Managing Landfill Leachate in a World Without Ash Basins: Lessons Learned and Practical Considerations

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Abstract

Prior to the Coal Combustion Residuals (CCR) Rule, leachate from coal-fired power plant landfills could be treated via their ash basins, which seldom had limitations on intake volume. With the closure of most ash basins mandated by the CCR Rule, CCR landfill leachate now must be conveyed to new treatment facilities that are being constructed to treat other plant wastewater flows previously treated by the ash basins. As a result of these changes, there has been a new focus on quantifying and reducing leachate flows. This presentation will focus on the complexities of managing CCR landfill leachate within the new, smaller footprint, treatment systems. Content will showcase some of Duke Energy’s challenges and solutions related to upgrading its existing leachate transmission, storage and treatment systems in response to ash basin closures. Topics include fill planning to support reduced leachate generation, temporary capping techniques, water balance modelling, as well as storm preparation and response. Obstacles to maintaining uninterrupted transmission, treatment and processing capabilities during these facility improvements also provide valuable lessons learned.

Introduction

As utilities transition towards closing ash basins, traditional water treatment methods are transitioning as well. Ash basins, which often encompassed hundreds of acres, historically served as water treatment facilities for multiple plant wastewater flows, including landfill leachate. These basins provided an almost unlimited treatment capacity for designated wastewater flows.

With ash basin closures, utilities are turning towards traditional water treatment methods that often have flow restrictions based on newly permitted effluent standards. So how does this shift in water treatment impact landfill design and operations? This paper recounts efforts that Duke Energy has undertaken at its Mayo Steam Station in North Carolina to ensure the landfill leachate volume and constituent concentrations are compatible with the station’s new wastewater treatment system thus ensuring the storage and treatment facilities maintain capacity to accept landfill flow in an uninterrupted manor.

The key elements to this process involve landfill operational fill planning, limiting open areas through the use of tarps or rain covers, and establishing a water balance model to better predict storage and treatment needs.
Facility Overview

Duke Energy's Mayo Steam Station (Mayo) is a single-unit, 727-megawatt coal-fired plant located near Roxboro, NC, less than one-half mile south of the North Carolina-Virginia line. The power plant began commercial operation in 1983, and is currently actively generating electricity. Reference Figure 1 for an overall site plan.

Coal Combustion Residuals (CCRs) have been historically managed through Mayo's ash pond via wet sluicing. However, Mayo altered its handling and transport of CCRs through subsequent system modifications as noted in this section.

In 2013, Mayo converted to a dry ash handling system. By November 2014, Duke Energy began placing CCR in a newly constructed on-site landfill. Since the landfill was permitted to receive a single material type, predominantly fly ash, it is referred to as a Monofill.

In 2009, Mayo was retrofitted with a wet Flue Gas Desulphurization (FGD) system. Despite use of a bioreactor treatment system in conjunction with the FGD, water quality monitoring suggested upward trends of some constituents as compared with Mayo's National Pollutant Discharge Elimination System (NPDES) Permit. In response, the bioreactor was decommissioned and replaced with a partial Zero-Liquid Discharge (ZLD) FGD wastewater treatment system in 2014.

The ZLD, through a thermal evaporation process, concentrates FGD wastewater into a brine that is then mixed with fly ash for disposal in the Monofill. As presented on Figure 2, Mayo's current wastewater cycle can be best described as a closed-loop system. Its primary components include: the ZLD (1); brine tanks (2); ash silos (3); and Monofill (4). Leachate from the Monofill is pumped to a lined FGD Pond (5) via pressurized force main. The FGD Pond can be emptied if its impounded wastewater is pumped to the ZLD feed tanks. However, since the ZLD requires main plant steam to operate, any reduction/concentration of the FGD wastewater (and Monofill leachate) fully depends on Mayo being online. Effluent cannot be released from the FGD Pond's overflow spillway pipe as this would be considered an unpermitted release of untreated wastewater under the current NPDES permit.
Monofill Design and Current Configuration

Currently, the Monofill is permitted as a single-phase 31-acre facility. The phase (Phase 1) has sufficient airspace for 1.5 M CY of CCR when final cover and operational cover are considered. However, during the Monofill’s operating life, fill rates in the Monofill have been historically low-volume and intermittent in nature when compared to comparable facilities in the Duke Energy fleet. As of May 2018, approximately 630,000 CY had been placed at the Monofill. However, with declining power generation at Mayo, only 100,000 CY of CCR placement occurred within the latest 12-month span. At the time of this report, annual CCR disposal rates are projected to decrease to approximately 80,000 CY.

