

Practical Approaches to Meeting the Pending Steam Electric Power Effluent Guidelines for CCB Landfill Leachate

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1. BACKGROUND

The standard practice for disposal of the Coal Combustion Byproducts (CCBs) that are produced during the generation of electricity at coal-fired steam electric generating stations is to place them in either wet or dry ‘stacks’. Liquid that leaches through the stacks can become impacted with metals, radionuclides, and other constituents that are harmful to groundwater and surface water quality. The common approach for management of such leachate has been to discharge it under a site’s NPDES permit, either before or after treatment. However, upcoming changes in the United States Environmental Protection Agency’s (USEPA’s) Steam Electric Power Effluent Guidelines [EPA 821-R-09-008] (Effluent Guidelines), and pending legislation in many states, may prohibit such discharges and will likely result in a need for additional treatment of CCB leachate and other coal-fired electric utility wastewaters to meet very low standards. Treatment of this CCB leachate and other utility wastewaters streams to these very low concentrations is presently not common practice.

In this paper, the characteristics of CCB landfill leachate and other wastewaters are described and practical approaches for achieving the required treatment standards under the new Effluent Guidelines are described. A technology summary of the state-of-the-practice for CCB leachate treatment is provided, and some recent innovations in CCB leachate treatment that have been used to achieve very low effluent concentrations for constituents found in CCB leachate are described. Finally, examples are provided, as well as recommendations for overcoming the practical challenges associated with meeting the anticipated treatment levels of the upcoming Effluent Guidelines.

2. CCB LANDFILL LEACHATE MANAGEMENT AND DISCHARGE PRACTICES

2.1 CCB Leachate: Characteristics and Typical Treatment/Discharge Methods

Leachate from CCB landfills is generated from the leaching of liquid, typically rainwater infiltration, through the CCB. The anoxic conditions in older CCB landfills create reducing

redox conditions, which tends to create a slightly acidic environment that can result in increased leaching of metal constituents from the CCB. These reducing conditions can also cause leaching of naturally-occurring metals constituents from soils directly beneath the landfill that are exposed to leachate from the CCB landfill.

Chemical characterization of CCB leachate has been the subject of several recent reports, including studies of CCB landfill leachate conducted by USEPA [2,3,4] and the Electric Power Institute (EPRI) [1]. These reports indicate that the constituents in CCB landfills that will likely require treatment to achieve the anticipated treatment levels of the upcoming Effluent Guidelines include antimony, arsenic, boron, cadmium, chromium, molybdenum, selenium, and thallium [1,2]. The allowable concentrations of these constituents in water, under a variety of regulations, are summarized in Table 1. Unless other plant wastewaters are routed to the CCB landfill (e.g., from the metals cleaning wastewaters, coal pile runoff), CCB leachate does not tend to exhibit concentrations of VOCs, SVOCs, or organics that are high enough to require treatment.

Table 1: Constituents in CCB Leachate Identified by USEPA [2009b] as Potentially Exceeding MCLs

<u>Constituent</u>	<u>Symbol</u>	<u>MCL</u> <u>($\mu\text{g/l}$)</u>	<u>DWEL</u> ¹ <u>($\mu\text{g/l}$)</u>	<u>SDWR</u> ² <u>($\mu\text{g/l}$)</u>	<u>CCC</u> ³ <u>(chronic) -</u> <u>Freshwater</u> <u>($\mu\text{g/l}$)</u>	<u>CMC</u> ⁴ <u>(acute) -</u> <u>Freshwater</u> <u>($\mu\text{g/l}$)</u>
Arsenic	As	10	10	-	150	340
Barium	Ba	2000	7000	-	-	-
Boron	B	-	7000	-	See note ⁵	See note ⁵
Cadmium	Cd	5	20	-	0.25	2
Chromium	Cr	100	100	-	Cr(III) – 74 Cr(VI) – 11	Cr(III) – 570 Cr(VI) – 16
Lead	Pb	15	-	-	2.5	65
Mercury	Hg	2	10	-	0.77	1.4
Molybdenum	Mo	-	200	-	-	-
Selenium	Se	50	200	-	5	290
Silver	Ag	-	200	100	-	3.2
Thallium	Tl	2	-	-	-	-

Because the processes used to treat leachate for selenium and arsenic are also effective at treating leachate for other metals and radionuclide species, and because arsenic and selenium were found

¹ Drinking water equivalent level - A lifetime exposure concentration protective of adverse, non-cancer health effects, which assumes that all of the exposure to a contaminant is from drinking water.

² Secondary drinking water regulations - Non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water.

³ Criterion continuous concentration - EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.

⁴ Criterion maximum concentration - EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards.

⁵ Based upon narrative statement contained in *Gold Book, Quality Criteria for Water 1986*, USEPA.

to be among those present in leachate at the greatest multiples of Maximum Contaminant Levels (MCL's) ^[3], the focus of this paper is on the design of treatment systems for arsenic and selenium in CCB leachate. Selenium is a common, naturally occurring constituent that is often present in coal and, therefore, may occur in leachates from coal ash. The maximum contaminant level goal (MCLG) and MCL for drinking water are currently set by USEPA at 50 µg/L, although USEPA is reportedly considering issuing a rule enforcing an even lower concentration. Arsenic is a common, naturally occurring constituent that is often present in coal and, therefore, may occur in leachates from coal ash. USEPA's recommended concentration for protection of aquatic life and human health in surface water is 5 µg/l for chronic exposure conditions and 290 µg/l for acute exposure conditions.

