IST Wellfield System – A Sustainable Clean Water Strategy for Dewatering Pond Ash

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ABSTRACT

Compared to mechanical dewatering methods and vacuum wellpoint systems, the In Situ Treatment (IST) Wellfield System is an advanced engineering technology which adapts drilled wells with a specialized anti-clogging filtration system and uses the full depth of the pond to optimize well flow. Extending deep into the pond ash deposit, individually controlled well pumps gradually lower the water level and stabilize the ash deposits for cap in place, ash removal, or overfill landfill development. Layered well completion materials provide in situ treatment by filtering Total Suspended Solids from the leachate. The IST method is generally a four stage process that uses pilot testing to verify wellfield design with system removal rates to fit the project schedule.

The primary benefits of the IST Wellfield System include increased safety factors, source control, and stabilization of the pond ash deposit for risk reduction. For sites with overfill or on-site landfills, reuse of the recovered pond leachate to moisture condition and compact new dry ash creates a sustainable clean water strategy for pond closure. For every 10 million megawatt hours, there is an opportunity to save 100 million gallons of clean water by removing pond leachate for reuse in the lined landfill. The IST Wellfield System with leachate reuse conserves clean water and manages risk by moving wastewater, not ash, to the lined landfill at sustainable rates.

Avoided wastewater treatment and reduced ash handling costs are two economic benefits that provide shared value to the enterprise and its customers.

A Sustainable Clean Water Strategy

Ash ponds come in all shapes and sizes, but they all share common characteristics and challenges. The risks and challenges are greater for sites with overfill landfills, upstream stages, or water dams. In any case, successfully dewatering the pond ash deposit is the primary goal that reduces risk on all levels, including safety, stability, source control, cost, and schedule. With the initial focus on priority sites, ash removal or grading has utilized existing maintenance practices to dewater pond ash by the dip, stack and drain method. In these cases the schedule demands established ash contractor methods. Aside from the crisis and priority jobs, advanced engineering solutions provide the opportunity to integrate existing methods with new technology and create a sustainable strategic plan for ash pond closures.

With more than 15 years of practice in coal ash projects, our engineers created the In Situ Treatment (IST) method to systematically reduce risk, conserve clean water, validate project schedules, and provide shared value to the enterprise and its customers. Where the coal-fired plant continues to generate dry ash for on-site landfill disposal, the IST System creates a sustainable clean water strategy for dewatering the historic ash pond.

Every contractor that has ever met a compaction requirement knows that dry fly ash requires aggressive moisture conditioning. For every dry ton of ash, 160 gallons of water is required to compact the ash at 40% moisture in a lined landfill or structural fill. It is common to use clean water resources in silos and water trucks to moisture condition dry ash for transport and landfill compaction. Reusing leachate from the pond ash deposit as a water substitute conserves clean water resources and moves the leachate from the old pond to new secure storage in the lined landfill.

For active plants with dry ash landfills, the ash pond dewatering schedule can be correlated with power generation and related factors. Every 10 million Megawatt Hours of generation is expected to produce 625,000 tons of dry ash, and provide the opportunity to reuse 100 million gallons of pond leachate, save millions in water treatment costs, and conserve the same amount of clean water. The IST System is an advanced engineering technology that can be your sustainable clean water strategy for ash pond closures, moving water not ash.

