BURNS McDONNELL

Morrow Station Regulatory Compliance Study

SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

SMEPA

Morrow Station CCR/ELG Study
Project No. 87483

Revision 1
2/12/2016

Morrow Station Regulatory Compliance Study

prepared for

SMEPA
Morrow Station CCR/ELG Study
Purvis, MS

Project No. 87483

Revision 1
2/12/2016

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, MO

INDEX AND CERTIFICATION

SMEPA
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Certification

I hereby certify, as a Professional Engineer in the state of Mississippi, the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the SMEPA or others without specific verification or adaptation by the Engineer.

This document has been digitally sealed and signed. February 12, 2016.

Randell Lee Sedlacek, P.E.

Date: 2/12/16

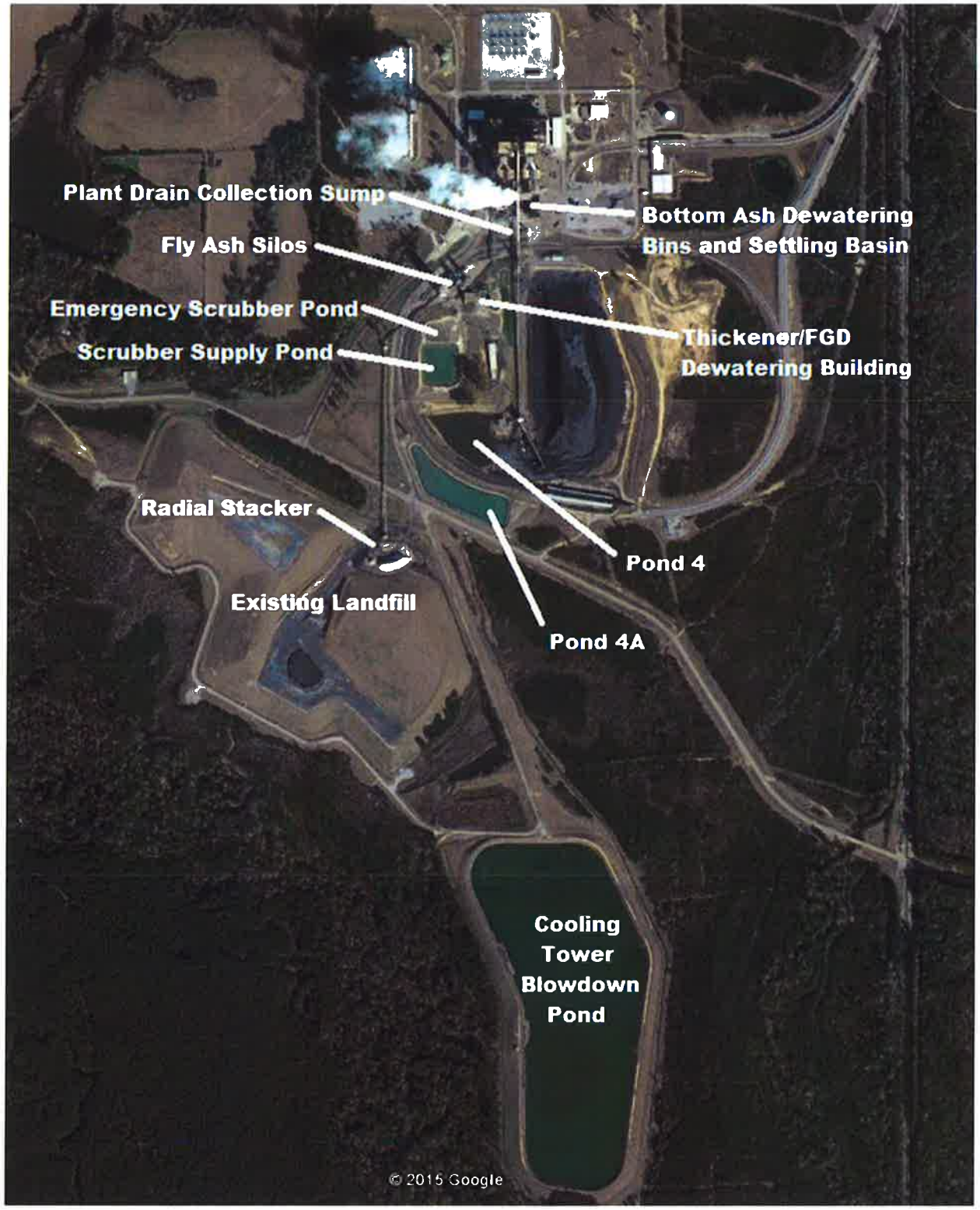

Figure 4-1: Morrow Site Plan

4.1 Current Site Operations

The following sections of this report describe Burns & McDonnell's understanding of the current plant operations, based on the discussions during the site visit on August 18, 2015.