Mayo Monofill is designed as a double-lined landfill with a Leachate Collection System (LCS). The LCS drainage layer consists of 24-in. thick washed stone containing multiple perforated collection pipes. These pipes are oriented predominantly on a north-south axis and connected to a perpendicular header that gravity drains to the LCS sump at the facility’s southeastern edge. From the sump, flows are pumped through the Side Slope Riser to the Lift Station. From the Lift Station, the Operator can decide whether flows are sent to the FGD Pond based on a chosen configuration of manual and motor operated valves.

An overall site plan of the Monofill (Figure 3) displays these components and designates each of the three Monofill cells within Phase 1: “Alpha/Bravo,” “Charlie,” and “Delta.”

As a whole, Delta cell represents approximately 14.5 acres of the 31-acre Phase 1. The “Delta” cell has not previously received CCR during the Monofill’s operating life and remains covered with a 20-mil LLDPE
rain cover. The 20-mil LLDPE geomembrane functions as a physical barrier between rainfall and the underlying LCS sump (as well as the greater LCS network).

At the time the facility was designed in 2011, leachate generation rates were estimated based on the Hydrologic Evaluation of Landfill Performance (HELP) computer program. Accordingly, the Monofill's 1.0M gallon (total) capacity leachate storage tanks were sized to hold at least 150% of peak daily drainage (approximately 550,000 gal) assuming one-third of the Phase 1 area was open at any given time. Mayo Monofill's Phase 1 Permit to Construct application was submitted at approximately the same time that the station's ZLD project was chartered – the end of 2011 [1].

**Figure 3: Mayo Monofill Site Plan**

**Landfill Operations and Fill Planning**

When the Mayo Monofill came online in November 2014, the open working area for "Alpha/Bravo" consisted of about 10 acres with the remainder of the landfill under rain cover. At about this time, the US EPA making final revisions to the CCR Rule, which was ultimately published in April 2015. Informal fill placement planning took place to coordinate basic concepts, such as landfill access, integration of various waste streams and adherence to placement specifications. However, compliance with the new regulations revealed the need for a more coordinated operational fill planning process, particularly to
properly manage stormwater. Among these requirements, the CCR Rule mandated the development of a Run On, Run Off Control System (ROROCS) Plan to govern not only the design of the landfill water management for the 25-year, 24-hour storm event, but also the ongoing operations and maintenance of the facility in accordance with this plan.

Prior to the development of the ROROCS Plan, there was not a strong link between the engineering plan for water management and the operational execution of the design. This resulted in undefined operational parameters to govern landfill operations related to water management.

Duke Energy landfills operate with internal, or chimney drains, to manage stormwater that contacts CCR material. Prior attempts to manage water by 'over the slope' methods, such as slope drains, proved problematic when needing to maintain leak-free drainage on dry stack ash landfills. These chimney drains typically consist of a perforated HDPE pipe suited to the planned burial depth in the landfill and are surrounded by a graded filter media to reduce the transfer of suspended solids to the leachate collection system. Reference Figure 4 for a typical chimney drain detail.

The institution of the Operational Fill Plan (OFP) provided the framework for this gap to be managed and requirements of all parties to be better understood and implemented.

Essentially, the OFP serves as a communications tool for landfill stakeholders to forecast future fill progression, anticipate operational issues, develop engineering products in support of the operational plan and modify existing permits or apply for new permits, if necessary.
In order to develop the OFP, Duke Energy provides its operational contractors with a disposal forecast, then the Design Engineer of Record (DEOR) produces a fill envelope that contains enough airspace to satisfy the projection. This fill envelope also identifies additional stormwater management features associated with the progressive waste placement. The fill envelope is then given to the operational contractor to further break down the waste placement plan that includes other pertinent operational considerations.

At Mayo, the fill planning process was aimed squarely at the goal of limiting leachate generation while maintaining adequate disposal capacity to support plant operations. Duke Energy began the process by forecasting plant run times, resulting ash disposal quantities and other non-operational sources of waste (e.g., project related needs, pond cleanouts) for a two-year period.

