Fax: 502.962.6411
Evansville 812.464.9000 Lexington 859.276.3506 Paducah 270.898.3637 Hazard 606.487.0511

L9D1108 LISA MARTIN
Imber

CHAIN OF CUSTODY

Route Freq.

LG&E - KU ENERGY LLC.
Roger Medina
220 West Main St., P.O. Box 32010
Louisville, KY 40232

EW Brown - Form C - KPDES Renewal

Cust. # EL056
Phone (502) 627-2997
Fax (502) 627-2550
Email roger.medina@lge-ku.com
Acct. Mgr. JOAN HEINSOHN

Project EW Brown - Form C Renewal REDO Short
Cust. P.O.
Permit #

Analysis	Method	Containers/Preservative	Suppress On COA	# Bottles	Units	Min	Max
Instructions							
01 001 - Site Auxiliary / Ash Pond — Type Grab				3 5 (JHQ)	Sample Date/Time/Field Results/Meter ID: 4 18 19 1135		
Semi-Volatile Organics Additional	SW846 8270C	A-1 LITER AMBER-4°C		2	mg/L		
Volatile Organic Compounds - 82(	SW846 8260B	O-40 ML VOA VIALS-HCL		3	mg/L		
02 002 - Units 1-2 Cooling Towers Blowdown — Type Grab				5	Sample Date/Time/Field Results/Meter ID: 4 18 19 11 16		
Semi-Volatile Organics Additional	SW846 8270C	A-1 LITER AMBER-4°C		2	mg/L		
Volatile Organic Compounds - 82(	SW846 8260B	O-40 ML VOA VIALS-HCL		3	mg/L		
03 003 - Unit 3 Cooling Tower Blowdown — Type Grab				5	Sample Date/Time/Field Results/Meter ID: 4 18 19 11 23		
Semi-Volatile Organics Additional	SW846 8270C	A-1 LITER AMBER-4°C		2	mg/L		
Volatile Organic Compounds - 82(	SW846 8260B	O-40 ML VOA VIALS-HCL		3	mg/L		
04 005 - Plant Intake - Herrington Lake — Type Grab				5	Sample Date/Time/Field Results/Meter ID: 4 18 19 1105		
Semi-Volatile Organics Additional	SW846 8270C	A-1 LITER AMBER-4°C		2	mg/L		
Volatile Organic Compounds - 82(	SW846 8260B	O-40 ML VOA VIALS-HCL		3	mg/L		

SETUP:_____ **Deg C Sunny/Cloudy/Ptly Cloudy/Rain** **REC:**_____ **Deg C Sunny/Cloudy/Ptly Cloudy/Rain** **Rain During Event: YES / NO**

NOTES:

Sampled By: [signature]

Relinq. Date/Time/Sign: [signature] 4-18-19 1428	Rec'd Date/Time/Sign: Crystal Williams 4/18/19 1428
Relinq. Date/Time/Sign:	Rec'd Date/Time/Sign:
Relinq. Date/Time/Sign:	Rec'd Date/Time/Sign:
Relinq. Date/Time/Sign:	Rec'd Date/Time/Sign:

SAMPLE RECEIPT DOCUMENTATION **Cooler/Sample Temp (Deg C): LEX** 2.4 **EVV**___ **PAD**___ **LOU**___ **HAZ**___

COC & proper paperwork provided & complete / COC, samples, & bottles are in agreement: (YES) / NO
Appropriate bottles provided intact with sufficient volume / Samples are within hold time / Samples properly preserved : (YES) / NO
Chain of Custody seal intact? NA **Samples on Ice?** Yes **Number of bottles** 20 **? Thermometer ID** 43

Notes, Correspondence, Subcontracting, & Non-Conformance Documentation (All Non-Conformances must be documented & client notified) **:**

ATTACHMENT 7

DMR QUARTERLY METALS ANALYSES

TWO-YEAR SUMMARY TABLE

Kentucky Utilities Company - Brown Station

KPDES DMR -Discharge Monitoring Reports - Quarterly Metals Analyses

Data Summary for 2016-2019, Rev May 11, 2019

Quarterly & Average Values [ppb]

BR-001 Auxiliary Ash Pond Discharge

Quarterly Values [ppb]

Year	Qtr	Date	Sb Antimony	As Arsenic	Be Beryllium	Cd Cadmium	Cr Chromium	Cu Copper	Pb Lead	Hg Mercury	Ni Nickel	Se Selenium	Ag Silver	Tl Thallium	Zn Zinc
2016	Q1	01/04/16	< 50	< 100	< 10	< 5.0	< 10	< 20	< 10	< 0.2	78.0	53.0	< 10	< 50	3.2
	Q2	04/01/16	< 25	< 50	< 5	< 2.5	< 5.0	< 20	< 5.0	< 0.2	31.0	32.0	< 5.0	< 25	11.0
	Q3	07/06/16	< 25	< 50	< 5	< 5.0	< 5.0	< 20	< 5.0	< 0.2	23.0	30.0	< 5.0	< 25	18.0
	Q4	10/03/16	< 25	< 50	< 5	< 5.0	< 5.0	< 20	< 5.0	< 0.2	32.0	< 25	< 5.0	< 25	13.0
2017	Q1	02/15/17	3.20	13.50	< 0.85	< 0.75	< 3.5	9.6	< 1.8	< 0.045	19.5	47.2	1.0	1.70	7.0
	Q2	04/03/17	1.30	8.90	< 0.34	0.69	< 1.4	5.3	< 0.7	< 0.007	30.0	16.5	< 0.35	3.50	9.6
	Q3	07/03/17	1.90	7.20	< 0.51	0.20	< 2.1	3.8	1.50	< 0.013	0.6	19.7	< 0.53	0.80	< 4.1
	Q4	10/02/17	< 2.0	4.0	< 2.0	<0.4	< 2.0	4.0	< 2.0	< 0.0125	11.0	6.0	< 3.0	< 0.4	< 4.0
2018	Q1	01/04/18	5.3	13.1	< 0.6	2.0	2.7	3.9	< 3	10	18.8	10.7	108	0.7	10.2
	Q2	06/05/18	4.8	9.9	0.8	1.8	2.9	7.9	< 2.5	*not sampl'd*	29.3	55.9	< 3.0	1.3	< 5.0
	Q3	07/09/2018 1	5.1	7.9	< 0.5	1.9	3.2	7.0	< 2.5	< 0.0063	25.5	39.5	< 2.5	2.1	9.4
	Q4	10/02/18	< 3	3.3	< 0.5	< 0.5	< 0.5	< 5	< 3	< 0.0125	26.1	5.7	< 2.5	0.61	18.1
2019	Q1	01/02/19	< 2.5	5.6	< 0.8	< 0.5	< 0.5	3.8	< 2.5	11	13.2	0.6	< 2.5	< 0.5	15.2

BR-005 Plant Intake

Quarterly Values [ppb]

Year	Qtr	Date	Sb Antimony	As Arsenic	Be Beryllium	Cd Cadmium	Cr Chromium	Cu Copper	Pb Lead	Hg Mercury	Ni Nickel	Se Selenium	Ag Silver	Tl Thallium	Zn Zinc
2016	Q1	01/06/16	< 50	< 100	< 10	< 5.0	< 10	< 20	< 10	< 0.2	< 10	< 50	< 10	< 50	< 10
	Q2	04/04/16	< 25	< 50	< 5	< 2.5	< 5	< 10	< 5	< 0.2	< 5	< 25	< 5	< 25	< 5
	Q3	07/05/16	< 25	< 50	< 5	< 5	< 5	< 10	< 5	< 0.2	< 5	< 25	< 5	< 25	0.0
	Q4	10/03/16	< 25	< 50	< 5	< 5	< 5	< 10	< 5	< 0.2	< 5	< 25	< 5	< 25	< 5
2017	Q1	01/04/16	< 0.78	< 2.38	< 0.85	< 0.74	< 3.53	< 3.58	< 1.79	< 0.025	< 1.27	< 2.57	< 0.88	0.70	6.8
	Q2	04/01/16	< 0.31	< 0.95	< 0.34	< 0.3	< 1.4	< 1.45	< 0.7	< 0.008	< 0.5	< 1.05	< 0.35	< 0.26	12.9
	Q3	07/06/16	< 0.47	1.50	< 0.51	< 0.45	< 2.1	< 2.1	0.96	< 0.13	0.6	< 1.5	< 0.53	< 0.38	2.1
	Q4	10/03/16	< 2.0	< 2.0	< 2.0	< 0.4	< 2.0	< 2.0	< 2.0	< 0.0125	< 2.0	< 2.0	3.00	< 0.4	< 4.0
2018	Q1	01/04/18	< 3.0	< 2.5	< 0.6	< 0.6	< 0.6	< 3.0	< 3.0	10	< 3.0	< 2.5	74.2	< 0.6	< 6.0
	Q2	04/02/18	< 3.0	< 3.0	< 0.6	< 0.5	< 0.5	< 3.0	< 3.0	<0.015	< 3.0	< 3.0	< 3.0	< 0.3	< 6.0
	Q3	2018 13:27:00	< 2.5	< 50	< 0.5	< 0.5	< 5	< 2.5	< 2.5	< 0.0063	< 5	< 5	< 2.5	< 0.5	< 5.0
	Q4	10/02/18	< 2.5	1.2	< 0.5	< 0.5	< 0.5	6.3	< 2.5	< 0.0125	< 2.5	< 5.0	< 2.5	< 0.5	10.6
2019	Q1	01/02/19	< 4	1.1	< 0.8	< 0.8	< 0.8	< 4.0	< 4.0	< 0.005	< 4	< 4	< 4	< 0.8	< 8

ATTACHMENT 8

STORMWATER RUNOFF CALCULATIONS

Stormwater Runoff Calculations
Kentucky Utilities - E.W. Brown Generating Station

April 29, 2019

Data

Area	# Acres	
Coefficient for Rainfall Runoff	Cr	
10-Year, 24-Hour Rainfall	**4.3**	inch/24 hours
Annual Average Rainfall	**44.49**	inch/year

Runoff Equations:

1-Day Maximum Flow:
(#Acres)(43560 ft2)/Acre)(Cr)(4.3 in/day)(1 ft/12 inch)
(7.481 gal/ft3)(1 MG/1000000 Gal)
= 0.1167709 (#Acres)(Cr) MGD

1-Day Flow: **0.116770929** MGD [million gal/day]

Daily Annual Average Flow:
(#Acres)(43560 ft2)/Acre)(Cr)(44.49 in/year)(1 ft/12 inch)
(7.481 gal/ft3)(1 year/365 days)(1 MG/1000000 Gal)
= 0.0033101 (#Acres)(Cr) MGD

30-Day Flow: **0.00331006** MGD [million gal/day]

Runoff Coefficients:	Cr
Vegetated Areas (without slope considerations)	0.25
Gypsum & Loose Gravel (substations, rail beds, dam face, rock-faced slopes, etc.)	0.25
Packed Surfaces (Coal, Bare Soil, Packed Gravel [Roads, Parking Areas, etc.])	0.5
Impervious Surfaces (Pavement, Roofs, Cooling Tower Direct Precip)	0.85
Basin Surfaces	1

	KPDES OUTFALLS DESCRIPTION	***Outfall Location***
001	Landfill Stormwater Ponds, Auxiliary Ash Pond, & Misc. Other Flows **Temporary/Transition to Include Process Ponds until January 1, 2020** (or Proc.Flows Emergency/Bypass if Outfall 006 Requires Maintenance) **FUTURE: includes Closed/Capped Auxiliary Pond Storm Runoff Flows**	Weir-Monitoring Structure at End of Lined Channel to Herrington Lake/Curds Inlet (southside)
002	Units 1-2 Cooling Tower Blowdown (Retired) & Misc. Storm Drains	Weir-Monitoring Point at Beginning of Channel to Herrington Lake/Curds Inlet (Northside)
003	Unit 3 Cooling Tower Blowdown & Misc. Storm Drains	same
004	Boiler Chemical Metal Cleaning Wastewaters	(Frac Tanks adjacent Unit 3)
005	Intake from Herrington Lake	Deep/Submerged Lake Intake
006	Process Pond(s) to 006 - ***Planned to Start July 1, 2019***	Flow Sample/Monitoring Structure In-Line from Pond Decant Structures to Diffuser
007	Treated FGD Wastewaters - Internal Outfall *(**monitored after Dec 31, 2023**)*	PWS Building Effluent Tank (adj Gypsum Dewatering)
008	Railway Stormwater & Landfill Wick Drain HighFlows *(**not sumped to Proc.Pond**)*	Weir-Monitoring Point at Beginning of Channel to Herrington Lake/Curds Inlet (Northside)

KU-BROWN STATION - Stormwater Runoff Areas Listing

(Organized by Outfalls/Areas to Herrington Lake or Dix River/Cedar Creek Tributaries to Kentucky River)

April 29, 2019

PLANT KPDES OUTFALLS TO HERRINGTON LAKE

1 **Outfall 001 - Landfill Stormwater Ponds, Misc. Flows and Auxiliary Pond Pre-Closure Transition Flows to Herrington Lake**
- 1.a Landfill North Stormwater Pond (1) Impoundment & Internal Slopes
- 1.b Landfill South Stormwater Pond (2) Impoundment & Internal Slopes
- 1.c Landfill Phase I (Cells 1-2) Perimeter Drainage Channel & Roadways
- 1.d Landfill Phase III Area including Cap/Cover Drainage Slopes to Landfill South Stormwater Pond
- 1.e CCRT Area (East, Non-CCR/Contact) Drains to North Storm Pond (1)
- 1.f Inter-Landfill-Auxiliary Pond Area (Headwater Areas Drainage to Lined Channel to Outfall 001)
- 1.g Inter-Landfill/Dam-to-Aux.Pond Berm-to-Process Ponds Areas (Landfill Dam Southern Face, Aux.Pond North Ext.Slopes, Process Pond West.Uphill
- 1.h Auxiliary Pond Closed/Capped/Vegetated Internal Slopes & Drainage Channel Areas to Outfall 001

2 **Outfall 002 - Units 1-2 (Retired) Cooling Tower Blowdown/Basins Direct Precipitation and Building Roof Drainage**
- 2.a Units 1-2 Boiler-Turbine and Office Buildings Roof Areas Stormwater Runoff

3 **Outfall 003 - Unit 3 Cooling Tower Blowdown/Basins Direct Precipitation and Building Roofs Drainage**
- 3.a Unit 3 Cooling Tower Basin(West)/Structural Areas Stormwater Runoff
- 3.b Unit 3 Cooling Tower Basin(East)/Structural Areas Stormwater Runoff
- 3.c Unit 3 Boiler-Turbine Building Roof Areas Stormwater Runoff

4-5 **Outfalls 004 and 005 *(Reserved)***

6 **Outfall 006 - Plant Process Ponds Treated Wastewater and Stormwater Flows to Herrington Lake**
- 6.a North Process Pond (1) - North Impoundment, Slopes & Roadways
- 6.b South Process Pond (2) - South Impoundment, Slopes & Roadways
- 6.c Combustion Turbines Facility Bermed Areas to Process/Auxiliary Pond through Oil/Water Separators OS-1, OS-2, OS-3
- 6.d Coal Storage-Handling and U1 RETIRED Cooling Tower Areas to Coal Settling Basin to TDCPRS/Landfill Leachate Pond to Process Pond(s)
- 6.e Limestone Storage Pile and Sump to Process Pond(s)
- 6.f U1-2 Oil/Water Separator - U1-2 Unit Areas, Chimneys, Transformers, Fuel Oil 15K Tank Berm, U2 RETIRED Cooling Tower and Parking Areas
- 6.g U3 Oil/Water Separator - U3 Unit Areas, FGD-Abs/Drain Tank, Fuel Oil 500K Tank Berm and Chimneys Areas
- 6.h Landfill Leachate Pond
- 6.i Landill Phase I Cells 1-2 (Under-Drainage/Runoff to Leachate Pond)
- 6.j CCRT Area (West, BA/Gypsum CCR-Contact) Drains to Landfill Leachate Pond
- 6.k Landfill Dam Toe Drain Sump/Area to TDCPRS/Landfill Leachate Pond to Process Pond(s)

7 **Outfall 007 *(Reserved)***

8 **Outfall 008 - Railway Stormwater & Landfill Wick Drain Sump High Flows (Base *Fraction Pumped to Proc.Pond*) to Herrington Lake**
- 8.a Landfill Embankment-North Slope (toward Railcar Sidings)
- 8.b Railcar Siding Gravel Areas (Between Fuel Unloading until U3 ESP railroad crossing & down to Bottom Ash PipeRack)
- 8.c Entrance Road Pavement (Fuel Unloading to Unit 3 ESP)
- 8.d CT Ice Plant (Thermal Storage Equipment-Bldg/Gravel)
- 8.e Natural Gas Pressure Regulation Station
- 8.f Limestone Unloading Area (Outside/Adjacent Pile)
- 8.g Limestone Handling-Slurry Prep.Bldgs, FDG/Abs-Drain Tank, to 500K Tank Area
- 8.h Field/Grass Areas

9 **Outfall 009 *(Reserved)***

HERRINGTON LAKE: NON-POINT UNCONTAMINATED RUNOFF AREAS

10 **Steam Plant-Coalyard South/Downhill Areas Sloped To Lake Herrington (i.e., Below Railroad Tracks)**
11 **Landfill-Damface North-to-South Slopes (Ditch Drains To Lake Herrington/Curds Inlet)**
12 **Auxiliary Pond External Berm & Downhill Fields Draining to Stream to Quarry/Stormwater Pond to Herrington Lake/Curds Inlet**
13 **Fields Below Auxiliary Pond/Stream to Quarry and Hardin Heights Road (from Curds Inlet to Subdivision Entrance)**
14 **Solar Farm to Hardin Heights Boat Ramp Inlet to Railroad Tracks**
15 **Southern Property (*prev. Dempsey Property*)**

DIX RIVER AND DAM SPILLWAY: NON-POINT UNCONTAMINATED RUNOFF AREAS

16 **Dix HydroElectric Areas (Including Spillway and Across/East Areas) Draining to Dix River**
17 **Westcliff Substation & Dix Dispatch Building/Complex Areas**
18 **Areas North of Steam Plant from Combustion Turbine Site Extending to Dam Spillway Including Brown North Substation**

CEDAR CREEK DRAINAGE AREAS TO KENTUCKY RIVER

19 **Combustion Turbines Facility - Uncontaminated Runoff Areas (Not Bermed/Pumped to Process Pond)**
20 **Plant Entrance Gate, Roadway & Railway Areas (From Entrance to Fuel Truck Unloading Area)**
21 **Gypsum Building (Retired/InActive) Near Entrance Gate**
22 **Areas Adjacent Retired Gypsum Building (to Webb Road Plant Entrance)**
23 **Landfill-West Embankment Along Curdsville Road Area to Retired Gypsum Bldg/Webb Road Entrance (Drains Northward)**
24 **Area Between Road/Railway Across Curdsville Road to Roadway Overpass Bridge (Drains Northward)**
25 **Middle/West Property Areas Across/West of Railway**
26 **Northwest Cedar Branch Property - West Across/Along Railway**
27 **North Property Area - East Along Railway (*prev. Haup Property*)**

HERRINGTON LAKE (*Water Area Portion included in Survey*)

E.W. Brown Station - Stormwater Runoff Calculations

PLANT KPDES OUTFALLS TO HERRINGTON LAKE

Outfall 001 — Outfall 001 - Landfill Stormwater Ponds, Misc. Flows and Auxiliary Pond Pre-Closure Transition Flows to Herrington Lake

1.a Landfill North Stormwater Pond (1) Impoundment & Internal Slopes

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	North Landfill Stormwater Pond	Basin Surface	1.000	3.18	0.3716	0.0105
2	Perimeter Roadway (East)	Packed Surface	0.500	0.26	0.0153	0.0004
			Total Area 1.a	**3.45**	**0.3870**	**0.0110**

1.b Landfill South Stormwater Pond (1) Impoundment, Slopes and Adjacent Roadways (not including Landfill)

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	South Landfill Stormwater Pond	Basin Surface	1.000	5.35	0.6248	0.0177
2	Perimeter Roadway (South-East)	Packed Surface	0.500	0.70	0.0411	0.0012
			Total Area 1.b	**6.05**	**0.6658**	**0.0189**

1.c Landfill Phase I (Cells 1-2) Perimeter Drainage Channel & Roadways

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Cell 1 (South) Perimeter Roadway & Drainage Channel (*includes middle roadway*)	Packed Surface	0.500	10.96	0.6401	0.0181
2	Cell 2 (North) Perimeter Roadway & Drainage Channel (*& Road Adj Phase III*)	Packed Surface	0.500	5.71	0.3331	0.0094
			Total Area 1.c	**16.67**	**0.9732**	**0.0276**

1.d Landfill Phase III Vegetated Slopes, Perimeter Drainage Channel & Roadways

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Vegetated Slopes	Vegetated Area	0.250	29.97	0.8750	0.0248
2	Perimeter Roadway & Drainage Channel	Packed Surface	0.500	3.55	0.2073	0.0059
			Total Area 1.d	**33.53**	**1.0824**	**0.0307**

1.e CCRT Area (East, Non-CCR/Contact) Drains to North Storm Pond (1)

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	East-side Pavement and CCRT Building Roof Drains	Impervious Surface	0.850	2.36	0.2345	0.0066
			Total Area 1.e	**2.36**	**0.2345**	**0.0066**

1.f Inter-Landfill-Auxiliary Pond Area (Headwater Areas Drainage to Lined Channel to Outfall 001)

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Graded Drainage Area and Access Road (NorthWest) adjacent Landfill	Packed Surface	0.500	7.39	0.4313	0.0122
			Total Area 1.f	**7.39**	**0.4313**	**0.0122**

1.g Inter-Landfill/Dam-to-Aux.Pond Berm-to-Process Ponds Areas (Landfill Dam Southern Face, Aux.Pond North Ext.Slopes,

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Slopes Areas Adjacent/Below Landfill Dam & Aux Pond Berm to Channel to 001	Packed Surface	0.500	2.53	0.1477	0.0042
			Total Area 1.g	**2.53**	**0.1477**	**0.0042**

1.h Auxiliary Pond Closed/Capped/Vegetated Internal Slopes & Drainage Channel Areas to Outfall 001

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Capped North Half Vegetated Slopes	Vegetated Area	0.250	18.06	0.5273	0.0149
2	Capped North Half Perimeter Roadway & Drainage Channel	Packed Surface	0.500	5.40	0.3154	0.0089
3	Capped South Half Vegetated Slopes	Vegetated Area	0.250	9.73	0.2841	0.0081
4	Capped South Half Perimeter Roadway & Drainage Channel	Packed Surface	0.500	5.66	0.3306	0.0094
			Total Area 1.h	**38.86**	**1.4575**	**0.0413**

AREA TOTAL	**1**	**110.83**	**1.9607**	**1.9607**

Outfall 002 — Outfall 002 - Units 1-2 (Retired) Cooling Tower Blowdown/Basins Direct Precipitation and Building Roof Drainage

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
2.a	Units 1-2 Boiler-Turbine and Office Buildings Roof Areas Stormwater Runoff	Impervious Surface	0.850	1.37	0.1358	0.0038
		AREA TOTAL	**2**	**1.37**	**0.1358**	**0.0038**

Outfall 003 — Outfall 003 - Unit 3 Cooling Tower Blowdown/Basins Direct Precipitation and Building Roofs Drainage

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
3.a	Unit 3 Cooling Tower Basin(West)/Structural Areas Stormwater Runoff	Impervious Surface	0.850	0.35	0.0350	0.0010
3.b	Unit 3 Cooling Tower Basin(East)/Structural Areas Stormwater Runoff	Impervious Surface	0.850	0.31	0.0307	0.0009
3.c	Unit 3 Boiler-Turbine Building Roof Areas Stormwater Runoff	Impervious Surface	0.850	2.38	0.2361	0.0067
		AREA TOTAL	**3**	**3.04**	**0.3018**	**0.0086**

Outfalls 004-5 — Outfalls 004 and 005 (Reserved)

Outfall 006

Outfall 006 - Plant Process Ponds Treated Wastewater and Stormwater Flows to Herrington Lake

6.a North Process Pond (1) - North Impoundment, Slopes & Roadways

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	North Process Pond Basin Surface	Basin Surface	1.000	0.78	0.0915	0.0026
2	Perimeter Roadway and Inner Slopes	Packed Surface	0.500	0.87	0.0507	0.0014
			Total Area 6.a	**1.65**	**0.1422**	**0.0040**

6.b South Process Pond (2) - South Impoundment, Slopes & Roadways

	Surface Details	Run Off Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	South Process Pond Basin Surface	Basin Surface	1.000	0.96	0.1117	0.0032
2	Perimeter Roadway and Inner Slopes	Packed Surface	0.500	0.60	0.0348	0.0010
			Total Area 6.b	**1.55**	**0.1465**	**0.0042**

6.c Combustion Turbines Facility Bermed Areas to Process/Auxiliary Pond through Oil/Water Separators OS-1, OS-2, OS-3

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	CT-Facility Diked Transformer Pads	Impervious Surface	0.850	0.14	0.0139	0.0004
2	Fuel Oil Storage Tank/Pumps Bermed Area	Impervious Surface	0.850	1.39	0.1378	0.0039
3	Fuel Oil Truck Diked Unloading Area	Impervious Surface	0.850	0.53	0.0528	0.0015
4	CT Facility Diked Fuel-Handling Equipment Areas	Impervious Surface	0.850	0.08	0.0080	0.0002
			Total Area 6.c	**2.14**	**0.2124**	**0.0060**

6.d Coal Storage and Handling Area to Coal Settling Basin to Auxiliary Pond (001)

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Basin Surface	Basin Surface	1.000	0.74	0.0870	0.0025
2	Coal Pile	Packed Surface	0.500	11.02	0.6435	0.0182
3	Unit 1 (**RETIRED/EMPTY**) Cooling Tower Direct Precipitation	Impervious Surface	0.850	0.43	0.0425	0.0012
			Total Area 6.d	**12.19**	**0.7729**	**0.0219**

6.e Limestone Storage Pile and Sump to Process Pond(s)

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Limestone Pile (and Sump small area)	Packed Surface	0.500	1.85	0.1083	0.0031
			Total Area 6.e	**1.85**	**0.1083**	**0.0031**

6.f U1-2 Oil/Water Separator - U1-2 Unit Areas, Chimneys, Transformers, Fuel Oil 15K Tank Berm, and Parking Areas

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Unit 1 (RETIRED) Circulating Pumps and North/Rear Gravel Areas	Packed Surface	0.500	0.11	0.0065	0.0002
2	Unit 2 (RETIRED) Chimney/ID Fans/ESP and North/Rear Gravel Areas	Packed Surface	0.500	0.43	0.0253	0.0007
3	Asphalt Parking/Roadway (Main lot & behind/front of Unit 1)	Impervious Surface	0.850	2.74	0.2724	0.0077
4	Grass (uphill towards cooling towers)	Vegetated Area	0.250	0.50	0.0145	0.0004
5	15,000 Fuel Oil Tank and Concrete Containment to Unit 1-2 OWS	Impervious Surface	0.850	0.03	0.0035	0.0001
6	Unit 1-2 GSU/Aux Transformers Bermed Containment	Loose Gravel	0.250	0.29	0.0084	0.0002
7	Coal Maintenance Fuel Tanks/Unloading Area (Bermed drains to Unit 1-2 OWS)	Impervious Surface	0.850	0.05	0.0049	0.0001
8	Unit 2 (**RETIRED/EMPTY**) Cooling Tower Direct Precipitation	Impervious Surface	0.850	0.37	0.0370	0.0011
			Total Area 6.f	**4.53**	**0.3725**	**0.0106**

6.g U3 Oil/Water Separator - U3 Unit Areas, FGD-Abs/Drain Tank, Fuel Oil 500K Tank Berm and Chimneys Areas

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Unit 3 Circ.Pumps/Rear, N/S Access, Old Stack/U2-3 Shop Access, U3 ID Fans-Baghouse, New Stack, FGD-Abs/Drain Tank, & Adjacent-to-Rear Access Areas	Impervious Surface	0.850	5.76	0.5720	0.0162
2	500,000 gal Fuel Oil Tank and Concrete Containment to Unit 3 OWS	Impervious Surface	0.850	0.49	0.0484	0.0014
			Total Area 6.g	**6.25**	**0.6203**	**0.0176**

6.h Landfill Leachate Pond & Adjacent Pavement Areas (Pumped to Process/Aux Pond)

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Landfill Leachate Pond	Basin Surface	1.000	2.42	0.2830	0.0080
2	Landfill Leachate Pond -Asphalt Perimeter Roads (North & South)	Impervious Surface	0.850	0.42	0.0421	0.0012
3	Landfill Leachate Pond -Gravel Perimeter Road (East)	Packed Surface	0.500	0.33	0.0193	0.0005
			Total Area 6.h	**3.18**	**0.3444**	**0.0098**

6.i Landill Phase I Cells 1-2 (Under-Drainage/Runoff to Leachate Pond)

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Phase I-**Cell 1** -Landfill Inside Perimeter Road & Drainage Channel	Packed Surface	0.500	35.94	2.0983	0.0595
2	Phase I-**Cell 2** -Landfill Inside Perimeter Road & Drainage Channel	Packed Surface	0.500	24.63	1.4378	0.0408
			Total Area 6.i	**60.57**	**3.5361**	**0.1002**

6.j CCRT Area (West, BA/Gypsum CCR-Contact) Drains to Landfill Leachate Pond

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	West-side Pavement and CCRT/Bottom Ash-Gypsum Handling Areas	Impervious Surface	0.850	3.32	0.3293	0.0093
			Total Area 6.j	**3.32**	**0.3293**	**0.0093**

6.k Landfill Dam Toe Drain Sump/Area to TDCPRS/Landfill Leachate Pond to Process Pond(s)

	Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
1	Landfill Dam Toe Drain Area (*assume drains into sump when not lake-flooded*)	Packed Surface	0.500	0.33	0.0190	0.0005
			Total Area 6.k	**0.33**	**0.0190**	**0.0005**

AREA TOTAL	**6**	**97.56**	**6.6040**	**0.1872**

E.W. Brown Station - Stormwater Runoff Calculations

Outfall 007 **Outfall 007 (Reserved)**

Outfall 008 **Outfall 008 - Railway Stormwater & Landfill Wick Drain Sump High Flows (Base Fraction Pumped to Proc.Pond) to Herrington Lake**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
8.a	Landfill Embankment-North Slope (toward Railcar Sidings)	Loose Gravel	0.250		6.86	0.2002	0.0057
8.b	Railcar Siding Gravel Areas (Between Fuel Unloading until U3 ESP railroad crossing & down to Bottom Ash PipeRack)	Loose Gravel	0.250		6.52	0.1904	0.0054
8.c	Entrance Road Pavement (Fuel Unloading to Unit 3 ESP)	Impervious Surface	0.850		1.53	0.1521	0.0043
8.d	CT Ice Plant (Thermal Storage Equipment-Bldg/Gravel)	Impervious Surface	0.850		0.55	0.0544	0.0015
8.e	Natural Gas Pressure Regulation Station	Packed Surface	0.500		1.21	0.0709	0.0020
8.f	Limestone Unloading Area (Outside/Adjacent Pile)	Packed Surface	0.500		5.12	0.2988	0.0085
8.g	Limestone Handling-Slurry Prep.Bldgs, FDG/Abs-Drain Tank, to 500K Tank Area	Impervious Surface	0.850		3.06	0.3039	0.0086
8.h	Field/Grass Areas Uphill of Plant Access Road	Vegetated Area	0.250		17.41	0.5082	0.0144
			AREA TOTAL	**8**	**42.26**	**1.7789**	**0.0504**

Outfall 009 **Outfall 009 (Reserved)**

HERRINGTON LAKE: NON-POINT UNCONTAMINATED RUNOFF AREAS

Area 10 **Steam Plant-Coalyard South/Downhill Areas Sloped To Lake Herrington (i.e., Below Railroad Tracks)**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
10.a	Substation-Brown Plant South	Loose Gravel	0.250		1.50	0.0437	0.0012
10.b	Coal Maintenance Buildings & Gravel Area	Packed Surface	0.500		3.17	0.1850	0.0052
10.c	Fields/Vegetation from DamFace-to-U3 CT Blowdown Channel	Loose Gravel	0.250		2.64	0.0770	0.0022
10.d	Fields/Vegetation from U3 CT Blowdown Channel to Coalyard, Dix Dispatch, Lake	Vegetated Area	0.250		40.45	1.1810	0.0335
			AREA TOTAL	**10**	**47.76**	**1.4867**	**0.0421**

Area 11 **Landfill-Damface North-to-South Slopes (Ditch Drains To Lake Herrington/Curds Inlet)**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
11	Landfill Embankment (Dam Face) East Slope (*Main Slope to Herrington Lake*)	Loose Gravel	0.250		10.54	0.3076	0.0087
			AREA TOTAL	**11**	**10.54**	**0.3076**	**0.0087**

Area 12 **Auxiliary Pond External Berm & Downhill Fields Draining to Stream to Quarry/Stormwater Pond to Herrington Lake/Curds Inlet**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
12.a	Quarry Basin Surface	Basin Surface	1.000		0.63	0.0731	0.0021
12.b	Fields/Vegetation Below Auxiliary Pond External Berms to Stream/Channel	Vegetated Area	0.250		31.47	0.9187	0.0260
12.c	Auxiliary Pond External Berm (Eastern, Southern & Western Slopes)	Loose Gravel	0.250		15.68	0.4576	0.0130
			AREA TOTAL	**12**	**47.77**	**1.4494**	**0.0411**

Area 13 **Fields Below Auxiliary Pond/Stream to Quarry and Hardin Heights Road (from Curds Inlet to Subdivision Entrance)**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
13	Fields/Vegetation Below Stream/Channel to Quarry Extending From Solar Farm, Along Hardin Heights, to Lake Edge and to Dam Face/Curds Inlet	Vegetated Area	0.250		40.20	1.1737	0.0333
			AREA TOTAL	**13**	**40.20**	**1.1737**	**0.0333**

Area 14 **Solar Farm to Hardin Heights Boat Ramp Inlet to Railroad Tracks**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
14.a	Solar Farm Central Pond	Basin Surface	1.000		0.82	0.0952	0.0027
14.b	Solar Panels	Impervious Surface	0.850		38.90	3.8614	0.1095
14.c	Solar Batteries/Switchgear Gravel Area	Packed Surface	0.500		4.39	0.2560	0.0073
14.d	Fields/Vegetation Adjacent/Surrounding Solar Facilities	Vegetated Area	0.250		108.98	3.1816	0.0902
			AREA TOTAL	**14**	**153.09**	**7.3942**	**0.2096**

Area 15 **Southern Property (prev. Dempsey Property)**

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
15	Fields/Vegetation of Property South of Solar Facilities	Vegetated Area	0.250		124.14	3.6240	0.1027
			AREA TOTAL	**15**	**124.14**	**3.6240**	**0.1027**

E.W. Brown Station - Stormwater Runoff Calculations

DIX RIVER AND DAM SPILLWAY: NON-POINT UNCONTAMINATED RUNOFF AREAS

Area 16 Dix HydroElectric Areas (Including Spillway and Across/East Areas) Draining to Dix River

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
16.a	Hydroelectric Building Roof and Roadway	Impervious Surface	0.850		0.23	0.0227	0.0006
16.b	Dix Substation	Loose Gravel	0.250		0.44	0.0127	0.0004
16.c	Gravel Parking & Roadways adjacent Substation	Packed Surface	0.500		1.05	0.0614	0.0017
16.d	Dix River Tailrace Area (to River-Center Property Line)	Basin Surface	1.000		2.16	0.2521	0.0071
16.e	Dix Dam & Spill Gates Inner Slopes to Herrington Lake	Impervious Surface	0.850		2.30	0.2284	0.0065
16.f	Dix Dam (Downstream) Embankment to Toe/Hydro Area	Packed Surface	0.500		7.02	0.4100	0.0116
16.g	Spillway Gates Concrete Discharge/Apron Area	Impervious Surface	0.850		0.92	0.0915	0.0026
16.h	Spillway Channel (rock) Area	Impervious Surface	0.850		13.74	1.3637	0.0387
16.i	Fields & Vegetated Slopes Across/East-Side of Herrington Lake & Dix River	Vegetated Area	0.250		16.97	0.4953	0.0140
16.j	Village Houses & Vegetated Areas Between Spillway, Dix Dam and Dix River	Vegetated Area	0.250		47.43	1.3846	0.0392
			AREA TOTAL	**16**	**92.26**	**4.3224**	**0.1225**

Area 17 Westcliff Substation & Dix Dispatch Building/Complex Areas

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
17.a	Westcliff Substation	Loose Gravel	0.250		1.12	0.0326	0.0009
17.b	Dix Dispatch Building and Adjacent Roadway/Parking Areas	Impervious Surface	0.850		2.37	0.2355	0.0067
			AREA TOTAL	**17**	**3.49**	**0.2681**	**0.0076**

Area 18 Areas North of Steam Plant from Combustion Turbine Site Extending to Dam Spillway Including Brown North Substation

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
18.a	Brown-North Substation	Loose Gravel	0.250		8.11	0.2367	0.0067
18.b	Brown-North Substation - Gravel Laydown Area	Packed Surface	0.500		6.11	0.3568	0.0101
18.c	Training Building & Fire Protection Buildings, Roadway & Gravel Areas Adjacent Buildings	Impervious Surface	0.850		1.92	0.1903	0.0054
18.d	Warehouse, Perimeter Roadway & Adjacent/Uphill Gravel Areas	Impervious Surface	0.850		3.81	0.3786	0.0107
18.e	Unit 3 Cooling Towers Gravel Areas Between/to Roadway	Packed Surface	0.500		3.35	0.1954	0.0055
18.f	Units 1-2 Cooling Towers Between/Adjacent Buildings (*incl GT Demin Bldg*), Roadway & Gravel Areas	Packed Surface	0.500		1.64	0.0958	0.0027
18.g	Septic Lateral Field	Vegetated Area	0.250		1.87	0.0546	0.0015
18.h	Vegetated/Field Areas Draining to Dix River from behind CT-site/Curdsville Road to Dix Dam Spillway including Areas behind/downhill of Steam Plant	Vegetated Area	0.250		125.39	3.6604	0.1038
			AREA TOTAL	**18**	**152.20**	**5.1687**	**0.1465**

CEDAR CREEK DRAINAGE AREAS TO KENTUCKY RIVER

Area 19 Combustion Turbines Facility - Uncontaminated Runoff Areas (Not Bermed/Pumped to Process Pond)

	Surface Details	Run Off Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
19.a	CT-Facility Building Roofs & Asphalt Pavement Areas	Impervious Surface	0.850		5.54	0.5504	0.0156
19.b	CT Facility Gravel Areas, Roads & Parking Lots	Packed Surface	0.500		19.55	1.1414	0.0324
19.c	CT Switchyard/Substation Gravel Areas	Loose Gravel	0.250		2.78	0.0813	0.0023
19.d	CT Facility Grass Areas	Vegetated Area	0.250		21.66	0.6323	0.0179
			AREA TOTAL	**19**	**49.54**	**2.4053**	**0.0682**

Area 20 Plant Entrance Gate, Roadway & Railway Areas (From Entrance to Fuel Truck Unloading Area)

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
20.a	Entrance Road Pavement & Guardhouse Roof Areas	Impervious Surface	0.850		0.92	0.0910	0.0026
20.b	Railroad Bed Gravel Areas	Loose Gravel	0.250		1.64	0.0480	0.0014
			AREA TOTAL	**20**	**2.56**	**0.1390**	**0.0039**

Area 21 Gypsum Building (Retired/InActive) Near Entrance Gate

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
21	Gypsum (Retired/Inactive) Building and Adjacent Gravel Areas	Packed Surface	0.500		3.09	0.1806	0.0051
			AREA TOTAL	**21**	**3.09**	**0.1806**	**0.0051**

Area 22 Gypsum Building (Retired/InActive) Near Entrance Gate

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
22	Fields/Slopes Surrounding/Adjacent Gypsum (Retired/Inactive) Building	Vegetated Area	0.250		10.69	0.3121	0.0088
			AREA TOTAL	**22**	**10.69**	**0.3121**	**0.0088**

Area 23 Landfill-West Embankment Along Curdsville Road Area to Retired Gypsum Bldg/Webb Road Entrance (Drains Northward)

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
23	Fields/Slopes Along/Between Roadway and Landfill West Slopes	Vegetated Area	0.250		23.48	0.6854	0.0194
			AREA TOTAL	**23**	**23.48**	**0.6854**	**0.0194**

E.W. Brown Station - Stormwater Runoff Calculations

April 29, 2019

Area 24 Area Between Road/Railway Across Curdsville Road to Roadway Overpass Bridge (Drains Northward)

Surface Details	RO Coefficient	Cr	#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)

24	Fields/Slopes Along/Between Roadway and Railway Across Curdsville Road	Vegetated Area	0.250		19.16	0.5593	0.0159
			AREA TOTAL	24	19.16	0.5593	0.0159

Area 25 Middle/West Property Areas Across/West of Railway

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
25	Fields/Slopes Across/Along Railway (Drains Northward)	Vegetated Area	0.250		68.75	2.0069	0.0569
			AREA TOTAL	25	68.75	2.0069	0.0569

Area 26 Northwest Cedar Branch Property - West Across/Along Railway

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
26	Fields/Woods/Slopes Across/Along Railway (Drains Northward)	Vegetated Area	0.250		23.12	0.6749	0.0191
			AREA TOTAL	26	23.12	0.6749	0.0191

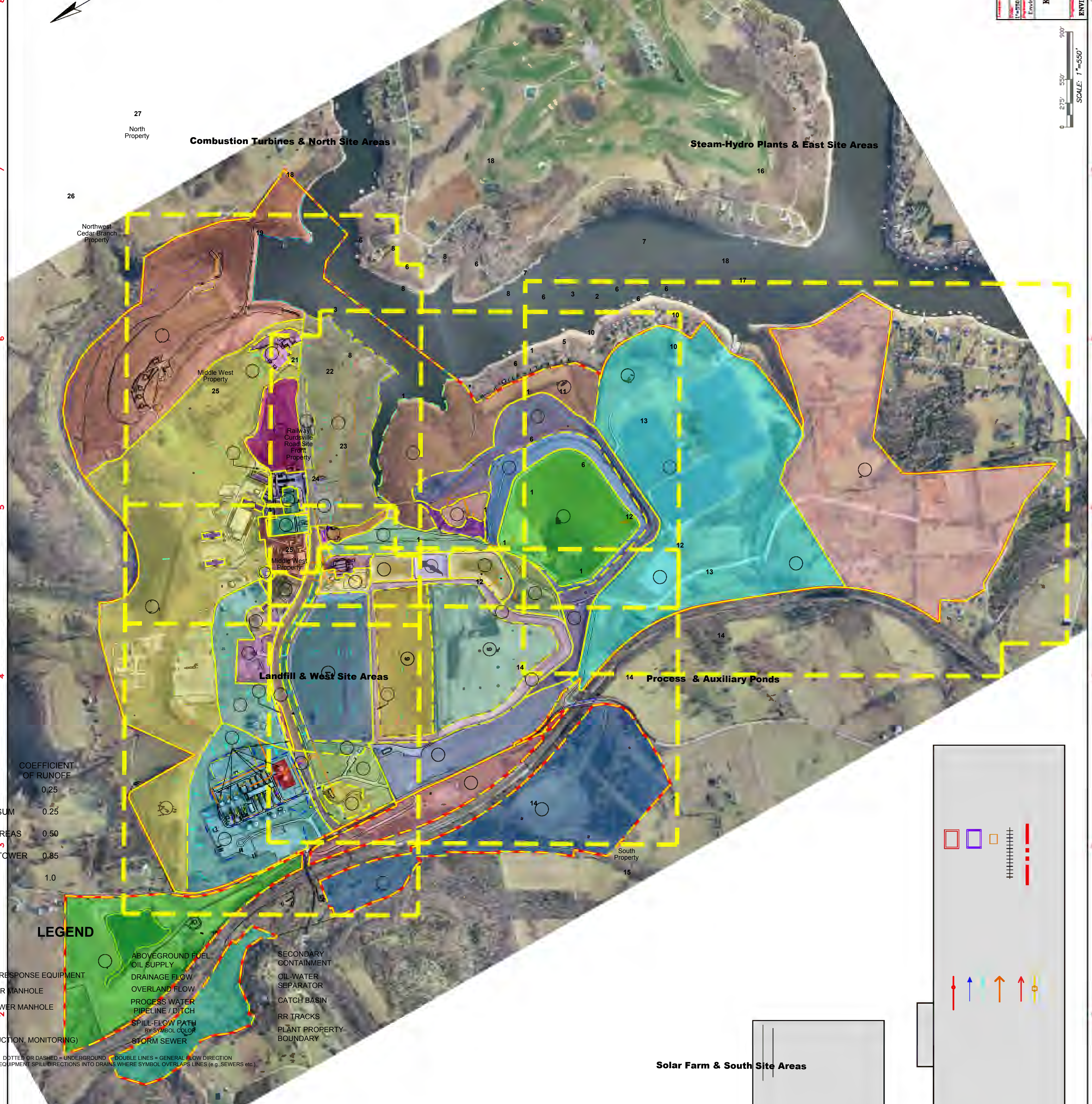
Area 27 North Property Area - East Along Railway (*prev. Haup Property*)

	Surface Details	RO Coefficient	Cr		#Acres	1-Day Max (MGD)	Daily (Avg) (MGD)
27.a	Borrow Area Pond Surface	Basin Surface	1.000		6.37	0.7434	0.0211
27.b	Vegetated/Field Areas Draining to Cedar Branch	Vegetated Area	0.250		51.91	1.5154	0.0430
			AREA TOTAL	0	58.28	2.2588	0.0640

TOTAL LISTED STORMWATER AREAS	Acres	1185.17
Herrington Lake Surface Area *(Included Inside Property Boundary Boundary)*	Acres	37.68
TOTAL SITE PER SURVEY 1,222.473	Acres	1222.85

ATTACHMENT 9

STORMWATER RUNOFF DIAGRAMS



STORMWATER RUNOFF AREA DESCRIPTION	COEFFICIENT OF RUNOFF
- VEGETATED - WOODS & GRASS AREAS	0.25
- UNCOMPACTED GRAVEL/LIMESTONE & GYPSUM	0.25
- COMPACTED GRAVEL, COALPILE, TRAFFIC AREAS	0.50
- IMPERVIOUS PAVEMENT, ROOFS, COOLING TOWER	0.85
- IMPOUNDMENT BASIN SURFACES	1.0

PLANT LAYOUT, BUILDINGS AND EQUIPMENT SHOWN CONSISTENT WITH SPCC/BMP/GPP SERIES DRAWINGS. CONSTRUCTION ACTIVITIES OF 2012 ADDED SEPARATELY.