Currently, CCRs and the water in CCR impoundments are excluded from management as hazardous wastes under the RCRA (40 CFR §264.1(b)(4)). Notably, this exemption extends to wastewaters produced in conjunction with the burning of fossil fuels which are co-disposed or co-treated with CCRs, a common practice at coal-fired power plants. Wastewater discharges from coal-fired power plants are typically discharged, with or without treatment, to a receiving waterbody under the facility's National Pollutant Discharge Elimination System (NPDES) discharge permit.

2.2 USEPA's Proposed New Effluent Guidelines

In 2008, USEPA published a profile of point-source discharges associated with steam-electric power generating stations [USEPA, 2009a]. The report indicates that changes in air pollution control equipment at coal-fired electric generating stations has caused changes in the quality of wastewaters generated at these stations, including leachate generated from CCB landfills. In response to this study, on 15 September 2009, USEPA announced plans to update the current Effluent Guidelines for the steam electric power generating industry, based on USEPA's multi-year study of wastewater discharges from power plants. By all accounts, the power industry expects to face more stringent effluent limits, and thus treatment requirements, for wastewater discharges in facility NPDES discharge permits. The USEPA is expected to publish a draft rule in 2011, have final regulations issued in fall 2012, and incorporate the new guideline requirements in renewed permits by fall 2013.

2.3 Impacts of New Effluent Guidelines on CCB Treatment Methods

Discharges associated with coal-ash handling/disposal operations and wastewater from FGD air pollution control systems (which are often comingled in CCB landfills or surface impoundments) comprise a significant portion of the waters discharged from electric power generating station operations. As such, USEPA's effluent guideline and CCR regulatory initiatives could have significant compliance implications for coal-fired electric power generating stations. The proposed rules represents a significant departure from current regulatory approaches and will likely require changes in the way that utilities manage their solid wastes and wastewater flows. Because many plants manage wastewater flows from a variety of processes, the regulations could require redesign and re-permitting of several processes. Of particular relevance is the effect of these new regulations on the current and future use of surface impoundments, where a variety of power plant wastewater streams are mixed and treated prior to discharge under NPDES permit.

The proposed changes to the Effluent Guidelines may require treatment of wastewaters (including landfill leachate) from coal-fired utility plants to different standards than currently required. Although the effluent standards have not yet been developed, it is expected that they will contain specific guidelines regarding acceptable concentrations of the constituents listed in Table 1, and perhaps many other constituents. This will require assessment of a plant's wastewater characteristics and, for many plants, new treatment systems to achieve the discharge limits for these constituents in the new Effluent Guidelines.

3. TREATMENT PROCESSES

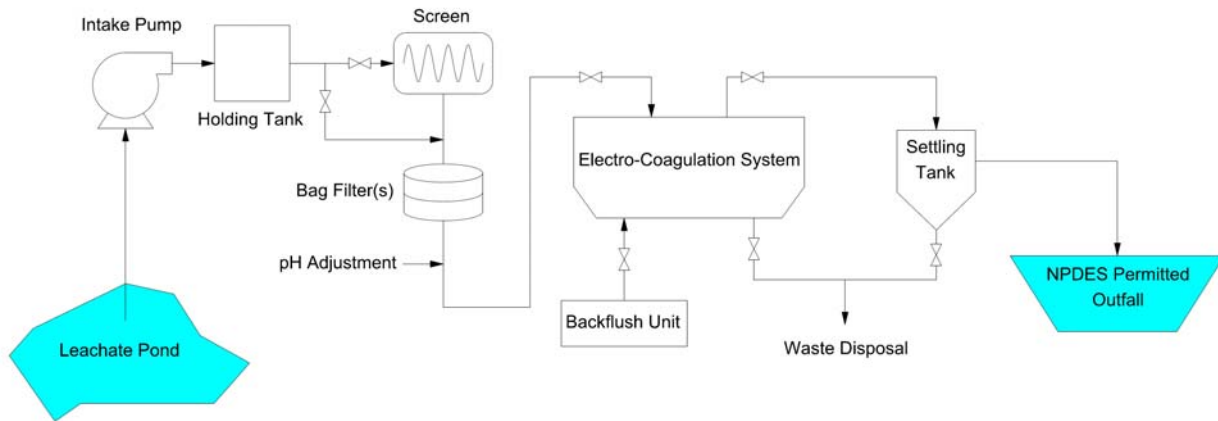
There are a number of widely-accepted approaches for treating leachate and other utility plant wastewaters. In this section, some common approaches are described, and some innovative approaches are introduced. First, physical and chemical treatment processes are described (Section 3.1), and then biological treatment processes are described (Section 3.2). Commonly-used physical and chemical treatment options include: coagulation/filtration, lime softening, reverse osmosis, and activated alumina adsorption. These options represent traditional technologies employed for industrial process discharges. They differ in their removal efficiencies and effectiveness, particularly with respect to selenium speciation. Each is described below. As described in Section 2.1, this section is focused on treatment of selenium and arsenic because the processes used to treat leachate for selenium and arsenic are also effective at treating leachate for the other metals and radionuclide species that are typically present in CCB landfill leachate.

