Steam Electric Power Generating Facilities: Meeting Future Wastewater Treatment Requirements

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ABSTRACT

The United States Environmental Protection Agency (EPA) is evaluating more stringent effluent limitations guidelines (ELGs) for water discharges which may impact NPDES permits in the future. In addition, the EPA is evaluating rules that will prohibit the storage of coal combustion products (CCPs) in ash ponds and require CCPs to be stored in lined landfills. To prepare for these changes, the Tennessee Valley Authority (TVA) is evaluating the elimination of CCP storage in impoundments. If the impoundments are closed, the other wastewater streams that currently discharge into them will also be affected. Therefore, TVA is investigating options to handle the miscellaneous wastewater streams that currently discharge to the impoundments and meet more stringent ELGs in the future.

This investigation includes characterization of the existing wastewater streams, determining the effects on wastewater streams associated with future plant modifications, developing methods to reduce and reuse wastewater streams to avoid discharge, and developing methods to treat the remaining wastewater streams that may be discharged to meet potential future ELGs.

TVA is in the forefront of addressing the pending EPA rules that may affect CCP handling and storage, and water discharges. This paper presents the process being used by TVA to address the impacts on wastewater handling at their facilities.

PROJECT DRIVERS

EPA issued proposed regulations in June 2010 seeking comments on a choice between regulating coal ash waste under Subtitle C (hazardous) or Subtitle D (non-hazardous) of the Resource Conservation and Recovery Act (RCRA). Subtitle C designation would phase out the use of existing and future surface impoundments, whereas Subtitle D designation would require existing surface impoundments to stop receiving CCRs or be retrofitted with a liner. Due to the high cost associated with removing the CCRs and

installing a liner, Subtitle D designation effectively phases out the use of existing surface impoundments. At the time of this writing there has been no final action on the proposed 2010 coal ash regulations.

In addition to the pending regulations for CCR management, EPA is developing a proposed rule to amend the ELGs for Steam Electric Power Generating facilities. In October 2009 EPA reported that the current regulations have not kept pace with changes in the electric power industry and do not adequately address the pollutants being discharged. Under a consent decree entered into in *Defenders of Wildlife v. EPA*, No. 10-cv-01915 (D.D.C.), and since revised, EPA agreed to sign proposed rulemaking by April 2013 and take final action by May 2014. These ELGs are one basis for establishing the discharge limits in the National Pollutant Discharge Elimination System (NPDES) permit for a given facility.

Another basis for establishing the discharge limits in NPDES permits are the water quality criteria of the receiving water body. These water quality criteria are based on the intended use of the water body such as domestic water supply, propagation and maintenance of fish and other aquatic life, recreation including the safe consumption of fish and shell fish, the propagation and maintenance of wildlife, and the assimilative capacity of the receiving water body. For streams and rivers the assimilative capacity is based on such factors as the volume of flow, rate of flow, and depth of channel.

More stringent discharge limits and monitoring requirements have been implemented in recent NPDES permits. For example, the draft NPDES permit for the Merrimack Station (Bow, NH) implemented discharge limits for the flue gas desulfurization (FGD) system waste treatment facility effluent for arsenic, cadmium, chromium, copper, lead, manganese, mercury, selenium, zinc, chlorides, and dissolved solids; and reporting requirements for boron, iron, BOD5, nitrogen and phosphorus. The Merrimack draft NPDES permit also implemented limits and reporting requirements for aluminum, arsenic, copper, mercury, selenium, chloride, suspended solids, oil and grease, and pH from the Slag Settling Pond discharge. Several wastewater streams, including the FGD system waste treatment facility, discharge into the Slag Settling Pond. It should be noted that the Public Service of New Hampshire, and several other utilities, have provided extensive comments to this draft NPDES permit.

The NPDES permit for Homer City Generation (Homer City, PA) implemented discharge limits for pH, temperature, CBOD5, suspended solids, oil and grease, beryllium, lead and selenium from the FGD wastewater treatment plant to the adjacent water body. The Homer City NPDES permit also implemented reporting requirements for flow, dissolved solids, boron and MBAS.

The Tennessee Department of Environment and Conservation (TDEC) has not implemented additional discharge limits in recent NPDES permits for TVA Steam Electric Power Generating facilities. However, TDEC has included monitoring requirements for approximately eighteen additional constituents in these recent permits, thereby indicating an increased level of attention to the pollutants in water discharges.

COMPLIANCE APPROACH

While the CCR disposal regulations have not been finalized, both Subtitle C and Subtitle D solid waste designations would effectively phase out the use of existing surface impoundments. Therefore, TVA is taking a proactive approach and starting the process of converting to dry CCR storage in landfills. The following projects are being implemented as needed to support the closure of the surface impoundments.

- Fly ash systems are being converted to dry pneumatic conveyance systems which do not have an operational water discharge. It is noted that several facilities currently have dry fly ash systems.
- Bottom ash dewatering facilities are being developed. These dewatering facilities recycle the bottom ash conveyance water and do not discharge water during normal operation. However, there may be water discharges to support maintenance operations.
- Gypsum (FGD effluent) dewatering facilities are being implemented. The water discharged from these facilities is sent to a surface impoundment. An alternative handling method would need to be developed to support the future impoundment closures.
- Lined landfills are being constructed.