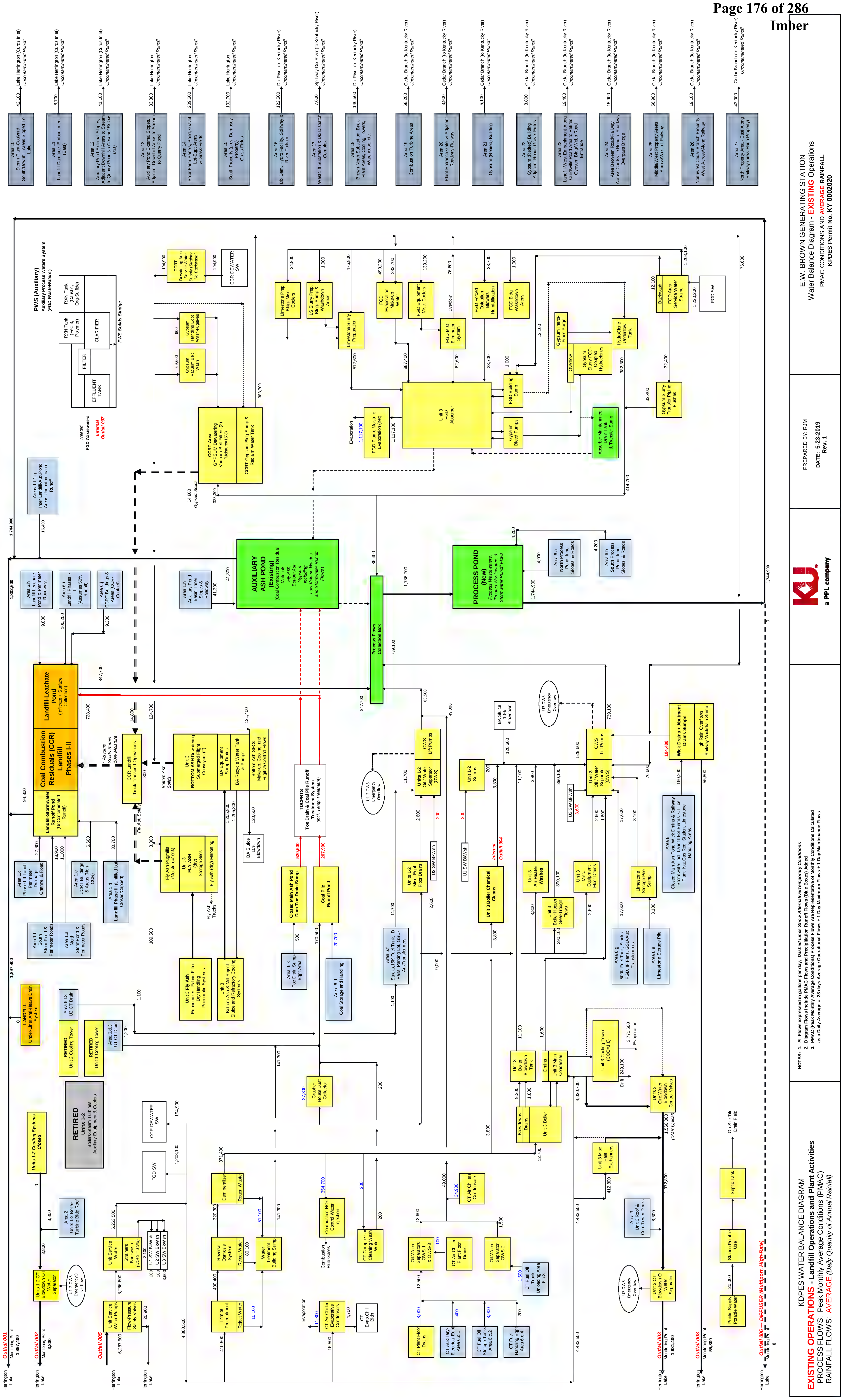
CEMETERY
EMERGENCY RESPONSE EQUIPMENT
STORM SEWER MANHOLE
SANITARY SEWER MANHOLE
VALVE
WELL (PRODUCTION, MONITORING)

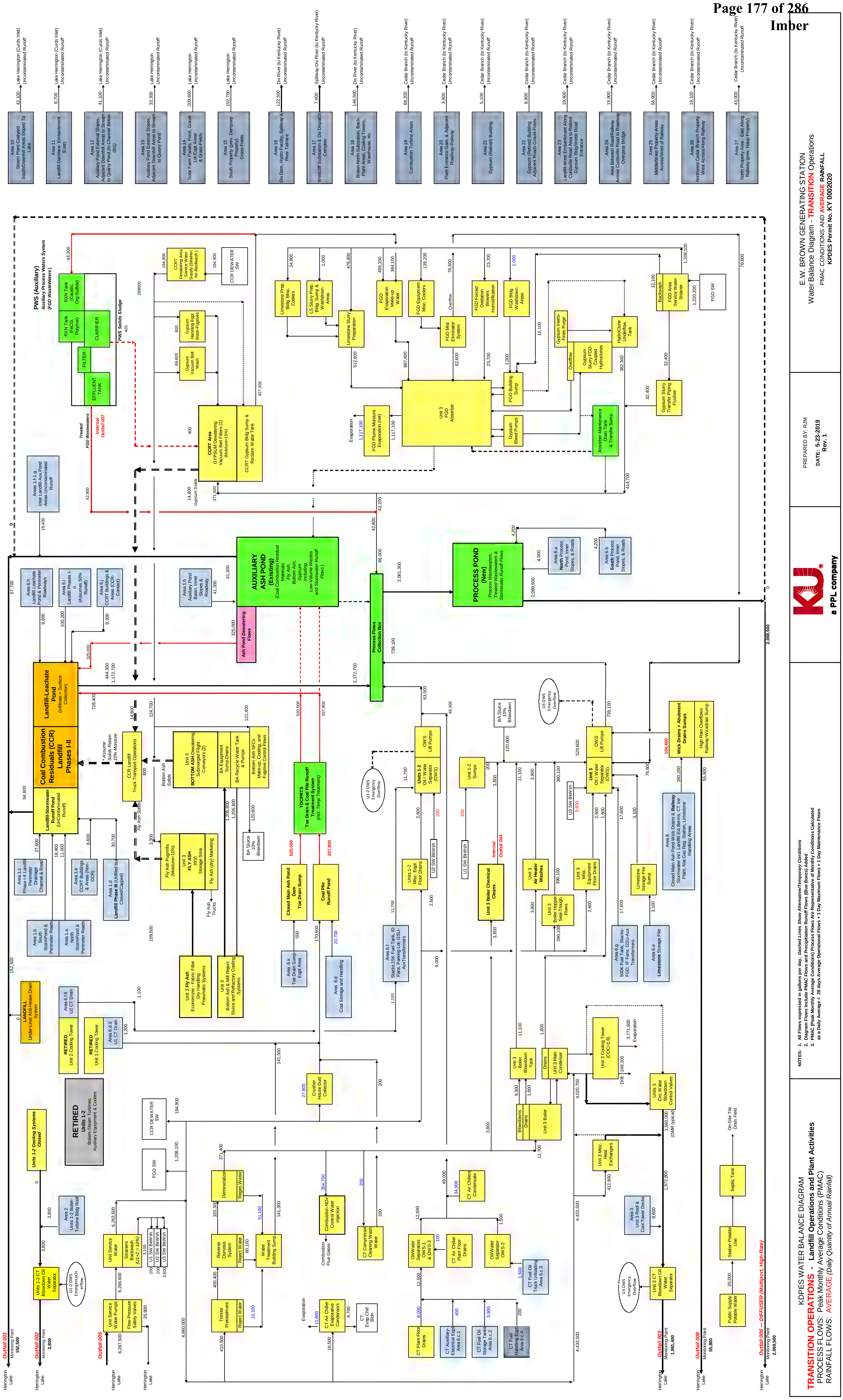
PPL companies

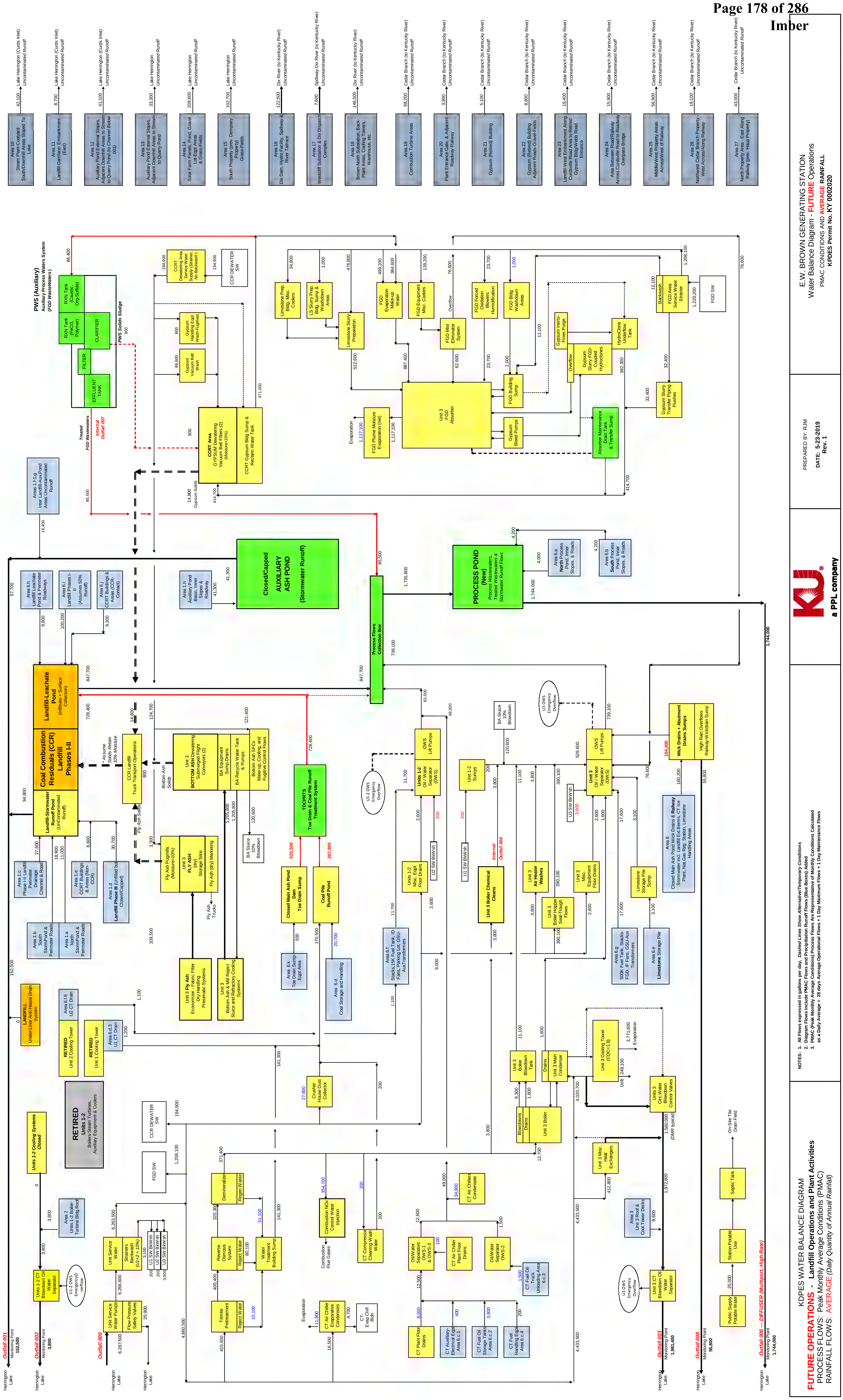
ATTACHMENT 10

WATER BALANCE DIAGRAMS

Diagrams for Process Operations and AVERAGE Stormwater Runoff


E.W. BROWN GENERATING STATION
Water Balance Diagram - EXISTING Operations
PMAC CONDITIONS AND AVERAGE RAINFALL
KPDES Permit No. KY 0002020
PREPARED BY: RJM
DATE: 5-23-2019
Rev. 1
a PPL company
KDPES WATER BALANCE DIAGRAM
EXISTING OPERATIONS - Landfill Operations and Plant Activities
PROCESS FLOWS: Peak Monthly Average Conditions (PMAC)
RAINFALL FLOWS: AVERAGE (Daily Quantity of Annual Rainfall)
AUXILIARY ASH POND (Existing)
PROCESS POND (New)
Coal Combustion Residuals (CCR) Landfill Phases I-II
Landfill-Leachate Pond


E.W. BROWN GENERATING STATION
Water Balance Diagram - TRANSITION Operations
PMAC CONDITIONS AND AVERAGE RAINFALL
KPDES Permit No. KY 0002020
PREPARED BY: RJM
DATE: 5-23-2019
Rev. 1
a PPL company
KDPES WATER BALANCE DIAGRAM
TRANSITION OPERATIONS - Landfill Operations and Plant Activities
PROCESS FLOWS: Peak Monthly Average Conditions (PMAC)
RAINFALL FLOWS: AVERAGE (Daily Quantity of Annual Rainfall)


KDPES WATER BALANCE DIAGRAM
FUTURE OPERATIONS - Landfill Operations and Plant Activities
PROCESS FLOWS: Peak Monthly Average Conditions (PMAC)
RAINFALL FLOWS: AVERAGE (Daily Quantity of Annual Rainfall)
E.W. BROWN GENERATING STATION
Water Balance Diagram - FUTURE Operations
PMAC CONDITIONS AND AVERAGE RAINFALL
KPDES Permit No. KY 0002020
PREPARED BY: RJM
DATE: 5-23-2019
Rev. 1
a PPL company

ATTACHMENT 11

CONSTRUCTION ACTIVITIES

AT

KU-BROWN GENERATING STATION

IMPACTING

THE SCHEDULE OF COMPLIANCE

WITH FEDERAL AND STATE REGULATIONS

KU - Brown Station – *KPDES Permit Renewal Information*

Construction Projects Work Required for CCR and ELG Federal Rules Compliance

SUMMARY

To update renewal information for issuance of the renewed Kentucky Utilities Company (KU) Brown Generating Station (Plant or Brown Station) KPDES permit, this document describes construction activities and scheduling information to support setting applicability dates for new KPDES permit conditions to meet Federal Effluent Limitations Guidelines (ELG) regulations and Kentucky Water Quality Standards (KyWQS). The USEPA announced it is reconsidering the ELG final rule regarding Flue Gas Desulfurization (FGD) Wastewater treatment requirements and bottom ash sluicing/transport waters. A September 18, 2017 final rule revised the earliest possible 'as-soon-as-possible' date from November 1, 2018 to November 1, 2020 for treatment requirements of FGD wastewaters and bottom ash sluice waters and retained December 31, 2023 as the latest possible compliance date for treatment of these wastewaters. USEPA anticipates completing its reconsideration rulemaking by November 2020, and that rule will establish the ELG treatment standards for these two wastestreams.

The Brown Station has completely converted to dry fly ash handling; therefore, the ELG regulatory prohibition of the discharge of fly ash transport waters conditionally beginning November 1, 2018 will not affect existing or planned operations at the station. For bottom ash, a remote submerged conveyor to dewater bottom ash sluice streams was installed but the equipment has operated unreliably; therefore, until the system is redesigned/repaired, a portion of bottom ash sluicing flows will continue to the Auxiliary Ash Pond and/or new Process Pond (under construction). KU is evaluating whether to redesign, modify and/or replace the equipment, which will be influenced by the ELG reconsideration. KU-Brown will comply with the bottom ash transport water ELG by no later than December 31, 2023, unless USEPA establishes a different deadline consideration in the revised rule..

For FGD wastewaters, the treatment technologies to meet the ELG regulations are similar to those required to be installed for plant discharges to meet anticipated KyWQS limits (e.g. mercury, selenium, arsenic, etc.) for the new diffuser discharge. However, because USEPA announced their reconsideration of ELG wastewaters treatment requirements, setting a compliance date for specific ELG treatment requirements for FGD waters cannot be definitively resolved without finalization of these ELG regulations. As a result, KU has proposed December 31, 2023 as the compliance date for this wastestream as well.

Simultaneously, the Coal Combustion Residual (CCR) Final Rule also profoundly impacts plans for future facility operations and water/solids management by in-effect, requiring the closure of existing CCR- related impoundments. As a result, the Brown plant CCR/ash/gypsum materials will be alternatively managed in the on-site landfill (and/or marketed when possible).

Therefore, to comply with anticipated KyWQS discharge limits and to best position the plant to meet future ELG requirements, KU has implemented the following projects:

- Segregate, recycle and treat FGD (Flue Gas Desulfurization) wastewaters with dedicated physical-chemical systems to meet anticipated KyWQS limits for the new diffuser discharge outfall by mid-2020 and ELG technology-based limits for FGD wastewater and bottom ash transport water by a compliance date of December 31, 2023 (which will be revisited upon finalization of the USEPA reconsideration of these treatment requirements for these wastewaters);

- Install dry handling for all fly ash systems to prevent the discharge of fly ash sluice waters – (this has already been completed);
- Install a recirculation system to recycle all bottom ash sluice waters (troubleshooting-optimizing efforts still continuing) to prevent the discharge of bottom ash sluice waters by December 31, 2023.

Specifically at the Brown Plant, construction of new wastewater treatment facilities for FGD (Flue Gas Desulfurization) systems wastewaters and other plant process waters require:

- Final conversion of handling systems from wet-to-dry solids management in the Coal Combustion Residuals Transport (CCRT) facility to manage fly ash, bottom ash, and gypsum for transport to the landfill or marketing/trucking these CCR materials off-site for beneficial reuse. This includes significant tank/piping modifications of FGD wastewaters and systems associated with the gypsum dewatering vacuum belts (2). Bottom ash sluice waters management includes redesign/repairs to Submerged Flight Conveyors (SFC) constructed to dewater sluice flows and facilitate ’dry‘ solids-truck handling to the landfill (reliability problems currently being addressed);
- A Process Water System (PWS) to treat FGD wastewaters (by physical-chemical and potential/future biological technology) including piping to segregate and manage FGD blowdown, gypsum dewatering, reclaim, and other related process flows - scheduled to be operational by mid-2020;
- Construction of a new physical/chemical treatment system for the closed Main Ash Pond toe drain and coal pile runoff treatment system (TDCPRTS) flows (the toe drain dedicated/closed system installed previously) which will discharge to the Process Pond – scheduled to be operational by mid-2020;
- Closure/capping/vegetation of the Auxiliary Ash Pond – scheduled completion by 2022;
- Expand the existing CCR-Landfill for Phase 1/Cell 2 operations and close/cap the Phase 3 phase of the landfill (not-needed following recent retirement of coal-fired Units 1-2 units);
- A New Process Pond (North and South cells) to settle/mix/neutralize all plant wastewaters (adjacent/north of the future closed/capped Auxiliary Ash Pond);
- A multiport, high-rate diffuser for enhanced mixing zone/ZID discharge of outfall 006 treated process wastewaters to Herrington Lake – completion date expected by 3rd quarter 2019;
- Installing three (3) new outfall monitoring/sample structures for flows associated with the Process Pond/Diffuser, FGD-PWS, and railway stormwater/wick-drain high flow events.

To reduce the discharge of wastewater contaminants as expeditiously and economically as possible, the description and schedule provided here are accelerated and represent a current best-estimate, but it must be recognized that detailed engineering is not yet complete and delays in contractual bidding, procurement and all-weather construction activities may have a profound effect upon the final completion date. Many of these work tasks are still in the design-phase, many tasks completion are serially dependent, and the simultaneous high-demands by others in the power industry is expected to impair vendors’ capabilities to supply equipment and services. Accordingly, KU-Brown plant will contact KDOW-KPDES staff to provide updated information if the actual schedule significantly deviates from that provided here, including whether adjustment in ELG applicability dates are required.

KU - Brown Station – *KPDES Permit Renewal Information*

Construction Projects Work Required for CCR and ELG Federal Rules Compliance

CONSTRUCTION ACTIVITIES – WORKFLOW SCHEDULING

In accordance with requirements of the recently finalized USEPA CCR-(Coal Combustion Residuals) and ELG (Effluent Limitation Guidelines) regulatory rules, the plant has commenced efforts to modify existing process equipment systems and construct new wastewater treatment equipment to comply with these new regulations. Generally the work requires modification, retirement/removal or the new installation of five (5) ponds, construction of the Process Water Treatment System (PWS) for FGD wastewater treatment and solids handling systems, construction of other water-treatment systems, completion of the CCRT/piping-handling systems modifications, CCR-Landfill expansion and partial closure/capping work, and very extensive changes or new piping systems associated with management of process waters from operating the plant coal-fired unit. The current ELG Rule considers that FGD wastewaters have high concentrations of metals and nutrients and must be segregated from other plant process waters for treatment by a physical-chemical and potential/future-biological system (or by equivalent performance technology) prior to co-mingling with other plant wastewater streams. In addition, compliance with water quality-based standards in light of the process wastewater changes and elimination of transport waters is a major consideration for the new combined/total plant discharges. Ensuring compliance with water quality standards is being achieved through treatment of contributing flows with elevated metals concentrations such as FGD wastewaters, and in particular mercury and selenium, and use of a new diffuser discharge outfall.

To determine compliance applicability dates with ELG requirements “as soon as possible”, permittees are required to provide information for regulators to consider:

- *Time to expeditiously plan (including to raise capital), design, procure, and install equipment to comply with the requirements of the final rule;*
- *Changes being made or planned at the plant in response to greenhouse gas regulations for new or existing fossil fuel-fired power plants under the Clean Air Act, as well as regulations for the disposal of coal combustion residuals under Subtitle D of the Resource Conservation and Recovery Act;*
- *For FGD wastewater requirements only, an initial commissioning period to optimize the installed equipment;*
- *Other factors as appropriate.*

It is challenging, costly and difficult-to-schedule the installation of systems to segregate and treat FGD wastewaters, which are currently co-managed as low-volume wastes with other CCR/plant wastewaters as provided by the current KPDES permit. Because the Plant’s coal-fired unit is large, the numerous auxiliary systems are complex and highly inter-connected, and required the retention of professional engineering design and construction firms to assist. These efforts include:

1. Select alternative process technologies for fly ash/bottom ash/gypsum handling and management including:
   i. Dry bottom ash handling for solids landfilling instead of ash pond impoundment management;
   ii. Conversion of air heaters/economizers fly ash management systems from wet-handling (currently sluiced to ash pond) to dry-handling (pneumatic piping, silos, and trucking to onsite landfill);
   iii. FGD wastewaters treatment systems of physical-chemical precipitation design (e.g., mercury, arsenic, other metals) followed by potential/future biological treatment (e.g., selenium, nitrates, etc.) with solids filtration and placement in the site landfill;

KU - Brown Station – *KPDES Permit Renewal Information*
Construction Projects Work Required for CCR and ELG Federal Rules Compliance

2. Select and contract consulting engineer firms for process and balance-of-plant equipment including planning, designing, specifying, bidding, procuring, construction management, etc.;
3. Prepare informational packages for submission to the Kentucky Public Service Commission for regulatory approval of these expenditures under base rate/environmental surcharge categories;
4. Conduct pilot testing of biological candidate process technologies to determine feasibility and finalize/optimize detailed systems process designs;
5. Complete general and detailed engineering designs for equipment selection, modifications, plan/coordinate installation according to unit outage schedules;
6. Prepare detailed equipment specifications;
7. Prepare, award, and negotiate bidding for contracts to procure and install the selected process technologies-equipment;
8. Demolition of existing facilities where required for plant footprint/tight-quarters require for various technical, practical, and economic reasons;
9. Install ponds, tanks, piping, pumps, structural/electrical/controls for segregation of existing plant flows and management by new wastewater treatment systems, including redundant systems for operational reliability;
10. Install facilities in new treatment buildings for plant staff operations control rooms, restrooms/locker-rooms and safe occupancy;
11. Startup/troubleshoot process and wastewater treatment systems operations and commission for up to 6 months to assure regulatory compliance with anticipated internal and lake outfall permitted discharge limits;
12. Site ponds-related work generally includes 3 scenarios:
    i. Pond flows diversion, excavation, pond liner installation, and restoration/refurbishment of piping/pumps/discharge flow controls;
    ii. Pond retirement by excavation, and backfill (for future plant maintenance/laydown areas);
    iii. Pond retirement by limited excavation, regrading, installation of in-place cap/vegetative cover and stormwater runoff management systems.

Currently, the Plant co-manages process waters from multiple CCR-materials and FGD wastewaters in many of the site impoundments to meet KPDES permit limits prior to discharge to Herrington Lake. Some of these ponds were configured to flow either in series or parallel which requires temporary diversion and later restoration of these flows in order to perform the closure/cleaning/re-lining activities as required by the CCR Rule. Furthermore, the new FGD wastewater treatment systems alone requires impacts to acres of buildings/tanks/piping/etc. (including the FGD Maintenance Drain Tank and modification/interconnects to hydrocyclone piping at the FGD); thus, to provide areas to construct the FGD and other plant process wastewater treatment systems, excavation/clean-closure of some of these ponds is required.

Scheduling for construction activities for both the Plant ponds and the new FGD wastewater treatment systems have been ***optimized and accelerated as much as possible***; but some of the ponds-related work must be scheduled sequentially to allow for the temporary flows redirections, while assuring continued compliance with KPDES permit conditions.

PROCESS FLOWS DISCHARGES OVERVIEW

FGD Wastewaters Processes
Currently, Unit 3 FGD wastewaters primarily include gypsum dewatering/filtration flows and inert-solids blowdown streams; these flows are pumped to the Auxiliary Ash Pond and combine with plant low volume waste streams and misc. stormwater flows for settling/mixing/neutralization of the combined flows prior to discharge to Herrington Lake.

By late-2019, FGD wastewaters will be completely segregated for treatment by reconfiguring piping between the FGD/gypsum slurry hydrocyclones, the new FGD maintenance drainage tank, and the CCRT gypsum dewatering equipment systems. Most surplus FGD process waters will be recycled to supply FGD systems makeup water (to reduce treatment volumes and reduce freshwater use), and the remaining wastewater flows will be treated by the new Process Waters Treatment System (PWS, using physical-chemical technology), which is scheduled to be operational in the first half of 2020. Treated effluent will discharge to a future ELG-compliance monitoring point (new Outfall 007) and then combines with plant low-volume wastes and other process flows for settling/mixing/neutralization in the new Process Pond and monitored at the new outfall 006 sampling-monitoring structure prior to discharge into Herrington Lake through a new diffuser.

With planned completion by mid-2019, the Outfall 006/Process Pond discharge to Herrington Lake will be installed with a multiport, high-rate diffuser; in combination with mid early-2020 “commercial” operation of the new PWS for FGD wastewaters and adequate time for mixed pond flows to reflect new treatment systems effluent flows, this is expected to assure compliance with current KYWQS. Ultimately the PWS system ELG compliance can be monitored at the new internal Outfall 007 prior to combining the discharge with any other flows (i.e., to satisfy ELG anti-circumvention measures). However, if the ELG reconsideration requires the installation of biological technology in order to meet the ELG limits, it is expected that design-procurement-installation-startup-testing and reliably operation of these units can require at least 36-42 months following the finalization announcement. Thus, although we plan the PWS system will begin startup-testing flows in December 2019 with reliable commercial physical-chemical operations by February 2020 (and subsequent pond mix/displacement flows until July 1, 2020), designing and installing any ELG- required biological systems to achieve full compliance would at least require the additional time until December 31, 2023.

Ash Sluice Waters
Currently, all fly ash is dry-managed using the plant CCRT system where fly ash is pugmill-moistened and truck-managed to the on-site landfill; therefore, the KU-Brown plant no longer sluices fly ash.

For bottom ash (as described previously), KU installed a remote submerged conveyor to convey/dewater sluiced bottom ash solids to the on-site landfill. However, the equipment has experienced operating/reliability problems (e.g., pH, corrosion, metal integrity/failure issues); consequently, to address these problems, it is estimated up to 10% of the recirculated bottom ash sluice flows have been directed to the existing Auxiliary ash pond. The company is currently evaluating requirements for the bottom ash sluice waters recirculation system per current ELG rule requirements to redesign/modify unreliable components of this remote submerged conveyor system. KU will provide an updated evaluation of the appropriate compliance date and approach for bottom ash water before the earliest compliance deadline of November 1, 2020. Therefore, in compliance with current ELG regulations, KU-Brown plans to cease discharging bottom ash sluice waters flows by December 31, 2023.

NEW OR MODIFIED PROCESS EQUIPMENT-FLOWS LISTING

Recent construction activities have profoundly changed the plant's CCRT materials handling management systems for fly ash, bottom ash and gypsum. Significant features of new/modified process equipment and/or flow changes related to FGD, CCRs and other materials processing-management include:

- Converting (wet) sluicing conveyance systems to dry fly ash from boiler air heaters/economizers hoppers to combine with existing dry fly ash silos for marketing, off-site/beneficial reuse, or pugmill-moistened for landfilling. Fly ash sluicing flows have already stopped; discharges of bottom ash sluicing flows are planned to stop by December 31, 2023, but may be affected by EPA's ongoing rule reconsideration;
- Remote submerged conveyors were installed to receive sluiced bottom ash sluicing flows to a process vessel where moist bottom ash solids can be dredged to bins beside the remote conveyor equipment; however, this system has experienced operational problems including pH, corrosion, and metal integrity/failure issues. Currently, equipment redesign/improvements/modification efforts continue but sometimes require draining of recirculated bottom ash sluice flows to perform the repair work. Current ELG regulations prohibit the discharge of any bottom ash sluice waters, but repairs-improvements of the remote submerged conveyors/system are expected to continue until the KU-requested applicability date of December 31, 2023 for compliance with this ELG requirement.
- Segregation of FGD wastewaters, flushwaters and FGD-gypsum filtration waters requires installing: large storage tanks; constructing new piping/pipe-racks between the vacuum-filtration solids-dewatering belt systems; recycling/flush systems, and complex water management-control systems;
- Construction of the Coal Combustion Residuals Transport (CCRT) system has included dry-fly ash storage silos, pneumatic/dry handling or pugmill-moistening capability for loading fly ash into truck-transport to the new on-site landfill; bottom ash handling capabilities for truck-transport to the new on-site landfill; FGD/gypsum de-watering and solids handling for landfilling or marketing beneficial re-use off-site by trucks---the FGD dewatering recycle flows to the FGD systems and bottom ash sluice water recycling systems require design, installation and troubleshooting work for reliable commercial operations;
- Construction of a PWS for FGD wastewaters using physical-chemical technology-based systems to reduce mercury, arsenic, selenium and other metals levels in discharge waters. If the ELG regulatory reconsideration requires compliance with reduced selenium/nitrates/nitrites limits, a biological system can be added later (if needed) to incrementally treat the physical-chemical system effluent. At this time the need for a biological system has not been demonstrated in order for combined plant discharges to comply with anticipated Kentucky water quality standards limits.
- Construction of clarification/sludge handling systems to convey precipitated solids to the gypsum filtration vacuum belts to manage the combined gypsum and PWS/physical-chemical solids produced (including future potential biological system solids) for landfilling on-site.

IMPOUNDMENTS AND OUTFALLS WORK OVERVIEW

Auxiliary Ash Pond Closure/Caps and New Process Pond

To close and cap the Auxiliary Ash Pond, construction of a New Process Pond to treat all plant wastewaters was necessary; due to plant site limitations, the most economic and feasible alternative was to excavate/construct the new Process Pond (North and South cells) adjacent the Auxiliary pond. They are designed to flow as two-cells-in-series with a first cell for primary settling coupled with a secondary/polishing cell; this pond is planned for completion in May 2019. This will facilitate closure of the Auxiliary ash pond and may require several months to divert/transfer flows from the Auxiliary Pond to the Process Pond for settling/mixing/neutralizing of all plant wastewaters prior to their monitored discharge to Herrington Lake. In August-2019 (*or new KPDES permit effective date*), dewatering flows from the Auxiliary ash pond are planned to begin to Outfall 006 in preparation for closure in accordance with the CCR final rule requirements.

With closure of this pond by December 31, 2021, all in-flows to this ash pond must stop and the process changes described in this document are required to handle the flows currently sent to this pond. The Auxiliary ash pond will be dewatered, capped, vegetative cover established, and uncontaminated stormwater runoff flows will be managed to combine with landfill stormwater runoff flows to the existing Outfall 001 to Herrington Lake. Dewatering will commence via the diffuser outfall (006) upon issuance of the KPDES permit.

Starting December-2019, FGD wastewaters currently sent to the Auxiliary Ash Pond will be treated by the PWS system and discharged thru a new internal Outfall 007 to the New Process Pond. There will be a shakedown period for the new PWS system, with commercial operation and displacement of untreated flows in the Process Pond anticipated by July 2020.The treated FGD wastewaters will combine with the plant low volume wastewaters, misc. other process flows and stormwater flows to Herrington Lake through Outfall 006 and a multiport, high-rate diffuser.

Landfill Leachate Pond

With retirement of Units 1-2, the landfill future Phase 3 was not needed, so the landfill permit was modified for Phase 1 to include Cells 1-2 (Phase 2 designation now ‘omitted’), and Phase 3 was to be closed/capped and vegetated. The Landfill Leachate Pond will receive flows from both Phase 1 Cell 1 (existing) and Cell 2 (new) active landfill sections; subsequently the leachate pond will be pumped to the new Process Pond(s) and to Outfall 006. Stormwater Runoff flows (deminimis CCR-contact) from the closed/capped Phase 3 drainage will be directly managed to the (South) Stormwater Pond. Liner installation for both Phase 1 Cell 2 and also for Phase 3 is planned for completion by late 2019; vegetation is expected to be established by mid-2020.

The Landfill Leachate pond will also be utilized to receive wastewater treatment flows from a new physical-chemical management facility for flows from the closed Main Ash Pond Toe Drain sump and Coal Pile Runoff Treatment System (TDCPRTS); for this purpose it will include a low-height partition to provide additional retention volume and enhance capture of suspended solids. This work is planned for completion during May 2019.

IMPOUNDMENTS AND OUTFALLS LISTING

These activities involve work on five (5) existing/future ponds, including closure or new construction of some of these same ponds, including:

- Closure of the Auxiliary Ash Pond (1) by dewatering, closure-in-place, regraded, liner/capped, and stormwater runoff management drainage from the capped areas;
- Construct the new Process Pond North Cell (1) and Process Pond South Cell (1) (collectively the "New Process Pond"), with liners and independent decant-discharge structures;
- Modification/construction of the landfill leachate pond(1) and landfill (north) temporary retention pond (1) for isolation from treatment of ash pond dewatering flows;
- Construct Outfalls Sampling Structures for Outfall 006/Process Ponds/Diffuser Flows monitoring and Outfall 008/Railway Stormwater/Wick-Drain High Rainfall Flows monitoring.

1. **Auxiliary Ash Pond** – Closure Started, Dewatering to begin Mid-2019, Completion by 2021

Close-in-place Auxiliary Ash Pond, Install geo-membrane/vegetative cap, future stormwater runoff controls to existing Outfall 001

- Channelize/reconfigure flows to allow initial re-grading efforts including wastewaters supplemental management (e.g., free-water drainage controls with turbidity curtains, etc.);
- Manage free-water discharges (at or above normal/typical pool level) to existing Outfall 001;
- Redirect Process Flows to new Process Pond with management to discharge to existing Outfall 001 (i.e., prior to new permit and subsequent redirection to new Outfall 006);
- Install dewatering pumps and infrastructure for dewatering flows discharge upon new KPDES permit effective date (potentially starting August 2019);
- Manage dewatering flows to new Process Pond thru new Diffuser/Outfall 006 monitoring/sample point in accordance with KPDES permit conditions;
- Provide pond fill solids, grade slopes for cap, install geo-membrane, soil cover, establish vegetation;
- Construct perimeter internal drainage channel for stormwater runoff from capped pond areas through new stormwater control structures to existing Outfall 001 to Herrington Lake.

2. **Process Pond North Cell** – Construction Started, Completion Planned for May 2019

Prepare North ('Secondary/Polishing Cell) Process Pond & Outfall Structure(s) to receive/redirected Plant Wastewater Flows currently discharged to Auxiliary Ash Pond

- Excavate final North Process Cell, slopes, emergency overflow, perimeter, and access roadways;
- Construct discharge piping/controls to direct flows to either existing Outfall 001 or to new Outfall 006 Monitoring/Sample control structure to Diffuser/Herrington Lake;
- Install pond liner (geomembrane);
- Construct Pipe-racks/infrastructure/Process Collection Box to divert process flows to New Process Pond, instead of to the Auxiliary Ash Pond including plant sumps, bottom ash sluice flows from Submerged Flight Conveyors (SFC) dewatering equipment (low solids %), FGD wastewaters (low solids %);

- Transition pond wastewater flows from Auxiliary Ash Pond Process Pond(s) during May 2019, allow simultaneous discharge from both New Process Pond and Auxiliary Ash Pond to combine into existing Outfall 001 to Herrington Lake until new KPDES permit and when Auxiliary Ash Pond Dewatering flows will commence (KPDES permit Phase 2). KPDES Phase 2 Flows will be directed to Outfall 006/Diffuser to Herrington Lake.

3. Process Pond South Cell – Construction Started, Completion Planned for May 2019

Prepare South ('Primary/Knock-out Cell) Process Pond & Outfall Structure(s) to receive/redirected Plant Wastewater Flows currently discharged to Auxiliary Ash Pond

- Excavate final South Process Cell, slopes, emergency overflow, perimeter, and access roadways;
- Construct discharge piping/controls capable of directing flows to either existing Outfall 001 or to new Outfall 006 Monitoring/Sample control structure to Diffuser/Herrington Lake;
- Install pond liner (geomembrane);
- Construct Pipe-racks/infrastructure/Process Collection Box to divert process flows to New Process Pond(s), instead of to the Auxiliary Ash Pond including plant sumps, bottom ash sluice flows from Submerged Flight Conveyors (SFC) dewatering equipment (low solids %), FGD wastewaters (low solids %);
- Transition pond wastewater flows from Auxiliary Ash Pond Process Pond during May 2019, allow simultaneous discharge from both New Process Pond and Auxiliary Ash Pond to combine into existing Outfall 001 to Herrington Lake until new KPDES permit when Auxiliary Ash Pond Dewatering flows will commence (KPDES permit Phase 2). KPDES Phase 2 Flows will be directed to Outfall 006/Diffuser to Herrington Lake.

4. Landfill Leachate Pond Modification – Started, Completion Planned for May 2019

Construct internal partition, connect additional Active Landfill areas inflow drainage piping.

- Construct low-height internal pond partition (to provide additional settling/retention volume), grout-in-place
- Connect piping to allow inflow drainage from Phase 1 Cell 2 new active landfill areas.

5. Process Pond to Diffuser to Herrington Lake – Outfall 006– Completion by July 2019

Construct Outfall 006 Monitoring/Sample Structure from new Process Pond discharge of Process and Stormwater Flows to Multiport, High-Rate Diffuser to Herrington Lake

- Install Outfall 006 Monitoring/Sampling structure at grade along buried pipe from Process Pond to Diffuser to Herrington Lake.

6. Railway Stormwater/Wick-Drain High Rain Flows Monitoring – Outfall 008

- Completion by July 2019

Construct Outfall 008 Monitoring/Sample Structure for stormwater sump (for monitoring any overflows s from infrequent high rainfall events where partial flows exceed maximum sump-pump capabilities to Process Pond/Outfall 006)

- Install Outfall 008 Monitoring/Sampling structure at outlet of existing discharge to Herrington Lake (prior to combining into Unit 3 Cooling Tower Blowdown flows ditch to lake).

ATTACHMENT 12

DESIGN REPORT FOR HIGH-RATE, MULTIPORT DIFFUSER

FOR OUTFALL 006 DISCHARGES TO HERRINGTON LAKE

Technical Memorandum

Date: 09/10/2018

To: Jeff Oeswein, PE

From: Wayne Ingram

CC: Wade Turner, John Storm

Ref: Project No. 567530067

Re: E.W. Brown Process Pond Effluent Discharge Mixing Analyses

This technical memorandum summarizes the analyses, results and recommendations of discharge mixing analyses for a multiport diffuser for discharge of polishing pond effluent into Herrington Lake. Wood relied upon Process Pond Effluent concentration flow data described in a separate technical memorandum (Amec Foster Wheeler, January 2018) and additional analyses described in this memorandum to develop inputs to the mixing analyses performed. Mixing analyses were performed using software CORMIX version 10.0.3 GT, a proprietary expert system software from MixZon, Inc.

Background

As part of the Auxiliary Pond CCR Rule Pond Closure activities, LG&E-KU will develop a polishing pond to manage future industrial waste streams and, potentially, partial stormwater discharges from the facility. Discharge from the polishing pond will be to Herrington Lake through a single discharge that will utilize a multiport diffuser to optimize initial mixing. LG&E-KU is required to utilize a multiport diffuser for the discharge. Standard requirements for mixing of wastewater discharges in receiving waters, or mixing zones, are provided at 401 Kentucky Administrative Regulation (KAR) 10:029. Kentucky surface water quality standards are provided at 401 KAR 10:031.

Water quality standards must be achieved within the boundaries of the permitted mixing zone. As an effluent mixes with a receiving water, the concentrations of materials in the effluent are changed by dilution with the ambient water. The rate of mixing is highly dependent upon both the discharge and the ambient water characteristics. Rapid mixing is achieved by disaggregating the discharge into multiple smaller discharges with high velocity, or "jets", which entrain ambient water. The trajectory of the effluent may also begin to either rise or sink due to density differences between the effluent and the ambient water. Density difference is associated with both the temperature and the concentrations of constituents in each. Beyond the zone where discharge characteristics, including velocity and momentum, control the plume or jet trajectory, it transitions to a true plume in which movement and mixing are controlled mainly by the turbulence associated with ambient water current and density difference. Mixing is typically very slow in that region compared to the initial mixing. The effluent plume movement and mixing may be significantly influenced by stratification in the ambient water.

A regulatory mixing zone in a reservoir in Kentucky is defined at 401 KAR 10:029 Section 4 and includes the following criterion:

- In a lake or a reservoir, unless assigned on or before December 8, 1999, an assigned mixing zone, from the point of discharge in any spatial direction, shall not exceed one-tenth (1/10) of the width of the lake, or reservoir at the discharge point.

A zone of initial dilution (ZID) is also defined with respect to toxic substances and criteria include:

- (3)(b) Concentrations of toxic substances shall not exceed the acute criteria for the protection of aquatic life at the edge of the assigned zone of initial dilution, except, numeric acute criteria may be exceeded within the zone if the frequency and duration of exposure of aquatic organisms are not sufficient to cause acute toxicity;

- (4) Unless assigned on or before July 6, 2009, a zone of initial dilution for a pollutant shall be available only to a submerged high-rate multiport outfall structure and shall be limited in size to the most restrictive of the acute criteria which shall be met:
  - Within ten (10) percent of the distance from the edge of the outfall structure to the edge of the regulatory mixing zone in a spatial direction;
  - Within a distance of fifty (50) times the square root of the cross-sectional area of a discharge port, in a spatial direction; or
  - In a horizontal direction within a distance of five (5) times the natural water depth that prevails under mixing zone design conditions, and exists before the installation of a discharge outlet.

