SULLIVAN, MOUNTJOY, STAINBACK & MILLER PSC
ATTORNEYS AT LAW

Ronald M. Sullivan
Jesse T. Mountjoy
Frank Stainback
James M. Miller
Michael A. Fiorella
R. Michael Sullivan
Bryan R. Reynolds*
Tyson A. Kamuf
Mark W. Starnes
C. Ellsworth Mountjoy
John S. Wathen

*Also Licensed in Indiana

August 7, 2014

RECEIVED
AUG 08 2014
PUBLIC SERVICE COMMISSION

Federal Express

Mr. Jeff Derouen
Executive Director
Public Service Commission
211 Sower Boulevard, P.O. Box 615
Frankfort, Kentucky 40602-0615

Re: *In the Matter of: The Application of Big Rivers Electric Corporation for a General Adjustment in Rates*, PSC Case No. 2013-00199

Dear Mr. Derouen:

Enclosed for filing are an original and ten (10) copies of (i) Big Rivers Electric Corporation's updated response to Item 15 of the requests for information from the January 2014 hearing in the above-referenced matter, and (ii) a petition for confidential treatment. I certify that on this date, a copy of this letter, a copy of the updated response, and a copy of the petition were served on each of the persons listed on the attached service list by first-class mail.

Sincerely,

TAK

Tyson Kamuf

TAK/lm
Enclosures

c. Billie Richert
DeAnna Speed
Service List

Telephone (270) 926-4000
Telecopier (270) 683-6694

100 St. Ann Building
PO Box 727
Owensboro, Kentucky
42302-0727

www.westkylaw.com

Service List
PSC Case No. 2013-00199

Jennifer B. Hans
Lawrence W. Cook
Assistant Attorneys General
1024 Capital Center Dr.
Suite 200
Frankfort, KY 40601

Mr. David Brevitz
3623 SW Woodvalley Terrace
Topeka, KS 66614

Mr. Bion C. Ostrander
1121 S.W. Chetopa Trail
Topeka, KS 66615

Mr. Larry Holloway
830 Romine Ridge
Osage City, KS 66523

Michael L. Kurtz, Esq.
Kurt J. Boehm, Esq.
Boehm, Kurtz & Lowry
36 E. Seventh St., Suite 1510
Cincinnati, Ohio 45202

Lane Kollen
J. Kennedy & Associates
570 Colonial Park Drive
Suite 305
Roswell, GA 30075

G. Kelly Nuckols
President and CEO
Jackson Purchase Energy Corporation
2900 Irvin Cobb Drive
P.O. Box 4030
Paducah, KY 42002-4030

Melissa D. Yates
Denton & Keuler, LLP
555 Jefferson Street
Suite 301
Paducah, KY 42001

Burns Mercer
Meade County RECC
1351 Hwy. 79
P.O. Box 489
Brandenburg, Kentucky 40108

Thomas C. Brite, Esq.
Brite & Hopkins, PLLC
83 Ballpark Road
Hardinsburg, KY 40143

Gregory Starheim
President & CEO
Kenergy Corp.
3111 Fairview Drive
P.O. Box 1389
Owensboro, KY 42302-1389

J. Christopher Hopgood, Esq.
318 Second Street
Henderson, Kentucky 42420

Joe Childers
Joe F. Childers & Associates
300 Lexington Building
201 West Short Street
Lexington, Kentucky 40507

Shannon Fisk
Senior Attorney
Earthjustice
1617 John F. Kennedy Blvd., Suite 1675
Philadelphia, PA 19103

Thomas Cmar
Earthjustice
5042 N. Leavitt Street, Suite 1
Chicago, IL 60625

Kristin Henry
Senior Staff Attorney
Sierra Club
85 Second Street
San Francisco, CA 94105-3441

Laurie Williams
Associate Attorney
Sierra Club
50 F Street, NW, Eighth Floor
Washington, DC 20001

BIG RIVERS ELECTRIC CORPORATION

APPLICATION OF BIG RIVERS ELECTRIC CORPORATION FOR A GENERAL ADJUSTMENT IN RATES CASE NO. 2013-00199

VERIFICATION

I, Robert W. (Bob) Berry, verify, state, and affirm that I prepared or supervised the preparation of my responses to data requests filed with this Verification, and that those responses are true and accurate to the best of my knowledge, information, and belief formed after a reasonable inquiry.

Robert W. Berry

Robert W. (Bob) Berry

COMMONWEALTH OF KENTUCKY)
COUNTY OF HENDERSON)

SUBSCRIBED AND SWORN TO before me by Robert W. (Bob) Berry on this the 4th day of August, 2014.

Paula Mitchell

Notary Public, Ky. State at Large
My Commission Expires 1-12-17

ORIGINAL

Big Rivers
ELECTRIC CORPORATION

Your Touchstone Energy® Cooperative

RECEIVED
AUG 08 2014
PUBLIC SERVICE
COMMISSION

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION OF KENTUCKY

In the Matter of:

APPLICATION OF BIG RIVERS	)	
ELECTRIC CORPORATION FOR A	)	Case No. 2013-00199
GENERAL ADJUSTMENT IN RATES	)	

Updated **Response to Item 15 of the Requests for Information from the Hearing of January 6-9, 2014**

FILED: August 8, 2014

ORIGINAL

BIG RIVERS ELECTRIC CORPORATION

APPLICATION OF BIG RIVERS ELECTRIC CORPORATION
FOR A GENERAL ADJUSTMENT IN RATES
CASE NO. 2013-00199

***Updated* Response to Item 15 of the**
Requests for Information from the
Hearing of January 6-9, 2014

August 8, 2014

Item 15) *Provide the study of Environmental Effluent Guidelines when completed.*

Response) Big Rivers retained Burns & McDonnell Engineering to perform a National Effluent Limitations Guidelines and Standards ("ELG") master planning study to assist in assessing the current discharges and develop a preliminary plan for complying with the proposed Federal ELG rules. Big Rivers is providing that study with a Petition for Confidential Treatment. A REDACTED copy of that study is attached hereto.

Witness) Robert W. Berry

Burns & McDonnell
SINCE 1898

Report on the

ELG Master Planning Study

(Steam Effluent Guidelines)

Big Rivers
ELECTRIC CORPORATION
Your Touchstone Energy Cooperative

Big Rivers Electric Corporation

Project No. 74658

June 2014

ELG Master Planning Study

prepared for

Big Rivers Electric Corporation
Henderson, KY

June 2014

Project No. 74658

prepared by

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

INDEX AND CERTIFICATION

Big Rivers Electric Corporation
ELG Master Planning Study
Project No. 74658

Report Index

Certification

I hereby certify, as a Professional Engineer in the state of Kentucky, that 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 Big Rivers Electric Corporation or others without specific verification or adaptation by the Engineer.

Ed Tohill

Edward T. Tohill, P.E.
Kentucky License #23271

Date: 06/20/14

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LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
BAT	Best Available Technology Economically Achievable
BMcD	Burns & McDonnell
BMPs	Best Management Practices
BOP	Balance of Plant
BPJ	Best Professional Judgment
BPT	Best Practicable Control Technology Currently Available
CCR(s)	Coal Combustion Residuals
CWA	Clean Water Act
DCS	Distributed Control System
DFC	Dry Flight Conveyor
ELG(s)	National Effluent Limitations Guidelines and Standards
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
FGD	Flue Gas Desulfurization
FGMC	Flue Gas Mercury Control
gpm	Gallons per Minute
KPDES	Kentucky Pollutant Discharge Elimination System
MATS	Mercury Air Toxics Standard
MGD	Million Gallons per Day
MW	Megawatts
NSPS	New Source Performance Standards

Abbreviation	Term/Phrase/Name
POTWs	Publicly Owned Treatment Works
ppm	Parts per million
PSES	Pretreatment Standards for Existing Sources
PSNS	Pretreatment Standards for New Sources
TDS	Total Dissolved Solids
TPY	Tons per year
TSS	Total Suspended Solids
ZLD	Zero Liquid Discharge

1.0 EXECUTIVE SUMMARY

Burns & McDonnell was selected by Big Rivers Electric Corporation (Big Rivers) to perform a National Effluent Limitations Guidelines and Standards (ELG) Master Planning Study for Big Rivers' coal fleet. The purpose of the ELG Master Planning Study is to assist Big Rivers in assessing their current discharges and developing a preliminary plan for complying with the proposed federal ELG rules.

Big Rivers' coal fleet includes units at Kenneth C. Coleman, D.B. Wilson, and Sebree Stations that are evaluated in this study. The scope of this study includes the development of conceptual compliance alternatives for each facility along with planning level capital cost estimates for each alternative to assist Big Rivers in understanding the range of investment involved in compliance with the proposed regulations. These options are summarized in Table 1-1, and each of these alternatives include [redacted] contingency which is considered appropriate based on the level of this study. Big Rivers should use the information presented in this study to evaluate implications of the proposed regulations on future plant operation. Once a regulation is promulgated, Big Rivers should implement a project definition study to further define the preferred option including development of budget level costs and implementation schedules.

Table 1-1: Summary of Planning Level Capital Cost Estimates for ELG Compliance Options

Facility	Coleman		Wilson	Sebree	
Waste Stream	**FGD Wastewater**	**Fly Ash Transport Water**	**FGD Wastewater**	**FGD Wastewater**	**Fly Ash Transport Water**
Anticipated Modifications	Physical/Chemical and Biological Treatment System	Dry Fly Ash Handling	Flow Minimization/ Segregation	Physical/Chemical and Biological Treatment System	Dry Economizer Ash Handling
Direct Cost	[redacted]				
Indirect Cost					
Owner Cost	Not included	Not included	Not included	Not included	Not included
Total Planning Level Capital Cost (2013 $)	[redacted]				
Total Projected ELG Compliance					

Note that Table 1-1 includes the cost for a two-stage physical/chemical and biological treatment system for the treatment of FGD wastewater at Coleman and Sebree. For the purposes of this study, Burns & McDonnell has identified this as the most likely compliance alternative based on the proposed ELG rules as of June 2014. There have been several comments returned to the EPA regarding the feasibility of using this technology to meet the proposed arsenic, mercury, selenium, and nitrate-nitrite discharge limits. The EPA has indicated within the proposed rules that this treatment technology should be considered as the best technology available to meet the proposed discharge limits; however, it has not yet been proven that this technology will consistently meet the specified limits at full-scale operation. The final ELG rules may be modified in response to these comments and any changes to the proposed rules could impact the selection of a preferred compliance alternative.

The proposed compliance options in Table 1-1 assume that Big Rivers will pursue low cost alternatives and each of these options can meet the currently anticipated compliance schedule. The proposed rule anticipates compliance with the ELG rule would be required between 2018 and 2023, depending on the Kentucky Pollutant Discharge Elimination System (KPDES) permit renewal cycle. Big Rivers should note that EPA is proposing two alternative schedules for compliance within the proposed ELG regulations. These alternatives, or tiers, ask utilities to go above and beyond what is required by the proposed regulations and Burns & McDonnell has assumed that these opportunities would not be pursued by Big Rivers at this time. The first tier would necessitate closure of the ash ponds at Coleman and Sebree and removing the ash ponds from service. This would provide an additional two years for compliance with the ELG rules; however, each of these ponds receives large amounts of other flows including coal pile runoff, plant drains, and stormwater runoff. There is not a simple way to close and cap these ponds, nor is there existing real estate available to allow construction of a new pond that could capture diverted stormwater flows. The second alternative would require that Big Rivers establish a zero liquid discharge (except for cooling water flows) and would provide an additional five years for compliance with the ELG rules. This would likely be the highest cost alternative for any of the Big Rivers plants and has not been considered further.

2.0 PROPOSED ELG REGULATIONS

The Clean Water Act (CWA) was enacted in 1948 (with several revisions thereafter) and establishes procedures and requirements for discharges of pollutants into the waters of the United States and regulates water quality standards for surface water discharges. The Clear Water Act is applicable to all wastewater discharges regardless of industry sector. The most recent revision to the Clean Water Act affecting the electric utility industry occurred in 1982.

2.1 Background

EPA is required by the CWA to establish national technology-based effluent limitations guidelines and standards (ELGs) and to periodically review all ELGs to determine whether revisions are warranted. In 2005, the EPA's annual ELG review identified the Steam Electric Power Generating industry for study due to pollutant discharges from power plants utilizing fossil-type fuels and the expectation that these discharges will increase significantly in the next few years as new air pollution controls are installed. A detailed study was conducted and the results were compiled into a report titled "Steam Electric Power Generating Point Source Category: Final Detailed Study" (October 2009). A summary of the findings of the report is as follows.

- The current regulations do not adequately address the pollutants being discharged and have not kept pace with changes that have occurred in the electric power industry over the last three decades.
- Steam electric power plants are responsible for a significant amount of the toxic pollutant loadings discharged to surface waters by point sources.
- Coal ash ponds and flue gas desulfurization (FGD) systems are the source of many of these pollutants.

Upon completion of the study in the fall of 2009, the EPA announced its intent to update the effluent guidelines for the Steam Electric Power Generating Point Source Category. The proposed guidelines were published in the Federal Register on June 7, 2013, with the final regulations expected in September 2015. Therefore, the 2015 – 2020 permit renewal cycle will likely be the first to contain provisions from the new rulemaking. Compliance will typically be required within 3 years from the date of permit issuance; the only exception being specific permit extensions offered within the proposed rule that are coupled with strict water management and impoundment changes to operations. In general, all facilities are expected to be in compliance between 2018 and 2023.

2.2 Scope/Applicability of the Proposed Rule

The proposed ELGs would establish new or additional effluent limitations for certain plants within the steam electric industry. The requirements would apply to discharges of wastewater associated with the following processes and byproducts:

- FGD Wastewater
- Fly Ash Transport Water
- Bottom Ash Transport Water
- Combustion Residuals Leachate from Landfills and Surface Impoundments
- Gasification of Fuels such as Coal and Petroleum Coke
- Flue Gas Mercury Control (FGMC) Wastewater
- Nonchemical Metal Cleaning Wastes

Depending on the regulatory option, EPA is proposing to revise or establish Best Available Technology Economically Achievable (BAT) for existing sources, New Source Performance Standards (NSPS), Pretreatment Standards for Existing Sources (PSES), and Pretreatment Standards for New Sources (PSNS) that apply to discharges of pollutants for the waste streams listed above. These limits will apply to the following facility types:

- BAT limits will be established for discharges directly to surface water from existing facilities (except oil-fired and <50 MW)
- NSPS limits will be established for discharges directly to surface water from new sources
- PSES limits will be established for discharges to publicly owned treatment works (POTWs) from existing facilities (except oil-fired and <50 MW)
- PSNS limits will be established for discharges to POTWs from new sources

The proposed discharge requirements would apply to all plants that are primarily engaged in the generation of electricity for distribution and sale, including plants fired by fossil-type fuel (coal, oil, or gas), fuel derived from fossil fuel (petroleum coke, synthetic gas), or nuclear fuel. As stated above, the proposed rules would not apply to existing small generating units (defined as 50 MW or less) or existing oil-fired units (units that are fired solely on oil and that do not burn coal or petroleum coke). BAT effluent limits will not be added as part of the proposed rule for these units, and the existing discharge limits based on the best practicable control technology currently available (BPT) will remain in place.