The Operator was consulted to understand where the best place would be to plan for this disposal need. Remaining in the current operational footprint of “Alpha/Bravo” was possible, but would require a permitting action to raise the Phase 1 landfill grades, opening a new area in cell “Charlie” would risk additional acreage contributing to leachate generation. It was determined that operating in cell “Charlie” was the best option, provided that cell “Alpha/Bravo” could be temporarily capped.

The DEOR then developed conceptual grades to store approximately 200,000 CY of CCR that also satisfied stormwater management requirements. As seen in Figure 5, with the disposal projections by waste type and projected operational grades in hand, the operational contractor identified ingress and egress routes, minimum acceptable working areas, sequence of chimney drain operations as well as non-contact stormwater management strategies. The OFP was divided into progressive grading plans limited to 20 vertical feet per planning phase to provide adequate detail to ensure all operational, engineering and environmental requirements were satisfied.

**FIGURE 5: MAYO MONOFILL OPERATIONAL FILL PLAN (PHASE 1 “CHARLIE,” SUBCELL 3 OF 5)**

**Temporary Capping with Rain Cover**

At various stages throughout the life of the Mayo Monofill, operations have benefitted from temporary cover of inactive cells by geomembrane for leachate management. The history and lessons learned for temporary rain covers at the Monofill are presented herein.

In June 2017, Duke Energy recognized that based on decreasing trends in production ash generation and concerns over leachate generation at Mayo, operating three active cells was no longer necessary.
Therefore, a project was completed to install a 5.7-acre temporary rain cover on “Charlie” cell. The rain cover consisted of 20-mil scrim-reinforced polyethylene with overlying geotextile windscreen in lieu of traditional sandbag ballast. Under the new configuration, the existing ash subgrade was reworked to enable positive drainage to a new stormwater sump on the eastern edge of the Monofill. From the sump, clean stormwater could then be discharged via an 18-inch diameter HDPE pipe to the existing ditch network along the Monofill perimeter. The new 18-inch diameter HDPE downspout was equipped with a manually actuated butterfly valve to limit or attenuate flow as necessary.

Immediately following the installation of the rain cover at “Charlie” cell, the facility saw a significant reduction in leachate generation. While leachate production had been as high as 1.6 Mgal in the month of April 2017, the balance of the 2017 calendar year only averaged approximately 0.5 Mgal per month. Refer to Figure 6 for a summary of monthly leachate and rainfall data. Accordingly, the project was deemed a success and contributing factors (e.g., rainfall intensity) were not thoroughly examined immediately thereafter.

![2017 Monthly Leachate Flows](image)

**Figure 6: Mayo Monofill Leachate Generation, 2017**

In September 2018, Hurricane Florence presented an additional challenge for the Mayo Monofill. Although the facility was located outside the storm’s direct path, Duke Energy’s internal rainfall forecasts still suggested that up to 10 inches of precipitation was possible at that time. Since Monofill leachate was integrated into Mayo’s closed-loop system and Mayo Steam Station was currently undergoing a
scheduled outage, minimizing leachate generation during Florence was paramount. Not only was the ZLD inoperable because of the plant outage, neither the FGD Pond nor Leachate Storage Tanks had sufficient storage capacity if "Alpha/Bravo" cell at the Monofill remained exposed to direct rainfall during Florence.

In the days immediately preceding Florence's landfall, all in-flight projects at Mayo had gone idle to prepare work sites for the impending rain. At that time, liner installation crews suspended activity on two wastewater treatment basin projects, one at Mayo and another at nearby Roxboro Steam Station, which permitted rapid response and mobilization. On September 11 and 12, 2018, a rain cover (20-mil geomembrane) was installed at “Alpha/Bravo.” The approximately 7.5-acre rain cover was ballasted by over 12,000 sandbags. A new spillway notch through the existing intercell separation berm was also constructed to ensure gravity flow of stormwater to adjacent “Charlie” cell.

At that time, Duke Energy's expectation was that the new rain cover would insulate the site from future rain events, and leachate generation rates would be limited to the facility's baseline flow. Continued leachate generation during Florence was attributed to in-situ moisture from prior rainfall. (The site received over 1-in. precipitation immediately prior to rain cover installation. Rainfall from Florence was approximately 6.4-in. over the ensuing four days.) During the storm, rain cover performance appeared acceptable with the geomembrane system continuing to remain ballasted and actively shedding water. For these reasons, it was not until Hurricane Michael the following month that rain cover performance was further scrutinized.