This memorandum provides a summary of effluent characteristics, Herrington Lake characteristics, CORMIX model mixing analyses, and basic diffuser system hydraulics.

MIXING ANALYSES

A mixing analysis requires information describing three basic categories of input information: the effluent characteristics, the ambient receiving water characteristics, and the discharge structure characteristics. Each of these are briefly summarized below.

Effluent Discharge Characteristics

Polishing pond effluent characteristics are summarized in Attachment A, Table 1 (Amec Foster Wheeler, January 2018). These effluent characteristics were developed based on flow weighted concentrations of several polishing pond influents that have been sampled.

Effluent Flow Rate

The maximum volumetric discharge rate from the pond is 19.5 cfs (12.6 MGD) and the average discharge is 3.0 cfs (1.9 MGD) (Amec Foster Wheeler, January 2018). Flows into the pond are from a number of sources with varying flow generation characteristics (i.e., seepage, process water, precipitation, etc.). For a temporary initial period, drainage of interstitial water from an ash impoundment that is to be closed may be directed to the polishing pond. That flow rate is estimated to be from 100,000 gpd to 400,000 gpd (0.15 cfs to 0.62 cfs) and is additional to flows anticipated during normal operations period (19.5 cfs and 3.0 cfs). For the mixing analyses a maximum flow of 20.0 cfs was assumed, allowing 0.5 cfs for the temporary condition with drainage of interstitial water from the ash pond.

Discharge from the polishing pond is assumed to occur as gravity flow from one or more control structures such as weirs or gated outlets at the polishing pond, with pond discharge responding to inflow to the pond and temporary storage in the pond.

Effluent Concentrations

Comparison of the expected effluent concentrations to water quality standards indicates a few parameters with anticipated concentrations at or over the standards, thus relying on mixing to achieve concentrations below the standard at the edge of the mixing zone or at the edge of the ZID. Based on the sampling data representing maximum concentrations and associated water quality standards for the constituents of interest, a dilution of less than 10 at the edge of the mixing zone appears to be required to lower concentrations below water quality standards.

Effluent Temperature and Density

Polishing pond effluent temperatures will vary seasonally and over the shorter time increments dependent upon weather and pond residence time that is dependent upon flow rate. Detailed data characterizing the effluent temperatures are not available and detailed analyses to predict pond effluent temperatures on a statistical basis are not available. Effluent density is dependent upon both temperature and constituent concentrations. The polishing pond will have a surface area of approximately 3.2 acres. The storage volume will be relatively steady over time based on a fixed outlet structure (i.e., not pumped or otherwise operationally controlled) at approximately 15 acre-feet (4.9 MG). Based on average and maximum flow rates of 3.1 cfs and 19.5 cfs, the average residence time would be 2.4 days and the residence time at the maximum effluent flow rate will be approximately 0.4 day, assuming complete mixing and no short-circuiting in the pond. Based on available information, the polishing pond effluent temperature may range from significantly higher than the Herrington Lake water temperature at the discharge depth (see next section) to lower than lake temperature. Consequently, the effluent plume may range from strongly positively buoyant to negatively buoyant.

Receiving Water Characteristics

Herrington Lake is the receiving water. The effluent discharge to Herrington Lake will occur near the downstream end of Herrington Lake near the left descending bank and approximately 2000 to 2600 feet upstream from Dix Dam. The Dix River drainage area at Dix Dam is approximately 439 square miles (USGS). Discharge from Herrington Lake is either via hydroelectric turbine discharge or discharge of excess storage over the spillway. A plot of water levels from 2015 to early 2018 from USGS Station 03286000 in provided in Figure 1.

Ambient Flow and Velocity

The project location is near the downstream end of Herrington Lake. The rate of flow through a lake cross section near the site under nearly all conditions of interest is controlled by gated outlet and power generation; natural river flow is highly modified by power generation periods and reservoir storage. USGS flow data at Dix Dam provides hourly flow data for 2015 – 2017, as well as mean daily flows for 2009 – 2018, which show consistent operations in terms of flow releases. Higher releases occurred during approximately 15 percent of the time with lower discharges occurring over the majority (80 percent) of the time (Figure 2). The hydro station has three units, each rated at approximately 9.4 MW electric power capacity http://globalenergyobservatory.org/geoid/480 (28.3 MW electric total). The maximum power generation flow rate is approximately 2400 cfs. However, power is not produced consistently for the present operation (LG&E KU, 2018; https://lge-ku.com/our-company/community/neighbor-neighbor/dix-dam-generating-station), but limited to times of high flow and above normal lake levels. The discharge is normally through gates at elevations near 532 ft and 584 ft (Crain et al, 2000). Therefore, in the vicinity of the dam and the diffuser, the velocity produced by discharge is likely limited to the lower portion of the water column due to stratification with current in the upper portion of the water column produced by wind driven circulation.

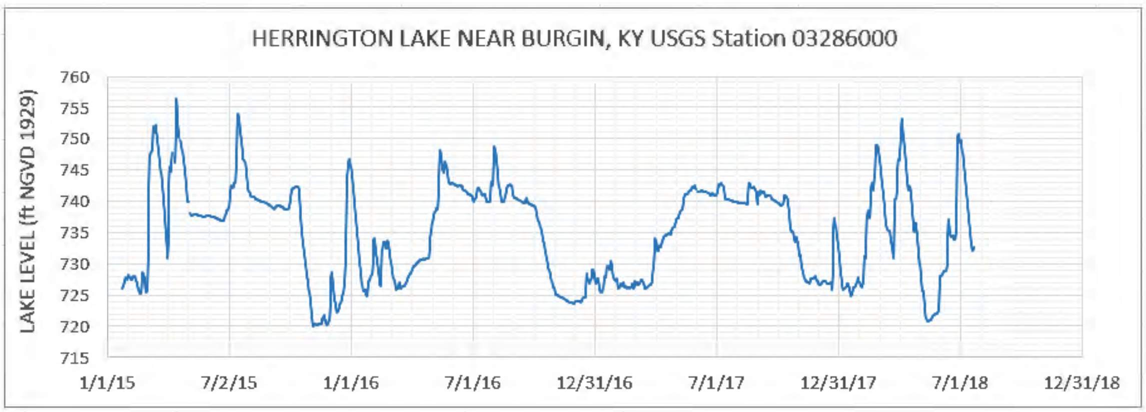


Figure 1. Daily Water Level Record USGS Station 03286000

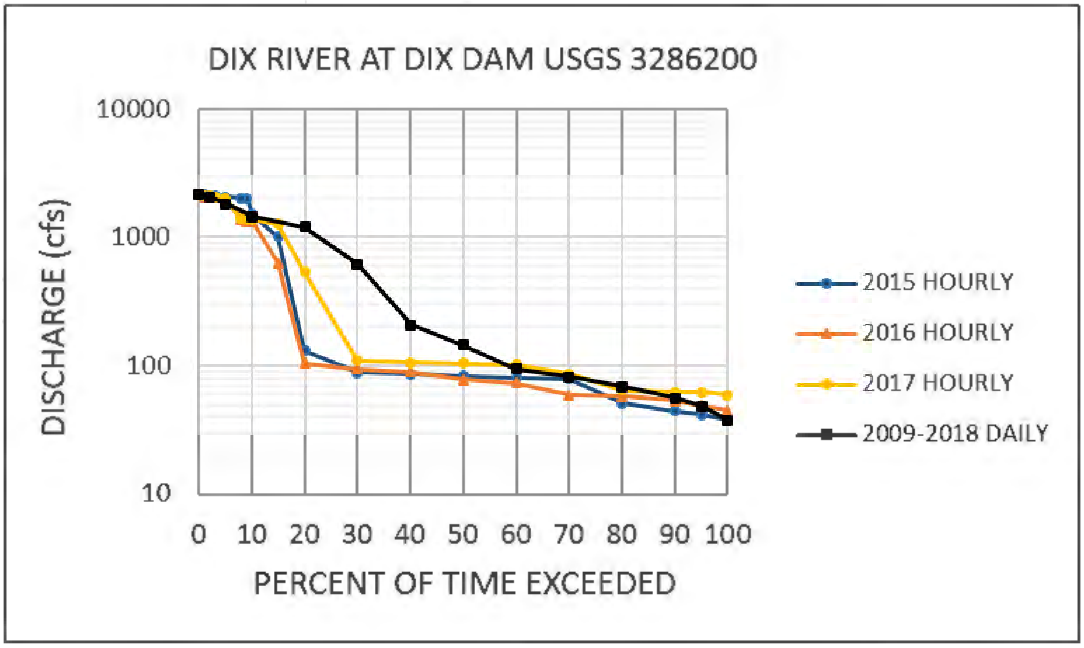


Figure 2. Hourly Flow Duration Plot, 2015, 2016, and 2017

Downstream average velocities in lower Herrington Lake are small, even for relatively infrequent high flow events; low flow conditions are most critical to mixing zone compliance. This is due to the large depth and cross sectional area of Herrington Herrington at this location and the flows discharged from Dix Dam. Near the diffuser, the average cross section area may be approximately 80,000 to 100,000 sq ft. A high flow is in the range of 2000 cfs, which yields an average velocity of less than 0.1 ft/s for a high flow condition. At a low flow of 100 cfs, the net average velocity would be approximately 0.01 ft/s. Wind driven circulation and density currents, which may be in any direction and not limited to the downstream direction, are likely to be significant than these average downstream flow velocities.

Constituent Concentrations

Herrington Lake concentrations for parameters of interest based on the polishing pond effluent have been estimated from limited lake sampling data. The primary source of data is the data available from the Corrective Action Plan (CAP) sampling that occurred in 2017 (LG&E KU, March 2018). That sampling consisted of two events, identified in the CAP as a “stratified” condition and an “over-turn” condition. The stratified condition sample was more extensive and included sampling at three depths at lake transects along the length of the lake and in embayments, including Curds Inlet and HQ Inlet in the vicinity of the discharge. Over-turn samples appeared to be from near the lake surface (no vertical profile sampling) and more limited. Selected information from the CAP in the form of concentration plots is included in Attachment B.

There is also limited other relevant sampling results available from other publically available sources, including data available through the National Water Quality Monitoring Council’s Water Quality Portal (https://www.waterqualitydata.us/).

<u>Temperatures / Density</u>
Herrington Lake is a deep, narrow reservoir with steeply sloping side walls, resulting in a relatively small surface area for the lake water volume. This contributes to the strong stratification observed in the available temperature profiles from Herrington Lake. The lake is reported to typically experience turn-overs. Reported vertical temperature information for Herrington Lake in the vicinity of the discharge are presented in Figures 3 (Buckaveckas and Crain, 1997), Figure 4 (USEPA, 1977), Figure 5 (NWQMC, 2018), and Figure 6 (Crain et al, 2000). The lake level and flow conditions on the dates of the USEPA profiles are not known, although reported monthly information indicates no unusual conditions.

A typical temperature gradient based on the available information is a nearly linear gradient with a slope of 0.2°F/ft depth. The local gradient at the diffuser depth may range from no stratification to more than 0.5°F/ft depth.

Process water intakes for the E.W. Brown plant are located immediately downstream of the alternative discharge locations, a distance of approximately 900 ft from the selected discharge location. During periods of low flow this may create the potential for re-circulation. However, recirculation would depend not only on horizontal distance but also on lake thermal stratification and plume density (temperature). The plant service water Intake elevation is at 661 feet (email from Brian Sumner to Scott Straight, 6/12/18). The normal lake level is controlled and the target elevation ranges seasonally from 720 feet (winter-spring) to 750 feet (summer – fall). The water level has periodically departed significantly from the target level in the past, however, including temporary drawdowns for dam maintenance or inspections or droughts. Since 2003, the water level is reported to have twice been as low as 716 ft. A review of data during the period from 1970 – 1990 found five instances of abnormally low pool levels between 703 and 712 feet in 1976, 1978, 1984, 1987 and 1989. Lake management and operations prior to 1970 are considered to be non-representative of current and future operations and not relevant.

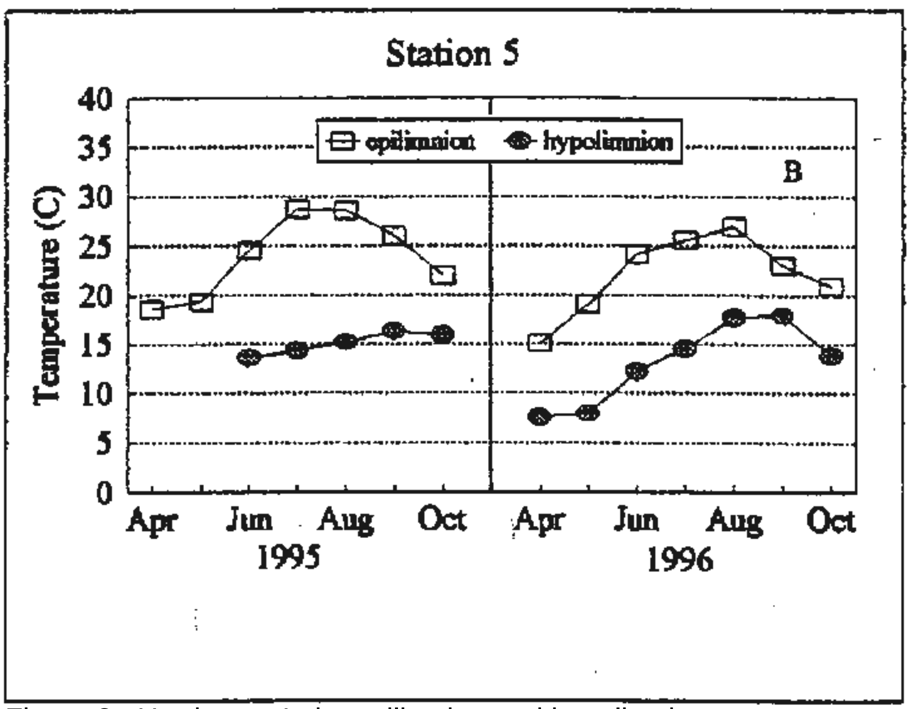


Figure 3. Herrington Lake epilimnion and hypolimnion temperatures near Dix Dam, 1995 – 1996 (Buckaveckas and Crain, 1997)

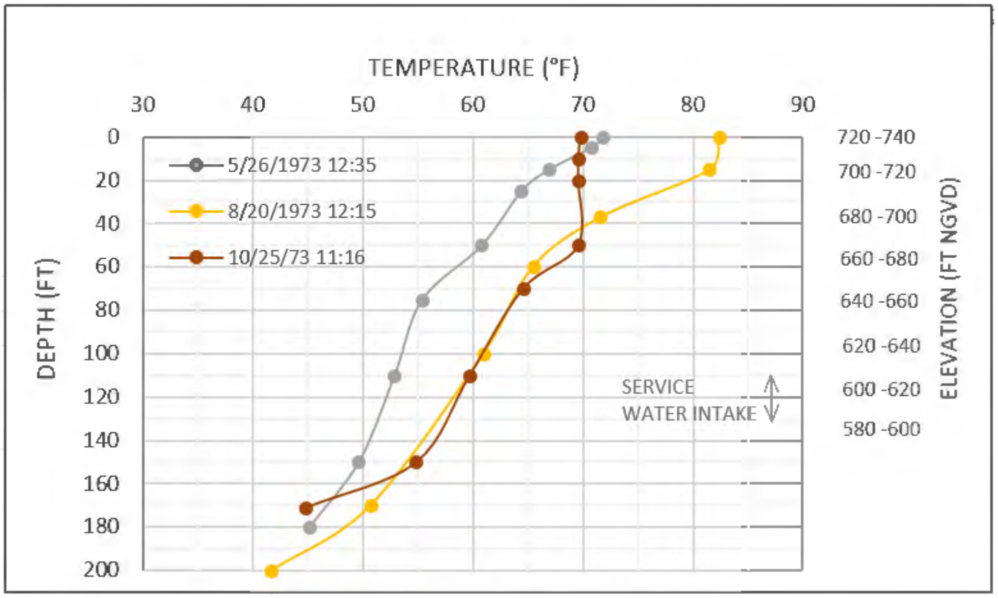


Figure 4. Observed Herrington Lake temperature profiles near proposed diffuser location, 1973 (USEPA, June 1977)

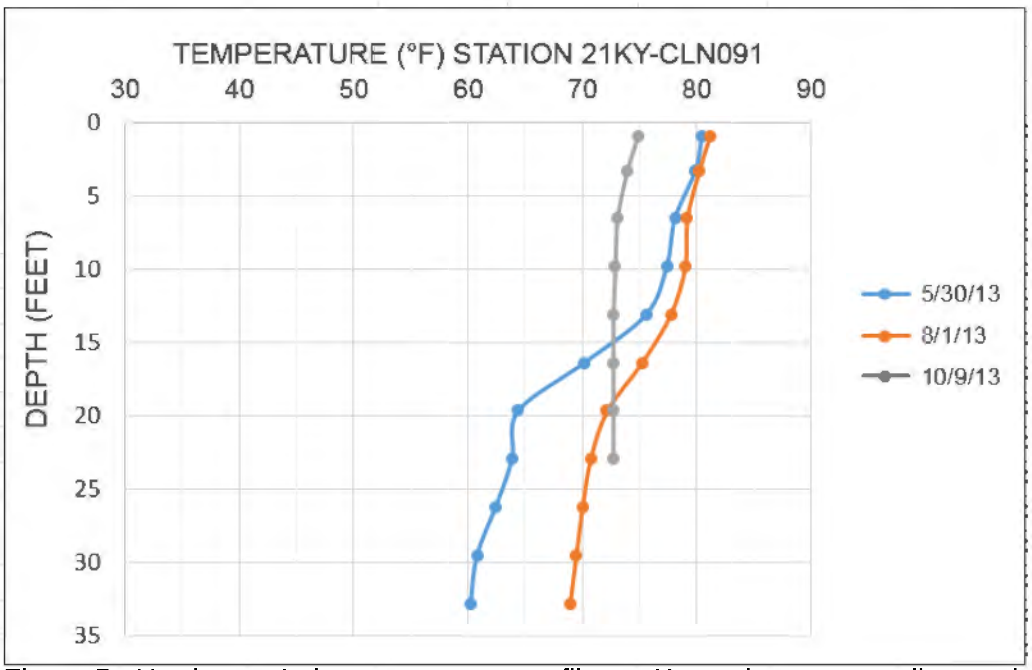


Figure 5. Herrington Lake temperature profiles at Kentucky water quality monitoring station 21KY-CLN091 (located in lower Herrington Lake) (NWQMC, 2018)

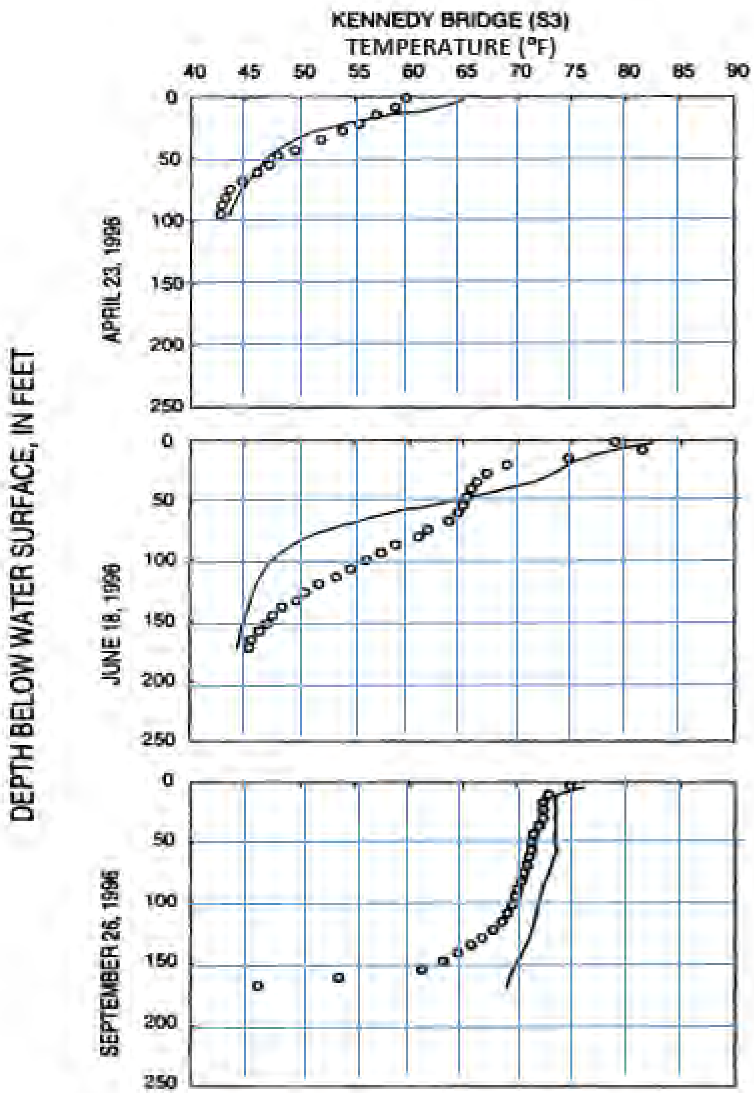


Figure 6. Observed (circles) and simulated (line) temperature profiles near Kennedy Bridge (Crain et al, 2000)

Mixing Analyses

Mixing analyses for the purpose of multiport diffuser design was performed using CORMIX. CORMIX is applicable to the near field with limited applicability and reliability to mixing beyond that region (i.e., the transition and far-field regions) due to the lake environment. Given the input information characterizing the effluent and receiving water characteristics, it remains to define the diffuser configuration based on those characteristics and the dilution required.

Target Diffuser Dilution

A multiport diffuser is required for the polishing pond discharge. A multiport diffuser optimizes initial mixing to reduce concentrations in the effluent to concentrations to meet water quality standards within the regulatory mixing zone. A multiport diffuser reduces the concentrations only by dilution resulting from rapid entrainment of ambient water. If the constituent of interest is present in the receiving water, then the dilution required to attain the water quality standard is larger than if the concentration in the ambient water is negligible. An element of design of a multiport diffuser, therefore, is to determine the dilution required for the design condition for one or more design constituent effluent concentrations.

Background concentrations in Herrington Lake are not constant and variations, in particular the high end of the range, are not well defined due to a limited number of samples. In particular, selenium, arsenic, copper, sulfate, total residual chlorine, and TDS are constituents that were identified as having a likelihood of maximum concentrations in the effluent exceeding the surface water quality standard or concentration allowed by permit. Comparing design high effluent concentrations and design ambient water concentrations, the required dilutions are generally approximately 20 or less. From sampling completed during 2012, the ambient concentrations exceeded the potential permit concentrations and a diffuser, while reducing the plume concentration at the edge of a regulatory mixing zone, could not provide for compliance for that condition.

The dilution needed to meet water quality standards at the mixing zone boundary is given by the following equation:

$$S = (C_e - C_a) / (C_s - C_a)$$

where S = required dilution
C_a = ambient background concentration
C_e = effluent concentration
C_s = maximum concentration (water quality standard)

A summary of representative pollutants with effluent, Herrington Lake, water quality standard concentrations, and required dilution is presented in Table 1. Not all parameters listed are likely to be of similar interest. Based on Table 1 and other considerations, a target dilution of 20 at the edge of the mixing zone was selected.

Diffuser Ports

Because of the large range in discharges anticipated, diffuser ports were assumed to be equipped with elastomeric duckbill diffuser valves. This type of valve opens to varying size as a result of the pressure and thereby maintains a more consistent, higher port discharge velocity which is beneficial for initial mixing. Based on vendor information for such valves, a relationship was used to relate an equivalent round port diameter required by CORMIX to an assumed valve maximum flow rate and nominal diameter. The shape of this generic curve and regression equations fit to the curve are presented in Figure 7. The relationship in Figure 7 was developed from representative TideFlex Series 35 product information and used to easily estimate an equivalent circular opening diameter approximating a typical duckbill valve by simply assuming a maximum diameter and design flow. The relationship is: $D/D_{max} = (Q/Q_{max})^{0.225}$.

Table 1. Representative Required Pollutant Concentrations and Dilutions

Pollutant	Concentration (mg/L)				Required Dilution	
	Water Quality Standard		Polishing Pond Effluent (max.)	Herrington Lake		
	chronic	acute			chronic	acute
Arsenic	0.150	0.340	0.115	0.0025	NR	NR
Cadmium [a]	0.00038[a]	0.0034	0.0005	0.0001[c]	1.4	NR
Copper [a]	0.0139 [a]	0.0218	0.174	0.002[b]	14.5	8.7
Selenium	0.005	0.005	0.02	0.002 [c]	6.0	6.0
Zinc[a]	0.178 [a]	0.178	0.13	0.004 [c]	NR	NR
Total Dissolved Solids	250	250	1109	175	12.5	12.5

[a] water quality standard based on 160 mg/L hardness as $CaCO_3$
[b] from PWS sampling data 2017
[c] from CAP sample data

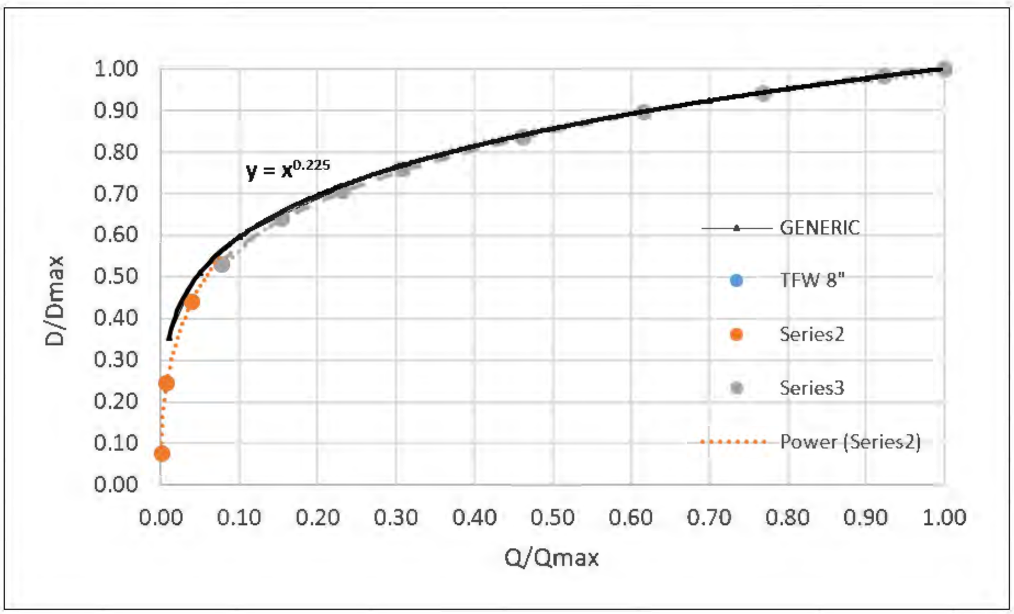


Figure 7. Duckbill Valve Generic Relationship between Flow and Equivalent Diameter

Scenarios Analyzed

The distance along the plume trajectory to a given dilution value will generally increase with effluent flow rate with other conditions remaining constant. However, threshold conditions for flow classification upon which CORMIX is based sometimes change such that sudden changes in plume characteristics occur and predicted dilution is not always continuous. The analyses includes consideration of all flows up to the maximum discharge rate (20 cfs). The majority of the time the discharge will be significantly lower than the maximum.

The difference in density between the pond effluent and Herrington Lake at the diffuser elevation will vary. Analyses were completed with a range of relative temperature differences to reflect strongly buoyant discharges to negatively buoyant discharges.

Mixing will generally be least when the ambient velocity is low. Downstream average velocities in lower Herrington Lake are small, even for relatively infrequent high flow events. Near the diffuser, the average cross section area may be approximately 80,000 to 100,000 sq ft. A high flow is in the range of 2000 cfs, yield an average velocity of less than 0.1 ft/s for a high flow condition. Consequently, a significant longitudinal downstream velocity was neglected and a near zero ambient velocity will provide the appropriate ambient velocity for conservative assessment of mixing within the regulatory mixing zone. Flows through Herrington Lake at water levels below the overflow spillway are limited by discharges through gates located relatively low in the water column (elevations 532 ft near the bottom and 584 ft MSL) as described by Crain et al (2000). Therefore, in the vicinity of the dam and the diffuser, the velocity produced by discharge is likely limited to the lower portion of the water column due to stratification with current in the upper portion of the water column produced by wind driven circulation.

The density difference between the effluent and ambient water is an important parameter that is expected to be significant influence on mixing and plume configuration. Density depends on both the temperature and the constituent concentrations. Based on relationships given in Morris and Fan (1998), there is a density difference of approximately 0.135 kg/m^3 per degree Fahrenheit (°F) of temperature difference and approximately 0.076 kg/m^3 per 100 mg/L of total dissolved solids (TDS) concentration difference. Based on available information, it appears that density differences will be primarily influenced by temperature differences. Accounting for TDS and TSS, the effluent may typically have a density up to approximately 0.3 kg/m^3 greater than the lake density with density differences due to temperature differences (15°F to -15°F) ranging from approximately 2 kg/m^3 to -2 kg/m^3. An overall range in density difference, therefore, would range from approximately 1.7 kg/m^3 (positively buoyant plume) to -2.3 kg/m^3 (negatively buoyant plume).

CORMIX merges three originally separate mixing programs into the single software. CORMIX2 is the multiport diffuser program while CORMIX1 is the single port mixing program. CORMIX2 models the discharge as a slot while CORMIX1 assumes a single circular port. It is appropriate to model individual ports of a multiport diffuser using CORMIX1 for the portion of the jet prior to merging with other jets. For the proposed diffuser, the jets/plumes do not merge until relatively near the edge of the mixing zone, and both single port and multiport analyses were completed.

Herrington Lake is approximately 800 feet wide at the location of the diffuser. Consequently, the regulatory mixing zone extends from the diffuser ports laterally for a distance of approximately 80 feet, or 10% of the lake width in accordance with 401 KAR 10:029 Section 4.

CORMIX includes numerous constraints regarding allowable input conditions, including geometry relating water depths and discharge structure configuration. For a multiport diffuser, there are limitations such that the ambient water depth cannot be greater than the diffuser length and the diffuser discharge port must be in either the lower or the upper one-third of the water column. Consequently, the depths on the ambient input data cannot be associated with either an actual assumed lake surface elevation or a lake bottom elevation. Rather, it is assumed to be a layer within the lake water column which was set approximately equal to the diffuser length.

CORMIX Predictions

A series of CORMIX analyses were completed using a range of effluent flow rates, holding other inputs constant (see Attachment C) at the final proposed diffuser design configuration. The results are plotted in Figure 8. For these conditions, the minimum dilution at a distance of 80 feet (24.4 m) is approximately 33 at the maximum discharge (20 cfs). The target dilution value of 20 occurs at a minimum of approximately 62 feet (19 m).

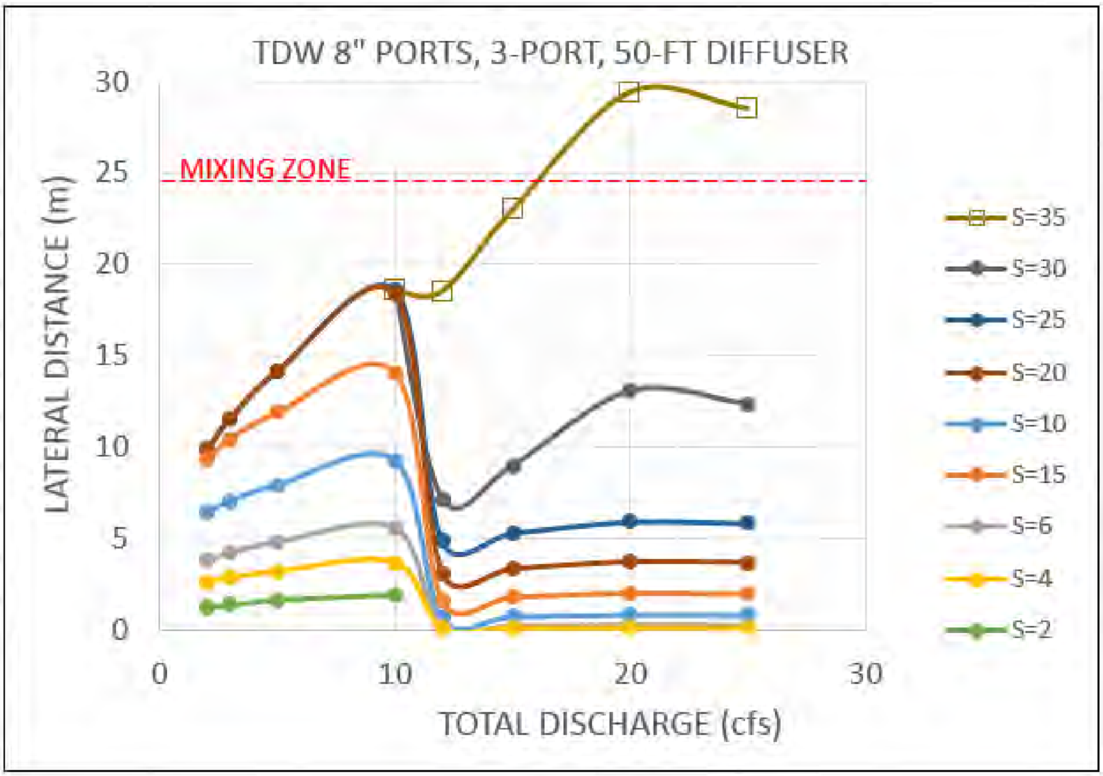


Figure 8. Lateral Distance to Selected Dilutions for Range of Diffuser Flow (for case of T_e=27°C, H0=10m)

It is observed that CORMIX predicts consideration variation in dilution based on effluent flow. This variation results from the approach used by CORMIX that utilizes flow classifications based on length-scale relationships. Plume characteristics can change significantly with a transition from one flow classification to the next. The flow classification at lower effluent discharge rates is IMS4, but at 12 cfs total effluent flow the flow class transitions to IMPU8.

CORMIX generates five different tabular output files with each analysis. Each file provides some unique information as well as some duplicative information. Tabular output for the proposed diffuser configuration for maximum and average flows, and multiport and single port analyses, is included in Attachment D.

Numerous other series of analyses were completed to evaluate changes in dilution with variations in other inputs, such as port vertical angle, temperature (density) differences defining buoyancy strength (as well as negatively and positive buoyancy), and number of ports.

Recommended Multiport Diffuser

The proposed diffuser configuration is as follows:

- Three ports spaced at approximately 25 ft.
- Each port equipped with an elastomeric duckbill valve that produces maximum and average velocities of approximately 19 ft/s and 6.7 ft/s for total flows of 20 cfs and 3 cfs (e.g., TideFlex Series 35W TFW 8-inch valve (Hydraulic Code 588), or equivalent).
- End ports oriented with horizontal angle of 22.5° from perpendicular to the diffuser axis, middle port perpendicular to the axis.
- End ports oriented with vertical angle of approximately -15° (downward) from horizontal and middle port oriented at approximately +15° (upward) from horizontal
- Diffuser axis located at approximately elevation 685 ft
- Diffuser ports located approximately 15 ft or more from the lake side slope.

This is based on the lake side slope being significantly steeper than 15° (1.2H:1V) in the vicinity of the ports such that the downward-angled ports do not cause a discharge impingement on the lake side or lake bed with potential erosion. Based on bathymetric mapping, the local slope is expected to accommodate these angles. However, if the local slope is found to be flatter and impingement potential exists, the port vertical angles should be adjusted to avoid that potential.

Because the diffuser will discharge flows generated by gravity discharge from overflow of the polishing pond and therefore potentially highly variable, it is recommended that an elastomeric "duck-bill" type of discharge port be provided. This type of valve functions with opening area and discharge related to pressure such that velocities are more consistent than would occur with a fixed port area. CORMIX does not provide the capability to define a duck-bill type port. For CORMIX analyses representing conditions consistent with vary effluent flow rates for a given diffuser design, a generic relationship based on typical manufacturer data was assumed relating discharge rate and port area (and therefore velocity). A port discharge velocity of approximately 19 ft/s was assumed for maximum discharge (20 cfs) and 6.7 ft/s at a discharge of 3.0 cfs.

It is noted that there is potential for operational control of the discharge to maximize mixing. As seen in Figure 8, at lower flows the lateral distance to a given dilution is larger than for higher flows. This is due to slower mixing at lower port velocities. Controlled discharges with higher flows released periodically might eliminate the lower flows at which the dilution is reduced. However, CORMIX modeling indicates that dilution is more than adequate to meet water quality standards at the edge of the mixing zone at any effluent flow rate. If compliance with a toxic substance standard and ZID criteria may be more significant based on Figure 8. For the proposed diffuser, the equivalent port diameter is 8 inches (0.203 m) with area of 0.35 sq ft. The 10% width of the mixing zone is the controlling ZID dimension, being 8 feet (2.44 m) compared to 30 feet (9.0 m) based on port area. For higher flows a dilution of 15 is predicted within 8 ft of the port while the dilution at lower flows may be approximately 3. However, it must be recognized that CORMIX provides a best estimate of mixing, but results must be considered approximate due to the complexity of mixing processes.

Placing the diffuser at approximately 685 ft puts the discharge at approximately 24 feet above the service water intake which, at 900 feet horizontal distance, is relatively close to the diffuser. CORMIX predictions indicate that in a normally stratified lake the plume beyond the near-field will quickly rise or sink and then spread laterally in a relatively thin vertical layer. That same thermally stratified condition is expected to result in the service water being obtained from a vertical layer that is likely relatively limited with little mixing with overlying or underlying water. Additionally, it is anticipated that the pond discharge will normally be at a higher temperature than the lake water at elevation 685 feet, resulting in a positively buoyant effluent plume. During the more infrequent periods of a negatively buoyant plume with the effluent temperature colder than the lake temperature at 685 feet, the plume appears unlikely to sink more than several feet before buoyance is reduced and the plume transitions to a lateral spreading regime.

CORMIX2 provides an option to specify a “fanned” multiport diffuser. CORMIX uses a specific configuration for a fanned diffuser; based on the equation given for unidirectional fanned diffusers, it appears that the end ports are rotated outward at a horizontal angle of approximately 8.6°. The proposed 3-port diffuser has the two end ports with horizontal angle of 22.5° from the diffuser axis and will generally result in each of the jets functioning as discreet jets with little opportunity for merging of jets in the near-field due to the angles and separation distances. This is expected to maximize the initial mixing potential.

Diffuser System Hydraulics

A single gravity flow pipeline will convey the process pond discharge to the diffuser manifold. The selected pipeline alignment length is approximately 1600 lineal feet. The pipe will slope from an upstream end elevation of approximately 822 feet to 685 feet, a fall of 127 feet. The slope varies along the alignment with a maximum slope at the diffuser end of where the elevation change is from 772 feet to 685 feet with a length of approximately 200 feet (slope of nearly 40%). An 800-feet long segment in the middle of the alignment has an average slope of 1.3%. The most upstream 500-feet long segment will have a slope of approximately 6%.

The pipe will be HDPE. Due to the smooth wall the pipe will have low friction head loss. The flat (1.3% slope) section would convey 20 cfs at a depth of approximately 12 inches.

The downstream end of the pipe will be submerged to varying elevations, from a high of approximately 772 feet to a low of approximately 685 feet. These elevations are all within the steep, 40%, slope segment. The head loss versus discharge relationship for the TideFlex Series 35W 8-inch TFW valve is approximately linear with flow, with a head loss of approximately 5.5 feet at a flow of 6.7 cfs. This indicates that the head loss will cause water to “back-up” in the steeply sloping pipe segment to a level slightly above the lake level, thus creating the pressure to open the duckbill valves to the corresponding opening size to pass that flow. Upstream of the port head level, flow in the pipe will be rapid down the steep slope with significant turbulence created by the water plunging into the full pipe.

Depending on the minimum installed slope along the pipe and potential for near full pipe flow, an air release valve may be appropriate to avoid potential for surging flow.

REFERENCES

Amec Environment & Infrastructure, Inc., September 27, 2013. Groundwater Assessment Report. E.W. Brown Generating Station, Mercer County, Kentucky, Agency Interest #3148, Activity ID No. AIN20120001. Prepared for LG&E – KU.

Buckaveckas, PA, and AS Crain, 1997. Calibration of a Water-Quality Model for Herrington Lake Using Empirically Derived Measurements of Phytoplankton Growth and Nutrient Assimilation. Research Report No. 22, University of Kentucky, Kentucky Water Resources Research Institute, Lexington, KY

Crain, Angela S., Allison A. Shipp, Thomas O. Mesko, and G. Lynn Jarrett, 2000. Modeling Hydrodynamics and Water Quality in Herrington Lake, Kentucky. Water-Resources Investigations Report 99-4281. Prepared in cooperation with the Kentucky Natural Resources and Environmental Protection Cabinet, Louisville, Kentucky

Kentucky Administrative Regulations, Title 401 Energy and Environment Cabinet – Department of Environmental Protection, Chapter 10 Water Quality Standards, Part 29 General Provisions

LG&E KU, March 2018. Draft Surface Water Data Tables, Sampling performed in accordance with Herrington Lake Corrective Action Plan, Mercer County, Kentucky. Prepared for Kentucky Utilities Company for submittal to Kentucky Division of Water, Agreed Order No. DOW-17001

Morris, G.L. and J. Fan, 1998. Reservoir Sedimentation Handbook. McGraw-Hill

National Water Quality Monitoring Council, . Water Quality Data Portal https://www.waterqualitydata.us/portal/ accessed February 2018.

Ramboll Environ, Herrington Lake Corrective Action Plan, Mercer County, Kentucky. Prepared for Kentucky Utilities Company for submittal to Kentucky Division of Water, Agreed Order No. DOW - 17001

US Geological Survey. National Water Information System: Web Interface.

U.S. Environmental Protection Agency, June 1977. National Eutrophication Survey, Report on Herrington Lake, Bolye, Garrard, and Mercer Counties, Kentucky, EPA Region IV, Working Paper 353. Prepared by Corvallis Environmental Research Laboratory and Environmental Monitoring & Support Laboratory.

ATTACHMENTS

A. Polishing Pond Effluent Concentrations
B. Herrington Lake Water Quality
C. CORMIX Input Windows
D. CORMIX Tabular Output

ATTACHMENT A

Polishing Pond Effluent Concentrations

Table 1: Polishing Pond Effluent Characteristics.

Description	Potential KPDES Permit Limits	MCL	Combined Streams (Average)	Combined Streams (Maximum)
Flow, gpm	---	---	1,377	8,731
Specific Gravity			1.00	1.00
Temp, ºC	---	---	21	28
Commons				
pH, S.U.	6 - 9	---	7.56	8.56
Total Alkalinity	---	---	144.7	179.1
Nitrogen, Ammonia	---	---	0.1	0.2
Nitrogen, Nitrate	4.4, (17)	---	1.4	1.9
Sulfide	---	---	0.1	0.1
Silica	---	---	-	-
Boron	---	---	2.6	3.9
Total Residual Chlorine	0.2	---	0.2	1.3
Anions				
Bicarbonate	---	---	173	181
Carbonate	---	---	1	12
Bromide	---	---	6	22
Chloride	1200	---	41	59
Fluoride	---	---	1	1
Nitrate	---	---	6.2	9
Sulfate	250	---	456	562
Cations				
Calcium	---	---	167	199
Magnesium	---	---	33	44
Sodium	---	---	60	82
Metals				
Aluminum	---	---	0.67	4.37
Antimony	0.640	0.006	0.000	0.000
Arsenic	0.340	0.01	0.027	0.115
Barium	---	2	0.03	0.06
Beryllium	0.010	0.004	0.000	0.000
Cadmium	0.00506	0.005	0.00051	0.00000
Chromium	0.1	0.1	0.00	0.01
Copper	0.0205	1.3	0.0595	0.1744
Cyanide	---	0.2	0.01	0.01
Iron*	4	---	< 4	< 4
Lead	0.13680	0.015	0.00086	0.00666
Manganese	---	---	1.86	3.98
Mercury	0.000051	---	0.000000	0.000000
Nickel	0.6612	---	0.0790	0.2284

Selenium	0.005, (0.02)	0.05	0.010	0.020
Silver	0.0076	---	0.0002	0.0007
Thallium	0.00047	0.002	0.00000	0.00000
Zinc	0.169	---	0.051	0.130
Other				
TSS[#]	30, (65)	---	< 30	< 30
TDS (180 ºC)	250	---	875	1,109
Total Hardness, mg/L $CaCO_3$	---	---	554.9	682.3

Notes:
All values in mg/L, unless noted otherwise;
$CaCO_3$ – calcium carbonate; OWS – oil water separator; TSS – Total suspended solids; TDS – Total dissolved solids; gpm – gallons per minute; Temp – temperature; °C – degree Celsius; S.U. – Standard Units; MCL – Maximum contaminant level; KPDES - Kentucky Pollutant Discharge Elimination System

*Iron average and maximum concentration immediately after mixing will be at 10.24 and 25.7 mg/L, respectively. After settling in the pond this concentration will be lesser than 4 mg/L, and will be able to meet the expected limits.
[#] Total Suspended Solids average and maximum concentrations immediately after mixing will be at 39 ad 299 mg/L, respectively. After settling in the pond the concentration will be lesser than 30 mg/L, and will be able to meet the expected limits.