For the purposes of this study, Burns & McDonnell will focus only on the impacts resulting from the BAT limits that are being established for existing facilities. Big Rivers does not currently discharge pollutants to POTWs (other than sanitary wastewater, which is not covered under the ELGs), and the development of any new plants or new sources is beyond the scope of the current master planning study.

2.3 ELG Regulatory Options

In the currently proposed ELGs, the EPA has developed eight regulatory options that establish BAT that may apply to discharges of seven waste streams from existing facilities. Of these eight options, four preferred options have been identified by the EPA as economically achievable; however, the final regulation could be comprised of one of these options or a combination of any of them. See Table 2-1 for a list of the critical waste streams, the pollutants of concern, and the BAT proposed for each waste stream under the eight various scenarios. The four preferred options identified by EPA are shown in the white columns in Table 2-1 and the other four options considered are shown in the gray columns.

Table 2-1: Main Regulatory Options

Waste Stream	Pollutants for Regulation	BAT for the main regulatory options (white options are identified as preferred)							
		1	3a	2	3b	3	4a	4	5
FGD Wastewater	Oil and Grease TSS Arsenic Mercury Nitrate/nitrite Selenium	Chemical Precipi- tation	BPJ Deter- mination	Chemical Precipi- tation + Biological Treatment	[1]Chemical Precipi- tation + Biological Treatment	Chemical Precipi- tation + Biological Treatment	Chemical Precipi- tation + Biological Treatment	Chemical Precipi- tation + Biological Treatment	Chemical Precipi- tation + Evapo- ration
Fly Ash Transport Water	Oil and Grease TSS *Zero Discharge	Impound- ment (equal to BPT)	*Dry Handling	Impound- ment (equal to BPT)	*Dry Handling	*Dry Handling	*Dry Handling	*Dry Handling	*Dry Handling
Bottom Ash Transport Water	Oil and Grease TSS *Zero Discharge	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	[2]*Dry Handling/ Closed Loop	*Dry Handling/ Closed Loop	*Dry Handling/ Closed Loop
Combustion Residual Leachate	Oil and Grease TSS Arsenic Mercury	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Impound- ment (equal to BPT)	Chemical Precipi- tation	Chemical Precipi- tation
Gasification Wastewater	TDS Arsenic Mercury Selenium	Evapo- ration	Evapo- ration	Evapo- ration	Evapo- ration	Evapo- ration	Evapo- ration	Evapo- ration	Evapo- ration
Flue Gas Mercury Control Wastewater	Oil and Grease TSS *Zero Discharge	Impound- ment (equal to BPT)	*Dry Handling	Impound- ment (equal to BPT)	*Dry Handling	*Dry Handling	*Dry Handling	*Dry Handling	*Dry Handling
Nonchemical Metal Cleaning Wastes	Oil and Grease TSS Copper Iron	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation	Chemical Precipi- tation

* For some options, EPA is proposing to establish zero discharge limitations rather than establish numerical discharge limits on pollutants of concern

[1]For Units at a facility with a total wet-scrubbed capacity of > 2,000 MW. Best Professional Judgment (BPJ) for < 2,000 MW.

[2]For Units > 400 MW. Impoundment (equal to BPT) for units < 400 MW.

For the purposes of this master planning study, Burns & McDonnell will review each of the Big Rivers plants and determine the potential compliance options with each of the four preferred options shown in Table 2-1. Note that these options become progressively more restricting. Under the first preferred regulatory option (Option 3a) for existing sources that discharge directly to surface water, the proposed rule would establish BAT for waste streams that include:

- "Zero Discharge" effluent limits for all pollutants in fly ash transport water and wastewater from flue gas mercury control systems;

- Numeric effluent limits for mercury, arsenic, selenium, and total dissolved solids (TDS) in discharges of wastewater from gasification processes (not applicable to Big Rivers);
- Numeric effluent limits for copper and iron in discharges of nonchemical metal cleaning wastes[1]; and
- Effluent limits for bottom ash transport water and combustion residual leachate from landfills and surface impoundments that are equal to the current BPT effluent limits for these discharges (i.e., numeric effluent limits for total suspended solids (TSS) and oil and grease).

Under the second preferred alternative for BAT (Option 3b in Table 2-1), the proposed rule would establish numeric effluent limits for mercury, arsenic, selenium, and nitrate-nitrite in discharges of FGD wastewater from all sites with a total wet scrubbed capacity of 2,000 MW or greater. All other proposed Option 3b requirements are the same as those listed for Option 3a above. The third preferred alternative (Option 3 in Table 2-1) would remove the 2,000 MW threshold and establish these limits for all plants with FGD systems. All other proposed Option 3 requirements would be the same as those listed for Option 3a above.

The fourth preferred alternative for BAT (Option 4a in Table 2-1) would establish "zero discharge" effluent limits for all pollutants in bottom ash transport water, with the exception of all generating units with a nameplate capacity of 400 MW or less. For those generating units that are less than or equal to 400 MW, the proposed rule would set BAT equal to BPT for discharges of pollutants found in the bottom ash transport water. All other proposed Option 4a requirements are identical to the proposed Option 3 requirements listed above.

For each of the BAT options presented in Table 2-1, EPA estimates that a system designed to represent the BAT level of control will be able to meet specific numerical limits for pollutants in the discharge of the critical wastewater streams. These limits are summarized in Table 2-2. Note that only the limits associated with chemical precipitation and biological treatment of FGD wastewater (the white rows in Table 2-2) will be applicable to the Big Rivers plants under the four preferred options identified by EPA. There will likely be numeric discharge limits established for nonchemical metal cleaning wastes; however, EPA is awaiting comments and will establish these requirements in the final rules. EPA has

[1] EPA will potentially exempt from new copper and iron BAT limitations any existing discharges of nonchemical metal cleaning wastes that are currently authorized without iron and copper limits. For these discharges, BAT limits would be set equal to BPT limits applicable to low volume wastes. This exemption may apply to wastewater resulting from air preheater wash activities at each of the Big Rivers plants, of which the current discharges are already treated as low volume wastes. Per the existing permits, all other Big Rivers metal cleaning wastewaters (chemical or nonchemical) are currently treated to meet permit limits for iron, copper, TSS, oil and grease, and pH.

indicated that they may establish limits equal to the existing BPT limits for all metal cleaning wastes. For the purposes of this study, Burns & McDonnell assumed that the numeric discharge limits for nonchemical metal cleaning wastes will match the existing discharge limits for metal cleaning wastes included in the KPDES permits for each of the Big Rivers plants.

Table 2-2: Numeric Discharge Limits for EPA specified BAT options

Treatment Technology	Pollutant of Concern	Long Term Average	Daily Limitation	Monthly Limitation	Applicable to Big Rivers per Preferred Option			
					3a	3b	3	4a
Chemical Precipitation for FGD	Arsenic (µg/L)	4.483	8	6				
	Mercury (ng/L)	75.404	242	119				
Chemical Precipitation and Biological Treatment for FGD	Arsenic (µg/L)	4.483	8	6			X	X
	Mercury (ng/L)	75.404	242	119				
	Nitrate-Nitrite (mg/L)	0.110	0.17	0.13				
	Selenium (µg/L)	7.455	16	10				
Chemical Precipitation and Evaporation for FGD	Arsenic (µg/L)	4.0	4	-				
	Mercury (ng/L)	17.788	39	24				
	Selenium (µg/L)	5.0	5	-				
	TDS (mg/L)	14.884	50	24				
Vapor-Compression Evaporation for Gasification	Arsenic (µg/L)	4.0	4	-				
	Mercury (ng/L)	1.075	1.76	1.29				
	Selenium (µg/L)	146.780	453	227				
	TDS (mg/L)	15.209	38	22				
Chemical Precipitation for Leachate	Arsenic (µg/L)	4.483	8	6				
	Mercury (ng/L)	75.404	242	119				

2.4 Prohibition of Comingling (Anti-Circumvention Provisions)

EPA is proposing to add provisions to the regulations that will prevent utilities from combining waste streams to circumvent applicable ELGs. The proposed provisions would clarify the acceptable conditions for discharge of reused process wastewater and establish effluent monitoring requirements in three ways:

1. Require that compliance with the new effluent limits applicable to a particular waste stream be demonstrated prior to use of the wastewater in another plant process resulting in surface water discharge or mixing the treated waste stream with other waste streams. The addition of internal compliance monitoring points will effectively eliminate the dilution of wastewater prior to discharge. These internal monitoring points would be required for the critical waste streams that are discharged and that have proposed BAT limits in excess of the existing BPT limits (e.g. FGD wastewater, gasification wastewater, and CCR leachate).

2. Establish requirements intended to prevent steam electric power plants from circumventing the effluent limits and standards by moving effluent produced by a process operation for which there is a zero discharge effluent limit/standard to another process operation for discharge under less stringent requirements than intended by the steam electric ELGs. For example, several options establish zero discharge requirements for fly ash transport water and if one of these options were selected for the final regulation, the anti-circumvention provisions would not allow power plants to reuse this water in another process that allows a discharge to surface waters (i.e., ash transport water could not be used as makeup to an FGD system since the FGD blowdown stream would eventually be discharged).
3. Require permittees to use analytical EPA-approved methods that are sufficiently sensitive to provide reliable quantified results at levels necessary to demonstrate compliance with the effluent limits in the proposed rules. When an EPA-approved method is available that can quantify the pollutant concentration at the lower levels needed for demonstrating compliance, facilities should not use less sensitive or less appropriate methods, thus potentially masking the presence of a pollutant in the discharge.

These provisions would not apply to wastewater generated before the compliance date (legacy wastewater). If a new treatment system is added for a particular waste stream to comply with the proposed rules, such as a tank-based system for FGD wastewater, the effluent from the tank-based treatment system (in compliance with numeric limits outlined in the proposed rules) could be combined with legacy FGD wastewater and then discharged to surface waters under the current BPT limits that apply to FGD wastewater. If a utility chooses to combine new FGD wastewater (generated after the compliance date required by the final rule) with legacy wastewater prior to treatment in a tank-based system, then the legacy wastewater would have to meet the new discharge limits as well. This same example would apply to ash transport water, leachate, and nonchemical metal cleaning wastes.

There is one specific case outlined in the proposed rules where commingling of waste streams, other than new and legacy wastewaters, is allowed. FGD wastewater and leachate can be combined prior to treatment and then discharged as long as it meets the effluent limitations and standards established for FGD wastewater. This exception would also allow utilities to use coal combustion residual leachate water as makeup to the FGD system.

2.5 Best Management Practices for CCR Surface Impoundments

As part of the proposed ELGs, EPA is considering establishing best management practices (BMPs) that would apply to existing surface impoundments that receive, store, dispose of, or are otherwise used to manage coal combustion residuals (CCRs) in order to prevent uncontrolled discharges from these impoundments. The BMPs outlined in the proposed ELG rule would apply to all CCR impoundments at steam electric power generating facilities, regardless of height and storage volume. EPA considers the following BMPs as critical steps to ensure that the owners and operators of surface impoundments become aware of any problems that may arise with the structural stability of surface impoundments before they occur:

1. Inspections should be performed every seven days by a person qualified to recognize specific signs of structural instability and other hazardous conditions by visual observation and, if applicable, to monitor instrumentation such as piezometers. If a potentially hazardous condition develops, the owner or operator shall immediately take action to eliminate the potentially hazardous condition; notify the Regional Administrator or the authorized State Director; and notify and prepare to evacuate, if necessary, all personnel from the property that may be affected by the potentially hazardous condition. Additionally, the owner or operator must notify state and local emergency response personnel if conditions warrant so that people living in the area down gradient from the surface impoundment can evacuate. Reports of these weekly inspections are to be maintained in the facility operating record.
2. Facilities using CCR impoundments would need to:
    a. Submit to EPA or the authorized state plans for the design, construction, and maintenance of existing impoundments.
    b. Submit to EPA or the authorized state plans for closure.
    c. Conduct periodic inspections by trained personnel who are knowledgeable in impoundment design and safety.
    d. Provide an annual certification by an independent registered professional engineer that all construction, operation, and maintenance of impoundments is performed in accordance with the approved plan.
    e. Address any problematic stability or safety issues within a timely manner.

2.6 Implementation Schedule

The limitations and standards in the proposed ELGs would not apply to existing sources until September, 2018, which is approximately 3 years after the effective date of the rule. Consequently, the proposed limitations would be in effect for all Big Rivers discharges following the next KPDES permit renewal after September, 2018. As stated in the proposed rules, EPA expects that all plants will have BAT limitations applied to their permits no later than September, 2023. Wastewaters generated before this compliance date ("legacy" wastewater) would be subject to the existing BPJ effluent limits and would not be subject to compliance with the proposed discharge limits unless they are mixed with untreated wastewaters produced after the compliance date.

EPA is also considering establishing a voluntary incentive program that would provide more time for utilities to implement the proposed BAT requirements if they agree to adopt additional process changes and controls beyond what is outlined in the preferred options within the proposed rule. Participation in the program would only be available to existing power plants that discharge directly to surface waters. Each plant would have until September, 2018 (approximately 3 years after promulgation of the final ELGs) to commit to the program and submit a plan for achieving the Tier 1 or Tier 2 requirements. Once a plant enrolls in the program, the NPDES permitting authority will develop specific discharge limits and key milestones consistent with that tier. The general requirements of these tiers are described further in the sections below. For the purposes of this study, Burns & McDonnell has assumed that these options would not be pursued by Big Rivers; however, these options are available if there is a need to extend the compliance schedule for the selected compliance alternatives in the future.

2.6.1.1 Tier 1 Compliance Schedule

Under the Tier 1 incentive program, utilities would be granted two additional years to comply with the proposed rules if they agree to dewater, close, and cap all CCR ponds at their facility (except for combustion residual leachate ponds), including ponds located on non-adjoining property that receive CCRs from the facility. A power plant participating in this incentive program could continue to operate their existing ponds for which CCR leachate was the only type of CCR solids or wastewater contained in the pond.

In general, this would require plants to convert ash handling systems either to dry handling systems or closed-loop tank-based systems and FGD wastewater treatment to tank-based systems in order to eliminate CCR contributions to the existing ponds on or before September, 2025, with the actual date depending on the NPDES permit cycle. The plants would then dewater the ponds by draining or pumping the wastewater out of them in compliance with the ELGs and other requirements in their existing NPDES permits. If not mixed with new waste streams after the ELGs are in effect, the legacy wastewaters would likely be subject to existing BPT limits for discharge. Once the ponds are dewatered, the contents would be graded, stabilized, and capped consistent with state requirements and any other additional requirements outlined by EPA as part of the Tier 1 program. .

2.6.1.2 Tier 2 Compliance Schedule

Under the Tier 2 incentive program, utilities would be granted five additional years (on or before September, 2028) to comply with the proposed rules if they agree to eliminate all process wastewater discharges (except cooling water) by reducing the amount of wastewater generated and preferentially using recycled wastewater to meet water supply demands. This may also require the addition of Zero Liquid Discharge (ZLD) technology to evaporate any excess wastewater, based on the plant specific water balance. The Tier 2 incentives would not apply to plants that eliminate direct discharge by sending the wastewater to a POTW.

3.0 KENNETH C. COLEMAN GENERATING STATION

Kenneth C. Coleman Generating Station (Coleman) is located northwest of Hawesville in Hancock County, Kentucky, along the south bank of the Ohio River. Coleman has three coal-fired units (443 MW total) with a common scrubber. All coal comes in via barge at Coleman; no pet coke is burned. There are two older ash ponds built in the late 1970's/early 1980's, and a third newer pond that was built in 2008 north of the plant site. The Coleman Site Plan is shown in Figure SK-001 in Appendix A.