4.1.1 Plant Water Balance

The current plant water balance is shown in Appendix A of this report. The latest discharge permit for the facility was issued by the Mississippi Department of Environmental Quality (MDEQ) in September 2014, and expires in August 2019. In general, the plant wastewater flows from north to south through a series of internal outfalls. There are two outfalls that leave the plant property and discharge to Black Creek: the Cooling Tower Blowdown Pond and the landfill stormwater collection and filtration area. The current discharge points and permit limits are summarized in Table 4-1.

Table 4-1: Morrow Station NPDES discharge limits established by MDEQ in September 2014

Outfall ID	Receiving Water	Description	Average Daily Flow (gpm)	Current Permit Dischage Limits		
				Characteristic	Monthly Max	Montly Average
002	Black Creek	Cooling Tower Blowdown Pond (including Cooling Tower Blowdown, Treated Coal Pile Runoff, and Outfall 006)	1007	Temperature (deg F)	90	-
				pH	6.0 < pH < 9.0	
				Oil & Grease (mg/L)	15	10
				TSS (mg/L)	45	30
004	Outfall 002	Cooling Tower Blowdown	709	Chromium (Annual - mg/L)	0.2	0.2
				Zinc (Annual - mg/L)	1.0	1.0
				Chlorine, Free Available (mg/L)	0.5	0.2
				Chlorine, Total Residual (min)	120	report
				pH (weekly grab)	report min/max	
005	Outfall 002	Treated Coal Pile Runoff	198	TSS (mg/L)	50	report
				pH (weekly grab)	report min/max	
006	Outfall 005	Scrubber Supply Pond (including plant drains, treated sanitary WW, recirculated WW through wet scrubber and ash sluice systems)	128	Total Copper (mg/L)	1.0	1.0
				Total Iron (mg/L)	1.0	1.0
				Oil & Grease (mg/L)	20	15
				pH (grab twice/discharge)	report min/max	
				TSS (mg/L)	100	30
007	Black Creek	Stormwater from solid waste landfill (includes leachate and non-contact water)	19	TSS (semiannual - mg/L)	report	
				pH (semiannual grab)	report	
				BOD_5 (semiannual - mg/L)	report	
				Oil & Grease (semiannual - mg/L)	report	
				Nitrogen (semiannual - mg/L)	report	
008	Outfall 006	Sanitary Waste	0.25	Fecal Coliform (annual grab - mg/L	report	

4.1.2 Bottom Ash Handling

Bottom ash is sluiced to a pair of dewatering bins located south of the units as shown in Figure 4-1 and Figure 4-2. Decanted water overflows to the adjacent settling surge basin, also shown in Figure 4-2. Any potential water lost from the bottom of the bins is captured in a pair of drop inlets that drain into the settling surge basin, and the area around the bins is curbed to limit the amount of stormwater that can contribute to the basin. The bottom ash sluice water supply pumps take suction off the settling surge basin. The sluice supply water is routed to the bottom ash hopper jet pumps and then sluiced back to the dewatering bins in a semi-closed loop. The basin does receive additional water from the stack drains, seal water from the fly ash vacuum pumps, non-chemical metal cleaning wastes, and stormwater that falls directly on the basin. These flows contribute to an average settling surge basin discharge of 50 gallons per minute (see the water balance in Appendix A), of which the primary source is the seal water from the ash vacuum pumps. The settling surge basin discharge is routed to the main plant drains sump, which is pumped directly to the Scrubber Supply Pond.

Figure 4-2: Bottom Ash Dewatering Bins and adjacent Settling Surge Basin

The settling surge basin is designed to be self-supporting and, based on clarification received from the EPA during a CCR workshop in April 2015, would not meet the definition of an impoundment; therefore, the basin is not considered to be a CCR impoundment. The basin does accumulate sludge from the bottom ash dewatering process, and periodically the basin is dewatered and the sludge is removed and hauled to the landfill for disposal. This occurs once every three to five years, and the water has historically been pumped to the coal pile runoff pond prior to discharging during these cleaning cycles.