3.1 Physical and Chemical Treatment Processes

3.1.1 Coagulation/Filtration

Selenium and other metals can be removed by coagulation and filtration processes, which results from the addition of coagulants, followed by rapid mixing, settling and filtration of the resulting supernatant. Chemical coagulation/filtration systems generate significant quantities of sludge requiring disposal. A newer, alternative mechanism for induced precipitation utilizes electro-coagulation, in which an electrical current is applied across the wastewater, inducing oxidation-reduction reactions. Figure 1 shows a simplified process flow diagram for a typical electro-coagulation system. The electro-coagulation system produces much less sludge, because no coagulant chemicals are utilized, making this a more attractive option versus traditional chemical coagulation. The performance of chemical coagulation systems depends primarily upon the influent water metals speciation. For example, $\text{Al}_2(\text{SO}_4)_3$ is typically the most effective coagulant for removing selenate and $\text{Fe}_2(\text{SO}_4)_3$ is typically the most effective coagulant for removing selenite. Depending upon residence times, mixing techniques, and the concentration of coagulant added, 50-90 percent metals removal is achievable using coagulation/filtration methods, and removal efficiencies as high as 99 percent can be achieved using electro-coagulation. Excessive build-up of carbonate scale may occur within pipes depending upon the influent water chemistry. The capital cost for the system is relatively average compared to the other systems compared in this paper (See Table 2), and the operation and maintenance costs are relatively low unless the wastewater produces a significant amount of sludge.

Figure 1: Electro-coagulation Process Flow Diagram

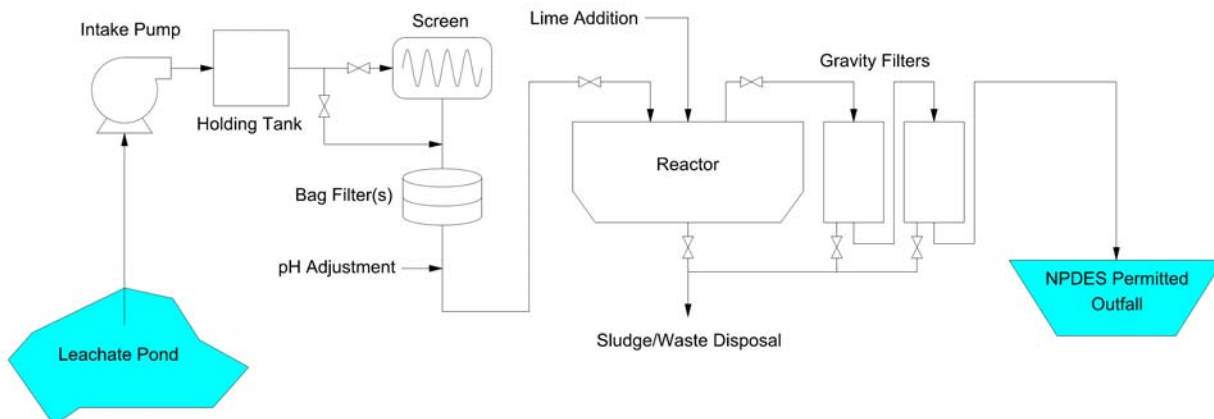


3.1.2 Lime Softening

Lime softening is a well-established technology, employing the addition of either $\text{Ca}(\text{OH})_2$ or Na_2CO_3 , followed by coagulation, flocculation, and clarification. The hydroxide and/or carbonate species in the lime react with selenium, arsenic, and other metals, forming a precipitate that is removed through physical separation methods (i.e., filtration and/or settling). Although highly reliable, the process has a high capital cost and generates large quantities of sludge requiring landfill disposal. Recovery of metals from sludge is possible, but is not usually economically viable. A typical lime-softening treatment system contains pre-filtration/screening devices, the mixing/reaction vessel, followed by settling vessels. Figure 2 shows a simplified process flow diagram for the proposed lime softening system.

The performance of lime softening systems depends largely on the pH of influent waters, with optimal removal occurring at pH greater than 10. At elevated pH, metals generally form hydroxide and carbonate precipitates capable of being physically removed from the process waste stream. Removal efficiencies range from 30 to 95 percent and vary depending upon the presence of other compounds, such as sulfate (which tends to interfere with reaction chemistries). The capital cost for the system is relatively high compared to the other systems compared in this paper (See Table 2), and the operation and maintenance costs are also relatively high.