Fly ash and bottom ash are co-mingled in the active pond (Ash Pond A) and in all CCR ponds at the plant. Ash Pond C no longer routinely receives CCR materials; however, it is used to manage stormwater and therefore has not been closed or removed from service. The ponds are part of a closed loop system. Coleman has a forced oxidized scrubber that was built between 2006 and 2007. While Big Rivers has been able to sell their gypsum for wallboard in the past, gypsum is currently stacked out and trucked via county road to the north pond for disposal due to the lack of market demand for wallboard. All CCR materials are dredged, dewatered, and disposed in the wastewater treatment facility, also referred to as Ash Pond D (400,000 TPY total).

3.1 Review of Existing Waste Streams

The latest KPDES permit for the Coleman plant was issued in February 2001. Big Rivers submitted a permit renewal application in September 2004. This was accepted by KPDES; however, a new permit has yet to be issued. In December 2012, Big Rivers submitted a letter indicating their intent to close their permitted discharge point for the plant's sanitary wastewater system. Table 3-1 summarizes the outfall information included in each of these documents.

Table 3-1: Coleman KPDES Permit Summary

			Reported Flow (MGD)			Current Permit Dischage Limits		
Outfall ID	**Receiving Water**	**Description**	**Daily Max**	**Montly Average**	**Treatment**	**Characteristic**	**Daily Max**	**Montly Average**
001	Ohio River	Once-through cooling waters and treated effluent from Outfall 004	357	277	NA	Free Available Chlorine (mg/L)	0.5	0.2
						Total Residual Chlorine (mg/L)	0.019	0.011
						pH (weekly grab)	6.0 < pH < 9.0	
002	Ohio River	Combined wastewaters of the ash pond overflow[1]	No Discharge	No Discharge	Sedimentation/ Neutralization	TSS (mg/L)	73	30
						Oil & Grease (mg/L)	9	9
						Acute Toxicity (TU_a)	1.00	N/A
						pH (1 grab/discharge)	6.0 < pH < 9.0	
003	Ohio River	Coal Pile Runoff Pond emergency overflow	No Discharge	No Discharge	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
004	Outfall 001 (Internal)	Sanitary Wastewater - submitted closure notification in December 2012 - diverted flow to City of Hawesville Wastewater Collection System	0.023	0.005	Extended aeration and chlorination prior to comingling	$CBOD_5$ (mg/L)	45	30
						TSS (mg/L)	45	30
						Ammonia (as N) (mg/L)	30	20
						Dissolved Oxygen - minimum (mg/L)	2.0	N/A
						Total Residual Chlorine - minimum (mg/L)	Report	0.2
						pH (monthly grab)	6.0 < pH < 9.0	
005	Outfall 002 (Internal)	Pretreated metal cleaning wastes	No Discharge	No Discharge	Batch Chemical Precipitation/ Settling Pond	Total Copper (mg/L)	1.0	1.0
						Total Iron (mg/L)	1.0	1.0
						TSS (mg/L)	100	30
						Oil & Grease (mg/L)	30	20
						pH (1 grab/discharge)	6.0 < pH < 9.0	
006	Ohio River	Intake at Ohio River	357	280	NA	pH (weekly grab)	6.0 < pH < 9.0	
007	Ohio River	Ash Pond Discharge - Location TBD		6.48	Sedimentation/ Neutralization	Not included in latest permit (2001). Values shown are from 2004 renewal application.		

[1]Wastewaters included are ash transport waters, low volume wastes, coal pile runoff, metal cleaning wastes, and plant storm water runoff. The system is normally operated as a re-circulating system without a discharge. Potential 7.533 MGD Intermittent discharge listed in renewal application.

The proposed ELG rules will affect the following waste streams at the Coleman site. The data shown in the following subsections of this report is based on water balance information provided by Big Rivers (see Appendix B) and conversations with operations staff at the Coleman plant.

3.1.1 FGD Wastewater

Based on discussions with the plant operations staff, the current FGD system discharges to the wastewater treatment building where the blowdown is sent through a clarifier system. The clarifier underflow is routed to the existing ash pond via the sludge sump in the wastewater treatment building. The clarified water is pumped to a multimedia filter and then comingled with the once-through cooling water prior to discharge in the Ohio River. This comingling will not be allowed under the proposed ELG regulations and all FGD blowdown will need to be treated with proposed BAT prior to discharge or mixing with other waste streams. It is also Burns & McDonnell's understanding that the existing filter equipment is undersized and that the FGD system blowdown is routed directly to the ash pond when scrubber chloride levels exceed 7,000 ppm. The existing water balance for Coleman shows a total of 0.232 million gallons per day (MGD) leaving the existing FGD treatment system (see existing plant water balance in Appendix B of this report). For the purposes of this study, Burns & McDonnell will base potential treatment options on this flow rate.

As part of the first two preferred regulatory options outlined in Section 2.3, or Options 3a and 3b (for facilities with a total wet-scrubbed capacity less than 2,000 MW), EPA is proposing not to characterize a technology basis for effluent limitations applicable to discharges of pollutants in FGD wastewater at this time. The EPA recognizes that there is a wide range of technologies currently in use for reducing pollutant discharges associated with FGD wastewater and expects development of these technologies to continue. Consequently, effluent limitations representing BAT for FGD discharges would be determined on a site-specific BPJ basis under these two options. Note that in the proposed rules, the EPA states that they do not believe surface impoundments represent best available demonstrated control technology for controlling pollutants in FGD wastewater, and the status quo is not likely to be considered BPJ any longer.

In the other two preferred regulatory options outlined in Section 2.3, or Options 3 and 4a, the technology 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 removal of selenium. For the purposes of this study, Burns & McDonnell will assume that site specific BPJ would establish BAT as chemical precipitation used in conjunction with biological treatment, or the same as the other proposed alternatives for BAT. Consequently, under any of the four preferred options Coleman would need to install additional wastewater treatment equipment to reduce the concentrations in their FGD wastewater to the limits shown in the white rows in Table 2-2. For details of what this will require at Coleman, refer to Section 3.2.1.

3.1.2 Fly Ash Transport Water

At the Coleman plant, all fly ash is currently sluiced to Ash Pond A, where the transport water can potentially be released through Outfall 002. Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of fly ash transport waters. Consequently, Burns & McDonnell projects that both the precipitator ash and the economizer ash will need to be converted to dry handling systems in order for the Coleman plant to comply with the proposed ELG regulations. Refer to Section 3.2.2 for details of what this conversion will require at Coleman.

As long as the piping that discharges fly ash transport water to the ash pond is isolated prior to the future compliance date, the ash pond and the legacy fly ash wastewater can remain in place and continue to be used as a stormwater pond to capture plant site runoff and miscellaneous plant drains. The discharge from this pond, including the legacy fly ash wastewater, would be subject to the existing BPT limits for TSS, oil and grease, and pH..

3.1.3 Bottom Ash Transport Water

At the Coleman plant, all bottom ash is currently sluiced to Ash Pond A, where the transport water can potentially be released through Outfall 002. Of the four preferred regulatory options outlined in Section 2.3, the first three (Options 3a, 3b, and 3) would maintain effluent limitations and standards for bottom ash transport water 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. Option 4a would require zero discharge of bottom ash transport waters (for units greater than 400 MW). Each of the three Coleman units is smaller than the 400 MW threshold. Consequently there are no discharges of bottom ash transport waters that will need to be eliminated as a result of the proposed ELG rules.

Since each of the four preferred options maintains the existing BPT limits for bottom ash transport water at Coleman, the anti-circumvention provisions in the proposed ELG rules would not be applicable to the bottom ash transport water generated at Coleman. Consequently, the ash pond could remain in service under any of these alternatives and no modifications would be required to meet the four preferred ELG options.

3.1.4 Combustion Residuals Leachate from Landfills and Surface Impoundments

Each of the four preferred regulatory options outlined in Section 2.3 would maintain effluent limitations and standards for leachate 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. Leachate is not currently collected at the Coleman site and based on Burns & McDonnell's interpretation of the proposed ELG rules, Big Rivers will not be required to retrofit the existing ponds with a composite liner and leak detection system to capture leachate for treatment

3.1.5 FGMC Wastewater

Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of FGMC wastewater. While Coleman does not currently have any waste streams associated with FGMC, there is potential for future of installation of activated carbon injection systems to comply with the Mercury Air

Toxics Standard (MATS). If installed, it is likely that the carbon will be captured with the fly ash and handled in a dry condition. This would comply with the BAT outlined in the four preferred regulatory scenarios outlined in the proposed ELG rules. If this is not the case and a sluicing system is added as part of a future mercury control system, the treatment of this water will need to be addressed in the design and capital cost estimate for those improvements. This scenario is not addressed in the current study.

3.1.6 Nonchemical Metal Cleaning Wastes

Based on discussions with the plant regarding operations, all existing nonchemical metal cleaning waste except the air preheater wash water is either captured in temporary tanks and hauled offsite for disposal by others or routed to the metal cleaning waste pond before being discharged to Ash Pond A through Outfall 005. The air preheater wash water is currently considered a low volume waste and is discharged directly to the ash pond as allowed by the existing KPDES permit. The EPA is currently considering two approaches for discharges of nonchemical cleaning wastes that are currently allowed without copper and iron limits and treated as low volume waste (such as the Coleman air preheater wash):

1. Provide an exemption and not specify PSES, allowing these waste streams to continue to be classified as low volume waste and discharged per the existing BPT limits (TSS, oil and grease).
2. Setting BAT limits for all nonchemical metal cleaning waste equal to the metal cleaning waste BPT and establishing PSES that include copper limits on discharges of nonchemical metal cleaning waste.

To take a conservative approach, Burns & McDonnell would suggest that all air preheater wash water be combined with other metal cleaning wastewaters in the existing metal cleaning waste pond at Coleman. The modifications required to reroute the air preheater wash to the metal cleaning waste pond are expected to be negligible, as these flows are likely already captured and pumped to the ash pond during temporary wash periods. Per the assumption in Section 2.3, all discharges of nonchemical metal cleaning wastewater from each of the Big Rivers plants will likely be required to meet the current permitted discharge limits for metal cleaning waste (copper, iron, TSS, pH, and oil and grease). The existing pond should be providing adequate treatment to meet the existing discharge limits. Consequently, all metal cleaning wastewater, including chemical and nonchemical waste streams, can continue to be discharged through Outfall 005 to Ash Pond A. Big Rivers will need to continue monitoring the Outfall 005 discharge to confirm it meets the permitted discharge limits before comingling this flow with any new or legacy ash pond water, as required by the existing permit. No further modifications should be required for nonchemical metal cleaning wastewater at Coleman.

3.2 Potential Compliance Alternatives

Based on the review of the existing waste streams at the Coleman plant (see Section 3.1 and all subsections), the following treatment technologies should be considered for the various waste streams at the Coleman site.

3.2.1 Physical/Chemical and Biological Treatment of FGD Wastewater

As described in Section 3.1.1, for the purposes of this study Burns & McDonnell has assumed that site specific BPJ would establish BAT as chemical precipitation used in conjunction with biological treatment, or the same as the other proposed alternatives for BAT. Consequently, under any of the four preferred options, Big Rivers would need to install additional wastewater treatment equipment at Coleman to reduce the concentrations in their FGD wastewater to the limits shown in the white rows in Table 2-2. This would likely require the addition of a physical treatment system including chemical precipitation followed by a biological treatment stage designed to optimize removal of selenium. While there is an existing chemical precipitation system installed at Coleman, Burns & McDonnell understands that this equipment is undersized for continuous operation based on discussions with the plant staff at Coleman. Consequently, a planning level capital cost estimate for a new larger capacity system has been developed as part of this study.

3.2.1.1 Process and Equipment Description

Physical treatment is generally used for removal of suspended solids inherent to FGD blowdown, such as calcium sulfate (gypsum). This process typically consists of a clarifier and/or thickener with a belt filter or filter press for final solids dewatering. Filter aids such as coagulants and flocculants may be used to assist with solids removal.

Chemical precipitation is commonly used to reduce heavy metals from wastewaters. Chemicals are added within agitated reaction tanks to convert soluble metals to insoluble metals that can be precipitated. These are easily removed with other suspended solids within a primary or secondary clarifier, depending upon the process design. Coagulants and flocculants can be used to ensure the settling and removal of newly formed solids. There are three main precipitation reactions for removal of heavy metals within a physical/chemical treatment system.

- Hydroxide precipitation
- Iron co-precipitation
- Sulfide precipitation

Lime or caustic feed uses hydroxide addition to convert dissolved metals into insoluble metal hydroxides that can then be precipitated out of solution. This is often a part of the primary clarification treatment step for heavy metals streams.

Iron co-precipitation acts as a coagulant and charge neutralizer to encourage precipitation of additional metals. Iron must be added at higher feed rates than the background concentration of the metals to be removed in order to drive the precipitation process. The flocs that are created are typically heavier and more easily precipitated.

For heavy metals reduction to low levels, sulfide addition is used. Metal sulfides are typically less soluble than metal hydroxides. Organosulfide is a typical chemical additive used.

For the first-stage chemical precipitation system for treatment of FGD wastewater at Coleman, Burns & McDonnell has included the following major components:

- Equalization tank to hold and store the wastewater
- Agitated reaction tanks for the addition of lime, organosulfide, ferric chloride, and polymers
- Solids-contact clarifier to remove suspended solids
- Gravity sand filter to reduce solids
- Sludge holding/thickener tank
- Sludge pumps
- Filter press for solids dewatering

An additional stage of biological treatment would be required to remove selenium and nitrates/nitrites. Biological treatment systems use microorganisms to consume nutrients and precipitate low solubility material. Pollutants can be reduced aerobically, anaerobically and by using anoxic reactions. There are two main types of treatment systems that have been identified for chloride laden wastewater: aerobic systems for BOD_5 removal and anoxic/anaerobic systems to remove metals and nutrients. Biological treatment can be applied through fixed films, suspended growth reactors, or sequencing batch reactors.

Aerobic treatment systems effectively reduce BOD_5 from wastewaters. Wastewater is fed through an aerated bioreactor. Microorganisms in the reactor use dissolved oxygen to digest organic matter in the wastewater and remove BOD_5. Aerobic bioreactors are typically used for the nitrification of ammonia that may be present in the waste stream due to ammonia slip from the SCR process. The ammonia is converted into nitrates which then can be removed using anaerobic or anoxic digestion. This digestion process creates sludge, which can be dewatered with a filter press for final disposal. Treated wastewater is allowed to overflow out of the reactor.

Anaerobic treatment can be a better process to remove certain pollutants such as selenium, arsenic, and nitrates from the wastewater streams. A fixed film bioreactor consists of an activated carbon bed inoculated with microorganisms. It is designed for plug flow, with different zones in the reactor having different potentials for oxidation. There are typically multiple reactors in series in order to get the required residence time to remove a group of metals.