A majority of the bottom ash produced at the Morrow site is sold for beneficial use, and is primarily used as an aggregate material for a nearby concrete block producer. Any bottom ash that is not sold can be disposed of in the onsite landfill.

4.1.3 Fly Ash Handling

Fly ash is handled dry and transported to a set of silos located south of the units as shown in Figure 4-1 and Figure 4-3. The low carbon fly ash generated at the site is either loaded into tanker trucks using a dustless unloader at the concrete silo and hauled offsite for beneficial use or conditioned using a pug mill (see Figure 4-4) and transported via conveyor to the radial stacker located in the permitted landfill area. The conditioned material is stacked out in a pile before being loaded onto trucks and disposed in the landfill. Any high-carbon fly ash is recycled back to the units for additional combustion or conditioned and sent to the landfill for disposal.

Fly ash is no longer conveyed with Hydroveyors, as shown on existing Piping and Instrumentation Diagrams (P&IDs). Rather, the ash is now conveyed using vacuum pumps. The seal water from the vacuum pumps has no contact with the fly ash and is currently discharged to the settling surge basin (as stated in Section 4.1.2).

Economizer ash is no longer handled with the fly ash, as shown on the P&IDs. Economizer ash now collects in the economizer ash hoppers and is emptied via a vacuum truck approximately twice a year. The economizer ash that is collected by the vacuum truck is then transported to the on-site landfill for disposal.

Figure 4-3: Fly Ash Silos and Conveyor to the Landfill

Figure 4-4: Pug mill between steel ash silos and conveyor

4.1.4 FGD Material Handling

The Morrow station has a wet scrubber installed on both units. FGD wastewater is normally routed to the thickener, at the location shown in Figure 4-1. The thickener underflow is routed to the filter feed tanks and dewatered using a filter press, shown in Figure 4-5. The water removed at the filter press is routed back to the thickener and the solids are conveyed to the radial stacker in the landfill, where they are loaded onto trucks for either beneficial use or disposal in the landfill. The thickener overflow is routed to the Emergency Scrubber Pond, which discharges to the Scrubber Supply Pond. These ponds are shown in Figure 4-1 and Figure 4-6. In addition to thickener overflow, the Emergency Scrubber Pond also receives FGD wastewater during thickener upset conditions or during periods when the thickener is unavailable for maintenance. The Scrubber Supply Pond can provide water to the scrubber for makeup, to the limestone system for slurry preparation, or to the discharge at Outfall 006.

Figure 4-5: Morrow Station Filter Press

Figure 4-6: Emergency Scrubber Pond (near) and Scrubber Supply Pond (far)

SMEPA provided testing results on samples from Outfall 006 (taken from piping leaving the Scrubber Supply Pond prior to discharge into Pond 4) which show the TSS levels in the discharge ranging from 15 to 21 mg/L. This is lower than the discharge limit for TSS at Outfall 002, meaning the water could be discharged to Black Creek at that quality (from a solids perspective). Consequently the remaining ponds onsite downstream of Outfall 006 (including Pond 4, Pond 4A, and the Cooling Tower Blowdown Pond) are not providing additional treatment to remove CCR materials and should not be classified as CCR impoundments. SMEPA should consult with legal counsel to confirm that any materials deposited in these other impoundments would be considered *de minimis*, as this is not clearly defined in the CCR rule.

If the discharge from the Emergency Scrubber Pond to the Scrubber Supply Pond could be tested, the Scrubber Supply Pond could potentially be excluded from the rule as well, depending on the discussions with legal counsel. Without results from this testing, and based on current operations and the potential to route the FGD wastewater directly to the Emergency Scrubber Pond during thickener upset conditions, both the Emergency Scrubber Pond and the Scrubber Supply Pond have been considered as CCR impoundments subject to the CCR rule.

4.1.5 Landfill

The current landfill site is shown in Figure 4-1. The landfill receives CCR material from the Morrow site that is not beneficially used (21,000 tons in 2014). SMEPA estimates that the current cell has 12 years of capacity remaining, but this could vary depending on the plant capacity factor. All of the material disposed in the landfill is transported to the radial stacker (also shown in Figure 4-1) via conveyor, with the exception of any bottom ash that is not beneficially reused. While almost all of this material is sent offsite, if any is landfilled it would be trucked from the dewatering bins to the landfill with enough moisture to be considered "conditioned" per the CCR rule. All fly ash sent to the landfill is conditioned with a pug mill prior to being loaded on the conveyor, and all FGD materials are removed from the filter press with approximately 10% moisture in the solids.