Figure 2: Lime Softening Process Flow Diagram

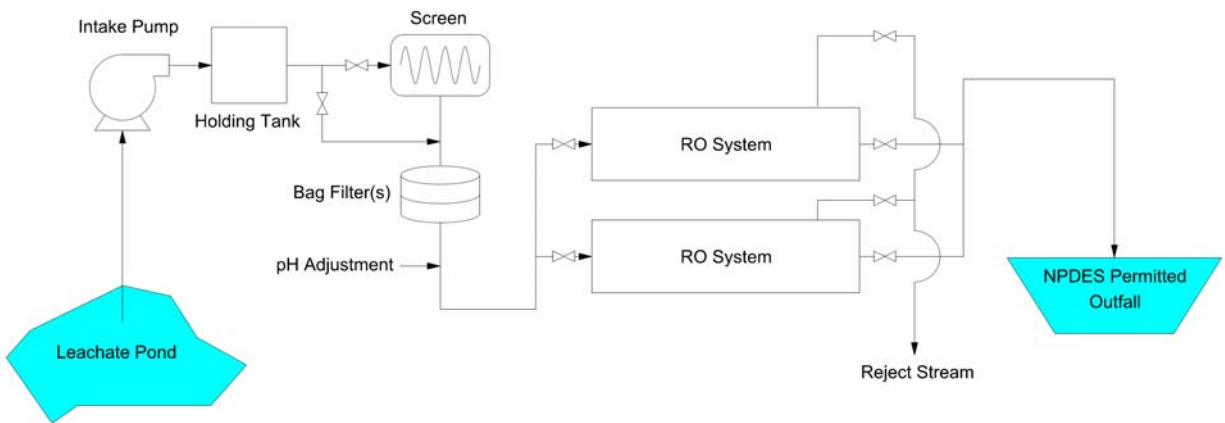


3.1.2 Reverse Osmosis

Reverse osmosis (RO) systems utilize differential pressure gradients to remove contaminants from influent waters by passing water through a semi-permeable membrane. Figure 2-3 shows a simplified process flow diagram for a typical RO system. The treated water contains reduced contaminant concentrations, while the concentrated by-product (the concentrate or reject) becomes highly enriched in contaminants. The efficiencies and effectiveness of RO systems depends largely on the concentrations of contaminants in the influent feed water, with higher TDS and total suspended solids (TSS) causing increased membrane-fouling, reduced operational capacities, and elevated system operating pressures (resulting in the possibility of system shut-down). Additionally, the capacity exists for developing highly enriched waste streams, which could require permitting and disposal as a hazardous waste material.

The performance of RO systems depends greatly on the water chemistry of the influent, with elevated total dissolved or total suspended solids dramatically increasing the cost of this treatment method and, at the same time, decreasing expected removal efficiencies. Removal efficiencies of up to 95 percent are often achievable, with much lower removal efficiencies and operational capacity for leachate having elevated TDS and TSS concentrations. The capital cost for the system is relatively average compared to the other systems compared in this paper (See Table 2), and the operation and maintenance costs are also relatively average unless the wastewater contains high TDS or TSS or produces a sludge requiring disposal as a hazardous waste.

Figure 3: Reverse Osmosis Process Flow Diagram



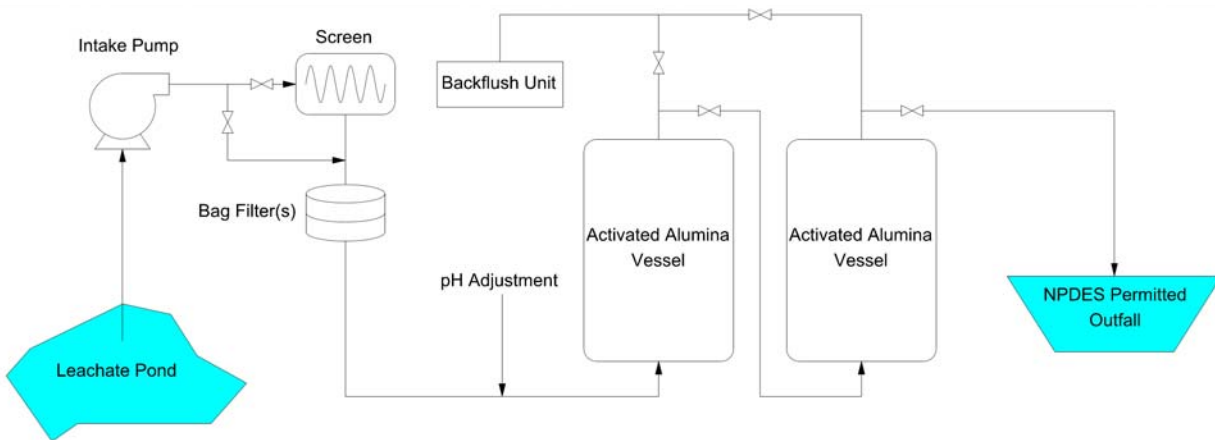
3.1.4 Alumina Adsorption

Treatment with activated alumina typically involves passing influent water through a pre-treatment filter unit for removing suspended solids and bacteria, followed by a treatment vessel containing activated alumina media. Figure 4 shows a simplified process flow diagram for the proposed activated alumina system. The activated alumina media is a porous material that is available in powder, pellet, or granular sizes. The treatment process is highly pH dependent and requires periodic regeneration of the media using alum or acid-base procedures. The presence of sulfate, bicarbonate, and silica can each affect the actual removal efficiencies by an order of magnitude or more. Arsenic removal efficiency is generally high (typically greater than 95 percent) but varies significantly, and is controlled primarily by the pH and arsenic concentration

and speciation of the leachate. Arsenate removal capacity is best in the narrow range from pH 5.5 to 6.0. Typically, activated alumina has a point of zero charge (PZC) at pH 8.2, below which the surface is positively charged, and above which the surface is negatively charged. Arsenic removal capacity drops sharply as the pH rises to the PZC. For neutral and basic waters, therefore, pH adjustment may be necessary for effective arsenic removal.

In summary, alumina adsorption is best suited as either a primary treatment step for low-flowrate or low-concentration wastewater streams, or as a secondary “polishing” step for wastewater streams having a higher flowrate or high-concentration wastewater stream. High flowrate or high concentration wastewater typically requires higher operation and maintenance costs and may require frequent change-out of alumina media. The capital cost for the system is relatively average compared to the other systems considered in this paper (See Table 2), and the operation and maintenance costs are relatively low.