For the second-stage biological treatment system, the following major equipment would be used in addition to the first-stage physical/chemical treatment equipment:

- Anoxic/anaerobic biological treatment system (two stages)
- Clarifier
- Final Filtration
- Dewatering

3.2.1.2 Planning Level Capital Cost Estimate

The planning level capital cost for the addition of this equipment at Coleman is summarized in Table 3-2, and the marked up water balance is included in Appendix B of this report to include the changes described above. As noted in Section 3.1.1, this treatment system is based on a flow rate of 0.232 MGD, or approximately 160 gallons per minute (gpm). Burns & McDonnell has assumed that all solids removed with this treatment system will be sent to Coleman's Ash Pond D for dry disposal, and that the permit for this facility can be modified to allow receipt of this material. Costs have not been included for additional auxiliary power, for operation and maintenance of the new equipment, or for additional waste hauling costs. This cost estimate was developed based on scaling from estimates developed for previous Burns & McDonnell projects. Should a regulation be promulgated and Big Rivers selects this system for FGD wastewater treatment at Coleman, Big Rivers should then implement a project definition study to further define the preferred compliance option including development of the budget level costs and implementation schedules.

Table 3-2: Planning Level Capital Cost Estimate for FGD Wastewater Treatment at Coleman

Direct Capital Costs	
Wastewater Treatment Equipment	[redacted]
Balance of Plant Modifications/Installation	[redacted]
Subtotal Direct Cost	[redacted]
Indirect Capital Cost	
Construction Management [redacted]	[redacted]
Engineering [redacted]	[redacted]
Start-Up and Testing [redacted]	[redacted]
Contingency [redacted]	[redacted]
Subtotal Indirect Cost	[redacted]
Total FGD Wastewater Treatment Cost	[redacted]

Notes: 1) Capital cost represents all units.
2) No escalation has been included. Costs are in 2013 dollars.
3) Owner's costs are not included.

3.2.2 Conversion to Dry Fly Ash Handling

Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of fly ash transport waters. As described in Section 3.2.2, the fly ash system for all of the Coleman Units will likely be required to convert to a dry handling technology.

3.2.2.1 Existing Fly Ash System

The existing system for each unit utilizes a water-power eductor to create the vacuum used to draw electrostatic precipitator (ESP) and economizer ash from their respective hoppers. After passing through air separators, the ash is sluiced to Ash Pond A. Eductor sluice water is supplied from Ash Pond A.

3.2.2.2 Ash Conversion System Criteria

There are several options for plant fly ash conversion equipment including vacuum systems, dilute or dense phase pressure systems, or a combination of several of these. The choice of which conversion option best suits each station depends on plant specific criteria including:

- Current and future fuel sources
- Existing pipe size and routing
- Available vertical clearance underneath the hoppers
- Temporary and final storage location(s)
- Distance and pipe routing to the storage location(s)
- System capacity
- Temporary storage volume (days of storage required)
- Final disposal method

- Possibility of beneficial resale of ash

In order to select the system best suited for the Coleman Station, several assumptions were made, including:

- Big Rivers has no plans to switch fuel types or sources at the Coleman Generating Station.
- The fly ash piping will be routed north of each unit, then west past the scrubber, before heading north again toward Ash Pond A. The lines will be on above grade pipe racks located next to the access road.
- Minimal clearance is available underneath the existing hoppers. This prevents a dilute phase or dense phase airlock system from being installed.
- Temporary storage will be redundant concrete fly ash silos located next to the access road, south of Ash Pond A. Final disposal location will either be in the existing dry disposal location at Coleman (Ash Pond D) or in a new landfill. The costs for a landfill have not been included as part of this study. Alternatively, the ash could be hauled to the Wilson landfill at Big Rivers' option.
- The ash silos will be located close enough from each unit to allow for a vacuum system to be installed.
- System capacity is assumed to be double the expected ash production rate for all three units. For volumetric calculations, fly ash density is assumed to be no less than 40 lbs/cf.
- Silo storage volume is assumed to be 5 days storage for all three units per silo.
- Prior to disposal in the landfill, the fly ash will be conditioned with a pug mill to a moisture content of 15-25%. Redundant ash conditioners will be provided in each silo.
- To provide provisions for future ash resale opportunities, a telescoping chute for dry disposal will be provided on each silo.

3.2.2.3 New Fly Ash Handling System

The equipment selected for the Coleman units is a standard vacuum system which utilizes mechanical exhausters to draw the vacuum, and combination filter/separators to remove the ash from the air stream and allow it to drop into the silos. Filter/separators will be located on top of each silo in addition to bin vent filters and pressure relief valves. Concrete silos will be flat bottom type with fluidizing air to allow for easy unloading. Fluidizing blowers, ash conditioners, and a telescoping chute for dry disposal will be located on the unloading floor.

Converting the existing sluicing ash systems to a dry system would require additional plant utilities for the new equipment. This conversion also adds a continuous dry ash waste product requiring truck hauling for disposal, incurs new auxiliary power requirements, and uses additional yard space for the new equipment. The existing plant distributed control system (DCS) will need to be modified to integrate the new control requirements. The new system will require instrument air and water for ash conditioning. Instrument air will be supplied from new compressors, dryers and an air receiver located in the mechanical exhauster building. Ash conditioning water will be supplied from the existing Ash Pond A located just north of the silos.

Balance of plant (BOP) modifications for Coleman's fly ash conversion includes civil, structural, mechanical and electrical additions to the plant to incorporate the new system. Civil and structural additions include a new pipe rack for dry vacuum fly ash lines and BOP conditioning water lines, foundations for new concrete ash silos and mechanical exhauster building, and road modifications for the new silos. Each silo will be provided with a stair tower for access to roof mounted equipment such as combination filter separators, bin vent filters, jib crane, and silo pressure relief valves. Mechanical and electrical additions include instrument and fluidizing air piping, service air and water hose connections, conditioning water piping, and each silo unloading floor and exhauster building HVAC. A medium voltage transformer along with motor control centers will be provided with the exhauster building to supply power to the exhausters, fluidizing air compressors, silo ash conditioners, and miscellaneous silo equipment.

3.2.2.4 Capital Cost Estimate

The benefits of the vacuum system chosen are its lower capital cost, simplicity and reliability, and ability to be retrofit without the need for additional headroom clearance beneath the fly ash hoppers. The estimate was prepared utilizing Burns &McDonnell's historical information for similar projects and construction experience. Should a regulation be promulgated and Big Rivers selects this system for installation at Coleman, Big Rivers should then implement a project definition study to further define the preferred compliance option including development of the budget level costs and implementation schedules.

The planning level cost estimate includes direct costs and indirect costs and is summarized in Table 3-3. The direct costs include equipment, materials, installation, and miscellaneous items such as surveying, testing, and start-up craft support. The indirect capital costs include construction management, engineering, start-up, and contingency. The estimate does not include any specific project insurance (such as builder's risk) or taxes for permanently installed equipment and materials. Costs have not been included for any traditional Owner's costs such as Owner's engineer, project support staff, additional operators, permits, etc. Costs have not been included for additional auxiliary power, for operation and maintenance of the new equipment, or for additional waste hauling costs.

Table 3-3: Planning Level Capital Cost Estimate for Coleman Fly Ash Conversion

Direct Capital Costs	
Fly Ash Silos	[redacted]
Fly Ash Equipment	
Balance of Plant Modifications	
Subtotal Direct Cost	
Indirect Capital Cost	
Construction Management [redacted]	[redacted]
Engineering [redacted]	
Start-Up and Testing [redacted]	
Contingency [redacted]	
Subtotal Indirect Cost	
Total Ash Conversion Project Cost	

Notes: 1) Capital cost represents all units.
2) No escalation has been included. Costs are in 2013 dollars.
3) Owner's costs are not included.

3.2.2.5 Project Schedule

The fly ash conversion schedule is based upon experience with similar projects. The project will require a 40 day outage for system tie-ins to the ash hopper valves and tie in of the new electrical system prior to start up activities. Total project schedule is approximately 28 months long.

4.0 D.B. WILSON GENERATING STATION

D.B. Wilson Generating Station (Wilson) is located northwest of Centertown in Ohio County, Kentucky. Wilson has one coal-fired unit (417 MW) with an enhanced scrubber (inhibitive oxidation process) from which they produce a true Poz-O-Tec material. The area north of Highway 85 was strip mined prior to plant construction, and it includes the coal pile and landfill. The Wilson Site Plan is shown in Figure SK-002 in Appendix A.

4.1 Review of Existing Waste Streams

The latest KPDES permit for the Wilson plant was issued in February 2001. Big Rivers submitted a permit renewal application in July 2004. This was accepted by KPDES; however, a new permit has yet to be issued. Big Rivers also submitted a permit renewal modification in May 2013 to request two additional outfalls for the stormwater coming off of the landfill. Table 4-1 summarizes the outfall information included in each of these documents.

Table 4-1: Wilson KPDES Permit Summary

Outfall ID	Receiving Water	Description	Reported Flow (MGD) Daily Max	Reported Flow (MGD) Montly Average	Treatment	Current Permit Dischage Limits Characteristic	Daily Max	Montly Average
001	Green River	Main Plant Discharge (includes 005 & 006)	5.82	0.84	NA	Temperature (deg F)	100	95
						TSS (mg/L)	61	30
						Oil & Grease (mg/L)	9.0	9.0
						pH (weekly grab)	6.0 < pH < 9.0	
002	Green River	Stormwater from the Scrubber Sludge Landfill	44.2	0.895	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
003	Elk Creek	Combined Plant Site Stormwater and 007	6.97	0.995	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
005	Outfall 001 (Internal)	Pretreated metal cleaning wastes	No Discharge	No Discharge	Batch Chemical Precipitation/ Settling Pond	Total Copper (mg/L)	1.0	1.0
						Total Iron (mg/L)	1.0	1.0
						TSS (mg/L)	100	30
						Oil & Grease (mg/L)	30	20
						pH (1 grab/discharge)	6.0 < pH < 9.0	
006	Outfall 001 (Internal)	Cooling Tower Blowdown	1.96	0.5	NA	Free Available Chlorine (mg/L)	0.5	0.2
						Total Residual Chlorine (mg/L)	0.2	0.2
						Total Chromium (mg/L)	0.2	0.2
						Total Zinc (mg/L)	1.0	1.0
						pH (monthly grab)	6.0 < pH < 9.0	
007	Outfall 003 (Internal)	Sanitary Wastewater	0.104	0.005	Extended aeration and chlorination prior to comingling	$CBOD_5$ (mg/L)	45	30
						TSS (mg/L)	45	30
						Ammonia (as N) (mg/L)	30	20
						Dissolved Oxygen - minimum (mg/L)	2.0	N/A
						Total Residual Chlorine (mg/L)	Report	0.2
						pH (monthly grab)	6.0 < pH < 9.0	
008	Green River	Intake at Green River	14	5.87	NA	pH (weekly grab)	6.0 < pH < 9.0	
009	Green River	Stormwater from the Scrubber Sludge Landfill	No Discharge	No Discharge	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
010	Green River	Stormwater runoff from solid fuel conveyor		0.22	Settlement	Not included in latest permit (2001). Data shown is from 2004 renewal application.		
011	Green River	Stormwater runoff from solid fuel conveyor		0.26	Settlement	Not included in latest permit (2001). Data shown is from 2004 renewal application.		
012	Green River	Stormwater runoff from solid fuel conveyor		0.25	Settlement	Not included in latest permit (2001). Data shown is from 2004 renewal application.		
013	Green River	Stormwater runoff from solid fuel conveyor		0.64	Settlement	Not included in latest permit (2001). Data shown is from 2004 renewal application.		
014	Green River	Stormwater runoff from solid waste landfill			Sedimentation/ Neutralization	Not included in latest permit (2001). Data shown is from 2013 renewal modification.		
015	Green River	Stormwater runoff from solid waste landfill			Sedimentation/ Neutralization	Not included in latest permit (2001). Data shown is from 2013 renewal modification.		

The proposed ELG rules will affect the following waste streams at the Wilson site. The data shown in the following subsections of this report is based on water balance information provided by Big Rivers (see Appendix B) and conversations with operations staff at the Wilson plant.

4.1.1 FGD Wastewater

Based on discussions with the plant regarding operations, there are currently no discharges of FGD wastewater from the Wilson plant. Scrubber chlorides are currently limited based on the use of low-chloride coals and if necessary for maintenance purposes, the plant will temporarily purge FGD water to one of two spare tanks onsite (oxidation tanks) or in even rarer cases to the concrete lined overflow pond. In either scenario this water is recycled back to the FGD system and used in the process as makeup water; however, in the past there have been heavy rain events that have caused an overflow of the concrete lined pond. It is possible, in the future, that a combination of heavy rain and purged FGD wastewater could cause the water from the overflow pond to be released from the site. Future ELG regulations may require controls and operating practices that eliminate this potential FGD discharge.

Piping may need to be modified to prevent any discharges of FGD wastewater directly (or indirectly via the Overflow Pond) to the Old Wastewater Impoundment Pond. This flow could potentially be rerouted to the spare thickener onsite, which could be modified and used as a dedicated storage tank for FGD wastewater in order to prevent comingling with other waste streams as required by the proposed ELG rules. For details of what this will require at Wilson, refer to Section 4.2.1.

4.1.2 Fly Ash Transport Water

All fly ash is currently handled in a dry condition at Wilson, both from the precipitator and the economizer. Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of fly ash transport waters. Consequently there are no discharges of fly ash transport waters that will need to be eliminated at Wilson as a result of the proposed ELG rules.

4.1.3 Bottom Ash Transport Water

Of the four preferred regulatory options outlined in Section 2.3, the first three (Options 3a, 3b, and 3) would maintain effluent limitations and standards for bottom ash transport water 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. Option 4a would require zero discharge of bottom ash transport waters (for units greater than 400 MW). While Wilson is larger than this 400 MW threshold, all bottom ash is currently handled in a dry condition at Wilson. Consequently there are no discharges of bottom ash transport waters that will need to be eliminated as a result of the proposed ELG rules.

4.1.4 Combustion Residuals Leachate from Landfills and Surface Impoundments

Each of the four preferred regulatory options outlined in Section 2.3 would maintain effluent limitations and standards for leachate 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. Landfill leachate is not currently collected at the Wilson site and based on Burns & McDonnell interpretation of the proposed ELG rule, Big Rivers will not be required to retrofit the existing landfill with a liner system to capture leachate for treatment.

Landfill contact stormwater could be considered to have the same treatment requirements as leachate based on comments by the EPA in both the proposed ELGs and the associated Technical Development Document. This could be up to the permit authority to decide and is a factor for Big Rivers to consider if EPA does not select one of the four preferred options and chooses to establish BAT for chemical precipitation of leachate (and potentially contact stormwater); however, the scope of the current study is limited to the four preferred alternatives only. Existing leachate (and potentially contact stormwater) waste streams that are already treated to BPT limits for TSS, oil, and grease via a settling pond would already be in compliance with these four options and consequently no changes would be necessary at Wilson.

4.1.5 FGMC Wastewater

Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of FGMC wastewater. While Wilson does not currently have any waste streams associated with FGMC, there is potential for the future of installation of activated carbon injection systems to comply with MATS. If installed, it is likely that the carbon will be captured with the fly ash and handled in a dry condition. This would comply with the BAT outlined in the four preferred regulatory scenarios outlined in the proposed ELG rules. If this is not the case and a sluicing system is added as part of a future mercury control system, the treatment of this water will need to be addressed in the design and capital cost estimate for those improvements. This scenario is not addressed in the current study.