The radial stacker is shown in Figure 4-7. While this area is not located on a concrete or asphalt surface, it is already contained within the perimeter berm around the landfill and within the limits of the existing groundwater monitoring network. Any runoff from this area is captured with the landfill contact water and routed through the existing stormwater treatment system prior to being discharged via Outfall 007. Consequently, this area should be considered part of the landfill area, and not a separate CCR pile subject to the CCR rule.

Figure 4-7: Radial Stacker Area

4.2 Expected CCR Impacts

The site landfill, the Emergency Scrubber Pond, and the Scrubber Supply Pond will likely all be affected by the CCR regulations. The only CCR pile located onsite is the radial stacker for fly ash and scrubber sludge products, which is located within the limits of the permitted landfill. Since this area has groundwater monitoring (as part of the landfill network) and both run-on and runoff controls, it should continue to be monitored with the existing landfill and should not require any additional modifications at this time. The following sections address the requirements and expected impacts for both the landfill and the scrubber ponds.

SMEPA should consider implementing a holistic program to evaluate compliance with each of the listed CCR demonstration efforts and studies outlined in these sections. Without knowing the results of these future studies, the only capital cost that can be quantified at this time is the implementation of a groundwater monitoring network around the scrubber ponds. This modification is further described in Section 5.0.

4.2.1 Existing CCR Landfill

Burns & McDonnell understands that the existing landfill operations, including groundwater monitoring and run-on/runoff controls, have been reviewed by Environmental Management Services (SMEPA's landfill consultant). For the purposes of this study, Burns & McDonnell has not further evaluated any of the existing information. Based on our review of the rule, SMEPA will be required to provide the following documents (published in the operating record and on the website) in order to demonstrate compliance with the CCR rule at the existing landfill:

- Prior to October 19, 2015
  - Develop a website to publish documents showing compliance with the CCR rule
  - Include a description of facility operations in the site dust control plan
  - Initiate the weekly inspection program, including training required for qualified persons
  - Burns & McDonnell understands that the existing landfill is equipped with a groundwater monitoring network that satisfies the state of Mississippi's requirements for landfills. This network has not been reviewed with respect to the CCR rule requirements as part of this study; however, SMEPA should consider evaluating the existing groundwater monitoring system and beginning to take samples within the remainder of 2015 to support quarterly sampling of Appendix III and Appendix IV constituents identified in the CCR rule.
- Prior to January 19, 2016
  - Initiate the annual inspection program, with inspections performed by a qualified professional engineer
- Prior to October 17, 2016
  - Publish a closure plan and post-closure plan for the facility, regardless of whether the closure start date has been defined at this time. Burns & McDonnell understands that SMEPA already has plans developed to meet the Mississippi landfill requirements; however, those plans have not been reviewed as part of this study.
  - Prepare the run-on and runoff control plan, documenting how the control systems have been designed and constructed to prevent flow onto the active portion of the unit and capture and control the runoff from a 25-year, 24-hour design storm.
- Prior to October 17, 2017
  - Install a groundwater monitoring well network that is compliant with the CCR rule and take eight samples from each well for both the Appendix III and Appendix IV constituents. The sampling frequency is not defined but many clients are planning on quarterly samples.
- Prior to January 31, 2018

  - Complete the statistical analysis on all groundwater samples and publish the first annual report documenting all groundwater monitoring results.
- Prior to October 17, 2018
  - Demonstrate that the unstable areas location restriction has been satisfied at the site

The new CCR rule will require closure of the landfill in any of the following scenarios:

- If the landfill fails to meet the unstable areas location restriction
- After the landfill receives the known final receipt of waste
- After the known final volume of CCR material is removed from the facility for beneficial use
- After the facility is idle for two years (no receipt of CCR material or removal for beneficial use, with a few exceptions listed in the rule)

If closure is required for any of these reasons, SMEPA will have six months to complete closure activities, with the possibility of two one-year extensions if the need for the extension can be justified to the public. The landfill will likely be closed by capping the material in place with the specified cover (see Section 2.7.1). Post-closure care will also be required, including groundwater monitoring for a minimum of 30 years.

