IN HARM'S WAY:
Lack Of Federal Coal Ash Regulations Endangers Americans And Their Environment

2010

Thirty-nine New Damage Cases of Contamination from Improperly Disposed Coal Combustion Waste

Environmental Integrity Project, Earthjustice and Sierra Club

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EXECUTIVE SUMMARY

An investigation led by expert hydrogeologists has identified 39 more coal combustion waste (CCW) disposal sites in 21 states that have contaminated groundwater or surface water with toxic metals and other pollutants. Their analysis is based on monitoring data and other information available in state agency files and builds on a report released in February of 2010, which documented similar damage at 31 coal combustion waste dumpsites in 14 states.[i] When added to the 67 damage cases that the U.S. Environmental Protection Agency (USEPA) has already acknowledged, the total number of sites polluted by coal ash or scrubber sludge comes to at least 137 in 34 states. This total represents nearly a three-fold increase in the number of damage cases identified in EPA's 2000 Regulatory Determination on the Wastes from the Combustion of Fossil Fuels.[ii]

Drinking Water Standards Routinely Exceeded On-site, Sometimes by Orders of Magnitude

At <u>every one</u> of the 35 sites with groundwater monitoring wells, on-site test results show that concentrations of heavy metals like arsenic or lead exceed federal health-based standards for drinking water. For example, arsenic levels were above the 10 microgram per liter "maximum contaminant level" (MCL) at 26 of 35 sites, with concentrations reaching as high as 3,419 micrograms (over 341 times the standard) at the Hatfield's Ferry site in Pennsylvania. Table A presents a summary of results for select contaminants.

Table A: Summary of On-Site Monitoring Results for Select Contaminants

Pollutant	# Of Sites Above MCL	MCL	Highest Value (µg/L)	Site	Owner/Operator
Alpha Particles	2	15 pCi/L	128 pCi/L	Muskingum (OH)	American Electric Power d/b/a Ohio Power Company
Arsenic	26	10 µg/L	3,419 µg/L	Hatfield's Ferry (PA)	Allegheny Energy
Beryllium	3	4 µg/L	23 µg/L	Gallatin (TN)	Tennessee Valley Authority
Cadmium	9	5 µg/L	850 µg/L	Bruce Mansfield [Little Blue] (PA)	FirstEnergy
Chromium	4	100 µg/L	225 µg/L	Northeastern (OK)	American Electric Power d/b/a Public Service Company of Oklahoma
Lead	11	15 µg/L	2,690 µg/L	Bruce Mansfield [Little Blue] (PA)	FirstEnergy
Selenium	11	50 µg/L	1,320 µg/L	Big Cajun 2 (LA)	NRG Energy d/b/a Louisiana Generating
Thallium	2	2 µg/L	10 µg/L	Uniontown (OH)	Hyman Budoff / Merle & Charles Kittinger

Drinking Water at Risk

Where off-site sampling of private wells occurred, contaminated drinking water was found in every case.

States do not generally require off-site monitoring of drinking water wells beyond the fenceline, even when there is documented contamination at the property boundary. Nevertheless, at four of the five sites examined in this report for which such monitoring data are available, test results show violations of the federal MCL or a federal or state health advisory at one or more wells used for drinking water. At the fifth site (Joliet 9 (IL)), although off-site monitoring data are limited and consequently violation of federal or state standards are not confirmed, at least 18 nearby drinking water wells were closed due to boron contamination.

Table B summarizes the four sites where testing of off-site private drinking water wells occurred.

Table B: Heavy Metal Contamination in Off-Site Private Wells

Site	Number of Wells Contaminated/Abandoned	Contaminants	Response Action Taken
Bruce Mansfield [Little Blue] (PA)	22	aluminum, antimony, arsenic, barium, boron, cadmium, chromium (hexavalent), fluoride, iron, lead, manganese, selenium, and thallium	Alternative drinking water source provided
Cayuga Generation Plant (NY)	1	iron, lead, manganese, zinc.	Contaminated well purchased
Oak Creek Power Plant (WI)	12	molybdenum and boron	Provision of bottled water
Industrial Excess Landfill (OH)	Unknown number of private wells/11 off-site monitoring well clusters in residential areas were contaminated	antimony, arsenic, beryllium, cadmium, chromium, lead, nickel and thallium	100 homes placed on public water, Superfund action in progress

State records indicate the potential for more private wells to be contaminated.

Contaminated groundwater underneath at least 15 of the 39 sites is within two miles of private wells, according to monitoring data and public information on private well locations at the following CCW dumpsites: Independence (AR), Joliet 9 (IL), Lansing (MI), Cayuga (NY), Cardinal (OH), Gavin (OH), Muskingum (OH), Uniontown (OH), Northeastern (OK), Boardman (OR), Bruce Mansfield (PA), Hatfield's Ferry (PA), Big Stone (SD), Fayette Power Project (TX), and Oak Creek (WI). Public information on private drinking water wells is often incomplete or out of date, but for at least eight of these CCW disposal sites – Joliet 9, Gavin, Lansing, Muskingum, Uniontown, Bruce Mansfield, Fayette Power Project and Oak Creek – there are 25 or more private drinking water wells at or within two miles of the site. At Joliet 9 and Uniontown, there are 90 or more private drinking water wells within a mile of the contaminated CCW disposal sites.

CCW contaminants may threaten public water wells or intakes, potentially requiring expensive cleanup.

Public wells that serve local communities have tremendous pumping capacities that often change the direction of groundwater flow and pull contaminated water into the public's water supply. These pollutants must be removed at drinking water treatment plants, sometimes at great expense, to meet federal and state standards for safe drinking water. At least 18 of the 39 contaminated sites are located within five miles of a public groundwater well that could potentially be affected by CCW pollutants. In fact, there are at least *five* public water wells within a 5-mile radius of at least eight of those sites, namely: Flint Creek (AR); Montville (CT); Lansing (IA); George Neal North (IA); George Neal South (IA); Big Cajun (LA); Cardinal (OH); and Fayette Power Project (TX).

In several cases (e.g., Hatfield's Ferry (PA), Gallatin (TN), and Johnsonville (TN)), CCW disposal sites are leaking their toxic cargo into rivers just upstream from intakes for public water systems. Often, metals like arsenic are discharged to rivers through adjacent groundwater. For example, monitoring wells in an aquifer that flows from the Hatfield's Ferry (PA) site to the Monongahela River, less than half a mile away, have consistently measured arsenic at levels substantially above the MCL for the last five years. The contaminated groundwater discharges to the river are across from the water supply intake for the community of Masontown. Although historically, Pennsylvania has only required this public water system to test for arsenic every eight years, even in this limited testing, arsenic 2-3 times higher than the federal drinking water standard was found in the intake water at least twice since 2000. Groundwater discharges from CCW dumps may load drinking water sources with additional contaminants that must ultimately be removed from the water supply at public expense.

Illegal open dumping in violation of federal law may be occurring.

As many as 27 of the 35 sites where groundwater is contaminated may be illegal open dumps according to federal law, based on the high levels of metals found in the groundwater.[iii] When concentrations of certain pollutants exceed limits established under "Subtitle D" of the Resource Conservation and Recovery Act, the law requires that the operator close the dump, stop the flow of contamination, or obtain a waiver from the state if certain criteria are satisfied. For example, at the two sites described above where off-site drinking water wells have been contaminated with arsenic, and other sites where monitoring wells hundreds of yards downgradient of the ash have been contaminated with heavy metals, such as the Spurlock (KY), Hatfield's Ferry (PA), and Northeastern (OK) sites, it is likely that federally prohibited "open dumping" has occurred. However, because open dumping regulations are part of subtitle D of the Resource Conservation and Recovery Act (RCRA), USEPA has no authority to enforce these standards. And even though states have the authority to enforce the prohibition, it appears that some states may have ignored the federal law and allowed illegal CCW dumps to operate and contaminate drinking water sources. The failure of states to enforce Subtitle D guidelines and the failure of plant operators to comply with those requirements indicate that "guidelines" under subtitle D of RCRA are insufficient to guarantee compliance with federal safeguards.

Most damaged sites are still active and virtually all show recent evidence of contamination.

The contaminated CCW sites identified cannot be dismissed as a legacy of past practices that are no longer allowed today. Almost all of the facilities described in the report are active CCW disposal sites. The contamination is documented by recent data (from 2007 or later) at 32 of the 35 sites for which groundwater monitoring results are available. Even the few closed sites show that contamination often continues and even worsens for generations after disposal ceases. For example, nearly 40 years after CCW disposal stopped at the Montville site (CT), average concentrations of arsenic in groundwater collected in 2007-2009 still exceed the MCL by 21 times and are higher than measurements taken ten years ago.

Many states require no groundwater monitoring at all.

The USEPA's 2000 Regulatory Determination noted that damages from CCW disposal sites were likely to be more widespread than the limited evidence available, due to the lack of groundwater monitoring at so many locations, especially coal ash ponds.[iv] Ten years later, this basic deficiency is still widespread.

Large coal ash-generating states like Alabama, Arizona, Georgia, Indiana, Ohio, Mississippi, Missouri, New Mexico, and Tennessee, to name a few, require <u>no</u> monitoring by law at coal ash ponds, at least while they are still in operation. Although data were available for the Lower Colorado River Authority's ash pond, most CCW disposal sites in Texas are exempt from any regulation or monitoring by the state. States whose regulations fail to require monitoring at coal ash ponds, both old and new, accounted for approximately 70% of the coal combustion waste generated nationwide in 2008.[v] A few of these states require monitoring only at new ponds, but since 75 percent of waste ponds are over 25 years old and 10 percent are over 50 years old, these state regulations leave a large and dangerous gap.[vi]

Many states, such as West Virginia, had limitations in their data that made further examination useless. Mississippi, Alabama, and Georgia either require no monitoring of their numerous ash ponds or monitoring only after the ponds have been closed, a rare event as most ponds are operated perpetually as "storage" sites. Monitoring data from state files in Georgia were so minimal that no assessment of impacts could be made.[vii] In Minnesota and Illinois, the state agency either refused to respond to our request for site files under the Freedom of Information Act or responded that no data were available, despite the presence of substantial data.[viii] The regulation of CCW in these states is so weak, or the staff so uncooperative, that it is often impossible to determine the extent of contamination at CCW sites.

Even when the groundwater is periodically sampled for pollutants, state agencies usually fail to look beyond CCW property boundaries to see how far that pollution has traveled. Off-site data were available at only 8 of the 35 sites evaluated in this report, despite clear evidence at 28 of the sites that contaminants had migrated away from coal ash ponds or landfills and toward the property boundary, and despite the fact that private or public drinking water wells were located downgradient and in close proximity to sources of contamination at many of the sites.

States agencies have not required polluters to cleanup even as contamination increases.

Power companies that own or operate coal ash disposal sites that contaminate groundwater ought to be required to clean them up. At 21 sites examined in this study, the evidence of groundwater contamination was serious enough to cause a state agency to require additional monitoring and some assessment of its causes. But as noted earlier, monitoring beyond the operator's fenceline was rare, and only at five sites have polluters attempted to determine how far the contamination has traveled and at what concentrations (at Montville (CT), Joliet 9 (IL) Uniontown (OH), Venice (IL), and Oak Creek (WI)).

At no site did a state require the power company to stop the contamination, let alone clean it up. In isolated cases, citizens were provided with alternative sources of drinking water, or groundwater may have been cordoned off from further use as drinking water. At Uniontown (OH), many domestic well users have been left to fend for themselves, even though monitoring data documented flows heavily contaminated with metals from the Industrial Excess Landfill moving toward their wells until such monitoring was stopped in 2004.

Too often, state agencies routinely accept claims by utilities that contaminant increases are the result of sampling anomalies, or that "nature" is responsible for heavy metal concentrations that are in fact far above background levels. Without further investigation of the flimsy evidence, states let operators return to reduced monitoring or stop monitoring altogether. And In the meantime, power companies may quietly purchase surrounding property where wells are contaminated, often without alerting the state or the community that a danger exists.

[illegible]

Four sites in the report demonstrate clear damage to off-site aquatic life that has been documented in peer-reviewed research or by government scientists:

- A U.S. Fish and Wildlife Service study found that aquatic life in Lake Erie was harmed by discharges with high selenium, arsenic and other metal concentrations from an ash basin at the J.R. Whiting Plant in Michigan.
- A catastrophic release in June 1967 from a coal ash pond at the Clinch River Plant in Virginia killed an estimated 217,000 fish a distance of 90.1 miles downstream and left the river ecosystem damaged for 35 years.
- Fly ash pond discharges containing high concentrations of cadmium and selenium from the Glen Lyn plant in Virginia resulted in dramatically reduced diversity of benthic macroinvertebrates in a mountain stream.
- High concentrations of metals and sediments from ash ponds at Wisconsin's Columbia Station virtually eliminated aquatic insects for 2.2 miles downstream in the 1970s.

One of the most basic steps to protecting the off-site environment at CCW disposal sites is to set limits on the discharge of leachate or wastewater that are based on best available treatment standards, and which are also designed to protect rivers or streams. Few CCW sites are subject to Clean Water Act permits that monitor, much less limit, the full range of toxic metals that are discharged from CCW disposal sites. The limited data available show violations of the few discharge limits that are in place for the Hatfield's Ferry and Bruce Mansfield sites in Pennsylvania and the Cardinal and Gavin sites in Ohio. Water quality criteria for metals in waters receiving discharges from the Bruce Mansfield and Gavin sites are being exceeded, but most waterways next to power plants are not monitored enough to make such determinations.

Of the 39 sites examined in our report, we found two, Gavin and Hatfield's Ferry, where state agencies or operators examined the toxic effects of surface discharges on life in receiving waters. At both sites the discharges had adverse impacts on stream life. Yet PADEP has yet to require a treatment of the discharges at Hatfield's that will stop the impacts. Furthermore despite the acutely toxic effect of those discharges on insect and fish life at Gavin, Ohio EPA has implemented relaxed surface water quality standards for beryllium, cadmium, chromium, lead, selenium, and other pollutants in Kyger Creek that appear to accommodate contaminated discharges from the ash landfill and closed ash pond.

Lax regulation of coal ash disposal sites that drain into large rivers ignores the long-term build-up of metals from such discharges in river ecosystems. But discharges from TVA's Shawnee (KY), Gallatin, and Johnsonville

(TN) sites along the Ohio, Cumberland, and Tennessee Rivers, respectively, the Big Cajun (LA) and Lansing (IA) sites along the Mississippi River or the Leland Olds (ND) site along the Missouri River, may contribute to harmful concentrations of metals that will be difficult to reverse.

The finding of heavy metal contamination in onsite wells at all of the sites with groundwater monitoring should serve as a warning to USEPA and state regulators that use of coal ash as fill poses a real and substantial danger to drinking water sources. At fill projects, there are no liners or monitoring wells. Often fill sites are in or near residential areas where the contaminants need only travel a short distance to drinking water wells.[ix] According to the American Coal Ash Association, use of coal ash as fill is pervasive -- over 20 million tons of coal ash per year are used as structural fill and minefill, representing more than a third of the total coal ash reused in the U.S.[x] In light of the significant contamination described in this report, the USEPA must require every fill site to employ effective safeguards, such as liners, monitoring, and leachate collection systems, to prevent off-site migration of dangerous contaminants.

The threat to public health and damage to the environment documented in this report provides additional evidence of the accumulating harm from poorly regulated CCW disposal sites. The quantum leap in coal ash sites with documented contamination from seven sites identified by EPA in its Report to Congress in 1999[xi] to 137 sites today that are recognized by USEPA or presented in this and our previous report demonstrates that when adequate monitoring systems are established and their results are publicly accessible, contamination is invariably found at virtually every coal ash pond and landfill currently operating. Yet data from more than half (200) of the major disposal sites used by power plants in 25 states, could not be examined by EIP staff and experts, either because groundwater monitoring is lacking (8 states), agencies have refused to respond to Freedom of Information Act Requests (5 states), or due to time and resource constraints (12 states). Expecting monitoring data and other technical information at most CCW sites to be readily available to citizens when EIP's professionals had such difficulties obtaining it is unrealistic.

Our examination shows that contamination of the environment and water supplies with toxic levels of arsenic, selenium, lead, cadmium, boron, molybdenum, and other pollutants is pervasive at America's CCW disposal sites because states are not preventing it. When contamination is documented repeatedly in monitoring at these sites, state agencies do not respond, or they allow operators and their hired consultants to explain it away without substantiation as somebody else's fault, a sampling problem, or even nature's doing. The states almost never require the extent of the contamination to be determined, rarely sample off-site wells – even nearby private drinking water wells that are in the path of the contamination – and almost never require that contamination be cleaned up.

The avalanche of data should give the federal government the information it needs to set federally enforceable standards that protect the public health, guarantee citizens the right to know what is being dumped in their drinking water and the ability to do something about it, and take action to order cleanup of the worst sites. The evidence is in. It is past time for the U.S. Environmental Protection Agency to act.

[i] The Environmental Integrity Project (EIP) and Earthjustice. 2010. Out of Control: Mounting Damages from Coal Ash Waste Sites (Feb. 24, 2010), http://www.environmentalintegrity.org/news_reports/news_02_24_10.php.
[ii] U.S. Environmental Protection Agency (USEPA). 2000. Final Regulatory Determination on Wastes from the Combustion of Fossil Fuels, 65 Fed. Reg. 32,214, 32,225 (May 22, 2000).
[iii] *See* 40 C.F.R. § 257.3-4 (providing that"(a) A facility or practice shall not contaminate an underground drinking water source beyond the solid waste boundary or beyond an alternative boundary specified in accordance with paragraph (b) of this section.").
[iv] USEPA, *supra* note ii.
[v] USEPA. 2010a. Regulatory Impact Analysis for EPA's Proposed RCRA Regulation of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry (Apr. 30, 2010), (Appendix E and analysis of state regulations by Earthjustice, Environmental Integrity Project and Southern Environmental Law Center, August 2010).
[vi] USEPA. 2010b. EPA's Proposed Rule for Coal Combustion Residuals, Betsy Devlin, Associate Director, Materials Recovery & Waste Management Division, USEPA at 4 (Aug. 5, 2010), *available at* http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccr-rule/ccr-webinar.htm.
[vii] Staff and volunteers of Greenlaw retrieved what monitoring data they could from files in Georgia for our researchers but it was so minimal that no assessment of impacts could be made.
[viii] Staff of the Prairie Rivers Network found substantial monitoring data when they visited the file room at the Illinois Environmental Protection Agency.
[ix] According to EPA, large fill sites are associated with 7 proven damage cases and 1 potential damage case. (See, for example, the Battlefield Golf Course in Chesapeake, VA, where 1.5 million yards of fly ash were used as fill for construction of a golf course and Town of Pines, IN). 75 Fed. Reg. 35155.
[x] American Coal Ash Association, 2008 Coal Combustion Product (CCP) Production & Use Survey Report, available at http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=3.
[xi] USEPA. 1999. Office of Solid Waste & Emergency Response, Report to Congress: Wastes from the Combustion of Fossil Fuels (Mar. 1999).

NATIONAL COAL COMBUSTION WASTE DAMAGE CASES MAPS

[1] These damage cases include the 39 documented in this report and the 31 cases described in: The Environmental Integrity Project (EIP) and Earthjustice. 2010.Out of Control: Mounting Damages from Coal Ash Waste Sites (Feb. 24, 2010), http://www.environmentalintegrity.org/news_reports/news_02_24_10.php.

[2] *See* Sierra Club, Kentucky Waterways Alliance, Global Environmental, LLC.2010. Slow Motion Spills: Coal Combustion Waste and Water in Kentucky (May 2010), *available at* http://kentucky.sierraclub.org/resources/Environmental_Research/Coal_Combustion_Waste_and_Water_In_KY_042110.pdf.

[3] *See* USEPA. 2010. Hazardous and Solid Waste Management System; Identification and Listing of Special Wastes; Disposal of Coal Combustion Residuals From Electric Utilities; Proposed Rule, 75 Fed. Reg. 35128, (June 21, 2010), *and* USEPA. 2007. Office of Solid Waste, Coal Combustion Waste Damage Case Assessments (July 9, 2007).

TABLE 1: SUMMARY OF DAMAGE CASES

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
AR	Flint Creek Power Plant	American Electric Power d/b/a SWEPCO	Coal fly ash, bottom ash, wastewater sludge, storm water runoff	Demonstrated damage to groundwater moving off-site (to an intermittent stream that drains to ash ponds which discharge to an off-site reservoir)	Groundwater downgradient of a CCW landfill has been contaminated with lead up to 33 times the MCL, barium, selenium, cadmium and chromium exceeding the MCL and iron, manganese and silver exceeding Arkansas groundwater standards. 2009 assessment monitoring found selenium at 3 times the MCL, and sulfate and TDS at 8 and 5 times the SMCL respectively in a well 360 feet downgradient from the landfill. A leachate seep with high metals discharges to a stream that drains to ash ponds which discharge to an off-site recreational reservoir without limits or monitoring of ash metals.	45 private wells are within a 2-mile radius of the plant. Six public wells are within a 5-mile radius of the plant.
AR	Independence Steam Station	Entergy d/b/a Arkansas Power and Light	Coal fly ash, bottom ash, process wastewaters	Demonstrated damage to groundwater moving off-site (to northern and eastern property lines)	The network of 34 monitoring wells at Independence has documented widespread contamination of groundwater with arsenic, cadmium and lead above MCLs. From 2002-2009, SMCLs have been exceeded repeatedly for iron, manganese, sulfate, pH and TDS in two downgradient CCW landfill wells closest to the eastern property line where flow off-site is magnified by farm irrigation pumping. Iron concentrations have been as high as 131 times the SMCL and arsenic is approaching the MCL in these wells.	25 irrigation wells and one drinking well are within a mile; 3 production wells have been used for drinking water at the plant.