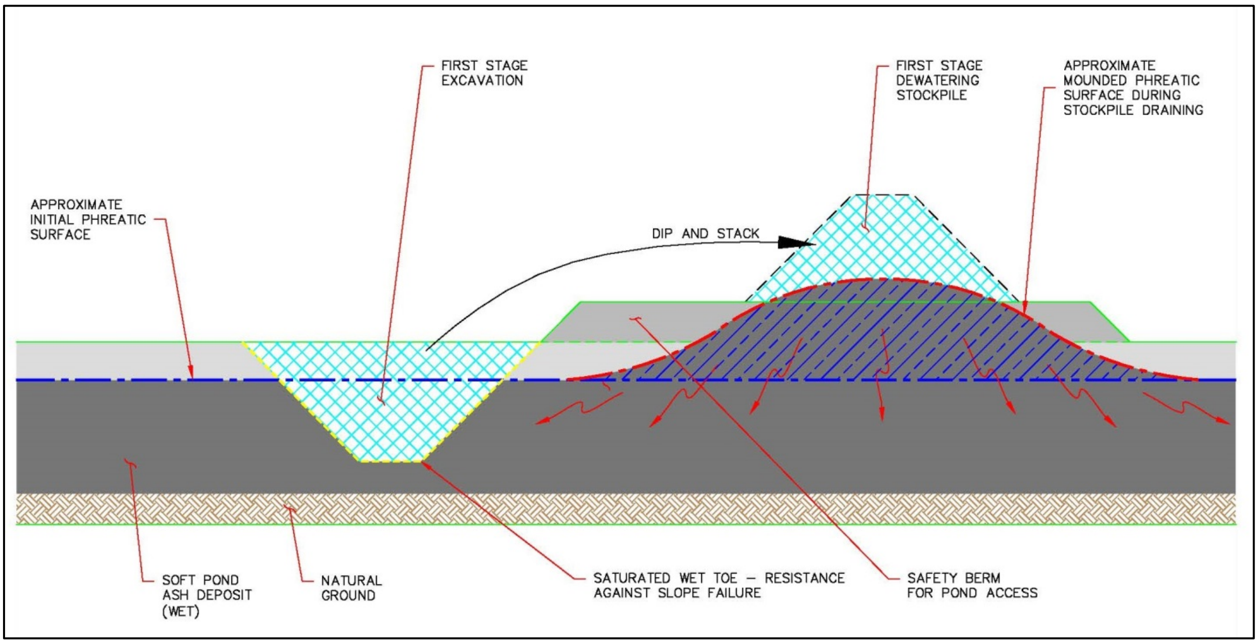
Conventional Methods Dewater Ash

In conventional dewatering methods, contractors use an excavator to dip the ash and leachate together, cast the mix onto a stack, and then wait for the leachate to drain back into the underlying ash layers. A simple analysis of the dip, stack, and drain method confirms that “working the ash” generates a mound of water under the stack. In engineering terms, the method creates a head and gradient for leachate to flow through the underlying ash. This method dewaters ash, sending the leachate back to the pond.

As illustrated in Figure 1, gravity drainage from the staged pile seeps back into the surrounding ash layer creating a mounded water surface and flow through the ash and partially back to the excavated ditch. The dip-stack-drain method requires multiple steps to create drainage through the surface layer of saturated ash and demonstrates that water flows through the surrounding ash under the pressure of a slight hydraulic gradient created by the mound. The fundamental principle of this established method is that lateral flow of leachate through the undisturbed pond ash layer is driven by gravity drainage and a differential head. This same fundamental flow principle is optimized in the IST Wellfield System, where water is separated and directly removed from the pond ash by deep wells flowing under the full head pressure in the pond.

Vacuum wellpoint dewatering methods are a current practice in ash ponds but have several limitations. In order to function, the short intake screen must be submerged at the bottom of the wellpoint. Inducing flow with a vacuum pressure increases well screen clogging and entrains fines in the leachate. Dewatering is generally limited to the top 20 feet. For these reasons, wellpoint applications typically support trench excavations and conventional mass handling methods. The failure of wellpoint systems to achieve project objectives in ash ponds has undermined the use of well systems for dewatering.

Figure 1 – Conventional Ash Dewatering Mound



Ash Drainage Properties

For more than a decade, dry fly ash has been compacted in lined landfills. At sites where moisture conditioning and compaction are monitored by engineers, observations confirm that water flows rapidly through loose ash at the surface. Storm infiltration drains through the compacted ash to depths over 100 feet and produces consistent flow rates from the leachate collection system aligned with HELP model predictions.

In ash ponds, Cone Penetrometer Testing (CPT) is the most effective geotechnical method for characterizing hydraulically placed, soft loose pond ash deposits. As a standard engineering practice, CPT analysis is primarily useful in evaluating sand-like and clay-like layers susceptible to flow liquefaction. (1) In 2012, Robertson provided an analysis of the Kingston ash pond failure using CPT and Soil Behavior Type (SBT) to identify soft, loose layers susceptible to liquefaction.(2) With pore pressure dissipation measurements, the CPT analysis quantifies the hydraulic conductivity (permeability) of the deposited ash layers. The hydraulic conductivity of loose pond ash layers confirms that flow through saturated pond ash will be greater than the rates observed from compacted ash landfills. Where sand-like bottom ash layers are present, flow is expected to be an order of magnitude greater than fly ash.