Any lateral expansion of the facility will need to be designed to meet all location restrictions, liner requirements, leachate collection requirements, groundwater monitoring, and other technical requirements of the CCR rule. Additionally, if the state regulator considers the landfill leachate from a lateral expansion to be a new source, the ELG rules would require treatment of the new leachate stream to meet limits for arsenic and mercury prior to commingling with other flows or discharging. This leachate flow could potentially be used as makeup to the scrubber system; however, the details of this would need to be determined during the permitting process for the landfill expansion.

SMEPA should note that for the purposes of this analysis, Burns & McDonnell has assumed that the current beneficial uses of fly ash and bottom ash will be allowed to continue under future regulations (primarily encapsulated uses based on BMcD's understanding). Using the scrubber byproducts for agricultural soil amending may require additional study and documentation to prove that this material is not harming the environment; however, Burns & McDonnell is not currently aware of the full extent of any evaluation that has already been performed by SMEPA and the state of Mississippi. If the beneficial use of the Morrow CCRs is curtailed or eliminated, then the disposal rates could increase significantly. This would result in a higher annual cost for CCR disposal and a shorter service life for the existing landfill.

4.2.2 Existing CCR Impoundments

The Emergency Scrubber Pond is approximately 0.5 acres in size. Consequently, SMEPA would not be required to develop a history of construction or perform the periodic stability and safety factor assessments for this impoundment. The permeability of the clay liner is unknown, and SMEPA should locate any specifications or soil testing records from the original installation in order to determine whether this impoundment would be considered lined per the CCR rule. This impoundment was not previously reviewed by EPA during the assessment effort following the TVA incident, and consequently a hazard potential classification has not been made for this impoundment.

The Scrubber Supply Pond is approximately 1.5 acres in size. No drawings were provided showing this pond was modified in 2011. The original Burns & McDonnell drawings (attached in Appendix B) show a top of berm elevation at 266 and a bottom of pond elevation at 254. Consequently, SMEPA would not be required to develop a history of construction or perform the periodic stability and safety factor assessments for this impoundment. Based on the original pond design drawings, the Scrubber Supply Pond has a liner system consisting of 3" of gravel underlain by 30" of compacted "impermeable cohesive material" (see the typical dike section on Drawing Y-67 in Appendix B). The permeability of this clay liner is unknown, and SMEPA should locate any specifications or soil testing records from the plant construction records in order to determine whether this impoundment would be considered lined per the CCR rule. This impoundment was not previously reviewed by EPA during the assessment effort following the TVA incident, and consequently a hazard potential classification has not been made for this impoundment.

Based on Burns & McDonnell's review of the rule, SMEPA will be required to provide the following initial documents (published in the operating record and on the website) in order to demonstrate compliance with the CCR rule for the existing Emergency Scrubber Pond and the Scrubber Supply Pond:

- Prior to October 19, 2015
  - Develop a website to publish documents showing compliance with the CCR rule
  - Include a description of facility operations in the site dust control plan
  - Initiate the weekly inspection program, including training required for qualified persons
  - Begin maintaining a 6" maximum height on all vegetation on the impoundment berms to facilitate inspections
- Prior to December 17, 2015

  - Install a permanent marker showing the facility ID number, name of the unit, and owner information
- Prior to January 19, 2016
  - Initiate the annual inspection program, with inspections performed by a qualified professional engineer
- Prior to October 17, 2016
  - Publish the details of the impoundment liner
  - Complete the hazard potential classification assessment
  - Publish a closure plan and post-closure plan for the facility, regardless of whether the closure start date has been defined at this time (consider including schedule for overall project scope required prior to impoundment closure as part of this plan)
  - Complete the hydrologic and hydraulic capacity assessment, showing that the impoundment is sized to handle flows from the specified design storm events
- Prior to October 17, 2017
  - Install a groundwater monitoring well network that is compliant with the CCR rule and take eight samples from each well for both the Appendix III and Appendix IV constituents. The sampling frequency is not defined but many clients are planning on quarterly samples.
- Prior to January 31, 2018
  - Complete the statistical analysis on all groundwater samples and publish the first annual report documenting all groundwater monitoring results.
- Prior to October 17, 2018
  - Demonstrate that the location restriction criteria have been satisfied at the site (for aquifer separation, seismic impact zones, fault areas, wetlands, and unstable areas.