4.1.6 Nonchemical Metal Cleaning Wastes

Based on discussions with the plant regarding operations, all existing nonchemical metal cleaning waste, including the air preheater wash water, is either captured in temporary tanks and hauled offsite for disposal by others or routed to the metal cleaning waste pond at Wilson. This flow can then be sent to the wastewater treatment plant for cleanup and discharged via Outfall 005 and 001 to the Green River. It can also be routed to the old wastewater impoundment pond, where it can be routed to either the FGD system for makeup or to the wastewater treatment plant for cleanup.

Per the assumption in Section 2.3, all discharges of nonchemical metal cleaning wastewater from each of the Big Rivers plants will likely be required to meet the current permitted discharge limits for metal cleaning waste (copper, iron, TSS, pH, and oil and grease). Consequently, all metal cleaning wastewater including chemical and nonchemical waste streams can continue to be discharged through the existing wastewater treatment plant and no modifications are assumed to be required for treatment of nonchemical metal cleaning wastewater at Wilson.

4.2 Potential Compliance Alternatives

Based on the review of the existing waste streams at the Wilson plant (see Section 4.1 and all subsections), the following treatment technologies should be considered for the various waste streams at the Wilson site.

4.2.1 Flow Minimization and Zero Discharge of FGD Wastewater

Based on discussions with the plant regarding operations, there are currently no discharges of FGD wastewater from the Wilson plant. Scrubber chlorides are currently limited based on the use of low-chloride coals and if necessary for maintenance purposes, the plant will temporarily purge FGD water to one of two spare tanks onsite (oxidation tanks) or in even rarer cases to the concrete lined overflow pond. In either scenario this water is recycled back to the FGD system and used in the process as makeup water; however, a heavy rain event could cause the overflow pond, which contains FGD wastewater, to be discharged. Described below are physical and operational changes to the FGD wastewater process that could be implemented to eliminate this potential discharge. If there is no FGD wastewater discharge, the Wilson FGD system should be in compliance with the proposed ELG regulations.

4.2.1.1 Flow Minimization

The primary mechanisms for removing water from an FGD system are stack evaporation and moisture in the filter cake. A general rule of thumb is that an FGD system can be expected to evaporate through the stack approximately 1 gpm per gross megawatt of generation. For Wilson this would be approximately 440 gpm at full load. Lesser evaporation would occur at lower loads. The primary mechanism used for the control of FGD system chloride levels is the removal of liquid entrained with the filter cake.

One key to achieving a net negative water balance in the FGD system is to minimize the use of water from outside the FGD system envelope. At Wilson, the primary source of non-process water is service water. Service water enters the Wilson FGD water balance in a variety of ways. It appears that the major service water users are the liquid ring vacuum pumps in the dewatering building (3 × 30 gpm = 90 gpm total value), shaft seal water for agitators on the absorber modules (16 × 10 gpm = 160 gpm total estimated value), miscellaneous pump shaft seals and wash down water. These flows into the system are relatively small, but they displace returned liquid in the evaporation cycle. Using a conservative estimate of 250 gpm service water reduction from the liquid ring vacuum pumps and agitators, the net evaporation at full load may be reduced from 440 gpm to 190 gpm. At lower loads, the impact of the service water is exacerbated because the stack evaporation is lower. Thus reduction of service water is imperative to reduce potential water discharges. Since evaporated water is essentially free of dissolved solids, water lost through evaporation does not lower chloride concentrations in the FGD system, but rather increases the concentration.

Steps to reduce service water inputs to the FGD system could include re-routing the vacuum pump seal water to a plant discharge provided that the water quality and/or the definition of use does not prevent this modification. If it is determined that the seal water cannot be discharged, the vacuum pumps may be capable of being replaced with a low flow or recirculating seal water design.

Another mentioned use of service water is in the shaft seals for the agitators in the FGD system. Currently these seals have seal water on them. Replacement of the seal with a mechanical type would reduce service water flow; however, moving to a mechanical seal may not be possible due to agitator shaft wobble creating variable shaft- to- seal clearances and resulting in seal damage.

Wash down water is another use of service water which adds to the FGD system water balance. Limiting wash down water to the minimum required will help reduce this input. Using reclaim water for wash down of heavy buildup followed by a service water rinse should also be considered. The availability of reclaim water in the immediate area, the effect of over spray on equipment and structures and any increase in the potential for safety slip/fall should also be considered.

The use of reclaim water for process flushes should also be considered for any applications where service water is currently being used.

4.2.1.2 Maintain Chloride Concentrations at Acceptable Levels

The primary mechanism used for the control of FGD system chloride levels is the removal of liquid with the filter cake. At Wilson, product for disposal is produced by Komline Sanderson rotary drum vacuum filters. The vacuum filters produce 25 to 30 tons of filter cake per hour. There are two sets of three filters installed. Only one set of three filters is in operation. Depending on unit load and coal sulfur content up to three filters are required at up to 24 hours per day operation.

After filtration the filter cake is treated in one of two ways. For interior placement in the landfill, the filter cake is stacked outside by a stacker conveyor. This material is approximately 63 percent solids. Material placed around the perimeter of the landfill is processed through the IUCS system where fly ash and lime are mixed in. The product is loaded by a front end loader and trucked to the landfill.

The amount of chloride removed by the FGD waste depends on the chloride entering with the coal, the amount of coal burned, the sulfur content of the coal and the moisture in the filter cake. The equilibrium chloride concentration is achieved when the chloride entering the FGD is equal to the chloride leaving the FGD.

The relationship between the four factors which influence the equilibrium chloride concentration are as follows. As coal chlorine content increases equilibrium chloride in the FGD increases. As the coal sulfur content increases, the equilibrium chloride concentration decreases. As the percent moisture in the filter cake decreases, the equilibrium chloride concentration in the FGD increases. The amount of coal burned affects the relative impacts of sulfur, chlorine and cake moisture.

Chlorides are currently maintained at allowable levels at Wilson by carefully selecting the coal that is burned at the plant and by producing a high-moisture filter cake. As long as this process is followed in the future and the plant continues to burn high-sulfur coals, chlorides can continue to be managed in the same way and FGD system purges would not be required for continued operation.

4.2.1.3 Segregation of FGD water from Stormwater

Once the FGD system has been optimized for net evaporation and chloride concentration, the remaining effort to achieve zero liquid discharge depends on the ability to segregate process water from site rain water. Based on current and historical plant operations, FGD water is currently contained in the overflow pond and the wastewater impoundment pond. The times at which the FGD waters are discharged are limited to periods after large rain events at the site, when these ponds become inundated with stormwater runoff and water is released from their outfall structures. If FGD water is segregated from stormwater, the potential for discharge would not affected by large rain events at the site and the water could be reused in the FGD system.

There are areas of concern in each of the sub- divisions of the absorber island. For the most part the Reagent Preparation system has in place a level of interior curbing that will help to contain some of the process water. The curbing is not continuous and has breaks at the roll up doors and in other locations around the building. Further analysis of the curbing should be done to make sure that likely process water releases are contained. An evaluation of the Reagent Preparation sump should also be undertaken to determine if upgrades to the agitator and pumps are necessary to keep the solids in suspension and capable of being pumped.

The Dewatering building lacks internal curbing to contain process flows. Overall the process flows within the building envelope appear to be relatively well contained with the exception of runoff from the byproduct stack out area. Additional recommendations to reduce co-mingling of process water include:

- The area around the thickeners appears to be uncontrolled at present. Improvements to consider include installation of a new larger sump in place of the abandoned sump. Reinstallation of sump pumps.
- Addition of height to the outer wall of the thickener launder would reduce thickener overflow potential.
- Modification of the thickener operating procedures to allow the out-of-service thickener to be used for overflow storage.
- Add instrumentation and alarms to detect thickener overflow conditions.
- Consider video monitoring or other operational practices in areas vulnerable to process leaks which may otherwise go undetected.

The absorber island requires an additional sump with the capability of pumping to any absorber in - service. Additional site grading may be required to direct process water releases to the sump. In addition, process water sumps need to be protected from intrusion of collecting site rainfall runoff. This will require additional study.

Areas where the potential for process water co-mingling with storm water or contamination of storm water ponds exist at any point where process water is transported. System leaks and catastrophic process water releases can occur at any time. The identification, isolation and cleanup of these events before they have the opportunity to contaminate site runoff ponds is imperative. If not already established, operating procedures should be developed to prevent process water spills and to cleanup following any uncontrolled releases. These procedures should also include guidelines on pond management and system monitoring.

4.2.1.4 Summary

There is a high probability that Wilson can achieve zero liquid discharge with regard to the FGD. At the current operating conditions we expect an equilibrium chloride concentration to be approximately 5000 ppm. The estimated discharge of water through the FGD system is approximately 500 gpm at full load, which includes approximately 250 gpm of service water added to the process. Eliminating/reducing the service water inputs will increase the net water loss from the system. The water loss through the FGD system will vary with unit load, fuel quality and dewatering performance. An aggressive program of water management and water segregation including measures described above should allow Wilson to achieve zero liquid discharge. The marked up water balance is included in Appendix B of this report to include the changes described in the sections above. Overall, these modifications should be expected to include a direct capital cost between two and three million dollars, depending on the results of the future studies to determine the full extent of the flow segregation required. The estimated overall cost of the project are summarized in Table 4-2.

Table 4-2: Planning Level Capital Cost Estimate for FGD Wastewater Flow Minimization and Segregation at Wilson

Direct Capital Costs	
Estimated Direct Cost	[redacted]
Indirect Capital Cost	
Construction Management [redacted]	[redacted]
Engineering [redacted]	
Start-Up and Testing [redacted]	
Contingency [redacted]	
Subtotal Indirect Cost	
Total Flow Minimization/Segregation	

5.0 SEBREE GENERATING STATION

Sebree Generating Station (Sebree) is located northeast of Sebree, Kentucky, on the Henderson-Webster county line along the west bank of the Green River. Sebree includes three stations with a total of five coal-fired units (831 MW total):

- Reid (65 MW)
- Henderson Unit 1 (153 MW)
- Henderson Unit 2 (159 MW)
- Green Unit 1 (231 MW)
- Green Unit 2 (223 MW)

The City of Henderson owns the two Henderson units and Big Rivers operates them. Big Rivers owns and operates the Reid and Green Stations. The Sebree Site Plan is shown in Figure SK-003 in Appendix A.

The HMPL and Green Stations have scrubbers and associated processing equipment that produce Poz-O-Tec material. The Poz-O-Tec stackout and fly ash silos are located northeast of the Green Station ash pond adjacent to the fly ash silos. The area has capacity for about 3 days of CCR material storage. Coal comes in by barge and truck. Approximately 1.1 million TPY of dry fly ash and Poz-O-Tec are produced at the five Sebree units. Green produces approximately 45,000 tons of bottom ash each year. HMPL bottom ash production is about 15,000 TPY. As Burns & McDonnell understands, the ash quantities are for Green and HMPL, and do not include the ash quantities associated with Reid.

5.1 Review of Existing Waste Streams

The latest KPDES permit for the Sebree plant was issued in March 2004. Big Rivers submitted a permit renewal application in April 2009. This was accepted by KPDES; however, a new permit has yet to be issued. Table 5-1 summarizes the outfall information included in each of these documents.

Table 5-1: Sebree KPDES Permit Summary

Outfall ID	Receiving Water	Description	Reported Flow (MGD) Daily Max	Reported Flow (MGD) Montly Average	Treatment	Current Permit Dischage Limits: Characteristic	Daily Max	Montly Average
001	Green River	Main Plant Discharge (includes R-1 cooling water and Outfall 002, 004, 007, & 009)	97.7	63.2	NA	Free Available Chlorine (mg/L)	0.5	0.2
						Total Residual Chlorine (mg/L)	0.019	0.019
						Total Residual Oxidants (mg/L)	0.2	Report
						Acute Toxicity (TU_a)	1.00	N/A
						pH (monthly grab)	6.0 < pH < 9.0	
002	Outfall 001 (Internal)	Cooling Tower Blowdown from H-1&2 prior to discharge to Outfall 001	2.79	0.34	NA	Free Available Chlorine (mg/L)	0.5	0.2
						Total Residual Chlorine (mg/L)	0.2	0.2
						Total Residual Oxidants (mg/L)	0.2	Report
						Total Chromium (mg/L)	0.2	0.2
						Total Zinc (mg/L)	1.0	1.0
003	Outfall 009	Coal pile runoff[1]	0.324	0.142	Sedimentation	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
004	Outfall 001 (Internal)	Reid Ash Pond combined wastestreams[2]	12.21	6.14	Sedimentation/ Neutralization	TSS (mg/L)	93	30
						Oil & Grease (mg/L)	18	14
						pH (weekly grab)	6.0 < pH < 9.0	
005	Outfall 009 (Internal)	Chemical cleaning wastes from R-1, H-1, and H-2 prior to discharge to Green Ash Pond (009)	No Discharge	No Discharge	NA	Total Copper (mg/L)	1.0	1.0
						Total Iron (mg/L)	1.0	1.0
						TSS (mg/L)	100	30
						Oil & Grease (mg/L)	30	20
						pH (1 grab/discharge)	6.0 < pH < 9.0	
007	Outfall 001 (Internal)	Cooling Tower Blowdown from G-1&2 prior to discharge to Outfall 001	19	1.12	NA	Free Available Chlorine (mg/L)	0.5	0.2
						Total Residual Chlorine (mg/L)	0.2	0.2
						Total Residual Oxidants (mg/L)	0.2	Report
						Total Chromium (mg/L)	0.2	0.2
						Total Zinc (mg/L)	1.0	1.0
008	Outfall 009 (Internal)	Chemical cleaning wastes from G-1&2 prior to discharge to Green Ash Pond (009)	No Discharge	No Discharge	NA	Total Copper (mg/L)	1.0	1.0
						Total Iron (mg/L)	1.0	1.0
						TSS (mg/L)	100	30
						Oil & Grease (mg/L)	30	20
						pH (1 grab/discharge)	6.0 < pH < 9.0	
009	Outfall 001 (Internal)	Green Ash Pond combined wastestreams[3]	5.07	0.722	Sedimentation/ Neutralization	TSS (mg/L)	84	30
						Oil & Grease (mg/L)	17	13.5
						pH (weekly grab)	6.0 < pH < 9.0	
010	Green River	Intake at Green River	112	74	NA	pH (weekly grab)	6.0 < pH < 9.0	
011	Outfall 009 (Internal)	Storm water runoff from the CSI yard[1]	0.158	0.093	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
012	Green River	Storm water runoff from the south area of the FGD landfill	0.288	0.041	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						Chlorides (mg/L)	1200	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
014	Green River	Storm water runoff from the east and north areas of the FGD landfill	0.576	0.039	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						Chlorides (mg/L)	1200	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	
015	Groves Creek Tributary	Storm water runoff from H-1&2 plant area, cooling tower, and scrubber	1.79	1.01	Sedimentation/ Neutralization	TSS (mg/L)	50	Report
						Chlorides (mg/L)	1200	Report
						pH (1 grab/discharge)	6.0 < pH < 9.0	

[1]During normal conditions, discharge is to the Green Ash Pond (Outfall 009). Under emergency conditions, direct discharge to the Green River occurs. These limits are applicable to emergency discharges only and do not apply to routine discharges to the Green ash pond.
[2]Combined wastestreams include R-1 ash hopper (1.35 MGD), H-1&2 ash hopper (3.28 MGD), area sump (ash hopper overflow, boiler blowdown, demineralizer, neutralization unit, and plant drains from units R-1, H-1, and H-2 - 2.1 MGD), fly ash sluice from R-1, H-1&2 (13.15 MGD), air preheater wash (0.033 MGD), stormwater runoff from Reid plant area, roof drains, and ash pond surface (78.64 MGD max). [3]Combined wastestreams include clarifier blowdown (0.31 MGD), demineralizer (0.36 MGD), G-1&2 bottom ash hopper seals (5.08 MGD) and sluice (13.45 MGD), G-1&2 chemical cleaning wastes (0.046 MGD), miscellaneous drains G-1&2 (0.6 MGD), stormwater runoff from Reid/Green coal pile, Green thickener area, plant area, roof drains, ash pond surface, and CSI (207 MGD max).