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
CT	Montville Generating Station	NRG Energy / Montville Power, LLC	Coal fly ash and bottom ash	Demonstrated damage to soil and groundwater moving off-site to surface water (discharging into the Thames River)	Multiple "areas of concern" (AOCs) exist in this urban site where coal ash has contaminated groundwater and soil with iron more than 1000 times the SMCL, and arsenic up to26 times and beryllium more than 3 times the MCL and increasing in one well despite ash disposal stopping 40 years ago. There are two groundwater zones, and arsenic has been up to 8 times the MCL and beryllium exceeding the MCL in the zone that is supposed to attain potable standards. Lead has exceeded "pollutant mobility criteria," and arsenic and beryllium exceed "direct exposure criteria" in soils and cadmium, nickel, zinc and copper have been "constituents of concern" in an AOC in this zone.	The area immediately west of the Plant is densely populated. Documents suggest over 300 private wells are likely within 2 miles and over 40 municipal wells are within 5 miles of the Plant.
FL	C.D. McIntosh, Jr. Power Plant	City of Lakeland	Coal fly ash, bottom ash and FGD waste	Demonstrated on-site damage to groundwater	Groundwater around two unlined CCW landfills and process waste water ponds is contaminated with arsenic, cadmium, lead, selenium, and nitrates above MCLs, vanadium above state std, and manganese, iron, sulfate, TDS and pH above SMCLs near property lines. FDEP Consent Order was issued in 2001 to address monitoring and cleanup. In 2010, MCL for arsenic was exceeded in 15 wells monitoring 3 water bearing zones.	Disposal areas are near Lake Parker, the shoreline of which is densely populated, and the lake is used recreationally.
IA	George Neal Station North	Berkshire Hathaway d/b/a MidAmerican Energy	Coal fly ash and bottom ash	Demonstrated damage to groundwater moving off-site, (into the Missouri River on the western perimeter of the property)	Since 2001, arsenic has exceeded the MCL in all 6 wells monitoring the shallow and deeper aquifers downgradient of the CCW monofill with maximum concentration exceeding the MCL by 22 times. High levels of iron, manganese and sulfate are also in groundwater downgradient from the monofill.	Unknown
IA	George Neal Station South	Berkshire Hathaway d/b/a MidAmerican Energy	Coal fly ash and bottom ash	Demonstrated damage to groundwater moving off-site, (as indicated by downgradient contaminant levels exceeding state standards that indicate contaminants are migrating in groundwater)	Groundwater monitoring implemented in 2000 has found arsenic up to 8.4 times the MCL in downgradient groundwater. Average iron and manganese levels surpass SMCLs by up to 32 and 75 times, respectively and the Lifetime Health Advisory for manganese by 6 times. Selenium, barium and zinc exceed "Upgradient Control Limits" set by IA DNR indicating these contaminants are migrating beyond the disposal site.	Unknown

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
IA	Lansing Power Station	Alliant Energy d/b/a Interstate Power & Light	Coal fly ash and bottom ash	Demonstrated damage to on-site groundwater	Groundwater downgradient from the ash landfill at Lansing Station has arsenic levels at more than twice the MCL. Sampling also shows that iron, sulfate and manganese are far above SMCLs and manganese concentrations also exceed EPA's Lifetime Health Advisory level by as much as 33 times.	There are about a dozen residences within 1000 feet of the landfill and ash ponds. There are 33 drinking wells within a 2-mile radius of the Plant and 5 public water sources within a 5-mile radius.
IL	Joliet 9 Generating Station	Edison International d/b/a Midwest Generations EME LLC	Coal bottom ash and boiler slag	Demonstrated damage to off-site groundwater, drinking water and surface water moving off-site	Midwest Generation bought out or replaced 18 off-site drinking water wells contaminated with boron from CCW dumped in its unlined landfill and two unlined ponds built in a quarry 1,000 feet away. IEPA has applied relaxed groundwater standards for boron, cadmium, molybdenum and selenium since 1996, e.g. allowing groundwater moving off-site to be contaminated 52 times over the MCL for cadmium. In Aug. 2009, IEPA issued a Notice of Violation citing 50 exceedances of groundwater standards for arsenic, barium, copper and molybdenum. Arsenic has exceeded the MCL by up to 8.3 times and molybdenum had exceeded the fed. Lifetime HA by 70 times in 2 off-site monitoring wells. Yet IEPA has not required testing or replacement of off-site private wells northeast of the site even though its modeling indicates their likely contamination.	There are 94 drinking wells within a mile radius of the landfill with wells downgradient to the northeast and southeast of the disposal sites. Concerns are that pumping in other quarries to the east will pull the contamination into more private wells.
IL	Marion Plant	Southern Illinois Power Cooperative	Coal fly ash, bottom ash, FGD waste	Demonstrated damage to groundwater moving off-site to surface water (discharging into Saline Creek on the northern perimeter of the site)	Cadmium levels from unlined ponds and a landfill have reached 17.6 times the MCL and 35 times federal water quality standard for acute toxicity in groundwater discharging to Saline Creek. Cadmium and iron also exceed Illinois Class I Groundwater Standards. 2009 data show high concentrations of aluminum, boron and manganese in ash pond discharges to Saline Creek.	There are 3 wells within a mile radius of the CCW disposal areas.
IL	Venice Power Station	Ameren Energy d/b/a/ AmerenUE	Coal fly ash, bottom ash, wastewater sludge, storm water runoff	Demonstrated damage to groundwater off-site (400 feet east of ash ponds & beyond property line)	Contaminant plumes from inactive, unlined ash ponds exceed the MCL for arsenic by 21 times on-site and by 3.8 times 400 feet east of ash ponds in off-site monitoring wells and exceed boron Health Advisories and IL Class I groundwater standards 600 feet from the ponds. Groundwater Management Zone proposed to control off-site contamination.	Unknown

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
KY	Mill Creek Station	E.ON d/b/a Louisville Gas & Electric	Coal fly ash, bottom ash, FGD waste, coal pile runoff	Demonstrated damage to groundwater moving off-site, (Ohio River).	Groundwater monitoring has measured arsenic, sulfate and TDS exceeding MCLs and SMCLs in a contaminant plume one-mile wide potentially endangering off-site use of shallow groundwater.	There are 15 private wells within a 2-mile radius and 4 public wells within a 5-mile radius of the Plant.
KY	Shawnee Fossil Plant	Tennessee Valley Authority	Coal fly ash and bottom ash	Demonstrated damage to groundwater moving off-site, (into Little Bayou Creek and Ohio River).	Groundwater in the Alluvial Aquifer is contaminated with arsenic and selenium exceeding MCLs, boron exceeding USEPA's Lifetime Health Advisory and sulfate and TDS exceeding SMCLs. Assessment documents contamination of the site since the 1980s. Reddish leachate seeps from CCW areas into Little Bayou Creek.	Unknown - Metropolis Lake in adjacent state-owned park is contaminated with mercury.
KY	Spurlock Power Station	East Kentucky Power Cooperative	Coal fly ash, bottom ash and FGD waste	Demonstrated damage to off-site groundwater, (750 feet beyond landfill boundary).	Spurlock's CCW landfill has contaminated underlying groundwater since at least 2005 with arsenic, iron, sulfate and TDS exceeding MCLs and SMCLs. Arsenic has reached 16 times the MCL in an off-site well 750 feet northeast of the landfill. The disposal site discharges to three receiving streams that flow into the Ohio River.	There are 25 private wells within a 2-mile radius and 3 public wells within a 5-mile radius of the Plant.
LA	Big Cajun 2 Power Plant	NRG Energy d/b/a Louisiana Generating	Coal fly ash, bottom ash, wastewater sludge	Demonstrated damage to groundwater moving off-site, (at property boundary).	A mile long complex of ash ponds has contaminated all five on-site monitoring wells with selenium up to 26.4 times the MCL. LDEQ has required 11 more wells be installed but also allowed approximately 11,500 tons of Big Cajun's ash to be dumped into the Mississippi River for barge mooring cells without any monitoring to assure that selenium or other ash metals are not contaminating the river.	There are 3 private drinking wells within a 2-mile radius and 11 public wells within a 5-mile radius of the Plant. Four public wells are downgradient of the Plant.
LA	Dolet Hills Power Station	Cleco Power	Coal fly ash, bottom ash, FGD waste, storm water runoff, metal cleaning waste	Demonstrated damage to groundwater moving off-site, (half mile from disposal sites).	Groundwater has been contaminated with arsenic, lead and selenium exceeding MCLs. Sulfate concentrations are up to 16 times higher than the SMCL and TDS is up to 28 times higher than the SMCL. Each is more than 4 times the SMCL a half mile downgradient of disposal sites.	There are 2 private wells within a 2-mile radius and 1 public well within a 5-mile radius of the Plant.
LA	Rodemacher Power Station	Cleco Power	Coal fly ash, bottom ash, storm water runoff, metal cleaning waste, clarifier sludge	Demonstrated damage to groundwater moving off-site, (to Lake Rodemacher, Bayou de Jean and the Red River).	Monitoring of four wells under a CCW landfill has found average arsenic 4 times and maximum arsenic up to 5.75 times the MCL and lead exceeding the MCL under other disposal units. Contamination is discharging to off-site surface water bodies 50 feet from waste disposal units with no attempt to monitor surface or groundwater off-site.	There are 36 registered water wells within a mile radius and 3 public drinking water wells within a 5-mile radius of the Plant. CLECO and the Louisiana DNR had conflicting well data. See site report.

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
MI	J.R. Whiting Generating Plant	CMS Energy d/b/a Consumers Energy	Coal fly ash, boiler cleaning wastes, treated sewage waste	Demonstrated off-site ecological damage to aquatic life.	A 1980s study conducted by the U.S. Fish and Wildlife Service concluded that effluent discharges from the coal ash basin adjacent to Lake Erie put oligochaetes (freshwater worms) and young fish at risk. Chronic exposure to effluent could undermine fitness of populations by increased susceptibility to disease, predation and reduced reproductive capacity.	Not Examined
NC	Dan River Steam Station	Duke Energy	Coal fly ash and bottom ash	Demonstrated on-site damage to groundwater	Voluntary groundwater monitoring at Dan River's ash ponds has revealed levels of chromium, iron, lead, manganese, silver and sulfate exceeding state groundwater standards and federal MCLs.	Several dozen private residences are within two miles of the ash ponds.
ND	Antelope Valley Station	Basic Electric Power Cooperative	Coal fly ash, bottom ash, FGD waste, inert construction waste	Demonstrated damage to on-site groundwater	A closed, clay-lined CCW landfill has contaminated underlying groundwater with arsenic that has increased to more than 3 times the MCL. ND regulators have no monitoring data, only trend graphs of results provided by the power plant.	The area surrounding the Plant is primarily agricultural and there are private wells used for irrigation. There are 2 public water supplies within 5 miles of the Plant.
ND	Leland Olds Station	Basic Electric Power Cooperative	Coal fly ash, bottom ash, coal pile runoff, coal slack, boiler blowdown	Demonstrated damage to on-site groundwater	Monitoring has measured arsenic at nearly 8 times and lead at nearly 5 times MCLs as well as elevated selenium and boron in groundwater underneath clay-lined, decommissioned ash ponds.	A municipal well is within 5 miles of the plant. Fish and irrigation water from the Missouri river could be at risk.
NE	Sheldon Station	Nebraska Public Power District	Coal fly ash and bottom ash	Demonstrated damage to groundwater moving off-site (at property boundary).	Selenium and sulfate have risen to levels exceeding MCLs and SMCLs in shallow groundwater 400 feet downgradient of a closed, clay-lined ash landfill at the northern property line. State has extended monitoring period and expanded monitoring to determine extent of the contamination.	An irrigation well is located downgradient within one mile of the landfill.
NY	Cayuga Generation Plant	AES	Coal fly ash and bottom ash	Demonstrated damage to groundwater on-site and a former private residential well (now owned by AES)	Concentrations of arsenic and selenium exceed MCLs in groundwater on-site by 10 times and 1.6 times, respectively. Ash leachate pond discharges to Cayuga Lake grossly exceed surface water quality standards for arsenic, cadmium and selenium, but NYDEC does not limit or monitor for these parameters in Cayuga Lake.	Cayuga Lake is one of New York's Finger Lake, and heavily used for recreation.

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
OH	Cardinal Plant	American Electric Power	Coal fly ash, bottom ash, FGD waste	Demonstrated damage to groundwater moving off-site (discharging into Riddles Run and Blockhouse Hollow).	A statistically significant increase in arsenic exceeding the MCL by up to 10 times and molybdenum exceeding the federal Health Advisory by more than 10 times are in groundwater underneath two unlined ash ponds. Private wells in the Tidd-Dale Subdivision are only a half mile downgradient, but have not been sampled.	The nearby Tidd-Dale subdivision is in the direct groundwater path of Fly Ash Reservoir 2. The subdivision relies on private drinking water wells. There are 16 private drinking wells with 2 miles of the Plant and 5 public drinking water sources within 5 miles.
OH	Gavin Power Plant	American Electric Power d/b/a Ohio Power Company	Coal fly ash, bottom ash, FGD waste, filter cake, lime	Demonstrated damage to groundwater off-site (in monitoring well beyond the southern property line and surface water and aquatic life in Stingy Run and Kyger Creek)	Ash landfill monitoring shows groundwater is contaminated with alpha activity, arsenic, barium, cadmium, lead and molybdenum in excess of MCLs and the federal Lifetime Health Advisory. Molybdenum has reached 2.5 times this advisory in groundwater 700 ft south of landfill. Wells exceeding alpha activity MCL have grown from 9 to 15. NPDES permit violations have occurred at the landfill and closed ash pond. Their discharges are acutely toxic to aquatic life.	There are at least 63 wells within 1.5 miles of the fly ash pond. Human exposure to contaminants may occur if fish is consumed from nearby surface waters.
OH	Muskingum River Plant	American Electric Power d/b/a Ohio Power Company	Coal fly ash and bottom ash	Demonstrated damage to groundwater moving off-site (to southern property line).	Monitoring shows exceedances of the MCL for alpha particles (up to 8.5 times the MCL), a notable increase in barium is occurring and iron and sulfate are substantially exceeding SMCLs in shallow downgradient groundwater 350 feet from an unlined ash pond. Arsenic and mercury exceed MCLs by more than 3 times in the seepage from the pond dike.	48 drinking water wells are within 1.5 miles of the plant; two wells are 0.25 miles from the plant
OH	Industrial Excess Landfill	Hyman Budoff / Merle & Charles Kittinger	Coal ash, masonry rubble, paper, scrap lumber, organic chemical liquid wastes, hospital waste, septic tank waste, other wastes	Demonstrated damage to off-site groundwater, including damage to many domestic drinking water wells	This site has been designated a Superfund Site by the EPA. MCLs for antimony, arsenic, beryllium, cadmium, chromium and lead has been exceeded often by many times and in off-site residential wells. Radionuclides and anthropogenic radioisotopes have migrated into nearby residential areas.	There are 90 private wells with 1500 feet of the site. There are documented cases of residents drinking contaminated well water.
OK	Northeastern Station	American Electric Power d/b/a Public Service Company of Oklahoma	Coal fly ash	Demonstrated damage to groundwater moving off-site (to the Verdigris river at the southern boundary).	Groundwater at this unlined ash landfill contains selenium up to 37 times, arsenic up to 6 times, lead up to 13 times, and barium up to 4 times the MCL. Chromium and thallium exceed MCLs. Vanadium is 9 times state standards. Contamination flows in 3 directions. Arsenic is 3 times the MCL 900 feet northwest of the landfill.	At least 6 private wells are downgradient within 2 miles in Oologah and 3 public wells are within 5 miles.

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
OR	Boardman Plant	Portland General Electric	Coal fly ash, bottom ash, economizer ash	Demonstrated damage to groundwater moving off-site (at monitoring wells 750 and 1,500 feet from CCW disposal area)	Groundwater contamination has been documented at the ash landfill and Carty Reservoir where ash sluice water has been disposed at the Boardman Plant since 1981. The Oregon Numerical Groundwater Quality Reference Level (ONGQRL) for selenium has been exceeded and vanadium has reached 2.5 times state standards in shallow groundwater 1,500 feet downgradient of the ash landfill which has a liner made of hydrated coal ash. No off-site monitoring is occurring. Carty Reservoir is not sampled for vanadium or selenium.	Groundwater in the vicinity of the plant is used for irrigation and livestock. Within 5 miles of the Plant, 14 wells are used for irrigation, 19 wells are used as private water supply and 18 wells are used for livestock watering. Carty Reservoir is also used for irrigation at a neighboring farm.
PA	Bruce Mansfield Power Station	FirstEnergy	Coal fly ash, FGD Waste	Demonstrated damage to off-site groundwater and surface water (in domestic wells and in Marks Run and other surface waters).	Contamination and discharges from the unlined Little Blue Run surface impoundment have caused exceedances of groundwater and/or surface water quality standards for aluminum, antimony, arsenic, barium, boron, cadmium, chloride, chromium, fluoride, iron, lead, manganese, pH, selenium, sulfate, TDS, thallium, turbidity. Contamination has been detected in multiple off-site residential drinking wells, in Mark's Run and other off-site surface waters, and at many on-site monitoring wells moving off-site.	At least 22 private wells have been contaminated above state standards, federal MCLs, SMCLs, or health advisories
PA	Hatfield's Ferry Power Station	Allegheny Energy	Coal fly ash, bottom ash, wastewater sludge, storm water runoff	Demonstrated damage to groundwater moving off-site and to off-site surface water and aquatic life (in Little Whitely Creek and tributaries).	Arsenic, molybdenum, boron, sulfate and total dissolved solids (TDS) are far over standards in groundwater flowing from this largely unlined CCW landfill. Total arsenic has reached 342 times the MCL, boron more than 5 times the lifetime Health Advisory and molybdenum 33 times this advisory in groundwater 1,500 feet from the landfill that is flowing toward a municipal water supply intake on the Monongahela River that has had documented exceedances of the arsenic MCL. The landfill's leachate pollutes streams with boron, molybdenum, sulfate, thallium and TDS violating PA water quality criteria and harms aquatic life.	There are seven drinking water wells within 2 miles of the ash site.
SD	Big Stone Power Plant	Otter Tail Power	Coal fly ash, bottom ash, FGD waste, wastewater	Demonstrated damage to groundwater moving off-site (at northern and eastern property boundaries and south toward the Whetstone River).	21 of 25 monitoring wells report exceedances of groundwater standards downgradient of CCW disposal units in two aquifers. Arsenic has been up to 13 times and lead up to 7 times the MCL, boron up to 34 times the Lifetime Health Advisory and sulfate up to 224 times the SMCL at 56,000 mg/L. Despite mounding of groundwater at the property lines, no monitoring of nearby ponds or private wells has occurred	Groundwater is the only source of public water supply in South Dakota. There are 119 wells within a 5-mile radius of the Plant.

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
TN	Cumberland Steam Plant	Tennessee Valley Authority	Coal fly ash and bottom ash	Demonstrated damage to on-site groundwater.	Groundwater downgradient of the gypsum storage area and ash ponds contains arsenic more than twice the MCL, selenium 3 times the MCL and boron 13 times the Child Health Advisory. Aluminum, chloride, iron, manganese, sulfate and TDS exceed the SMCL. Placement of two CCW storage-disposal areas over older unlined ash ponds that were built in a former creek channel has created conditions conducive to contamination.	There are 440 households within 3 miles. The majority of nearby drinking water sources utilize groundwater.
TN	Gallatin Fossil Plant	Tennessee Valley Authority	Coal fly ash and bottom ash	Demonstrated damage to on-site groundwater moving off-site (into the adjacent Cumberland River)	An unlined closed ash pond has contaminated groundwater with beryllium up to 6 times the MCL , cadmium exceeding the MCL, nickel exceeding the TN MCL by 2.5 times and boron consistently exceeding the federal Child Health Advisory. Concentrations of aluminum, iron, manganese, sulfate and TDS exceed Secondary MCLs. Two newer active ash impoundments are not lined or monitored.	Many public drinking water sources for communities near Gallatin use treated water from the Cumberland River. The Gallatin Water Department draws water just over 1 mile downstream of the plant's ash ponds.
TN	Johnsonville Fossil Plant	Tennessee Valley Authority	Coal fly ash and bottom ash	Demonstrated damage to on-site groundwater discharging to surface water, (Tennessee River).	An active ash disposal area resides on an unlined island in the middle of the Tennessee River. Groundwater on the island and at-on shore dumps contains arsenic, aluminum, boron, cadmium, chromium, iron, lead, manganese, molybdenum, sulfate and TDS far above federal Maximum Contaminant Levels (MCL), SMCLs, and federal health advisory levels.	Disposal areas discharge into recreational waters of Tennessee River within a mile of New Johnsonville and Camden municipal water intake pipes.
TX	Fayette Power Project	Lower Colorado River Authority	Coal fly ash, bottom ash, FGD waste, boiler slag construction wastes, other non-CCW wastes	Demonstrated damage to groundwater moving off-site (to the southeast and southwest and discharging to Cedar and Baylor Creeks).	Groundwater sampling has found arsenic, cobalt, molybdenum and selenium exceeding Texas Protective Contamination Levels, MCLs and Health Advisories by 2-4 times. Aluminum, chloride, manganese, sulfate and TDS concentrations exceed federal SMCLs. Molybdenum contamination in the middle sand water bearing unit appears to be moving off-site.	TCEQ has notified two neighboring landowners of possible molybdenum contamination. There are 42 private wells and 23 public wells within 5 miles of the Plant.
VA	Clinch River Plant	American Electric Power d/b/a Appalachian Power	Coal fly ash and bottom ash	Demonstrated off-site ecological damage to aquatic ecosystems, (fish, snails, mussels, and aquatic macroinvertebrates in the Clinch River).	In 1967 a dike from a coal ash pond at Clinch River Plant collapsed releasing a caustic ash slurry into the Clinch River. Some 217,000 fish were killed for up to 90 miles downriver and benthic macroinvertebrates, snails and mussels were also wiped out or very negatively affected. Forty years after the spill, aquatic ecosystems downstream remain degraded. High concentrations of copper and aluminum from power plant effluent also contribute to biotic impairment.	Unknown

State	Site	Owner	Wastes Present	Determination	Documented Impact	At Risk Populations
VA	Glen Lyn Plant	American Electric Power d/b/a Appalachian Power	Coal fly ash and bottom ash	Demonstrated off-site damage to surface water and aquatic ecosystems, (aquatic macroinvertebrates and bacteria in a receiving stream).	Scientific studies in the 1970s and 1980s documented acute toxicity of effluent discharges from a fly ash holding pond to aquatic insects (mayflies) and bacteria in a mountain stream that flows into the New River. High TSS, pH at 9.5 units and cadmium and selenium exceeding Virginia Water Quality Standards for acute toxicity by 30 times and 4 times, respectively in the stream were responsible for the mortality. Bioaccumulation of copper by 580 times and cadmium and nickel by 10,000 times in Duckweek, a floating plant in the pond over levels in the water or sediments posed a toxic potential to off-site life if the plant was flushed from the pond.	Unknown
WI	Columbia Energy Center	Alliant Energy d/b/a Wisconsin Power & Light	Coal fly ash and bottom ash	Demonstrated off-site damage to aquatic ecosystems (aquatic macroinvertebrates in a receiving stream).	Ecological studies in the late 1970s identified devastating impacts on aquatic life in a stream receiving discharge from ash ponds wiping out nearly all aquatic insects for 2.2 miles downstream. High conductivity and concentrations of cadmium and copper that likely exceeded federal and Wisconsin water quality criteria for acute toxicity in the stream as well as flocculent in the discharge coating the stream bottom were the culprits.	Unknown
WI	Oak Creek Power Plant (Caledonia)	Wisconsin Energy(WE Energies) d/b/a Wisconsin Electric Power Co.	Coal fly ash, bottom ash, FGD waste, wastewater solids	Demonstrated damage to off-site drinking water wells	Twelve private drinking wells within 1500 feet of the Oak Creek and Caledonia CCW landfills have been contaminated with molybdenum exceeding WI Enforcement Standard (ES) and the federal Lifetime Health Advisory by up to 3 times and boron levels exceeding WI's Preventative Action Limit by up to 3.8 times. WE Energies started providing bottled water to residences in August 2009. WIDNR has started an investigation. Molybdenum in monitoring wells at the Oak Creek landfills is up to 13.5 times higher than WI ES and federal Lifetime HA and 375 times higher than these standards in landfill leachate.	In August 2009, WE Energies informed nearby residents that their water was unsafe to drink and has been providing bottled water to about two dozen residences. There about 100 more households north of these homes and potentially in the pathway of contamination but most are on public water. Other homes are potentially effected by localized contamination further west.