The new CCR rule would require closure of the existing scrubber ponds under any of the following scenarios:

- If the impoundment is found to be unlined and contaminating groundwater
- If the impoundment fails to meet any of the five location restrictions
- After the impoundment receives the known final receipt of waste, either CCR or non-CCR stream
- After the known final volume of CCR material is removed from the facility for beneficial use
- After the facility is idle for two years (no receipt of CCR material or removal for beneficial use, with a few exceptions listed in the rule)

If groundwater or location restrictions trigger closure SMEPA would be required to cease placing CCR material in the impoundments within six months and begin the closure or retrofit process. SMEPA may be able to continue operating after this 6 month period if they can demonstrate that no alternative disposal capacity exists and that they are making progress toward implementing alternative disposal measures.

For the Morrow site, this could include a spare thickener and new CCR impoundment, or potentially a scrubber supply tank. Following implementation of this system, SMEPA would either completely remove the CCR material and any liner or contaminated soil from the impoundment and dispose of it (clean closure) or dewater the existing impoundment and cap the CCR material in place with the specified cover (see Section 2.7.1). Based on the size of the scrubber ponds, SMEPA would have five years to complete closure activities, with the possibility of one two-year extension if the need for the extension can be justified to the public. Groundwater monitoring is required under all scenarios for active impoundments. Under clean closure at least one year of assessment monitoring showing no contamination is required. Capping and closing the CCR material in place will require monitoring for a minimum of 30 years, along with other post-closure care requirements.

4.3 ELG Impacts

The following sections of this report address the ELG compliance impacts for the Morrow Station with respect to each regulated waste stream. The details for any expected plant modifications are outlined in Section 6.0.

4.3.1 FGD Wastewater

Based on discussions with the plant operations staff, the current FGD systems for Morrow Station Units 1 & 2 discharge to the Emergency Scrubber Pond where solids settle out. The Emergency Scrubber Pond overflows to the Scrubber Supply Pond, where water is currently comingled with the Plant Drains Stream. After additional settling in the Scrubber Supply Pond, the water overflows to Pond 4A and subsequently overflows to the Cooling Tower Blowdown pond prior to being discharged to Black Creek. The final ELG rule requires all FGD blowdown to be treated with BAT prior to discharge. The existing water balance for Morrow shows an average of 128 gallons per minute (GPM) of combined FGD blowdown and plant drains flow going to Pond 4A.

BAT and existing source discharge limits for FGD blowdown are outlined in Section **Error! Reference source not found.**

The BAT basis for the effluent limitations and standards for discharges of FGD wastewater is chemical precipitation/co-precipitation used in combination with anoxic/anaerobic biological treatment designed to optimize reduction of selenium. BMcD has also considered bypass evaporator technology as a potential alternate technology for compliance at Morrow.

4.3.2 Fly Ash Transport Water

Fly ash and economizer ash are transported in a dry condition at Morrow. Consequently, the site does not have a discharge associated with fly ash transport water, and consequently there should be no impact from the upcoming ELG regulation.

4.3.3 Bottom Ash Transport Water

The final ELGs require zero discharge of bottom ash transport waters. Recommended modifications to the bottom ash system are discussed further with the site wide compliance options in 6.1 and 0.

4.3.4 Combustion Residuals Leachate

SMEPA collects leachate at the landfill, comingles the leachate with landfill non-contact stormwater runoff in the stormwater collection and filtration area, and then discharges the wastewater via Outfall 007. The discharge limits for existing leachate collection systems are equal to the current BPT effluent limitations (for TSS and oil and grease) based on the technology of gravity settling in surface impoundments to remove suspended solids, and consequently there should be no impact from the upcoming ELG regulation.

EPA has placed numeric discharge limits for arsenic and mercury on new sources of leachate. If new landfills are constructed in the future, or potentially if lateral expansions of the existing landfills are constructed, then those facilities may be required to meet the new source performance standards, including the arsenic and mercury limits; however, conceptual design of future treatment systems should be included in the scope of those projects and has not been included as part of this study.

4.3.5 Gasification Wastewater

SMEPA does not currently generate or discharge gasification wastewater and no impacts are expected from this portion of the final regulation.