Prepared by: SO; Checked by RK

Table 2a: Water Quality of Waste Streams (Average)

Description	Potential KPDES Permit Limits	MCL	Combustion Turbine OWS 1	Combustion Turbine OWS 2	Unit 1 & 2 OWS	Unit 3 OWS	Abutment Drain	Wick Drain	Landfill Leachate	Coal Pile Runoff	Toe Drain Sump	Limestone Pile Runoff Sump	Briar Patch Spring
Flow, gpm	---	---	3.00	3.00	347.00	383.00	60.00	62.00	120.00	120.00	120.00	35.00	69.00
Temp, ºC	---	---	24	23	18	25	18	19	26	24	23	-	17
Commons													
pH, S.U.	6 - 9	---	7.88	7.95	7.82	7.81	6.87	8.34	8.16	5.74	7.82	8.30	6.93
Total Alkalinity	---	---	81.3	60.6	120.1	146.0	171.2	186.0	161.7	75.8	184.2	100.0	192.1
Nitrogen, Ammonia	---	---	0.1	0.2	0.1	0.1	1.1	0.1	0.1	0.1	0.1	-	0.1
Nitrogen, Nitrate	4.4, (17)	---	1.0	0.1	1.1	1.1	0.1	1.3	3.7	1.5	1.0	-	1.7
Sulfide	---	---	0.1	0.2	0.1	0.0	-	0.0	0.0	0.1	0.1	-	0.0
Boron	---	---	0.2	0.1	0.3	0.7	4.9	0.3	17.6	0.4	3.3	-	2.7
Total Residual Chlorine	0.2	---	0.1	0.3	0.2	0.3	0.2	0.1	0.1	0.1	0.1		0.1
Anions													
Bicarbonate	---	---	98	73	145	176	208	220	173	92	221	121	234
Carbonate	---	---	0	0	0	1	0	3	3	0	1	1	0
Bromide	---	---	-	1	-	1	26	1	28	13	1	-	7
Chloride	1200	---	6	61	13	14	65	18	248	25	39	-	23
Fluoride	---	---	-	0	0	0	0	1	5	0	0	-	1
Nitrate	---	---	4.5	0.4	5.0	5.0	0.4	5.6	16.3	6.8	4.3	-	7.7
Sulfate	250	---	20	8	28	141	1,073	309	2,212	582	318	-	731
Cations													
Calcium	---	---	32	26	48	95	402	26	633	120	159	40	292
Magnesium	---	---	6	18	9	15	62	1	133	28	38	-	59
Sodium	---	---	4	3	5	8	42	217	333	135	9	-	16
Metals													
Aluminum	---	---	0.05	0.50	0.10	0.30	0.04	0.04	0.97	3.73	0.05	-	0.09
Antimony	0.640	0.006	0.004	0.002	0.000	0.002	0.002	0.002	0.003	0.000	0.000		0.001
Arsenic	0.340	0.01	0.001	0.030	0.003	0.012	0.222	0.001	0.006	-	0.140	-	0.009
Barium	---	2	0.03	0.46	0.03	0.03	0.03	0.03	0.04	0.04	0.04	-	0.03

Beryllium	0.010	0.004	0.001	0.005	0.000	0.001	0.001	0.001	0.001	0.000	0.000		0.001
Cadmium	0.00506	0.005	-	0.00300	-	0.00094	0.00100	0.00100	0.00073	-	-	-	0.00100
Chromium	0.1	0.1	-	0.06	-	0.00	0.00	0.00	0.00	-	-	-	0.00
Copper	0.0205	1.3	0.0870	0.0846	0.2000	0.0221	0.0008	0.0008	0.0078	0.0200	-	-	0.0010
Cyanide	---	0.2	0.01	0.01	0.01	0.00	0.01	0.01	0.03	-	0.01		0.01
Iron	4	---	0.70	76.45	0.25	4.48	73.38	0.13	1.36	57.08	2.16	-	0.16
Lead	0.13680	0.015	-	0.08989	-	0.00100	0.00100	0.00100	0.00240	-	-	-	0.00100
Manganese	---	---	0.06	2.27	0.03	1.70	24.31	0.19	0.98	1.60	0.39	-	0.04
Mercury	0.000051	---	0.000002	0.000019	0.000005	0.000004	0.000001	0.00100	0.000073	0.000003	0.000002		0.000002
Nickel	0.6612	---		0.0768	0.2300	0.0062	0.0189	0.0007	0.0064	0.2000	-	-	0.0028
Selenium	0.005, (0.02)	0.05	0.002	0.006	-	0.001	0.002	0.001	0.118	-	-		0.010
Silver	0.0076	---		0.0010	-	-	-	0.0010	0.0010	-	-	-	0.0010
Thallium	0.00047	0.002	0.00100	0.00173	0.00000	0.00096	0.00100	0.00100	0.00241	0.00000	0.00000		0.00052
Zinc	0.169	---	0.083	0.685	0.010	0.016	0.008	0.006	0.018	0.440	0.010	-	0.009
Other													
TSS	30, (65)	---	3	460	16	58	68	2	61	90	5	-	3
TDS (180 ºC)	---	---	123	159	184	375	1,828	694	3,798	964	700	101	1,269
Total Hardness, mg/L $CaCO_3$	---	---	105.4	144.1	155.2	303.0	1,300.7	68.5	2,126.1	415.7	553.7	100.0	969.9

Notes:
All values in mg/L, unless noted otherwise
$CaCO_3$ – calcium carbonate; OWS – oil water separator; TSS – Total suspended solids; TDS – Total dissolved solids; gpm – gallons per minute; Temp – temperature; °C – degree Celsius; S.U. – Standard Units

Prepared by: SO; Checked by RK

Table 2b: Water Quality of Waste Streams (Maximum)

Description	Potential KPDES Permit Limits	MCL	Combustion Turbine OWS 1	Combustion Turbine OWS 2	Unit 1 & 2 OWS	Unit 3 OWS	Abutm ent Drain	Wick Drain	Landfill Leachate	Coal Pile Runoff	Toe Drain Sump	Limestone Pile Runoff Sump	Briar Patch Spring
Flow, gpm	---	---	41.00	41.00	694.00	4,379.00	721.00	721.00	533.00	533.00	533.00	150.00	500
Temp, ºC	---	---	26	27	31	30	19	21	37	28	25	20	20
Commons													
pH, S.U.	6 - 9	---	8.53	8.92	8.87	8.98	8.33	9.36	9.01	4.30	8.53	8.30	7.73
Total Alkalinity	---	---	193.0	90.7	140.0	180.0	219.0	230.0	228.0	-	204.0	100.0	219.0
Nitrogen, Ammonia	---	---	0.1	1.2	0.1	0.2	1.2	0.1	0.1	0.2	0.1	-	0.1
Nitrogen, Nitrate	4.4, (17)	---	3.5	0.1	1.3	1.6	0.1	3.0	6.0	2.8	1.5	-	2.4
Sulfide	---	---	0.1	1.2	0.1	0.0	0.1	0.0	0.0	0.1	0.1	-	0.0
Boron	---	---	0.5	0.3	0.4	0.8	5.3	0.4	36.5	0.6	5.0	-	6.5
Total Residual Chlorine	0.2	---	0.3	1.7	0.3	2.2	1.3	0.2	0.3	0.2	0.1		0.2
Anions													
Bicarbonate	---	---	224	93	152	188	252	208	104	-	229	119	263
Carbonate	---	---	5	5	8	14	4	34	16	-	6	1	1
Bromide	---	---	1	1	1	1	100	5	95	100	1	-	20
Chloride	1200	---	21	57	53	17	73	27	475	38	53	-	55
Fluoride	---	---	0	0	0	0	0	1	6	1	1	-	2
Nitrate	---	---	16	0	6	7	0	13	27	12	7	-	10
Sulfate	250	---	63	13	50	192	1,190	388	2,900	1,300	433	-	848
Cations													
Calcium	---	---	76	35	57	116	430	185	701	168	202	40	337
Magnesium	---	---	20	2	9	18	67	29	270	42	51	-	62
Sodium	---	---	14	9	37	15	101	49	515	404	9	-	50
Metals													
Aluminum	---	---	0.14	556.00	0.41	1.57	0.10	0.13	5.06	9.72	0.10	-	0.27
Antimony	0.640	0.006	0.017	0.002	0.000	0.002	0.002	0.002	0.007	0.000	0.000		0.002
Arsenic	0.340	0.01	0.002	0.295	0.003	0.023	0.978	0.002	0.023	0.010	0.290	-	0.015
Barium	---	2	0.04	4.33	0.03	0.04	0.03	0.03	0.09	0.07	0.05	-	0.05
Beryllium	0.010	0.004	0.001	0.040	0.000	0.001	0.001	0.001	0.002	0.000	0.000		0.001

Cadmium	0.00506	0.005	0.00100	0.02110	0.00000	0.00094	0.00100	0.00100	0.00073	0.01000	0.00000	0.00000	0.00100
Chromium	0.1	0.1	0.00	0.62	-	0.00	0.00	0.00	0.01	-	-	-	0.00
Copper	0.0205	1.3	0.1740	0.8230	1.8100	0.0388	0.0008	0.0022	0.0198	0.0800	-	-	0.0014
Cyanide	---	0.2	0.01	0.01	0.01	0.01	0.01	0.01	0.12	0.01	0.01		0.01
Iron	4	---	1.06	756.00	1.37	6.58	118.00	0.19	5.11	137.00	3.88	-	1.23
Lead	0.13680	0.015	0.00100	0.89200	-	0.00345	0.00100	0.00100	0.00840	-	-	-	0.00100
Manganese	---	---	0.11	21.00	0.16	2.34	27.70	0.28	2.52	2.94	0.73	-	0.09
Mercury	0.000051	---	0.000003	0.000142	0.000018	0.000012	0.000002	0.000008	0.000206	0.000005	0.000003		0.000003
Nickel	0.6612	---	0.0026	0.7580	2.2700	0.0179	0.0921	0.0007	0.0105	0.4400	0.0000	0.0000	0.0036
Selenium	0.005, (0.02)	0.05	0.002	0.042	-	0.002	0.002	0.001	0.180	0.010	0.010		0.037
Silver	0.0076	---	0.0010	0.0014	0.0000	0.0000	0.0000	0.0010	0.0010	0.0000	0.0000	0.0000	0.0100
Thallium	0.00047	0.002	0.00100	0.00829	0.00000	0.00100	0.00100	0.00100	0.00386	0.00000	0.00000		0.00100
Zinc	0.169	---	0.144	6.720	0.080	0.049	0.016	0.014	0.067	0.960	0.010	-	0.009
Other													
TSS	30, (65)	---	5	4,490	77	470	101	3	242	196	11	-	7
TDS (180 ºC)	---	---	331	209	305	483	2,152	838	5,270	2,073	907	101	1,554
Total Hardness, mg/L $CaCO_3$	---	---	269.2	135.0	181.5	368.5	1,396.9	579.2	2,863.9	596.4	716.6	100.0	1,093.7

Notes:
All values in mg/L, unless noted otherwise
$CaCO_3$ – calcium carbonate; OWS – oil water separator; TSS – Total suspended solids; TDS – Total dissolved solids; gpm – gallons per minute; Temp – temperature; °C – degree Celsius; S.U. – Standard Units

Prepared by: SO; Checked by RK

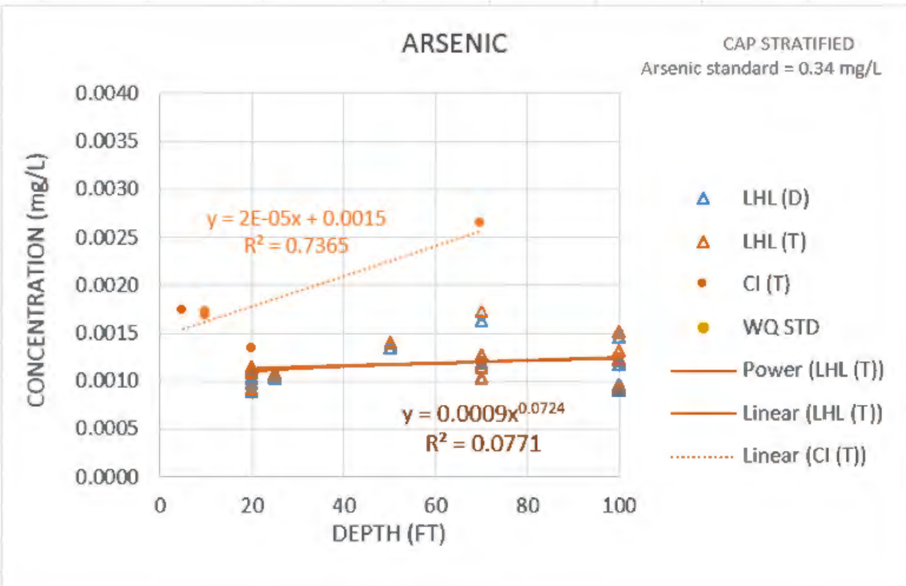
ATTACHMENT B

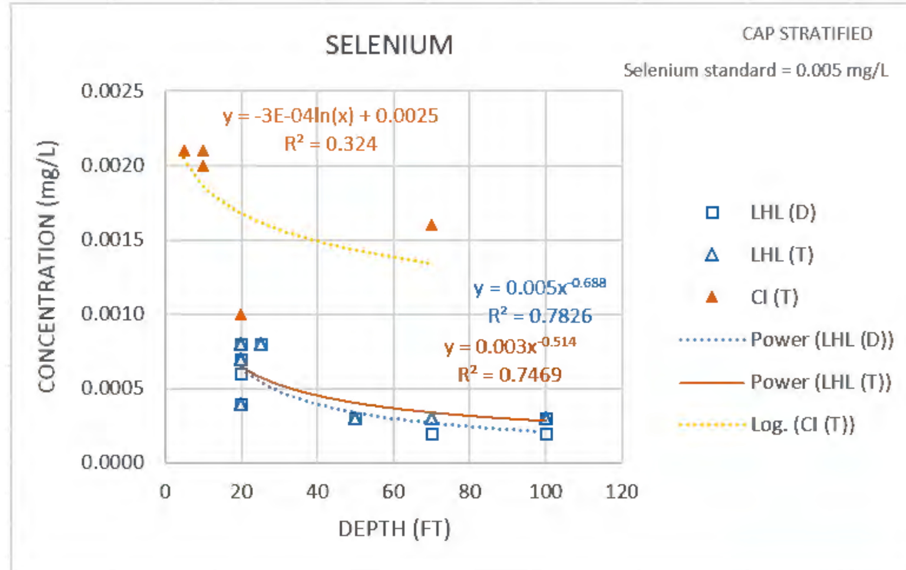
HERRINGTON LAKE WATER QUALITY SAMPLE PLOTS

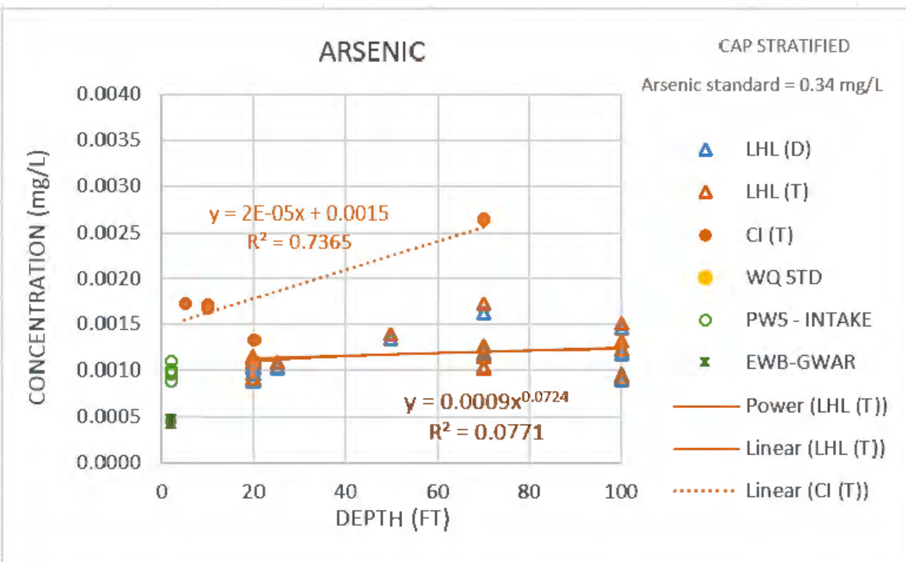
CORRECTIVE ACTION PLAN SAMPLES 2017

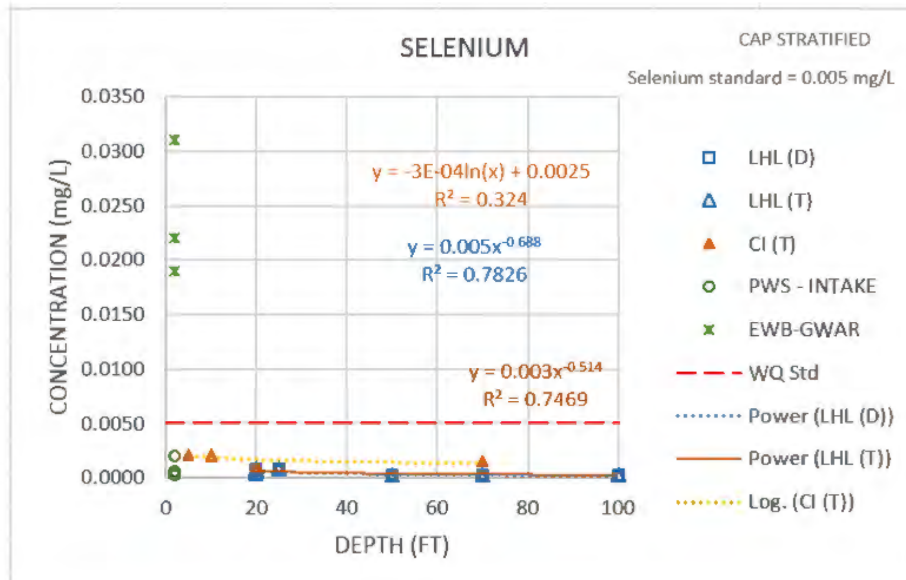
(LG&E KU, March 2018)

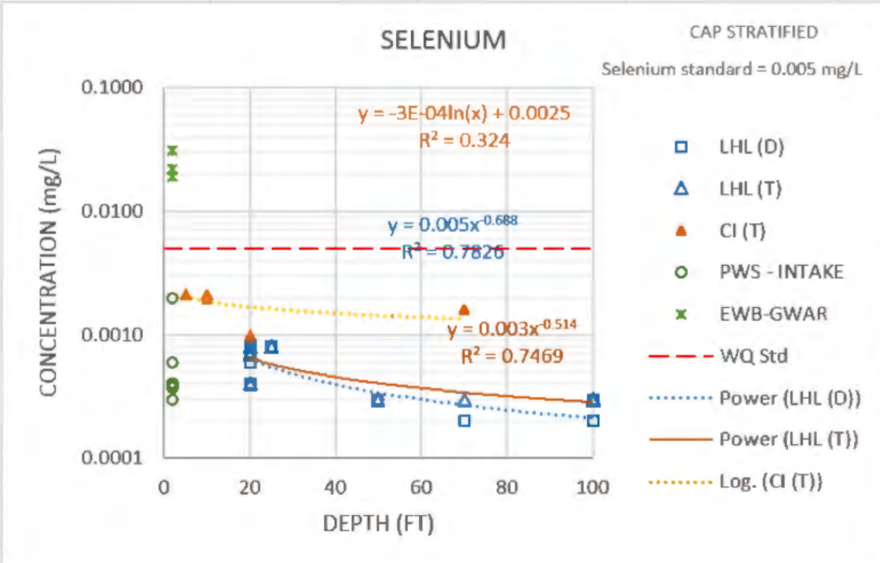
LHL	Lower Herrington Lake
CI	Curds Inlet Lake
T	Total
D	Dissolved

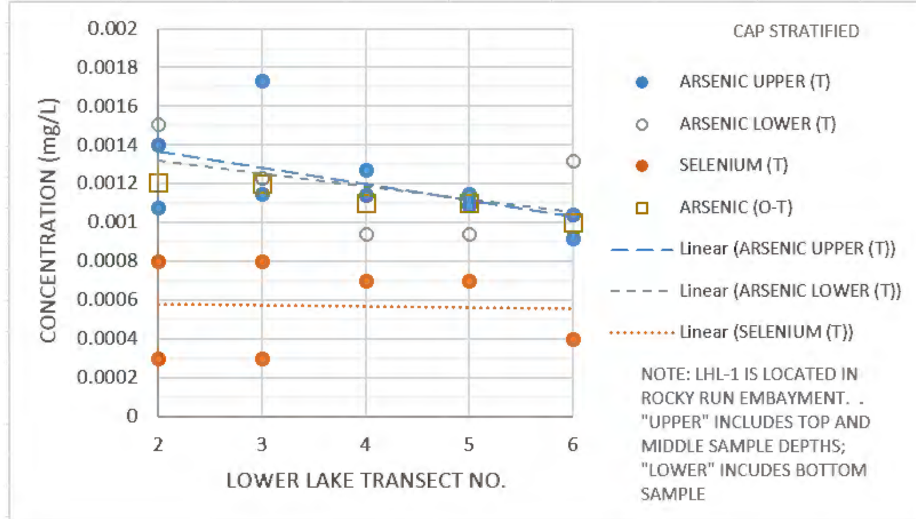

ARSENIC
CAP STRATIFIED
Arsenic standard = 0.34 mg/L
CONCENTRATION (mg/L)
DEPTH (FT)
y = 2E-05x + 0.0015
R² = 0.7365
y = 0.0009x^0.0724
R² = 0.0771
LHL (D)
LHL (T)
CI (T)
WQ STD
Power (LHL (T))
Linear (LHL (T))
Linear (CI (T))

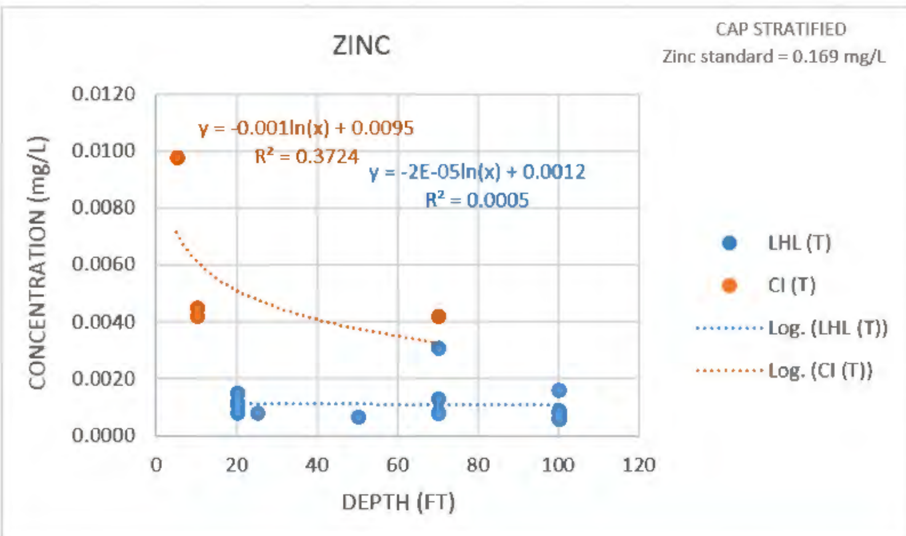

SELENIUM
CAP STRATIFIED
Selenium standard = 0.005 mg/L
CONCENTRATION (mg/L)
DEPTH (FT)
y = -3E-04ln(x) + 0.0025
R² = 0.324
y = 0.005x^-0.688
R² = 0.7826
y = 0.003x^-0.514
R² = 0.7469
LHL (D)
LHL (T)
CI (T)
Power (LHL (D))
Power (LHL (T))
Log. (CI (T))

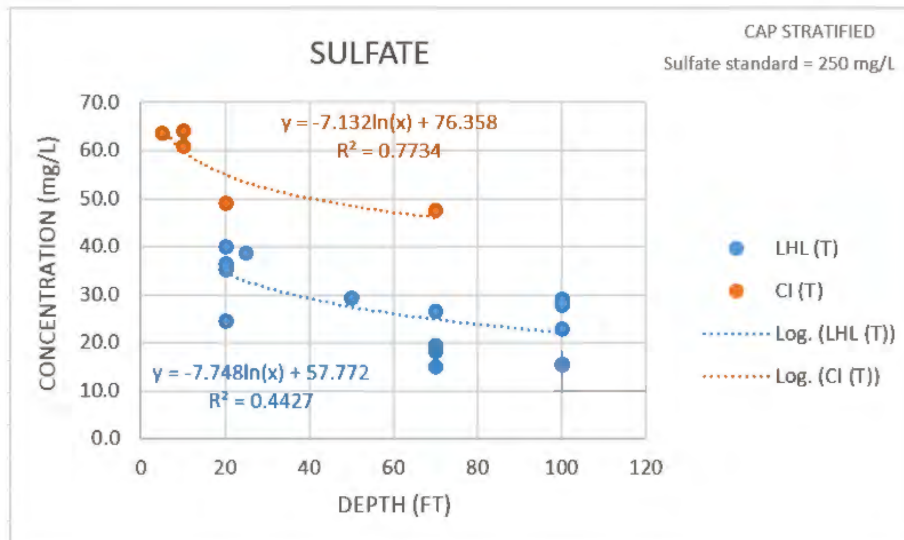

ARSENIC
CAP STRATIFIED
Arsenic standard = 0.34 mg/L
CONCENTRATION (mg/L)
DEPTH (FT)
y = 2E-05x + 0.0015
R² = 0.7365
y = 0.0009x^0.0724
R² = 0.0771
LHL (D)
LHL (T)
CI (T)
WQ STD
PWS - INTAKE
EWB-GWAR
Power (LHL (T))
Linear (LHL (T))
Linear (CI (T))

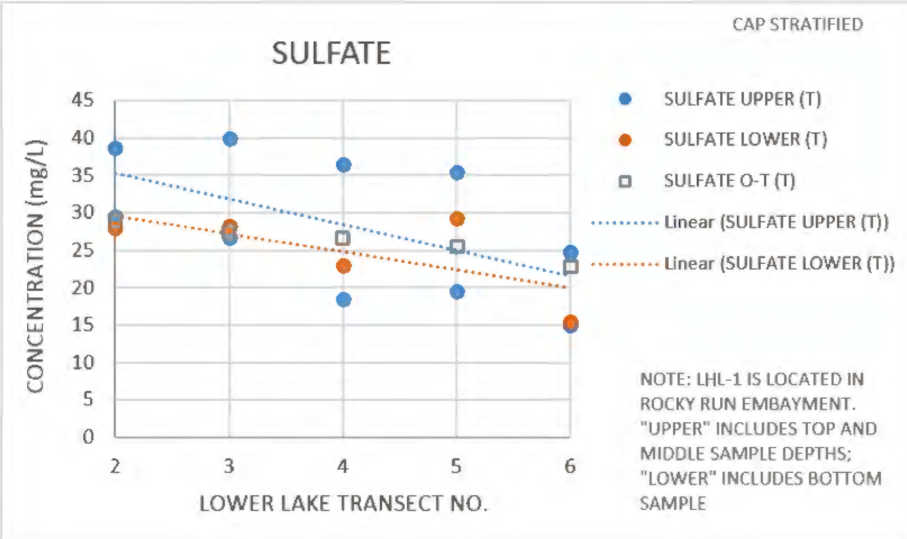

SELENIUM
CAP STRATIFIED
Selenium standard = 0.005 mg/L
CONCENTRATION (mg/L)
DEPTH (FT)
y = -3E-04ln(x) + 0.0025
R² = 0.324
y = 0.005x^-0.688
R² = 0.7826
y = 0.003x^-0.514
R² = 0.7469
LHL (D)
LHL (T)
CI (T)
PWS - INTAKE
EWB-GWAR
WQ Std
Power (LHL (D))
Power (LHL (T))
Log. (CI (T))

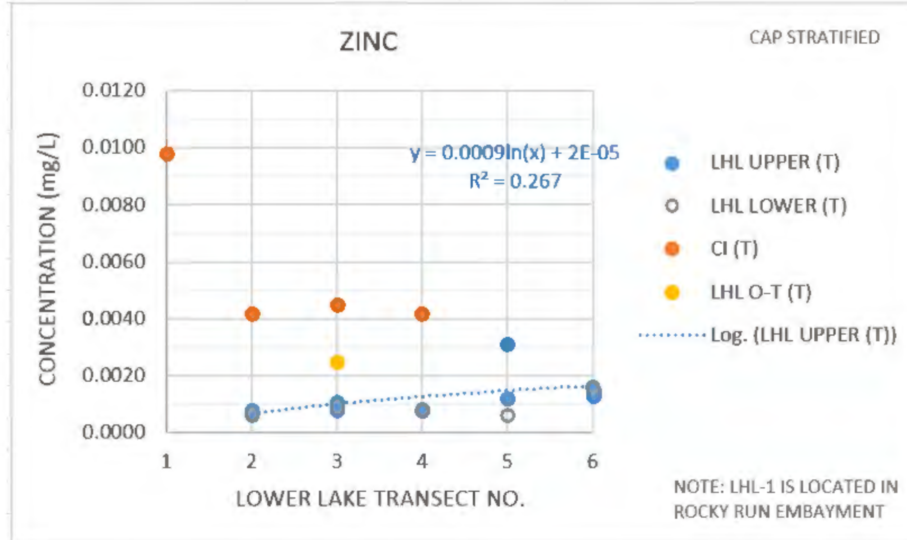

SELENIUM
CAP STRATIFIED
Selenium standard = 0.005 mg/L
y = -3E-04ln(x) + 0.0025
R² = 0.324
y = 0.005x^-0.688
R² = 0.7826
y = 0.003x^-0.514
R² = 0.7469
CONCENTRATION (mg/L)
DEPTH (FT)
LHL (D)
LHL (T)
CI (T)
PWS - INTAKE
EWB-GWAR
WQ Std
Power (LHL (D))
Power (LHL (T))
Log. (CI (T))

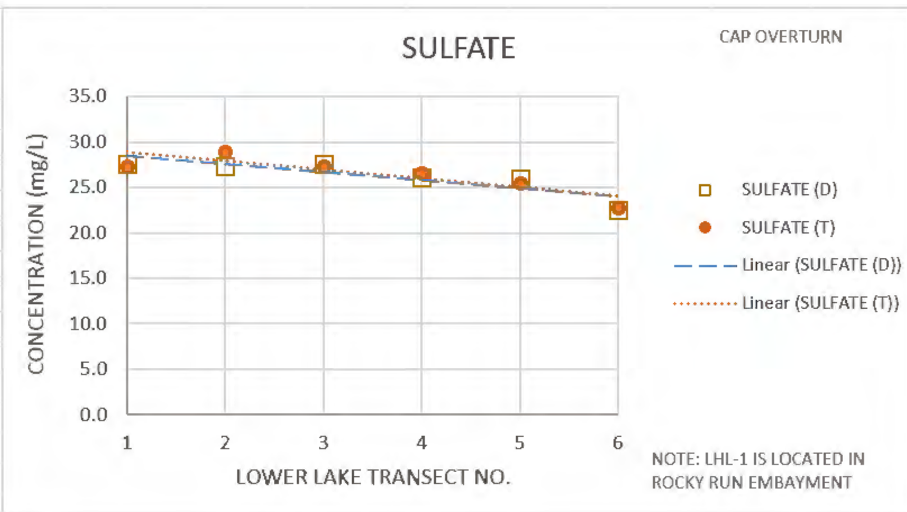

CAP STRATIFIED
CONCENTRATION (mg/L)
LOWER LAKE TRANSECT NO.
ARSENIC UPPER (T)
ARSENIC LOWER (T)
SELENIUM (T)
ARSENIC (O-T)
Linear (ARSENIC UPPER (T))
Linear (ARSENIC LOWER (T))
Linear (SELENIUM (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT. . "UPPER" INCLUDES TOP AND MIDDLE SAMPLE DEPTHS; "LOWER" INCUDES BOTTOM SAMPLE

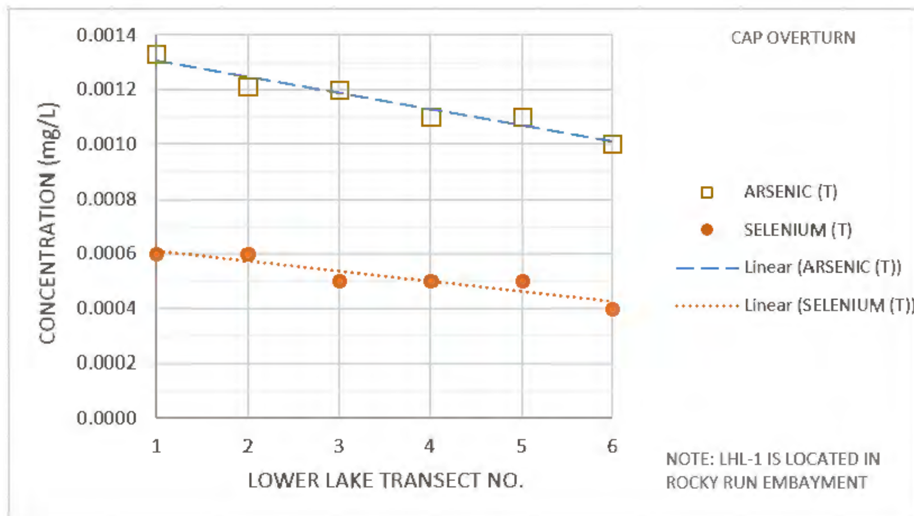

ZINC
CAP STRATIFIED
Zinc standard = 0.169 mg/L
y = -0.001ln(x) + 0.0095
R² = 0.3724
y = -2E-05ln(x) + 0.0012
R² = 0.0005
CONCENTRATION (mg/L)
DEPTH (FT)
LHL (T)
CI (T)
Log. (LHL (T))
Log. (CI (T))

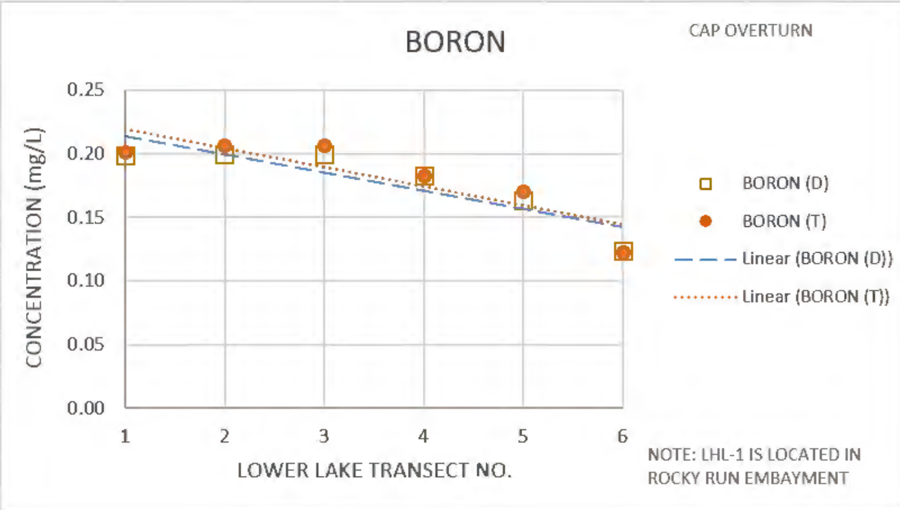

SULFATE
CAP STRATIFIED
Sulfate standard = 250 mg/L
y = -7.132ln(x) + 76.358
R² = 0.7734
y = -7.748ln(x) + 57.772
R² = 0.4427
CONCENTRATION (mg/L)
DEPTH (FT)
LHL (T)
CI (T)
Log. (LHL (T))
Log. (CI (T))

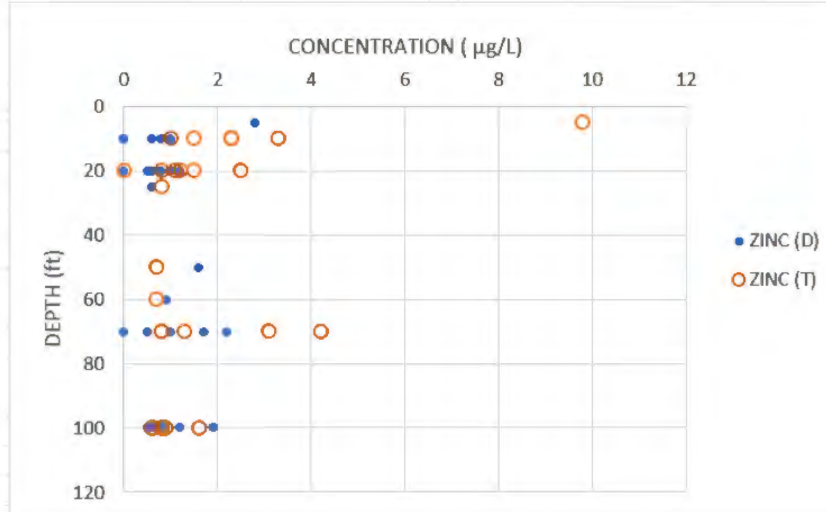

CAP STRATIFIED
SULFATE
CONCENTRATION (mg/L)
45
40
35
30
25
20
15
10
5
0
2
3
4
5
6
LOWER LAKE TRANSECT NO.
SULFATE UPPER (T)
SULFATE LOWER (T)
SULFATE O-T (T)
Linear (SULFATE UPPER (T))
Linear (SULFATE LOWER (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT. "UPPER" INCLUDES TOP AND MIDDLE SAMPLE DEPTHS; "LOWER" INCLUDES BOTTOM SAMPLE

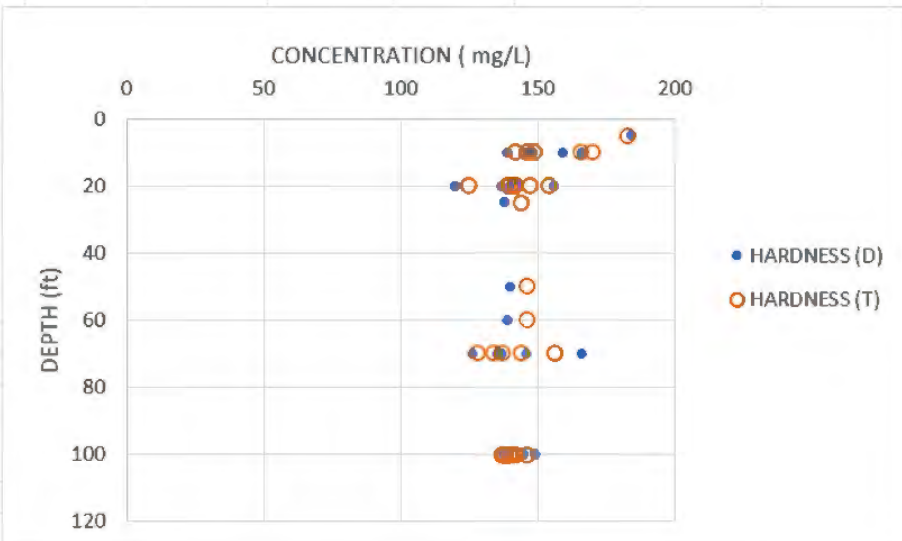

ZINC
CAP STRATIFIED
CONCENTRATION (mg/L)
0.0120
0.0100
0.0080
0.0060
0.0040
0.0020
0.0000
1
2
3
4
5
6
LOWER LAKE TRANSECT NO.
y = 0.0009ln(x) + 2E-05
R² = 0.267
LHL UPPER (T)
LHL LOWER (T)
CI (T)
LHL O-T (T)
Log. (LHL UPPER (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT

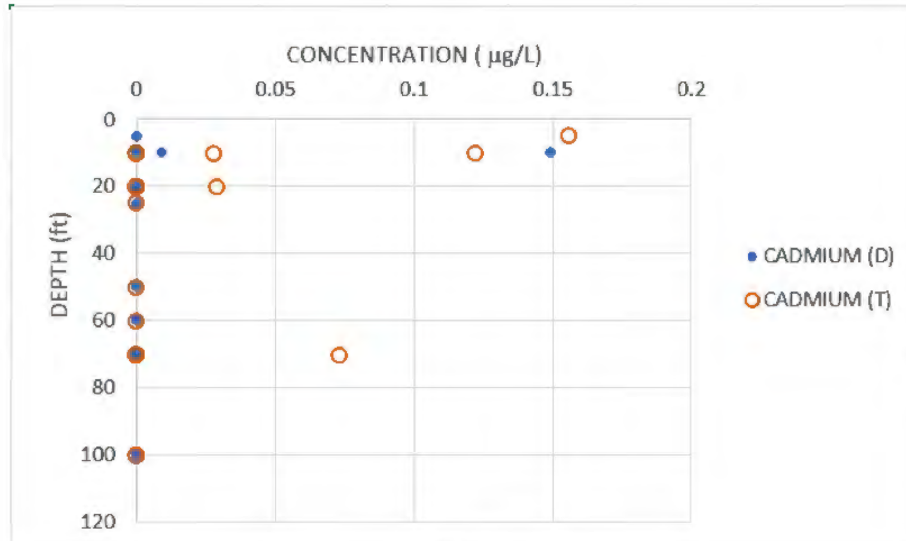

SULFATE
CAP OVERTURN
CONCENTRATION (mg/L)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1
2
3
4
5
6
LOWER LAKE TRANSECT NO.
SULFATE (D)
SULFATE (T)
Linear (SULFATE (D))
Linear (SULFATE (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT

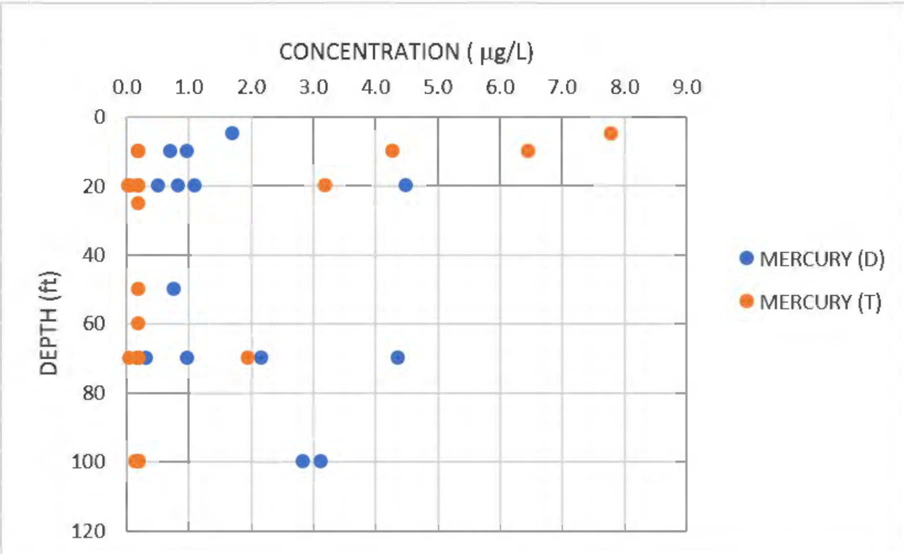

CAP OVERTURN
CONCENTRATION (mg/L)
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
1
2
3
4
5
6
LOWER LAKE TRANSECT NO.
ARSENIC (T)
SELENIUM (T)
Linear (ARSENIC (T))
Linear (SELENIUM (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT

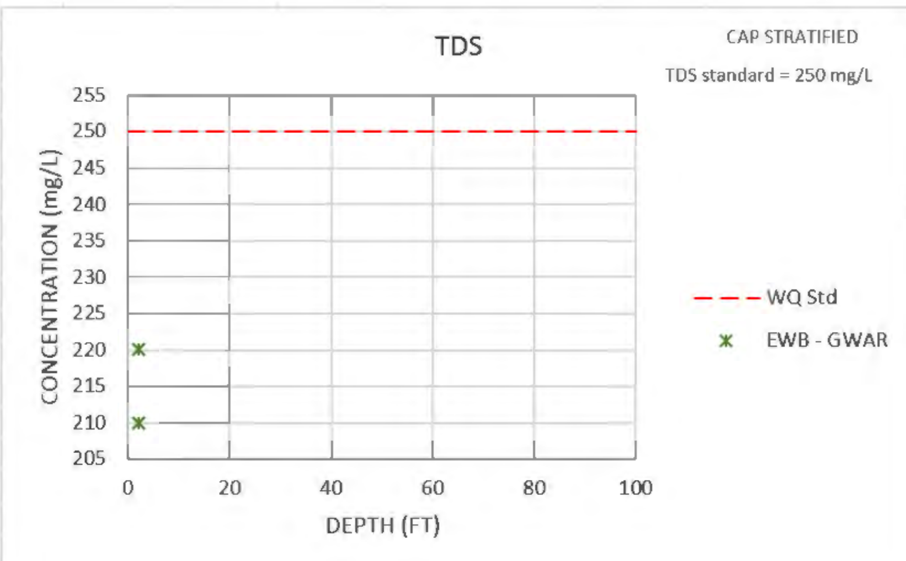

BORON
CAP OVERTURN
CONCENTRATION (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
1
2
3
4
5
6
LOWER LAKE TRANSECT NO.
BORON (D)
BORON (T)
Linear (BORON (D))
Linear (BORON (T))
NOTE: LHL-1 IS LOCATED IN ROCKY RUN EMBAYMENT


CONCENTRATION (µg/L)
0
2
4
6
8
10
12
DEPTH (ft)
0
20
40
60
80
100
120
ZINC (D)
ZINC (T)


CONCENTRATION (mg/L)
0
50
100
150
200
DEPTH (ft)
0
20
40
60
80
100
120
HARDNESS (D)
HARDNESS (T)


CONCENTRATION (µg/L)
0
0.05
0.1
0.15
0.2
DEPTH (ft)
0
20
40
60
80
100
120
CADMIUM (D)
CADMIUM (T)


CONCENTRATION (µg/L)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
DEPTH (ft)
0
20
40
60
80
100
120
MERCURY (D)
MERCURY (T)


TDS
CAP STRATIFIED
TDS standard = 250 mg/L
CONCENTRATION (mg/L)
255
250
245
240
235
230
225
220
215
210
205
0
20
40
60
80
100
DEPTH (FT)
WQ Std
EWB - GWAR

ATTACHMENT C

CORMIX INPUT WINDOWS

(BASIC INPUT DATA FOR DESIGN CONFIGURATION)

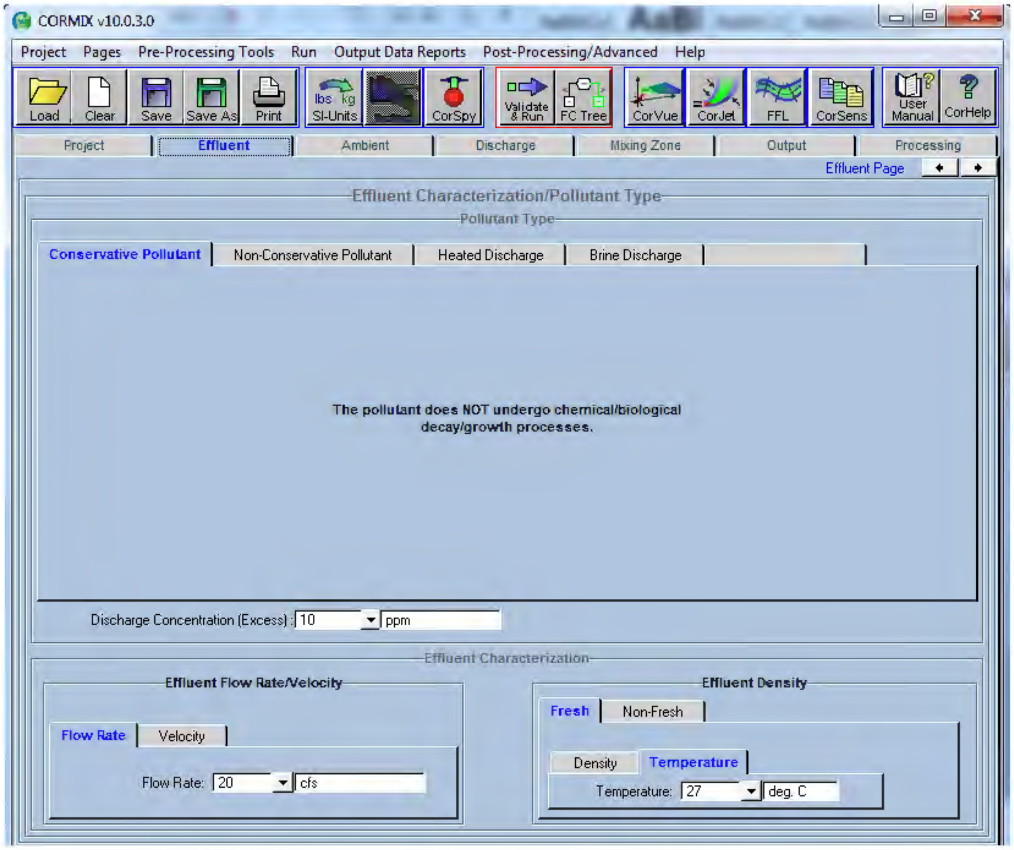


Figure C-1. CORMIX2 Effluent Window (for 20 cfs effluent flow case)

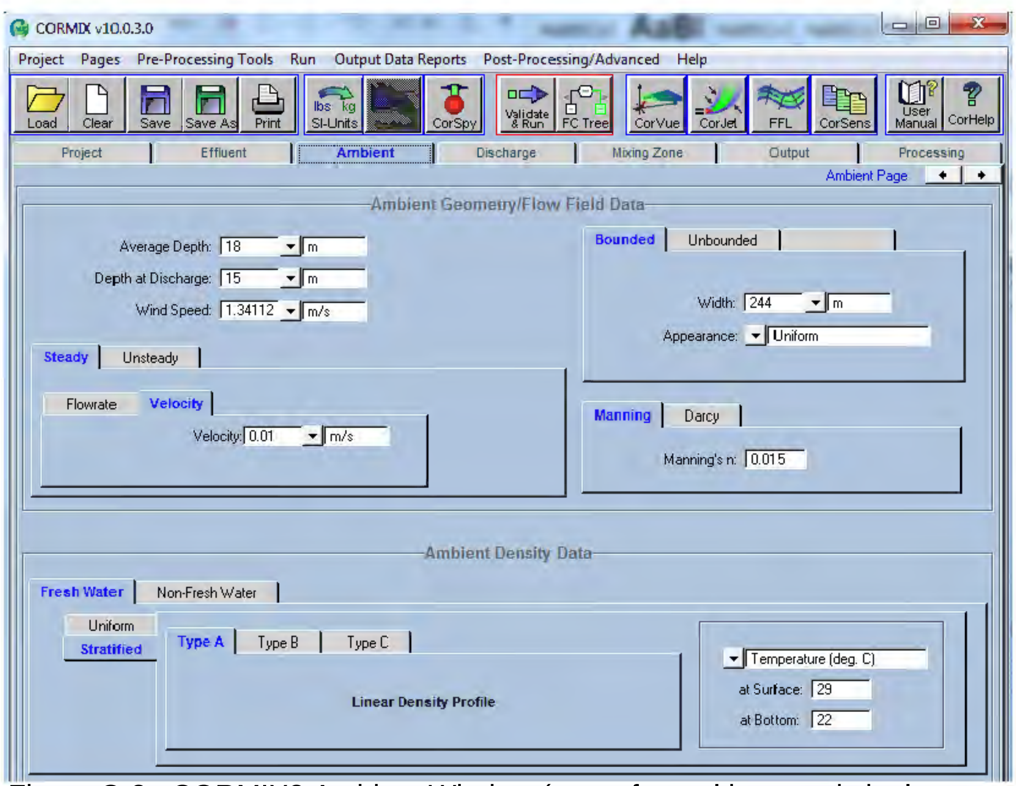


Figure C-2. CORMIX2 Ambient Window (same for multiport and single port cases)

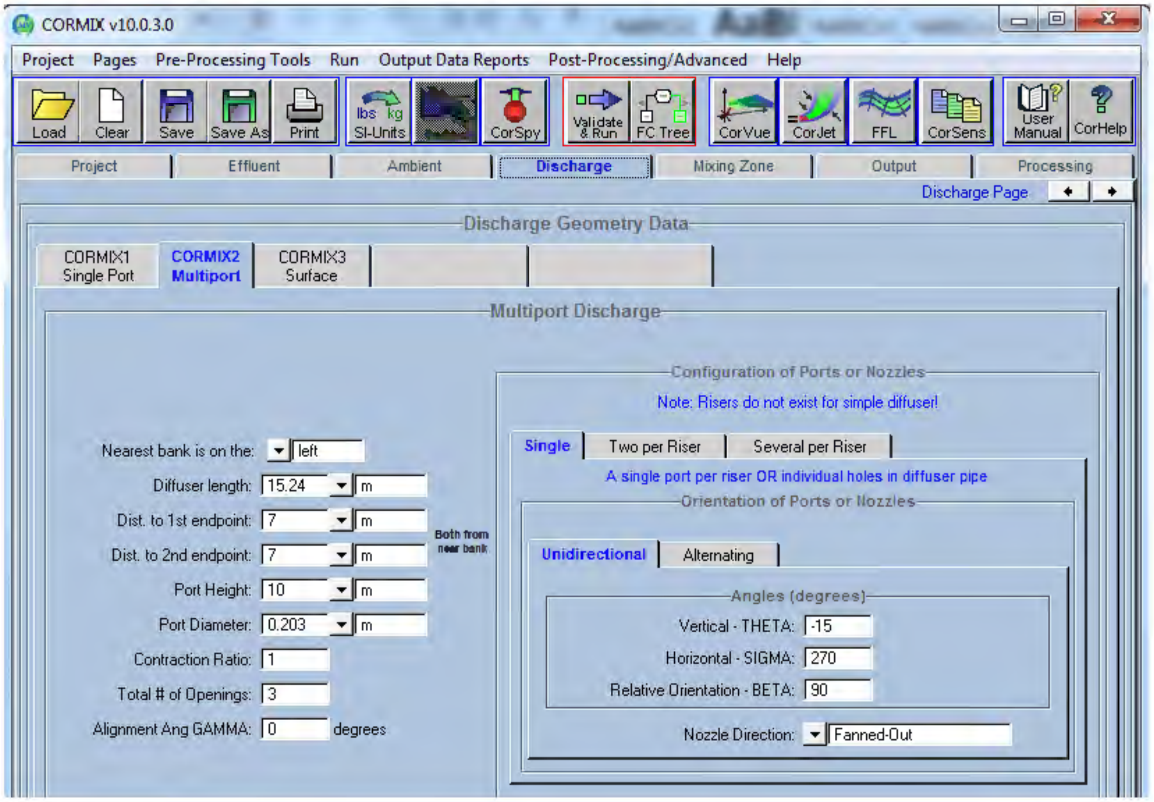


Figure C-3. CORMIX2 Discharge window (for 20 cfs effluent flow case)

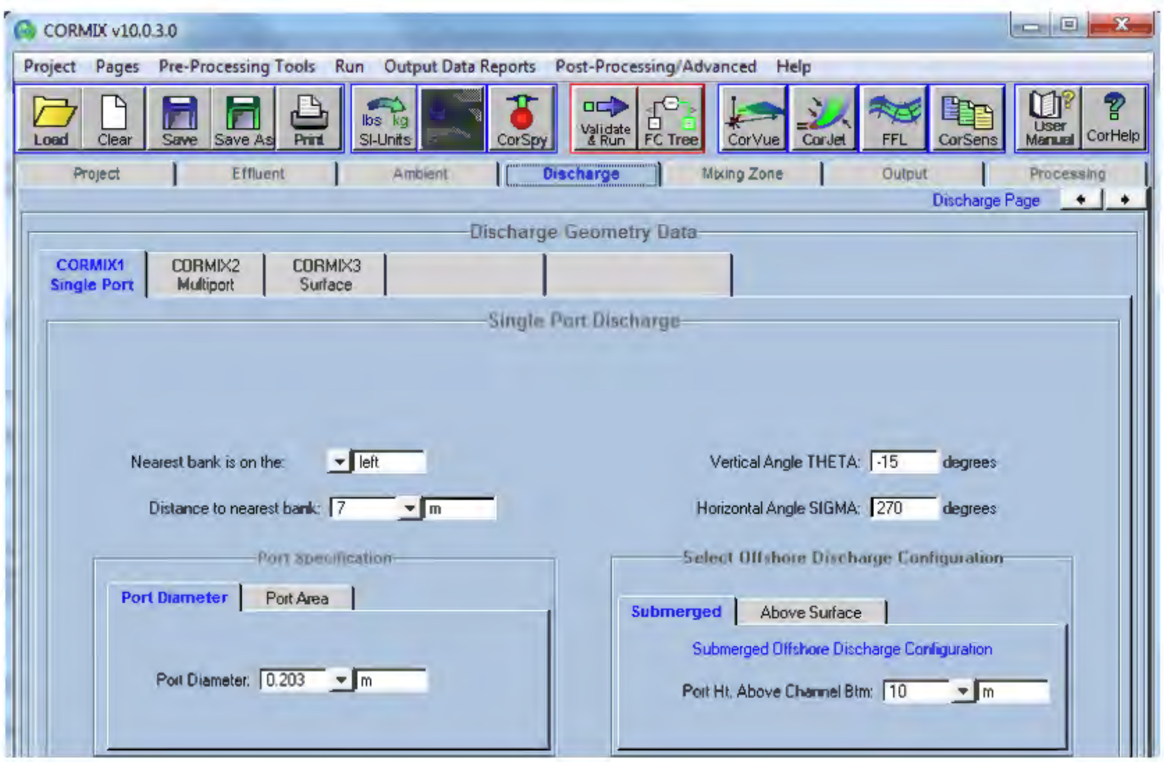


Figure C-4. CORMIX1 Discharge window (for single port effluent flow of 6.6 cfs)

ATTACHMENT D

CORMIX TABULAR OUTPUT

CORMIX2 Multiport Diffuser, Effluent Flow 20 cfs

CORMIX2 Multiport Diffuser, Effluent Flow 3 cfs

CORMIX1 Single Port Diffuser, Effluent Flow 6.6 cfs

CORMIX1 Single Port Diffuser, Effluent Flow 1.0 cfs

CORMIX SESSION, PROCESSING, AND PREDICTION FILES – Multiport Diffuser with 20 cfs Discharge

Date: 07/27/18
Time: 14:15:10

Design Case: Location 1; MP diffuser; 3 ports
Site Name: EW BROWN - HERRINGTON LK
Prepared By: DWI

Project Notes:

Location 1 is conceptual location along main lake bank, 15 ft from lake bank/bed
3 port multiport diffuser, 25-ft port spacing, 8-inch TFW, -15 degree vertical angle
linear ambient stratification
20 cfs discharge

VALIDATING INPUT DATA ...

Checking Pages for invalid or missing inputs...

Effluent Page has been validated.
Ambient Page has been validated.
Discharge Page has been validated.
Mixing Zone Page has been validated.

Finished checking Pages for invalid or missing inputs.

Loading Correct RuleBases

Validating RuleBases ...

AMBIENT DATA:

Ambient flowrate = 43.920 m^3/s.

Equivalent Darcy-Weisbach friction factor = 0.007

Ambient surface density = 995.9449 kg/m^3.

Ambient bottom density = 997.7714 kg/m^3.

The ambient DENSITY PROFILE you have specified is DYNAMICALLY STABLE in the presence of the given ambient crossflow. (This has been checked with a FLUX RICHARDSON NUMBER CRITERION).

Ambient Rule Base has been validated.

DISCHARGE DATA:
CORMIX2: Multiport Diffuser Discharges

Diffuser center (mid-point of diffuser line) is located 7 m from left bank/shore.

Average spacing between the individual ports/nozzles = 7.62 m.

This spacing is of the order of, or less than, the discharge water depth of 15 m. Therefore, significant lateral interaction of adjacent jets in the near field is expected, forming essentially two-dimensional near-field conditions as if the discharge would issue from a two-dimensional slot.

CORMIX2 is FULLY APPLICABLE for this situation and will analyze this discharge using two-dimensional prediction models in the near field.

*** WARNING ***

You have entered a multiport diffuser with the minimum number of ports/openings NOPEN = 3 allowed in CORMIX. Please carefully check your multiport diffuser input configuration with CORMIX2 line source assumptions.

Effective port/nozzle diameter D0 = 0.203 m
Effective port X-sectional area of each port A0 = 0.0324 m^2
Effective port X-sectional area of all ports in each riser A0RG = 0.0324 m^2

This is a Slightly Submerged Discharge, where the height of the discharge port (H0 = 10 m), above the bottom, Exceeds two-thirds of the local ambient water depth (HD = 15 m)
Note: For special advice on this limitation please consult Section 5.3 of the CORMIX2 technical report (Akar and Jirka, 1991).; yet more detail can be found in the CORMIX1 report, Doneker and Jirka, 1990

The present diffuser type is UNIDIRECTIONAL WITH PARALLEL ALIGNMENT.

Discharge velocity U0 = 5.833 m/s.
Note:
Discharge Velocity (U0) < 2.5 m/s may in some cases be recommended to avoid possible adverse conditions for sensitive fish populations.

Effective discharge velocity U0 = 5.83 m/s

The submergence of the port below the water surface is SUB0 = 5 m.

Discharge density RHO0 = 997.0456 kg/m^3.

Discharge Rules for CORMIX2 have been validated.

MIXING ZONE SPECIFICATION:

REGULATORY MIXING ZONE (RMZ) Specifications:

In general practice, there are two possible interpretations for the RMZ:

Interpretation 1: The RMZ is a spatially defined (by State/Federal agencies) restricted region at whose boundary a specified water quality standard for conventional pollutants - or the CCC for toxic pollutants - has to be met.

Interpretation 2: The applicant or the State/Federal agency may propose on an ad-hoc basis an RMZ as that region at whose boundary a water quality standard - or CCC - has been demonstrated to be met. That demonstration is usually made by means of a mixing zone prediction.

CORMIX will evaluate the RMZ conditions on the basis of both interpretations.

Mixing Zones Rule Base has been validated.

Finished validating RuleBases.

Calculating Parameters.

FLOW PARAMETERS AND LENGTH SCALES:

Relative density differences between discharge and ambient:

Ambient density at the discharge level RHOAH0 = 996.553718 kg/m^3
Vertical mean ambient density RHOAM = 996.858144 kg/m^3

The effluent density (997.04559 kg/m^3) is greater than the surrounding ambient water density at the discharge level (996.55372 kg/m^3). Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards the bottom.
IMPORTANT NOTE:
Since the effluent is NEGATIVELY BUOYANT, it is recommended that you consider using the Brine or Sediment options for Effluent specification for a more detailed analysis, particularly for coastal discharges over a sloping bottom where density currents are important.

CORMIX will however continue with the current simulation.

Flow bulk parameters:
(Bulk variables are defined on a 2-D basis, i.e. per unit diffuser length)

Ambient momentum flux ma = 0.0015 m^3/s^2

Discharge volume flux q0 = 0.03716 m^2/s
Discharge momentum flux m0 = 0.21675 m^3/s^2
This flux has a net component in the discharge direction (orientation of ports/nozzles).

Discharge buoyancy flux j0 = -0.00018 m^3/s^3

Flow length scales:
(Length scales are defined on a 2-D basis, i.e. per unit diffuser length)

Discharge length scale lq = 0.0064 m.

Jet-to-crossflow length scale lm = 2167.51 m.

Jet-to-plume transition length scale lM = 59.18 m.

Jet stratification length scale lm' = 5.66 m.
Plume stratification length scale lb' = 1.63 m.
Crossflow stratification length scale la = 0.29 m.

Non-dimensional parameters:

Slot densimetric Froude number FR0 = 1286.39
Equivalent slot width B0 = 0.0042m

CORMIX2 uses the equivalent two-dimensional slot diffuser concept to classify the actual three-dimensional diffuser dynamics.
For the dilution predicted however, CORMIX2 models the flow from each port or, if applicable, collectively from each riser group.

Port/nozzle densimetric Froude number FRD0 = 186.08
Jet/crossflow velocity ratio R = 583.27

Parameters for CORMIX2 have been calculated.

Classifying Flows.

FLOW CLASSIFICATION:

CORMIX2 includes FIVE MAJOR CLASSES of possible flow configurations:
Classes MS, IMS: Flows trapped in a layer within linear ambient stratification.
Classes MU   : Near Bottom, Positively buoyant flows in a uniform density layer.
Classes IMU   : Near Surface, Negatively buoyant flows in a uniform density layer.
Classes MNU   : Near Bottom, Negatively buoyant flows in uniform density layer.
Classes IMPU   : Near Surface, Positively buoyant flows in uniform density layer.

The NEAR FIELD FLOW will have the following features:

If flow trapping occurs, then the flow is jet-like and is strongly affected by the ambient density stratification with weak crossflow effect (if any).

Terminal Height Level Zt = -8.60

The specified ambient density stratification is weak relative to the discharge conditions and is dynamically unimportant. The discharge will behave as if the ambient were unstratified.

New length scales will be computed based on a vertically averaged uniform ambient.

Since ambient density stratification is unimportant, the ambient density will be approximated with its mean vertical value 996.8581 kg/m^3.
New jet to plume transition length scale lM = 129.85 m.

The discharge near-field behavior is dominated by either the negative buoyancy of the discharge or the downward vertical orientation of the discharge port.

The discharge flow will experience INSTABILITIES WITH FULL VERTICAL MIXING in the near-field. There may be surface impact of high pollutant concentrations.

The following conclusion on the flow configuration applies to a layer corresponding to the full water depth at the discharge site:

*** FLOW CLASS = IMU3 ***

Applicable layer depth HS = 15 m.

*** Limiting Dilution S = (QA/Q0)+ 1.0 = 78.6 ***

Flow has been classified.

Executing the simulation... FORTRAN simulation complete.

Generating Session Report... Session Report complete.

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 10.0GT
                       HYDRO2:Version-10.0.2.0  April,2017
SITE NAME/LABEL:                EW BROWN - HERRINGTON LK
  DESIGN CASE:                  Location 1; MP diffuser; 3 ports
  FILE NAME:                    D:\LG&E KU Brown\CORMIX\EW BROWN HERRINGTON IN-LAKE 3-PORT
DIFFUSER.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/27/2018--14:15:10
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                           = bounded
  Width                          BS       = 244 m
  Channel regularity             ICHREG = 1
  Ambient flowrate               QA       = 43.92 m^3/s
  Average depth                  HA       = 18 m
  Depth at discharge             HD       = 15 m
  Ambient velocity               UA       = 0.01 m/s
  Darcy-Weisbach friction factor F        = 0.0067
    Calculated from Manning's n           = 0.015
  Wind velocity                  UW       = 1.34 m/s
  Stratification Type            STRCND = A
  Surface temperature                     = 29 degC
  Bottom temperature                      = 22 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                RHOAS  = 995.9449 kg/m^3
  Bottom density                 RHOAB  = 997.7714 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Submerged Multiport Diffuser Discharge
  Diffuser type                  DITYPE = unidirectional parallel
  Diffuser length                LD       = 15.24 m
  Nearest bank                            = left
  Diffuser endpoints             YB1      = 7 m;    YB2 = 7 m
  Number of openings             NOPEN  = 3
  Number of Risers               NRISER = 3
  Ports/Nozzles per Riser        NPPERR  = 1
  Spacing between risers/openings SPAC   = 7.62 m
  Port/Nozzle diameter           D0       = 0.203 m
    with contraction ratio                = 1
  Equivalent slot width          B0       = 0.0042 m
  Total area of openings         TA0      = 0.0971 m^2
  Discharge velocity             U0       = 5.83 m/s
  Total discharge flowrate       Q0       = 0.566337 m^3/s
  Discharge port height          H0       = 10 m
  Nozzle arrangement             BETYPE = unidirectional with fanning
  Diffuser alignment angle       GAMMA  = 0 deg
  Vertical discharge angle       THETA  = -15 deg
  Actual Vertical discharge angle THEAC  = -15 deg
  Horizontal discharge angle     SIGMA  = 270 deg
  Relative orientation angle     BETA   = 90 deg
  Discharge temperature (freshwater)      = 25 degC
  Corresponding density          RHO0   = 997.0456 kg/m^3
  Density difference             DRHO   = -0.1874 kg/m^3
  Buoyant acceleration           GP0    = -0.0018 m/s^2
  Discharge concentration        C0       = 10 ppm
  Surface heat exchange coeff.   KS       = 0 m/s
  Coefficient of decay           KD       = 0 /s
---------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)        q0       = 0.037161 m^2/s
  Momentum flux                  m0       = 0.216751 m^3/s^2
  Buoyancy flux                  j0       = -0.000069 m^3/s^3
```

```
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m         Lm  = 2167.51 m         LM  = 129.85 m
  lm' = 99999 m         Lb' = 99999 m         La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 2084.15
  Port/nozzle Froude number       FRD0   = 301.47
  Velocity ratio                  R      = 583.27
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard          CSTD   = 5 ppm
  Regulatory mixing zone                 = yes
  Regulatory mixing zone specification   = distance
  Regulatory mixing zone value           = 25 m (m^2 if area)
  Region of interest                     = 5000 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = IMU3 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.  The ambient density stratification at the
  discharge site is relatively weak and unimportant so the discharge flow
  penetrates to the surface and/or breaks down the existing stratification
  through vigorous mixing.
  Applicable layer depth = water depth = 15 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 78.6

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    7 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.1499 ppm
  Dilution at edge of NFR              s = 66.7
  NFR Location:                        x = 64.94 m
    (centerline coordinates)           y = -189.60 m
                                       z = 0 m
  NFR plume dimensions:  half-width (bh) = 42.90 m
                          thickness (bv) = 7.23 m
Cumulative travel time:       7829.1289 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is greater than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards
  the bottom.
IMPORTANT NOTE:
Since the effluent is NEGATIVELY BUOYANT, it is recommended that you consider using the Brine or
Sediment options for Effluent specification for a more detailed analysis, particularly for coastal
discharges over a sloping bottom where density currents are important.

CORMIX will however continue with the current simulation.
```

```
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is weak relative to the
  discharge conditions and is dynamically unimportant. The discharge will
  behave as if the ambient were unstratified.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume is vertically fully mixed WITHIN NEAR-FIELD (or a fraction thereof),
  but RE-STRATIFIES LATER.
  Plume becomes vertically fully mixed again at 95.67 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section contacts one bank only at 64.94 m downstream.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.198427  ppm
  Corresponding dilution               s = 50.4
  Plume location:                      x = 25 m
    (centerline coordinates)           y = -94.56 m
                                       z = 0 m
  Plume dimensions:      half-width (bh) = 15.13 m
                          thickness (bv) = 12.13 m
Cumulative travel time < 7829.1289 sec. (RMZ is within NFR)

Note:
Plume concentration c and dilution s values are reported based on prediction
file values - assuming linear interpolation between predicted points just
before and just after the RMZ boundary has been detected.

Please ensure a small step size is used in the prediction file to account
for this linear interpolation. Step size can be controlled by increasing
(reduces the prediction step size) or decreasing (increases the prediction
step size) the - Output Steps per Module - in CORMIX input.

At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 5  ppm
  Corresponding dilution               s = 2.9
  Plume location:                      x = 0 m
    (centerline coordinates)           y = -0.05 m
                                       z = 7.5 m
  Plume dimensions:      half-width (bh) = 7.54 m
                          thickness (bv) = 0.10 m
-----------------------------------------------------------------------------
Regulatory Mixing Zone Analysis:
  The RMZ specification occurs before the near-field mixing regime (NFR) has
  been completed.  The specification of the RMZ is highly restrictive.
******************** FINAL DESIGN ADVICE AND COMMENTS ********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
```

```
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 10.0GT
                     HYDRO2 Version 10.0.2.0 April 2017
---------------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   EW BROWN - HERRINGTON LK
 Design case:       Location 1; MP diffuser; 3 ports
 FILE NAME:         D:\...X\EW BROWN HERRINGTON IN-LAKE 3-PORT DIFFUSER.prd
 Time stamp:        07/27/2018--14:19:03

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    244.00  AS    =   4392.00  QA    =     43.92  ICHREG= 1
 HA    =     18.00  HD    =     15.00
 UA    =     0.010  F     =      0.007 USTAR =0.2903E-03
 UW    =     1.341  UWSTAR=0.1449E-02
 Density stratified environment
 STRCND=  A         RHOAM =  996.8582
 RHOAS =  995.9449  RHOAB =  997.7714  RHOAH0=  996.5537  E     =0.1197E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_parallel
 BANK  =  LEFT      DISTB =      7.00  YB1   =      7.00  YB2   =      7.00
 LD    =     15.24  NOPEN =    3       NRISER=    3       SPAC  =      7.62    NPPERR =    1
 D0    =     0.133  A0    =      0.014 H0    =     10.00  SUB0  =      5.00
 D0INP =     0.133  CR0   =      1.000
 Nozzle/port arrangement:   unidirectional_with_fanning
 GAMMA =      0.00  THETA =    -15.00  SIGMA =    270.00  BETA  =     90.00
 U0    =     2.038  Q0    =      0.085 Q0A   =0.8495E-01
 RHO0  =  997.0456  DRHO0 =-.4919E+00  GP0   =-.4840E-02
 C0    =0.1000E+02  CUNITS=  ppm
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.5574E-02  m0    =0.7574E-02  j0    =-.1799E-04  SIGNJ0=     -1.0
 Associated 2-d length scales (meters)
 lQ=B  =     0.003 lM    =     11.01  lm    =    113.61
 lmp   =      2.12  lbp   =      0.87  la    =      0.29

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.8495E-01  M0    =0.1154E+00  J0    =-.2741E-03
 Associated 3-d length scales (meters)
 LQ    =      0.12  LM    =     11.96  Lm    =     41.61  Lb    =    411.18
                                       Lmp   =      3.47  Lbp   =      1.78

NON-DIMENSIONAL PARAMETERS
 FR0   =    686.12  FRD0  =     80.33  R     =    203.82  PL    =   59.34
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =     2.038  D0    =      0.133 A0    =      0.014 THETA =    -15.00
 FR0   =    686.12  FRD0  =     80.33  R     =    203.82
 (slot)             (riser group)

FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    IMS4   2
 2  Applicable layer depth HS =    15.00  2
 2  Limiting Dilution S =QA/Q0=   518.01  2
 222222222222222222222222222222222222222222
```

```
MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+02  CUNITS=  ppm
 NTOX  =  0
 NSTD  =  1         CSTD  =0.5000E+01
 REGMZ =  1
 REGSPC=  1         XREG  =     25.00  WREG  =      0.00  AREG  =      0.00
 XINT  =   5000.00  XMAX  =   5000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
         7.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

       X        Y       Z        S       C       BV       BH       Uc        TT
      0.00     0.00   10.00     1.0 0.100E+02   0.07     0.07     2.038   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=    -15.00  SIGMAE=    270.12
  LE    =      0.65  XE    =      0.00  YE    =     -0.63  ZE    =      9.83

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S       C       BV       BH       Uc        TT
  Individual jet/plumes before merging:
      0.00    -0.63    9.83     1.0 0.100E+02   0.07     0.07     2.038   .00000E+00
      0.00    -0.63    9.83     1.0 0.100E+02   0.07     0.07     2.038   .95307E-03
      0.00    -0.75    9.80     1.0 0.999E+01   0.08     0.08     2.038   .45995E-01
      0.00    -0.86    9.77     1.2 0.860E+01   0.09     0.09     2.038   .98972E-01
      0.00    -0.97    9.74     1.3 0.754E+01   0.11     0.11     1.815   .15988E+00
      0.00    -1.09    9.71     1.5 0.672E+01   0.12     0.12     1.617   .22873E+00
      0.00    -1.20    9.68     1.7 0.606E+01   0.13     0.13     1.458   .30551E+00
      0.01    -1.31    9.65     1.8 0.551E+01   0.14     0.14     1.327   .39022E+00
      0.01    -1.43    9.62     2.0 0.505E+01   0.16     0.16     1.216   .48512E+00
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.500E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
      0.01    -1.54    9.59     2.1 0.467E+01   0.17     0.17     1.124   .58588E+00
      0.01    -1.66    9.55     2.3 0.434E+01   0.18     0.18     1.044   .69458E+00
      0.01    -1.77    9.52     2.5 0.405E+01   0.20     0.20     0.976   .81121E+00
      0.01    -1.88    9.49     2.6 0.380E+01   0.21     0.21     0.915   .93577E+00
      0.02    -2.00    9.46     2.8 0.358E+01   0.22     0.22     0.862   .10683E+01
      0.02    -2.11    9.43     3.0 0.338E+01   0.24     0.24     0.815   .12087E+01
      0.02    -2.23    9.40     3.1 0.320E+01   0.25     0.25     0.771   .13606E+01
      0.02    -2.34    9.37     3.3 0.304E+01   0.26     0.26     0.733   .15171E+01
      0.03    -2.45    9.34     3.5 0.290E+01   0.27     0.27     0.698   .16815E+01
      0.03    -2.57    9.31     3.6 0.277E+01   0.29     0.29     0.667   .18539E+01
```

0.03	-2.68	9.27	3.8	0.265E+01	0.30	0.30	0.638	.20342E+01
0.04	-2.79	9.24	3.9	0.254E+01	0.31	0.31	0.612	.22225E+01
0.04	-2.91	9.21	4.1	0.243E+01	0.33	0.33	0.587	.24234E+01
0.04	-3.02	9.18	4.3	0.234E+01	0.34	0.34	0.564	.26277E+01
0.05	-3.14	9.15	4.4	0.225E+01	0.35	0.35	0.544	.28400E+01
0.05	-3.25	9.12	4.6	0.217E+01	0.37	0.37	0.524	.30603E+01
0.06	-3.36	9.08	4.8	0.210E+01	0.38	0.38	0.506	.32885E+01
0.06	-3.47	9.05	4.9	0.203E+01	0.39	0.39	0.489	.35247E+01
Level of buoyancy reversal in stratified ambient.								
0.07	-3.59	9.02	5.1	0.196E+01	0.40	0.40	0.474	.37689E+01
0.07	-3.70	8.99	5.3	0.190E+01	0.42	0.42	0.458	.40271E+01
0.08	-3.82	8.96	5.4	0.184E+01	0.43	0.43	0.444	.42875E+01
0.08	-3.93	8.93	5.6	0.179E+01	0.44	0.44	0.431	.45559E+01
0.09	-4.04	8.89	5.8	0.174E+01	0.46	0.46	0.419	.48323E+01
0.10	-4.16	8.86	5.9	0.169E+01	0.47	0.47	0.407	.51168E+01
0.10	-4.27	8.83	6.1	0.164E+01	0.48	0.48	0.396	.54093E+01
0.11	-4.38	8.80	6.2	0.160E+01	0.50	0.50	0.386	.57098E+01
0.12	-4.50	8.77	6.4	0.156E+01	0.51	0.51	0.375	.60258E+01
0.13	-4.61	8.74	6.6	0.152E+01	0.52	0.52	0.366	.63427E+01
0.13	-4.72	8.71	6.7	0.148E+01	0.54	0.54	0.357	.66678E+01
0.14	-4.84	8.68	6.9	0.145E+01	0.55	0.55	0.348	.70011E+01
0.15	-4.95	8.64	7.1	0.141E+01	0.56	0.56	0.340	.73425E+01
0.16	-5.06	8.61	7.2	0.138E+01	0.58	0.58	0.332	.76920E+01
0.17	-5.18	8.58	7.4	0.135E+01	0.59	0.59	0.324	.80583E+01
0.18	-5.29	8.55	7.6	0.132E+01	0.60	0.60	0.317	.84245E+01
0.19	-5.41	8.52	7.7	0.129E+01	0.62	0.62	0.310	.87990E+01
0.20	-5.52	8.50	7.9	0.127E+01	0.63	0.63	0.303	.91818E+01
0.21	-5.63	8.47	8.1	0.124E+01	0.64	0.64	0.297	.95730E+01
0.22	-5.75	8.44	8.2	0.122E+01	0.66	0.66	0.290	.99725E+01
0.23	-5.86	8.41	8.4	0.119E+01	0.67	0.67	0.284	.10380E+02
0.24	-5.98	8.38	8.6	0.117E+01	0.68	0.68	0.279	.10807E+02
0.25	-6.09	8.35	8.7	0.115E+01	0.70	0.70	0.273	.11232E+02
0.26	-6.21	8.33	8.9	0.113E+01	0.71	0.71	0.268	.11665E+02
0.28	-6.32	8.30	9.0	0.111E+01	0.72	0.72	0.262	.12107E+02
0.29	-6.43	8.28	9.2	0.109E+01	0.74	0.74	0.257	.12558E+02
0.30	-6.55	8.25	9.4	0.107E+01	0.75	0.75	0.253	.13017E+02
0.32	-6.67	8.23	9.5	0.105E+01	0.76	0.76	0.248	.13496E+02
0.33	-6.78	8.20	9.7	0.103E+01	0.78	0.78	0.243	.13973E+02
0.35	-6.89	8.18	9.9	0.101E+01	0.79	0.79	0.239	.14459E+02
0.36	-7.01	8.16	10.0	0.997E+00	0.80	0.80	0.234	.14954E+02
0.38	-7.12	8.14	10.2	0.981E+00	0.82	0.82	0.230	.15457E+02
0.39	-7.24	8.12	10.4	0.965E+00	0.83	0.83	0.226	.15969E+02
0.41	-7.35	8.10	10.5	0.950E+00	0.84	0.84	0.222	.16490E+02
0.43	-7.47	8.08	10.7	0.935E+00	0.86	0.86	0.219	.17033E+02
0.44	-7.59	8.07	10.9	0.921E+00	0.87	0.87	0.215	.17572E+02
0.46	-7.70	8.05	11.0	0.907E+00	0.88	0.88	0.211	.18120E+02
0.48	-7.82	8.04	11.2	0.893E+00	0.90	0.90	0.208	.18677E+02
0.50	-7.93	8.03	11.4	0.880E+00	0.91	0.91	0.204	.19243E+02
0.52	-8.05	8.01	11.5	0.868E+00	0.93	0.93	0.201	.19818E+02
0.54	-8.17	8.00	11.7	0.855E+00	0.94	0.94	0.198	.20416E+02
0.56	-8.28	7.99	11.9	0.843E+00	0.95	0.95	0.195	.21010E+02
0.58	-8.40	7.99	12.0	0.831E+00	0.97	0.97	0.192	.21613E+02
0.60	-8.51	7.98	12.2	0.819E+00	0.98	0.98	0.189	.22224E+02
0.63	-8.63	7.98	12.4	0.807E+00	1.00	1.00	0.186	.22845E+02
0.65	-8.74	7.97	12.6	0.796E+00	1.01	1.01	0.184	.23474E+02
0.67	-8.86	7.97	12.7	0.785E+00	1.02	1.02	0.181	.24113E+02
Minimum jet height has been reached.								
0.70	-8.98	7.97	12.9	0.774E+00	1.04	1.04	0.178	.24775E+02
0.72	-9.09	7.97	13.1	0.764E+00	1.05	1.05	0.176	.25432E+02
0.75	-9.21	7.98	13.3	0.753E+00	1.07	1.07	0.173	.26097E+02
0.77	-9.32	7.98	13.5	0.743E+00	1.08	1.08	0.171	.26772E+02
0.80	-9.43	7.99	13.6	0.733E+00	1.09	1.09	0.169	.27454E+02
0.82	-9.55	8.00	13.8	0.723E+00	1.11	1.11	0.167	.28146E+02
0.85	-9.66	8.01	14.0	0.713E+00	1.12	1.12	0.165	.28846E+02
0.88	-9.78	8.02	14.2	0.704E+00	1.14	1.14	0.162	.29572E+02
0.91	-9.89	8.03	14.4	0.694E+00	1.15	1.15	0.161	.30289E+02
0.94	-10.01	8.04	14.6	0.685E+00	1.16	1.16	0.159	.31015E+02

```
     0.97   -10.12    8.06     14.8 0.676E+00    1.18      1.18      0.157   .31749E+02
     1.00   -10.23    8.08     15.0 0.667E+00    1.19      1.19      0.155   .32492E+02
     1.03   -10.34    8.10     15.2 0.658E+00    1.21      1.21      0.153   .33243E+02
     1.06   -10.45    8.12     15.4 0.650E+00    1.22      1.22      0.151   .34002E+02
     1.09   -10.57    8.14     15.6 0.641E+00    1.23      1.23      0.150   .34788E+02
     1.13   -10.68    8.16     15.8 0.633E+00    1.25      1.25      0.148   .35564E+02
     1.16   -10.79    8.19     16.0 0.625E+00    1.26      1.26      0.146   .36349E+02
     1.19   -10.90    8.21     16.2 0.617E+00    1.28      1.28      0.145   .37142E+02
     1.23   -11.01    8.24     16.4 0.609E+00    1.29      1.29      0.143   .37943E+02
     1.26   -11.12    8.26     16.6 0.601E+00    1.31      1.31      0.141   .38753E+02
     1.30   -11.22    8.29     16.8 0.594E+00    1.32      1.32      0.140   .39571E+02
     1.34   -11.33    8.32     17.0 0.587E+00    1.34      1.34      0.138   .40418E+02
     1.38   -11.44    8.35     17.3 0.580E+00    1.35      1.35      0.137   .41254E+02
     1.41   -11.55    8.38     17.5 0.573E+00    1.36      1.36      0.135   .42099E+02
     1.45   -11.66    8.41     17.7 0.566E+00    1.38      1.38      0.134   .42953E+02
     1.49   -11.76    8.44     17.9 0.560E+00    1.39      1.39      0.132   .43817E+02
     1.53   -11.87    8.47     18.1 0.553E+00    1.41      1.41      0.131   .44689E+02
     1.57   -11.98    8.50     18.3 0.547E+00    1.42      1.42      0.129   .45572E+02
 Terminal level in stratified ambient has been reached.
Cumulative travel time =          45.5716 sec  (    0.01 hrs)
 Merging of individual jet/plumes not found in this module, but interaction
   will occur in following module.  Overall jet/plume interaction dimensions:
     1.57   -11.98    8.50     18.3 0.547E+00    1.42      7.69      0.129   .45572E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =     11.45 m
        Layer thickness in impingement region   =      0.69 m
        Upstream intrusion length               =    135.07 m
        X-position of upstream stagnation point =   -133.49 m
        Thickness in intrusion region           =      0.69 m
        Half-width at downstream end            =    269.59 m
        Thickness at downstream end             =      0.53 m

  Control volume inflow:
      X        Y        Z        S        C        BV       BH        TT
     1.57   -11.98    8.50     18.3 0.547E+00    1.42      7.69   .45572E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

      X        Y        Z        S        C        BV       BH       ZU       ZL        TT
  -133.49   -11.98    8.50   9999.9 0.000E+00    0.00      0.00     8.50     8.50   .13525E+05
  -128.10   -11.98    8.50     73.0 0.137E+00    0.17     38.13     8.58     8.41   .45572E+02
  -101.65   -11.98    8.50     30.4 0.329E+00    0.42     92.61     8.71     8.29   .45572E+02
   -75.20   -11.98    8.50     23.1 0.433E+00    0.55    125.29     8.77     8.22   .45572E+02
   -48.76   -11.98    8.50     20.0 0.499E+00    0.63    151.07     8.81     8.18   .45572E+02
   -22.31   -11.98    8.50     18.6 0.536E+00    0.68    173.04     8.84     8.16   .45572E+02
     4.13   -11.98    8.50     18.3 0.546E+00    0.69    247.04     8.84     8.15   .30182E+03
** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
In this prediction interval the plume DOWNSTREAM distance meets or exceeds
the regulatory value =    25.00 m.
This is the extent of the REGULATORY MIXING ZONE.
    30.58   -11.98    8.50     20.9 0.479E+00    0.67    252.22     8.83     8.16   .29464E+04
    57.03   -11.98    8.50     25.9 0.387E+00    0.61    256.99     8.80     8.19   .55911E+04
    83.47   -11.98    8.50     30.2 0.332E+00    0.57    261.44     8.78     8.21   .82357E+04
   109.92   -11.98    8.50     32.5 0.308E+00    0.54    265.62     8.77     8.23   .10880E+05
```

```
    136.37   -11.98    8.50    33.7 0.297E+00   0.53   269.59    8.76    8.23   .13525E+05
 Cumulative travel time =       13524.9756 sec  (    3.76 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
-----------------------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
 Some BOUNDARY INTERACTION with both banks occurs at end of near-field.
   The dilution values in one or more of the preceding zones may be too high.
 Carefully evaluate results in near-field and check degree of interaction.
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -3.00m
-----------------------------------------------------------------------------------------------
BEGIN MOD281: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION

 An UPSTREAM INTRUDING BOTTOM WEDGE is formed.