TABLE 2: COAL COMBUSTION WASTE DAMAGE TO GROUNDWATER

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
AR	Flint Creek Power Plant	Barium	Federal Primary MCL	2 mg/L	2.4 mg/L	Groundwater	On-site	None
		Cadmium	Federal Primary MCL	0.005 mg/L	0.01 mg/L	Groundwater	On-site	
		Chromium	Federal Primary MCL	0.1 mg/L	0.128 mg/L	Groundwater	On-site	
		Lead	Federal Primary MCL	0.015 mg/L	0.5 mg/L	Groundwater	On-site	
		Selenium	Federal Primary MCL	0.05 mg/L	0.152 mg/L	Groundwater	On-site	State Required Assessment Monitoring
		Silver	Federal Secondary MCL[i]	0.1 mg/L	0.2 mg/L	Groundwater	On-site	None
AR	Independence Steam Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.016 mg/L (0.061 mg/L rejected due to turbidity)	Groundwater	On-site	None
		Cadmium	Federal Primary MCL	0.005 mg/L	0.006 mg/L	Groundwater	On-site	
		Lead	Federal Primary MCL	0.015 mg/L	0.023 mg/L	Groundwater	On-site	
CT	Montville Generating Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.262 mg/L	Groundwater	On-site	EPA Proposed RCRA Remedial Action Plan
		Beryllium	Federal Primary MCL	0.004 mg/L	0.0138 mg/L	Groundwater	On-site	
FL	C.D. McIntosh, Jr. Power Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.0165 mg/L	Groundwater	On-site	Consent Decree issued in December 2001; State Required Assessment Monitoring
IA	George Neal Station North	Arsenic	Federal Primary MCL	0.01 mg/L	0.218 mg/L	Groundwater	On-site	Risk evaluation requested by State
IA	George Neal Station South	Arsenic	Federal Primary MCL	0.01 mg/L	0.0839 mg/L	Groundwater	On-site	None
IA	Lansing Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.023 mg/L	Groundwater	On-site	None

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
IL	Joliet 9 Generating Station	Ammonia	IL Applicable Groundwater Quality Standard (IAGQS)	1.57 mg/L	5.3 mg/L	Groundwater	On-site	Illinois EPA issued a Notice of Violation in August 2009 for 50 groundwater exceedances. No cleanup required as of yet
		Arsenic	Federal Primary MCL and IAGQS	0.01 mg/L	0.1 mg/L	Groundwater	Off-site, unconfirmed	
		Barium	Federal Primary MCL[ii]	2 mg/L	0.36 mg/L	Surface Water	Discharge Point	
		Boron	Federal Child Health Advisory[iii]	3.0 mg/L	10 mg/L	Groundwater	Off-site, unconfirmed	
		Cadmium	Federal Primary MCL [iv]	0.005 mg/L	Exceeded 0.264 mg/L	Groundwater	Unknown	
		Molybdenum	Federal Lifetime Health Advisory[v]	0.04 mg/L	2.9 mg/L	Groundwater	Off-site, unconfirmed	
		pH	Federal Secondary MCL[vi]	6.5 - 8.5	9.98	Groundwater	Off-site, unconfirmed	
		Selenium	Federal Primary MCL[vii]	0.05 mg/L	Exceeded 0.325 mg/L	Groundwater	Unknown	
		Sodium	Federal Health-based Drinking Water Advisory [viii]	20 mg/L	470 mg/L	Groundwater	Off-site, unconfirmed	
		Sulfate	Federal Secondary MCL[ix]	250 mg/L	690 mg/L	Groundwater	Off-site, unconfirmed	
		TDS	Federal Secondary MCL[x]	500 mg/L	1,300 mg/L	Groundwater	Off-site, unconfirmed	
IL	Marion Plant	Boron	Illinois Groundwater Standard[xi]	2 mg/L	2.53 mg/L	Groundwater	On-site	State Required Assessment Monitoring
		Cadmium	Federal Primary MCL	0.005 mg/L	0.088 mg/L	Groundwater	On-site	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
IL	Venice Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.215 mg/L	Groundwater	On-site	State Required Assessment Monitoring, Groundwater Management Zone proposed.
		Boron	Federal Child Health Advisory[xii]	3 mg/L	27.7 mg/L	Groundwater	On-site	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.006 mg/L	Groundwater	On-site	
KY	Mill Creek Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.015 mg/L	Groundwater	On-site	State Required Assessment Monitoring
KY	Shawnee Fossil Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.012 mg/L	Groundwater	On-site	None
		Boron	Federal Child Health Advisory	3 mg/L	15 mg/L	Groundwater	On-site	
		Selenium	Federal Primary MCL	0.05 mg/L	0.087 mg/L	Groundwater	On-site	
KY	Spurlock Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.16 mg/L	Groundwater	Off-site	None
LA	Big Cajun 2 Power Plant	Selenium	Federal Primary MCL	0.05 mg/L	1.32 mg/L	Groundwater	On-site	Notice of Deficiency; State Required Assessment Monitoring
LA	Dolet Hills Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.0156 mg/L	Groundwater	On-site	State Required Assessment Monitoring
		Lead	Federal Primary MCL	0.015 mg/L	0.023 mg/L	Groundwater	On-site	
		Selenium	Federal Primary MCL	0.05 mg/L	0.173 mg/L	Groundwater	On-site	
LA	Rodemacher Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.0575 mg/L	Groundwater	On-site	State Required Assessment Monitoring
		Lead	Federal Primary MCL	0.015 mg/L	0.0209 mg/L	Groundwater	On-site	
NC	Dan River Steam Station	Chromium	North Carolina Groundwater Standard	0.05 mg/L	0.0611 mg/L	Groundwater	On-site	None
		Lead	Federal Primary MCL	0.015 mg/L	0.0392 mg/L	Groundwater	On-site	
		Silver	North Carolina Groundwater Standard	0.0175 mg/L	0.0411 mg/L	Groundwater	On-site	

Table 2: Coal Combustion Waste Damage to Groundwater

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
ND	Antelope Valley Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.035 mg/L[xiii]	Groundwater	On-site	None
ND	Leland Olds Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.0789 mg/L	Groundwater	On-site	None
		Lead	Federal Primary MCL	0.015 mg/L	0.0716 mg/L	Groundwater	On-site	
NE	Sheldon Station	Selenium	Federal Primary MCL	0.05 mg/L	.0728 mg/L	Groundwater	On-site	Post-closure groundwater monitoring extended with more monitoring wells
NY	Cayuga Generation Plant[xiv]	Arsenic	Federal Primary MCL	0.01 mg/L	0.019 mg/L	Groundwater	On-site	None
		Selenium	New York Groundwater Standard[xv]	0.01 mg/L	0.076 mg/L	Groundwater	On-site	
OH	Cardinal Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.1 mg/L	Groundwater	On-site	State Required Assessment Monitoring
		Boron	Federal Child Health Advisory	3 mg/L	5.57 mg/L	Groundwater	On-site	
		Molybdenum	Federal Lifetime Health Advisory	0.04 mg/L	0.43 mg/L	Groundwater	On-site	
OH	Gavin Power Plant[xvi]	Alpha Particles	Federal Primary MCL	15 pCi/L	1,497 pCi/L	Groundwater	On-site	State Required Assessment Monitoring
		Arsenic	Federal Primary MCL	0.01 mg/L	0.057 mg/L	Groundwater	On-site	
		Barium	Federal Primary MCL	2 mg/L	13.8 mg/L	Groundwater	On-site	
		Boron	Daily Maximum Concentration in NPDES Discharge Permit	8.551 mg/L	9.47 mg/L	Outfall 007	Landfill Discharge to Surface Water	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.007 mg/L	Groundwater	On-site	
		Lead	Federal Primary MCL	0.015 mg/L	0.051 mg/L	Groundwater	On-site	
		Molybdenum	Federal Lifetime Health Advisory	0.04 mg/L	0.409 mg/L	Groundwater	On-site	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
OH	Muskingum River Plant	Alpha Particles	Federal Primary MCL	15 pCi/L	128 pCi/L	Groundwater	On-site	Monitoring required due to increase in impoundment dam height
OH	Industrial Excess Landfill (Uniontown)	Antimony	Federal Primary MCL	0.006 mg/L	0.315 mg/L	Groundwater	Off-site (close to or within a residential area)	EPA Designated Superfund Site
		Arsenic	Federal Primary MCL	0.01 mg/L	0.132 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Barium	Federal Primary MCL	2 mg/L	2.3 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Beryllium	Federal Primary MCL	0.004 mg/L	0.121 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.265 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Chromium	Federal Primary MCL	0.1 mg/L	1.680 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Lead	Federal Primary MCL	0.015 mg/L	0.70 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Mercury	Federal Primary MCL	0.002 mg/L	0.0055 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Nickel	Federal Primary MCL	0.1 mg/L	2.2 mg/L	Groundwater	Off-site (close to or within a residential area)	
		Thallium	Federal Primary MCL	0.002 mg/L	0.0129 mg/L	Groundwater	Off-site (close to or within a residential area)	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
OK	Northeastern Station	Arsenic	Federal Primary MCL	0.01 mg/L	0.094 mg/L	Groundwater	On-site[xvii]	State Required Investigation and possible remediation of contaminant plume moving south but no action on contamination moving north.
		Barium	Oklahoma Groundwater Standard[xviii]	1 mg/L	8.69 mg/L	Groundwater	On-site	
		Chromium	Federal Primary MCL	0.1 mg/L	0.225 mg/L	Groundwater	On-site[xxi]	
		Lead	Federal Primary MCL	0.015 mg/L	0.208 mg/L	Groundwater	On-site[xxi]	
		Selenium	Oklahoma Groundwater Standard[xix]	0.01 mg/L	1.85 mg/L	Groundwater	On-site	
		Thallium	Federal Primary MCL	0.002 mg/L	0.003 mg/L	Groundwater	On-site	
		Vanadium	Florida Groundwater Standard (see site report)	0.049 mg/L	0.465 mg/L	Groundwater	On-site	
OR	Boardman Plant	Selenium	Oregon Groundwater Standard	0.01 mg/L	0.019 mg/L	Groundwater	On-site	None
		Vanadium	Florida Groundwater Standard (see site report)	0.049 mg/L	0.126 mg/L	Groundwater	On-site[xx]	
PA	Bruce Mansfield Power Station (Little Blue)	Aluminum	Federal Secondary MCL	0.05 - 0.2 mg/L	0.711 mg/L	Groundwater	Off-site Private Drinking Well	PADEP and FirstEnergy entered into a settlement agreement in 1994 for groundwater contamination; since then, PADEP has issued two NOVs for fugitive dust and required resampling of 10 wells with elevated arsenic levels, but no comprehensive remediation plan has been required nor penalties assessed.
		Antimony	Pennsylvania WQC Health Criteria	0.0056 mg/L	0.01 mg/L	Surface Water	Off-site (seep 1,490 feet from the impoundment)	
		Arsenic	Federal Primary MCL	0.01 mg/L	0.021 mg/L	Groundwater	Off-site Private Drinking Well	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
PA	Bruce Mansfield Power Station (Little Blue)	Arsenic	Federal Primary MCL	0.01 mg/L	0.036 mg/L	Groundwater	On-site[xxi]	PADEP and FirstEnergy entered into a settlement agreement in 1994 for groundwater contamination; since then, PADEP has issued two NOVs for fugitive dust and required resampling of 10 wells with elevated arsenic levels, but no comprehensive remediation plan has been required nor penalties assessed.
		Arsenic	Pennsylvania Criteria Continuous Concentration	0.01 mg/L	0.028 mg/L	Surface Water	Off-site (a spring over 2,000 feet from the impoundment)	
		Barium	Federal Primary MCL	2 mg/L	5.98 mg/L	Groundwater	Off-site Private Drinking Well	
		Boron	Pennsylvania Criteria Continuous Concentration	1.6 mg/L	15.2 mg/L	Surface Water	Off-site	
		Boron	Pennsylvania Criteria Continuous Concentration	1.6 mg/L	11.8 mg/L	Surface Water	On-site (a seep over 1,800 feet from the impoundment)	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.85 mg/L (total)	Groundwater	Off-site Private Drinking Well	
		Cadmium	Pennsylvania Criteria Continuous Concentration	0.00064 mg/L	0.00074 mg/L	Surface Water	Off-site	
		Chloride	Federal Secondary MCL	250 mg/L	3,520 mg/L / 1,900 mg/L	Groundwater	Off-site Monitoring Well/Private Drinking Water Well	
		Fluoride	Federal Secondary MCL	2 mg/L	2.3 mg/L	Groundwater	Off-site Private Drinking Well	
		Fluoride	Pennsylvania Primary MCL	2 mg/L	6.4 mg/L	Groundwater	On-site[xxi]	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
PA	Bruce Mansfield Power Station (Little Blue)	Hexavalent Chromium	Pennsylvania Criteria Continuous/Maximum Concentration	0.01 mg/L 0.016 mg/L	0.028 mg/L	Surface Water	Off-site	PADEP and FirstEnergy entered into a settlement agreement in 1994 for groundwater contamination; since then, PADEP has issued two NOVs for fugitive dust and required resampling of 10 wells with elevated arsenic levels, but no comprehensive remediation plan has been required nor penalties assessed.
		Hexavalent Chromium	Pennsylvania Criteria Continuous/Maximum Concentration	0.01 mg/L 0.016 mg/L	0.02 mg/L	Surface Water	On-site	
		Iron	Federal Secondary MCL	0.3 mg/L	36 mg/L / 29 mg/L	Groundwater	Off-site Monitoring Well/Private Drinking Water Well	
		Lead	Federal Primary MCL	0.015 mg/L	2.69 mg/L	Groundwater	On-site[xxi]	
		Lead	Federal Primary MCL[xxii]	0.015 mg/L	1.8 mg/L (total)	Groundwater	Off-site Private Drinking Well	
		Lead	Pennsylvania Criteria Continuous Concentration	0.01094 mg/L	0.150 mg/L	Surface Water	Off-site	
		Manganese	Federal Secondary MCL	0.05 mg/L	3.72 mg/L / 2.399 mg/L	Groundwater	Off-site Monitoring Well/Private Drinking Water Well	
		pH	Federal Secondary MCL	6.5 - 8.5	8.7	Groundwater	Off-site Private Drinking Well	
		pH	Pennsylvania Secondary WQC Health Criteria	6.5 (minimum)	5.5 (minimum result)	Surface Water	Off-site	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
PA	Bruce Mansfield Power Station (Little Blue)	Selenium	Pennsylvania Criteria Continuous Concentration	0.0046 mg/L	0.150 mg/L	Surface Water	Off-site	PADEP and FirstEnergy entered into a settlement agreement in 1994 for groundwater contamination; since then, PADEP has issued two NOVs for fugitive dust and required resampling of 10 wells with elevated arsenic levels, but no comprehensive remediation plan has been required nor penalties assessed.
		Selenium	Pennsylvania Criteria Continuous Concentration	0.0046 mg/L	0.0939 mg/L	Surface Water	On-site[xxi] (a seep just below impoundment dam)	
		Sulfate	Federal Secondary MCL	250 mg/L	1,710 mg/L	Groundwater	Off-site Private Drinking Well	
		TDS	Federal Secondary MCL	500 mg/L	7,310 mg/L / 2,900 mg/L	Groundwater	Off-site Monitoring Well/Private Drinking Water Well	
		Thallium	Pennsylvania WQC Health Criteria	0.00024 mg/L	0.00046 mg/L	Surface Water	Off-site creek	
		Turbidity	Pennsylvania Groundwater Standard	1 NTU	220 NTU / 40 NTU	Groundwater	Off-site Monitoring Well/Private Drinking Well	
PA	Hatfield's Ferry Power Station	Arsenic	Federal Primary MCL	0.01 mg/L	3.419 mg/L (total)	Groundwater	On-site[xxiii]	2008 Consent Order and Agreement for violations of effluent limits in ash landfill discharges to the unnamed tributary to Little Whitely Creek. Required corrective action plan to address deficiencies in landfill's wetland treatment system. Steps to be implemented are unclear.
		Boron	Federal Child Health Advisory	3 mg/L	31.7 mg/L	Groundwater	On-site[xxiv]	
		Boron	Pennsylvania Criteria Continuous Concentration	1.600 mg/L	8.428 mg/L	Surface Water	Off-site in unnamed tributary of Little Whitely Creek	
		Chromium	Federal Primary MCL	0.1 mg/L	0.104 mg/L	Groundwater	On-site[xxv]	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
PA	Hatfield's Ferry Power Station	Manganese	Federal Secondary MCL	0.050 mg/L	0.355 mg/L	Surface Water	Off-site in unnamed tributary of Little Whitely Creek	2008 Consent Order and Agreement for violations of effluent limits in ash landfill discharges to the unnamed tributary to Little Whitely Creek. Required corrective action plan to address deficiencies in landfill's wetland treatment system. Steps to be implemented are unclear.
		Molybdenum	EPA Lifetime Health Advisory	0.04 mg/L	1.31 mg/L	Groundwater	On-site[xxvi]	
		Molybdenum	EPA Lifetime Health Advisory	0.04 mg/L	0.49 mg/L	Surface Water	Off-site in unnamed tributary of Little Whitely Creek	
		Sulfate	Federal Secondary MCL	250 mg/L	1,256 mg/L	Surface Water	Off-site in unnamed tributary of Little Whitely Creek	
		TDS	Federal Secondary MCL	500 mg/L	2,537 mg/L	Surface Water	Off-site in unnamed tributary of Little Whitely Creek	
SD	Big Stone Power Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.1322 mg/L	Groundwater	On-site	Assessment required additional wells in 1990. Contamination has continued.
		Boron	Federal Child Health Advisory	3 mg/L	204 mg/L	Groundwater	On-site	
		Lead	Federal Primary MCL	0.015 mg/L	0.1086 mg/L	Groundwater	On-site	
		Strontium	Federal Lifetime Health Advisory	4 mg/L	6.03 mg/L	Groundwater	On-site	
		Sulfate	Federal Secondary MCL	250 mg/L	56,000 mg/L	Groundwater	On-site	

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
TN	Cumberland Steam Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.022 mg/L	Groundwater	On-site	No actions evident
		Boron	Federal Child Health Advisory	3 mg/L	38 mg/L	Groundwater	On-site	
		Selenium	Federal Primary MCL	0.05 mg/L	0.15 mg/L	Groundwater	On-site	
TN	Gallatin Fossil Plant	Beryllium	Federal Primary MCL	0.004 mg/L	0.023 mg/L	Groundwater	On-site	No actions evident. There are two active disposal units on-site that are not monitored.
		Boron	EPA Child Health Advisory	3 mg/L	5.6 mg/L	Groundwater	On-site	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.0064 mg/L	Groundwater	On-site	
		Nickel	Tennessee Groundwater Standard	0.1 mg/L	0.25 mg/L	Groundwater	On-site	
TN	Johnsonville Fossil Plant	Arsenic	Federal Primary MCL	0.01 mg/L	0.570 mg/L	Groundwater	On-site	No actions evident. TDEC has allowed TVA to stop monitoring the two most contaminated areas on-site.
		Boron	Federal Child Health Advisory	3 mg/L	48 mg/L	Groundwater	On-site	
		Cadmium	Federal Primary MCL	0.005 mg/L	0.260 mg/L	Groundwater	On-site	
		Chromium	Federal Primary MCL	0.1 mg/L	0.16 mg/L	Groundwater	On-site	
		Lead	Federal Primary MCL	0.015 mg/L	0.39 mg/L	Groundwater	On-site	
		Molybdenum	EPA Lifetime Health Advisory	0.04 mg/L	1.20 mg/L	Groundwater	On-site	
TX	Fayette Power Project (Sam Seymour)	Arsenic	Federal Primary MCL	0.01 mg/L	0.023 mg/L	Groundwater	On-site	None
		Cobalt	Texas Residential Protective Contamination Level	0.0073 mg/L	0.0303 mg/L	Groundwater	On-site	None

State	Site	Pollutant	Reference	Limit	Maximum Result	Media	Location	Enforcement Action
TX	Fayette Power Project (Sam Seymour)	Molybdenum	Federal Lifetime Health Advisory[xxvii]	0.04 mg/L	0.154 mg/L	Groundwater	On-site	Letter sent to neighboring landowners warning of potential molybdenum contamination
		Selenium	Federal Primary MCL	0.05 mg/L	0.212 mg/L	Groundwater	On-site	State required assessment monitoring for selenium.
WI	Oak Creek Power Plant (Caledonia)	Boron	Wisconsin Preventative Action Limit	0.19 mg/L	0.72 mg/L	Groundwater	Off-Site - Douglas and Avenue Private Wells	Utility and WDNR are sampling off-site private wells.
		Molybdenum	Wisconsin Enforcement Standard	0.04 mg/L	0.094 mg/L	Groundwater	On-site	
		Molybdenum	Federal Lifetime Health Advisory	0.04 mg/L	0.124 mg/L	Groundwater	Off-Site - Douglas and Botting Avenue Wells	

[i] Arkansas Groundwater Protection Standard for silver is 0.18 mg/L.

[ii] The IAGQS for barium is 0.075 mg/L. IAGQS are site specific standards approved by IL EPA for the Joliet Site.

[iii] The IAGQS for boron is 5.9 mg/L.

[iv] The IAGQS for cadmium is 0.264 mg/L, 52.8 times higher than the Federal Primary MCL.

[v] The IAGQS for molybdenum is 1.38 mg/L, 34.5 times higher than the Federal Life-time Health Advisory.

[vi] The IAGQS for pH is 6.14 to 8.56.

[vii] The IAGQS for selenium is 0.325 mg/L, 6.5 times higher than the Federal Primary MCL.

[viii] The IAGQS for sodium is 165 mg/L, more than 8 times higher than the health-based Federal Drinking Water Advisory.

[ix] The IAGQS for sulfate is 493 mg/L.