There are several other wastewater streams that currently discharge to the surface impoundments that will need to be handled differently to support their closure. The following are some of the typical wastewater streams:

- Station Sumps
- Boiler Bottom Overflow Sumps
- Raw Water Treatment Facility Waste
- Fly Ash Silo Sumps
- Precipitator Wash Down Sumps
- Coal Yard Runoff
- Miscellaneous Plant Outdoor Sumps
- Gypsum dewatering facility effluent

Since it is evident that more stringent limits on water discharges will be enacted, TVA has started a program to evaluate options to handle the wastewater from their facilities.

PROJECT APPROACH

TVA has a structured project approach consisting of four phases:

Phase 1: Preliminary Engineering – Evaluate all alternatives, determine the best solution, develop a well-defined project baseline (scope, cost and schedule), and develop detailed project plans.

Phase 2: Detailed Design – Complete the detailed design, obtain any necessary property and permits, and prepare the construction management plan.

Phase 3: Implementation – Complete construction and testing, and turn the project over to operations.

Phase 4: Close-Out – Complete any remaining punch list items from Phase 3, finalize project documentation, conduct a project assessment, and complete the administrative close-out process.

The wastewater projects are currently in Phase 1 Preliminary Engineering.

WASTEWATER PRELIMINARY ENGINEERING

The goal of Phase 1 Preliminary Engineering is to determine projects that will reduce, reuse and/or treat the wastewater at each facility to meet the future regulatory requirements. Phase 1 Preliminary Engineering is divided into four Tasks.

Task 1: Characterize the Existing Configuration

A first step in developing methods to handle the various wastewaters is to characterize these streams. This involves determining which wastewater streams need to be addressed, the amount (flow rate) of wastewater generated from each stream, and the concentration of the constituents of concern in each stream.

Using the flow diagrams from the NPDES permit applications, process flow diagrams, an inspection of the plant, and interviews with plant environmental, engineering and operations personnel, the wastewater streams that are to be addressed are established. The plant personnel also provide information on how these streams are affected during the operation of the facility in all conditions including normal operation, startup, shutdown and outages.

Any data currently available to characterize the wastewater streams is collected. This may include flow data from plant instrumentation, equipment or system design data, and chemical analysis previously conducted. A test plan is developed and implemented to complete the characterization of the various wastewater streams. This includes measuring flow rates, collecting and analyzing samples from the wastewater streams, and recording plant operating conditions such as power generation, fuel (coal) analysis data, and rainfall. Flow rates are measured using non-intrusive ultrasonic flow meters, pump runtime data loggers and existing plant instrumentation, or are approximated by storm water runoff calculations. Composite 24 hour samples and discrete grab samples of the wastewater streams are collected and analyzed. Since the constituents to be regulated in the future are not known, the sample testing covers an extensive list of parameters. In addition, storm water runoff samples are collected during significant rain

events and component wash water samples are collected during unit outages to complete the characterization.

The data collected is analyzed to determine nominal (average) and maximum flow rates and constituent concentrations. This analysis includes adjustments for plant operating conditions such as the number of generating units in operation and the amount of power produced by these units if applicable to the individual wastewater stream. The analysis also includes adjustments for precipitation as applicable.

Based on the data obtained from the sampling events, the FGD effluent and outage wash waters contain higher constituent concentrations than the other plant process wastewater streams. These other process streams include station sumps, boiler bottom overflow sumps, raw water treatment facility waste, fly ash silo sumps, precipitator wash down sumps, coal yard runoff and miscellaneous plant outdoor sumps. The constituent concentrations in these other process wastewater streams are generally low. However, the constituents observed to have the highest concentrations include copper, aluminum and iron; with select locations having higher selenium concentrations. The concentrations measured in the individual streams may or may not be of concern depending on the discharge limits implemented in the future. Also, which streams are allowed to be combined prior to being regulated will affect whether specific individual streams are of concern.

The FGD effluent and outage washes such as boiler wash, precipitator wash and air preheater wash contain higher concentrations of similar constituents including aluminum, arsenic, cadmium, copper, iron, lead, mercury, nickel, selenium, thallium and zinc. Again, the concentrations measured in these streams may or may not be of concern depending on the discharge limits implemented in the future and if these streams are allowed to be combined with other wastewater streams prior to being regulated.

It should be noted that all samples were collected from the location of concern, are untreated and do not represent the conditions at the final discharge or compliance point in current NPDES permits.

Task 2: Characterize Future Conditions

Each plant has projects currently in process, being developed or scheduled to occur in the near future that may impact wastewater generation. These projects may include the addition of or modifications to existing Air Quality Control System (AQCS) equipment, conversion to dry fly ash conveyance, conversion to closed loop recirculating bottom ash conveyance with dewatering, and the addition of gypsum dewatering facilities. The data available for these projects is reviewed and the associated affects on wastewater generation are compiled.

In addition, the variations in coal properties due to source changes are evaluated, and the impacts on the applicable wastewater sources are determined. For example, the

typical mercury concentration is 0.01 ppm – 0.5 ppm (PRB) and 0.05 ppm – 0.07 ppm (bituminous), and the typical concentration of selenium is 0.5 ppm to 5.0 ppm (PRB) and 2.0 ppm – 2.7 ppm (bituminous). Therefore, facilities that are adding or increasing their use of bituminous coal due to the addition of an FGD may experience a reduction in these constituents.