4.3.6 FGMC Wastewater

SMEPA does not currently generate or discharge mercury control wastewater and no impacts are expected from this portion of the final regulation. Any future modifications would be subject to the regulations in place at the time of construction.

4.3.7 Nonchemical Metal Cleaning Wastes

The final ELG rule did not impose new limits on nonchemical metal cleaning wastes, however it did reserve its ability to establish these limits as part of future regulations. These modifications should be evaluated further once a final rule is promulgated for nonchemical metal cleaning wastes and the requirements for this waste stream are more clearly defined.

5.0 CCR COMPLIANCE - MONITORING WELL INSTALLATION

For compliance with the CCR rule, SMEPA will need to prepare the documents outlined in Section 4.2 for the Morrow site. The primary capital cost that will be required, without knowing the results of the future CCR demonstration studies, will be the implementation of a groundwater monitoring network around the scrubber ponds. These modifications are described below.

5.1 Groundwater Monitoring

A component of the final CCR rule requires the owner or operator of a CCR unit to install a system of groundwater monitoring wells at all new and existing CCR units and establish a groundwater monitoring program consisting of detection monitoring and assessment monitoring. Once a groundwater monitoring system and groundwater monitoring program have been established for a CCR unit, the owner or operator must conduct groundwater sampling in order to detect the presence of hazardous constituents (e.g., metals) and other inorganic indicator parameters (e.g., boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids) released from these CCR units. In the event that the monitoring well systems detect statistically significant increases in constituents of concern above groundwater protection standards, the owner or operator must begin the corrective action process outlined in the CCR Rule to determine the extent of the contamination and to clean up the contamination caused by the CCR unit. Corrective action may continue throughout the active life and post-closure care period of the CCR unit. If the CCR unit causing the contamination is an unlined surface impoundment, it must begin the closure process or must cease CCR placement until the unit can be retrofit with a compliant liner system.

This section serves as the basis for a budgetary cost estimate for the design, installation, and completion of groundwater monitoring networks around existing CCR impoundments at the Morrow Station. Some site-specific project details will require further definition to incorporate site impoundments into the existing groundwater monitoring program. This section will be further developed after review and characterization of available site-specific hydrogeologic data. The contents within this section are for budgetary cost estimation purposes only and are not intended for implementation.

The work items necessary for installing a groundwater monitoring system are as follows:

- Perform Review of Existing Data and Conceptual Site Hydrogeologic Characterization
- Prepare and Submit Groundwater Monitoring Well Installation Work Plan (WP)
- Prepare Site-Specific Health and Safety Plan (HASP)
- Perform Groundwater Monitoring Well Installation Field Activities

- Prepare and Submit Groundwater Monitoring Well Installation Report

5.1.1 Schedule and Costs

The total anticipated schedule is approximately 15 weeks, based on the breakdown of tasks listed in Table 5-1, below.

Table 5-1: Estimated Schedule

Estimated Schedule		
1.0	**Conceptual Site Hydrogeologic/Data Review**	**1-2 weeks**
2.0	**Prepare Work Plan and Health and Safety Plan**	**5 weeks**
2.1	Work Plan and Health and Safety Plan	3 weeks
2.2	Client Review	1 week
2.3	Address Client Comments and Submit Final	1 week
3.0	**Groundwater Monitoring Well Installation Activities**	**3-4 weeks**
3.1	Utility Locate	3 days
3.2	Well Drilling, Installation, Completion, Development	8-11 days
3.3	Well Slug Tests	3 days
3.4	Well Surveying	2 days
4.0	**Groundwater Monitoring Well Installation Report**	**4 weeks**
4.1	Prepare Report	2 weeks
4.2	Client Review	1 week
4.3	Address Client Comments and Submit Final	1 week

An itemized cost estimate is provided in Table 5-2. The estimated capital costs for installing six (6) groundwater monitoring wells was prepared assuming well depths of 50 feet below grade and installed using mud/wash rotary drilling techniques. This assumes one network for both impoundments, making it a multiunit network. Given the close proximity of the ponds, this would be the most efficient use of the space available and would be the more cost effective path forward in monitoring. While the rule requires a minimum of one upgradient and three downgradient wells, we have assumed installation of six wells to account for the potential cost of two additional wells. In general Burns & McDonnell would recommend more than one upgradient well to accurately characterize background quality; therefore, we've currently assumed a total of six monitoring wells in the comprehensive network for both impoundments.