 UPSTREAM WEDGE INTRUSION PROPERTIES in bounded channel (laterally uniform):
        Wedge length                          =    2344.69 m
        X-Position of wedge tip               =   -2208.32 m
        Thickness at discharge (end of NFR)   =       1.17 m
         (Wedge thickness gradually decreases to zero at wedge tip.)

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in combination
   with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
  will be acceptable, however.

       X        Y       Z        S        C        BV       BH      ZU      ZL       TT
    136.37     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .13525E+05
 Cumulative travel time =       13524.9746 sec  (    3.76 hrs)
 Flow is LATERALLY MIXED over the channel width.

END OF MOD281: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

  Vertical diffusivity (initial value)   = 0.143E-09 m^2/s
  Horizontal diffusivity (initial value) = 0.545E-02 m^2/s

 Profile definitions:
   BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
      = or equal to layer depth, if fully mixed
   BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
        measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X        Y       Z        S        C        BV       BH      ZU      ZL       TT
    136.37     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .13525E+05
    185.00     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .18389E+05
    233.64     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .23252E+05
    282.28     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .28116E+05
    330.91     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .32980E+05
    379.55     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .37843E+05
    428.18     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .42707E+05
    476.82     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .47570E+05
    525.46     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .52434E+05
    574.09     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .57298E+05
```

622.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.62161E+05
671.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.67025E+05
720.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.71889E+05
768.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.76752E+05
817.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.81616E+05
865.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.86480E+05
914.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.91343E+05
963.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.96207E+05
1011.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.10107E+06
1060.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.10593E+06
1109.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.11080E+06
1157.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.11566E+06
1206.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.12052E+06
1255.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.12539E+06
1303.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13025E+06
1352.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13512E+06
1400.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13998E+06
1449.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.14484E+06
1498.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.14971E+06
1546.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.15457E+06
1595.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.15943E+06
1644.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.16430E+06
1692.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.16916E+06
1741.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.17402E+06
1790.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.17889E+06
1838.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.18375E+06
1887.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.18862E+06
1935.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.19348E+06
1984.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.19834E+06
2033.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.20321E+06
2081.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.20807E+06
2130.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.21293E+06
2179.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.21780E+06
2227.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.22266E+06
2276.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.22752E+06
2325.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.23239E+06
2373.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.23725E+06
2422.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.24212E+06
2470.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.24698E+06
2519.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.25184E+06
2568.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.25671E+06
2616.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.26157E+06
2665.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.26643E+06
2714.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.27130E+06
2762.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.27616E+06
2811.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.28102E+06
2860.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.28589E+06
2908.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.29075E+06
2957.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.29562E+06
3005.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.30048E+06
3054.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.30534E+06
3103.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31021E+06
3151.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31507E+06
3200.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31993E+06
3249.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.32480E+06
3297.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.32966E+06
3346.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.33452E+06
3395.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.33939E+06
3443.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.34425E+06
3492.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.34912E+06
3540.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.35398E+06
3589.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.35884E+06
3638.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.36371E+06
3686.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.36857E+06
3735.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.37343E+06
3784.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.37830E+06
3832.72	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.38316E+06

3881.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.38802E+06
3930.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.39289E+06
3978.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.39775E+06
4027.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.40262E+06
4075.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.40748E+06
4124.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.41234E+06
4173.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.41721E+06
4221.81	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.42207E+06
4270.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.42693E+06
4319.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.43180E+06
4367.72	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.43666E+06
4416.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.44152E+06
4465.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.44639E+06
4513.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.45125E+06
4562.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.45612E+06
4610.90	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.46098E+06
4659.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.46584E+06
4708.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.47071E+06
4756.81	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.47557E+06
4805.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.48043E+06
4854.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.48530E+06
4902.72	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.49016E+06
4951.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.49502E+06
4999.99	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.49989E+06

Cumulative travel time = 499888.3438 sec (138.86 hrs)

Note:
CORMIX is a steady state model and assumes discharge and ambient conditions do not vary over time. The predicted plume cumulative travel time exceeds 48 hours at this trajectory distance. Keep in mind that ambient and discharge conditions are likely to vary over large space and time scales. Predictions at such large space and time scales may be inconsistent with CORMIX modeling assumptions.

Please carefully evaluate your simulation results and limit model interpretation to space and time scales consistent with steady state assumptions and ambient schematization.

Simulation limit based on maximum specified distance = 5000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

CORMIX2: Multiport Diffuser Discharges End of Prediction File
222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222

CORMIX SESSION, PROCESSING, AND PREDICTION FILES – Multiport; 3 cfs Discharge

Date: 07/27/18
Time: 15:10:43

Design Case: Location 1; MP diffuser; 3 ports
Site Name: EW BROWN - HERRINGTON LK
Prepared By: DWI

Project Notes:

Location 1 is conceptual location along main lake bank, 15 ft from lake bank/bed
3 port multiport diffuser, 25-ft port spacing, 8-inch TFW, -15 degree vertical angle
linear ambient stratification
20 cfs discharge

VALIDATING INPUT DATA ...

Checking Pages for invalid or missing inputs...

Effluent Page has been validated.
Ambient Page has been validated.
Discharge Page has been validated.
Mixing Zone Page has been validated.

Finished checking Pages for invalid or missing inputs.

Loading Correct RuleBases

Validating RuleBases ...

AMBIENT DATA:

Ambient flowrate = 43.920 m^3/s.

Equivalent Darcy-Weisbach friction factor = 0.007

Ambient surface density = 995.9449 kg/m^3.

Ambient bottom density = 997.7714 kg/m^3.

The ambient DENSITY PROFILE you have specified is DYNAMICALLY STABLE in the presence of the given ambient crossflow. (This has been checked with a FLUX RICHARDSON NUMBER CRITERION).

Ambient Rule Base has been validated.

DISCHARGE DATA:
CORMIX2: Multiport Diffuser Discharges

Diffuser center (mid-point of diffuser line) is located 7 m from left bank/shore.

Average spacing between the individual ports/nozzles = 7.62 m.

This spacing is of the order of, or less than, the discharge water depth of 15 m. Therefore, significant lateral interaction of adjacent jets in the near field is expected, forming essentially two-dimensional near-field conditions as if the discharge would issue from a two-dimensional slot.

CORMIX2 is FULLY APPLICABLE for this situation and will analyze this discharge using two-dimensional prediction models in the near field.

*** WARNING ***
You have entered a multiport diffuser with the minimum number of ports/openings NOPEN = 3 allowed in CORMIX. Please carefully check your multiport diffuser input configuration with CORMIX2 line source assumptions.

Effective port/nozzle diameter D0 = 0.133 m
Effective port X-sectional area of each port A0 = 0.0139 m^2
Effective port X-sectional area of all ports in each riser A0RG = 0.0139 m^2

This is a Slightly Submerged Discharge, where the height of the discharge port (H0 = 10 m), above the bottom, Exceeds two-thirds of the local ambient water depth (HD = 15 m)
Note: For special advice on this limitation please consult Section 5.3 of the CORMIX2 technical report (Akar and Jirka, 1991).; yet more detail can be found in the CORMIX1 report, Doneker and Jirka, 1990

The present diffuser type is UNIDIRECTIONAL WITH PARALLEL ALIGNMENT.

Effective discharge velocity U0 = 2.04 m/s

The submergence of the port below the water surface is SUB0 = 5 m.

Discharge density RHO0 = 997.0456 kg/m^3.

Discharge Rules for CORMIX2 have been validated.

MIXING ZONE SPECIFICATION:

REGULATORY MIXING ZONE (RMZ) Specifications:

In general practice, there are two possible interpretations for the RMZ:

Interpretation 1: The RMZ is a spatially defined (by State/Federal agencies) restricted region at whose boundary a specified water quality standard for conventional pollutants - or the CCC for toxic pollutants - has to be met.

Interpretation 2: The applicant or the State/Federal agency may propose on an ad-hoc basis an RMZ as that region at whose boundary a water quality standard - or CCC - has been demonstrated to be met. That demonstration is usually made by means of a mixing zone prediction.

CORMIX will evaluate the RMZ conditions on the basis of both interpretations.

Mixing Zones Rule Base has been validated.

Finished validating RuleBases.

Calculating Parameters.

FLOW PARAMETERS AND LENGTH SCALES:

Relative density differences between discharge and ambient:

Ambient density at the discharge level RHOAH0 = 996.553718 kg/m^3
Vertical mean ambient density RHOAM = 996.858144 kg/m^3

The effluent density (997.04559 kg/m^3) is greater than the surrounding ambient water density at the discharge level (996.55372 kg/m^3). Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards the bottom.
IMPORTANT NOTE:
Since the effluent is NEGATIVELY BUOYANT, it is recommended that you consider using the Brine or Sediment options for Effluent specification for a more detailed analysis, particularly for coastal discharges over a sloping bottom where density currents are important.

CORMIX will however continue with the current simulation.

Flow bulk parameters:
(Bulk variables are defined on a 2-D basis, i.e. per unit diffuser length)

Ambient momentum flux ma = 0.0015 m^3/s^2

Discharge volume flux q0 = 0.00557 m^2/s
Discharge momentum flux m0 = 0.01136 m^3/s^2
This flux has a net component in the discharge direction (orientation of ports/nozzles).

Discharge buoyancy flux j0 = -0.00003 m^3/s^3

Flow length scales:
(Length scales are defined on a 2-D basis, i.e. per unit diffuser length)

Discharge length scale lq = 0.0027 m.

Jet-to-crossflow length scale lm = 113.61 m.

Jet-to-plume transition length scale lM = 11.01 m.

Jet stratification length scale lm' = 2.12 m.
Plume stratification length scale lb' = 0.87 m.
Crossflow stratification length scale la = 0.29 m.

Non-dimensional parameters:

Slot densimetric Froude number FR0 = 686.12
Equivalent slot width B0 = 0.0018m

CORMIX2 uses the equivalent two-dimensional slot diffuser concept to classify the actual three-dimensional diffuser dynamics.
For the dilution predicted however, CORMIX2 models the flow from each port or, if applicable, collectively from each riser group.

Port/nozzle densimetric Froude number FRD0 = 80.33
Jet/crossflow velocity ratio R = 203.82

Parameters for CORMIX2 have been calculated.

Classifying Flows.

FLOW CLASSIFICATION:

```
CORMIX2 includes FIVE MAJOR CLASSES of possible flow configurations:
Classes MS, IMS:  Flows trapped in a layer within linear ambient stratification.
Classes MU     :  Near Bottom, Positively buoyant flows in a uniform density layer.
Classes IMU    :  Near Surface,Negatively buoyant flows in a uniform density layer.
Classes MNU    :  Near Bottom, Negatively buoyant flows in uniform density layer.
Classes IMPU   :  Near Surface,Positively buoyant flows in uniform density layer.
```

The NEAR FIELD FLOW will have the following features:

If flow trapping occurs, then the flow is jet-like and is strongly affected by the ambient density stratification with weak crossflow effect (if any).

Terminal Height Level Zt = -3.43

The specified ambient density stratification is dynamically important. The discharge near field flow may be trapped within the linearly stratified ambient density layer.

The discharge near-field behavior is dominated by either the negative buoyancy of the discharge or the downward vertical orientation of the discharge port.

The following conclusion on the flow configuration applies to a layer corresponding to the full water depth at the discharge site:

*** FLOW CLASS = IMS4 ***

Applicable layer depth HS = 15 m.

*** Limiting Dilution S = (QA/Q0)+ 1.0 = 518.0 ***

Flow has been classified.

Executing the simulation... FORTRAN simulation complete.

```
Generating Session Report... Session Report complete.

CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 10.0GT
                       HYDRO2:Version-10.0.2.0  April,2017
SITE NAME/LABEL:                EW BROWN - HERRINGTON LK
  DESIGN CASE:                  Location 1; MP diffuser; 3 ports
  FILE NAME:                    D:\LG&E KU Brown\CORMIX\EW BROWN HERRINGTON IN-LAKE 3-PORT
DIFFUSER.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/27/2018--15:10:43
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                            BS      = 244 m
  Channel regularity               ICHREG = 1
  Ambient flowrate                 QA      = 43.92 m^3/s
  Average depth                    HA      = 18 m
  Depth at discharge               HD      = 15 m
  Ambient velocity                 UA      = 0.01 m/s
  Darcy-Weisbach friction factor  F       = 0.0067
    Calculated from Manning's n            = 0.015
  Wind velocity                    UW      = 1.34 m/s
  Stratification Type              STRCND = A
  Surface temperature                      = 29 degC
  Bottom temperature                       = 22 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                  RHOAS  = 995.9449 kg/m^3
  Bottom density                   RHOAB  = 997.7714 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:              Submerged Multiport Diffuser Discharge
  Diffuser type                    DITYPE = unidirectional parallel
  Diffuser length                  LD      = 15.24 m
  Nearest bank                             = left
  Diffuser endpoints               YB1     = 7 m;    YB2 = 7 m
  Number of openings               NOPEN  = 3
  Number of Risers                 NRISER = 3
  Ports/Nozzles per Riser          NPPERR  = 1
  Spacing between risers/openings SPAC    = 7.62 m
  Port/Nozzle diameter             D0      = 0.133 m
    with contraction ratio                 = 1
  Equivalent slot width            B0      = 0.0018 m
  Total area of openings           TA0     = 0.0417 m^2
  Discharge velocity               U0      = 2.04 m/s
  Total discharge flowrate         Q0      = 0.084951 m^3/s
  Discharge port height            H0      = 10 m
  Nozzle arrangement               BETYPE = unidirectional with fanning
  Diffuser alignment angle         GAMMA  = 0 deg
```

```
  Vertical discharge angle        THETA  = -15 deg
  Actual Vertical discharge angle THEAC  = -15 deg
  Horizontal discharge angle      SIGMA  = 270 deg
  Relative orientation angle      BETA   = 90 deg
  Discharge temperature (freshwater)     = 25 degC
  Corresponding density           RHO0   = 997.0456 kg/m^3
  Density difference              DRHO   = -0.4919 kg/m^3
  Buoyant acceleration            GP0    = -0.0048 m/s^2
  Discharge concentration         C0     = 10 ppm
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.005574 m^2/s
  Momentum flux                   m0     = 0.011361 m^3/s^2
  Buoyancy flux                   j0     = -0.000027 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m         Lm  = 113.61 m         LM  = 11.01 m
  lm' = 2.12 m         Lb' = 0.87 m         La  = 0.29 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 686.12
  Port/nozzle Froude number       FRD0   = 80.33
  Velocity ratio                  R      = 203.82
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard          CSTD   = 5 ppm
  Regulatory mixing zone                 = yes
  Regulatory mixing zone specification   = distance
  Regulatory mixing zone value           = 25 m (m^2 if area)
  Region of interest                     = 5000 m
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = IMS4 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 15 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 518.0

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
```

```
    7 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.2969 ppm
  Dilution at edge of NFR              s = 33.7
  NFR Location:                        x = 136.37 m
    (centerline coordinates)           y = -11.98 m
                                       z = 8.50 m
  NFR plume dimensions:  half-width (bh) = 269.59 m
                          thickness (bv) = 0.53 m
Cumulative travel time:       13524.9746 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is greater than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards
  the bottom.
IMPORTANT NOTE:
Since the effluent is NEGATIVELY BUOYANT, it is recommended that you consider using the Brine or
Sediment options for Effluent specification for a more detailed analysis, particularly for coastal
discharges over a sloping bottom where density currents are important.

CORMIX will however continue with the current simulation.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                          =  135.07 m
  Intrusion stagnation point                =  -133.49 m
  Intrusion thickness                       =  0.69 m
  Intrusion half width at impingement       =  269.59 m
  Intrusion half thickness at impingement =  0.53 m

  In this case, the UPSTREAM INTRUSION IS VERY LARGE, exceeding ten (10)
    times the local water depth.
  This may be caused by the small ambient velocity, perhaps in combination
    with the strong buoyancy of the effluent, or alternatively, a strong
    ambient stratification.
  If the ambient conditions are quite unsteady (e.g. tidal), then the
    CORMIX steady-state predictions of the upstream intrusion are probably
    unrealistic.  The plume predictions in the immediate near-field, prior
    to the intrusion layer formation, are acceptable, however.
```

```
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes laterally fully mixed at 0 m downstream.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration             c = 0.493056  ppm
  Corresponding dilution              s = 20.3
  Plume location:                     x = 25 m
    (centerline coordinates)          y = -11.98 m
                                      z = 8.50 m
  Plume dimensions:      half-width (bh) = 251.13 m
                          thickness (bv) = 0.67 m
Cumulative travel time < 13524.9746 sec. (RMZ is within NFR)

Note:
Plume concentration c and dilution s values are reported based on prediction
file values - assuming linear interpolation between predicted points just
before and just after the RMZ boundary has been detected.

Please ensure a small step size is used in the prediction file to account
for this linear interpolation. Step size can be controlled by increasing
(reduces the prediction step size) or decreasing (increases the prediction
step size) the - Output Steps per Module - in CORMIX input.

At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                = 5  ppm
  Corresponding dilution              s = 2
  Plume location:                     x = 0.01 m
    (centerline coordinates)          y = -1.44 m
                                      z = 9.61 m
  Plume dimensions:      half-width (bh) = 0.16 m
                          thickness (bv) = 0.16 m
-----------------------------------------------------------------------------
Regulatory Mixing Zone Analysis:
  The RMZ specification occurs before the near-field mixing regime (NFR) has
  been completed.  The specification of the RMZ is highly restrictive.
******************** FINAL DESIGN ADVICE AND COMMENTS *********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
```

```
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 10.0GT
                     HYDRO2 Version 10.0.2.0 April 2017
----------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   EW BROWN - HERRINGTON LK
 Design case:       Location 1; MP diffuser; 3 ports
 FILE NAME:         D:\...X\EW BROWN HERRINGTON IN-LAKE 3-PORT DIFFUSER.prd
 Time stamp:        07/27/2018--15:10:43

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =    244.00  AS     =   4392.00  QA     =     43.92  ICHREG= 1
 HA     =     18.00  HD     =     15.00
 UA     =      0.010 F      =      0.007 USTAR =0.2903E-03
 UW     =      1.341 UWSTAR=0.1449E-02
 Density stratified environment
 STRCND=  A          RHOAM =  996.8582
 RHOAS =  995.9449  RHOAB =  997.7714  RHOAH0=  996.5537  E      =0.1197E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_parallel
 BANK  =  LEFT      DISTB =      7.00  YB1    =      7.00  YB2    =      7.00
 LD     =     15.24  NOPEN =    3       NRISER=    3       SPAC   =      7.62    NPPERR =    1
 D0     =      0.133 A0     =      0.014 H0     =     10.00  SUB0   =      5.00
 D0INP =      0.133 CR0    =      1.000
 Nozzle/port arrangement:   unidirectional_with_fanning
 GAMMA =      0.00  THETA =    -15.00  SIGMA =    270.00  BETA   =     90.00
 U0     =      2.038 Q0     =      0.085 Q0A   =0.8495E-01
 RHO0  =  997.0456  DRHO0 =-.4919E+00  GP0   =-.4840E-02
 C0     =0.1000E+02  CUNITS=  ppm
 IPOLL =  1          KS     =0.0000E+00  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.5574E-02  m0     =0.7574E-02  j0     =-.1799E-04  SIGNJ0=     -1.0
 Associated 2-d length scales (meters)
 lQ=B  =      0.003 lM     =     11.01  lm     =    113.61
 lmp   =      2.12  lbp    =      0.87  la     =      0.29

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.8495E-01  M0     =0.1154E+00  J0     =-.2741E-03
 Associated 3-d length scales (meters)
 LQ     =      0.12  LM     =     11.96  Lm     =     41.61  Lb     =    411.18
                                          Lmp    =      3.47  Lbp    =      1.78

NON-DIMENSIONAL PARAMETERS
 FR0    =    686.12  FRD0  =     80.33  R      =    203.82  PL     =   59.34
 (slot)             (port/nozzle)
```

```
RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =      2.038 D0    =      0.133 A0    =      0.014 THETA =    -15.00
 FR0   =    686.12  FRD0  =     80.33  R     =    203.82
 (slot)             (riser group)

FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    IMS4   2
 2  Applicable layer depth HS =    15.00  2
 2  Limiting Dilution S =QA/Q0=   518.01  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+02  CUNITS=  ppm
 NTOX  =  0
 NSTD  =  1         CSTD  =0.5000E+01
 REGMZ =  1
 REGSPC=  1         XREG  =     25.00  WREG  =      0.00  AREG  =      0.00
 XINT  =   5000.00  XMAX  =   5000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
         7.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

       X        Y        Z        S        C        BV       BH       Uc        TT
      0.00     0.00    10.00      1.0 0.100E+02    0.07     0.07     2.038   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=    -15.00  SIGMAE=    270.12
  LE    =      0.65  XE    =      0.00  YE    =     -0.63  ZE    =      9.83

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
```

```
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X         Y         Z         S        C        BV        BH        Uc         TT
  Individual jet/plumes before merging:
      0.00     -0.63     9.83      1.0 0.100E+02   0.07      0.07      2.038   .00000E+00
      0.00     -0.63     9.83      1.0 0.100E+02   0.07      0.07      2.038   .95307E-03
      0.00     -0.75     9.80      1.0 0.999E+01   0.08      0.08      2.038   .45995E-01
      0.00     -0.86     9.77      1.2 0.860E+01   0.09      0.09      2.038   .98972E-01
      0.00     -0.97     9.74      1.3 0.754E+01   0.11      0.11      1.815   .15988E+00
      0.00     -1.09     9.71      1.5 0.672E+01   0.12      0.12      1.617   .22873E+00
      0.00     -1.20     9.68      1.7 0.606E+01   0.13      0.13      1.458   .30551E+00
      0.01     -1.31     9.65      1.8 0.551E+01   0.14      0.14      1.327   .39022E+00
      0.01     -1.43     9.62      2.0 0.505E+01   0.16      0.16      1.216   .48512E+00
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.500E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
      0.01     -1.54     9.59      2.1 0.467E+01   0.17      0.17      1.124   .58588E+00
      0.01     -1.66     9.55      2.3 0.434E+01   0.18      0.18      1.044   .69458E+00
      0.01     -1.77     9.52      2.5 0.405E+01   0.20      0.20      0.976   .81121E+00
      0.01     -1.88     9.49      2.6 0.380E+01   0.21      0.21      0.915   .93577E+00
      0.02     -2.00     9.46      2.8 0.358E+01   0.22      0.22      0.862   .10683E+01
      0.02     -2.11     9.43      3.0 0.338E+01   0.24      0.24      0.815   .12087E+01
      0.02     -2.23     9.40      3.1 0.320E+01   0.25      0.25      0.771   .13606E+01
      0.02     -2.34     9.37      3.3 0.304E+01   0.26      0.26      0.733   .15171E+01
      0.03     -2.45     9.34      3.5 0.290E+01   0.27      0.27      0.698   .16815E+01
      0.03     -2.57     9.31      3.6 0.277E+01   0.29      0.29      0.667   .18539E+01
      0.03     -2.68     9.27      3.8 0.265E+01   0.30      0.30      0.638   .20342E+01
      0.04     -2.79     9.24      3.9 0.254E+01   0.31      0.31      0.612   .22225E+01
      0.04     -2.91     9.21      4.1 0.243E+01   0.33      0.33      0.587   .24234E+01
      0.04     -3.02     9.18      4.3 0.234E+01   0.34      0.34      0.564   .26277E+01
      0.05     -3.14     9.15      4.4 0.225E+01   0.35      0.35      0.544   .28400E+01
      0.05     -3.25     9.12      4.6 0.217E+01   0.37      0.37      0.524   .30603E+01
      0.06     -3.36     9.08      4.8 0.210E+01   0.38      0.38      0.506   .32885E+01
      0.06     -3.47     9.05      4.9 0.203E+01   0.39      0.39      0.489   .35247E+01
  Level of buoyancy reversal in stratified ambient.
      0.07     -3.59     9.02      5.1 0.196E+01   0.40      0.40      0.474   .37689E+01
      0.07     -3.70     8.99      5.3 0.190E+01   0.42      0.42      0.458   .40271E+01
      0.08     -3.82     8.96      5.4 0.184E+01   0.43      0.43      0.444   .42875E+01
      0.08     -3.93     8.93      5.6 0.179E+01   0.44      0.44      0.431   .45559E+01
      0.09     -4.04     8.89      5.8 0.174E+01   0.46      0.46      0.419   .48323E+01
      0.10     -4.16     8.86      5.9 0.169E+01   0.47      0.47      0.407   .51168E+01
      0.10     -4.27     8.83      6.1 0.164E+01   0.48      0.48      0.396   .54093E+01
      0.11     -4.38     8.80      6.2 0.160E+01   0.50      0.50      0.386   .57098E+01
      0.12     -4.50     8.77      6.4 0.156E+01   0.51      0.51      0.375   .60258E+01
      0.13     -4.61     8.74      6.6 0.152E+01   0.52      0.52      0.366   .63427E+01
      0.13     -4.72     8.71      6.7 0.148E+01   0.54      0.54      0.357   .66678E+01
      0.14     -4.84     8.68      6.9 0.145E+01   0.55      0.55      0.348   .70011E+01
      0.15     -4.95     8.64      7.1 0.141E+01   0.56      0.56      0.340   .73425E+01
      0.16     -5.06     8.61      7.2 0.138E+01   0.58      0.58      0.332   .76920E+01
```

0.17	-5.18	8.58	7.4	0.135E+01	0.59	0.59	0.324	.80583E+01
0.18	-5.29	8.55	7.6	0.132E+01	0.60	0.60	0.317	.84245E+01
0.19	-5.41	8.52	7.7	0.129E+01	0.62	0.62	0.310	.87990E+01
0.20	-5.52	8.50	7.9	0.127E+01	0.63	0.63	0.303	.91818E+01
0.21	-5.63	8.47	8.1	0.124E+01	0.64	0.64	0.297	.95730E+01
0.22	-5.75	8.44	8.2	0.122E+01	0.66	0.66	0.290	.99725E+01
0.23	-5.86	8.41	8.4	0.119E+01	0.67	0.67	0.284	.10380E+02
0.24	-5.98	8.38	8.6	0.117E+01	0.68	0.68	0.279	.10807E+02
0.25	-6.09	8.35	8.7	0.115E+01	0.70	0.70	0.273	.11232E+02
0.26	-6.21	8.33	8.9	0.113E+01	0.71	0.71	0.268	.11665E+02
0.28	-6.32	8.30	9.0	0.111E+01	0.72	0.72	0.262	.12107E+02
0.29	-6.43	8.28	9.2	0.109E+01	0.74	0.74	0.257	.12558E+02
0.30	-6.55	8.25	9.4	0.107E+01	0.75	0.75	0.253	.13017E+02
0.32	-6.67	8.23	9.5	0.105E+01	0.76	0.76	0.248	.13496E+02
0.33	-6.78	8.20	9.7	0.103E+01	0.78	0.78	0.243	.13973E+02
0.35	-6.89	8.18	9.9	0.101E+01	0.79	0.79	0.239	.14459E+02
0.36	-7.01	8.16	10.0	0.997E+00	0.80	0.80	0.234	.14954E+02
0.38	-7.12	8.14	10.2	0.981E+00	0.82	0.82	0.230	.15457E+02
0.39	-7.24	8.12	10.4	0.965E+00	0.83	0.83	0.226	.15969E+02
0.41	-7.35	8.10	10.5	0.950E+00	0.84	0.84	0.222	.16490E+02
0.43	-7.47	8.08	10.7	0.935E+00	0.86	0.86	0.219	.17033E+02
0.44	-7.59	8.07	10.9	0.921E+00	0.87	0.87	0.215	.17572E+02
0.46	-7.70	8.05	11.0	0.907E+00	0.88	0.88	0.211	.18120E+02
0.48	-7.82	8.04	11.2	0.893E+00	0.90	0.90	0.208	.18677E+02
0.50	-7.93	8.03	11.4	0.880E+00	0.91	0.91	0.204	.19243E+02
0.52	-8.05	8.01	11.5	0.868E+00	0.93	0.93	0.201	.19818E+02
0.54	-8.17	8.00	11.7	0.855E+00	0.94	0.94	0.198	.20416E+02
0.56	-8.28	7.99	11.9	0.843E+00	0.95	0.95	0.195	.21010E+02
0.58	-8.40	7.99	12.0	0.831E+00	0.97	0.97	0.192	.21613E+02
0.60	-8.51	7.98	12.2	0.819E+00	0.98	0.98	0.189	.22224E+02
0.63	-8.63	7.98	12.4	0.807E+00	1.00	1.00	0.186	.22845E+02
0.65	-8.74	7.97	12.6	0.796E+00	1.01	1.01	0.184	.23474E+02
0.67	-8.86	7.97	12.7	0.785E+00	1.02	1.02	0.181	.24113E+02

Minimum jet height has been reached.

0.70	-8.98	7.97	12.9	0.774E+00	1.04	1.04	0.178	.24775E+02
0.72	-9.09	7.97	13.1	0.764E+00	1.05	1.05	0.176	.25432E+02
0.75	-9.21	7.98	13.3	0.753E+00	1.07	1.07	0.173	.26097E+02
0.77	-9.32	7.98	13.5	0.743E+00	1.08	1.08	0.171	.26772E+02
0.80	-9.43	7.99	13.6	0.733E+00	1.09	1.09	0.169	.27454E+02
0.82	-9.55	8.00	13.8	0.723E+00	1.11	1.11	0.167	.28146E+02
0.85	-9.66	8.01	14.0	0.713E+00	1.12	1.12	0.165	.28846E+02
0.88	-9.78	8.02	14.2	0.704E+00	1.14	1.14	0.162	.29572E+02
0.91	-9.89	8.03	14.4	0.694E+00	1.15	1.15	0.161	.30289E+02
0.94	-10.01	8.04	14.6	0.685E+00	1.16	1.16	0.159	.31015E+02
0.97	-10.12	8.06	14.8	0.676E+00	1.18	1.18	0.157	.31749E+02
1.00	-10.23	8.08	15.0	0.667E+00	1.19	1.19	0.155	.32492E+02
1.03	-10.34	8.10	15.2	0.658E+00	1.21	1.21	0.153	.33243E+02
1.06	-10.45	8.12	15.4	0.650E+00	1.22	1.22	0.151	.34002E+02
1.09	-10.57	8.14	15.6	0.641E+00	1.23	1.23	0.150	.34788E+02
1.13	-10.68	8.16	15.8	0.633E+00	1.25	1.25	0.148	.35564E+02
1.16	-10.79	8.19	16.0	0.625E+00	1.26	1.26	0.146	.36349E+02
1.19	-10.90	8.21	16.2	0.617E+00	1.28	1.28	0.145	.37142E+02

```
      1.23   -11.01    8.24    16.4 0.609E+00   1.29     1.29     0.143   .37943E+02
      1.26   -11.12    8.26    16.6 0.601E+00   1.31     1.31     0.141   .38753E+02
      1.30   -11.22    8.29    16.8 0.594E+00   1.32     1.32     0.140   .39571E+02
      1.34   -11.33    8.32    17.0 0.587E+00   1.34     1.34     0.138   .40418E+02
      1.38   -11.44    8.35    17.3 0.580E+00   1.35     1.35     0.137   .41254E+02
      1.41   -11.55    8.38    17.5 0.573E+00   1.36     1.36     0.135   .42099E+02
      1.45   -11.66    8.41    17.7 0.566E+00   1.38     1.38     0.134   .42953E+02
      1.49   -11.76    8.44    17.9 0.560E+00   1.39     1.39     0.132   .43817E+02
      1.53   -11.87    8.47    18.1 0.553E+00   1.41     1.41     0.131   .44689E+02
      1.57   -11.98    8.50    18.3 0.547E+00   1.42     1.42     0.129   .45572E+02
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          45.5716 sec  (    0.01 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
      1.57   -11.98    8.50    18.3 0.547E+00   1.42     7.69     0.129   .45572E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =     11.45 m
        Layer thickness in impingement region   =      0.69 m
        Upstream intrusion length               =    135.07 m
        X-position of upstream stagnation point =   -133.49 m
        Thickness in intrusion region           =      0.69 m
        Half-width at downstream end            =    269.59 m
        Thickness at downstream end             =      0.53 m

  Control volume inflow:
       X        Y       Z        S       C        BV       BH        TT
      1.57   -11.98    8.50    18.3 0.547E+00   1.42     7.69   .45572E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S       C        BV       BH       ZU       ZL        TT
   -133.49   -11.98    8.50  9999.9 0.000E+00   0.00     0.00     8.50     8.50   .13525E+05
   -128.10   -11.98    8.50    73.0 0.137E+00   0.17    38.13     8.58     8.41   .45572E+02
   -101.65   -11.98    8.50    30.4 0.329E+00   0.42    92.61     8.71     8.29   .45572E+02
    -75.20   -11.98    8.50    23.1 0.433E+00   0.55   125.29     8.77     8.22   .45572E+02
    -48.76   -11.98    8.50    20.0 0.499E+00   0.63   151.07     8.81     8.18   .45572E+02
    -22.31   -11.98    8.50    18.6 0.536E+00   0.68   173.04     8.84     8.16   .45572E+02
      4.13   -11.98    8.50    18.3 0.546E+00   0.69   247.04     8.84     8.15   .30182E+03
 ** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
```

```
 In this prediction interval the plume DOWNSTREAM distance meets or exceeds
 the regulatory value =    25.00 m.
 This is the extent of the REGULATORY MIXING ZONE.
     30.58   -11.98    8.50    20.9 0.479E+00   0.67   252.22    8.83    8.16   .29464E+04
     57.03   -11.98    8.50    25.9 0.387E+00   0.61   256.99    8.80    8.19   .55911E+04
     83.47   -11.98    8.50    30.2 0.332E+00   0.57   261.44    8.78    8.21   .82357E+04
    109.92   -11.98    8.50    32.5 0.308E+00   0.54   265.62    8.77    8.23   .10880E+05
    136.37   -11.98    8.50    33.7 0.297E+00   0.53   269.59    8.76    8.23   .13525E+05
 Cumulative travel time =       13524.9756 sec  (    3.76 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
---------------------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
 Some BOUNDARY INTERACTION with both banks occurs at end of near-field.
   The dilution values in one or more of the preceding zones may be too high.
 Carefully evaluate results in near-field and check degree of interaction.
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -3.00m
---------------------------------------------------------------------------------------------
BEGIN MOD281: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION

 An UPSTREAM INTRUDING BOTTOM WEDGE is formed.

 UPSTREAM WEDGE INTRUSION PROPERTIES in bounded channel (laterally uniform):
        Wedge length                            =    2344.69 m
        X-Position of wedge tip                 =   -2208.32 m
        Thickness at discharge (end of NFR)     =       1.17 m
         (Wedge thickness gradually decreases to zero at wedge tip.)

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in combination
   with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
  will be acceptable, however.

       X        Y       Z        S       C       BV       BH      ZU      ZL       TT
    136.37     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .13525E+05
 Cumulative travel time =       13524.9746 sec  (    3.76 hrs)
 Flow is LATERALLY MIXED over the channel width.

END OF MOD281: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

  Vertical diffusivity (initial value)   = 0.143E-09 m^2/s
  Horizontal diffusivity (initial value) = 0.545E-02 m^2/s

 Profile definitions:
```

```
BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
   = or equal to layer depth, if fully mixed
BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
     measured horizontally in Y-direction
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S  = hydrodynamic centerline dilution
C  = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time
```

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
136.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13525E+05
185.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.18389E+05
233.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.23252E+05
282.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.28116E+05
330.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.32980E+05
379.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.37843E+05
428.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.42707E+05
476.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.47570E+05
525.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.52434E+05
574.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.57298E+05
622.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.62161E+05
671.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.67025E+05
720.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.71889E+05
768.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.76752E+05
817.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.81616E+05
865.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.86480E+05
914.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.91343E+05
963.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.96207E+05
1011.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.10107E+06
1060.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.10593E+06
1109.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.11080E+06
1157.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.11566E+06
1206.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.12052E+06
1255.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.12539E+06
1303.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13025E+06
1352.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13512E+06
1400.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.13998E+06
1449.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.14484E+06
1498.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.14971E+06
1546.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.15457E+06
1595.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.15943E+06
1644.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.16430E+06
1692.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.16916E+06
1741.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.17402E+06
1790.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.17889E+06
1838.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.18375E+06
1887.28	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.18862E+06
1935.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.19348E+06
1984.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.19834E+06
2033.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.20321E+06

2081.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.20807E+06
2130.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.21293E+06
2179.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.21780E+06
2227.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.22266E+06
2276.37	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.22752E+06
2325.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.23239E+06
2373.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.23725E+06
2422.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.24212E+06
2470.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.24698E+06
2519.55	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.25184E+06
2568.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.25671E+06
2616.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.26157E+06
2665.46	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.26643E+06
2714.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.27130E+06
2762.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.27616E+06
2811.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.28102E+06
2860.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.28589E+06
2908.64	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.29075E+06
2957.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.29562E+06
3005.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.30048E+06
3054.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.30534E+06
3103.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31021E+06
3151.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31507E+06
3200.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.31993E+06
3249.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.32480E+06
3297.73	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.32966E+06
3346.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.33452E+06
3395.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.33939E+06
3443.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.34425E+06
3492.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.34912E+06
3540.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.35398E+06
3589.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.35884E+06
3638.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.36371E+06
3686.82	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.36857E+06
3735.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.37343E+06
3784.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.37830E+06
3832.72	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.38316E+06
3881.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.38802E+06
3930.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.39289E+06
3978.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.39775E+06
4027.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.40262E+06
4075.91	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.40748E+06
4124.54	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.41234E+06
4173.18	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.41721E+06
4221.81	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.42207E+06
4270.45	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.42693E+06
4319.09	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.43180E+06
4367.72	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.43666E+06
4416.36	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.44152E+06
4465.00	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.44639E+06
4513.63	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.45125E+06
4562.27	7.00	8.50	33.7	0.297E+00	1.17	244.00	9.08	7.91	.45612E+06

```
   4610.90     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .46098E+06
   4659.54     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .46584E+06
   4708.18     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .47071E+06
   4756.81     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .47557E+06
   4805.45     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .48043E+06
   4854.09     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .48530E+06
   4902.72     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .49016E+06
   4951.36     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .49502E+06
   4999.99     7.00    8.50    33.7 0.297E+00   1.17   244.00    9.08    7.91   .49989E+06
 Cumulative travel time =      499888.3438 sec  (  138.86 hrs)

Note:
CORMIX is a steady state model and assumes discharge and ambient conditions do not vary
 over time. The predicted plume cumulative travel time exceeds 48 hours at this trajectory
 distance. Keep in mind that ambient and discharge conditions are likely to vary over
 large space and time scales. Predictions at such large space and time scales may be
 inconsistent with CORMIX modeling assumptions.

Please carefully evaluate your simulation results and limit model interpretation to space
 and time scales consistent with steady state assumptions and ambient schematization.

 Simulation limit based on maximum specified distance =   5000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX2: Multiport Diffuser Discharges       End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
```

CORMIX SESSION, PROCESSING, AND PREDICTION FILES – Single Port; 6.6 cfs Discharge

Date: 07/30/18
Time: 10:01:18

Design Case: Location 1; single port
Site Name: EW BROWN - HERRINGTON LK
Prepared By: DWI

Project Notes:

Location 1 is conceptual location along main lake bank
Single diffuser
10-ft submergence of ports
linear ambient stratification

VALIDATING INPUT DATA ...

Checking Pages for invalid or missing inputs...

Effluent Page has been validated.
Ambient Page has been validated.
Discharge Page has been validated.
Mixing Zone Page has been validated.

Finished checking Pages for invalid or missing inputs.

Loading Correct RuleBases

Validating RuleBases ...

AMBIENT DATA:

Ambient flowrate = 43.920 m^3/s.

Equivalent Darcy-Weisbach friction factor = 0.007

Ambient surface density = 995.9449 kg/m^3.

Ambient bottom density = 997.7714 kg/m^3.

The ambient DENSITY PROFILE you have specified is DYNAMICALLY STABLE in the presence of the given ambient crossflow. (This has been checked with a FLUX RICHARDSON NUMBER CRITERION).

Ambient Rule Base has been validated.

DISCHARGE DATA:
CORMIX1: Single Port Discharges

Port cross-sectional area A0 = 0.032 m^2.

Discharge flowrate Q0 = 0.187 m^3/s.

Discharge velocity U0 = 5.774 m/s.
Note:
Discharge Velocity (U0) < 2.5 m/s may in some cases be recommended to avoid possible adverse conditions for sensitive fish populations.

This is a Slightly Submerged or Above Surface Discharge, where the height of the discharge port (H0 = 10 m) and the local ambient water depth (HD = 15 m).

The submergence of the port below the water surface is SUB0 = 5 m.

Discharge density RHO0 = 996.2338 kg/m^3.

Discharge Rules for CORMIX1 have been validated

MIXING ZONE SPECIFICATION:

REGULATORY MIXING ZONE (RMZ) Specifications:

In general practice, there are two possible interpretations for the RMZ:

Interpretation 1: The RMZ is a spatially defined (by State/Federal agencies) restricted region at whose boundary a specified water quality standard for conventional pollutants - or the CCC for toxic pollutants - has to be met.

Interpretation 2: The applicant or the State/Federal agency may propose on an ad-hoc basis an RMZ as that region at whose boundary a water quality standard - or CCC - has been demonstrated to be met. That demonstration is usually made by means of a mixing zone prediction.

CORMIX will evaluate the RMZ conditions on the basis of both interpretations.

Mixing Zones Rule Base has been validated.

Finished validating RuleBases.

Calculating Parameters.

FLOW PARAMETERS AND LENGTH SCALES:

Relative density differences between discharge and ambient:

Ambient density at the discharge level RHOAH0 = 996.5537 kg/m^3.
Vertical mean ambient density RHOAM = 996.8581 kg/m^3.

The effluent density (996.2338 kg/m^3) is less than the surrounding ambient water density at the discharge level (996.5537 kg/m^3).

Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

Flow bulk parameters:

Discharge volume flux Q0 = 0.18689 m^3/s.
Discharge momentum flux M0 = 1.07918 m^4/s^2.

Discharge buoyancy flux J0 = 0.000588 m^4/s^3.

Flow length scales:

Jet-to-crossflow length scale Lm = 103.88 m.

Plume-to-crossflow length scale Lb = 588.38 m.

Discharge length scale LQ = 0.1799 m.

Jet-to-plume transition length scale LM = 43.65 m.

Jet stratification length scale Lm' = 5.48 m.
Plume stratification length scale Lb' = 1.94 m.

Non-dimensional parameters:

Densimetric Froude number FR0 = 228.41
Jet/crossflow velocity ratio R = 577.44

Parameters for CORMIX1 have been calculated

Classifying Flows.

FLOW CLASSIFICATION:

```
CORMIX1 includes SIX MAJOR CLASSES of possible flow configurations:
Classes S,  IS : Flows trapped in a layer within linear stratification.
Classes V,  H  : Near Bottom, Positively buoyant flows in a uniform density layer.
Classes IV, IH : Near Surface, Negatively buoyant flows in a uniform density layer.
Classes NV, NH : Near Bottom, Negatively buoyant flows in uniform density layer.
Classes IPV,IPH: Near Surface, Positively buoyant flows in uniform density layer.
Classes A,  AI : Flows affected by dynamic bottom or surface attachment.

The NEAR FIELD FLOW will have the following features:

If flow trapping occurs, then the flow is jet-like and is strongly affected by the ambient density
stratification with a weak crossflow effect (if any).

Terminal Height Level Zt = -1.65

The specified ambient density stratification is dynamically important. The discharge near field
flow may be trapped within the linearly stratified ambient density layer.

The discharge near-field behavior is dominated by either the negative buoyancy of the discharge or
the downward vertical orientation of the discharge port.
There is the possibility of dynamic surface attachment.

The following conclusion on the NEAR-FIELD FLOW CONFIGURATION applies to a layer corresponding to
the FULL WATER DEPTH at the discharge site:

*** FLOW CLASS = IS3 ***

Applicable layer depth HS = 15 m.

*** Limiting Dilution S = (QA/Q0)+ 1.0 = 236.0 ***

Flow has been classified.

Executing the simulation... FORTRAN simulation complete.