The proposed ELG rules will affect the following waste streams at the Sebree site. The data shown in the following subsections of this report is based on water balance information provided by Big Rivers (see Appendix B) and conversations with operations staff at the Sebree station.

5.1.1 FGD Wastewater

Based on review of the water balance, the current FGD system from both the Henderson units and the Green units is routed to a set of thickeners. The sludge from these thickeners is sent to the dewatering facility (referenced as CSI on the water balance named after the equipment vendor Conversions System Incorporated), where a portion of the wastewater is used to condition fly ash and the remaining portion is either returned to the thickener or sent to the Green ash pond via the CSI yard sump. This flow is comingled with storm drainage, bottom ash transport water, and other miscellaneous plant flows in the ash pond before being discharged. From there, it is combined with the Reid cooling flow, the Henderson and Green cooling tower blowdown, and the Reid ash pond wastewater and discharged to the Green River. This comingling will not be allowed under the proposed ELG regulations and all FGD blowdown will need to be treated with proposed BAT prior to discharge or mixing with other waste streams. The existing water balance for Sebree shows a total of 0.428 MGD discharged from the FGD system to the Green Bottom Ash Pond (see existing plant water balance in Appendix B of this report). For the purposes of this study, Burns & McDonnell will base potential treatment options on this flow rate.

As part of the first two preferred regulatory options outlined in Section 2.3, or Options 3a and 3b (for facilities with a total wet-scrubbed capacity less than 2,000 MW), EPA is proposing not to characterize a technology basis for effluent limitations applicable to discharges of pollutants in FGD wastewater at this time. The EPA recognizes that there is a wide range of technologies currently in use for reducing pollutant discharges associated with FGD wastewater and expects development of these technologies to continue. Consequently, effluent limitations representing BAT for FGD discharges would be determined on a site-specific BPJ basis under these two options. Note that in the proposed rules, the EPA states that they do not believe surface impoundments represent best available demonstrated control technology for controlling pollutants in FGD wastewater, and the status quo is not likely to be considered BPJ any longer.

In the other two preferred regulatory options outlined in Section 2.3, or Options 3 and 4a, the technology 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 removal of selenium. For the purposes of this study, Burns & McDonnell will assume that site specific BPJ would establish BAT as chemical precipitation used in conjunction with biological treatment, or the same as the other proposed alternatives for BAT. Consequently, under any of the four preferred options Sebree would need to install additional wastewater treatment equipment to reduce the concentrations in their FGD wastewater to the limits shown in the white rows in Table 2-2. For details of what this will require at Sebree, refer to Section 5.2.1.

5.1.2 Fly Ash Transport Water

Although listed as a discharge in the current KPDES permit, all fly ash is currently handled in a dry condition at Sebree with the exception of the economizer hopper ash from the Green units. The Reid and Henderson units were recently equipped with dry fly ash handling systems and no longer sluice any fly ash while the precipitator fly ash from the Green units is also handled in a dry condition. There will be no modifications required for these systems to comply with the proposed ELG rules.

The Green economizer ash is currently sluiced to the Green ash pond where the transport water can potentially be discharged under the existing permit limits. Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of fly ash transport waters. Consequently, Burns & McDonnell projects that the Green economizer ash sluicing system will need to be converted to a dry handling system in order for the Sebree plant to comply with the proposed ELG regulations. Refer to Section 5.2.2 for details of what this conversion will require at Sebree.

As long as the piping that discharges the Green economizer ash transport water to the ash pond is isolated prior to the future compliance date, the ash pond and the legacy fly ash wastewater can remain in place and continue to be used as a stormwater pond to capture plant site runoff and miscellaneous plant drains. The discharge from this pond, including the legacy fly ash wastewater, would be subject to the existing BPT limits for TSS, oil and grease, and pH.

5.1.3 Bottom Ash Transport Water

At the Sebree station, all Reid and Henderson bottom ash is currently sluiced to the Reid ash pond, where the transport water can potentially be released to the Green River through Outfall 004 and Outfall 001. All of the Green bottom ash is currently sluiced to the Green ash pond, where the transport water can potentially be released to the Green River through Outfall 009 and Outfall 001. Of the four preferred regulatory options outlined in Section 2.3, the first three (Options 3a, 3b, and 3) would maintain effluent limitations and standards for bottom ash transport water 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. Option 4a would require zero discharge of bottom ash transport waters (for units greater than 400 MW). Each of the Sebree units is smaller than the 400 MW threshold. Consequently there are no discharges of bottom ash transport waters that will need to be eliminated as a result of the proposed ELG rules.

Since each of the four preferred options maintains the existing BPT limits for bottom ash transport water at Sebree, the anti-circumvention provisions in the proposed ELG rules would not be applicable to the bottom ash transport water generated at Sebree. Consequently, the ash ponds could remain in service under any of these alternatives and no modifications would be required to meet the four preferred ELG options.

5.1.4 Combustion Residuals Leachate from Landfills and Surface Impoundments

Each of the four preferred regulatory options outlined in Section 2.3 would maintain effluent limitations and standards for leachate 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. Leachate is not currently collected from the ash ponds at the Sebree station, and, based on Burns & McDonnell interpretation of the proposed ELG rules, Big Rivers will not be required to retrofit the existing ponds with a composite liner and leak detection system to capture leachate for treatment.

Landfill leachate is not currently collected at Sebree and based on Burns & McDonnell interpretation of the proposed ELG rule, Big Rivers will not be required to retrofit the existing landfill with a liner system to capture leachate for treatment. Landfill contact stormwater could be considered to have the same treatment requirements as leachate based on comments by the EPA in both the proposed ELGs and the associated Technical Development Document. This could be up to the permit authority to decide and is a factor for Big Rivers to consider if EPA does not select one of the four preferred options and chooses to establish BAT for chemical precipitation of leachate (and potentially contact stormwater); however, the scope of the current study is limited to the four preferred alternatives only. Existing leachate (and potentially contact stormwater) waste streams that are already treated to BPT limits for TSS, oil, and grease via a settling pond would already be in compliance with these four options and consequently no changes would be necessary at Sebree.

5.1.5 FGMC Wastewater

Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of FGMC wastewater. While Sebree does not currently have any waste streams associated with FGMC, there is potential for future of installation of activated carbon injection systems to comply with MATS. If installed, it is likely that the carbon will be captured with the fly ash and handled in a dry condition. This would comply with the BAT outlined in the four preferred regulatory scenarios outlined in the proposed ELG rules. If this is not the case and a sluicing system is added as part of a future mercury control system, the treatment of this water will need to be addressed in the design and capital cost estimate for those improvements. This scenario is not addressed in the current study.

5.1.6 Nonchemical Metal Cleaning Wastes

Based on discussions with the plant regarding operations, all existing nonchemical metal cleaning waste except the air preheater wash water is either captured in temporary tanks and hauled offsite for disposal by others or routed to the metal cleaning waste ponds before being discharged to the Green ash pond. The air preheater wash water is currently considered a low volume waste and is discharged directly to the ash ponds as allowed by the existing KPDES permit. The EPA is currently considering two approaches for discharges of nonchemical cleaning wastes that are currently allowed without copper and iron limits and treated as low volume waste (such as the Sebree air preheater wash):

1. Provide an exemption and not specify PSES, allowing these waste streams to continue to be classified as low volume waste and discharged per the existing BPT limits (TSS, oil and grease).
2. Setting BAT limits for all nonchemical metal cleaning waste equal to the metal cleaning waste BPT and establishing PSES that include copper limits on discharges of nonchemical metal cleaning waste.

To take a conservative approach, Burns & McDonnell would suggest that all air preheater wash water be combined with other metal cleaning wastewaters in the existing metal cleaning waste ponds at Sebree. The modifications required to reroute the air preheater wash to the metal cleaning waste pond are expected to be negligible, as these flows are likely already captured and pumped to the ash pond during temporary wash periods. Per the assumption in Section 2.3, all discharges of nonchemical metal cleaning wastewater from each of the Big Rivers plants will likely be required to meet the current permitted discharge limits for metal cleaning waste (copper, iron, TSS, pH, and oil and grease). The existing pond should be providing adequate treatment to meet the existing discharge limits. Consequently, all metal cleaning wastewater, including chemical and nonchemical waste streams, can continue to be discharged through Outfall 005 and 008 to the Green ash pond. Big Rivers will need to continue monitoring these discharges to confirm that they meet the permitted discharge limits before comingling this flow with any new or legacy ash pond water, as required by the existing permit. No further modifications should be required for nonchemical metal cleaning wastewater at Sebree.

5.2 Potential Compliance Alternatives

Based on the review of the existing waste streams at the Sebree plant (see Section 5.1 and all subsections), the following treatment technologies should be considered for the various waste streams at the Sebree station.

5.2.1 Physical/Chemical and Biological Treatment of FGD Wastewater

As described in Section 5.1.1, for the purposes of this study Burns & McDonnell has assumed that site specific BPJ would establish BAT as chemical precipitation used in conjunction with biological treatment, or the same as the other proposed alternatives for BAT. Consequently, under any of the four preferred options, Big Rivers would need to install additional wastewater treatment equipment at Sebree to reduce the concentrations in their FGD wastewater to the limits shown in the white rows in Table 2-2. This would likely require the addition of a physical treatment system including chemical precipitation followed by a biological treatment stage designed to optimize removal of selenium.

For a description of the process and equipment required for this type of treatment system, refer to Section 3.2.1.1. The planning level capital cost for the addition of this equipment at Sebree is summarized in Table 5-2, and the marked up water balance is included in Appendix B of this report to include the changes described above. As noted in Section 5.1.1, this treatment system is based on a flow rate of 0.428 MGD, or approximately 300 gpm. Burns & McDonnell has assumed that all solids removed with this treatment system will be sent to the onsite landfill at Sebree for dry disposal, and that the permit for this facility can be modified to allow receipt of this material. Costs have not been included for additional auxiliary power, for operation and maintenance of the new equipment, or for additional waste hauling costs. This cost estimate was developed based on scaling from estimates developed for previous Burns & McDonnell projects. Should a regulation be promulgated and Big Rivers selects this system for FGD wastewater treatment at Sebree, Big Rivers should then implement a project definition study to further define the preferred compliance option including development of the budget level costs and implementation schedules.

Table 5-2: Planning Level Capital Cost Estimate for FGD Wastewater Treatment at Sebree

Direct Capital Costs	
Wastewater Treatment Equipment	[redacted]
Balance of Plant Modifications/Installation	
Subtotal Direct Cost	
Indirect Capital Cost	
Construction Management [redacted]	[redacted]
Engineering [redacted]	
Start-Up and Testing [redacted]	
Contingency [redacted]	
Subtotal Indirect Cost	
Total FGD Wastewater Treatment Cost	

Notes: 1) Capital cost represents all units.
2) No escalation has been included. Costs are in 2013 dollars.
3) Owner's costs are not included.

5.2.2 Conversion to Dry Economizer Fly Ash Handling

Each of the four preferred regulatory options outlined in Section 2.3 require zero discharge of fly ash transport waters. As described in Section 5.1.2, Burns & McDonnell projects that the Green economizer ash sluicing system will need to be converted to a dry handling system in order for the Sebree plant to comply with the proposed ELG regulations.

5.2.2.1 Existing Fly Ash System

The existing economizer ash handling system for each Green unit utilizes a water-power eductor to create the vacuum used to draw economizer ash from their respective hoppers. After passing through air separators, the ash is sluiced to the ash pond. Eductor sluice water is supplied from either the ash pond or the clarification system.

5.2.2.2 Ash Conversion System Criteria

As previously outlined in Section 3.2.2.2, there are several criteria that must be considered for a wet-to-dry ash conversion, such as hopper clearance, storage location, system capacity, and the possibility of beneficially selling ash. In addition, to select the dry economizer ash handling system, several assumptions about the Green Station were made, including:

- Big Rivers has no plans to switch fuel types or sources at the Green Generating Station.
- There are no plans to sell fly ash due to activated carbon and dry sorbent injection. Therefore blending the fly ash and economizer ash streams is acceptable.
- Adequate clearance underneath the existing economizer hoppers is available for dry flight conveyors (DFC). Additionally, clearance is available for the DFCs to be routed away from the economizer hoppers to a location above a small economizer storage tank.

- There is adequate space at grade for 2x100% economizer blowers and a small storage tank.
- Economizer discharge lines can be routed and supported on existing structural steel to the fly ash silo.

5.2.2.3 New Fly Ash Handling System

Because the economizer ash can be mixed with the fly ash, the system selected for the Green Station is to replace the existing economizer vacuum and sluicing piping with dry flight conveyors that capture and convey the economizer ash away from the hoppers, directing it into a small storage tank at grade. The dry economizer storage tank has a conical bottom where the ash will be guided through a crusher before being dilute phase blown to the existing fly ash silo.

Converting the existing sluicing ash system to a dry system would require additional plant utilities for the new equipment such as the dry flight conveyors, economizer storage tank, crusher, and dilute phase pressure blowers. This conversion incurs new auxiliary power requirements of approximately 90 horsepower per unit. The existing DCS will need to be modified to integrate the new control requirements. The new system will require instrument air for actuated valves. Because the air requirement is small, it is assumed adequate instrument air is available from the existing plant system.

5.2.2.4 Capital Cost Estimate

The estimate was prepared utilizing Burns &McDonnell's historical information for similar projects and construction experience. Should a regulation be promulgated and Big Rivers selects this system for installation at Sebree, Big Rivers should then implement a project definition study to further define the preferred compliance option including development of the budget level costs and implementation schedules.

The planning level cost estimate includes direct costs and indirect costs and is summarized in Table 5-3. The direct costs include equipment, materials, installation, and miscellaneous items such as surveying, testing, and start-up craft support. The indirect capital costs include construction management, engineering, start-up, and contingency. The estimate does not include any specific project insurance (such as builder's risk) or taxes for permanently installed equipment and materials. Costs have not been included for any traditional Owner's costs such as Owner's engineer, project support staff, additional operators, permits, etc. Costs have not been included for additional auxiliary power, for operation and maintenance of the new equipment, or for additional waste hauling costs.

Table 5-3: Planning Level Capital Cost Estimate for Green Economizer Ash Handling Conversion

Direct Capital Costs	
Economizer Ash Equipment	[redacted]
Balance of Plant Modifications	
Subtotal Direct Cost	
Indirect Capital Cost	
Construction Management [redacted]	[redacted]
Engineering [redacted]	
Start-Up and Testing [redacted]	
Contingency [redacted]	
Subtotal Indirect Cost	
Total Ash Conversion Project Cost	

Notes: 1) Capital cost represents both Green units.
2) No escalation has been included. Costs are in 2013 dollars.
3) Owner's costs are not included.