On October 11, 2018, Hurricane Michael produced approximately 6-inches of precipitation in a single day. With Mayo still in extended outage, production ash was not being generated at the facility. Accordingly, Phase 1 remained covered in its entirety since Hurricane Florence – either by geomembrane or intermediate soil cover. Because Hurricane Michael's rainfall occurred over a single day, it afforded the first significant opportunity to validate the existing rain cover performance. Duke Energy's records show that approximately 152,800 gallons of leachate were pumped from the LCS the following day, corresponding to roughly 3.6 times the average daily rate for the 2018 calendar year. Leachate continued to be generated at higher than normal rates (approximately 1.6 to 1.9 times the daily average) for the next three days. These findings suggested a direct and immediate response from Hurricane Michael.

In response to these findings, Duke Energy solicited bids to replace the existing 20-mil geomembrane rain cover. The rain cover in "Delta" cell was installed in 2014 and is currently beyond its warranty life. A key learning point with the rain cover was that it is designed to shed water, not necessarily store water. Within that 14.5-acre cell, approximately 2.5 acres consists of the stormwater sump – a section of the rain cover intended to be regularly submerged. The rain cover panels were sewn together, which likely was contributing to leakage in the system through the submerged seams. Conversely, thicker HDPE liner material can be fusion welded. The latter is expected to provide increased water tightness, especially when considering available testing (e.g., air testing for double wedge welds). Accordingly, Duke Energy
will replace the stormwater sump with a 60-mil HDPE geomembrane and 40-mil transition strip. Otherwise, the existing 20-mil rain cover will be replaced in kind.

Water Balance

Although a site-specific water balance was previously completed for Mayo Steam Station in 2015, that study produced a model primarily centered on the replacement of Mayo's Ash Basin due to the EPA's pending changes to the Effluent Limitations Guidelines and Standards (ELGs) and promulgation of the CCR Rule.

A need for a quantitative and predictive water balance for day-to-day Monofill operations was not apparent to Duke Energy until the aforementioned events in the fall of 2018. Within the context of the Mayo Monofill, the key regulatory driver is the North Carolina Solid Waste Management Rules (15A NCAC 13B .2010) requiring that leachate systems be designed to reduce the head on the liner below 12-inches for a 25-year, 24-hour storm within 72 hours after the storm event. With leachate integrated into Mayo's closed loop system, placing excessive head on the liner for a prolonged period of time would not be consistent with State regulations. Moreover, a leachate water balance is critical for short-term facility budget forecasts and underpins financial decision making for long-term capital projects.

The water balance model was developed to address three key demands: (1) determine how much water is in the landfill that will require transport, storage or treatment; (2) provide visibility of available storage in the system; and (3) predict the time at which available storage is depleted and off-site treatment would need to be implemented.

In the following section, the key variables identified for the Monofill's water balance will be discussed as well as the associated challenges and methodology for data collection. Refer to Figure 8 for a process flow diagram (PFD) for leachate handling at the Monofill. The water balance predictive model used at Mayo was developed in collaboration with the DEOR. Key assumptions and parameters for the water balance were initially based on a review of four years of historical data. Operational use of the predictive model and subsequent field observations allow Duke Energy and the DEOR to continue to refine the water balance.
Daily Rainfall Inflows to Monofill (1) and FGD Pond (7)

Daily rainfall is recorded by the landfill operator using the on-site digital weather station. Rainfall, among other select variables, has been logged throughout the Monofill's service life. It should be noted that the goal of the leachate water balance is to develop a quantitative and predictive model as a function of rain at Mayo. In the context of leachate handling at Mayo, direct rainfall impacts both Monofill Phase 1 and the existing FGD Pond – approximately 31-acre and 5-acre watersheds, respectively.