Figure 4: Activated Alumina Process Flow Diagram



3.2 Biological Treatment Process

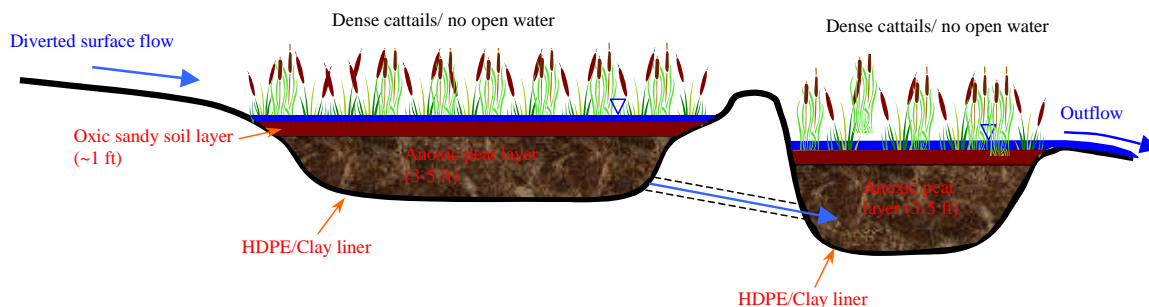
Biological treatment relies upon the microbial transformation of highly soluble species into relatively insoluble species, a process known as reduction. The capacity for this metabolic process exists in a diverse range of ubiquitous microbes. Numerous treatment technologies currently exist for promoting the microbe-mediated removal of metals. Three treatment options are described below that have been demonstrated to have the capacity to meet anticipated limitations of the new Effluent Guidelines for leachates at CCB sites.

3.2.1 Surface Flow Wetlands

Surface flow wetlands treat wastewaters through microbial and vegetative treatment in large, artificially constructed wetland cells. Figure 5 shows a simplified flow diagram for a surface flow wetland system. These systems typically have water flowing at shallow depths over the soil surface and through plants to remove constituents of concern (such as arsenic and selenium) through redox reactions. Through reduction, dissolved metals constituents are transformed into insoluble forms that precipitate in sediments, accumulate in plant tissues, and/or volatilize to the atmosphere. There are a number of past and ongoing studies on the ability of constructed wetlands to remove metals. These systems generally require relatively low initial capital but a larger footprint when compared with traditional physical/chemical treatment options, and low

maintenance. When properly constructed, they can tolerate wide fluctuations in flowrates and contaminant concentrations, while providing numerous collateral benefits (e.g., water recycling, limited environmental impact, stabilization/flood protection). However, predicting their performance can be challenging. To the best of the author's knowledge, no mechanisms currently exist for flushing constructed wetlands and removing the buildup of selenium, raising concerns regarding possible bioaccumulation pathways.

Figure 5: Surface Flow Wetlands



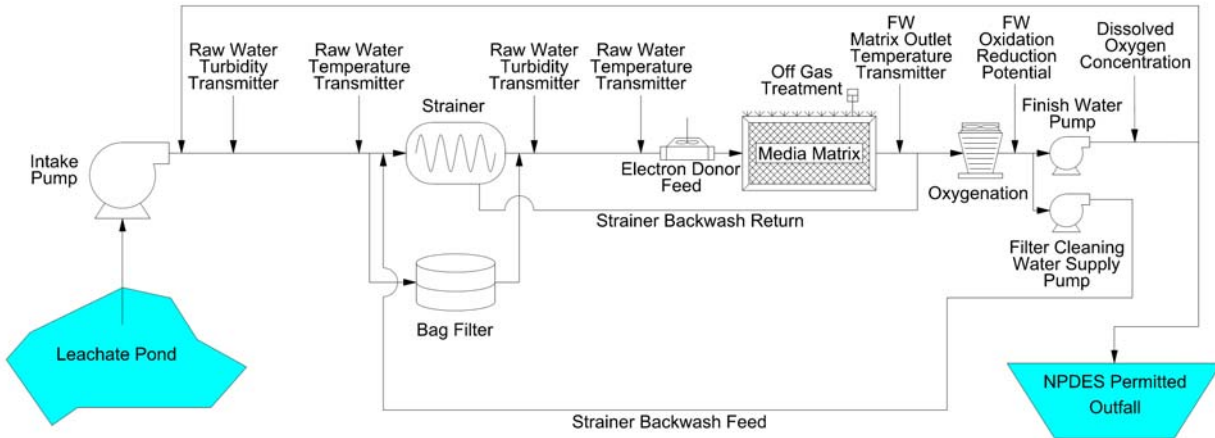
3.2.2 Gravel Media Biofilter

Gravel media biofilters (GMBs) act as fixed-film microbial treatment units, where a gravel media forms a biofilm covering. Figure 6 shows a simplified process flow diagram for a typical GMB system. These systems provide flexibility in the design parameters, and are capable of removing a wide variety of metals and other contaminants, such as nitrates, phosphate, TSS and possibly other metals. The GMB treatment technology is distinct from surface water flow constructed wetlands in one key respect: optimization of the microbial populations result in a significantly smaller footprint. The gravel media bed system size depends strictly on the required hydraulic residence time (HRT) of the system. The HRT, in turn, depends upon site specific water quality data, including: selenium, nitrogen, and phosphorus concentrations and speciation, alkalinity, hardness, biochemical oxygen demand (BOD), TOC, pH, TDS, TSS, and temperature. For example, for leachate flowrate in the range of approximately 10 gpm (15,000 gpd), a GMB treatment system would be approximately 1,000 square in area and have a depth of 10 feet. This technology has only recently been applied to selenium reduction, with a first-of-its-kind 150 gpm pilot system being tested by Geosyntec in southern California (See description in Section 4 of this paper).