Fly ash and bottom ash are soil-like materials with drainage properties that can be evaluated using laboratory procedures. ASTM D5101[3] test method is a useful test for quantifying the permeability of sluiced ash materials with and without a filtration system. When tested with a filter geotextile, filtration compatibility is acceptable when the Gradient Ratio < 2. Filtration and drainage are optimized when the ash-filter system permeability is aligned with the ash permeability, and in the absence of fines observed in the filtered effluent. In the dewatering well design, the Gradient Ratio test matches the well filter design with the pond ash to optimize flow and filter suspended solids. [4]

The IST Wellfield System

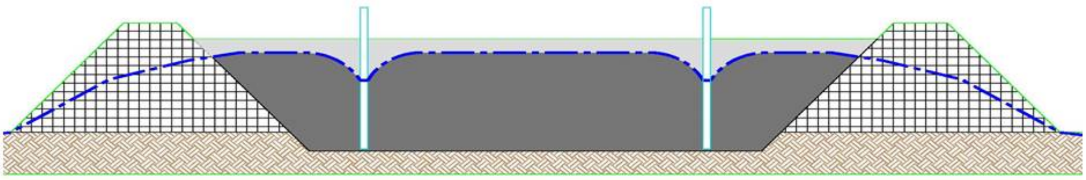
The In Situ Treatment (IST) Wellfield System is an advanced engineering technology which adapts drilled wells with a specialized anti-clogging filtration system and uses the full depth of the pond to optimize well flow. In function, the wellfield system operates under the shared principle with conventional mass handling where gravity drainage and differential head drive inflow to the well. The wellfield system uses the existing depth of the pond to drive gravity drainage and flow to the well, then directly removes the water from the pond ash deposit. The key elements to the wellfield system are filtration, anti-clogging, and gradually lowering the water level in the pond ash deposit. The IST method and system specification is published in U.S. Patent No. 9,556,579. [5]

The IST Wellfield System is an economic and environmental solution that defines a Best Available Technology. Through advanced well filtration and minimal ash disturbance the method is also a Best Management Practice. The well filtration system treats the recovered leachate for Total Suspended Solids, retaining the fines in the well completion materials and pumping the filtered liquid into a collection system. Every ash pond closure can benefit from the risk reduction provided by in situ dewatering. The IST method is implemented by qualified contractors with engineering supervision.

Engineering tests and observations before, during, and after will confirm the source reduction and stability improvements of dewatering. The greatest system value is for operating plants with overfill or on-site landfills. Advanced dewatering provides safe working conditions for clean closure projects and can be integrated with conventional practices. For cap in place sites, dewatering stabilizes the pond ash deposit, remedies surface seeps, and provides source control to improve groundwater quality. Following site characterization and preliminary engineering, the system is implemented in four stages.

Figure 2 illustrates the IST wells installed in an ash pond and the initial dewatering stage, where the water level is gradually lowered in the pond ash deposit.

Figure 2 - IST Wellfield System



The four stages in the IST Wellfield method are generally described as follows:

Stage 1- Site Preparation & Wellfield Pilot Test removes free water and dewaters the surficial pond ash layer as needed to improve access, installs IST wells for Pilot Test to verify dewatering system build-out plans, schedule, and secondary treatment needs.

Stage 1 Wellfield Pilot Test

- Install Pilot Wellfield & Startup Collection System
- Monitor Water Levels
- Verify Recovery Rates & Wellfield System Buildout
- Leachate Characterization
- Discharge or Landfill Reuse

Stage 2 - Wellfield Buildout is full scale installation of the dewatering wellfield system. Components include specialized wells extending to the full depth of the pond that filter Total Suspended Solids, individual well pumps and controls, collection system piping, and transmission lines for landfill reuse or discharge as permitted.