[x] The IAGQS for TDS is 1,112 mg/L.

[xi] The federal Child Health Advisory for boron is 3.0 mg/L.

[xii] The Illinois Groundwater Protection Standard for boron is 2.0 mg/L.

[xiii] This is an approximate value, based on a trend graph. The state had only trend graphs of data available for public review from the operator.

[xiv] Ash leachate discharges to Cayuga Lake contain arsenic up to 0.086 mg/L, 4778 times the federal human health /fish consumption water quality criteria, cadmium up to 0.052 mg/L, 26 times the federal aquatic life acute toxicity water quality criteria (a hardness dependent standard), selenium up to 0.273 mg/L, 55 times the federal aquatic life chronic toxicity water quality criteria and boron up to 75.1 mg/L, 25 times the federal Child Health Advisory. Cayuga Lake is not monitored for possible water quality criteria (standard) violations resulting from these discharges.

[xv] The federal primary MCL for selenium is 0.05 mg/L.

[xvi] Nickel and zinc concentrations exceeding water quality criteria in discharges from the ash pond are suspected of killing the test aquatic insect, *Ceriodaphnia dubia*, in Stingy Run.

[xvii] Arsenic, chromium and lead have been measured up to 9.4 times, 2.25 times and 9.3 times higher than their federal primary MCLs respectively in groundwater 900 feet downgradient of the ash landfill to the north reflecting contamination moving off-site.

[xviii] The federal primary MCL for barium is 2.0 mg/L.

[xix] The federal primary MCL for selenium is 0.05 mg/L.

[xx] This vanadium concentration was measured at a well 1,500 feet downgradient of the ash landfill reflecting contamination moving off-site.

[xxi] Result reflects on-site contamination moving off-site.

[xxii] The Pennsylvania Groundwater Standard for lead is 0.005 mg/L.

[xxiii] This arsenic concentration was measured at a well approximately 1,500 feet downgradient of the ash landfill reflecting contamination moving off-site.

[xxiv] This boron concentration was measured at a well approximately 1,500 feet downgradient of the ash landfill reflecting contamination moving off-site.

[xxv] This chromium concentration was measured at a well approximately 1,500 feet downgradient of the ash landfill reflecting contamination moving off-site.

[xxvi] This molybdenum concentration was measured at a well approximately 1,500 feet downgradient of the ash landfill reflecting movement of contamination off-site.

[xxvii] The Texas Protective Contamination Level (TPCL) for molybdenum is 0.122 mg/L.

DAMAGE CASES

Entity/Company – Location

American Electric Power (AEP) d/b/a Southwestern Electric Power Company (SWEPCO) - Flint Creek Power Plant
21797 SWEPCO Plant Road
Gentry, AR 72734
Benton County
Latitude: 36.489495 Longitude: -79.715427

Determination

Demonstrated damage to off-site groundwater 360 feet west of the landfill; full extent of contamination not known

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants from the landfill to groundwater

Summary

Groundwater flowing from the CCW landfill at the Flint Creek Power Plant is contaminated at least 360 feet beyond the solid waste boundary of the landfill at concentrations that have exceeded Arkansas groundwater protection standards (GWPS), EPA Maximum Contaminant Levels (MCL), and EPA Secondary MCLs (SMCL). From 1994 through 1996, groundwater monitoring documented barium at 1.2 times the MCL, cadmium at twice the MCL, lead at 33 times the MCL, iron at 4.8 times the GWPS, manganese at 33 times the GWPS, and silver at 1.1 times the GWPS in multiple groundwater wells.

The Arkansas Department of Environmental Quality (ADEQ) required Flint Creek Power Plant to begin assessment monitoring in 2005 because of statistically significant increases (SSIs) of selenium, sulfate, pH, and total dissolved solids (TDS) in groundwater. Sampling of wells installed in 2009 to define the downgradient nature and extent of the contamination documented numerous additional exceedances of groundwater and drinking water protection standards. These exceedances included chromium at 1.2 times the MCL in one well, and, in another well approximately 360 feet from the landfill, selenium at 3 times the MCL, TDS at 5 times the SMCL, and sulfate at 8 times the SMCL. However, as of 2010, the downgradient extent of contamination has still not been fully defined and no off-site surface water or groundwater sampling has occurred. A CCW leachate seep with high concentrations of metals was identified in 2006, but, as of March 2010, the seep was still not mitigated. The seep reportedly drains to CCW ponds that have neither groundwater monitoring requirements nor any NPDES monitoring requirements or limits on metals in their discharge to an off-site reservoir.

Southwestern Electric Power Company's (SWEPCO's) sampling of four wells at the CCW landfill for the Flint Creek Plant from November 1994 to May 1996 intended to establish statistical background groundwater quality (SWEPCO, 1996a&b) revealed exceedances of standards for multiple constituents. SWEPCO and its current owner, American Electric Power (AEP), have argued that the November 1994 exceedances were due to improperly developed wells that had high turbidity (SWEPCO, 2006a&b). However, the location of these wells at the edges of the landfill makes them unsuitable for measuring natural background groundwater quality. Even without considering the November 1994 data, exceedances of Groundwater Protection Standards (GWPS) have continued to occur since at least November 3, 1995 when cadmium concentrations exceeded the federal MCL and state GWPS (0.01 mg/L versus the 0.005 mg/L MCL and GWPS) in three wells (B-01, B-04, and B-05) (AEP, 2006a). Another sample collected from well B-02 on May 7, 1996 found exceedances of MCLs and GWPS for barium (2.4 mg/L versus 2 mg/L MCL and GWPS) and lead (0.5 mg/L, over 33 times the MCL and GWPS of 0.015 mg/L) and exceedances of the GWPS for iron (53 mg/L, almost five times the 11 mg/L GWPS), manganese (56 mg/L, almost 33 times the GWPS of 1.7 mg/L), and silver (0.2 mg/L versus 0.18 mg/L GWPS) (AEP, 2010). Note that the GWPSs for iron, manganese, and silver are less stringent than the federal SMCLs of 0.3 mg/L, 0.05 mg/L, and 0.1 mg/L, respectively.

The trend of GWPS exceedances has continued after 1996. The landfill was required to initiate assessment monitoring in April 2005 because of statistically significant increases (SSIs) of sulfate, pH, TDS, and selenium (AEP, 2010, concentrations and well numbers not given). As has been noted, the wells used to determine "background" were already contaminated, so the SSIs reflected upward trends in contaminants, rather than evidence of new contamination. AEP was required to install additional downgradient monitoring wells as a result of the selenium concentrations. Three wells (NE-1, NE-2, and NE-3), all downgradient of the landfill, were to be placed east of Well B-02, and a fourth well was planned near the property line after collection of new data (AEP, 2009). Four years later, the first three wells were installed in July to August 2009, although there is no evidence that the fourth well along the property line was ever installed (AEP, 2010).

A review of historical groundwater data published in an April 2010 monitoring report (AEP, 2010) found that numerous groundwater criteria have been continually exceeded but the downgradient extent of contamination has never been fully defined. Contamination above regulatory standards is documented approximately 360 feet beyond the solid waste boundary (as defined by ADEQ Regulation 22) in Well NE-3. Specifically, the groundwater monitoring report found that:

- **Boron** – Concentrations in Well NE-3 have ranged from 0.92 to 1.24 mg/L since August 2009 (AEP, 2010).

- **Chromium** – The concentration in Well NE-01 was 0.128 mg/L (exceeding the MCL and GWPS of 0.1 mg/L) in the October 28, 2009 sampling event.
- **Selenium** – Concentrations routinely exceeded the MCL and GWPS (0.05 mg/L) in Well B-02 from May 2008 through January 7, 2009 (0.063 to 0.089 mg/L) and again on January 26, 2010 (0.103 mg/L). Selenium concentrations also exceeded the MCL and GWPS in Well NE-3 numerous times (0.134 to 0.152 mg/L) since August 2009 when the well was installed. AEP concedes that selenium concentrations are trending upward in Wells B-02 and B-05 (AEP, 2006a).
- **TDS** – Concentrations have exceeded the SMCL (500 mg/L) in Well B-02 since December 9, 1997 (maximum 1,540 mg/L). TDS concentrations have also exceeded the SMCL in Well NE-3 since it was installed (2,130–2,370 mg/L maximum). TDS concentrations in Well B-04 are trending upward (AEP, 2006a).
- **Sulfate** – Concentrations in Well B-02 have been greater than the SMCL (250 mg/L) since November 18, 1998 (888 mg/L maximum) but less than the GWPS (1,200 mg/L). However, concentrations in Well NE-3 have exceeded both the GWPS and the SMCL since it was installed (1,450 - 1,940 mg/L). Sulfate concentrations in Well B-05 are trending upward (AEP, 2006a).
- **pH** – Numerous wells are out of compliance with the federal SMCL (6.5 to 8.5 units). Levels of pH have been lower than the SMCL: consistently in Well B-02 since April 2009 (lowest measurement of 5.5); in Well B-04 for virtually every event since April 1995 (lowest measurement of 5.45); in Well B-05 for every event since April 1995 (lowest measurement of 3.6); in Well B-06 occasionally since August 2005 (lowest measurement of 6.21); in Well B-08 for virtually every event since May 2007 (lowest measurement of 6.05); and in new Wells NE-1, NE-2, and NE-3since October 2009 (6.23 lowest, 5.98 lowest, 6.3 lowest, respectively).

ADEQ first documented a CCW landfill leachate seep discharging from the southeast corner of the landfill in December 2006 during an inspection (AEP, 2008). The CCW leachate exited the landfill area on AEP property through a culvert where stormwater runoff also exits the landfill. From there, the CCW leachate flowed through an intermittent stream on AEP property and, depending on the flow, either disappeared into the streambed or flowed to the primary ash pond.

Since February 2007, the landfill permit has required that SWEPCO collect surface water samples from a discharge point (if a discharge is present) at the southeast corner of the landfill (AEP, 2010). The Solid Waste Branch staff at ADEQ maintained that the surface water samples were in fact leachate seeps from the landfill (Leamons, May 2010). The monitoring results showed numerous metals and other CCW indicator parameters in the leachate accordingly:

- **Barium** – concentrations ranged from 0.015 to 0.378 mg/L;
- **Boron** – concentrations ranged from 3.89 to max 12.1 mg/L;
- **Chromium** – concentrations ranged from 0.089 to 0.336 mg/L;
- **Lead** – concentrations ranged from 0.001 to 0.003 mg/L;
- **pH** – concentrations ranged from 11.2 to 11.74;
- **Selenium** – concentrations ranged from 0.151 to 0.421 mg/L;
- **TDS** – concentrations ranged from 3,260 to 3,680 mg/L;
- **Sulfate** – concentrations ranged from 1,770 to 2,270 mg/L.

Barium, boron, cadmium, chromium, iron, lead, manganese, pH, selenium, silver, sulfate, and total dissolved solids

At Risk Population

According to the Arkansas Well Drilling Commission, 45 five private wells were found within a two-mile radius of the Flint Creek landfill. Data was obtained by sending the location of the Flint Creek landfill with a specified two-mile radius to GIS specialists, who generated an excel table that included latitude/longitude data for private wells in the area. All private wells serve rural homes. Public well data was found by requesting data within a five-mile radius of the landfill. Six public wells were found to serve the towns of Siloam Springs and Gentry. Arkansas is in the process of placing all well data online in a public database with the help of USGS, so well records may be incomplete and not represent all private and public well locations.

Incident and Date Damage Occurred / Identified

CCW pollutant concentrations have exceeded federal MCLs and SMCLs and state GWPSs since 1994. CCW leachate discharges to surface water have been identified since December 2006.

Regulatory Actions

Statistically significant increases (SSIs) in January 2005 for sulfate, pH, TDS, and selenium resulted in ADEQ requiring SWEPCO to initiate assessment monitoring at the landfill (AEP, 2006a). AEP prepared a "Nature and Extent Workplan" four years later, in June 2009, to "characterize the nature and extent of selenium in groundwater."

ADEQ issued a Notice of Deficiency (NOD) to SWEPCO on November 5, 2008 because of an uncontrolled discharge of CCW leachate from the southeast corner of the landfill (AEP, 2008). The NOD requested that AEP install a leachate collection system and treat CCW leachate prior to its discharge to the ponds. AEP argued that no treatment other than discharge to the pond was necessary and that continued discharge through the intermittent stream was acceptable because the ponds have adequate treatment capacity. As of March 2010, construction of the leachate collection system was not complete.

Fly ash, bottom ash, low volume (unspecified) plant wastewater sludges, and coal pile runoff solids

Although the Flint Creek Plant has operated a 40-acre Class 3N landfill since 1978, the Plant has only had a landfill permit in 1994 (AEP, 2006a). The current landfill permit allows for disposal of dried fly ash and dredged bottom ash. The permit requires only semi-annual groundwater monitoring. It does not require daily or interim cover, and it requires post-closure care for only two years (SWEPCO, 1994). The permit does not specify if a liner was required.

The Flint Creek Plant also has a 30-acre primary ash pond and a 3.2-acre secondary ash pond south of the plant operations area. The primary pond is a treatment unit that is permitted to receive bottom ash sluice water, low volume wastewater, stormwater runoff, coal pile run-off, and treated domestic wastewater (0.03 million gallons a day (MGD)) from the town of Gentry's wastewater treatment plant (WWTP). The ponds provide treatment through settling and neutralization (AEP, 2006b). The estimated combined flow through the ash ponds that discharge to SWEPCO Lake is 7.29 MGD (AEP, 2008), but the flow can be up to 9.83 MGD (AEP, 2006b).

Active

The groundwater flow direction is variable and can flow in three directions from the landfill—to the north, northwest, and northeast (AEP, 2006a). Although not illustrated on potentiometric surface diagrams in groundwater monitoring reports (which show the direction of groundwater flow), a southeasterly flow is also likely given the large CCW leachate seep in that area and the surface topography drainage to the southeast. The groundwater seepage velocity was almost 17 feet per year during an August 26, 2006 sampling event (AEP, 2006a) and almost 19 feet per year during a January 2010 event (AEP, 2010). Wells are screened in both soil and bedrock (AEP, 2010). The average depth to water is approximately 36 feet in ten wells screened in soil and 47 feet in one bedrock well (B-07A) (AEP, 2010).

According to Solid Waste Branch staff at ADEQ, coal ash ponds and surface impoundments at Arkansas power plants are used for storage, not disposal, of CCW. The SWEPCO ponds at Flint Creek are managed for an exempted reuse of coal bottom ash; the ponds are dredged for re-use of the solids and/or their disposal elsewhere (Leamons, 2010b). The ponds and their dredged materials are exempt from regulation under the "use of recovered materials" provision in ADEQ Regulation 22. Solid Waste Branch staff maintained that the ADEQ Water Branch would be the Branch to require groundwater monitoring of ponds, although Water Branch staff stated that groundwater monitoring is not required for any ash pond in the state and that any regulation of such ponds would be conducted by the Solid Waste Branch (Kort, 2010). In short, groundwater monitoring is not required around the coal ash ponds at Flint Creek Power Plant.

A follow-up conversation with Solid Waste Branch staff revealed that the Solid Waste Branch staff did not know if the dredged pond material is beneficially re-used at Flint Creek, did not know how often the coal ash ponds are dredged, did not know how the dredged material is de-watered once dredged, and did not know if the landfill is even lined (Leamons, 2010a). Given the age of the landfill, a liner meeting current ADEQ Regulation 22 requirements is unlikely. Those regulations (approved March 28, 2007) require that Class 3 landfills have a two-foot compacted clay liner with a maximum hydraulic conductivity of 1 X 10^{-7} centimeters per second and a leachate collection system that is designed to maintain less than 30 centimeters of leachate over the liner. There is no indication in the AEP landfill permit that either design standard was ever required for this Class 3 landfill.

The NPDES permit that regulates discharges from the ash ponds at Flint Creek only includes numeric limits for total suspended solids (TSS, 25 mg/L monthly average, 43 mg/L Daily Maximum), pH (6 to 9 units), and chronic bio-monitoring (AEP, 2006b). The permit includes no limits or monitoring for parameters known to exist in CCW at this site, such as selenium, boron, or chromium.

AEP. 2010. Letter from Terry Wehlong, Engineer to William Sadler, ADEQ, Re: First Quarter 2010 Groundwater Analysis Report, Flint Creek Power Station, Ash Disposal Landfill (Apr. 26, 2010).

AEP. 2009. Letter from Terry Wehling, P.E., AEP, to Bill Sadler, P.G., ADEQ, Re: Nature and Extent Workplan, (June 8, 2009) by Terracon (June 10, 2009).

AEP. 2008. Letter from David Hall, PhD., Manager, Water and Ecological Resource Services, ADEQ, to Kim Fuller, P.E., ADEQ, Re: Fly Ash Landfill Seepage, NPDES Permit Number AR0037842, (Dec. 15, 2008).

AEP. 2006a. Letter from Curtis Carter, Manager, AEP, to Gerald Delavan, ADEQ, Groundwater Analysis Report, Flint Creek Power Station, Ash Disposal Landfill, Sampling Event of August 24, 2006 (Oct. 24, 2006).

AEP. 2006b. Authorization to Discharge Wastewater Under the National Pollutant Discharge Elimination System and the Arkansas Water and Air Pollution Control Act, Final Permit, Permit Number AS0037842 (effective Mar. 1, 2006).

Kort. 2010. Phone conversation with Evelyn Kort, Geologist, ADEQ, Water Division (May 5, 2010).

Leamons. 2010a. Phone conversation with Bryan Leamons, P.E., Technical Branch Manager, ADEQ, Solid Waste Management Division (May 19, 2010).

Leamons. 2010b. Phone conversation with Bryan Leamons, P.E., Technical Branch Manager, ADEQ, Solid Waste Management Division (Apr. 30, 2010).

SWEPCO. 1996a. Letter to Dave Ann Pennington, ADEQ from Brian Whatley, Geologist (Sept. 12, 1996).

SWEPCO. 1996b. Letter to Dave Ann Pennington, ADEQ from Brian Whatley, Geologist (Feb. 26, 1996).

SWEPCO. 1994. Permit for the Construction and Operation of a Solid Waste Disposal Facility. Southwestern Electric Power Company, Flint Creek Plant, Permit Class 3N (effective date May 16, 1994).

United States Environmental Protection Agency (USEPA). 2009. Steam Electric Power Generating Point Source Category: Final Detailed Study Report, USEPA 821-R-09-008 (Oct. 2009).

Entity/Company – Location

Entergy, d/b/a Arkansas Power and Light (AP&L) - Independence Steam Station
555 Point Ferry Road
Newark, AR 72562
Independence County
Latitude: 35.674444 Longitude: -91.396111

Determination

Demonstrated damage to groundwater moving off-site (to northern and eastern property lines)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants to groundwater from the ash landfill, surge pond, coal storage pile, recycle ponds, and underground plant piping

Summary

Thirty-four monitoring wells have documented widespread groundwater contamination around the coal combustion waste (CCW) landfill and ponds at the Independence Steam Station. Groundwater monitoring since the 1990s has documented exceedances of federal Maximum Contaminant Levels (MCL) for arsenic (up to 6 times the MCL), cadmium (1.2 times the MCL), and lead (1.5 times the Federal Action Level), and Secondary MCL (SMCL) exceedances for iron (131 times the SMCL), manganese (167 times the SMCL), pH (5.5 units), total dissolved solids (TDS) (3.6 times the SMCL), and sulfate (4 times the SMCL). Nearby farm irrigation systems draw groundwater from beneath the landfill and surge pond towards the eastern, northeastern, and southeastern property lines. Wells along the eastern property line downgradient of the landfill have continually exceeded SMCL standards making it extremely likely that off-site contamination is occurring. Nevertheless, no corrective actions, off-site monitoring, or enforcement actions have occurred, and AP&L recently stopped sampling 26 wells at the surge pond and plant areas without objection from the Arkansas Department of Environmental Quality (ADEQ).

Test of Proof

Eight groundwater monitoring wells are currently monitored semi-annually at the landfill, surge pond, coal pile, and power plant area for arsenic, boron, sulfate, chloride, pH, total dissolved solids (TDS), specific conductance, iron, manganese, total organic carbon, sodium, potassium, magnesium, strontium, total alkalinity, turbidity, and calcium (FTN, 2009). At least 26 other wells around the surge pond, various wastewater treatment ponds, and the plant area are no longer sampled (Sadler, 2010) even though prior monitoring at these wells indicated exceedances of federal standards.

AP&L's analysis of the fly ash and bottom ash generated by the plant reveals the presence of the same heavy metals and CCW indicator parameters that are found in the contaminated groundwater (Entergy, 2005). A partial summary of those results, for parameters that have been reported in on-site groundwater samples, is as follows:

Parameter	Fly Ash Total Composition (mg/kg)	Bottom Ash Total Composition (mg/kg)
Arsenic	11 to 14	< 5
Boron	500 to 630	120 to 300
Cadmium	0.56 to 0.99	<0.4
Iron	20,000 to 65,000	12,000 to 53,000
Lead	21 to 26	< 4 to 7.4
Manganese	93 to 200	49 to 160
Strontium	2,000 to 5,700	1,100 to 4,500
Sulfate	290 to 5,600	480 to 1,200

Groundwater monitoring began in 1990 (AP&L, 1996). From 1990 to 1995, AP&L monitored a more extensive list of heavy metals and other CCW indicator parameters than it currently monitors. The 1990 to 1995 groundwater monitoring results indicated that:

- **Strontium** concentrations were the highest at the following locations: MW-1D (near production/ drinking water well, maximum concentration was 0.82 mg/L in May 1994); MW-2D (near production/drinking water well at 0.78 mg/L); well 413 (north of coal pile, west of landfill, maximum concentration was 0.72 mg/L in November 1993); well 501 (northwest of coal pile, maximum concentration was 2.72 mg/L in November 1995); surge pond wastewater (maximum concentration was 2.05 mg/L in June 1992); West Recycle Pond wastewater (maximum concentration was 2.15 mg/L in June 1992); East Recycle Pond wastewater (maximum concentration was 2.02 mg/L in June 1995); and WR Sump (maximum concentration was 1.83 mg/L in May 1993). While there is no MCL for strontium, the higher concentrations among these approached USEPA's current Lifetime Health Advisory Level for strontium of 4.0 mg/L.
- **Arsenic** exceeded the MCL (0.010 mg/L) at the following locations: well C-409 (near the recycled water pond at 0.013 mg/L), in well C-410 (downgradient of the surge pond at 0.016 mg/L), and well C-411 (downgradient of the coal storage pile at 0.015 mg/L).
- **Lead** exceeded the Federal Action Level (0.015 mg/L) in well C-410 (downgradient of the surge pond at 0.023 mg/L).
- **Cadmium** exceeded the MCL (0.005 mg/L) at well C-410 (downgradient of the surge pond at 0.006 mg/L).
- SMCLs were routinely exceeded. The highest concentrations of **TDS** (maximum 1,796 mg/L, well D501) and **sulfate** (maximum 1,005 mg/L, well MW-1D) generally occurred near the surge pond, the coal storage pile, and the plant production/ drinking water wells that create a cone of depression

from those areas, which draws groundwater toward the well by lowering the level of groundwater in the vicinity of the well.