Task 3: Develop Wastewater Handling Options

The various wastewater streams are analyzed to determine changes that can be made to systems, equipment or operations that would reduce the amount of wastewater generated. For example, many TVA facilities use “once through” cooling for miscellaneous equipment; fan bearings, pump bearings, pulverizers, turbine lube oil, generator hydrogen, etc. The “once through” cooling systems pump river water through the component heat exchangers which discharge to station sumps; the station sumps are pumped to the ash pond. There are several options that could be implemented to prevent this non-contact cooling water from being sent to the ash ponds such as segregation of the non-contact cooling water discharges from the station sumps or the installation of a closed cooling water system for the miscellaneous equipment.

In addition, the characterization data is analyzed to determine if there are wastewater streams that can be used within the facility without treatment, or with minimal treatment, in lieu of being discharged to surface impoundments. For example, the level of soluble (dissolved) constituents in several of the miscellaneous plant outdoor sumps is similar to the concentration in the raw river water. Therefore, these wastewater streams may be reused within the facility following a settling or filtration process.

The wastewater remaining after the reduction and reuse options are implemented will require some level of treatment prior to being discharged. The characterization data is evaluated to determine if certain wastewater streams are to be segregated because they require different treatment processes than the remaining streams. Once the permit limits are known, various treatment processes will be investigated to determine those required to achieve the permit requirements.

Task 4: Evaluate Selected Options

The various options for managing the wastewater streams are evaluated to determine which options will be implemented.

All of the options are evaluated based on a life cycle cost (capital, operation, maintenance, etc.) analysis of the overall wastewater handling project. Therefore, the analysis includes cost savings associated with a reduction in the required treatment associated with wastewater reduction and reuse projects.

A risk assessment is also performed for the wastewater handling options. The assessment includes an analysis of the regulatory impacts, ease of implementation and

public acceptance of each option. The assessment also includes a review of the maintainability, availability, reliability, constructability and operability (MARCO) of each option.

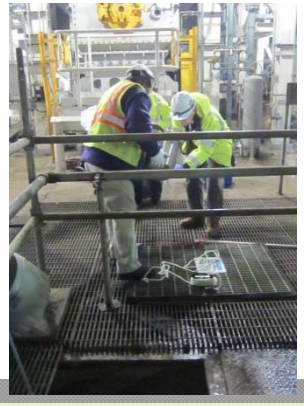
Certain wastewater reduction or reuse projects may be initiated before the permit requirements are known or need to be implemented if they achieve an overall minimization of life cycle costs, facilitate meeting permit regulations, and maximize the overall MARCO for wastewater handing.

REFERENCES

[1] NPDES Permit No. NH0001465 (draft) Authorization to Discharge Under the National Pollutant Discharge Elimination System, Public Service of New Hampshire (PSNH), Merrimack Station, 97 River Road, Bow, NH 03301

[2] NPDES Permit No. PA0005037, Amendment No. 1, Authorization to Discharge Under the National Pollutant Discharge Elimination System Discharge Requirements for Industrial Wastewater Facilities, EME Homer City Generation L.P., 1750 Power Plant Road, Homer City, PA 15748-8009