Generating Session Report... Session Report complete.
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 10.0GT
                       HYDRO1:Version-10.0.1.0  April,2017
SITE NAME/LABEL:                EW BROWN - HERRINGTON LK
  DESIGN CASE:                  Location 1; single port
  FILE NAME:                    D:\LG&E KU Brown\CORMIX\EW BROWN HERRINGTON IN-LAKE SINGLE PORT
DIFFUSER.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             07/30/2018--10:01:18
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = bounded
  Width                           BS     = 244 m
  Channel regularity              ICHREG = 1
  Ambient flowrate                QA     = 43.92 m^3/s
  Average depth                   HA     = 18 m
  Depth at discharge              HD     = 15 m
  Ambient velocity                UA     = 0.01 m/s
  Darcy-Weisbach friction factor  F      = 0.0067
    Calculated from Manning's n          = 0.015
  Wind velocity                   UW     = 1.34 m/s
  Stratification Type             STRCND = A
  Surface temperature                    = 29 degC
  Bottom temperature                     = 22 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                 RHOAS  = 995.9449 kg/m^3
  Bottom density                  RHOAB  = 997.7714 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Single Port Discharge
  Nearest bank                           = left
  Distance to bank                DISTB  = 7 m
  Port diameter                   D0     = 0.203 m
  Port cross-sectional area       A0     = 0.0324 m^2
  Discharge velocity              U0     = 5.77 m/s
  Discharge flowrate              Q0     = 0.186891 m^3/s
  Discharge port height           H0     = 10 m
  Vertical discharge angle        THETA  = -15 deg
  Horizontal discharge angle      SIGMA  = 270 deg
  Discharge temperature (freshwater)     = 28 degC
  Corresponding density           RHO0   = 996.2338 kg/m^3
  Density difference              DRHO   = 0.3199 kg/m^3
  Buoyant acceleration            GP0    = 0.0031 m/s^2
  Discharge concentration         C0     = 10 ppm
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.18 m         Lm  = 103.88 m         Lb  = 588.38 m
  LM  = 43.65 m         Lm' = 5.48 m         Lb' = 1.94 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 228.41
  Velocity ratio                  R      = 577.44
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard          CSTD   = 5 ppm
  Regulatory mixing zone                 = yes
  Regulatory mixing zone specification   = width
  Regulatory mixing zone value           = 24.40 m (m^2 if area)
  Region of interest                     = 5000 m
*****************************************************************************
```

```
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = IS3 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 15 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 236.0

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    7 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.206 ppm
  Dilution at edge of NFR              s = 48.5
  NFR Location:                        x = 341.58 m
    (centerline coordinates)           y = -24.31 m
                                       z = 7.77 m
  NFR plume dimensions:  half-width (bh) = 681.51 m
                          thickness (bv) = 0.67 m
Cumulative travel time:       34116.7031 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  314.16 m
  Intrusion stagnation point              =  -313.33 m
  Intrusion thickness                     =  0.69 m
  Intrusion half width at impingement     =  681.51 m
  Intrusion half thickness at impingement =  0.67 m

  In this case, the UPSTREAM INTRUSION IS VERY LARGE, exceeding ten (10)
    times the local water depth.
  This may be caused by the small ambient velocity, perhaps in combination
    with the strong buoyancy of the effluent, or alternatively, a strong
    ambient stratification.
  If the ambient conditions are quite unsteady (e.g. tidal), then the
    CORMIX steady-state predictions of the upstream intrusion are probably
    unrealistic.  The plume predictions in the immediate near-field, prior
    to the intrusion layer formation, are acceptable, however.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes laterally fully mixed at 0 m downstream.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
No TDZ was specified for this simulation.
```

```
********************* REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.449431  ppm
  Corresponding dilution               s = 22.2
  Plume location:                      x = -597.64 m
    (centerline coordinates)           y = -24.31 m
                                       z = 7.77 m
  Plume dimensions:      half-width (bh) = 12.20 m
                          thickness (bv) = 0.61 m
Cumulative travel time < 34116.7031 sec. (RMZ is within NFR)

Note:
Plume concentration c and dilution s values are reported based on prediction
file values - assuming linear interpolation between predicted points just
before and just after the RMZ boundary has been detected.

Please ensure a small step size is used in the prediction file to account
for this linear interpolation. Step size can be controlled by increasing
(reduces the prediction step size) or decreasing (increases the prediction
step size) the - Output Steps per Module - in CORMIX input.

At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 5  ppm
  Corresponding dilution               s = 2.0
  Plume location:                      x = 0.00 m
    (centerline coordinates)           y = -2.11 m
                                       z = 9.44 m
  Plume dimension:       half-width (bh) = 0.25 m
-----------------------------------------------------------------------------
Regulatory Mixing Zone Analysis:
  The RMZ specification occurs before the near-field mixing regime (NFR) has
  been completed.  The specification of the RMZ is highly restrictive.
******************** FINAL DESIGN ADVICE AND COMMENTS *********************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX1 PREDICTION FILE:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                       CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 10.0GT
                     HYDRO1 Version 10.0.1.0 April 2017
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   EW BROWN - HERRINGTON LK
 Design case:       Location 1; single port
 FILE NAME:         D:\...BROWN HERRINGTON IN-LAKE SINGLE PORT DIFFUSER.prd
 Time stamp:        07/30/2018--10:01:18

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    244.00  AS    =   4392.00  QA    =     43.92  ICHREG= 1
 HA    =     18.00  HD    =     15.00
 UA    =     0.010  F     =     0.007 USTAR =0.2903E-03
 UW    =     1.341 UWSTAR=0.1449E-02
 Density stratified environment
 STRCND=  A         RHOAM =  996.8582
 RHOAS =  995.9449  RHOAB =  997.7714  RHOAH0=  996.5537  E     =0.1197E-02

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT      DISTB =      7.00
 D0    =     0.203 A0    =     0.032 H0    =     10.00  SUB0  =      5.00
 THETA =    -15.00  SIGMA =    270.00
 U0    =     5.774 Q0    =     0.187       =0.1869E+00
 RHO0  =  996.2338  DRHO0 =0.3199E+00  GP0   =0.3148E-02
 C0    =0.1000E+02  CUNITS=  ppm
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1869E+00  M0    =0.1079E+01  J0    =0.5884E-03  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.18  LM    =     43.65  Lm    =    103.88  Lb    =    588.38
                                       Lmp   =      5.48  Lbp   =      1.94

NON-DIMENSIONAL PARAMETERS
 FR0   =    228.41  R     =    577.44

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IS3    1
 1  Applicable layer depth HS =   15.00   1
 1  Limiting Dilution S =QA/Q0=   236.00  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+02  CUNITS=  ppm
 NTOX  =  0
 NSTD  =  1         CSTD  =0.5000E+01
 REGMZ =  1
 REGSPC=  2         XREG  =      0.00  WREG  =     24.40  AREG  =      0.00
 XINT  =   5000.00  XMAX  =   5000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         7.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
---------------------------------------------------------------------------------------------
---------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B        Uc        TT
```

```
      0.00      0.00   10.00      1.0 0.100E+02   0.10    5.774   .00000E+00

END OF MOD101: DISCHARGE MODULE
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=    -15.00  SIGMAE=    270.04
  LE    =      1.01  XE    =      0.00  YE    =     -0.97  ZE    =      9.74

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y        Z        S       C        B        Uc        TT
      0.00      0.00   10.00      1.0 0.100E+02   0.10    5.774   .00000E+00
      0.00     -0.97    9.74      1.0 0.100E+02   0.11    5.774   .16490E-01
      0.00     -1.09    9.71      1.1 0.952E+01   0.13    5.774   .34867E-01
      0.00     -1.32    9.65      1.3 0.790E+01   0.15    5.383   .77284E-01
      0.00     -1.55    9.58      1.5 0.675E+01   0.18    4.599   .12725E+00
      0.00     -1.78    9.52      1.7 0.589E+01   0.21    4.015   .18477E+00
      0.00     -2.01    9.46      1.9 0.523E+01   0.23    3.562   .24984E+00
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.500E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
      0.00     -2.24    9.40      2.1 0.470E+01   0.26    3.201   .32245E+00
      0.00     -2.47    9.34      2.3 0.427E+01   0.29    2.906   .40262E+00
      0.01     -2.70    9.28      2.6 0.391E+01   0.31    2.661   .49035E+00
      0.01     -2.93    9.21      2.8 0.360E+01   0.34    2.454   .58563E+00
      0.01     -3.16    9.15      3.0 0.334E+01   0.36    2.277   .68846E+00
      0.01     -3.39    9.09      3.2 0.312E+01   0.39    2.124   .79885E+00
      0.01     -3.62    9.03      3.4 0.292E+01   0.42    1.990   .91679E+00
      0.01     -3.86    8.97      3.6 0.275E+01   0.44    1.872   .10423E+01
      0.02     -4.09    8.91      3.9 0.259E+01   0.47    1.767   .11754E+01
      0.02     -4.32    8.85      4.1 0.246E+01   0.50    1.673   .13160E+01
      0.02     -4.55    8.79      4.3 0.233E+01   0.52    1.589   .14642E+01
      0.02     -4.78    8.72      4.5 0.222E+01   0.55    1.513   .16200E+01
      0.03     -5.01    8.66      4.7 0.212E+01   0.57    1.443   .17833E+01
      0.03     -5.24    8.60      4.9 0.203E+01   0.60    1.380   .19542E+01
      0.03     -5.47    8.54      5.1 0.194E+01   0.63    1.322   .21327E+01
      0.04     -5.70    8.48      5.4 0.186E+01   0.65    1.269   .23188E+01
      0.04     -5.93    8.42      5.6 0.179E+01   0.68    1.219   .25125E+01
      0.04     -6.16    8.36      5.8 0.173E+01   0.71    1.174   .27137E+01
      0.05     -6.39    8.30      6.0 0.166E+01   0.73    1.131   .29226E+01
      0.05     -6.62    8.24      6.2 0.161E+01   0.76    1.092   .31391E+01
      0.05     -6.85    8.18      6.4 0.155E+01   0.78    1.055   .33631E+01
      0.06     -7.09    8.12      6.7 0.150E+01   0.81    1.021   .35949E+01
      0.06     -7.32    8.07      6.9 0.146E+01   0.84    0.988   .38342E+01
      0.07     -7.55    8.01      7.1 0.141E+01   0.86    0.958   .40811E+01
      0.07     -7.78    7.95      7.3 0.137E+01   0.89    0.930   .43358E+01
      0.08     -8.01    7.89      7.5 0.133E+01   0.92    0.903   .45980E+01
      0.09     -8.36    7.81      7.8 0.128E+01   0.96    0.865   .50058E+01
      0.09     -8.59    7.75      8.0 0.124E+01   0.98    0.841   .52872E+01
      0.10     -8.82    7.70      8.3 0.121E+01   1.01    0.819   .55764E+01
      0.10     -9.05    7.64      8.5 0.118E+01   1.03    0.798   .58732E+01
      0.11     -9.29    7.59      8.7 0.115E+01   1.06    0.778   .61778E+01
      0.11     -9.52    7.53      8.9 0.112E+01   1.09    0.759   .64901E+01
      0.12     -9.75    7.48      9.1 0.110E+01   1.11    0.740   .68101E+01
      0.13     -9.98    7.43      9.3 0.107E+01   1.14    0.723   .71379E+01
      0.13    -10.22    7.38      9.5 0.105E+01   1.17    0.706   .74735E+01
```

```
     0.14   -10.45    7.33     9.7 0.103E+01   1.19     0.690   .78169E+01
     0.15   -10.68    7.28    10.0 0.100E+01   1.22     0.675   .81681E+01
     0.15   -10.92    7.23    10.2 0.983E+00   1.25     0.660   .85271E+01
     0.16   -11.15    7.18    10.4 0.963E+00   1.27     0.646   .88939E+01
     0.17   -11.38    7.13    10.6 0.944E+00   1.30     0.633   .92686E+01
     0.17   -11.62    7.09    10.8 0.926E+00   1.32     0.620   .96511E+01
     0.18   -11.85    7.04    11.0 0.908E+00   1.35     0.607   .10042E+02
     0.19   -12.09    7.00    11.2 0.891E+00   1.38     0.595   .10440E+02
     0.20   -12.32    6.96    11.4 0.875E+00   1.40     0.584   .10846E+02
     0.21   -12.56    6.92    11.6 0.859E+00   1.43     0.573   .11260E+02
     0.21   -12.79    6.88    11.9 0.844E+00   1.46     0.562   .11682E+02
     0.22   -13.03    6.85    12.1 0.829E+00   1.48     0.552   .12112E+02
     0.23   -13.26    6.81    12.3 0.815E+00   1.51     0.542   .12550E+02
     0.24   -13.50    6.78    12.5 0.801E+00   1.54     0.532   .12996E+02
     0.25   -13.73    6.75    12.7 0.788E+00   1.56     0.523   .13450E+02
     0.26   -13.97    6.72    12.9 0.775E+00   1.59     0.514   .13912E+02
     0.27   -14.21    6.69    13.1 0.763E+00   1.62     0.505   .14382E+02
     0.28   -14.44    6.66    13.3 0.751E+00   1.64     0.497   .14860E+02
     0.29   -14.68    6.64    13.5 0.739E+00   1.67     0.489   .15346E+02
     0.30   -14.92    6.62    13.7 0.728E+00   1.70     0.481   .15839E+02
     0.31   -15.16    6.60    13.9 0.717E+00   1.72     0.473   .16341E+02
     0.32   -15.39    6.58    14.2 0.707E+00   1.75     0.466   .16851E+02
     0.33   -15.63    6.57    14.4 0.696E+00   1.77     0.459   .17368E+02
     0.34   -15.87    6.56    14.6 0.686E+00   1.80     0.452   .17894E+02
     0.35   -16.11    6.55    14.8 0.676E+00   1.83     0.445   .18427E+02
     0.36   -16.35    6.54    15.0 0.667E+00   1.85     0.439   .18968E+02
     0.37   -16.58    6.54    15.2 0.657E+00   1.88     0.432   .19517E+02
     0.38   -16.82    6.54    15.4 0.648E+00   1.91     0.426   .20074E+02
 Minimum jet height has been reached.
     0.39   -17.06    6.54    15.6 0.639E+00   1.93     0.421   .20638E+02
     0.40   -17.30    6.54    15.9 0.631E+00   1.96     0.415   .21210E+02
     0.42   -17.54    6.55    16.1 0.622E+00   1.99     0.410   .21790E+02
     0.43   -17.78    6.56    16.3 0.614E+00   2.01     0.404   .22378E+02
     0.44   -18.01    6.57    16.5 0.606E+00   2.04     0.399   .22972E+02
     0.45   -18.25    6.58    16.7 0.598E+00   2.07     0.394   .23575E+02
     0.46   -18.49    6.60    17.0 0.590E+00   2.09     0.389   .24185E+02
     0.48   -18.73    6.62    17.2 0.582E+00   2.12     0.385   .24802E+02
     0.49   -18.96    6.65    17.4 0.575E+00   2.14     0.380   .25426E+02
     0.50   -19.20    6.67    17.6 0.567E+00   2.17     0.376   .26058E+02
     0.52   -19.44    6.70    17.9 0.560E+00   2.20     0.372   .26697E+02
     0.53   -19.67    6.73    18.1 0.553E+00   2.22     0.368   .27343E+02
     0.54   -19.91    6.77    18.3 0.546E+00   2.25     0.364   .27996E+02
     0.56   -20.14    6.80    18.5 0.539E+00   2.28     0.360   .28657E+02
     0.57   -20.38    6.84    18.8 0.533E+00   2.30     0.356   .29324E+02
     0.58   -20.61    6.89    19.0 0.526E+00   2.33     0.352   .29999E+02
     0.60   -20.85    6.93    19.2 0.520E+00   2.35     0.348   .30680E+02
     0.61   -21.08    6.98    19.5 0.514E+00   2.38     0.345   .31369E+02
     0.63   -21.31    7.02    19.7 0.508E+00   2.41     0.341   .32064E+02
     0.64   -21.55    7.07    19.9 0.502E+00   2.43     0.338   .32767E+02
     0.66   -21.78    7.13    20.2 0.496E+00   2.46     0.335   .33476E+02
     0.67   -22.01    7.18    20.4 0.490E+00   2.49     0.331   .34193E+02
     0.69   -22.24    7.23    20.6 0.485E+00   2.51     0.328   .34916E+02
     0.70   -22.47    7.29    20.9 0.479E+00   2.54     0.325   .35647E+02
     0.72   -22.70    7.35    21.1 0.474E+00   2.56     0.322   .36385E+02
     0.73   -22.93    7.41    21.3 0.469E+00   2.59     0.319   .37130E+02
     0.75   -23.16    7.47    21.5 0.464E+00   2.62     0.316   .37882E+02
     0.76   -23.39    7.53    21.8 0.459E+00   2.64     0.312   .38642E+02
     0.78   -23.62    7.59    22.0 0.455E+00   2.67     0.309   .39410E+02
     0.80   -23.85    7.65    22.2 0.450E+00   2.70     0.306   .40184E+02
     0.81   -24.08    7.71    22.4 0.446E+00   2.72     0.303   .40967E+02
     0.83   -24.31    7.77    22.5 0.443E+00   2.74     0.302   .41361E+02
 Terminal level in stratified ambient has been reached.
Cumulative travel time =          41.3614 sec  (    0.01 hrs)

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
```

```
BEGIN MOD137: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =     12.43 m
        Layer thickness in impingement region   =      0.69 m
        Upstream intrusion length               =    314.16 m
        X-position of upstream stagnation point =   -313.33 m
        Thickness in intrusion region           =      0.69 m
        Half-width at downstream end            =    681.51 m
        Thickness at downstream end             =      0.67 m

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in
   combination with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
   will be acceptable, however.

  Control volume inflow:
       X        Y       Z        S       C        B        TT
      0.83   -24.31    7.77    22.5 0.443E+00   2.74 .41361E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S       C        BV       BH      ZU      ZL        TT
   -313.33   -24.31    7.77  9999.9 0.000E+00   0.00     0.00    7.77    7.77 .34117E+05
   -300.23   -24.31    7.77    88.1 0.113E+00   0.18    96.38    7.86    7.69 .41361E+02
   -236.05   -24.31    7.77    36.7 0.272E+00   0.43   234.11    7.99    7.56 .41361E+02
   -171.87   -24.31    7.77    28.0 0.357E+00   0.56   316.74    8.05    7.49 .41361E+02
   -107.69   -24.31    7.77    24.4 0.410E+00   0.64   381.89    8.10    7.45 .41361E+02
    -43.51   -24.31    7.77    22.8 0.438E+00   0.69   437.44    8.12    7.43 .41361E+02
 ** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
 In this prediction interval the TOTAL plume width meets or exceeds
 the regulatory value =    24.40 m.
 This is the extent of the REGULATORY MIXING ZONE.
     20.67   -24.31    7.77    22.9 0.437E+00   0.69   486.69    8.12    7.43 .20259E+04
     84.86   -24.31    7.77    28.2 0.355E+00   0.69   531.40    8.12    7.43 .84440E+04
    149.04   -24.31    7.77    36.3 0.275E+00   0.68   572.63    8.11    7.44 .14862E+05
    213.22   -24.31    7.77    43.0 0.232E+00   0.67   611.08    8.11    7.44 .21280E+05
    277.40   -24.31    7.77    46.7 0.214E+00   0.67   647.25    8.11    7.44 .27699E+05
    341.58   -24.31    7.77    48.5 0.206E+00   0.67   681.51    8.11    7.44 .34117E+05
 Cumulative travel time =       34116.6953 sec  (    9.48 hrs)

END OF MOD137: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
-----------------------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
 Some BOUNDARY INTERACTION with both banks occurs at end of near-field.
   The dilution values in one or more of the preceding zones may be too high.
 Carefully evaluate results in near-field and check degree of interaction.
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -3.00m
-----------------------------------------------------------------------------------------------
BEGIN MOD181: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION

 An INTERNAL UPSTREAM INTRUDING WEDGE is formed.

 UPSTREAM WEDGE INTRUSION PROPERTIES in bounded channel (laterally uniform):
        Wedge length                            =   60838.27 m
```

```
       X-Position of wedge tip                  =  -60496.68 m
       Thickness at discharge (end of NFR)      =       3.72 m
        (Wedge thickness gradually decreases to zero at wedge tip.)

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in combination
   with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
  will be acceptable, however.

       X         Y        Z        S        C        BV       BH       ZU       ZL        TT
    341.58     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .34117E+05
 Cumulative travel time =       34116.7031 sec  (    9.48 hrs)
 Flow is LATERALLY MIXED over the channel width.

END OF MOD181: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN MOD162: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

  Vertical diffusivity (initial value)   = 0.143E-09 m^2/s
  Horizontal diffusivity (initial value) = 0.545E-02 m^2/s

 Profile definitions:
   BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
      = or equal to layer depth, if fully mixed
   BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
        measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 2 (bank attached):
       X         Y        Z        S        C        BV       BH       ZU       ZL        TT
    341.58     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .34117E+05
    388.17     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .38775E+05
    434.75     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .43434E+05
    481.33     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .48092E+05
    527.92     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .52750E+05
    574.50     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .57409E+05
    621.09     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .62067E+05
    667.67     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .66726E+05
    714.26     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .71384E+05
    760.84     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .76042E+05
    807.42     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .80701E+05
    854.01     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .85359E+05
    900.59     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .90018E+05
    947.18     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .94676E+05
    993.76     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .99335E+05
   1040.34     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .10399E+06
   1086.93     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .10865E+06
   1133.51     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .11331E+06
   1180.10     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .11797E+06
   1226.68     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .12263E+06
   1273.27     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .12729E+06
   1319.85     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .13194E+06
   1366.43     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .13660E+06
   1413.02     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .14126E+06
   1459.60     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .14592E+06
   1506.19     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .15058E+06
   1552.77     7.00     7.77    48.5 0.206E+00   3.72   244.00    9.63     5.92 .15524E+06
```

1599.36	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.15989E+06
1645.94	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.16455E+06
1692.52	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.16921E+06
1739.11	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.17387E+06
1785.69	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.17853E+06
1832.28	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.18319E+06
1878.86	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.18784E+06
1925.45	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.19250E+06
1972.03	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.19716E+06
2018.61	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.20182E+06
2065.20	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.20648E+06
2111.78	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.21114E+06
2158.37	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.21580E+06
2204.95	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.22045E+06
2251.53	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.22511E+06
2298.12	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.22977E+06
2344.70	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.23443E+06
2391.29	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.23909E+06
2437.87	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.24375E+06
2484.46	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.24840E+06
2531.04	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.25306E+06
2577.62	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.25772E+06
2624.21	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.26238E+06
2670.79	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.26704E+06
2717.38	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.27170E+06
2763.96	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.27635E+06
2810.55	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.28101E+06
2857.13	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.28567E+06
2903.71	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.29033E+06
2950.30	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.29499E+06
2996.88	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.29965E+06
3043.47	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.30431E+06
3090.05	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.30896E+06
3136.64	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.31362E+06
3183.22	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.31828E+06
3229.80	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.32294E+06
3276.39	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.32760E+06
3322.97	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.33226E+06
3369.56	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.33691E+06
3416.14	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.34157E+06
3462.72	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.34623E+06
3509.31	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.35089E+06
3555.89	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.35555E+06
3602.48	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.36021E+06
3649.06	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.36486E+06
3695.65	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.36952E+06
3742.23	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.37418E+06
3788.81	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.37884E+06
3835.40	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.38350E+06
3881.98	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.38816E+06
3928.57	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.39282E+06
3975.15	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.39747E+06
4021.74	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.40213E+06
4068.32	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.40679E+06
4114.90	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.41145E+06
4161.49	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.41611E+06
4208.07	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.42077E+06
4254.66	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.42542E+06
4301.24	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.43008E+06
4347.82	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.43474E+06
4394.41	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.43940E+06
4440.99	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.44406E+06
4487.58	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.44872E+06
4534.16	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.45337E+06
4580.74	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.45803E+06
4627.33	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.46269E+06
4673.91	7.00	7.77	48.5	0.206E+00	3.72	244.00	9.63	5.92	.46735E+06

```
   4720.50     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .47201E+06
   4767.08     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .47667E+06
   4813.66     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .48132E+06
   4860.25     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .48598E+06
   4906.83     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .49064E+06
   4953.42     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .49530E+06
   5000.00     7.00    7.77    48.5 0.206E+00   3.72   244.00     9.63    5.92 .49996E+06
 Cumulative travel time =      499958.4375 sec  (  138.88 hrs)

Note:
CORMIX is a steady state model and assumes discharge and ambient conditions do not vary
 over time. The predicted plume cumulative travel time exceeds 48 hours at this trajectory
 distance. Keep in mind that ambient and discharge conditions are likely to vary over
 large space and time scales. Predictions at such large space and time scales may be
 inconsistent with CORMIX modeling assumptions.

Please carefully evaluate your simulation results and limit model interpretation to space
 and time scales consistent with steady state assumptions and ambient schematization.

 Simulation limit based on maximum specified distance =   5000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD162: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges             End of Prediction File
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

CORMIX SESSION, PROCESSING, AND PREDICTION FILES – Single Port; 1.0 cfs Discharge

Date: 07/30/18
Time: 10:03:46

Design Case: Location 1; single port
Site Name: EW BROWN - HERRINGTON LK
Prepared By: DWI

Project Notes:

Location 1 is conceptual location along main lake bank
Single diffuser
10-ft submergence of ports
linear ambient stratification

VALIDATING INPUT DATA ...

Checking Pages for invalid or missing inputs...

Effluent Page has been validated.
Ambient Page has been validated.
Discharge Page has been validated.
Mixing Zone Page has been validated.

Finished checking Pages for invalid or missing inputs.

Loading Correct RuleBases

Validating RuleBases ...

AMBIENT DATA:

Ambient flowrate = 43.920 m^3/s.

Equivalent Darcy-Weisbach friction factor = 0.007

Ambient surface density = 995.9449 kg/m^3.

Ambient bottom density = 997.7714 kg/m^3.

The ambient DENSITY PROFILE you have specified is DYNAMICALLY STABLE in the presence of the given ambient crossflow. (This has been checked with a FLUX RICHARDSON NUMBER CRITERION).

Ambient Rule Base has been validated.

DISCHARGE DATA:
CORMIX1: Single Port Discharges

Port cross-sectional area A0 = 0.014 m^2.

Discharge flowrate Q0 = 0.187 m^3/s.

Discharge velocity U0 = 13.452 m/s.
Note:
Discharge Velocity (U0) < 2.5 m/s may in some cases be recommended to avoid possible adverse conditions for sensitive fish populations.

This is a Slightly Submerged or Above Surface Discharge, where the height of the discharge port (H0 = 10 m) and the local ambient water depth (HD = 15 m).

The submergence of the port below the water surface is SUB0 = 5 m.

Discharge density RHO0 = 996.2338 kg/m^3.

Discharge Rules for CORMIX1 have been validated

MIXING ZONE SPECIFICATION:

REGULATORY MIXING ZONE (RMZ) Specifications:

In general practice, there are two possible interpretations for the RMZ:

Interpretation 1: The RMZ is a spatially defined (by State/Federal agencies) restricted region at whose boundary a specified water quality standard for conventional pollutants - or the CCC for toxic pollutants - has to be met.

Interpretation 2: The applicant or the State/Federal agency may propose on an ad-hoc basis an RMZ as that region at whose boundary a water quality standard - or CCC - has been demonstrated to be met. That demonstration is usually made by means of a mixing zone prediction.

CORMIX will evaluate the RMZ conditions on the basis of both interpretations.

Mixing Zones Rule Base has been validated.

Finished validating RuleBases.

Calculating Parameters.

FLOW PARAMETERS AND LENGTH SCALES:

Relative density differences between discharge and ambient:

Ambient density at the discharge level RHOAH0 = 996.5537 kg/m^3.
Vertical mean ambient density RHOAM = 996.8581 kg/m^3.

The effluent density (996.2338 kg/m^3) is less than the surrounding ambient water density at the discharge level (996.5537 kg/m^3).

Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

Flow bulk parameters:

Discharge volume flux Q0 = 0.18689 m^3/s.
Discharge momentum flux M0 = 2.51411 m^4/s^2.

Discharge buoyancy flux J0 = 0.000588 m^4/s^3.

Flow length scales:

Jet-to-crossflow length scale Lm = 158.56 m.

Plume-to-crossflow length scale Lb = 588.38 m.

Discharge length scale LQ = 0.1179 m.

Jet-to-plume transition length scale LM = 82.31 m.

Jet stratification length scale Lm' = 6.77 m.
Plume stratification length scale Lb' = 1.94 m.

Non-dimensional parameters:

Densimetric Froude number FR0 = 657.41
Jet/crossflow velocity ratio R = 1345.23

Parameters for CORMIX1 have been calculated

Classifying Flows.

```
FLOW CLASSIFICATION:

CORMIX1 includes SIX MAJOR CLASSES of possible flow configurations:
Classes S,  IS : Flows trapped in a layer within linear stratification.
Classes V,  H  : Near Bottom, Positively buoyant flows in a uniform density layer.
Classes IV, IH : Near Surface, Negatively buoyant flows in a uniform density layer.
Classes NV, NH : Near Bottom, Negatively buoyant flows in uniform density layer.
Classes IPV,IPH: Near Surface, Positively buoyant flows in uniform density layer.
Classes A,  AI : Flows affected by dynamic bottom or surface attachment.

The NEAR FIELD FLOW will have the following features:

If flow trapping occurs, then the flow is jet-like and is strongly affected by the ambient density
stratification with a weak crossflow effect (if any).

Terminal Height Level Zt = -2.60

The specified ambient density stratification is dynamically important. The discharge near field
flow may be trapped within the linearly stratified ambient density layer.

The discharge near-field behavior is dominated by either the negative buoyancy of the discharge or
the downward vertical orientation of the discharge port.
There is the possibility of dynamic surface attachment.

The following conclusion on the NEAR-FIELD FLOW CONFIGURATION applies to a layer corresponding to
the FULL WATER DEPTH at the discharge site:

*** FLOW CLASS = IS3 ***

Applicable layer depth HS = 15 m.

*** Limiting Dilution S = (QA/Q0)+ 1.0 = 236.0 ***

Flow has been classified.

Executing the simulation... FORTRAN simulation complete.

Generating Session Report... Session Report complete.
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 10.0GT
                       HYDRO1:Version-10.0.1.0  April,2017
SITE NAME/LABEL:                EW BROWN - HERRINGTON LK
  DESIGN CASE:                  Location 1; single port
  FILE NAME:                    D:\LG&E KU Brown\CORMIX\EW BROWN HERRINGTON IN-LAKE SINGLE PORT
DIFFUSER.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:             07/30/2018--10:03:46
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = bounded
  Width                         BS       = 244 m
  Channel regularity            ICHREG = 1
  Ambient flowrate              QA       = 43.92 m^3/s
  Average depth                 HA       = 18 m
  Depth at discharge            HD       = 15 m
  Ambient velocity              UA       = 0.01 m/s
  Darcy-Weisbach friction factor F       = 0.0067
    Calculated from Manning's n          = 0.015
  Wind velocity                 UW       = 1.34 m/s
  Stratification Type           STRCND = A
  Surface temperature                    = 29 degC
  Bottom temperature                     = 22 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density               RHOAS  = 995.9449 kg/m^3
  Bottom density                RHOAB  = 997.7714 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                           = left
  Distance to bank              DISTB  = 7 m
  Port diameter                 D0       = 0.133 m
  Port cross-sectional area     A0       = 0.0139 m^2
  Discharge velocity            U0       = 13.45 m/s
  Discharge flowrate            Q0       = 0.186891 m^3/s
  Discharge port height         H0       = 10 m
  Vertical discharge angle      THETA  = -15 deg
  Horizontal discharge angle    SIGMA  = 270 deg
  Discharge temperature (freshwater)     = 28 degC
  Corresponding density         RHO0   = 996.2338 kg/m^3
  Density difference            DRHO   = 0.3199 kg/m^3
  Buoyant acceleration          GP0    = 0.0031 m/s^2
  Discharge concentration       C0       = 10 ppm
  Surface heat exchange coeff.  KS       = 0 m/s
  Coefficient of decay          KD       = 0 /s
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.12 m         Lm  = 158.56 m        Lb  = 588.38 m
  LM  = 82.31 m         Lm' = 6.77 m         Lb' = 1.94 m
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number FR0     = 657.41
  Velocity ratio                R        = 1345.23
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard        CSTD   = 5 ppm
  Regulatory mixing zone                 = yes
  Regulatory mixing zone specification   = width
  Regulatory mixing zone value           = 24.40 m (m^2 if area)
  Region of interest                     = 5000 m
*****************************************************************************
```

```
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = IS3 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 15 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 236.0

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    7 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.1049 ppm
  Dilution at edge of NFR              s = 95.3
  NFR Location:                        x = 591.76 m
    (centerline coordinates)           y = -29.93 m
                                       z = 7.11 m
  NFR plume dimensions:  half-width (bh) = 1181.85 m
                          thickness (bv) = 0.75 m
Cumulative travel time:       59133.7539 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  538.14 m
  Intrusion stagnation point              =  -537.30 m
  Intrusion thickness                     =  0.69 m
  Intrusion half width at impingement     =  1181.85 m
  Intrusion half thickness at impingement =  0.75 m

  In this case, the UPSTREAM INTRUSION IS VERY LARGE, exceeding ten (10)
    times the local water depth.
  This may be caused by the small ambient velocity, perhaps in combination
    with the strong buoyancy of the effluent, or alternatively, a strong
    ambient stratification.
  If the ambient conditions are quite unsteady (e.g. tidal), then the
    CORMIX steady-state predictions of the upstream intrusion are probably
    unrealistic.  The plume predictions in the immediate near-field, prior
    to the intrusion layer formation, are acceptable, however.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes laterally fully mixed at 0 m downstream.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
No TDZ was specified for this simulation.
```

```
********************* REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 0.249742  ppm
  Corresponding dilution               s = 39.8
  Plume location:                      x = -1039.05 m
    (centerline coordinates)           y = -29.93 m
                                       z = 7.11 m
  Plume dimensions:      half-width (bh) = 12.20 m
                          thickness (bv) = 0.61 m
Cumulative travel time < 59133.7539 sec. (RMZ is within NFR)

Note:
Plume concentration c and dilution s values are reported based on prediction
file values - assuming linear interpolation between predicted points just
before and just after the RMZ boundary has been detected.

Please ensure a small step size is used in the prediction file to account
for this linear interpolation. Step size can be controlled by increasing
(reduces the prediction step size) or decreasing (increases the prediction
step size) the - Output Steps per Module - in CORMIX input.

At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 5  ppm
  Corresponding dilution               s = 2.0
  Plume location:                      x = 0.00 m
    (centerline coordinates)           y = -1.34 m
                                       z = 9.64 m
  Plume dimension:       half-width (bh) = 0.17 m
-----------------------------------------------------------------------------
Regulatory Mixing Zone Analysis:
  The RMZ specification occurs before the near-field mixing regime (NFR) has
  been completed.  The specification of the RMZ is highly restrictive.
******************** FINAL DESIGN ADVICE AND COMMENTS *********************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX1 PREDICTION FILE:
11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                       CORMIX MIXING ZONE EXPERT SYSTEM
                   Subsystem CORMIX1: Single Port Discharges
                             CORMIX Version 10.0GT
                     HYDRO1 Version 10.0.1.0 April 2017
----------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   EW BROWN - HERRINGTON LK
 Design case:       Location 1; single port
 FILE NAME:         D:\...BROWN HERRINGTON IN-LAKE SINGLE PORT DIFFUSER.prd
 Time stamp:        07/30/2018--10:03:46

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    244.00  AS    =   4392.00  QA    =     43.92  ICHREG= 1
 HA    =     18.00  HD    =     15.00
 UA    =     0.010  F     =      0.007 USTAR =0.2903E-03
 UW    =     1.341  UWSTAR=0.1449E-02
 Density stratified environment
 STRCND=  A         RHOAM =  996.8582
 RHOAS =  995.9449  RHOAB =  997.7714  RHOAH0=  996.5537  E     =0.1197E-02

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT      DISTB =      7.00
 D0    =     0.133  A0    =      0.014 H0    =     10.00  SUB0  =      5.00
 THETA =    -15.00  SIGMA =    270.00
 U0    =    13.452  Q0    =      0.187       =0.1869E+00
 RHO0  =  996.2338  DRHO0 =0.3199E+00  GP0   =0.3148E-02
 C0    =0.1000E+02  CUNITS=  ppm
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.1869E+00  M0    =0.2514E+01  J0    =0.5884E-03  SIGNJ0=      1.0
 Associated length scales (meters)
 LQ    =      0.12  LM    =     82.31  Lm    =    158.56  Lb    =    588.38
                                       Lmp   =      6.77  Lbp   =      1.94

NON-DIMENSIONAL PARAMETERS
 FR0   =    657.41  R     =   1345.23

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)      =    IS3    1
 1  Applicable layer depth HS =   15.00   1
 1  Limiting Dilution S =QA/Q0=   236.00  1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+02  CUNITS=  ppm
 NTOX  =  0
 NSTD  =  1         CSTD  =0.5000E+01
 REGMZ =  1
 REGSPC=  2         XREG  =      0.00  WREG  =     24.40  AREG  =      0.00
 XINT  =   5000.00  XMAX  =   5000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         7.00 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 100 display intervals per module
----------------------------------------------------------------------------------------------
----------------------------------------------------------------------------------------------
BEGIN MOD101: DISCHARGE MODULE

       X        Y       Z        S       C       B        Uc        TT
```

```
      0.00     0.00   10.00     1.0 0.100E+02   0.07   13.452   .00000E+00

END OF MOD101: DISCHARGE MODULE
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=    -15.00  SIGMAE=    270.02
  LE    =       0.66  XE    =      0.00  YE    =     -0.64  ZE    =      9.83

 Profile definitions:
   B = Gaussian 1/e (37%) half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)
  Uc = Local centerline excess velocity (above ambient)
  TT = Cumulative travel time

       X        Y       Z        S       C        B        Uc        TT
      0.00     0.00   10.00     1.0 0.100E+02   0.07   13.452   .00000E+00
      0.00    -0.64    9.83     1.0 0.100E+02   0.08   13.452   .74036E-02
      0.00    -0.87    9.77     1.3 0.756E+01   0.11   12.003   .25835E-01
      0.00    -1.21    9.68     1.8 0.552E+01   0.14    8.768   .62541E-01
**WATER QUALITY STANDARD OR CCC HAS BEEN FOUND**
 The pollutant concentration in the plume falls below water quality standard
   or CCC value of 0.500E+01 in the current prediction interval.
 This is the spatial extent of concentrations exceeding the water quality
   standard or CCC value.
      0.00    -1.44    9.61     2.1 0.468E+01   0.17    7.432   .93053E-01
      0.00    -1.78    9.52     2.6 0.381E+01   0.21    6.050   .14788E+00
      0.00    -2.01    9.46     3.0 0.339E+01   0.24    5.382   .19047E+00
      0.00    -2.35    9.37     3.4 0.291E+01   0.27    4.618   .26342E+00
      0.00    -2.58    9.31     3.8 0.266E+01   0.30    4.218   .31809E+00
      0.01    -2.92    9.22     4.3 0.235E+01   0.34    3.734   .40916E+00
      0.01    -3.15    9.16     4.6 0.218E+01   0.36    3.468   .47592E+00
      0.01    -3.49    9.07     5.1 0.197E+01   0.40    3.134   .58512E+00
      0.01    -3.83    8.97     5.6 0.180E+01   0.44    2.858   .70519E+00
      0.01    -4.06    8.91     5.9 0.170E+01   0.47    2.700   .79129E+00
      0.01    -4.40    8.82     6.4 0.157E+01   0.51    2.493   .92949E+00
      0.02    -4.63    8.76     6.7 0.149E+01   0.53    2.372   .10277E+01
      0.02    -4.97    8.67     7.2 0.139E+01   0.57    2.210   .11840E+01
      0.02    -5.20    8.61     7.5 0.133E+01   0.60    2.114   .12943E+01
      0.02    -5.54    8.52     8.0 0.125E+01   0.64    1.985   .14688E+01
      0.03    -5.76    8.46     8.3 0.120E+01   0.66    1.907   .15912E+01
      0.03    -6.11    8.37     8.8 0.114E+01   0.70    1.801   .17838E+01
      0.03    -6.45    8.28     9.3 0.108E+01   0.74    1.707   .19874E+01
      0.04    -6.68    8.22     9.6 0.104E+01   0.77    1.649   .21291E+01
      0.04    -7.02    8.13    10.1 0.989E+00   0.81    1.569   .23509E+01
      0.04    -7.25    8.07    10.4 0.959E+00   0.83    1.520   .25048E+01
      0.05    -7.59    7.98    10.9 0.916E+00   0.87    1.452   .27447E+01
      0.05    -7.82    7.92    11.2 0.889E+00   0.90    1.409   .29107E+01
      0.06    -8.16    7.83    11.7 0.853E+00   0.94    1.350   .31689E+01
      0.06    -8.39    7.77    12.1 0.830E+00   0.96    1.314   .33471E+01
      0.06    -8.73    7.68    12.5 0.797E+00   1.00    1.262   .36235E+01
      0.07    -8.96    7.62    12.9 0.777E+00   1.03    1.230   .38139E+01
      0.07    -9.30    7.54    13.3 0.749E+00   1.07    1.185   .41086E+01
      0.08    -9.64    7.45    13.8 0.723E+00   1.10    1.143   .44143E+01
      0.08    -9.87    7.39    14.2 0.706E+00   1.13    1.116   .46242E+01
      0.09   -10.21    7.31    14.6 0.683E+00   1.17    1.079   .49482E+01
      0.09   -10.44    7.25    15.0 0.668E+00   1.20    1.055   .51704E+01
      0.10   -10.79    7.17    15.4 0.647E+00   1.23    1.021   .55128E+01
      0.11   -11.02    7.11    15.8 0.634E+00   1.26    1.000   .57473E+01
      0.11   -11.36    7.03    16.3 0.615E+00   1.30    0.970   .61082E+01
      0.12   -11.59    6.98    16.6 0.603E+00   1.33    0.950   .63550E+01
      0.12   -11.93    6.90    17.1 0.586E+00   1.36    0.923   .67344E+01
      0.13   -12.28    6.82    17.5 0.570E+00   1.40    0.897   .71250E+01
```

```
     0.14   -12.51    6.76    17.9 0.560E+00   1.43    0.880   .73916E+01
     0.15   -12.85    6.69    18.3 0.545E+00   1.47    0.856   .78008E+01
     0.15   -13.08    6.64    18.7 0.536E+00   1.49    0.841   .80798E+01
     0.16   -13.43    6.56    19.1 0.523E+00   1.53    0.819   .85077E+01
     0.17   -13.66    6.52    19.4 0.514E+00   1.56    0.805   .87992E+01
     0.17   -14.01    6.44    19.9 0.502E+00   1.60    0.785   .92459E+01
     0.18   -14.24    6.40    20.2 0.494E+00   1.63    0.772   .95499E+01
     0.19   -14.58    6.33    20.7 0.483E+00   1.66    0.753   .10015E+02
     0.20   -14.82    6.29    21.0 0.475E+00   1.69    0.741   .10332E+02
     0.21   -15.16    6.22    21.5 0.465E+00   1.73    0.724   .10817E+02
     0.22   -15.51    6.16    22.0 0.455E+00   1.77    0.707   .11312E+02
     0.22   -15.74    6.12    22.3 0.448E+00   1.80    0.697   .11649E+02
     0.23   -16.09    6.07    22.8 0.439E+00   1.83    0.681   .12164E+02
     0.24   -16.33    6.03    23.1 0.433E+00   1.86    0.672   .12514E+02
     0.25   -16.68    5.98    23.6 0.425E+00   1.90    0.657   .13048E+02
     0.26   -16.91    5.95    23.9 0.419E+00   1.93    0.648   .13410E+02
     0.27   -17.26    5.90    24.3 0.411E+00   1.97    0.635   .13963E+02
     0.28   -17.49    5.87    24.7 0.406E+00   1.99    0.626   .14338E+02
     0.29   -17.84    5.83    25.1 0.398E+00   2.03    0.614   .14910E+02
     0.30   -18.20    5.79    25.6 0.391E+00   2.07    0.602   .15494E+02
     0.31   -18.43    5.77    25.9 0.386E+00   2.10    0.594   .15889E+02
     0.32   -18.78    5.74    26.4 0.379E+00   2.14    0.583   .16492E+02
     0.33   -19.02    5.72    26.7 0.374E+00   2.16    0.575   .16900E+02
     0.34   -19.37    5.70    27.2 0.368E+00   2.20    0.565   .17522E+02
     0.35   -19.60    5.69    27.5 0.364E+00   2.23    0.558   .17942E+02
     0.36   -19.96    5.67    28.0 0.357E+00   2.27    0.548   .18583E+02
     0.37   -20.19    5.66    28.3 0.353E+00   2.29    0.542   .19016E+02
     0.38   -20.55    5.65    28.8 0.348E+00   2.33    0.533   .19676E+02
     0.39   -20.78    5.65    29.1 0.344E+00   2.36    0.527   .20122E+02
 Minimum jet height has been reached.
     0.41   -21.14    5.65    29.6 0.338E+00   2.40    0.518   .20800E+02
     0.42   -21.49    5.65    30.1 0.333E+00   2.44    0.510   .21489E+02
     0.43   -21.72    5.66    30.4 0.329E+00   2.46    0.505   .21954E+02
     0.45   -22.08    5.67    30.9 0.324E+00   2.50    0.497   .22661E+02
     0.46   -22.31    5.68    31.2 0.320E+00   2.53    0.492   .23139E+02
     0.47   -22.67    5.70    31.7 0.315E+00   2.57    0.485   .23864E+02
     0.48   -22.90    5.72    32.0 0.312E+00   2.59    0.480   .24354E+02
     0.50   -23.25    5.75    32.5 0.307E+00   2.63    0.473   .25097E+02
     0.51   -23.49    5.77    32.9 0.304E+00   2.66    0.469   .25598E+02
     0.52   -23.84    5.81    33.4 0.300E+00   2.69    0.462   .26359E+02
     0.54   -24.19    5.85    33.9 0.295E+00   2.73    0.456   .27129E+02
     0.55   -24.42    5.89    34.2 0.292E+00   2.76    0.452   .27649E+02
     0.56   -24.77    5.94    34.8 0.288E+00   2.80    0.446   .28437E+02
     0.58   -25.00    5.97    35.1 0.285E+00   2.82    0.443   .28968E+02
     0.59   -25.35    6.03    35.6 0.281E+00   2.86    0.437   .29773E+02
     0.60   -25.58    6.07    36.0 0.278E+00   2.89    0.433   .30315E+02
     0.62   -25.93    6.14    36.5 0.274E+00   2.93    0.428   .31137E+02
     0.63   -26.16    6.18    36.8 0.271E+00   2.95    0.425   .31690E+02
     0.65   -26.51    6.25    37.4 0.268E+00   2.99    0.420   .32528E+02
     0.66   -26.74    6.30    37.7 0.265E+00   3.02    0.416   .33093E+02
     0.68   -27.08    6.38    38.2 0.262E+00   3.06    0.411   .33948E+02
     0.70   -27.43    6.46    38.8 0.258E+00   3.09    0.407   .34813E+02
     0.71   -27.66    6.51    39.1 0.256E+00   3.12    0.403   .35395E+02
     0.73   -28.00    6.60    39.6 0.252E+00   3.16    0.399   .36278E+02
     0.74   -28.23    6.66    40.0 0.250E+00   3.19    0.396   .36871E+02
     0.76   -28.57    6.74    40.5 0.247E+00   3.22    0.391   .37770E+02
     0.77   -28.80    6.80    40.8 0.245E+00   3.25    0.388   .38376E+02
     0.79   -29.14    6.89    41.3 0.242E+00   3.29    0.384   .39293E+02
     0.80   -29.37    6.95    41.7 0.240E+00   3.32    0.381   .39910E+02
     0.82   -29.71    7.04    42.2 0.237E+00   3.35    0.376   .40844E+02
     0.84   -29.93    7.11    42.5 0.235E+00   3.38    0.373   .41474E+02
 Terminal level in stratified ambient has been reached.
 Cumulative travel time =          41.4736 sec  (    0.01 hrs)

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
```

```
BEGIN MOD137: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =     12.86 m
        Layer thickness in impingement region   =      0.69 m
        Upstream intrusion length               =    538.14 m
        X-position of upstream stagnation point =   -537.30 m
        Thickness in intrusion region           =      0.69 m
        Half-width at downstream end            =   1181.85 m
        Thickness at downstream end             =      0.75 m

 In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
   the local water depth.
 This may be caused by a very small ambient velocity, perhaps in
   combination with large discharge buoyancy.
 If the ambient conditions are strongly transient (e.g. tidal), then the
   CORMIX steady-state predictions of upstream intrusion are probably
   unrealistic.
 The plume predictions prior to boundary impingement and wedge formation
   will be acceptable, however.

  Control volume inflow:
      X         Y        Z         S       C        B         TT
      0.84    -29.93    7.11     42.5 0.235E+00   3.38 .41474E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in Y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

      X         Y        Z         S       C        BV        BH       ZU       ZL        TT
   -537.30    -29.93    7.11   9999.9 0.000E+00   0.00      0.00     7.11     7.11 .59134E+05
   -514.72    -29.93    7.11    165.6 0.604E-01   0.18    167.14     7.19     7.02 .41474E+02
   -404.07    -29.93    7.11     69.0 0.145E+00   0.43    405.98     7.32     6.89 .41474E+02
   -293.43    -29.93    7.11     52.6 0.190E+00   0.56    549.27     7.39     6.83 .41474E+02
   -182.78    -29.93    7.11     45.8 0.218E+00   0.64    662.26     7.43     6.78 .41474E+02
    -72.13    -29.93    7.11     43.0 0.233E+00   0.69    758.59     7.45     6.76 .41474E+02
 ** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region **
 In this prediction interval the TOTAL plume width meets or exceeds
 the regulatory value =    24.40 m.
 This is the extent of the REGULATORY MIXING ZONE.
     38.52    -29.93    7.11     43.3 0.231E+00   0.69    844.01     7.45     6.76 .38097E+04
    149.17    -29.93    7.11     54.3 0.184E+00   0.71    921.54     7.46     6.75 .14875E+05
    259.81    -29.93    7.11     70.8 0.141E+00   0.73    993.03     7.47     6.74 .25939E+05
    370.46    -29.93    7.11     84.3 0.119E+00   0.74   1059.71     7.48     6.73 .37004E+05
    481.11    -29.93    7.11     91.6 0.109E+00   0.75   1122.44     7.48     6.73 .48069E+05
    591.76    -29.93    7.11     95.3 0.105E+00   0.75   1181.85     7.48     6.73 .59134E+05
 Cumulative travel time =       59133.7461 sec  (   16.43 hrs)

END OF MOD137: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
-----------------------------------------------------------------------------------------------
** End of NEAR-FIELD REGION (NFR) **
 Some BOUNDARY INTERACTION with both banks occurs at end of near-field.
   The dilution values in one or more of the preceding zones may be too high.
 Carefully evaluate results in near-field and check degree of interaction.
 Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -3.00m
-----------------------------------------------------------------------------------------------
BEGIN MOD181: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION

 An INTERNAL UPSTREAM INTRUDING WEDGE is formed.

 UPSTREAM WEDGE INTRUSION PROPERTIES in bounded channel (laterally uniform):
        Wedge length                            =  460664.75 m
```

```
        X-Position of wedge tip                    = -460073.00 m
        Thickness at discharge (end of NFR)        =       7.30 m
         (Wedge thickness gradually decreases to zero at wedge tip.)

    In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times
      the local water depth.
    This may be caused by a very small ambient velocity, perhaps in combination
      with large discharge buoyancy.
    If the ambient conditions are strongly transient (e.g. tidal), then the
      CORMIX steady-state predictions of upstream intrusion are probably
      unrealistic.
    The plume predictions prior to boundary impingement and wedge formation
     will be acceptable, however.

          X         Y        Z         S        C        BV        BH       ZU       ZL        TT
       591.76     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .59134E+05
    Cumulative travel time =       59133.7539 sec  (   16.43 hrs)
    Flow is LATERALLY MIXED over the channel width.

   END OF MOD181: MIXED PLUME/BOUNDED CHANNEL/POSSIBLE UPSTREAM WEDGE INTRUSION
   -----------------------------------------------------------------------------------------------
   -----------------------------------------------------------------------------------------------
   BEGIN MOD162: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

     Vertical diffusivity (initial value)   = 0.143E-09 m^2/s
     Horizontal diffusivity (initial value) = 0.545E-02 m^2/s

    Profile definitions:
      BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
         = or equal to layer depth, if fully mixed
      BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
           measured horizontally in Y-direction
      ZU = upper plume boundary (Z-coordinate)
      ZL = lower plume boundary (Z-coordinate)
      S  = hydrodynamic centerline dilution
      C  = centerline concentration (includes reaction effects, if any)
      TT = Cumulative travel time

    Plume Stage 2 (bank attached):
          X         Y        Z         S        C        BV        BH       ZU       ZL        TT
       591.76     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .59134E+05
       635.84     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .63542E+05
       679.92     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .67950E+05
       724.01     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .72358E+05
       768.09     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .76767E+05
       812.17     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .81175E+05
       856.25     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .85583E+05
       900.34     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .89991E+05
       944.42     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .94400E+05
       988.50     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .98808E+05
      1032.58     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .10322E+06
      1076.67     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .10762E+06
      1120.75     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .11203E+06
      1164.83     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .11644E+06
      1208.91     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .12085E+06
      1252.99     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .12526E+06
      1297.08     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .12967E+06
      1341.16     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .13407E+06
      1385.24     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .13848E+06
      1429.32     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .14289E+06
      1473.41     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .14730E+06
      1517.49     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .15171E+06
      1561.57     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .15612E+06
      1605.65     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .16052E+06
      1649.74     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .16493E+06
      1693.82     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .16934E+06
      1737.90     7.00     7.11     95.3 0.105E+00    7.30    244.00    10.76     3.45 .17375E+06
```