Stage 2 – Full Scale Wellfield & Collection System Buildout

Stage 3 - **Production Dewatering** is the period where lowering the leachate level in the pond ash from the stabilized surface layer through the saturated deposit to the base of the pond. Duration can match leachate recovery rates with the plant's schedule for closure and leachate reuse to moisture condition new dry ash for landfill disposal.

Stage 4 - Final Stabilization is accomplished by removal of the expected total volume for leachate recovery, water level monitoring, and geotechnical testing. Supplemental components may be installed prior to final cover construction and closure, or for overfill landfill development.

The Benefits of Engineering Technology

The current ash management practices provide information on what works and where improvements are needed. By understanding the overall objectives, innovation can turn a problem into an opportunity. Current ash dewatering practices illustrate that pond ash drains by gravity flow and under a slight gradient. Instead of draining the leachate back into the pond ash, we need to separate and remove it from the pond directly. Today, we know that coal ash can be safely stored in lined landfills and a large volume of water is needed to properly compact ash in fills. We also know that filtration and drainage are key components of those lined landfills. Engineering technology combines this know-how with new materials and methods to create a clean water strategy for pond closure.

Those that advocate protection of clean water by excavating and removing pond ash are driving high risk and high cost projects. They are missing the point. Removing the water from the pond ash controls the source and stabilizes the site for safe closure. While ash removal and clean closure may be part of the overall strategy for retired sites, moving the water to lined landfills and capping the ash in place is a sustainable solution for managing risk on all levels. Using engineering technology for pond ash dewatering provides the opportunity to create a clean water strategy without moving the ash.

Redefining Expectations

Conventional practices for ash dewatering and removal have fueled the myth that dewatering pond ash by means other than dip-stack-drain is not feasible. Environmental dialogue has focused on ash removal as the protective goal. In situ dewatering provides the opportunity to avoid costly ash removal and redefine the owner's plan as a "clean water" solution. In redefining expectations for coal ash management, progressively reducing risk by dewatering pond ash can be evaluated with the business of producing electricity.

Based on the latest five-year average heat and efficiency values for coal-fired generation from the U.S. Energy Information Agency, generating 10 million megawatt hours of electricity is estimated to produce about 625,000 tons of dry fly ash. Compacting the ash at 40% moisture content in a landfill requires adding 100 million gallons of water or pond leachate. When the pond leachate can be reused to compact new dry ash, risk is managed, savings from avoided leachate treatment is prudently captured, and clean water is conserved.

On the pond side of the equation, expectations for dewatering must be established and tested prior to wellfield buildout. Assuming a free liquid percentage of 20% is a reasonable estimate for recovering pond ash leachate. Using the 10 million megawatt hour basis for new ash generation, dewatering 2 million cubic yards of saturated pond ash would provide the leachate needed for ash compaction in the landfill. If the project goal is to complete dewatering in 3 years, then the wellfield buildout requires 22 wells pumping at an average rate of 3 gallons per minute. This is a reasonable expectation for pilot testing, and adjustments can be made according to the project goals.

Independent Review

The IST Wellfield System was developed by experienced engineers who have observed contractor methods, tested innovations, and understand the industry. Consultation and independent review was provided by leading experts in mine refuse impoundments, geotechnical soil behavior, and flow liquefaction. In his review of the in situ method, Peter K. Robertson PhD, describes the benefits of in situ dewatering for overfills and other pond closures as follows:

"Dewatering has the advantage of reducing the in-situ saturation of the ash and therefore reducing the risk of liquefaction. Dewatering may also foster increased in-situ consolidation in the ash that would further reduce the risk of liquefaction."

"*The expected additional benefits of in-situ dewatering include decreased ash saturation levels, removal of wastewater and settlement of the pond ash layers that will improve the long-term integrity of a cap system*."

Through water level observations and CPT geotechnical methods, the source reduction and stability benefits of in situ dewatering can be quantified. Flow metering records the volume of wastewater removed from the pond ash deposit for achieving closure.

Altogether, the technical and economic benefits of in situ dewatering provide value to the enterprise, its customers and the environment as part of a clean water strategy for all types of ash pond closures, moving water not ash.

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