AP&L attributed Statistically Significant Increases (SSIs) of TDS, sulfate, and strontium in one well (C-413, labeled as 413S on the site photo, above) near the coal storage pad to *off-site* agricultural contamination. AP&L based this conclusion upon the well's location near the northern property line (north of the coal pile), its interpretation of groundwater flow directions during winter and spring (not summer) months being towards plant production and drinking water wells, and a change in off-site crops from soybeans to rice in the spring of 1993. AP&L's interpretation was flawed for several reasons. It failed to consider that well C-413 is *downgradient* of the coal pile during *summer* months when off-site irrigation pumping is the greatest and thus pulling groundwater away from coal pile. Furthermore, rice generally requires more water for irrigation; therefore, more pumping for rice should increase the rate of flow of contaminated water away from the plant property. In addition, increased TDS, strontium, and sulfate are classic indicator parameters of CCW runoff at C-413, and are consistent with groundwater flow to the north from pumping. Finally, there are no off-site wells north of the property line to demonstrate that off-site degraded groundwater quality was caused by agricultural uses.

AP&L's coal ash landfill is located along the eastern property boundary. A review of potentiometric surface diagrams which indicate groundwater flow directions for February 1995, June 1995, August 1995, and November 1995 indicates that the contour of groundwater movement was relatively flat (or shallow), except near three production/drinking water wells in the plant area. Production well drawdown did not affect groundwater flow at the landfill or the eastern portion of the surge pond which exited the property to the east and southeast. As occurs at the coal pile, irrigation pumping creates northeasterly and easterly groundwater flow directions *off-site* and away from the landfill and away from the surge pond with the strongest period of influence in August when pumping is the greatest.

The CCW landfill was issued a Class 3N Landfill permit on February 14, 2002 (ADEQ, 2002), but has been in operation since at least 1990 (AP&L, 1996). The new permit required wells to be sampled quarterly for two years to establish "baseline water quality conditions" and samples to be collected semi-annually thereafter. The permit required monitoring for 28 heavy metal and indicator parameters, and statistical analyses of increases in concentrations as a basis for corrective actions.

- A 2007 groundwater monitoring report (FTN, 2007) indicates the in-depth monitoring required by the permit is not being performed. Sampling only includes 17 parameters and, of those, only one, arsenic, is a heavy metal (FTN, 2007). Five new wells, 602S through 606S, have been installed. Two of those, 604S and 605S, are along the eastern property boundary and downgradient from the landfill. Contamination from these wells is moving east beyond the property boundary. The landfill monitoring program uses water levels from the entire plant area, but only analyzes samples from eight wells around the landfill, the coal pile, the plant production wells, and the surge pond.

Key points from the 2007 groundwater monitoring report that summarized the results of data from 2002 to 2007 include:

- The laboratory detection limit for arsenic was equal to the MCL, making it impossible to determine if arsenic concentrations were increasing until the MCL had already been exceeded.
- Arsenic exceeded the MCL by more than six times in one well (including a reading of 0.061 mg/L in 602S, September 2006). The well is located in the coal pile area near the plant production wells. AP&L rejected that result and other metal results because of apparent high turbidity in the well.

- The highest reported TDS (910 mg/L in well 603S, October 2003) and sulfate (455 mg/L in well 603S, October 2005) and the most frequent exceedances of SMCLs were associated with wells closest to the landfill (wells 511S, 603S, 604S, 605S, and 606S).
- TDS concentrations exceeded the SMCL for virtually every sampling event since October 2003 in wells 604S and 605S, located approximately 270 feet and 180 feet, respectively, from the eastern property line where drawdown from off-site irrigation occurs. From 2002 to 2007, other SMCLs were exceeded:
  - **pH** was lower than the SMCL range (6.5-8.5 units) in eight wells. Samples farthest from the pH range were taken in wells 604S and 605S in every sampling period, with 5.5 units being the worst result).
  - **Iron** exceeded the SMCL (0.30 mg/L) in seven wells. The greatest exceedances in every sampling event occurred in well 605S, and its maximum concentration was 39.3 mg/L, 131 times the SMCL.
  - **Manganese** exceeded the SMCL (0.05 mg/L) in six wells. The greatest exceedances were in wells 602S and 605S, and the maximum concentration was 8.35 mg/L, 167 times the SMCL.
- A statistically significant increase (SSI) in chloride concentrations was reported in well 605S.
- A SSI of manganese greater than the SMCL was reported in well 604S, a well along the eastern property line.
- AP&L rejected data for some sampling events when some results were too high. For example, AP&L rejected: arsenic and boron results for well 602S (September 2006); manganese results for wells 413S (October 2004), 602S (September 2006), and 605S (May 2004); and iron results for wells 602S (September 2006), and 605S (May 2004). The files reviewed did not indicate whether ADEQ accepted or denied those rejections or asked for documentation to support a claim that values were outliers.

A CCW landfill groundwater monitoring report submitted in December 2009 also included the shortened 17-parameter list (FTN, 2009). Key points of the report which, tabulated results from 2007 to 2009, include:

- Arsenic in one well (605S, 0.007 mg/L, October 2009) along the eastern property line was slightly less than the MCL (0.01 mg/L). The October event represented the first time the laboratory report limit for arsenic was lower than the MCL (0.005 mg/L versus 0.01 mg/L), because ADEQ finally required AP&L to report at the lower limit (Entergy, 2009).
- AP&L rejected groundwater elevation data for well 605S (along the eastern property line) as "potentially anomalous."
- Boron concentrations, considered by AP&L to be a coal ash leachate indicator, are the highest in the wells closest to the landfill and the surge pond. These include 0.319 mg/L at well 603S and 0.607 mg/L at well 511S.
- The highest reported TDS and sulfate concentrations occurred in wells 511S, 603S, 604S, and 605S, which surround the CCW landfill with maximum TDS of 820 mg/L and sulfate of 288 mg/L in well 603S in October 2007.
- TDS concentrations were greater than the SMCL at five wells. Two of them are the downgradient landfill wells adjacent to the eastern property line, wells 604S and 605S.
- Other SMCLs were exceeded:
  - **pH** (SMCL of 6.5-9.0 units) – in four wells. The worst results were again from wells 604S and 605S at 6.2 units.
  - **Iron** (SMCL of 0.300 mg/L) – in five wells. Highest exceedances, up to 3.91 mg/L, 13 times the standard, again came from wells 604S and 605S.
    Manganese (SMCL of 0.050 mg/L) – in five wells. Highest exceedances, up to 0.315 mg/L, 6.3 times the standard, from wells 413S and 602S north of the coal pile.

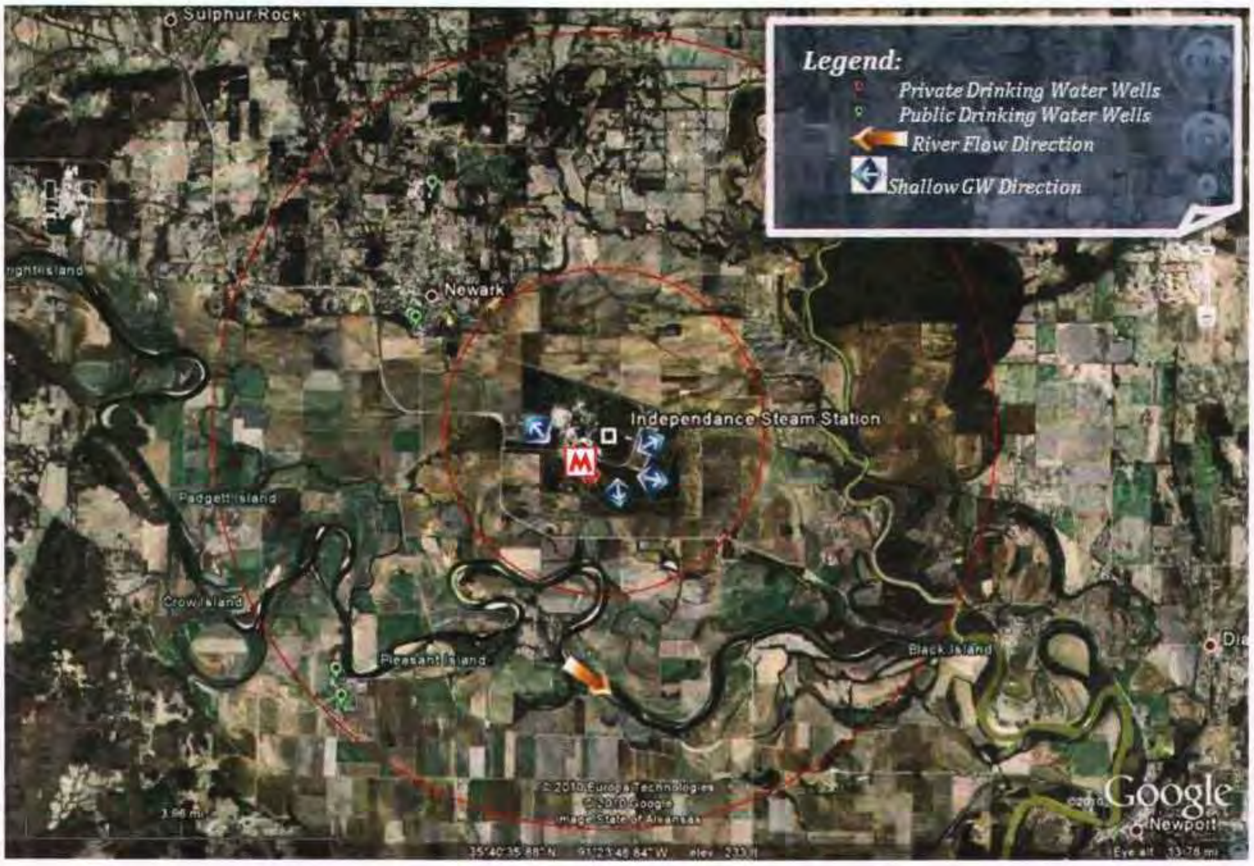
In a letter from Entergy (d/b/a AP&L) to ADEQ in 2009 to address ADEQ's concerns that groundwater monitoring was insufficient at the ash landfill and other concerns about the lack of unaffected background or upgradient wells (Entergy, 2009), Entergy (d/b/a AP&L) stated that:

- ADEQ's request for wells almost ¾-mile west of the CCW landfill to serve as "background" wells was improper because the area "between these monitoring wells and the landfill groundwater has been impacted by other sources (e.g. underground cooling water pipes, recycle ponds, surge pond, coal yard, and off-site agricultural impacts)."
- It would install two additional background wells west of the CCW landfill (locations not given but assumed in close proximity to the landfill and coal pile to the west), and that results from the new wells, and old wells 413S, 511S, and 603S, would be used to establish statistical background concentrations. However, this proposal ignores exceedances of MCLs or SMCLs that have occurred at all of those wells, which are not indicative of "background" or unaffected groundwater from CCW and the coal pile. Under this proposal, groundwater concentrations downgradient from the CCW landfill would be compared to already-contaminated concentrations in order to determine if SSIs are occurring and if corrective action is needed.
- It would not use pre-2002 groundwater data to determine background, pre-CCW disposal water quality, even though monitoring data from 1990 and onwards exists. Instead, AP&L suggested using recent groundwater data to establish statistical "background" levels – years after CCW landfill operations began and during which time significant, widespread groundwater contamination has been documented.

Arsenic, cadmium, iron, lead, manganese, pH, sulfate, total dissolved solids, and elevated levels of strontium and boron

At least 25 irrigation wells and three drinking water wells exist within a two-mile radius of the plant. Several are "immediately adjacent to the plant property." Data was obtained by sending the location of the Flint Creek site with a specified two-mile radius and GIS specialists generated an excel table that included latitude and longitude data with the private wells in the area. Public well data was found the same way but instead of a two-mile radius, a five-mile radius was specified. In addition, three production wells screened in the contaminated shallow gravel aquifer have been used for drinking water at the plant. Arkansas is in the process of placing all well data online in a public database with USGS. Well records may be incomplete and not represent all private and public well locations.

Despite contamination over a broad area, ADEQ has never required any off-site sampling of private or public wells near this facility to define the lateral and vertical extent of groundwater contamination. It is also unclear what influence CCW disposal is having on the nearby White River. AP&L has asserted that the direction of groundwater flow has varied in part according to recharge from the White River located approximately one mile to the south. This claim is also not supported by any off-site data that indicates an influence on localized groundwater flow at the plant from the White River.



Mounding of groundwater in the disposal area may cause localized flow in other directions.

Incident and Date Damage Occurred / Identified

Exceedances of MCLs and SMCLs were documented beginning in the early 1990s.

Regulatory Actions

The ADEQ has not ordered any "assessment monitoring," taken any corrective action, undertaken any off-site monitoring, or required AP&L to undertake such monitoring despite evidence of groundwater contamination moving off-site and State regulatory requirements prohibiting off-site contamination (Leamons and Sadler, 2010).

However, AP&L recently stopped voluntary monitoring of 26 plant-area and surge pond groundwater monitoring wells, many of which had documented contamination without objection from ADEQ (Sadler, 2010).

Wastes Present

Fly ash, bottom ash, and process wastewaters

Type(s) of Waste Management Unit

A fly ash/bottom ash landfill, two wastewater recycle ponds, a surge pond, and a coal storage pile. The landfill and surge pond are each nearly ¾-mile long.

AP&L has applied for a landfill expansion and ADEQ will require that the lateral expansion to the east of the existing landfill have a leachate collection system; however, the collected leachate is planned for disposal into the surge pond (Leamons and Sadler, 2010) – which is believed to be an unlined, wet disposal unit.

The surge pond currently receives the following process wastewaters, ash handling waters, and coal combustion related wastes (Entergy, 2006):

- Ash handling water
- Ash landfill stormwater runoff
- Coal pile stormwater runoff
- Switchyard runoff
- Chemical metal cleaning waste
- Boiler blowdown and area runoff
- Recycle ponds discharge
- Oil / water separator discharge

The two recycle ponds receive ash handling water, chemical metal cleaning wastewater, boiler blowdown, and area runoff. The combined flow of the recycle ponds discharges to the surge pond.

Active

Shallow groundwater conditions exist in a gravel aquifer beneath the plant (AP&L, 1996). The water table is approximately 20 to 30 feet below ground surface. The monitoring well system includes water obtained from the top of the gravel aquifer (400-series wells) and the base of the gravel aquifer (500-series wells). The 600-series well screen interval depths are the same as the 400-series wells, in the uppermost portion of the gravel aquifer (FTN, 2009). Potentiometric surface diagrams indicate a relatively flat contour of groundwater flow except near three production and drinking water wells in the plant area. Nevertheless, groundwater flow rates are high, according to the following seepage velocities:

- 1990–1995 – seepage velocities ranged from 0.2 to 13.4 feet per day, or 73 to 4,891 feet per year (AP&L, 1996).
- 2007 – the average seepage velocity was 0.95 feet per day, or 345 feet per year (FTN, 2007).
- 2009 – the average groundwater seepage velocity was 0.20 feet per day, or 74 feet per year (FTN, 2009).

A mound of groundwater has been documented beneath the surge pond, which alters the local direction of groundwater flow. Further, plant production and drinking water wells near the plant operations area create a cone of depression from beneath waste disposal and treatment areas. Off-site irrigation wells located immediately adjacent to the property line seasonally altar the northern and eastern direction of flow from the coal pile, the landfill, and the surge pond – particularly during the summer when irrigation pumping is the greatest. Groundwater flow from the landfill and surge pond typically exits the property to the east and southeast, but that direction is more northeasterly during summer irrigation months.

Arkansas Department of Environmental Quality (ADEQ). 2002. ADEQ, Class 3N Landfill, Permit Number 0200-S3N, Entergy Arkansas, Independence Plant (Feb. 14, 2002).

APL. 1996. Letter from Rosemarie Peckham, Arkansas Power and Light (APL), to Kim Kresse, Arkansas Department of Pollution Control and Ecology, Re: 1995 Annual Groundwater Monitoring Program Report, Independence Plant (Mar. 29, 1996).

Entergy. 2009. Letter from Mark Bowles, Manager, Arkansas Environmental Support, Entergy, to Bill Sadler, Solid Waste Management Division (Sept. 17, 2009).

Entergy. 2006. NPDES Supplemental Permit Renewal Application, Entergy-Arkansas Independence Plant (Feb. 21, 2006).

Entergy. 2005. Letter from Mark Bowles, Entergy, to Ryan Benefield, P.E., Waste Management Division, ADEQ, Re: Coal Ash Analysis Results (Dec. 5, 2005).

FTN. 2009. FTN Associates, Ltd., Second Half 2009, Semi-Annual Groundwater Monitoring Report, Entergy Class 3N Landfill (Dec. 11, 2009).

FTN. 2007. FTN Associates, Ltd., First Half 2007, Semi-Annual Groundwater Monitoring Report, Entergy Class 3N Landfill (June 28, 2007).

Leamons and Sadler. 2010. Telephone conversation with Bryan Leamons, P.E., Engineer Supervisor, and Bill Sadler, Waste Management Division, Arkansas Department of Environmental Quality (June 9, 2010).

Sadler, Bill. 2010. Phone conversation with Bill Sadler, Solid Waste Management Division, Arkansas Department of Environmental Quality (May 6, 2010).

Entity/Company – Location

NRG Energy/Montville Power, LLC - Montville Generating Station
Inactive On-site and Off-site Coal Ash Disposal Areas in Hunts Brook Watershed
74 Lathrop Road
Uncasville, CT 06382
New London County
Latitude: 41.4283 Longitude: -72.1024

Determination

Demonstrated damage to groundwater on-site discharging to the Thames River, including exceedances of MCLs for arsenic and beryllium, and exceedances of SMCLs for iron, manganese and pH. Demonstrated damage to soil above health-based compliance standards.

Probable Cause(s)

Leaching of coal combustion waste (CCW) metals and pH into groundwater in beneath the following Areas of Concern (AOC): AOC5 (former ash settling ponds); AOC9 (ash/dredge disposal area); and AOC12 (former coal and ash storage area).

Summary

Groundwater and soil at the NRG Energy's Montville Generating Station was contaminated with metals as a result of historic placement of coal ash and slurry throughout the 49-acre site. In the northeastern part of the Montville Station, **average** concentrations (2007–2009) of arsenic in one groundwater Monitoring Well, NRG-MW-6, were more than 20 times the federal Maximum Contaminant Level (MCL). Average concentrations of beryllium also exceeded the MCL in this well. Data indicate that concentrations of arsenic and beryllium have increased somewhat in the last ten years at this well even though no new fly ash has been produced at the site in 40 years.

In the western part of the Montville Station, groundwater has average concentrations of iron far over the secondary MCL (SMCL), manganese over the SMCL, and pH below the minimum SMCL. Soil sampling in former ash disposal areas in the western part of the Montville Station found multiple metals that exceed the Pollutant Mobility Criteria (PMC) for Class GA designated areas (groundwater designated for private and public supply without treatment) and arsenic and beryllium exceeding the residential and industrial/commercial Direct Exposure Criteria (DEC) for concentrations of these metals in soils.

The groundwater under the Montville Station is divided into two different zones, for which different standards apply.

In the western part of Montville Station, the Connecticut Department of Environmental Protection (CTDEP) has designated groundwater as "GA/GAA," which means it must be suitable for drinking without treatment, and must comply with drinking water standards. This western zone includes Area of Concern (AOC) AOC5 (former ash settling ponds) and AOC9 (ash/dredge disposal area).

In the eastern part of Montville Station, CTDEP has designated groundwater as "GB," which means that it is not suitable for human consumption without treatment and does not have to comply with drinking water standards. This zone includes AOC12 (former coal and ash storage area), and within AOC12 are two smaller areas, AOCs 3 and 6.

However, groundwater from both zones discharges into the Thames River; therefore, CTDEP's Surface Water Protection Criteria (SWPC) within both zones were also used to identify contaminants of concern (COCs) at the Montville Generating Station (USEPA, 2000).

Environmental investigations performed in 1999 identified arsenic and beryllium as major COCs in both groundwater zones, and cadmium, copper, nickel, and zinc were also identified as more localized COCs (Metcalf and Eddy, 1999a-c).

Recent groundwater monitoring data (Shaw Environmental, 2007–2009) indicates that arsenic and beryllium concentrations remain high in the eastern zone (GB area). Both zones (GA/GAA and GB areas) have high concentrations of iron far above the SMCL, manganese above SMCL and USEPA's Lifetime Health Advisory Level, and pH below the SMCL. Information on specific contaminants is summarized below:

- **Arsenic** concentrations in 1999 to 2000 ranged from 0.021 to 0.082 mg/L (2 to 8 times above the MCL of 0.010 mg/L) in AOC 5 at Monitoring Well NRG-MW-5, where drinking water standards apply. In the zone where drinking water standards do not apply (GB area), the maximum arsenic concentration in AOC3/AOC12 at Monitoring Well NRG-MW6 was more than 21 times the MCL in 1999–2000 (from 0.138 to 0.211 mg/L) and more than 50 times USEPA's 2000 SWPC (0.004 mg/L). From 2007–2009, arsenic at Monitoring Well NRG-MW-6 ranged from 0.134 to 0.262 mg/L and averaged 0.216 mg/L indicating an overall increase in arsenic concentrations in the last ten years. Another well in this same zone, Monitoring Well SB1-MW1, also showed high concentrations of arsenic above the MCL (average 0.0285 mg/L, maximum 0.071 mg/L), with the average more than 7 times the CTDEP SWPC.
- **Beryllium** concentrations in 1999 to 2000 exceeded the MCL and CTDEPs SWPC of 0.004 mg/L in AOC 9 at Monitoring Well NRG-MW-1 (0.006 mg/L) and in AOC12 at Monitoring Well MW-6 (0.012 mg/L, 3 times the MCL), where drinking water standards apply. Monitoring Well NRG-MW-1 was not sampled from 2007 to 2009, so a comparison with the earlier sampling is not possible. However, beryllium concentrations at Monitoring Well NRG-MW-6 showed an upward trend, exceeding both the MCL and SWPC from 2007 to 2009 (ranging from 0.0053 to 0.0138 mg/L, average of 0.0073 mg/L). Monitoring Well SB1-MW1 also exceeded the MCL for beryllium in recent sampling with the highest value of 0.0077 mg/L collected in 2009. From1999 to 2000, **cadmium, nickel**, and **zinc** were identified as constituents of concern in AOCs 9 and 12, and copper was identified as a COC in AOC 9. Sampling results for zinc from

2007 to 2009 showed exceedances of USEPA's 2000 SWPC in AOC 12 (0.212 mg/L average, 1.7 times SWPC), but no exceedances for cadmium, copper, or nickel.