The GMB technology uses a redox-control approach for biological removal of selenium (and, potentially, other metals constituents) in an artificially constructed system consisting of an aboveground or belowground treatment cell. The treatment processes rely on microbial-facilitated sequestration of constituents resulting from reduction processes; for example, GMB treatment of selenium involves reduction of selenate and selenite to elemental selenium and/or selenide. The reduced constituents precipitate from solution, becoming immobilized within the system. The GMB receives metered-doses of an electron donor (i.e., food for the microbes). The system resides inside a hydraulic containment system to contain the liquids within the treatment cell and to isolate the system from oxygen. Depending on the influent water

chemistry, removal efficiencies of up to 99 percent are achievable. The capital cost for the GMB system is relatively low compared to the other systems considered in this paper (See Table 2), and the operation and maintenance costs are also relatively low unless the GMB generates substantial amounts of precipitates requiring excavation/replacement of the gravel in the GMB cell.

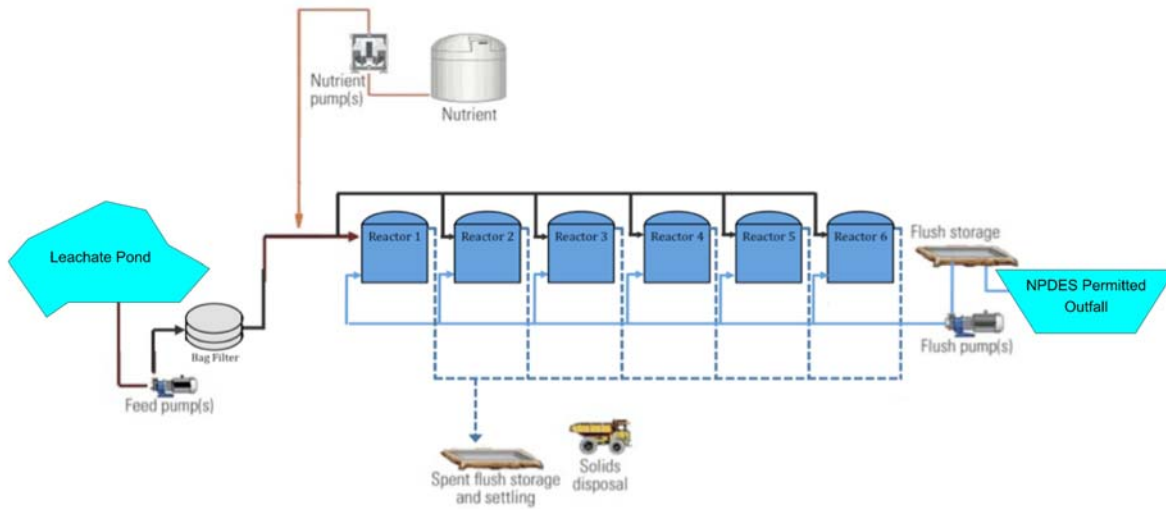
Figure 6: Gravel Media Biofilter System Process Flow Diagram



3.3.3 ABMet®

The General Electric (GE) Water and Process Technologies division produces a commercially available biological system for removal of metals, metalloids, and inorganics from wastewater or process streams. Figure 7 below shows a simplified process flow diagram for a typical ABMet® treatment system. These systems are similar to the GMB system described in Section 3.3.2, but use only aboveground infrastructure. The GE Advanced Biological Metals Removal Process (ABMet®) system incorporates a series of bioreactors that contain a bed of granular activated carbon (GAC) and enriched site-specific bacteria to process a waste stream. Water flows through the bioreactor, contacting microbial mixtures at specific rates and retention times, ensuring that a reducing environment is maintained. Precipitated contaminants remain in the biomatrix until flushed out for recovery or disposal. The ABMet® system relies on specific and proprietary microbial mixtures to perform a specific treatment activity. Assuming favorable water chemistry, removal efficiencies of up to 99 percent are achievable. The capital cost for the system is relatively high compared to the other systems considered in this paper (See Table 2), and the operation and maintenance costs are typically very high compared to the costs for other systems considered in this paper.

Figure 7: ABMet® Process Flow Diagram



Off-site treatment plants are another candidate method for disposal of CCB landfill leachates. It is common practice at many landfills to send their leachate to a local publicly owned treatment works (POTW) for treatment, after which the POTW discharges the effluent and disposes of, or reuses the solids. In order to utilize the off-site treatment alternative, an industrial discharge permit is needed with a POTW or a private treatment vendor. If the leachate is transferred via hauling vehicles, then a leachate transfer area is needed to allow for transfer of leachate from the CCB disposal cell to the leachate tanker trucks for disposal at the local POTW (this scenario is illustrated in Figure 8). Leachate transfer areas typically consist of a concrete pad with secondary containment and pumps for the transfer operation. The performance of the off-site treatment alternative is a function of the POTW or private treatment vendor’s ability to meet the discharge limitations set forth in their individual discharge permits. This option could have a high capital cost if a leachate transfer and storage area needs to be constructed and if leachate pretreatment is required by the off-site treatment works.