Table 5-2: Groundwater Monitoring Well Installation Costs

Groundwater Monitoring Well Installation (assumes 6 wells)	Qty	Unit	Unit Price	Price
General				
Driller Mobilization	1	LS	$7,000	$7,000
Driller Per Diem (2-man crew)	8	DAYS	$200	$1,600
Subtotal				**$8,600**
Well Installation				
Drilling - Mud/Wash Rotary (w/ discrete sampling)	300	LF	$60	$18,000
2" Sch. 40 PVC Well Construction/Installation	300	LF	$20	$6,000
2" Well Completion - Standard (stick-up)	6	EA	$550	$3,300
Protective Bollards - Min. 3 Posts	6	EA	$150	$900
Decontamination (2-man crew)	12	HRS	$150	$1,800
Well Development (2-man crew)	24	HRS	$150	$3,600
Well Registration	6	EA	$50	$300
Subtotal				**$33,900**
Geologist				
Oversight and Borehole Logging	1	LS	$13,500	$13,500
Truck Rental	8	DAYS	$70	$600
Field Equipment/Supplies	1	LS	$1,200	$1,200
Aquifer Slug Testing	6	EA	$500	$3,000
Subtotal				**$18,300**
Surveyor				
Up to approximately 10 survey points	1	LS	$1,500	$1,500
Subtotal				**$1,500**
Total Construction and QA/QC (Only)				**$62,300**
Contingency (30%)				**$18,700**
Project Management (10%)				**$6,300**
Total Cost				**$87,300**
Total Cost (per well)				**$14,550**

The assumptions made to develop these costs are as follows:

- Following review of available hydrogeologic data from the Morrow Station site and existing monitoring network at the landfill, additional well installations may be required at the landfill to appropriately characterize and monitor site-specific groundwater conditions. Costs for any additional wells at the landfill have not been included at this time.
- The costs are based on estimated unit rates and assumed scope of work (e.g. number of wells needed, pre- and post-document preparation).
- Mud/wash rotary drilling techniques will be used for well installations.
- Groundwater in the overburden is representative of the uppermost continuous aquifer and shall yield sufficient quantities for total analyses to meet the CCR requirements. In the event that the

upper most groundwater is within rock, drilling method will likely require some rock coring, the cost of which is not included in this estimate.

- All monitoring well borings will be logged in the field by a geologist.
- Groundwater and soil sampling/analysis are not included in this estimate.
- Newly installed monitoring wells will be constructed of 2-inch (inside diameter), Schedule 40 polyvinyl chloride (PVC), flush-threaded riser pipe and 10 feet of 0.010-inch, machine slotted screen. If aquifer formation is composed of very fine particle size (e.g. clay, silt, fine sand) the well screen may need to be designed to allow for low turbidity groundwater samples.
- Costs are not included for groundwater monitoring/sampling and statistical analysis, preparing groundwater monitoring programs or sampling and analysis plans, groundwater monitoring reports, Corrective Action Study, and Corrective Action Plan.
- Costs are not included for dedicated groundwater sampling equipment (e.g., bladder pumps).
- Newly installed monitoring wells will require quarterly groundwater sampling to establish a background data set in order to perform statistical analysis of evaluating groundwater quality, and the existing monitoring network at the landfill will require that background sampling be completed for all constituents in the CCR rule that are not in SMEPA's current sampling plan. The cost of quarterly background sampling/analysis and any future sampling/analysis has not been included in this estimate.
- If newly installed monitoring wells detect exceedances of groundwater protection standards, the owner/operator will need to perform corrective action activities, the cost of which has not been included in this estimate.
- This estimate assumes six individual shallow wells installed at the CCR impoundments, and includes an estimated price breakout of cost per well. While the rule requires only one upgradient and three downgradient wells at each facility, more wells may be deemed necessary during detailed review to fully characterize the subsurface conditions.
- Estimated depths may be less, or greater, than the distance of the proposed monitoring well increases away from nearby surface waters and/or depths may change following detailed review of available hydrogeologic data for the plant.

Additional costs necessary in implementing field activities for the installation of groundwater monitoring wells include site-specific review of available hydrogeologic data and both pre- and post-well installation document preparation and submittal. Burns & McDonnell has prepared a proposal, separate from this report, for completion of this engineering work associated with well installation.