1781.98	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.17816E+06
1826.07	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.18256E+06
1870.15	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.18697E+06
1914.23	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.19138E+06
1958.31	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.19579E+06
2002.40	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.20020E+06
2046.48	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.20461E+06
2090.56	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.20901E+06
2134.64	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.21342E+06
2178.73	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.21783E+06
2222.81	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.22224E+06
2266.89	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.22665E+06
2310.97	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.23106E+06
2355.06	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.23546E+06
2399.14	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.23987E+06
2443.22	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.24428E+06
2487.30	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.24869E+06
2531.39	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.25310E+06
2575.47	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.25750E+06
2619.55	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.26191E+06
2663.63	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.26632E+06
2707.72	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.27073E+06
2751.80	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.27514E+06
2795.88	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.27955E+06
2839.96	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.28395E+06
2884.05	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.28836E+06
2928.13	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.29277E+06
2972.21	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.29718E+06
3016.29	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.30159E+06
3060.38	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.30600E+06
3104.46	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.31040E+06
3148.54	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.31481E+06
3192.62	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.31922E+06
3236.71	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.32363E+06
3280.79	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.32804E+06
3324.87	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.33244E+06
3368.95	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.33685E+06
3413.04	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.34126E+06
3457.12	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.34567E+06
3501.20	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.35008E+06
3545.28	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.35449E+06
3589.37	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.35889E+06
3633.45	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.36330E+06
3677.53	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.36771E+06
3721.61	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.37212E+06
3765.70	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.37653E+06
3809.78	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.38094E+06
3853.86	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.38534E+06
3897.94	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.38975E+06
3942.03	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.39416E+06
3986.11	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.39857E+06
4030.19	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.40298E+06
4074.27	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.40739E+06
4118.36	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.41179E+06
4162.44	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.41620E+06
4206.52	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.42061E+06
4250.60	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.42502E+06
4294.69	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.42943E+06
4338.77	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.43383E+06
4382.85	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.43824E+06
4426.93	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.44265E+06
4471.02	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.44706E+06
4515.10	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.45147E+06
4559.18	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.45588E+06
4603.26	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.46028E+06
4647.35	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.46469E+06
4691.43	7.00	7.11	95.3	0.105E+00	7.30	244.00	10.76	3.45	.46910E+06

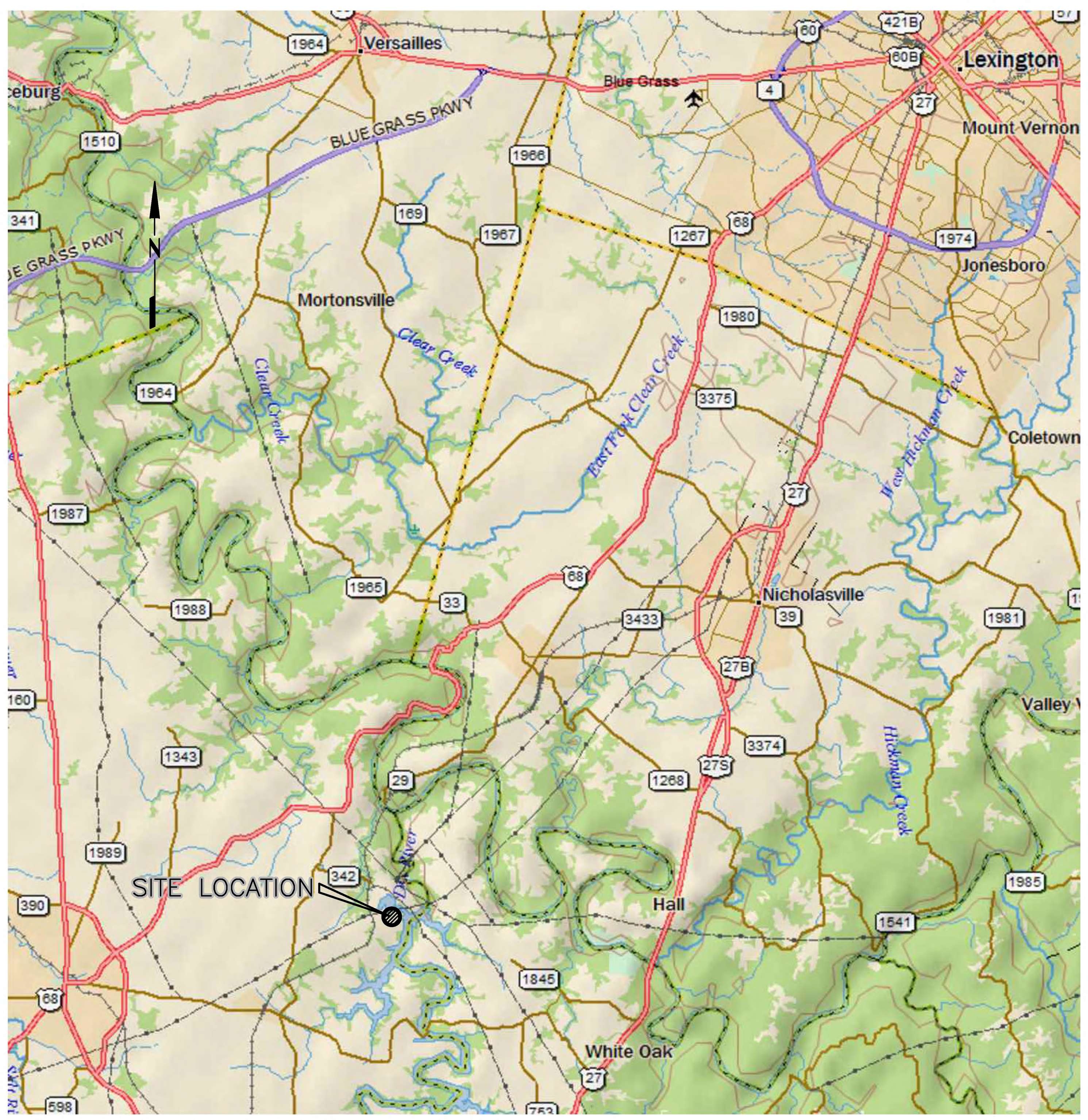
```
   4735.51     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .47351E+06
   4779.59     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .47792E+06
   4823.68     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .48233E+06
   4867.76     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .48673E+06
   4911.84     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .49114E+06
   4955.92     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .49555E+06
   5000.01     7.00    7.11    95.3 0.105E+00   7.30   244.00   10.76    3.45 .49996E+06
 Cumulative travel time =      499957.8750 sec  (  138.88 hrs)

Note:
CORMIX is a steady state model and assumes discharge and ambient conditions do not vary
 over time. The predicted plume cumulative travel time exceeds 48 hours at this trajectory
 distance. Keep in mind that ambient and discharge conditions are likely to vary over
 large space and time scales. Predictions at such large space and time scales may be
 inconsistent with CORMIX modeling assumptions.

Please carefully evaluate your simulation results and limit model interpretation to space
 and time scales consistent with steady state assumptions and ambient schematization.

 Simulation limit based on maximum specified distance =   5000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD162: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT
-----------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------
CORMIX1: Single Port Discharges              End of Prediction File
111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
```

KU E.W. BROWN GENERATING STATION PROCESS POND DISCHARGE PIPE AND DIFFUSER SYSTEM HARRODSBURG, KENTUCKY

JANUARY 2, 2019

PREPARED FOR:
LOUISVILLE GAS & ELECTRIC COMPANY AND KENTUCKY UTILITIES,
820 WEST BROADWAY
LOUISVILLE, KY 40202

PREPARED BY:
WOOD
ENVIRONMENT & INFRASTRUCTURE SOLUTIONS, INC
11003 BLUEGRASS PKWY, SUITE 690
LOUISVILLE, KY 40299



SOURCE INFO: IMAGERY TAKEN FROM DELORME TOPO NORTH AMERICA.

SOURCE INFO: IMAGERY TAKEN FROM THE STATE OF KENTUCKY GIS SYSTEM.

ISSUED FOR CONSTRUCTION

wood.
Environment & Infrastructure Solutions, Inc.
11003 Bluegrass Parkway, Suite 690, Louisville, KY 40299
Phone: (502) 267-0700 Fax: (502) 267-5900

REVISIONS

Rev.	Drawn Date	Drawn By	Revision Made

Title: PROCESS POND DISCHARGE PIPE AND DIFFUSER SYSTEM

COVER SHEET AND LOCATION MAPS

Location and Unit: EW BROWN GENERATING STATION

Scale: AS SHOWN
Drawn: SS
Date: 8/22/2018
Checked: JD
Approved: WT

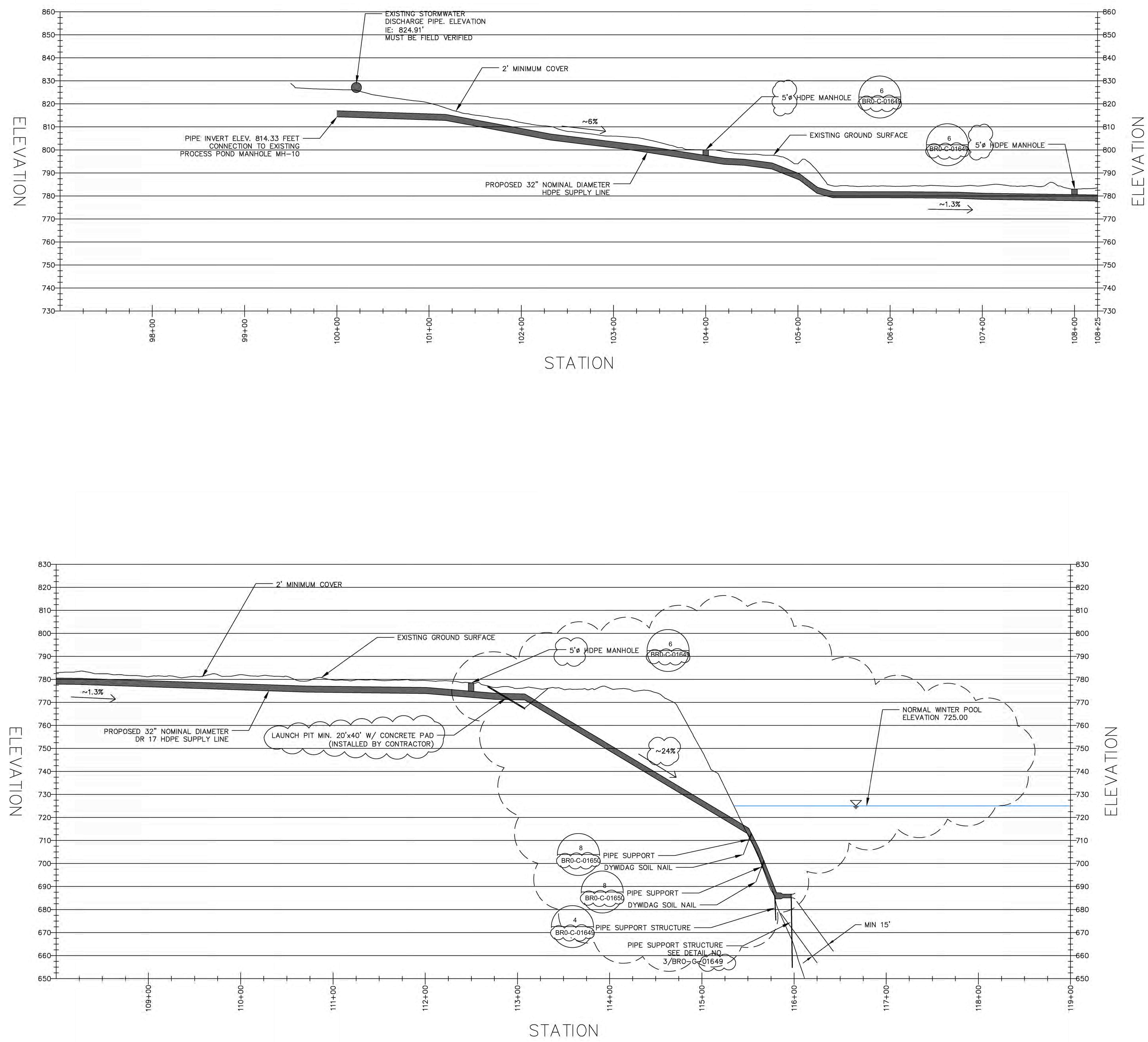
Kentucky Utilities Company

Drawing No: BRO-C-01640
Rev. A

BRO-C-01640


ISSUED FOR CONSTRUCTION
SCALE: 1"=50'
PROCESS POND DISCHARGE PIPE AND DIFFUSER SYSTEM
PROCESS POND BID ALTERNATE PIPE ALIGNMENT
EW BROWN GENERATING STATION
Scale: AS SHOWN
Date: 8/22/2018
Kentucky Utilities Company
Drawing No.: BR0-C-01643
Rev. A
REVISIONS
Environment & Infrastructure Solutions, Inc.
11003 Bluegrass Parkway, Suite 690, Louisville, KY 40299
Phone: (502) 267-0700 Fax: (502) 267-5900
BR0-C-01643
PROPOSED DIFFUSER
PIPE SUPPORT
PIPE SUPPORT STRUCTURE
5Ø HDPE MANHOLE
PROCESS POND DISCHARGE 32" HDPE PIPE ALIGNMENT
TIE-IN TO EXISTING MH-10
AUX. POND DISCHARGE PIPE (EXISTING)
CCR IMPOUNDMENT
PROPOSED PROCESS POND
HERRINGTON LAKE
WATER ELEV. 725.50'
WATER ELEV. 788.48
LIMITS OF BATHYMETRIC SURVEY
CURDS INLET
HQ INLET
TRANS. TOWER
TRANS. POLE
DIST. POLE
MONITORING WELL

BR0-C-01648



1 PROCESS POND PIPE ALIGNMENT PROFILE

VERTICAL
0 10' 20' 40'
SCALE: 1"=20'

HORIZONTAL
0 50' 100'
SCALE: 1"=50'

ISSUED FOR CONSTRUCTION

Environment & Infrastructure Solutions, Inc.
11003 Bluegrass Parkway, Suite 690, Louisville, KY 40299
Phone: (502) 267-0700 Fax: (502) 267-5900

REVISIONS

Rev.	Drawn Date	Drawn By	Revision Made
1	12 NOV 2018		

Title
PROCESS POND DISCHARGE PIPE
AND DIFFUSER SYSTEM

PROCESS POND PIPE BID
BID ALTERNATE PIPE PROFILE

Location and Unit:
EW BROWN GENERATING STATION

Scale: AS SHOWN
Drawn: SS
Date: 8/22/2018
Checked: JS
Approved: WT

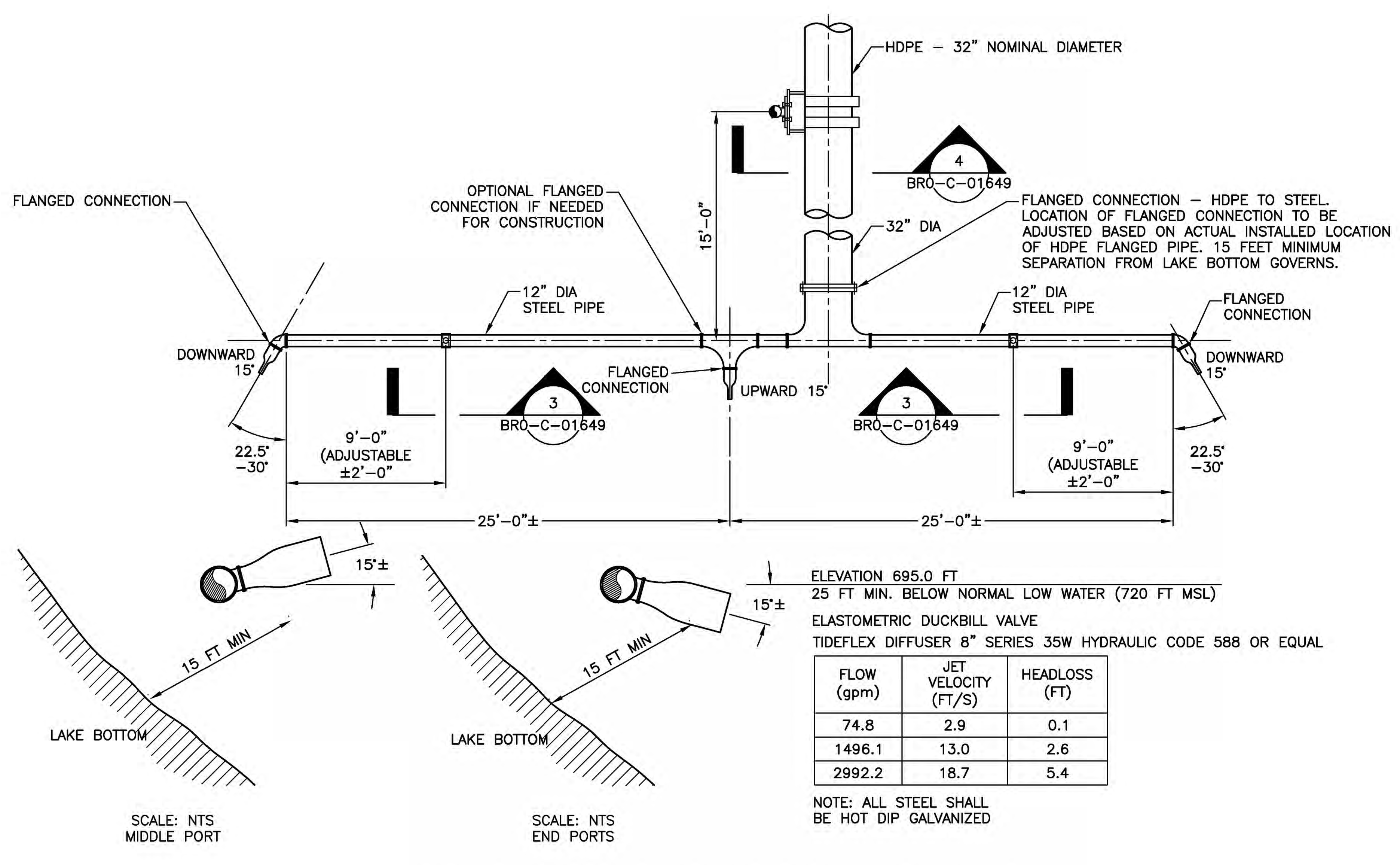
JOB NO. JOB NO. JOB NO. JOB NO. JOB NO.

Kentucky Utilities Company

Drawing No: BR0-C-01648
Rev: A

DMS Version 2.0

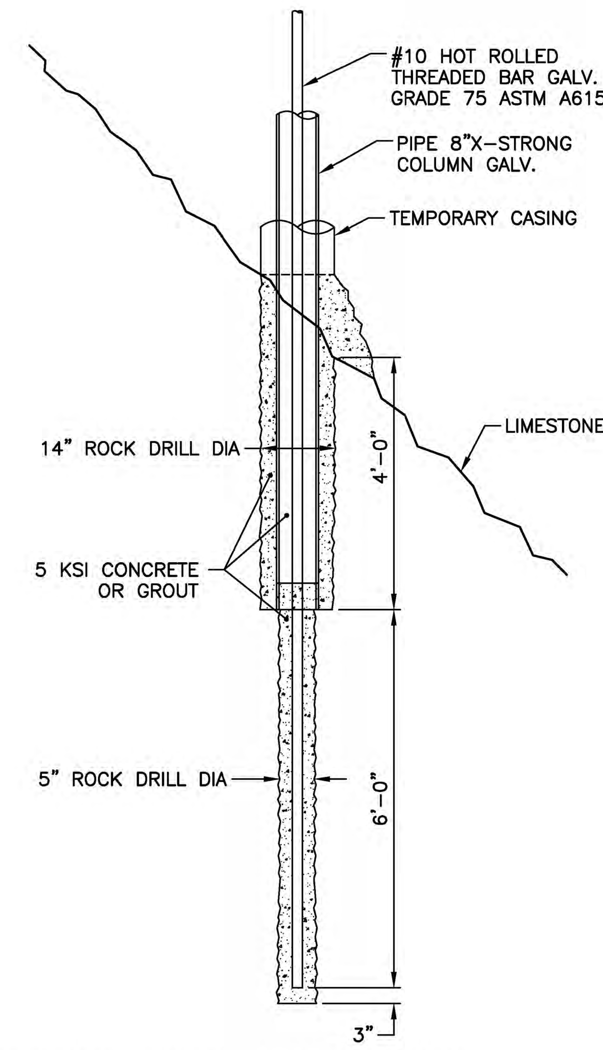
BRO-C-01649



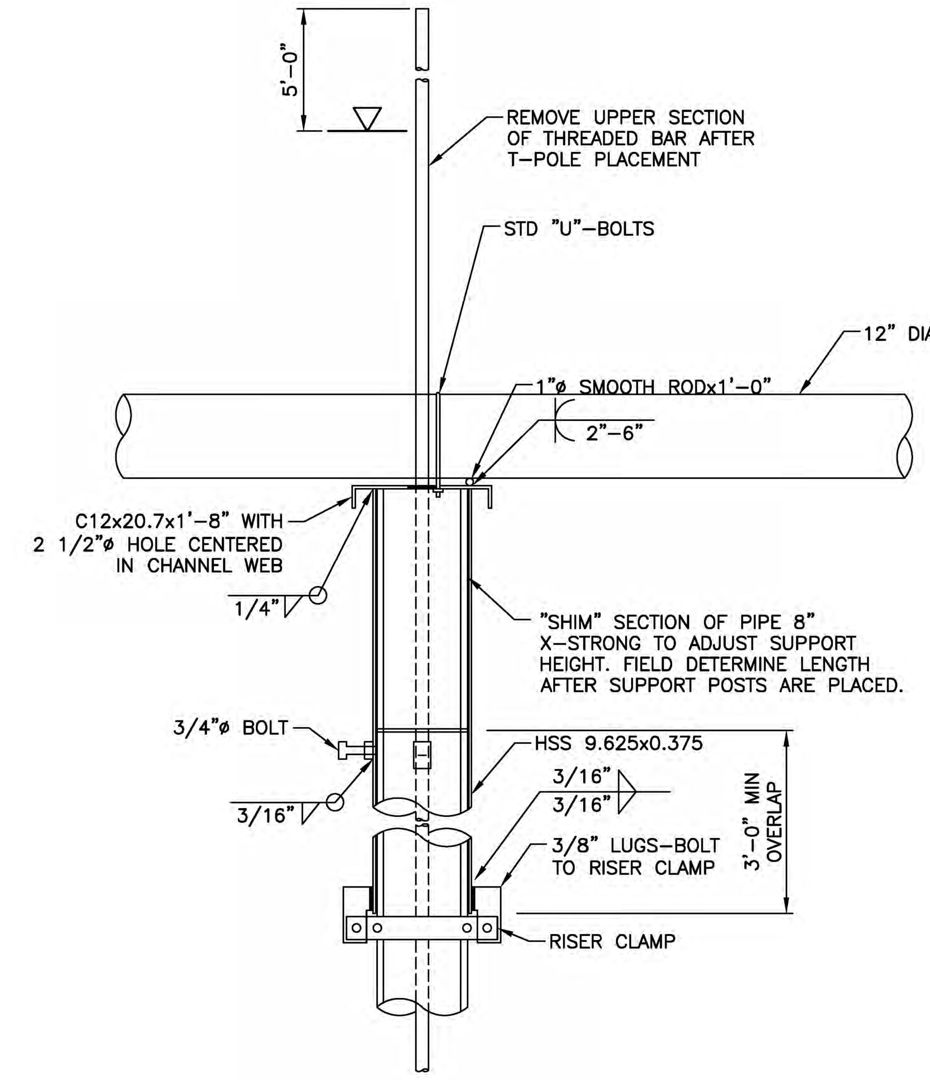
FLOW (gpm)	JET VELOCITY (FT/S)	HEADLOSS (FT)
74.8	2.9	0.1
1496.1	13.0	2.6
2992.2	18.7	5.4

NOTE: ALL STEEL SHALL BE HOT DIP GALVANIZED

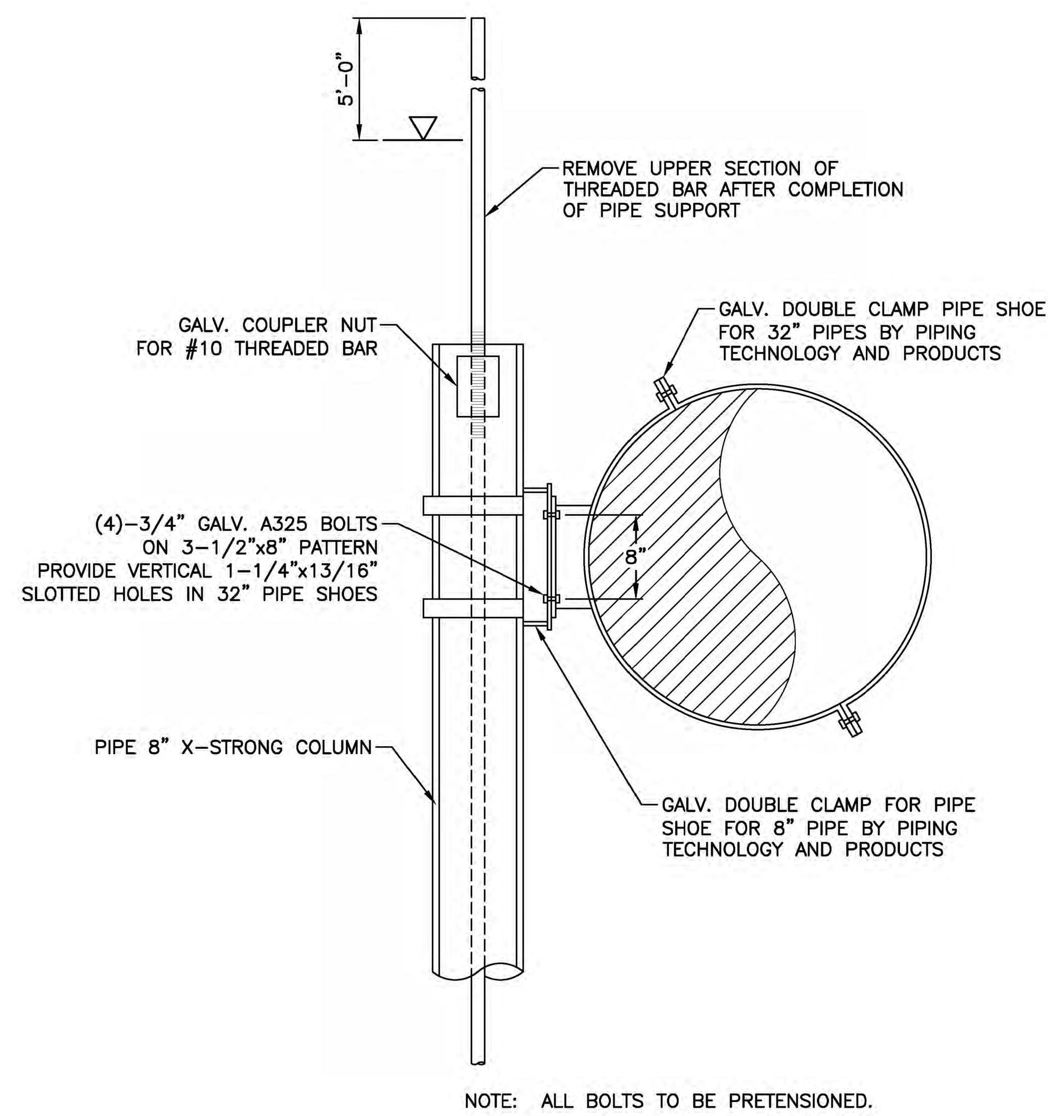
1 DIFFUSER CONFIGURATION – PLAN VIEW
SCALE: NOT TO SCALE



2 SUPPORT POST AND CASING
SCALE: NOT TO SCALE

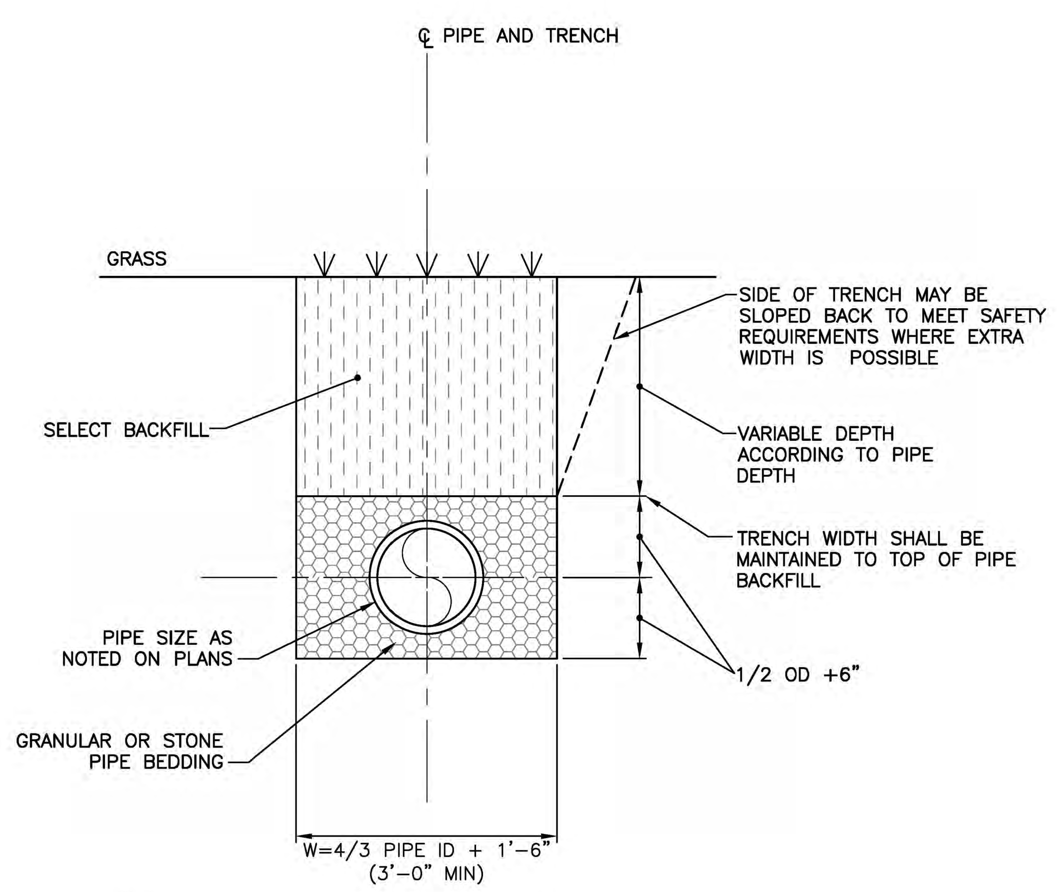


3 PIPE T-POLE SUPPORT
SCALE: NOT TO SCALE
SEE DETAIL 2/THIS SHEET FOR ANCHORAGE

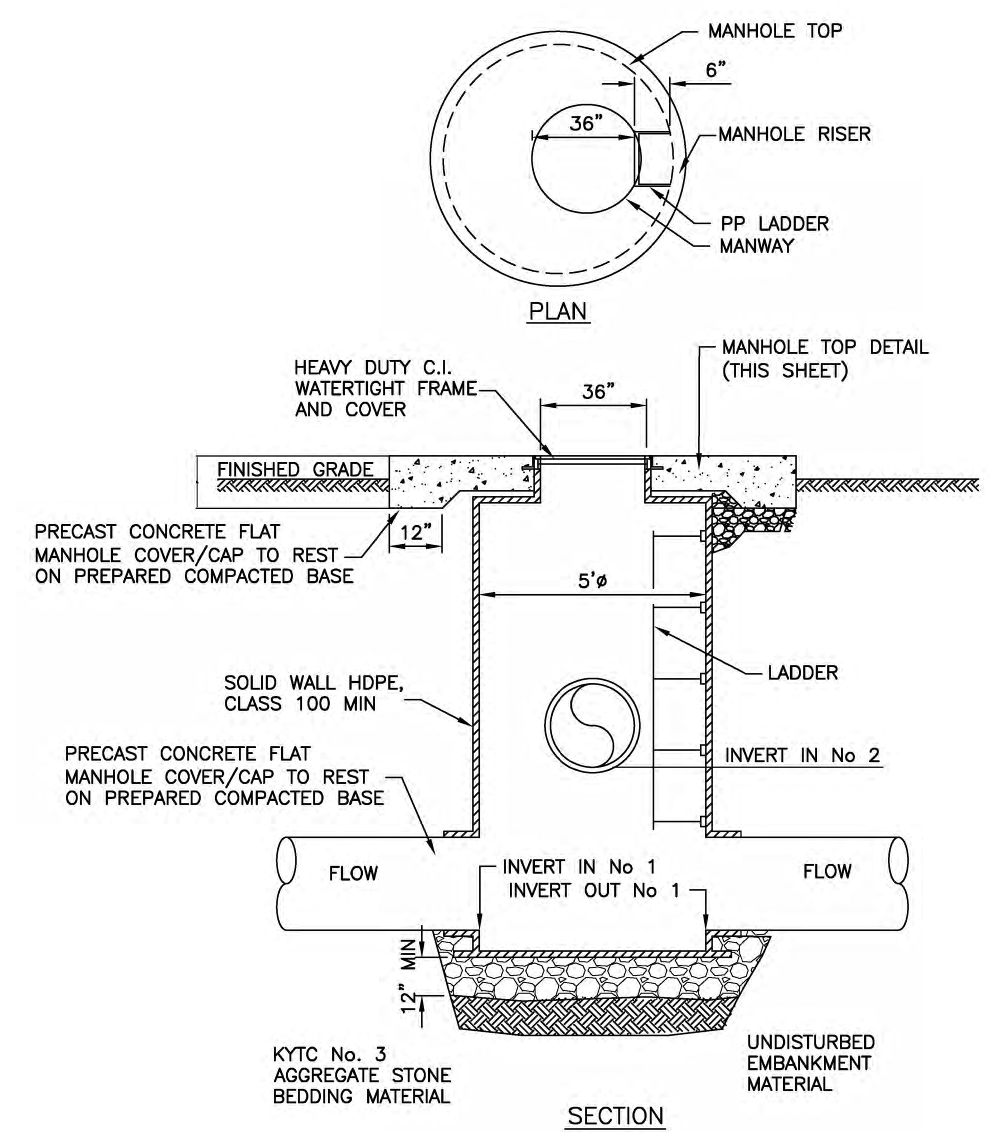


NOTE: ALL BOLTS TO BE PRETENSIONED.

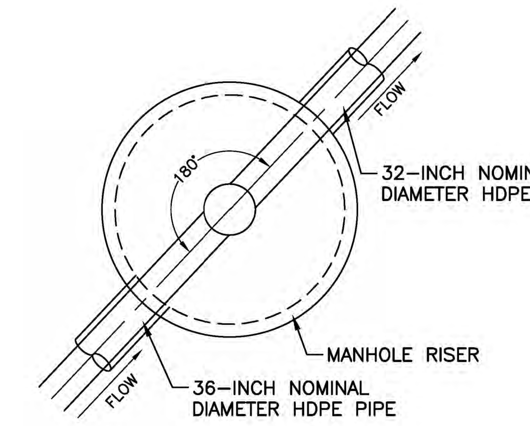
4 PIPE BRACKET SUPPORT
SCALE: NOT TO SCALE
SEE DETAIL 2/THIS SHEET FOR ANCHORAGE



5 TYPICAL PIPE TRENCH
SCALE: NOT TO SCALE



6 HDPE MANHOLE
SCALE: NOT TO SCALE



7 MANHOLE (TYP) PLAN VIEW

ISSUED FOR CONSTRUCTION

wood.
Environment & Infrastructure Solutions, Inc.
11003 Bluegrass Parkway, Suite 690, Louisville, KY 40299
Phone: (502) 267-0700 Fax: (502) 267-5900

REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Note

Title
PROCESS POND DISCHARGE PIPE AND DIFFUSER SYSTEM
DIFFUSER DETAILS
Location and Unit:
EW BROWN GENERATING STATION

Scale: AS SHOWN
Drawn: BS
Date: 8/22/2018
Checked: JD
Approved: WT
JOB NO. JOB NO. JOB NO. JOB NO.

KU Kentucky Utilities Company

Drawing No: BRO-C-01649
Rev: A

DMS Version 2.0