5.2.2.5 Project Schedule

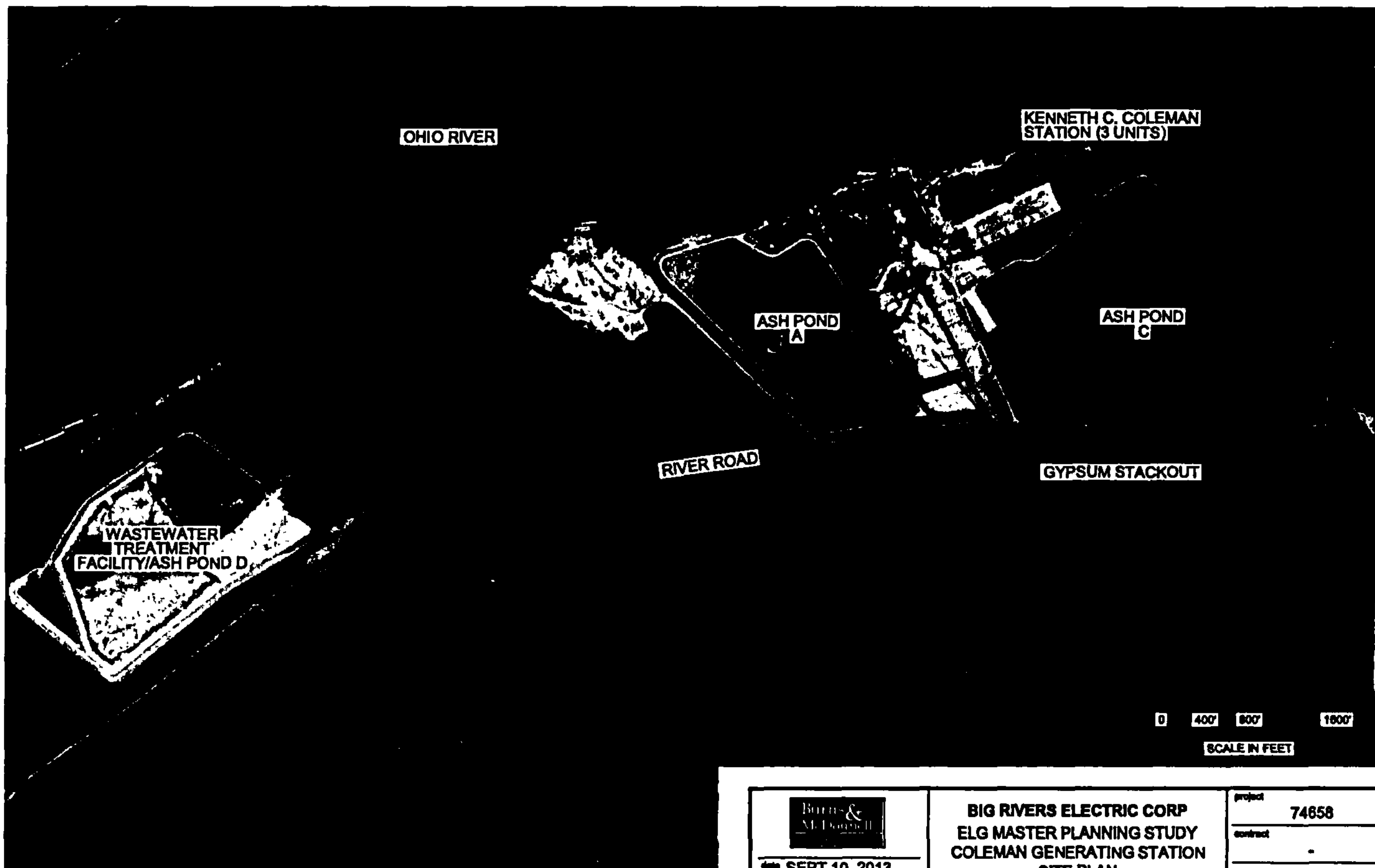
The economizer ash conversion schedule is based upon experience with similar projects. The project will require a 7 day outage for system tie-ins to the ash hopper valves and tie in of the new electrical system prior to start up activities. Depending on available space adjacent to the hoppers, the economizer dry fly conveyors may be able to be assembled with the unit online and only shifted over underneath the hoppers after completely assembled, thus decreasing outage time. Total project schedule is approximately 9 months long.

6.0 QUALIFICATIONS

Burns & McDonnell's estimates, analyses, and recommendations contained in this report are based on professional experience, qualifications, and judgment. Burns & McDonnell has no control over weather; cost and availability of labor, material, and equipment; labor productivity; energy or commodity pricing; demand or usage; population demographics; market conditions; changes in technology; and other economic or political factors affecting such estimates, analyses, and recommendations. Therefore, Burns & McDonnell makes no guarantee or warranty (actual, expressed, or implied) that actual results will not vary, perhaps significantly, from the estimates, analyses, and recommendations contained herein."

In the preparation of this report, the information provided by Big Rivers was used by Burns & McDonnell to make certain assumptions with respect to conditions which may exist in the future. While Burns & McDonnell believes the assumptions made are reasonable for the purposes of this study, Burns & McDonnell makes no representation that the conditions assumed will, in fact, occur. In addition, while Burns & McDonnell has no reason to believe that the information provided by Big Rivers, and on which this report is based, is inaccurate in any material respect, Burns & McDonnell has not independently verified such information and cannot guarantee its accuracy or completeness. To the extent that actual future conditions differ from those assumed herein or from the information provided to Burns & McDonnell, the actual results will vary from those forecasted.

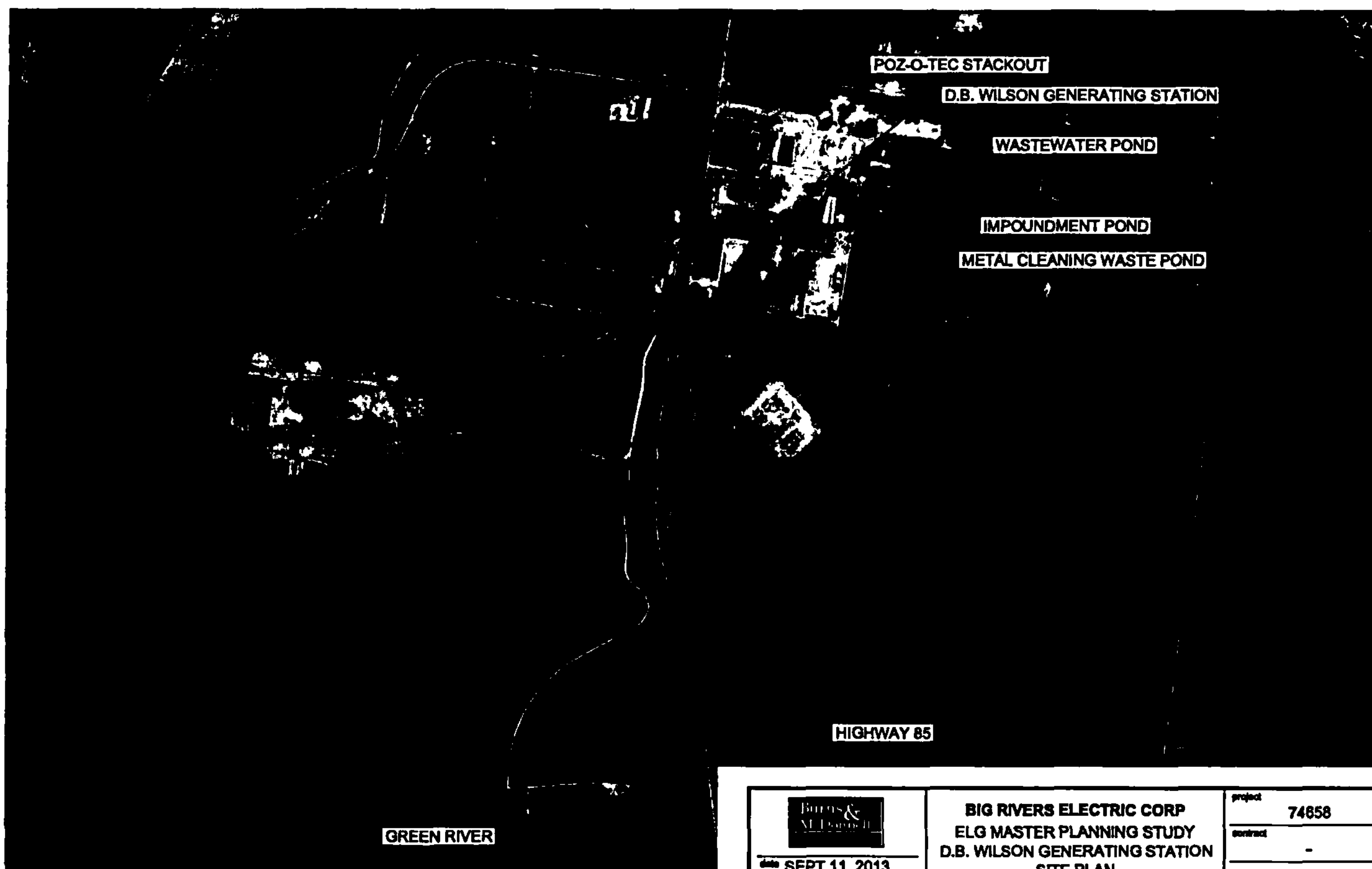
APPENDIX A - SITE PLANS



Burns & McDonnell	BIG RIVERS ELECTRIC CORP	project 74658
	ELG MASTER PLANNING STUDY	contract -
date SEPT 10, 2013	COLEMAN GENERATING STATION	
designed EICHENBERGER	SITE PLAN	SK - 001

10/21/2013

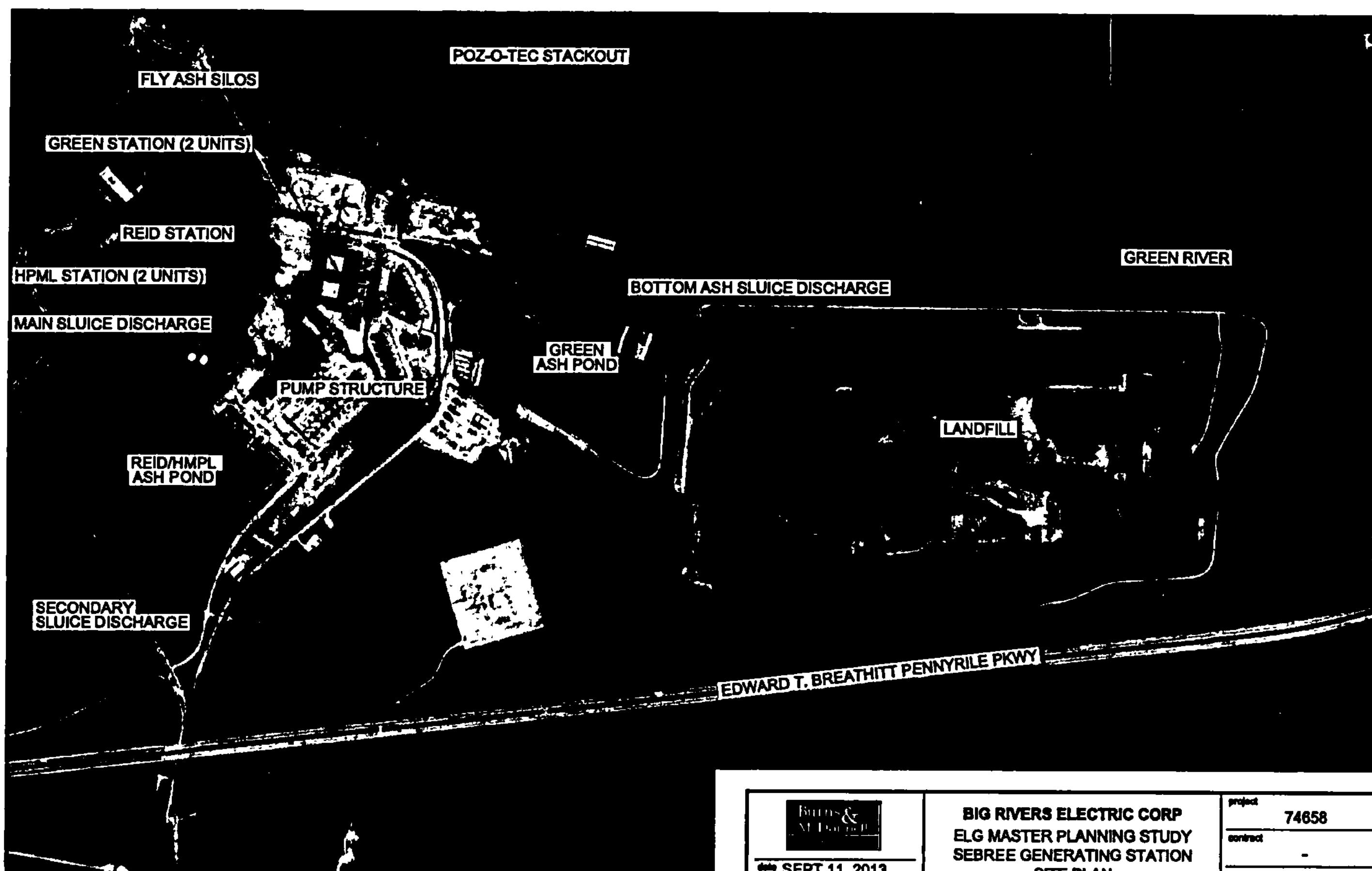
M:\Big_Rivers\74658\CAD\COMMON\74658SK001.dgn



Burns & McDonnell	**BIG RIVERS ELECTRIC CORP**	project 74658
date SEPT 11, 2013	ELG MASTER PLANNING STUDY D.B. WILSON GENERATING STATION SITE PLAN	contract -
designed EICHENBERGER		SK - 002