FGD Pond Freeboard Level and Volume (D)

Duke Energy developed a stage-storage table for the existing FGD Pond based on available design information, select surveying activities, and bathymetric data. A staff gauge was installed to measure water level in the pond in October 2018 and to obtain accurate daily freeboard readings. For purposes of the leachate water balance, the FGD Pond is only modeled in terms of available leachate storage capacity. Therefore, the current level in the pond, in conjunction with forecasted rainfall, dictates whether leachate may be pumped to the impoundment through the force main system. Drawdown rates from the pond to Mayo's ZLD system are not accounted for in the water balance, because wastewater processing is dependent on Mayo Steam Station being online. Although the FGD Pond was constructed with an overflow spillway pipe, wastewater discharge from the pond into the adjacent Ash Basin is not allowed under Mayo's current NPDES wastewater discharge permit. This requirement is another key regulatory driver and impetus to develop a leachate water balance.

Other Stormwater to FGD Pond (8)

Additional pumped stormwater to the FGD Pond was considered in development of a water balance, and two distinct contributing flows were identified. First, the ZLD sump receives CCR contact water from various sources at the power station’s northwest corner, including the adjacent ash silos, ash sumps, truck wash, and building roof drains. Based on review of available drawings and discussions with Mayo plant staff, the contributing area was estimated at approximately 0.7 acres. Secondly, at the time of this writing, dredging operations are in progress to remove solids from the FGD Pond. The solids removal and liquid separation process involves use of Geotube technology (essentially a high-strength geotextile bladder) requiring a lined sump to recirculate drained wastewater back to the impoundment. Any incidental rainfall on the lined sump becomes CCR contact water and must also be pumped back into the FGD Pond. The current lined sump is approximately 1 acre in size. However, at the time of this writing, Duke Energy plans to construct a second identical lined sump to double FGD solids removal capacity.

Leachate Storage Tank Level and Volume (C)

The Monofill is equipped with three above-ground, glass-lined steel leachate storage tanks with aluminum domed roofs. Collectively, the tanks hold a nominal volume of 1Mgal, and tank levels can be measured with a permanent gauge board liquid level indicator affixed to the exterior of each tank. Although tank
levels have been recorded by the operator regularly since the Monofill began operation, additional review of available construction submittals was needed to relate that information to actual available storage volume. Limited operational changes were made to maximize tank storage capacity within reasonable safety margins. Mayo's storage tank level indicators are equipped to an automatic shutoff alarm, which disables leachate pumping from the facility's lift station. An alarm point that is set too low relative to the tank overflow piping can artificially limit available storage.

**Leachate Pumped from Tank Loadout (5)**

Although the tank loadout station is equipped with a 7.5-hp pump capable of discharging leachate at up to 400 gpm, the leachate removal quantity for dust control on the Monofill is fairly small compared to other flow streams within the water balance. (For example, throughout 2018, the month of June required the most leachate for dust control, yet averaged about 2,500 gal/day.) Combined loadout was historically tracked by the permanent flow totalizer. More recently, at Duke Energy's request, detailed records are being maintained that differentiate between leachate used for dust control and leachate hauled off-site to a publicly owned treatment works (POTW) for more accurate tracking.

**Leachate Pumped to Storage Tanks (4) and FGD Pond (6)**

The Monofill's Lift Station Valve Vault is equipped with dual flow totalizers to indicate the volume of leachate pumped to the Leachate Storage Tanks and FGD Pond, respectively. The Valve Vault directs leachate to each of these two destinations depending on the vault's configuration. One significant challenge of measuring historical flow data is that the Leachate Storage Tanks are equipped with a return line, and leachate must backflow to the Lift Station Valve Vault in order to be transferred to the FGD Pond. When this occurs, leachate effectively becomes double counted. Therefore, for earlier years of the Monofill where less detailed recordkeeping occurred, leachate volumes are likely overestimated or conservative. The sum of these two totalized flows from historical data was used to quantify the landfill's overall leachate production rate. At the time of this writing, Duke Energy is exploring options to install an inline flowmeter and datalogger upstream of the Lift Station to more accurately quantify leachate.

**Leachate Generation Rates for Closed (2) and Open Cells (3)**

Throughout the Monofill's operating life, production ash is placed within a limited space, the active cell, in accordance with the approved fill plan. The inactive portion of Phase 1 typically remains covered with a geomembrane rainfly. The water balance model attempts to quantify and predict total leachate generation through the development of a separate infiltration rate (inactive cells) and generation rate (active cell), respectively. These parameters have proven to be challenging to estimate for reasons described in this subsection.