Figure 8: Off-Site Treatment Flow Diagram

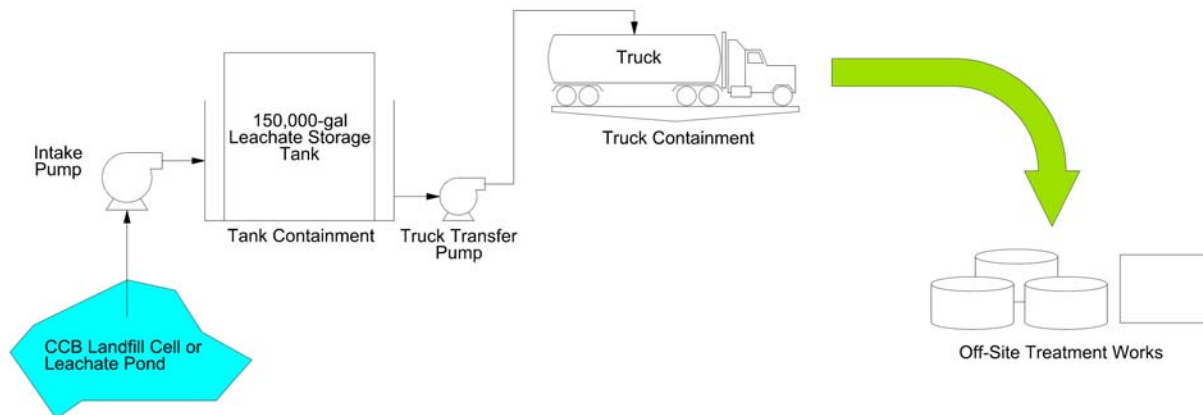


Table 2: Summary of CCB Leachate Treatment Technologies

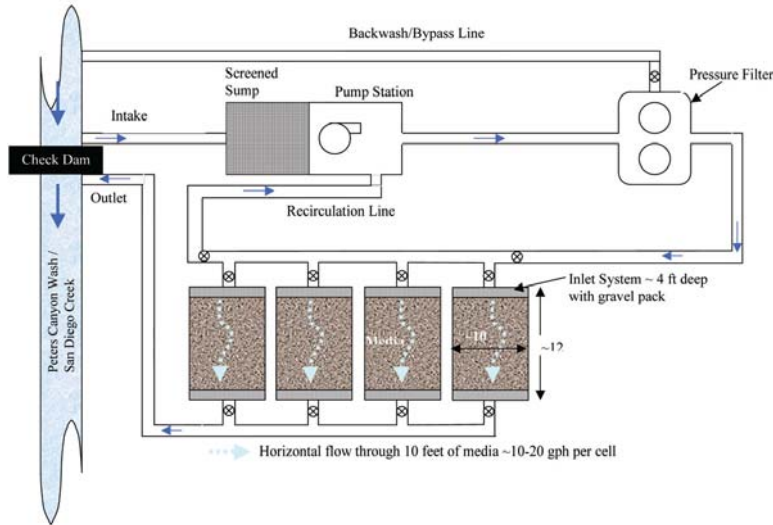
Treatment Technology	Ability to Remove Se and As	Relative Cost		Additional Considerations
		Construction	O&M	
<i>Physical/Chemical Treatment Options</i>				
Coagulation/Filtration	Possible	Medium	Low	Sludge management can be difficult and potentially costly
Lime Softening	Possible	High	High	Skilled operator is required , high quantities of sludge are typically generated requiring disposal
Reverse Osmosis	Possible	High	Medium	Can be fouled by TDS, TSS, and scaling, must address RO reject waste streams
Alumina Adsorption	Expected	Medium	low	Media disposal is required at regular intervals
<i>Biological Treatment Options</i>				
Surface Flow Wetlands	Unlikely	Medium	High	Only low degrees of selenium reduction can be expected
Gravel Media Biofilter	Expected	Low	Medium	Few full-scale projects to date
ABMet®	Expected	High	Very high	Not typically employed at low-temperature, relatively low concentration conditions
<i>Offsite Treatment Option</i>				
Off-Site Treatment Works	Expected	High	Medium	On-site transfer system may be required; possible pretreatment requirements

4. EXAMPLES

4.1 Cienega Selenium Treatment System, Irvine, California

The Cienega Filtration Project uses GMB technology (as discussed in Section 3.3.2 of this paper) to treat selenium in groundwater. Selenium is among the pollutants of concern in a growing number of areas within the United States. In 2002, the USEPA set an in-stream selenium standard of 5 ppb in California with the adoption of the California Toxics Rule. In many regions throughout California, selenium is naturally occurring and, in Orange County, is distributed throughout the San Diego Creek Watershed, a major tributary to Upper Newport Bay. Many of the potential selenium source areas in the watershed correspond to locations where, over the centuries, naturally occurring selenium became sequestered under anaerobic conditions in peat soils within a swamp. It is thought that draining of the swamp because of urbanization created aerobic conditions, resulting in the release of selenium from these sediments into shallow groundwater in a soluble phase. This groundwater then enters various storm drainage features at elevated levels. Selenium concentrations in the discharges from local pump and treat facilities have been observed in the 50 ppb range, and local groundwater selenium concentrations commonly exceed 100 ppb. The purpose of the Cienega project is to treat the selenium in this water to achieve the USEPS selenium in-stream standard of 5 ppb.

Figure 9: Schematic Diagram of Cienega Filtration Project Treatment System



For the Cienega project, approximately 3.75 acres of land were available to treat a flow rate of approximately 3 cubic feet per second (cfs). The system needed to be buried to support surface recreational activities, and cleanout options needed to be minimized to avoid conflict with these and other nearby activities. The system discharges directly to a creek flowing through an urban setting so water quality is an issue. Size and flow constraints required that selenium removal be accomplished within a residence time of one day, while the limited ability for media cleanout and the necessity of sufficient structural integrity dictated a suitable coarse media to minimize the impact of biological and particulate plugging. The schematic diagram showing the layout of the GMB treatment system is shown on Figure 9, and the below-ground construction of the treatment cells is shown in Figure 10.