SMCLs are relevant in the GA/GAA groundwater zone which includes AOCs 5 and 9. Groundwater sampling from 2007 to 2009 found the following:

- Average pH in AOC5 wells was below the SMCL of 6.5 in Monitoring Wells NRG-MW5 (5.98), MW201 (5.59), and MW202 (5.96).
- The average manganese concentration in Monitoring Well NRG-MW-5 (0.56 mg/L) was more than 10 times the SMCL, and almost twice USEPA's Lifetime Health Advisory Level.
- The average iron concentration in Monitoring Well NRG-MW-5 (3.68 mg/L) was more than 12 times the SMCL.

Although SMCLs do not apply in the GB area (including AOC3, AOC6 and AOC12), Monitoring Well NRG-MW-6 (east of AOC3) had very low pH (4.69 average) and exceptionally high iron concentrations (230.6 mg/L average, more than 700 times the SMCL and a maximum of 339 mg/L, more than 1000 times the SMCL).
Soil sampling performed as part of the proposed partial Remedial Action Plan (RAP) for the Montville Station (Shaw Environmental, 2009) found the following:

- In AOC 5, the former ash settling ponds, lead exceeded the GA pollutant mobility criteria (PMC), and both arsenic and beryllium exceeded the residential and industrial/commercial (IC) Direct Exposure Criteria (DEC).
- In AOC 9, the former coal ash and dredge spoils area, multiple metals (not specifically identified in the RAP) exceeded the GA PMC and the residential and IC DEC.

The remedial goals of the proposed partial RAP are to achieve compliance with GA PMC for metals and reduce potential ecological risk in both AOC5 and AOC9.

Arsenic, beryllium, cadmium, copper, iron, lead, manganese, nickel, pH

The area immediately west of the Montville Station is densely populated. When NRG Energy submitted its request to reclassify the ground water under the western portion of the station property from Class GA (potable) to Class GB (industrial) in 2000, NRG funded six nearby homes that were still on wells to connect to public water (Keith, 2010). At the time CTDEP sampled some of the wells but did not share the results with NRG Energy. NRG Energy was told that all but one well was compliant. The one not meeting standards was upriver from the station shallow and very close to the river and the contamination was considered to be coming from the river (Keith, 2010). In 2001, both CTDEP and USEPA judged human exposure via groundwater to not be a concern (USEPA, 2001).

Mapping of private and public wells is nearly impossible because Connecticut keeps paper records of private water wells at the county level under the Department of Health. In addition, data about public water supplies are closely held and will not be released for "security reasons." Furthermore, precise well locations are difficult to determine as data points occur within a five acre by five acre quadrant. However, CTDEP Water Bureau staff stated that it is highly probable that over 300 private wells exist within a two-mile radius of the Montville Station and that at least 40 municipal wells exist within five miles of the Station.

In addition, groundwater at the Montville Generating Station discharges to the nearby Thames River. USEPA's draft determination states that groundwater migration at the site is under control, but notes that it is not known whether contaminants have actually discharged to the Thames River at or above the concentrations measured in groundwater. USEPA includes calculations that suggest the high flow in the Thames River is sufficient to make any potential surface water impacts "insignificant" (USEPA, 2000). However, no surface water monitoring data was available from points upstream and downstream of the Montville Station in order to evaluate this claim.

Incident and Date Damage Occurred / Identified

Groundwater monitoring began in 1985 with an initial network of 12 wells (NRG and MV series). Sampling of these wells and additional wells installed in 1999 and 2000 identified arsenic above the MCL in the former coal ash lagoon area and arsenic, beryllium, cadmium, copper, nickel and zinc as constituents of concern in the former coal ash storage area.

Regulatory Action

In the 1980s, Montville began groundwater monitoring, and, in 1999, conducted soil and groundwater assessments after an Equalization Basin (EB2) constructed in 1978 (in an area formerly used for coal ash storage wastewaters) became regulated as a RCRA hazardous waste unit due to corrosivity as well as occasional presence of chromium and lead. EB2 was a single membrane-lined surface impoundment, and investigations of EB2's impact on groundwater led to implementation of a groundwater monitoring program in the late 1980s. Soil and groundwater sampling related to Phase I and II Environmental Site Assessments (ESAs) and subsequent investigations (Metcalf & Eddy, 1999a-c) led to identification of multiple potential areas of concern (AOCs), including metals contamination attributable to coal ash disposal areas in various locations at the project site. This included the classification of groundwater under the western portion of the facility as GA/GAA and thus suitable for human consumption without treatment. An application to reclassify this groundwater as GB and thus suitable for industrial uses with more relaxed standards was made in 2000 (Metcalf & Eddy, 2000), but withdrawn based on the CTDEP's opinion that the level of contamination did not merit reclassification (USEPA, 2000).

In 2000, USEPA made a provisional determination that migration of contaminated groundwater at Montville Station was under control and that contaminated groundwater flowing into the Thames River was not having a significant impact on surface water quality (USEPA, 2000). In 2001, USEPA made a final determination that current human exposure is under control. One soil boring (MNV-63) in AOC 5 (at the former ash settling ponds) identified arsenic, beryllium, and lead at concentrations exceeding acceptable levels in soil for groundwater areas classified as GA/GAA. Accordingly, the proposed partial remedial action plan is to excavate and remove soil in this area (Shaw Environmental, 2009).

Coal ash from the Montville Generating Station. The RCRA Corrective Action investigations have identified 14 areas of concern (AOCs) with contaminants that include metals and volatile and semi-volatile organic compounds around the Montville Station. This report examines data from AOCs that were both wet and dry coal ash placement areas containing coal ash from this plant where contamination can be primarily attributed to the coal ash.

During the 52 years that coal was burned at Montville Station, coal ash and slurry was placed throughout the site in various disposal areas. The following three areas of concern (AOC) are the focus of this report:

- AOC 5 includes former coal ash settling ponds. The exact dates of use of the ponds are not known, but earthwork activities in the area are evident in 1965 and 1970 air photos and absent in a 1975 air photos.
- AOC 9 was used for placement of dredge spoils and coal ash.
- AOC 12 includes former coal and coal ash handling and storage areas. Within AOC 12 are two smaller AOCs:
    - o AOC 3 includes a bulk fuel storage area; and

- AOC 6 includes the former Equalization Basin which was earlier used for coal storage before becoming a RCRA-regulated surface impoundment for corrosive wastes.

Inactive. Ash storage areas and ponds have been inactive since Montville Generating Station converted from coal to oil in 1971.

The main aquifer in the vicinity of Montville Generating Station is in about 40 feet of alluvium immediately under the Thames River. Bedrock lies at about 40 feet. The general direction of shallow groundwater flow is to the east and discharging to the Thames River. The same alluvial aquifer is divided between the two different CTDEP groundwater classification zones discussed above.

The Montville Generating Station is a 50-acre site that has been in continuous service since 1919. The Station used coal as a fuel for approximately 52 years until the station converted to oil in 1971.

In the late 1960s, the Montville Generating Station disposed of coal ash at several sites in the Hunts Brook watershed around Montville and Waterford, CT, which significantly degraded surface water with iron, sulfate, and total dissolved solids. Specifically, fly ash from the Montville Station was transported and dumped outside the station property in three separate sites in the Hunts Brook watershed in the Montville and Waterford communities from the mid-1960s until 1969. These are the Chesterfield-Oakdale, Moxley Hill, and Linda sites. Contamination of the watershed by the fly ash generated considerable environmental concern and the Connecticut College Archives for the Conservation and Research Foundation contain water quality reports and correspondence between environmental advocates, state and municipal officials, law offices, and laboratories dating from 1968 to 1973. USEPA (1988) summarized information on surface water quality studies that took place in the watershed. Upstream surface water samples were compared to downstream samples to determine if the surface water quality had been degraded at any of the sites. The most notable impacts were documented at the Chesterfield-Oakdale site, where concentrations of iron in the surface water increased from less than the SMCL to more than 100 times the SMCL downstream. Sulfate concentrations increased by over an order of magnitude, from 20 to 299 mg/L, a bit above the SMCL, while TDS increased from less than the SMCL to 44 times higher than the SMCL downstream. At a sampling point about 1.2 miles downstream from the site, the measured parameters had returned to levels close to the upstream values. The data clearly show damage to surface water from ash disposal in the Hunts Brook Watershed, especially at the Chesterfield-Oakdale site, in addition to groundwater damage at AOCs at the Montville Station that were coal ash disposal areas, although USEPA classified this case as "indeterminate" in its 2007 damage case assessment report (USEPA, 2007).

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USEPA. 1988. USEPA, Report to Congress: Wastes from the Combustion of Coal by Electric Utility Plants, EPA/530-SW-88-002 (1988).

Entity/Company – Location

City of Lakeland - C.D. McIntosh, Jr. Power Plant
3030 East Lake Parker Drive
Lakeland, FL 33805
Polk County
Latitude: 28.084167 Longitude: -81.924167

Determination

Demonstrated on-site damage to groundwater

Probable Cause(s)

Contamination of groundwater from unlined waste disposal units and a coal storage area

Summary

Two unlined coal combustion waste (CCW) landfills and several process wastewater ponds have contaminated groundwater in excess of Maximum Contaminant Levels (MCLs) for arsenic, lead, selenium, cadmium, and other metals at the McIntosh Power Plant. A Consent Order was issued in 2001 to address the problem, but the contamination has continued. Groundwater monitoring in January 2010 found arsenic concentrations exceeding the MCL in fifteen wells monitoring three water-bearing zones of groundwater. The highest concentration for arsenic was 0.0165 mg/L (1.65 times the MCL). Exceedances of Secondary MCLs (SMCLs) for iron, manganese, pH, total dissolved solids, or sulfate have been measured in 32 of 36 wells monitoring the CCW landfill and a coal pile area. The McIntosh Power Plant and its CCW disposal sites are adjacent to Lake Parker, yet no off-site assessments or monitoring have been performed to determine the extent of contamination off-site despite a relatively high number or residences around the lake.

Test for Proof

Although a 2001 Florida Department of Environmental Protection (FDEP) Consent Order identified arsenic, lead, manganese, selenium, cadmium, vanadium, nitrate, and total dissolved solids (TDS) exceeding MCLs and SMCLs in groundwater at McIntosh Power Plant (FDEP, 2001), the contamination continues. Groundwater monitoring in January 2010 documented arsenic contamination above the MCL and iron, pH, sulfate, TDS, and manganese concentrations above SMCLs in water downgradient of CCW units and very close to the McIntosh Power Plant property line (Lakeland Electric, 2010).

As of November 2001, 21 shallow surficial aquifer wells, 11 intermediate (deep surficial aquifer) wells, and 9 deep aquifer wells existed around McIntosh Power Plant's two CCW landfills, coal pile area, and sludge de-watering area (FDEP, 2001). Additional wells are near the process wastewater ponds and in a "marsh treatment area" along the western property boundary; however, monitoring results are not available for most of these wells because the FDEP does not require the McIntosh Power Plant to sample these wells (FDEP, 2001).

The 2001 Consent Order required McIntosh Power Plant to install additional downgradient groundwater monitoring wells, and included the proposed well locations in the Order (FDEP, 2001). However, no wells in these proposed locations were identified in the January 2010 groundwater sampling event (Lakeland Electric, 2010). In fact, McIntosh Power Plant no longer samples most of the groundwater monitoring wells in the plant operations area west of the CCW landfills, despite the fact that the Consent Order suggested that groundwater in this area was contaminated with unspecified constituents (FDEP, 2001).

Sampling of 36 wells in January 2010 during "interim" groundwater monitoring for the CCW landfills, the CCW landfill sedimentation basins, the coal pile, and the sludge de-watering area found exceedances of the MCL for arsenic (0.010 mg/L) in 14 wells and exceedances of at least one Secondary MCL (SMCL) in 32 wells (Lakeland Electric, 2010).

The arsenic concentration reported in January 2010 associated with the northern CCW landfill was 0.0162 mg/L in well 19S monitoring the shallow aquifer. An arsenic concentration of 0.0159 mg/L was found in well 21D, which monitors the deep aquifer near the northern landfill and sits approximately 40 feet from the northeastern property line and adjacent to an abandoned phosphate mine lake. The maximum arsenic concentration for the southern landfill was 0.0165 mg/L, in well 29S, which monitors the shallow aquifer. The maximum concentration for the northwestern marsh treatment area and coal pile was 0.0159 mg/L, in well 17S, which monitors the shallow aquifer. Arsenic was measured at 0.014 mg/L in well W-9, near the western property boundary and downgradient from the plant and the process wastewater ponds. It should be noted that the McIntosh Power Plant used a very high detection limit for arsenic of 0.0113 mg/L, which is higher than the 0.010 mg/L MCL; therefore, it is impossible to tell from laboratory reports exactly how many wells were contaminated with arsenic at or just below the MCL.

The January 2010 sampling event also found that Well 23I, monitoring the intermediate aquifer and approximately 90 feet from the northern property line, was contaminated above SMCLs for iron (17.66 mg/L), pH (4.09 units), sulfate (394 mg/L), and TDS (615 mg/L).

The highest concentrations of sulfate, both exceeding the SMCL, in the January 2010 sampling event were found around the southern landfill in wells 28S and 29S (monitoring the shallow aquifer), at 1,274 mg/L and 485 mg/L, respectively, the sedimentation basin of the southern landfill in well 6I (monitoring the intermediate aquifer), at 770 mg/L, and near the property line by the northern landfill in well 23I, mentioned above. The highest concentrations of TDS, which were also greater than the SMCL (500 mg/L), were generally associated with wells that had the highest concentrations of sulfate. The SMCL for pH (6.5 – 8.5 units) was not achieved at 25 of the 36 wells sampled. Lowest values, ranging from 3.94 to 4.41 units, were found in wells monitoring the shallow and intermediate aquifers near the coal pile/sludge stack-out pile, the northern landfill area near the property line, and the southern landfill.

A review of groundwater monitoring reports in the file found no further information on the location of sampling points, rate and direction of groundwater flow, or statistical or trend analysis of monitoring results. Lake Parker water samples (locations not given) are only tested for pH, specific conductance, temperature, and water levels and not for ash metals or other CCW indicator parameters.

Constituents Involved

Arsenic, cadmium, lead, manganese, selenium, vanadium, nitrate, iron, sulfate, TDS, and pH

At Risk Population

The shoreline of Lake Parker is densely populated with residences, and the Lake is used for recreational purposes. There are a total of 111 potable water supply wells that are used for commercial purposes and municipal purposes (noted by green marker on the map below) within a five-mile radius of the McIntosh Power Plant, and two private drinking water wells within a two-mile radius of the Plant. In addition, 20 of the 111 commercial and municipal wells are located within a two-mile radius of the plant. Private and public drinking water data was obtained from FDEP in an online geospatial database and mapped using Google Earth. Well records from geospatial database may be incomplete.

Note: There was not enough information available to show the main directions of groundwater flow from the ash disposal areas, but localized shallow groundwater in the landfills probably flows in all directions

Incident and Date Damage Occurred / Identified

Unauthorized discharges of process water and CCW contaminants to the soil and groundwater occurred between April 1997 and June 2001 (FDEP, 2001) and discharges have continued into 2010.

Regulatory Action

FDEP issued a final Consent Order on December 7, 2001 (FDEP, 2001). FDEP also issued a Warning Letter on November 16, 2000 for failure to notify FDEP of parameter exceedances during quarterly groundwater monitoring, failure to submit required annual reports from 1990 to 1999, and for discharges of process wastewater to the storm water drainage system (FDEP, 2001).

The Consent Order identified impacts to groundwater and required additional groundwater monitoring along the western property boundary downgradient from the process wastewater ponds, between Lake Parker and the neutralization basins, at the southern landfill, and at a "tipping area" (FDEP, 2001). Lake-level gauges were required for on-site and nearby off-site lakes to determine elevation relative to the groundwater.

FDEP required additional "assessment activities" in 2001 to determine if contamination had migrated off-site (FDEP, 2001). According to a 2010 telephone conversation with FDEP to determine the status of this off-site migration determination, FDEP staff stated that the Consent Order did not require off-site monitoring and therefore none has been performed (Watson, 2010). Further, FDEP stated that identifying and sampling off-site drinking water wells would be specified in a Contamination Assessment Plan (CAP), if FDEP saw the need to do so (Watson, 2010). A CAP was not available in the files reviewed to determine what actions, if any, had been completed relative to any off-site assessment activities.

Nine years ago, the final Consent Order required that an Interim Groundwater Monitoring Plan (IGWMP) be submitted within 30 days of the effective date of the Order, a CAP be implemented within 90 days, and a Source Characterization Work Plan (SCWP) be implemented within 180 days (FDEP, 2001). The Consent Order also required that Lakeland pay $180,691 in civil penalties (FDEP, 2001).

Flue gas desulfurization (FGD) sludge, fly ash, and bottom ash (FDEP, 2001)

Two unlined CCW landfills that contain FGD sludge, fly ash, and bottom ash exist at the plant (FDEP, 2001). The plant became operational in 1981 (FDEP, 2001).

The southern landfill sedimentation pond and the de-watering and stacking area (for process wastewater dredged sludge) were built on top of an abandoned phosphate mine pit (FDEP, 2001).

An un-defined "marsh treatment system" along the northwestern, western, and southwestern property line has been used for unspecified CCW treatment (FDEP, 2001).

Active

Apparently there are no maps of potentiometric surfaces or the direction of groundwater provided in groundwater monitoring reports and, as a result, neither FDEP nor the McIntosh Plant personnel definitively know what the localized direction of groundwater is in water bearing zones around disposal units. Three layers of groundwater are monitored at the CCW landfills and coal storage area (FDEP, 2001).

The groundwater rate and direction of flow are likely influenced by the abandoned phosphate mines to the northwest of the plant, construction fill areas, placement of low-permeability FGD sludge as liners, and the presence of concrete structures (FDEP, 2001).

Florida Department of Environmental Protection (FDEP). 2001. Consent Order, City of Lakeland Department of Electric Utilities (Dec. 7, 2001).

Lakeland Electric. 2010. Letter from Douglas Doerr, to William Kutash, FDEP, Waste Program Administrator, C.D. McIntosh, Jr. Power Plant, Re: Interim Groundwater Monitoring Plan Results (Apr. 1, 2010).

Watson. 2010. Telephone conversation with Stephanie Watson, Environmental Specialist III, FDEP, Solid Waste Program (May 25, 2010).

Entity/Company – Location

Berkshire Hathaway, d/b/a MidAmerican Energy Company - George Neal Station North Landfill
1151 260th St.
Sergeant Bluff, IA 51054
Woodbury County
Latitude: 42.326658 Longitude: -96.379203

Determination

Demonstrated damage to groundwater moving off-site (into the Missouri River on the western edge of the property)

Probable Cause(s)

Leaching of coal combustion waste (CCW) constituents to shallow aquifer from CCW monofill (landfill only accepting CCW)

Summary

CCW has been placed in a monofill at the Neal North plant on the Missouri River since 1978. When a groundwater monitoring program was implemented in 2001, every downgradient well in the shallow and deeper alluvial aquifer exceeded the federal Maximum Contaminant Level (MCL) for arsenic, with average values in all but one of the wells ranging from 0.0251 to 0.0882 mg/L (2.5 to 8.8 times the MCL) and a maximum concentration recorded of 0.218 mg/L (22 times the MCL). Available information indicates that the monofill is the primary source of arsenic in the shallow and deep aquifers, though there may be some contribution of arsenic to the deep aquifer from an upgradient source. High levels of manganese, iron, and sulfate have also been found in groundwater downgradient of the CCW monofill.

W = west monofill area, E = east monofill area, P = ash pond areas.

Groundwater monitoring was first implemented in 2001. The first groundwater samples found concentrations of arsenic that exceeded the MCL in all downgradient monitoring wells and one incorrectly designated "upgradient" well. High concentrations of manganese were also found in all shallow wells and very high concentrations of sulfate were found in one shallow well. In 2008, sampling for iron began, and high concentrations were found in all shallow wells. The results of groundwater sampling for arsenic, iron, manganese, and sulfate from 2001 to 2008 are summarized as follows (see Table 1 for actual values):

- **Arsenic.** Average values in three downgradient shallow wells ranged from 2.5 to 3.2 times the MCL, with the highest maximum reading of 5.4 times the MCL. Average concentrations in the incorrectly designated "upgradient" shallow well (MW15R) and one downgradient well (MW19) were less than the MCL, but have had maximum concentrations near or above the MCL. Average values in two downgradient deep wells ranged from 5.9 to 8.8 times the MCL with a maximum of 22 times the MCL. Average concentrations in the "upgradient" deep well (MW16) were more than two times higher than the MCL. See discussion below for evidence that MW15R and MW16 are incorrectly identified as upgradient wells.
- **Iron.** Groundwater sampling for iron only began in 2008. Concentrations in three downgradient shallow wells were very high, ranging from 34 to 46 times the SMCL (0.3 mg/L). Concentrations in the "upgradient" shallow well (7.7 times SMCL) and one downgradient well (MW19—10 times SMCL) were also high.
- **Manganese.** Average concentrations in all shallow wells exceeded the USEPA Lifetime Health Advisory Level (LTHA) (0.3 mg/L). The highest average concentration (MW19) was 27 times the LTHA and 162 times the SMCL (0.05 mg/L).
- **Sulfate.** Average concentrations in downgradient shallow well MW19 were six times the SMCL (250 mg/L).

Although MW15R and MW16 are classified as upgradient wells, potentiometric maps show groundwater to be flowing from the monofill toward these wells (MWH, 2008). Additionally, there are three ash ponds at the site and the location of one, Pond 3, adjacent to MW15R and MW16 could be contributing arsenic to these wells, although there are no data to evaluate possible impacts of these ponds on groundwater readily available for review. There is little doubt that the high concentrations of arsenic in the shallow aquifer come from the CCW at the monofill. Average arsenic concentrations in the "upgradient" shallow well MW15R are less than the MCL while average concentrations of MW1R, MW3R, and MW5R, which intercept groundwater flow from the monofill before it reaches the Missouri River, are all well above the MCL. The reason for the high concentrations of arsenic in the deep aquifer, which average two to four times higher than comparable shallow downgradient wells, is less clear, but available evidence suggests that the CCW monofill is the primary source of arsenic in this aquifer, although a consultant to MidAmerican Energy Company has suggested that there are upgradient sources of arsenic (MWH, 2006). Lines of evidence that support the monofill as being the main source of arsenic include:

- There is a downward gradient between the shallow and deep aquifer. The fact that concentrations are lower in the shallow aquifer may be explained by the shallow wells missing preferential downward pathways of higher shallow concentrations moving into the deep aquifer.
- The average concentration in the "upgradient" MW16 is one-quarter the average concentration at downgradient MW4. If there were a significant upgradient source, concentrations would be expected to be at least as high in MW16.
- A new "upgradient" well about 1,000 feet east of the East Monofill area was installed in 2008 and showed a concentration of arsenic exceeding the MCL at 0.0129 mg/L. It is possible that this well is showing arsenic from an upgradient source. However, this well, though new, is located in an expansion area which has already received CCW (see satellite photo). Furthermore, the concentration in this well is only 15% that of in downgradient MW4 which is in the direct flow path for groundwater from MW14. If there was a significant upgradient source, then the concentrations in MW14 would be expected to be similar to that in MW4.