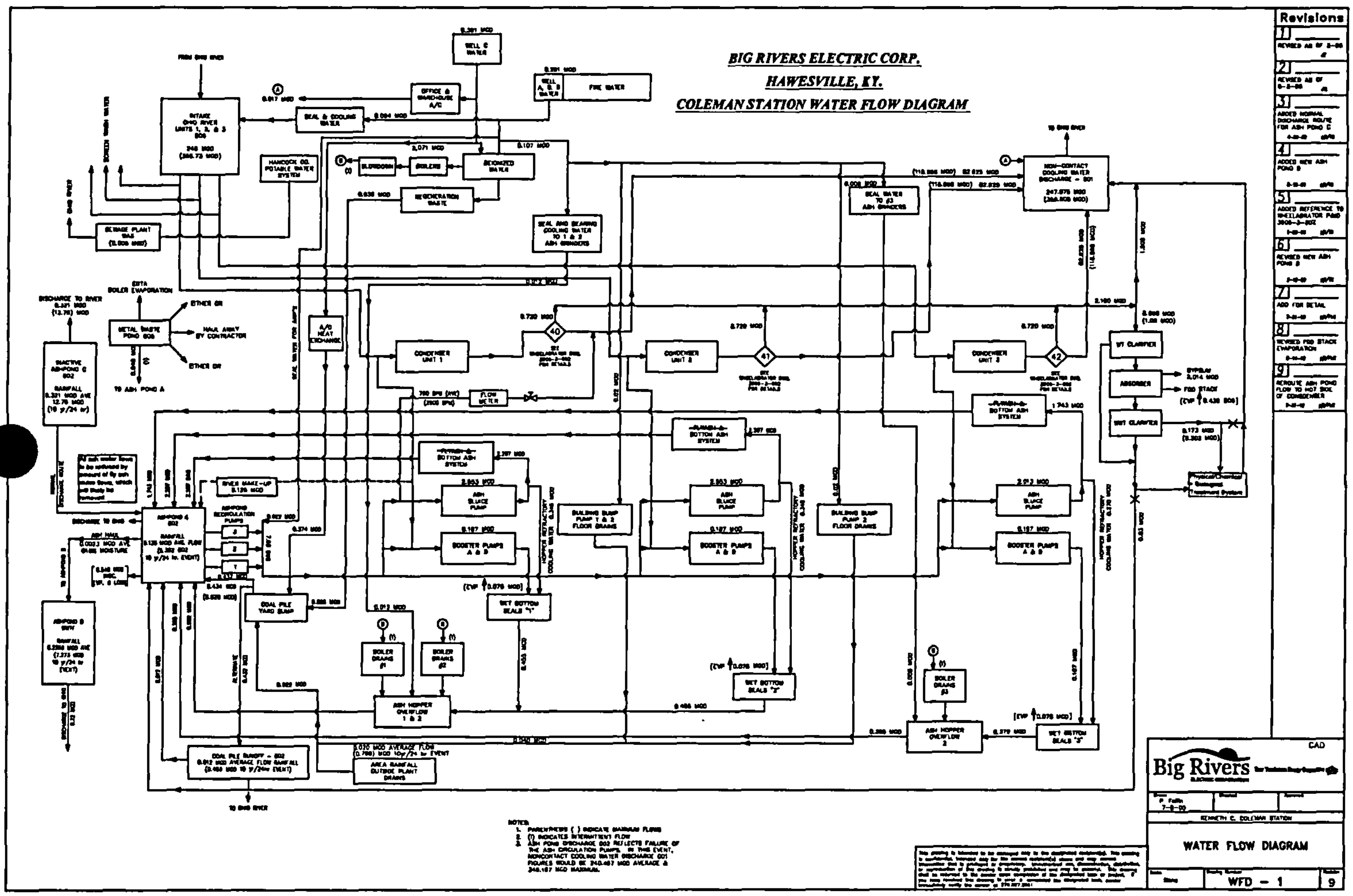
10/23/2013

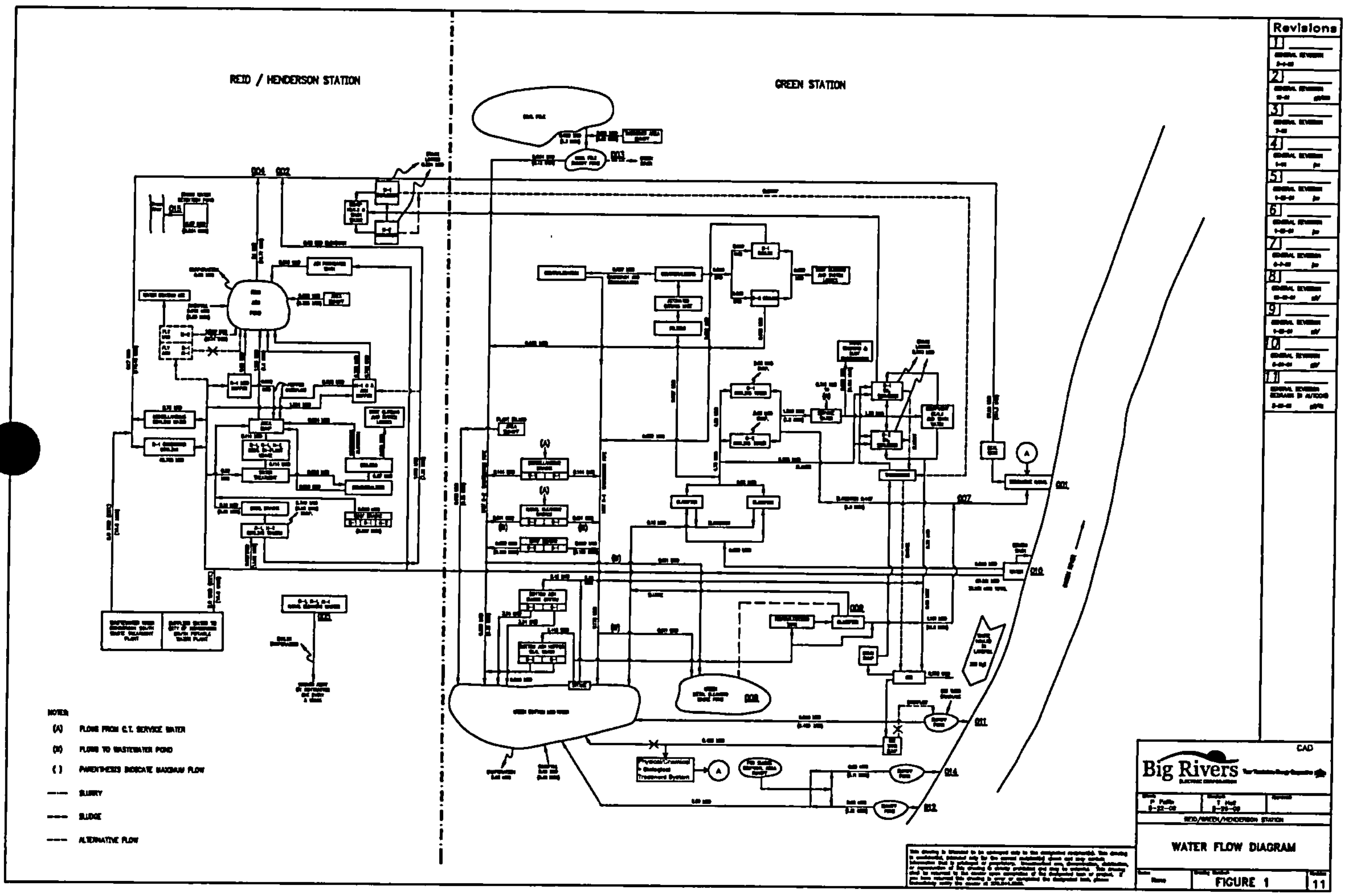
M:\Big_Rivers\74658\CAD\COMMON\74658SK002.dgn

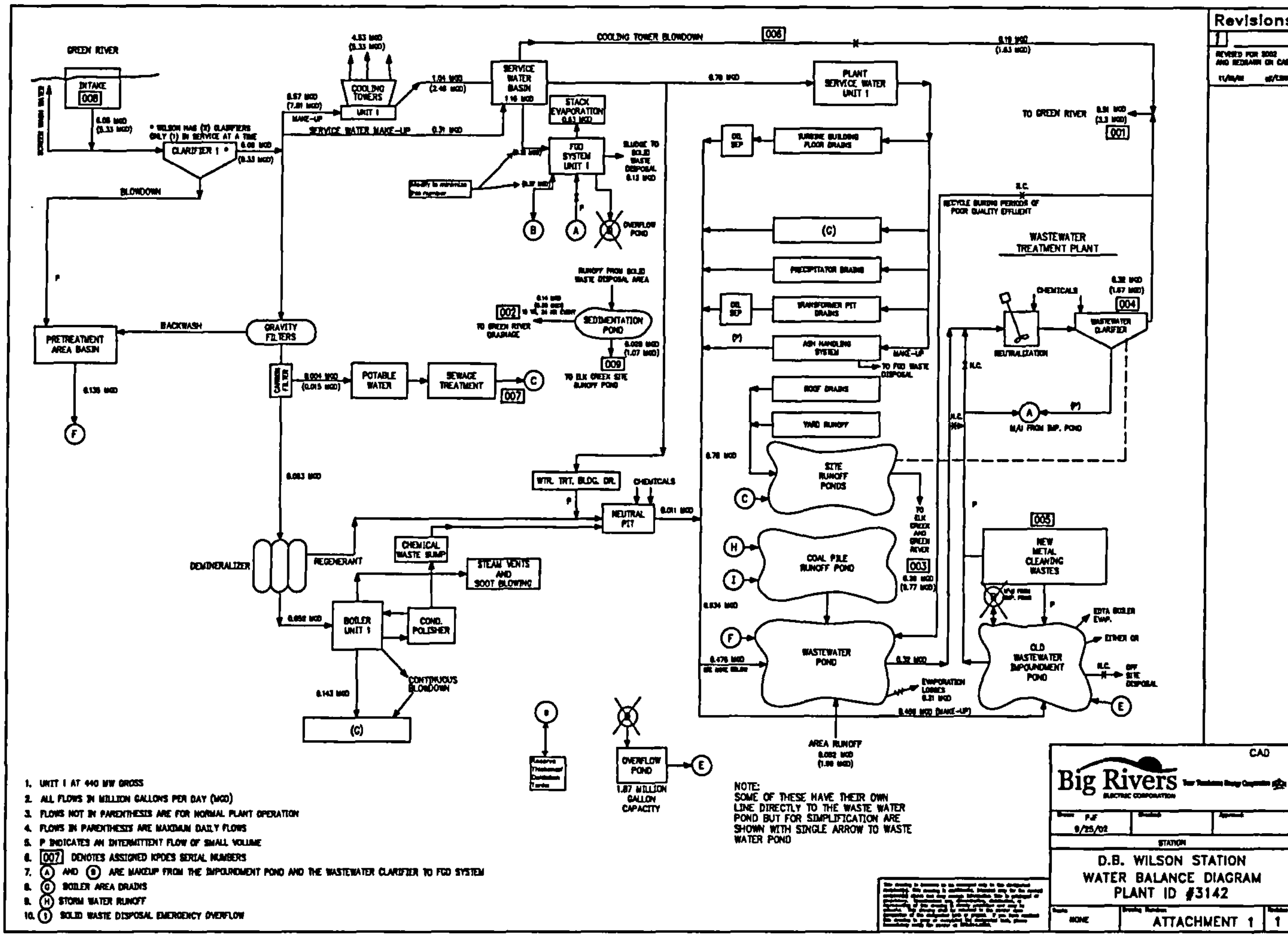


Burns & McDonnell date SEPT 11, 2013 designed EICHENBERGER	BIG RIVERS ELECTRIC CORP ELG MASTER PLANNING STUDY SEBREE GENERATING STATION SITE PLAN	project 74658 contract - SK-003

APPENDIX B - EXISTING WATER BALANCES


BIG RIVERS ELECTRIC CORP.
HAWESVILLE, KY.
COLEMAN STATION WATER FLOW DIAGRAM
Revisions
CONDENSER UNIT 1
CONDENSER UNIT 2
CONDENSER UNIT 3
ASH HOPPER OVERFLOW 2
WET BOTTOM SEALS "3"
NOTES:
1. PARENTHESIS ( ) INDICATE MAXIMUM FLOWS
2. (I) INDICATES INTERMITTENT FLOW
3. ASH POND DISCHARGE 002 REFLECTS FAILURE OF THE ASH CIRCULATION PUMPS. IN THIS EVENT, NONCONTACT COOLING WATER DISCHARGE 001 FIGURES WOULD BE 240.467 MGD AVERAGE & 348.167 MGD MAXIMUM.
CAD
Big Rivers
P. Fallin
7-9-00
KENNETH C. COLEMAN STATION
WATER FLOW DIAGRAM
WFD – 1
9


REID / HENDERSON STATION
GREEN STATION
Revisions
NOTES:
(A) FLOWS FROM C.T. SERVICE WATER
(B) FLOWS TO WASTEWATER POND
( ) PARENTHESES INDICATE MAXIMUM FLOW
SLURRY
SLUDGE
ALTERNATIVE FLOW
CAD
Big Rivers
WATER FLOW DIAGRAM
FIGURE 1
11


Revisions
GREEN RIVER
INTAKE
008
COOLING TOWERS
UNIT 1
SERVICE WATER BASIN
COOLING TOWER BLOWDOWN
006
PLANT SERVICE WATER UNIT 1
STACK EVAPORATION
FGD SYSTEM UNIT 1
SERVICE WATER MAKE-UP
MAKE-UP
CLARIFIER 1 *
* WILSON HAS (2) CLARIFIERS ONLY (1) IN SERVICE AT A TIME
BLOWDOWN
TO GREEN RIVER
001
OVERFLOW POND
OIL SEP
TURBINE BUILDING FLOOR DRAINS
(C)
PRECIPITATOR DRAINS
TRANSFORMER PIT DRAINS
ASH HANDLING SYSTEM
SOOT DRAINS
YARD RUNOFF
RECYCLE DURING PERIODS OF POOR QUALITY EFFLUENT
WASTEWATER TREATMENT PLANT
CHEMICALS
004
WASTEWATER CLARIFIER
NEUTRALIZATION
M/U FROM IMP. POND
RUNOFF FROM SOLID WASTE DISPOSAL AREA
002
SEDIMENTATION POND
009
TO ELK CREEK SITE RUNOFF POND
PRETREATMENT AREA BASIN
BACKWASH
GRAVITY FILTERS
CARBON FILTER
POTABLE WATER
SEWAGE TREATMENT
007
WTR. TRT. BLDG. DR.
CHEMICALS
NEUTRAL PIT
SITE RUNOFF PONDS
TO ELK CREEK AND GREEN RIVER
003
COAL PILE RUNOFF POND
005
NEW METAL CLEANING WASTES
DEMINERALIZER
REGENERANT
CHEMICAL WASTE SUMP
STEAM VENTS AND SOOT BLOWING
BOILER UNIT 1
COND. POLISHER
CONTINUOUS BLOWDOWN
WASTEWATER POND
EVAPORATION LOSSES
OLD WASTEWATER IMPOUNDMENT POND
OFF SITE DISPOSAL
AREA RUNOFF
OVERFLOW POND
1.87 MILLION GALLON CAPACITY
1. UNIT 1 AT 440 MW GROSS
2. ALL FLOWS IN MILLION GALLONS PER DAY (MGD)
3. FLOWS NOT IN PARENTHESIS ARE FOR NORMAL PLANT OPERATION
4. FLOWS IN PARENTHESIS ARE MAXIMUM DAILY FLOWS
5. P INDICATES AN INTERMITTENT FLOW OF SMALL VOLUME
6. 007 DENOTES ASSIGNED KPDES SERIAL NUMBERS
7. A AND B ARE MAKEUP FROM THE IMPOUNDMENT POND AND THE WASTEWATER CLARIFIER TO FGD SYSTEM
8. G BOILER AREA DRAINS
9. H STORM WATER RUNOFF
10. I SOLID WASTE DISPOSAL EMERGENCY OVERFLOW
NOTE:
SOME OF THESE HAVE THEIR OWN LINE DIRECTLY TO THE WASTE WATER POND BUT FOR SIMPLIFICATION ARE SHOWN WITH SINGLE ARROW TO WASTE WATER POND
CAD
Big Rivers
ELECTRIC CORPORATION
9/25/02
STATION
D.B. WILSON STATION
WATER BALANCE DIAGRAM
PLANT ID #3142
NONE
ATTACHMENT 1
1

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
Phone: 816-333-9400
Fax: 816-333-3690
www.burnsmcd.com

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