April 2013

Steam Electric Generation Facilities

Meeting Future Wastewater Treatment Requirements

Presenter Introductions

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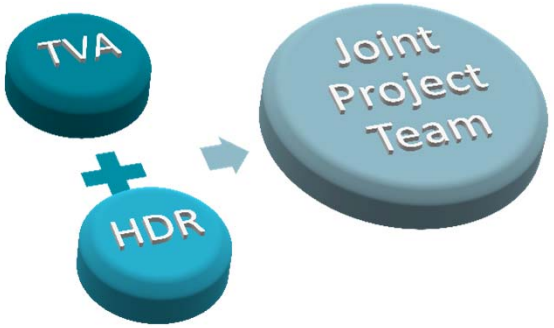
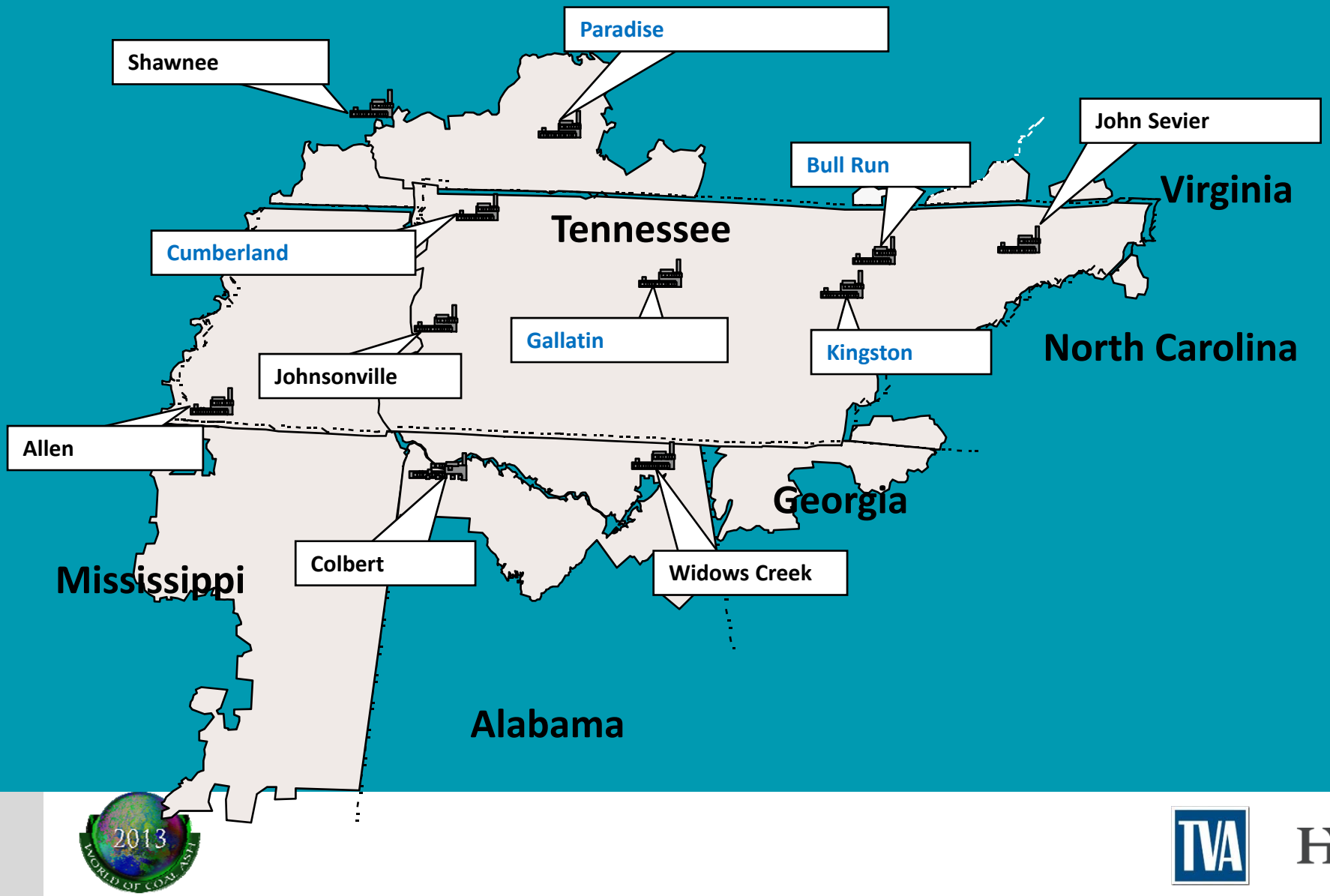