IA DNR has asked MidAmerican Energy to provide more evidence for their argument that the high concentrations of arsenic are from off-site sources or submit a plan to determine the extent of the plume (IADNR, 2007).

Table 1. Groundwater Sampling Results for Shallow and Deep Aquifer, Neal North Ash Monofill 2001 to 2008 (all values in mg/L)

Monitoring Well*	Arsenic		Iron**	Manganese		Sulfate	
	Average	Maximum	Maximum	Avgerage	Maximum	Average	Maximum
MW15R shallow aquifer, "upgradient"**	0.0059	0.0098	**2.32**	**2.88**	**4.44**	198	**348**
MW1R shallow aquifer downgradient	**0.0252**	**0.0298**	**10.10**	**1.72**	**2.3**	249	**320**
MW3R shallow aquifer downgradient	**0.0322**	**0.0540**	**13.80**	**3.36**	**3.98**	**255**	**370**
MW5R shallow aquifer downgradient	**0.0251**	**0.0300**	**10.90**	**2.08**	**2.42**	129	190
MW19 shallow aquifer downgradient	0.0046	**0.0105**	**3.08**	**8.1**	**12.3**	**1494**	**2400**
MW14 deep aquifer "upgradient"**	***	**0.0129**					
MW16 deep aquifer "upgradient"**	**0.0234**	**0.0327**	--	--	--	--	--
MW4 deep aquifer downgradient	**0.0882**	**0.0992**	--	--	--	--	--
MW20 deep aquifer downgradient	**0.0588**	**0.218**	--	--	--	--	--

* See Satellite photo for location of monitoring wells
** See text discussion for evidence that these wells are improperly classified as upgradient.
*** Only one year reported (2008)
Boldface = MCL, SMCL or LTHA exceeded

Constituents Involved

Arsenic, iron, manganese, and sulfate

At Risk Populations

The risk evaluation report prepared by MidAmerican Energy Company consultants identified no known human receptors or water wells downgradient of the CCW Monofill. However, the report did note that the closest water wells are two wells MidAmerican Energy uses for drinking water at the Neal North facility. These wells were sampled four times for arsenic in 2002, but the detection limit (0.08 mg/L) was 8 times higher than the current MCL, making it impossible to determine whether there were any exceedances of the MCL up to eight times the MCL.

Mounding (when CCW disposal areas cause higher elevations of groundwater in the disposal area, which creates localized flow of groundwater in all directions from the disposal area, including upgradient with respect to the regional groundwater flow direction) in the disposal area may cause localized flow in other directions.

Data obtained from Iowa State University's private and public well data GIS layer reveal 8 public drinking water sources within a five mile radius and two private drinking water wells within a two mile radius. Iowa State University has been working with the Iowa DNR for three years to convert paper records to a single GIS dataset. Because data goes from well drillers' logs to the state and then to the University's GIS department, it is highly probably that some wells, both private and public, are missing from the dataset. The status of groundwater usage in the surrounding area and down river should also be ascertained, and off-site wells should be sampled.

Incident and Date Damage Occurred / Identified

Exceedances of arsenic MCL were measured in all downgradient wells when groundwater was first sampled in June, 2001 and have continued since 2001.

Regulatory Action

No enforcement action has been taken at the Neal North Generating Facility Ash Monofill. MidAmerican Energy Company submitted a risk evaluation for arsenic to IA DNR in 2006 (MWH, 2006b), and IA DNR requested more data to support the conclusion in the risk evaluation attributing the high concentrations of arsenic to off-site sources or the submission of a plan to address the arsenic plume (IA DNR, 2007).

Coal fly ash and bottom ash

The Neal North Generating Facility Ash Monofill has been receiving CCW since 1978 and was originally permitted in May 1997. It currently operates under a permit issued on April 19, 2001. There are two main fill areas, a 32-acre west fill area, which receives primarily fly ash, and a 50-acre east fill area, which receives various types of coal combustion waste (MWH, 2006). Permit amendments, which could include use of a liner and expansion plans to extend the filling to the east and south, are currently under review at IA DNR (MWH, 2009). There are also three surface impoundments at the power plant (MidAmerican Energy, 2009): 12.2-acre Pond #1; a26.9-acre Pond #2 (placed in service in 1972); and a 76.1-acre Pond #3 (placed in service in 1975).

Active

A 2006 hydrogeologic investigation report prepared in connection with the proposed expansion of the CCW monofill updates earlier hydrogeologic studies conducted in 1997 (MWH, 1997 and 2006). The monofill rests on alluvial sediments of the Missouri River. A shallow aquifer is present in finer-grained near-surface alluvium and a deeper aquifer is present in thick sand and gravel deposits. The natural flow of both aquifers is to the southwest toward the Missouri River. There is a general vertical hydraulic gradient between the shallow and deeper aquifer (MWH, 2006), which suggests that contaminants in the shallow aquifer are able to migrate to the deeper aquifer. Mounded water table conditions are evident in the area of the monofill, resulting in localized flow to the east and south (see Figure 3, MWH, 2008).

(Unless otherwise indicated, cited documents are available at: https://programs.iowadnr.gov/solidwaste/reports/DocumentDNA.aspx by searching for Permit No. 97-SDP-12-95.)

IA DNR. 2007. Iowa Department of Natural Resources (IA DNR), 2007, Letter from Amy Davidson, Environmental Engineer, to Dana Ralston, MidAmerican Energy (June 28, 2007) (rejecting the Arsenic Risk Assessment and asking for further information).

MidAmerican Energy. 2009. MidAmerican Energy, Response to USEPA Coal Combustion Residue Impoundment Survey, Neal North Generating Station, Sioux City, Iowa, *available at* http://www.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys/index.htm.

MWH. 2009. MWH Global, Inc. (MWH), Leachate Management Permit Amendment Request, Neal North Combustion Residue Monofill (May 20, 2009).

MWH. 2008. MWH, 2008 Annual Water Quality Report, MidAmerican Energy Company, Neal North Ash Monofill (Nov. 26, 2008).

MWH. 2006a. MWH, Hydrogeological Investigation Report, Coal Combustion Residue Monofill, Neal North Generating Facility, Woodbury County, Iowa (2006).

MWH. 2006b. MWH, Risk Evaluation of Arsenic in Groundwater, Neal North Coal Combustion Residue Monofill, Sergeant Bluff, Iowa (Nov. 20, 2006).

MWH. 1997. MWH, Hydrogeological Investigation Report and Hydrologic Monitoring System Plan for the Neal North Ash Landfill, Sioux City, Iowa (1997).

Entity/Company – Location

Berkshire Hathaway, d/b/a MidAmerican Energy Company - George Neal Station South Ash Monofill
2761 Port Neal Cir.
Salix, IA 51052
Woodbury County
Latitude: 42.301944 Longitude: -96.358012

Determination

Demonstrated damage to groundwater moving off-site, (as indicated by downgradient contaminant levels exceeding state standards that indicate contaminants are migrating in groundwater)

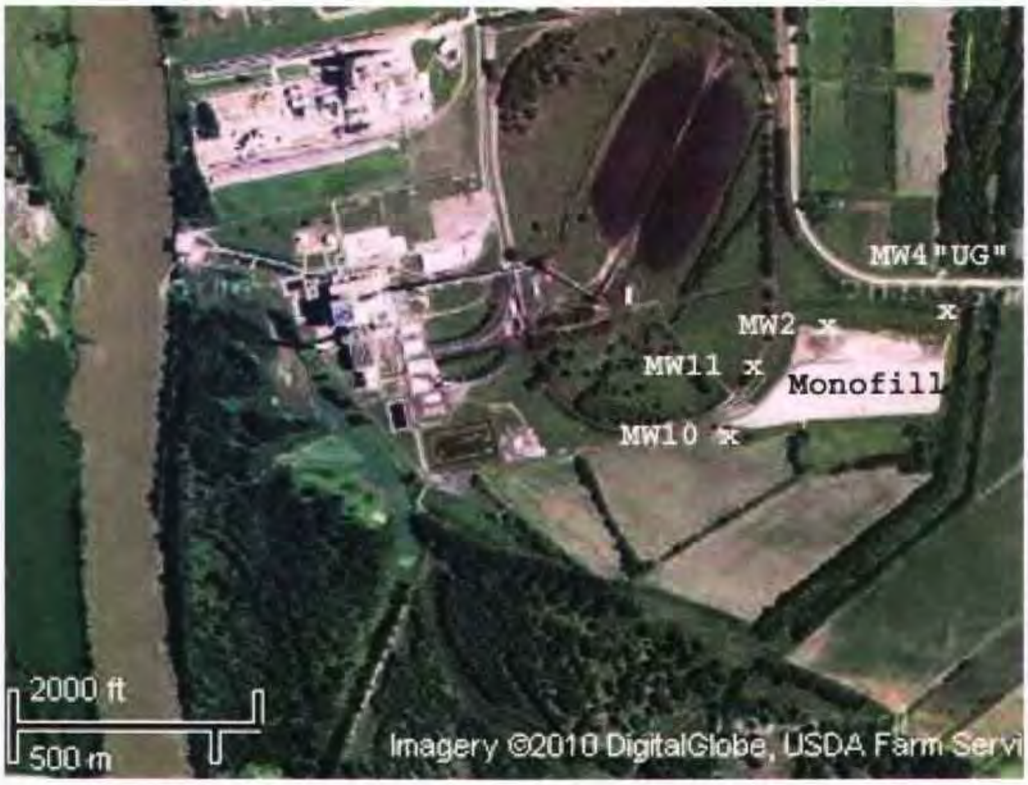
Probable Cause(s)

Leaching of coal combustion waste (CCW) constituents to shallow aquifer from CCW monofill

Summary

CCW has been placed in a monofill (a landfill receiving only CCW) at MidAmerican Energy's Neal South Power Plant on the Missouri River south of Sioux City since the early 1980s. When a groundwater monitoring program was implemented in 2000, average concentrations of arsenic in two downgradient wells ranged from 0.011 to 0.035 mg/L, 1.1 to 3.5 times the Maximum Contaminant Levels (MCL) and a maximum concentration was more than 8 times the MCL.

High levels of manganese, iron, sulfate, barium, selenium, and zinc have also been found in groundwater downgradient of the CCW monofill. There are indications that the only "upgradient" monitoring point has been affected by CCW constituents as a result of groundwater mounding within the CCW monofill (elevated levels of groundwater in the disposal area that causes localized flow of contaminants in an upgradient direction).



Groundwater sampling began in 2000. Arsenic exceeded the MCL in MW2 in the first year of sampling, and arsenic concentrations have continued to exceed the MCL. High concentrations of iron and manganese have been present in all wells since monitoring began, and high concentrations of sulfate were more localized to a few wells. The results of groundwater sampling for arsenic, iron, manganese, and sulfate from 2000 to 2008 are summarized as follows (see Table 1 for actual values):

- **Arsenic.** Average values in two downgradient wells (MW2 and MW10) ranged from 1.1 to 3.5 times the MCL for drinking water with a maximum of 8.4 times the MCL. There is an upward trend in the concentrations in MW2. Average concentrations in the upgradient monitoring well (MW4) and one downgradient well (MW11) were less than the MCL
- **Iron.** Average concentrations in two downgradient wells (MW2 and MW10) were very high, ranging from 25 to 32 times the Secondary MCL (SMCL), and upward trends were evident in both wells. Average concentrations in the upgradient well were moderately high (2.5 times SMCL).
- **Manganese.** Average concentrations in two downgradient wells (MW2 and MW10) were moderately high (6 times the Lifetime Health Advisory Level (LTHA)). However, average concentrations in the upgradient well and one downgradient well (MW11) were higher (10 and 12.5 times the LTHA respectively). Average concentrations for the downgradient monitoring wells ranged from 36 to 75 times the SMCL.
- **Sulfate.** Average concentrations in one downgradient well (MW11) were somewhat above the SMCL. Average concentrations in the other three wells are less than the SMCL, but the upgradient well and downgradient MW10 show possible upward trends in concentrations.

The IA DNR uses Upgradient Control Limits (UCLs) to identify ash constituents that may be moving off-site from ash disposal areas. The UCL is calculated as the historic average in upgradient monitoring wells plus two standard deviations. When downgradient concentrations exceed the UCL, it is an indication that groundwater has been affected by migration of ash constituents. The concentration of barium at MW2 has exceeded the UCL since monitoring began (average 0.230 mg/L, about one-tenth the MCL), and other downgradient wells sometimes exceed the UCL for this constituent. The UCL for selenium (0.0025 mg/L) has been exceeded in MW10 and MW11 several times (0.0052 to 0.0453 mg/L). Average concentrations for zinc have exceeded the UCL (0.017 mg/L) in all three downgradient wells (0.022 to 0.038 mg/L).

The upgradient monitoring well MW4 is close to the edge of the CCW monofill, and the relatively high concentrations of iron, manganese, and sulfate in this well suggest the possibility that it is affected by ash constituents as a result of groundwater mounding within the monofill, which is elevated 20 feet above the floodplain. There are not enough monitoring wells at this monofill to determine whether mounding has taken place, but mounding is evident at the Neal North CCW monofill which is in a similar hydrogeologic setting. Mounding is a process that occurs when CCW disposal areas cause higher elevations of groundwater within the disposal area that creates localized flow of groundwater in all directions from the disposal area, including upgradient with respect to the regional groundwater flow direction. The association of high arsenic and high iron concentrations in MW2 and MW10 is consistent with the redox zone model for variations in arsenic concentrations in groundwater described by Hensel and Kovatch (2007). The relatively low concentrations of arsenic in downgradient MW11 may be the result of different redox conditions. The redox model relates the mobility of arsenic in an aquifer when reducing conditions (low oxygen levels) are present in an aquifer. Arsenic tends to be more mobile when iron-reducing bacteria are active and less mobile when sulfate reducing bacteria are active.

Table 1. Groundwater Sampling Results Neal South Ash Monofill 2000 to 2008 (mg/L)

Monitoring Well*	Arsenic		Iron		Manganese		Sulfate	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
MW4** "upgradient"	0.001	0.0019	**1.06**	**3.3**	**2.97**	**3.9**	184	**288**
MW2 downgradient	**0.035**	**0.0839u**	**7.57**	**20.6u**	**1.79**	**2.04**	76	100
MW10 downgradient	**0.011**	**0.0434**	**9.61**	**19.3u**	**1.99**	**2.7**	178	**335**
MW11 downgradient	0.001	0.002	0.28	**0.55**	**3.76**	**6.4**	**271**	**370**

* See Satellite photo for location of monitoring wells
**May be affected by flow of contaminants from the monofill as a result of mounding.
Boldface = exceedance of MCL, SMCL or LTHA

Constituents Involved

Arsenic, barium, selenium, zinc, iron, manganese, sulfate

At Risk Populations

MidAmerican Energy did not address the question raised by IA DNR (2005) of whether there are any off-site receptors such as private residential wells or other uses of water that may be adversely affected by the CCW contamination documented at the Neal Station South Ash Monofill. Data obtained from the University of Iowa's GIS department shows a total of five public drinking water sources within a five-mile radius of Neal South (two of which are downstream of the Neal South site) and two private drinking water sources within a two-mile radius. The University Of Iowa has been working with the Iowa DNR for three years to convert paper well records to a single GIS dataset. Because data goes from well drillers' logs to the state and then to the University's GIS department, some wells, both private and public, may be missing from the dataset.

Mounding of groundwater in the disposal area may cause localized flow in other directions.

Incident and Date Damage Occurred / Identified

Arsenic concentrations exceeding the MCL were measured at MW2 the first year monitoring began in 2000. Exceedances of SMCLs for iron, manganese, and sulfate have been measure in one or more wells since monitoring began.

Regulatory Action

Despite high levels of arsenic and other contaminants in downgradient shallow groundwater, IA DNR has not required any off-site monitoring, or even monitoring at an appreciable distance from the ash ponds. IA DNR has not taken any enforcement actions with respect to the contaminated groundwater, however, in 2005, IA DNR specified that future Annual Water Quality Reports from MidAmerican Energy should: (1) discuss the potential for groundwater mounding and its influence on upgradient and downgradient wells; (2) evaluate all upgradient groundwater points to determine whether they are currently functioning as valid upgradient sampling points based on groundwater table contour map and water quality data results; and (3) discuss water quality data results with respect to potential for leachate migration beyond the waste boundary and, if MCLs are exceeded, provide information on potential receptors (IA DNR, 2005). MidAmerican Energy's 2008 Annual Water Quality Report (MWH, 2008), however, does not address any of the points above.

Wastes Present

Fly ash and bottom ash

Type(s) of Waste Management Unit

A 30-acre CCW ash monofill, which first received a permit in 2000, about twenty years after the power plant at the site began operating. Thus, extensive CCW contamination and pollutant migration may have occurred well before any safeguards were in place at the site.

Active or Inactive Waste Management Unit

Active

Hydrogeologic Conditions

The monofill rests on alluvial sediments about three-quarters of a mile east of the Missouri River. The natural direction of groundwater flow is west toward the Missouri River. Paired shallow (23 to 28 feet deep) and deeper wells (49 to 59 feet deep) show very little difference in head, indicating lateral flow is dominant with little vertical component. The ash monofill is 20 feet higher than the surrounding area, and groundwater mounding may have altered groundwater flow directions in the vicinity of the monofill.

(Unless otherwise indicated, cited documents are available at: https://programs.iowadnr.gov/solidwaste/reports/DocumentDNA.aspx, by searching for Permit No. 97-SDP-13-98.)

Hensel, Bruce R. and Eric P. Kovatch. 2007. Evolution of Dissolved Arsenic in Groundwater Downgradient of a Coal Ash Impoundment (paper presented at 2007 World of Coal Ash Conference, Covington, Kentucky) (May 7-10, 2007).

IA DNR. 2005. Letter from Amie Hart, Environmental Engineer, Iowa Department of Natural Resources (IA DNR), to Dana Ralston, MidAmerican Energy, Re: 2004 Annual Water Quality Report (Feb. 7, 2005).

MidAmerican Energy. 2001. December 2000 Groundwater Sampling and Analysis, Neal South Ash Landfill (Jan. 22, 2001).

MWH Global, Inc. 2008. 2008 Annual Water Quality Report, MidAmerican Energy Company, Neal South Ash Monofill (Nov. 26, 2008).

Entity/Company – Location

Alliant Energy d/b/a Interstate Power and Light - Lansing Station Ash Ponds and Landfill
2320 Power Plant Dr.
Lansing, IA 52151
Allamakee County
Latitude: 43.334954 Longitude: -91.167075

Determination

Demonstrated damage to on-site groundwater

Probable Cause(s)

Leaching of CCW constituents from either the CCW landfill or impoundment

Summary

Arsenic has been measured at more than twice the Maximum Contaminant Level (MCL) in a groundwater monitoring well (MW11) located between Lansing Station's ash ponds and coal combustion waste (CCW) landfill. Manganese has also been measured far above USEPA's Lifetime Health Advisory Level and iron and manganese have been measured far above Secondary MCLs (SMCL). It is difficult to fully assess the extent of groundwater contamination because the groundwater monitoring network does not appear to be designed to detect contamination that may be leaving the site, there is no off-site monitoring, and other downgradient monitoring wells do not appear to be located effectively in the path of shallow groundwater flow.

Test of Proof

Groundwater monitoring well MW11 has detected contamination from CCW disposal at the Lansing Plant from 2002 onward. Groundwater monitoring samples from MW11 shows the following:

- **Arsenic** averages 0.0143 mg/L (1.4 times federal MCL). Maximum value is 0.023 mg/L (2.3 times MCL).
- **Iron** averages 13.1 mg/L (43 times the SMCL). Maximum value is 28 mg/L (93 times SMCL).
- **Manganese** averages 7.1 mg/L (142 times the SMCL). Maximum value is 10 mg/L (200 times the SMCL).
- **Sulfate** averages 243 mg/L (almost equal to the SMCL). Maximum value is 380 mg/L (about 1.5 times SMCL).

The groundwater monitoring data from MW11 is problematic because the well is located within the seasonal fluctuations of the water table, meaning that groundwater samples could be collected in only three out of ten sampling events. In addition, the location of the well between the CCW landfill (to the east) and the Ash Settling Pond (to the west) makes it difficult to determine which CCW disposal area is the source of the contamination (if not both areas)(BT[2] Inc., 2005). Lastly, the data is derived from only three sampling events from 2002 through 2004, too few to sufficiently assess trends.

The groundwater monitoring network does not appear to be designed to detect contamination that may be leaving the site. For example, MW4 and MW5, located on the north side of the landfill, are identified as "downgradient" wells, but their data do not show significant differences from "upgradient" well MW6, and MW4 and MW5 do not appear to be in a location that would detect the migration of contaminants off-site. As discussed under the Hydrogeologic Conditions section, a more likely flow path for contaminated groundwater is toward the alluvium in the stream valley, southwest and west of the landfill, which is where contaminants have been detected in MW11 (located west of the north end of the landfill). Furthermore, there are no groundwater monitoring wells installed for the specific purpose of identifying possible groundwater contamination by the ash ponds.

Arsenic, iron, manganese, and sulfate

Review of the USGS topographic map and satellite photos indicates that there are about a dozen private residences within a thousand feet of the landfill and ash ponds and about three dozen residences within a mile. In this area private wells are the main source of drinking water.

However, private well records from IA DNR and Iowa's State University Geographic Information Systems (GIS) clearinghouse records indicated 33 private drinking water wells within a two-mile radius of the Lansing plant and five public drinking water sources within a five-mile radius. Iowa State University has been working with the IA DNR for three years to convert paper records to a single GIS dataset. Because data goes from well drillers' logs to the state and then to the university's GIS department, it is highly probable that some wells, private and public, are missing from the dataset.

Incident and Date Damage Occurred / Identified

Groundwater monitoring results first documented exceedances of the MCL for arsenic and secondary MCLs for iron, manganese, and sulfate in a March 8, 2002 sampling event.