To initially determine the infiltration rate, data were reviewed from September 2018 to December 2018. During that time, all 31 acres of Phase 1 were capped with either a geomembrane rainfly or intermediate soil cover.

Next, historical data was reviewed from throughout the Monofill's operational life. (Refer to Figure 9 for a graphical display of historical leachate information.) Total pumped leachate was compared to the known acreage of the active and inactive cells, as well as historical rainfall data. With the assumed infiltration rate for the inactive cells, the leachate generation rate for active cells was estimated.
Pumped leachate was noticeably higher in 2015 for reasons that are not completely known to Duke Energy. Totalized flow may be over reported due frequent transfer between the tanks and FGD Pond during that time. Another explanation is that “Alpha/Bravo” cell was relatively new and the thinner ash grades within that cell did not help attenuate flow to the LCS.

Another complicating factor is the design of the Monofill’s existing chimney drains, as displayed in Figure 4. The vertically oriented chimney drains, consisting of 8-in diameter perforated HDPE pipe are directly connected to the horizontal leachate collection piping with a tee fitting. This results in a direct pathway for leachate to travel to the LCS Sump. For this reason, HELP model analysis from the Monofill's original design was not incorporated into the water balance. Future chimney drains are planned to be divorced from the LCS piping.

The water balance model represents two distinct generation rates – one for rain cover infiltration, and another for open cells. Parameters have been revised periodically based on operational data. Work is in progress to refine the model and its parameters.

**LCS Sump Level Indicator (A) and Stored Leachate Volume (B)**

Duke Energy recognized that quantifying the volume of leachate stored in the LCS Sump in real time would be a critical component of a predictive model. As is typical of landfill operation, routine maintenance and repair of system components (e.g., valves, pumps) and occasional improvements to the LCS necessitate temporary interruptions of leachate conveyance. Therefore, as leachate accumulates
under these circumstances, there is a need to ensure sufficient storage is available once system operation resumes. Because Mayo handles leachate in a closed loop system, quantifying accumulated leachate in the sump is of heightened importance.

A schematic of the Monofill’s LCS Sump is presented in Figure 10. Leachate depth within the LCS, or, alternatively, head on the liner system, can be obtained from submersible level sensors. Each sensor is integrated into the corresponding sump pump and allows for direct readout from the Monofill’s Side Slope control panel.

To develop a working estimate of leachate contained in the LCS sump, Duke Energy and the DEOR first reviewed the as-built topographic contours for the underlying liner system to develop a stage-storage relationship. The contours examined in this way not only included the sump, but also those across the entire Phase 1 footprint. Leachate was assumed to collect in the 2-ft thick stone layer above the liner system and interconnected LCS pipe network when elevations exceeded the height of the sump. Void ratios (e) of 0.4 and 0.5, respectively, were also assumed for the 2-ft thick granular layer within the LCS.

Next, real operational data was used to validate the stage-storage relationship from the as-built contours. In September and October 2018, pressure transducer levels at the LCS Sump were compared to pumped leachate volumes obtained from totalized flow. Data was selected for periods where both limited precipitation occurred and LCS pumps were consistently running. Figure 11 displays applicable trendlines from the depth-volume relationship. Based on field data consistency and ease of use, a simple linear relationship was selected by Duke Energy and the DEOR to quantify accumulated leachate within the Monofill’s LCS.
FIGURE 11: LCS HEIGHT-VOLUME RELATIONSHIP

Time to Fill Leachate Storage Tanks

Under the current framework of the Monofill’s Permit to Operate, the facility primarily manages its leachate through available storage in the Leachate Storage Tanks. Therefore, a key concern is mitigating a scenario where Monofill leachate can no longer be discharged due to a lack of available space. In response to this concern, Duke Energy incorporated a predictive estimate of the Leachate Storage Tanks’ time of fill into its water balance model. This output parameter is intended to enable proactive decision making by the landfill operator and Duke Energy.

The primary driver for the time to fill the tanks is the limiting flow rate across the entire force main. The two submersible pumps within the LCS Sump combine to produce a peak flow rate of approximately 350 gpm. (This compares to approximately 380 gpm from the Monofill’s Lift Station pumps.) The pumps cycle on and off based on the LCS Sump level, as shown in Figure 10. Therefore, actual flow through the force main is determined by the pump usage rate at the Side Slope Riser. In the absence of a direct flow readout at the Side Slope Riser, pumped flow rates have proven extremely difficult to estimate. Pump duty cycle percentages were estimated based on recurring field trials where run times were directly observed, measured with a stopwatch, and recorded. The process was repeated for varying sump levels. At the time of this writing, Duke Energy estimates duty cycle percentages as low as 20% for baseline conditions, increasing incrementally to a ceiling of 75% as a function of pressure transducer levels within the LCS Sump.