TVA's Fossil Generation Fleet



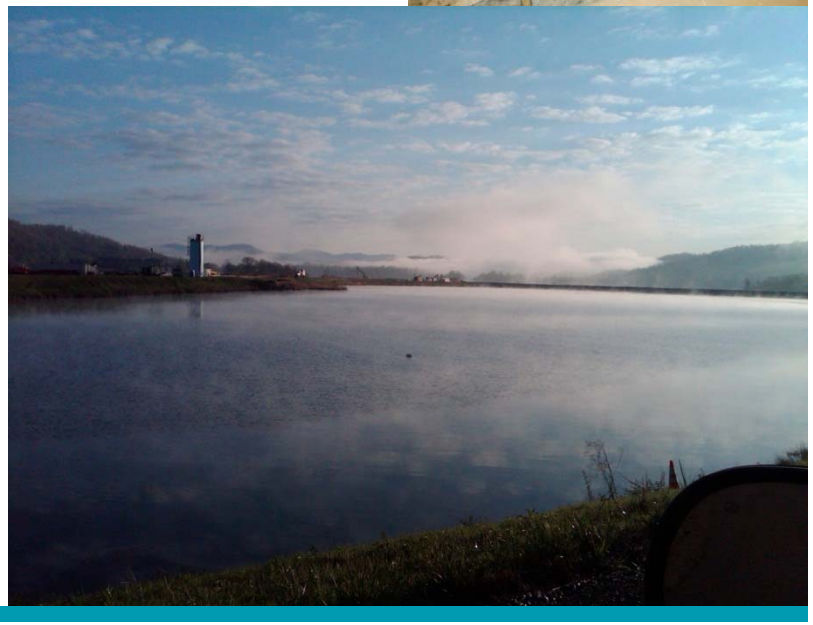
Outline

Drivers

Project Approach

Wastewater Characteristics

Treatment Process



2013 WORLD OF COAL ASH

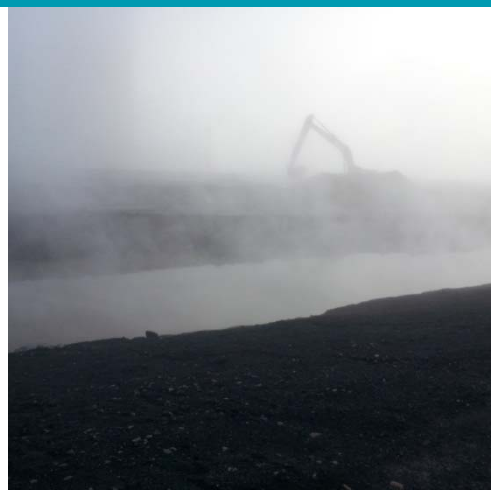
TVA HDR




TVA Fossil Plant Wastewater Treatment Study

Project Drivers