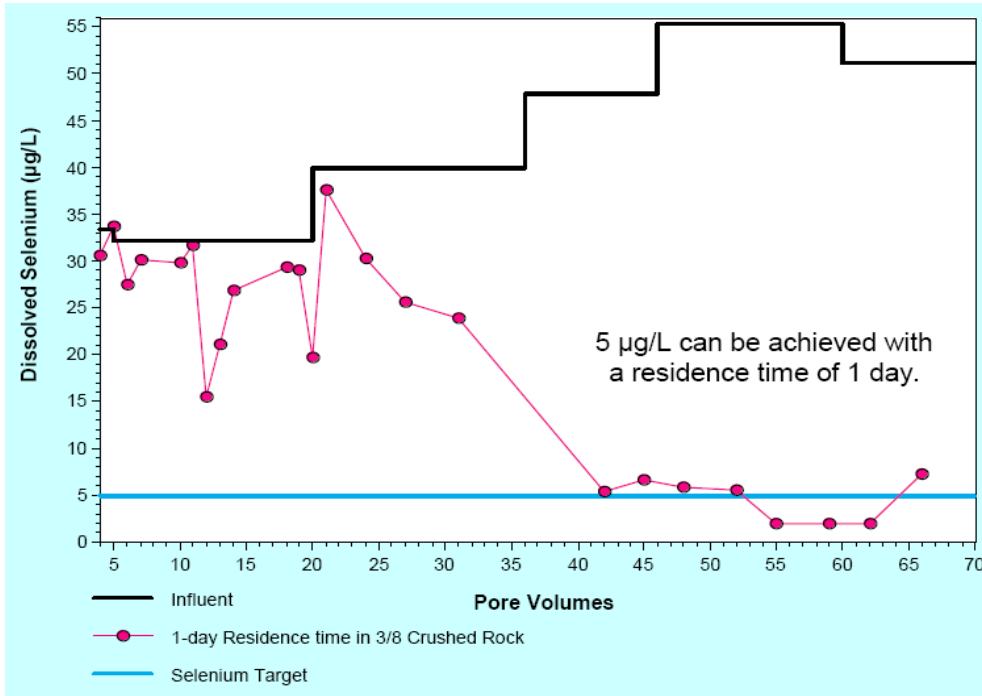
Figure 10: Photograph of Below-Ground Gravel Media Bioreactor Chambers



After construction, the system has achieved the required effluent discharge limits after brief period during which the biological media were being established. As shown on Figure 11, selenium concentrations are being reduced from approximately 50 ppb to approximately 5 ppb. Coarse materials with adequate hydraulic conductivity can be used as the media matrix and the hydraulic conductivity of the treatment chamber does not appear to be a controlling

factor in establishing residence times for crushed rock. Also, no significant reduction of hydraulic conductivity – due to biofilm accumulation or other mechanical clogging - was observed during the study period.

Figure 11: Performance of Cienega GMB



4.2 Metals Treatment System, Anclote Station, Florida

Groundwater at the Anclote power generating station in Pinellas County, Florida, was experiencing high concentrations of nickel that exceeded the facility’s permitted limits. An evaluation of the source of the nickel revealed high concentrations of this constituent in the facility’s air heater wash water, which had been routed without treatment directly to the plant’s industrial wastewater (percolation) ponds in accordance with the facility’s permit requirements.

To address the issue, a treatment system is being designed using coagulation/filtration technology. The system will include a new equalization tank (to replace the existing boiler room tank for pH adjustment and the existing settling tanks) and a new solids clarifier. The new inclined plate clarifier will be designed to treat 350 gpm, which is the expected maximum wash water flow, and will include an integrated solids thickener. Because solids removal can be conducted at the anticipated maximum wash water flow, the working equalization tank volume required to provide 30 minutes of retention time and consistent pH adjustment would be 12,500 gallons. Additionally, a polymer will be added to the wash water to enhance particle coagulation/flocculation and settling within the clarifier. Wash water exiting the clarifier will subsequently be conveyed to a percolation pond that will include an amended soil mixture developed for supplemental metals removal. Under this treatment train alternative, the percolation pond will serve as the final polishing step to

remove fine particulates and dissolved metals as the wash water filters through the pond soil media. This treatment system for the air heater washwater is anticipated to reduce nickel concentrations in the air-heater wash water from 50 to 100 mg/L to approximately 0.1 mg/L.

5. RECOMMENDATIONS FOR COMPLYING WITH THE NEW EFFLUENT LIMITATIONS

Based on the author's experience, the following recommendations are provided for complying with the new Effluent Guidelines that are expected to be published by USEPA in 2011.

- Assess existing and/or potential future surface-water discharges for the presence of constituents that are not specifically identified in the current facility discharge permit (e.g., arsenic, boron, selenium, cadmium, mercury).
- Evaluate treatment technology alternatives and associated costs for managing wastewater streams that are currently being treated in CCR surface impoundments, but which will not be able to be treated in these impoundments under the new regulations.
- Develop NPDES permitting strategies if new discharge outfalls may be necessary.
- Evaluate how storm water that is currently being routed to CCR surface impoundments might need to be managed differently under the new regulations, realizing that mixing storm water and wastewater could unnecessarily increase the volume and cost of wastewater treatment under the new regulations.
- Develop a plan for retrofitting surface impoundments with a composite liner system (where their future use may be allowed) to comply with the new rules, as well as a cost-benefit analysis of alternatives to lining the ponds.

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