Landfill Leachate Management: The Next Steps

The events described within this paper characterize an ongoing process to manage leachate within Mayo’s closed loop treatment system. Accordingly, as of this writing, there are still unresolved issues and next steps to be taken by Duke Energy. The following section describes those remaining challenges.
Duke Energy recognized an immediate spike in leachate generation following significant rain events. Since the trend is understood to be attributed to two possible sources, a two-pronged strategy has been proposed. First, existing chimney drains are directly connected to the LCS, providing an immediate flow path to the leachate sump. As a new best practice for fill plan sequencing, existing chimney drains are to be phased out in favor of disconnected chimney drains to help attenuate flow. Second, existing geomembrane rain cover is expected to be upgraded to reduce infiltration rates in spring 2019. While 20-mil HDPE had historically been used for this purpose, areas intended to collect stormwater will be upgraded to 60-mil geomembrane. Panel wedge welding techniques for the thicker material are expected to offer increased water tightness.

The predictive water balance model currently in use by Duke Energy at the Mayo Monofill continues to be improved based on operational data. However, one major challenge relates to quantifying a baseline flow. Even during extended periods without rainfall, the brine conditioned ash continues to generate leachate at the facility. To gain insight into this phenomenon, a flow meter with integrated datalogger is proposed at the Monofill Side Slope to obtain detailed leachate trending information in real time. Flow information is currently manually recorded from existing totalizers and direct panel readout at the Monofill Lift Station Valve Vault. Since readings are taken daily by the operator, this yields a 24-hour average under most circumstances.

Conclusion

The transition from ash basins to traditional water treatment methods will have an impact on all plant wastewater flows. For landfill leachate management, several management techniques employed by Duke Energy at its Mayo Steam Station have proven effective in limiting leachate volumes and predicting storage and treatment needs. While Mayo’s closed loop system is unique, there are many applicable lessons that can be applied to all coal generating plants.

Beginning with the Operational Fill Plan, the landfill working face can be limited to the extent practical based on estimated disposal needs. Operations staff input is critical to this planning to ensure that operational considerations are accounted for while still satisfying engineering and environmental permit requirements for the management of stormwater and leachate. The fill plan can be re-evaluated whenever the planning variables change to realize the full impact of change. For example, if a project (e.g., FGD Pond dredging) is expected to generate large quantities of waste that may also be difficult to manage, the fill plan can be utilized to understand all the impacts of that project, gain support from stakeholders, and identify the extent of the project’s impact on the system.

Once the fill plan is developed, the working face can be restricted using rain covers or other temporary capping methods to realize the leachate generation reductions needed to meet leachate volume demands. Considering pathways to shed water by gravity, such as will diversion berms or temporary drainage piping with flow control valves, limits the operational burden of pumping stormwater from an impounded area. Lastly, scrutinizing areas where water will pond and designing a more watertight containment in these areas will maximize the effectiveness of the stormwater segregation role of the rain cover.

Finally, the establishment of a predictive water balance model can assist in understanding the volume of water in the landfill that will require transport, storage, and treatment in addition to predicting the timeframe in which alternative treatment or storage methods may need to be utilized. As with any model, the accuracy of the input variables has a significant effect on the output of the model. Clearly identifying the input parameters and engineering controls to monitor this data will assist in refining the accuracy of the model.

These three approaches greatly increase communication between all landfill stakeholders. The increased understanding from all parties on how the system works has led to several secondary benefits. First, the
forecast model can be used to look at larger than design event storms to help guide storm preparation efforts up to and including placing temporary cover over the entire facility, if needed. Second, routine operations and maintenance activities on the system can be scheduled for times where the leachate system can be offline for the necessary period. This drives contingency planning to work around the maintenance area and keep the system online for uninterrupted flow of leachate. Third, routine use and adjustment of this work product continues to broaden the understanding of how all the landfill systems work together to drive compliance, efficiency, and readiness to support plant operations.

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