CCR Regulations



1976 RCRA

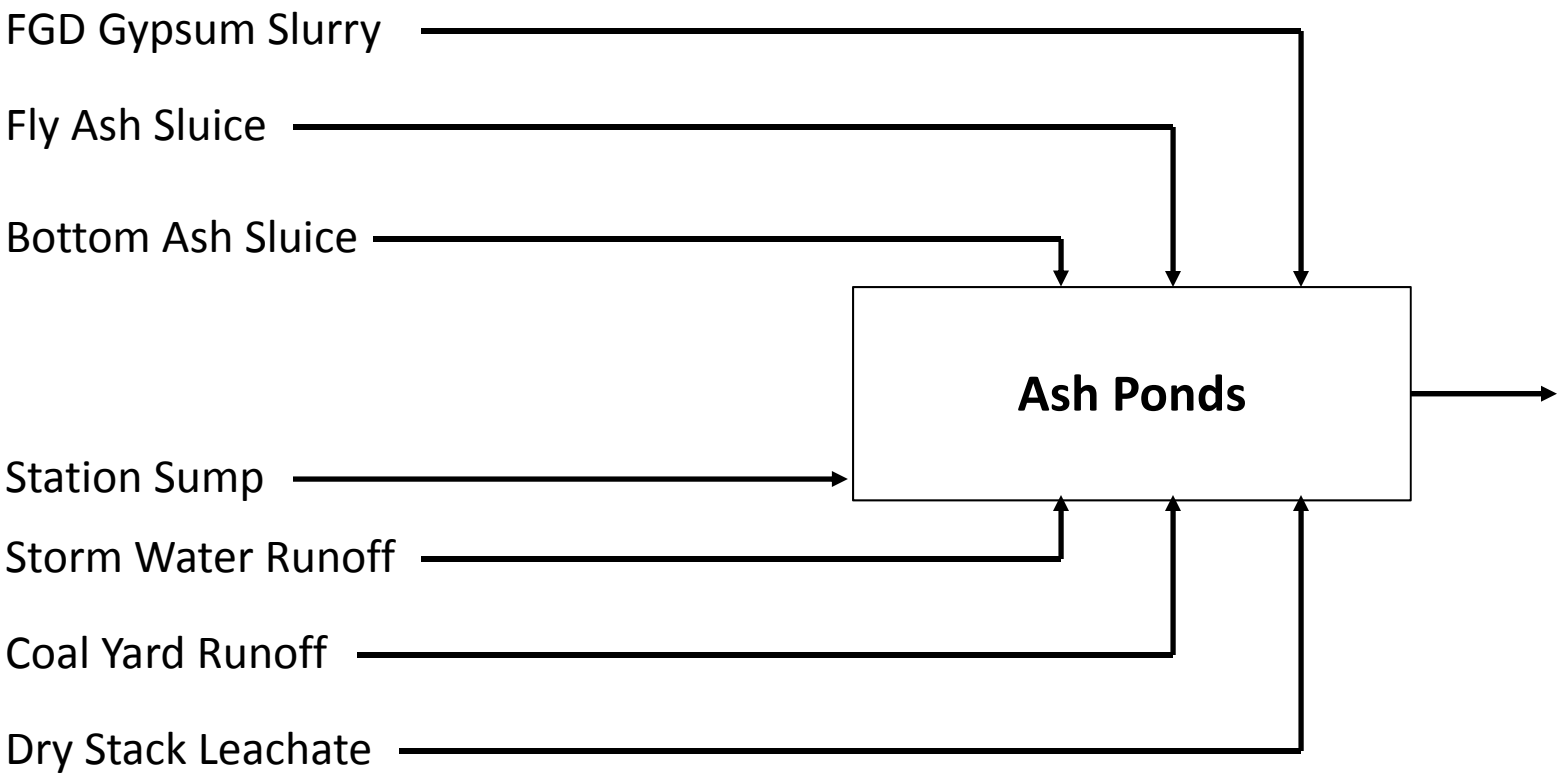
1980 Bevill Amendment

-Exempt from Subtitle C

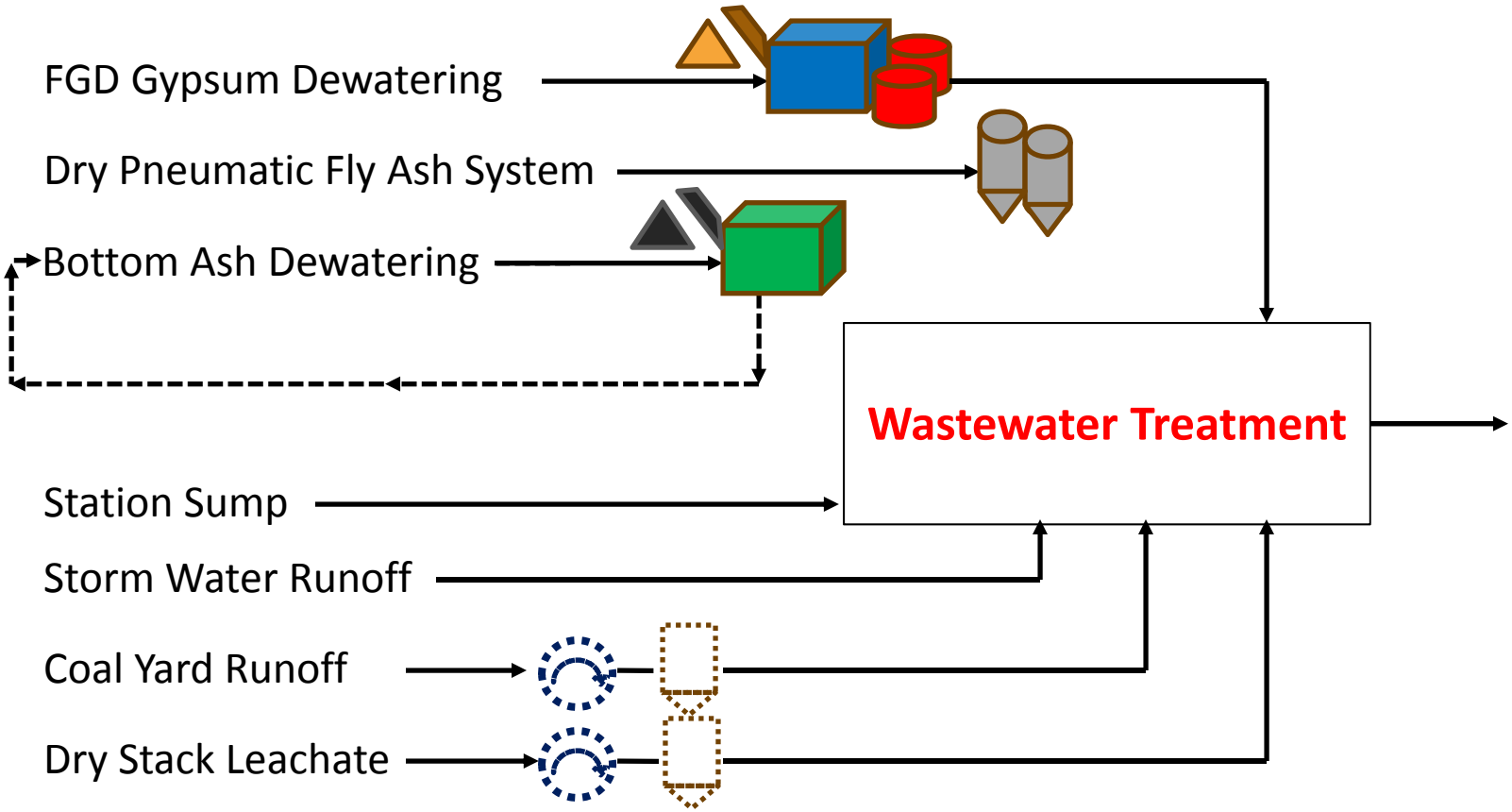
2010 EPA proposes regulations:

- Subtitle D
- Subtitle C

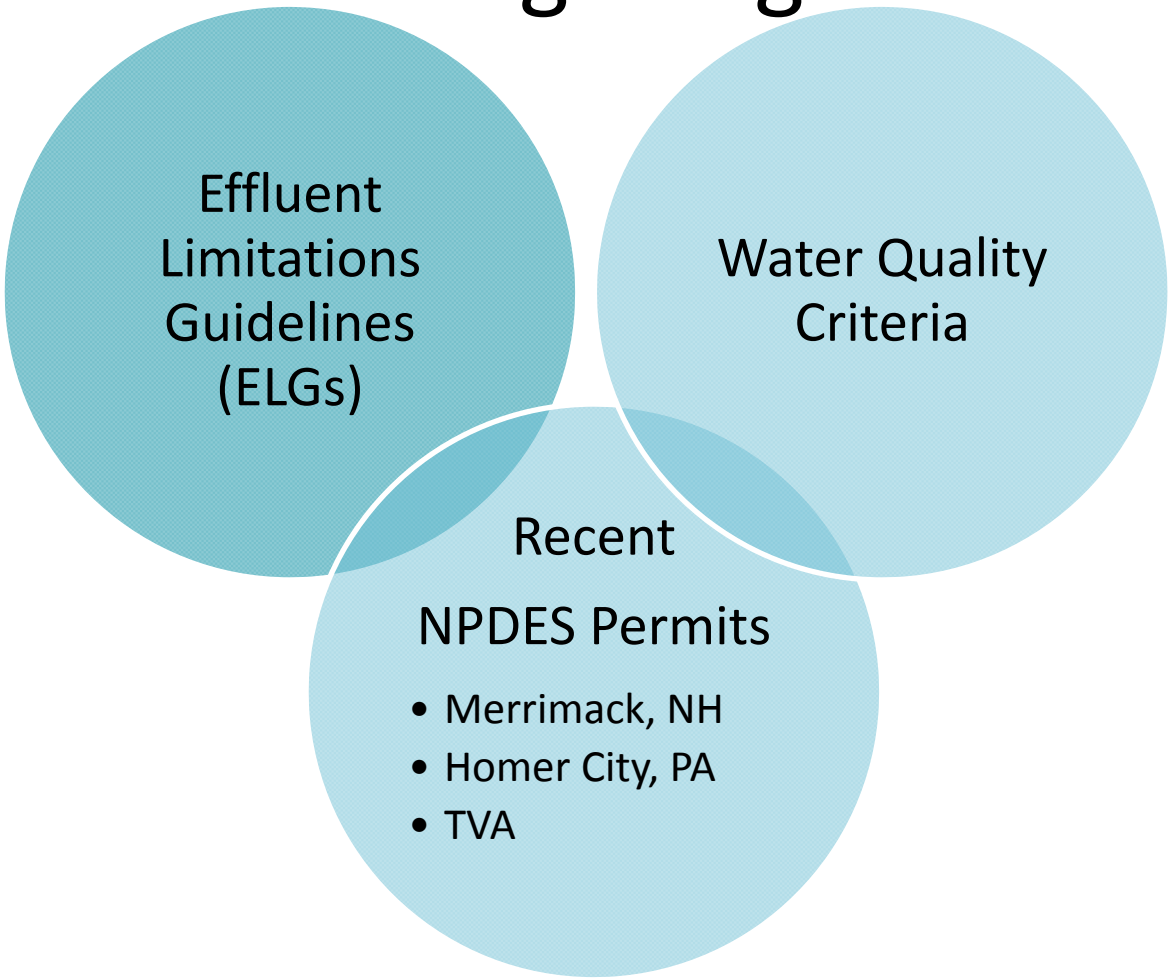
Project Drivers:
CCR Storage Regulations

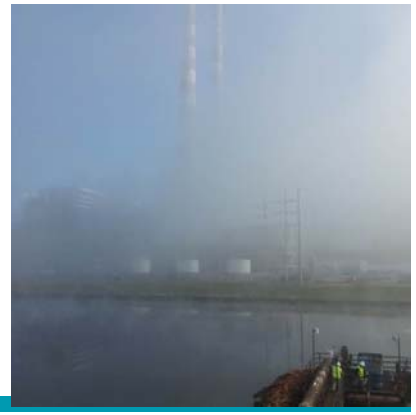


Project Drivers:
CCR Storage Regulations=Pond Closures



Project Drivers:
Water Discharge Regulations=Treatment








TVA Fossil Plant Wastewater Treatment Study

Project Approach

TVA Project Process

Phase 0
- Project Initiation

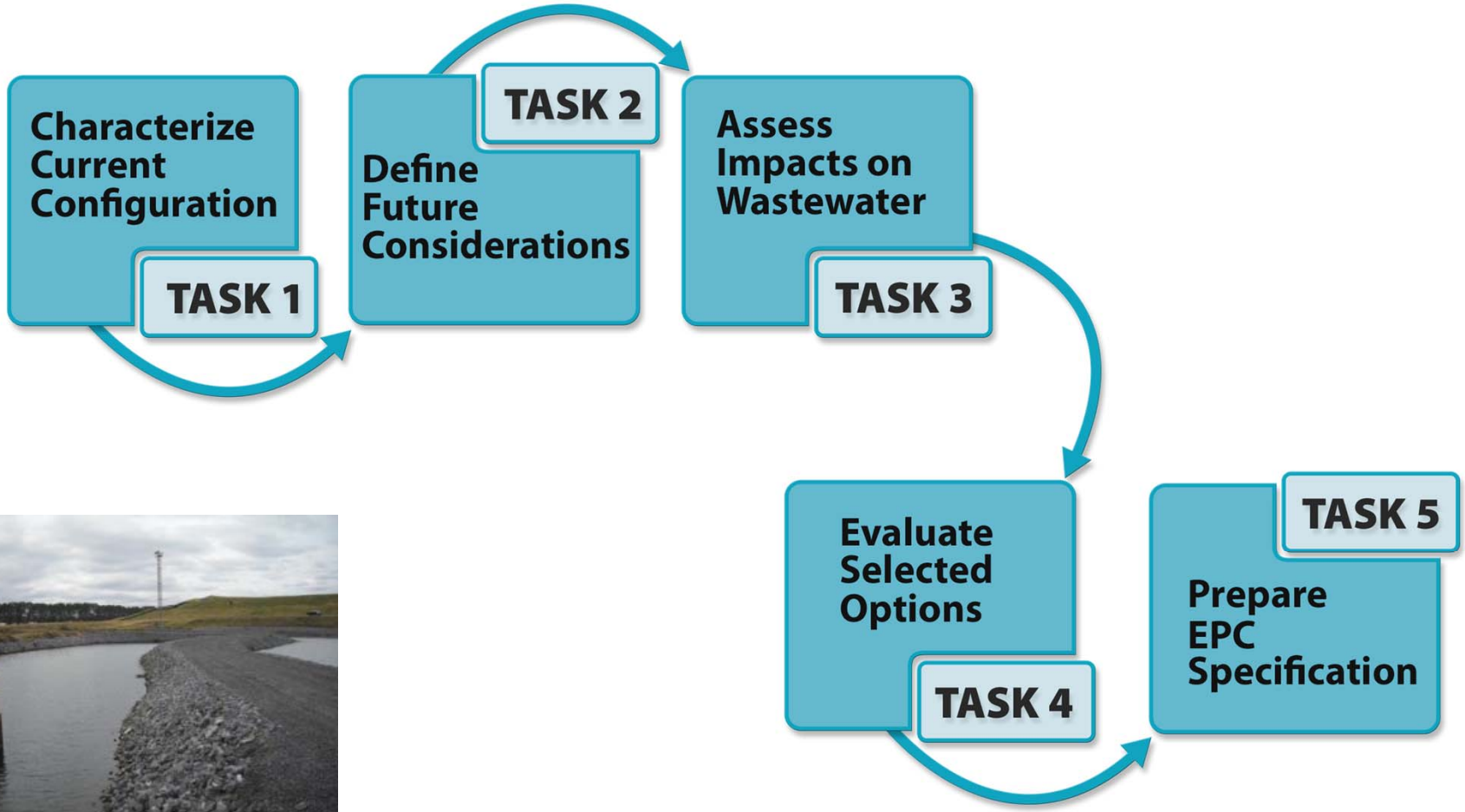
Phase I
- Preliminary Engineering

Phase II
- Detailed Engineering

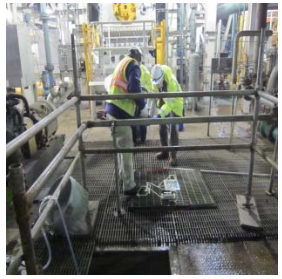
Phase III
- Construction

Phase IV
- Close Out

Phase 1 – Preliminary Engineering Wastewater Treatment Study





Wastewater Characteristics & Conceptual Treatment Process

Characterization Results

General Plant Wastewater

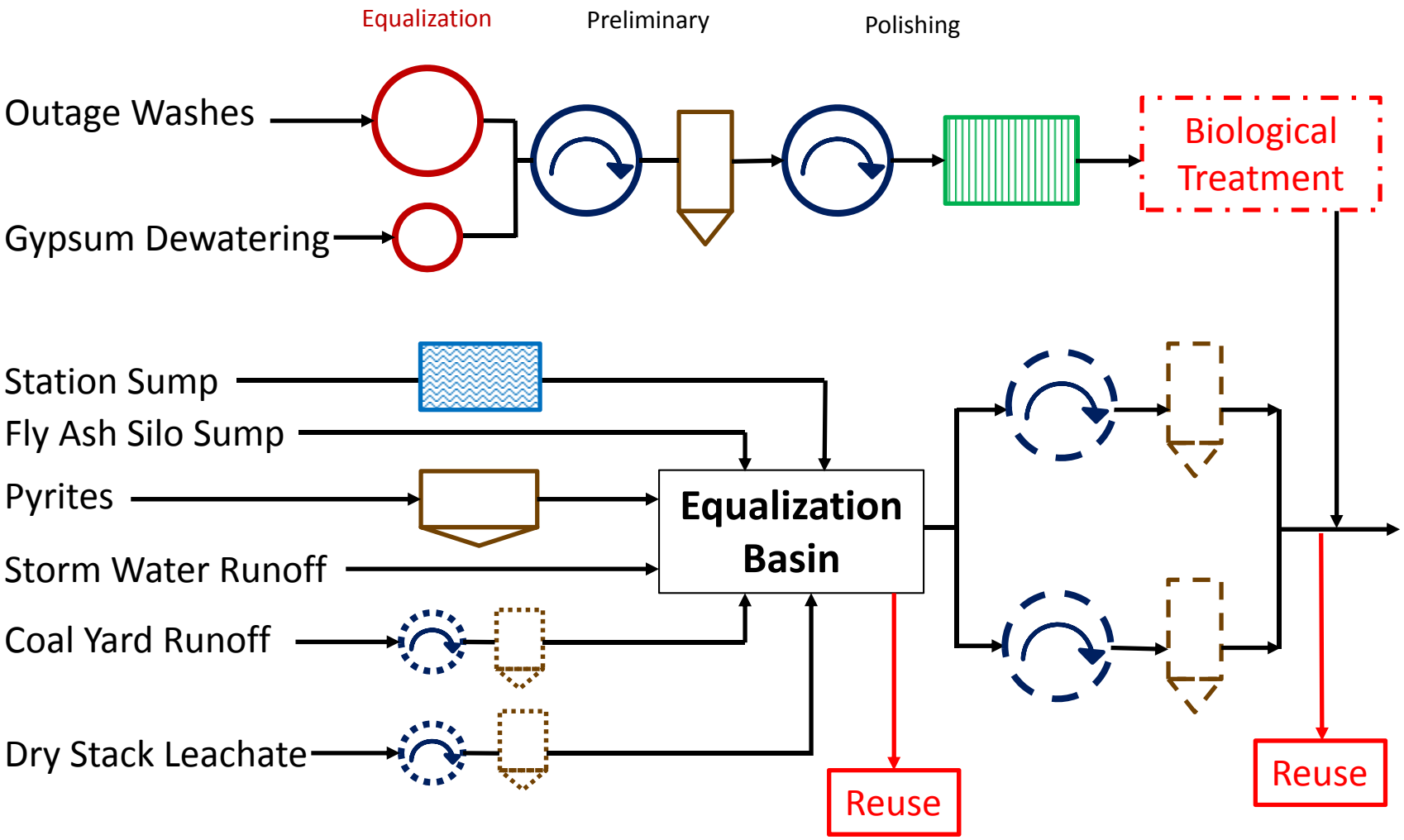
aluminum, copper and iron

selenium at select locations

Gypsum Dewatering (FGD) Wastewater & Outage Washes

aluminum, arsenic, cadmium, copper, iron, lead, mercury, nickel, selenium, thallium and zinc

Conceptual Treatment Process



Summary

Drivers

Project Approach

Wastewater Characteristics

Treatment Process

Questions?