Regulatory Action

IA DNR has required that MW11 be evaluated to determine why it has been difficult to obtain groundwater samples and to replace it with a water-bearing well if it continues to remain dry (Koger, 2009), but has not required installation of monitoring wells to evaluate possible groundwater impacts of the ash ponds northwest of the landfill or at any off-site location.

Wastes Present

Coal fly ash and bottom ash

Type(s) of Waste Management Unit

The Ash Landfill (IA DNR Permit 03-SDP-05-01) first received coal ash between 1985 and 1987. A current landfill permit was issued by IA DNR on September 11, 2003. Also there is a 14.8-acre Main Ash Pond and 0.2-acre Lower Ash Pond northeast of the landfill (Alliant Energy, 2009a), for which no groundwater monitoring is required.

Active or Inactive Waste Management Unit

Active

Hydrogeologic Conditions

Alluvium/colluvium of varying thicknesses lies over interbedded sandstones and siltstones in the area of the CCW Landfill. Alluvial deposits of the Mississippi River are at least 50 feet thick in the vicinity of the Power Plant north of the current Ash Pond. A 1982 soil boring within the area of a closed ash lagoon found a shallow water table in alluvial silt and sand about 25 to 30 feet thick (Howard R Green Company, 1995). The ash landfill and ponds are underlain by interbedded fine sandstones and siltstones of the Lone Rock Formation, which overlies the regional Dresbach Aquifer. Monitoring wells are completed in the Lone Rock Formation and the MW4 and MW5 cluster shows an upward hydraulic gradient, consistent with a groundwater discharge area. The flow of the regional aquifer is north-northwest toward the Mississippi River (BT[2] Inc. 2001). However, the potentiometric map of the area does not appear to take into account the localized, more westerly flow in shallow groundwater in the alluvium of the valley in which the CCW landfill and impoundments are located. The alluvium, which is generally more permeable than the fine-grained sandstones of the bedrock aquifer, probably represent a near-surface groundwater system that creates a preferential flow path for contaminants to the west-northwest. The presence of contaminants in MW11 is consistent with this interpretation.

The Lansing Power Station was first constructed in 1948, with additional units added in 1957 and 1976. The location(s) of ash disposal areas other than the ash ponds and landfill discussed here could not be readily determined from IA DNR files.

Alliant Energy. 2009a. Response to USEPA Information Collection Request on Coal Combustion Residues (CCR) Surface Impoundments, Lansing Generating Station (submitted on behalf of Interstate Power & Light) (Mar. 27, 2009).

BT[2] Inc. 2009. 2009 Annual Water Quality Report, Alliant Energy/Interstate Power & Light Lansing Power Station CCR Landfill (Aug. 4, 2009).

BT[2] Inc. 2005. 2005 Annual Water Quality Report, Alliant Energy/Interstate Power & Light Lansing Power Station CCR Landfill (Aug. 4, 2009).

BT[2] Inc. 2001. Permit Application, Coal Combustion Residue Landfill Expansion, Alliant Energy Lansing Power Station (2001).

Green. 1995. Howard R. Green Company, Work Plan for Hydrogeologic Investigation of the Proposed Landfill for the Lansing Power Station, Interstate Power Company (1995).

Koger, Nina M. 2009. Letter from Nina Koger, Senior Environmental Engineer, IA DNR Land Quality Bureau to Martin Burckhardt, Plant Manager, Interstate Power & Light Company, Lansing IA, Re: 2006/2007/2008/2009 Annual Water Quality Reports (Oct. 27, 2009.

Entity/Company – Location

Midwest Generation Joliet Generating Station 9, Lincoln Stone Quarry Landfill
1601 South Patterson Rd.
Joliet, IL 60436
Will County
Latitude: 41.493314 Longitude: -88.103128

Determination

Demonstrated damage to off-site groundwater, drinking water, and surface water moving off-site

Probable Causes

Leaching of coal combustion waste (CCW) constituents from bottom ash and slag landfill and associated ponds

Summary

Since 1962, Midwest Generation has disposed of its bottom ash and slag from the Joliet 9 and Joliet 29 Generating Stations in the unlined Lincoln Quarry Ash Landfill (Landfill). Since 1996, the Landfill has been exempt from complying with Illinois Class I Groundwater Protection Standards within the Landfill, and the Illinois Environmental Protection Agency (IEPA) has applied relaxed standards for boron, cadmium, selenium, and molybdenum that allow groundwater with concentrations up to 52 times standards for protection of public health to flow off-site. As of early 2007, unsafe concentrations of arsenic, boron, and molybdenum were flowing off-site to the south. IEPA issued a Notice of Violation (NOV) in response to the groundwater contamination in late August 2009. The NOV identified 50 exceedances of groundwater quality standards in ten wells, including high concentrations of arsenic, barium, boron, copper, and molybdenum. Arsenic was measured in two off-site groundwater monitoring wells at 0.022 to 0.083 mg/L (2.2 to 8.3 times the Illinois Class I Groundwater standard of 0.01 mg/L). The locations of the groundwater monitoring wells indicate that contamination is flowing from the CCW Landfill off-site to the southeast, south, west, and north.

The IEPA Bureau of Water recently found the CCW Landfill to be in an area with very high geologic vulnerability and a high potential for potable well contamination. There are 94 wells within a mile of the CCW Landfill. Drinking water wells up to a thousand feet south of the Landfill show evidence of degradation of water quality, and there is evidence to suggest that contamination is moving toward the Smiley Subdivision northeast of the Landfill. Midwest Generation has bought out nearby residents or had deeper wells drilled for residents. Only limited sampling has been done by IEPA to assess the extent of contamination in private drinking water wells. As of mid-2010, there was no evidence that IEPA had taken significant actions to address the contamination flowing off-site in violation of the CCW Landfill operating permit.

The Lincoln Stone Quarry CCW Landfill has been used as a disposal facility for bottom ash and slag from two coal-fired generating stations (Joliet 9 and 29) since around 1962. The chronology presented below shows that contamination of groundwater by coal ash at the Lincoln Quarry Ash Landfill has been known since at least the mid-1990s, and that actions by Midwest Generation and IEPA have been largely ineffective in addressing the problems.

- In May 1994, an application for Significant Landfill Permit Modification documented exceedances of the applicable groundwater quality standard for boron, selenium, manganese, sulfate, total dissolved solids (TDS), and fluoride and acknowledged that groundwater quality was degraded due to arsenic, cadmium, molybdenum, zinc, pH, ammonia, chloride, potassium, sodium, and total organic carbon (TOC) levels. The application further noted that any contaminants derived from CCW can migrate to downgradient areas and to the river bank area "with no significant reduction in concentration" (Driver, 2009).
- IEPA permit reviewer notes for the Landfill dated August 1, 2002 and October 15, 2003, state that the groundwater sampling "indicates that the site has caused statistically measured impacts on downgradient groundwater quality" (Driver, 2009).
- In 2004, Andrews Engineering submitted to IEPA, on behalf of Midwest Generation, a proposed "assessment monitoring program" to address confirmed exceedances of several pollutants. This submittal also clearly acknowledged that inward gradient was not being maintained at the Landfill's Main Quarry (Driver, 2009).
- Midwest Generation's February 15, 2005 submittal (Log No. 2005-058) acknowledged that the Des Plaines River is a "major area of discharge for the Silurian dolomite aquifer," and identified elevated concentrations of pollutants associated with the CCW Landfill operations in the groundwater monitoring wells located along the River. The same submittal also acknowledged that monitoring wells located on the south side of the Landfill (G38 and G39), which had been permitted as upgradient wells, were no longer "upgradient," and proposed the installation of a new, "upgradient" well on the south side of the CCW Landfill—Well G46 (Driver, 2009).
- By the end of 2005 and 2006, submittals to IEPA made on behalf of Midwest Generation conceded that there were no longer any upgradient monitoring well locations that could be considered upgradient for shallow zone conditions. The October 13, 2005 Significant Modifications Application (Log No. 2005-413) concluded that "current water levels in the Main Quarry and the shallow monitoring wells indicate that there is an outward gradient from the Main Quarry such that groundwater movement is to the south, west, and north." Midwest Generation's consultants, KPRG, confirmed to IEPA on February 22, 2006 that water level measurements in all of the existing monitoring well locations around the perimeter of the CCW Landfill demonstrated the loss of hydraulic gradient at the Landfill. This submittal proposed the installation of a new shallow zone monitoring well in an off-site location and stated that "evaluations are also being performed relative to potential corrective measures which may be implemented" to address the loss of hydraulic gradient (Driver, 2009).
- In April 2006, Midwest Energy conducted sampling of 18 private wells on Brandon Road along the east side of the Landfill and south to Laraway Road about 4,000 feet south of the southeast corner of the landfill. Only boron (and no other ash-related contaminants) was analyzed in the samples. The results were reported to the residents in May 2006 (Arcadis, 2006). Concentrations of boron in two wells exceeded 1.0 mg/L, with a maximum being 1.5 mg/L – far above the natural background concentration,

which has been identified by Midwest Generation's consultant to be around 0.3 mg/L in the local carbonate rocks in the vicinity of the Quarry (KPRG, 2008c). Boron concentrations in six other wells ranged between 0.33 to 0.71 mg/L, also above natural background concentrations. Assuming that the wells with elevated boron are from residences closest to the CCW Landfill, it appears that groundwater quality has been degraded in wells possibly up to 1,000 feet south of the Landfill. The results of this sampling led Midwest Generation to either buy out or drill deeper wells for the residences south of the Landfill. Nothing has been done to systematically sample private wells in the Smiley neighborhood northeast of the Landfill despite the fact that, as discussed in the next bullet, groundwater modeling indicates migration of contaminants in that direction as well (Thompson, 2010).

- In response to concerns that dewatering of the Brandon Road/Boyd Quarry east of the landfill would cause contaminants to migrate toward the residential area, groundwater modeling found that a boron contaminant plume with concentrations greater than 2.0 mg/L (Illinois Class I Groundwater Standard) would discharge into the dewatered Quarry within 5 years, and that the 1.0 mg/L iso-concentration line for boron would extend more than 1,000 feet into the Smiley residential area to the northeast (KPRG, 2008c).The Annual Groundwater Flow Evaluations submitted by KPRG to IA EPA for the Midwest Generation CCW Landfill for 2006 to 2008 confirm a change in direction of groundwater flow at the Landfill and concede that the change in direction of groundwater flow "is also a change from the conditions that existed at the time of the adjusted standard for the facility" (Driver, 2009).
- KPRG's 2007 Annual Report for the Landfill, submitted on behalf of Midwest Generation, showed high concentrations of arsenic, boron, and molybdenum and pH above applicable groundwater quality standards in well G47S (four-quarter average: arsenic 0.045 mg/L – maximum 0.10 mg/L; boron 6.46 mg/L – maximum 9.1 mg/L; molybdenum 0.775 mg/L – maximum 1.3 mg/L; maximum ph of 9.98; and also maximum of 1.9 mg/L fluoride) and well G48S (four-quarter average: arsenic 0.025 mg/L with upward trend; boron 9.2 mg/L – with upward trend; molybdenum 2.54 mg/L – maximum 2.9 mg/L, more than 70 times the USEPA LTHA; maximum pH of 9.14 with upward trend).
  IEPA's applicable groundwater quality standards (AGQSs)for the first quarter of 2008 were exceeded for eight dissolved parameters (arsenic, boron, molybdenum, ammonia, chloride, sodium, and fluoride), and concentrations of total copper and nitrate exceeded the AGQS (KPRG, 2008c).

On August 31, 2009, IEPA issued a Notice of Violation (NOV) to Midwest Generation for "failure to operate a leachate collection and management system that assures the protection of Class I potable resource groundwater" (IEPA, 2009a). The NOV cited exceedances of AGQS between July 14 to August 31, 2009 at the site, as summarized below:

- Ten wells were identified where AGQS violations were found, including "upgradient" G38S, four wells within zone of attenuation (G30S, R08S, G47S, G48S) and five compliance wells (G31S&D, G41S&D, G42D). Of these wells, G38S, G47S, and G48S and the five compliance wells are from 150 to 200 feet beyond the edge of the landfill and are called off-site wells in the discussion below.
- There were a total of 50 exceedances for individual monitoring parameters, including arsenic, barium, boron, copper, molybdenum, sulfate (maximum 493 mg/L; AGQS 493 mg/L), TDS (maximum 1300 mg/L, AGQS 1112 mg/L), pH (maximum 9.98, AGQS maximum 8.56), ammonia (maximum 5.3 mg/L, AGQS 1.57 mg/L), chloride (190 mg/L, AGQS 144 mg/L), dissolved nitrate and sodium (470 mg/L, AGQS 165 mg/L).
- There were four exceedances for arsenic at off-site wells G47S and G48S (0.022 to 0.083 mg/L, 2.2 to 8.3 times the Illinois Class I Groundwater standard of 0.01 mg/L).
- There were six exceedances in four wells for boron with the highest exceedances at off-site wells G47S and G48S (8.7 to 10.0 mg/L, four to five times the Illinois Class I Groundwater standard of 2.0 mg/L).
- There were two exceedances for molybdenum in off-site well G48S (1.6 to 2.7 mg/L, 40 to 67 times USEPA's LTHA).
- All the exceedances for arsenic and molybdenum were in G47S and G48S, indicating that a significant contaminant plume is migrating to the southeast from the Landfill.

- Exceedances of boron were in the southeast wells, G47S and G48S, but also G46S and R08, indicating that contamination is also migrating to the south and west from the Landfill.
- Discharge from NPDES Outfall S501 also violated the AGQS for barium (0.36 mg/L, AGQS 0.075), copper (0.03 mg/L, AGQS 0.02 mg/L), and dissolved nitrate (3.4 mg/L, AGQS 2.43 mg/L).

The current NPDES permit, issued by IEPA for the CCW Landfill in 2000, identifies Outfall No. 5 as "quarry (ash pond) discharge." Despite the extensive documentation of contamination of groundwater by ash constituents, and the fact that the surface water discharges are mostly water that has been in contact with the ash slurried to the landfill, IEPA requires only testing for pH and total suspended solids. The latest IEPA Inspection Report indicates that Midwest Generation is in compliance with the permit (IEPA, 2009a). The limited data contained in this report indicates that from January 2008 to May 2009, pH exceeded the AGQS (6.14 to 8.56) in 7 of the 17 sampling events (maximum pH of 8.8). As noted above, apparently separate sampling related to the Groundwater NOV found exceedances of the AGQSs for barium, copper, and nitrate at the No. 5 Outfall.

Ammonia, arsenic, boron, chloride, fluoride, manganese, molybdenum, pH, sodium, sulfate, total dissolved solids, barium, copper, nitrate

Knowledge of contamination of groundwater at the CCW landfill dates back to at least 1994.

In response to documented groundwater contamination at the CCW Landfill identified in the 1994 application for Significant Permit Modification, the Illinois Pollution Control Board (IPCB) issued an adjusted standard (AS) for the Landfill in 1996. The conditions of the AS include:

- Maintenance of an inward hydraulic gradient at the Landfill to prevent leachate migration; and
- Any statistically significant increase above Applicable Groundwater Quality Standard (AGQS) that is attributable to the facility and which occurs at or beyond the zone of attenuation within 100 years after closure of the last unit accepting waste will constitute a violation.

The operating permit for the Landfill has gone through a complex series of modifications since 1994 related to groundwater at the site, with additions and removals of monitoring wells and parameters monitored. The latest Significant Modification of the Landfill operating permit was submitted in 2006 (KPRG, 2006) and approved in 2007 (IEPA, 2007). Key provisions of the current operating permit include:

- A zone of attenuation for contaminants in groundwater from the ground surface to the bottom of the uppermost aquifer within an area defined by a distance of 100 feet from the edge of Lincoln Quarry on the upgradient side with respect to groundwater flow and at the property boundary on the downgradient side with respect to groundwater flow.
- The groundwater monitoring program must be capable of determining background groundwater quality hydraulically upgradient of and unaffected by the units and to detect from all potential sources of discharge, any release to groundwater within the facility. IEPA (2007) classifies wells as follows: upgradient (G38S&D, G39S), wells within zone of attenuation (G30S&D, G20S, R16D, R08S&D, R32S, G44S&D, G46S&D, G47S&D, G48S&D) and compliance wells (G31S&D, G33S&D, G41S&D, G42S&D). As has been noted in the Test of Proof section, a consequence of reversal in groundwater flow direction on the south side of the quarry as a result of dewatering of the Laraway Quarry is that there are no monitoring wells in the current network that can be reliably considered upgradient.
  AGQSs (applicable groundwater quality standards), which apply to upgradient and compliance boundary wells, and MAPCs (maximum allowable predicted concentrations), which apply to wells within the zone of attenuation, have been established for all parameters in the detection monitoring program. The permit sets the MAPCs equal to the AGQSs, so only AGQSs are referred to in the discussion here. A

"G1" list of parameters that must be sampled quarterly includes: pH, specific conductance, ammonia, arsenic, boron, cadmium, chloride, fluoride, manganese, molybdenum, potassium, selenium, sodium, sulfate, TDS, TOC, and zinc (chemical constituents are tested for dissolved concentrations). A "G2" list of parameters that must be sampled annually includes: barium, copper, iron, lead, mercury, and nitrate (unfiltered total concentration). The request in the latest Significant Permit Modification (KPRG, 2006) to eliminate ten parameters from the G2 list (dissolved antimony, beryllium, chromium, cobalt, cyanide, iron, lead, mercury, nickel, and thallium) was approved by IEPA (IEPA, 2007).

A review of the AGQSs, as defined in the latest significant permit modification approval, indicates that the modified standards for boron, cadmium, manganese, molybdenum, and selenium for the Landfill are significantly higher than either Illinois Class I Groundwater Standards or other health-based water quality standards (IEPA, 2007):

- The boron AGQS (5.9 mg/L) is well above the Illinois Class I groundwater standard of 2.0 mg/L (IGQS, 2002);
- The cadmium AGQS of 0.264 mg/L is 52 times higher than the Illinois Class I groundwater standard and federal MCL of 0.005 mg/L;
- The AGQS for manganese (0.634 mg/L) is 4.2 times higher than the Illinois Class I groundwater standard of 0.15 mg/L;
- The selenium AGQS of 0.325 mg/L is 6.5 times higher than the Illinois Class I groundwater standard and federal MCL of 0.05 mg/L; and
- Illinois has no molybdenum standard but the AGQS at the Landfill (1.38 mg/L) is more than 34 times higher than the federal Lifetime Health Advisory (LTHA) value of 0.04 mg/L.

A consequence of the IPCB's AS for groundwater, combined with the AGQSs that have been set, is that groundwater with significant concentrations of toxic metals can move off-site and be in compliance with the terms of the current Landfill operating permit.
Submittals by Midwest Generation to IEPA and other public documents reveal that the Landfill has not been in compliance with the AS or the Permit for some period of time and probably as early as 2004 (Driver, 2009). Despite evidence that groundwater contamination at the Landfill has repeatedly exceeded even the relaxed AGQSs that have been allowed by IEPA, no significant enforcement action was taken until a Notice of Violation dated August 31, 2009 was issued. The details of the NOV are summarized in the Test of Proof section.

The IEPA Ash Impoundment Assessment identifies the Lincoln Quarry Ash Landfill as having an IPCB Ground Water Management Zone (GMZ) designation (IEPA, 2009c). Such a designation has the potential for allowing off-site contamination of groundwater within the designated zone. However according to IEPA internal communications there is no GMZ at the site (IEPA, 2010). The only information available as part the voluminous material eventually received in response to FOIA requests for information about the Joilet 9 ash disposal site that would indicate that a GMZ is even being considered is a June 2009 map prepared by KPRG showing proposed locations of initial GMZ monitoring wells.

Slurried bottom ash and slag

The Lincoln Quarry has been used as a disposal facility for bottom ash and slag from two coal-fired generating stations (Joliet 9 and 29) since around 1962. It operates under a landfill operating permit, but also includes two below-grade surface impoundments for the slurry water that is used to move the coal ash from the generating stations to the Landfill. Ash is sluiced into the Main Quarry, which occupies the southern area of the site and slurry waters collect in a large pond in the north part of the Main Quarry (P1). A North Quarry, designated as the zone of attenuation, includes a settling pond and another pond in the southeast part of this area. Neither the ash landfill fill nor the ponds are lined.

Active or Inactive Waste Management Unit

Most of the unlined disposal area is active. An area in the southwest corner of the site is inactive.

Hydrogeologic Conditions

The area of the Lincoln Quarry CCW Landfill has four main hydrogeologic units: (1) the upper unconsolidated glacial materials; (2) the upper weathered Silurian dolomite; (3) the lower Silurian dolomite; and (4) the Brainard Shale/Ft. Atkinson dolomite. The underlying Skales formation is a regional aquitard. Consultants for Midwest Generation have developed a nine-layer three dimensional groundwater flow model for the site (KPRG, 2008b), details of which have been questioned by consultants for Brandon Road Properties (owners of the old quarry east of the ash landfill) (C&E, 2008).

The monitoring well network for the Landfill includes 11 shallow zone wells (G38S, G39S, G30S, G20S, R32S, G44S, G31S, G33S, G41S and P40S), nine deep zone wells (G38D, G30D, R16D, R08D, G44D, G31D, G41D and G42D), and one surface water discharge point (S501, main quarry leachate). As a result of groundwater flow shifts caused by quarrying activities to the southeast, three well clusters were added south of the Landfill (G46S&D, G47S&D, and G48S&D).

Natural groundwater flow beneath the quarry landfill has historically been from south and east to the north and west toward the Des Plaines River. Dewatering connected to expansion of mining activities at the Laraway Quarry about 1,000 feet to the southeast of the Lincoln Quarry has created a flow component to the south and southeast toward that quarry. A proposal by Brandon Road Properties (BRP), LLC to dewater an inactive quarry immediately east of the Lincoln Quarry Ash Landfill (referred to in documents variously as the BRP, Boyd, and former De Be Land Quarry) raised concerns that groundwater would also begin to flow east to the this quarry and northeast toward a residential area. This concern led IEPA to deny BRP's application for an NPDES permit, a denial that BRP has contested (Driver, 2009). Even without dewatering of the BRP Quarry, there is evidence that contamination is moving to the northeast into the Smiley subdivision, probably as a result of residential well usage.

There are 94 wells used for drinking water within a one-mile radius of the Landfill (IEPA, 2009c). An unincorporated area lies northeast of the Landfill, and a few private residences lie to the south. Private and public well data for the state of Illinois is maintained on a county by county basis via online database operated by the Illinois State Water Survey. Plotting the wells from this database on a map is nearly impossible for the reason that instead of each well being assigned an exact x and y location (Latitude and Longitude), the exact position of the well falls in a one- to five-mile area of a square that is arranged by section, township, and range. It is unknown how many wells are downgradient of the site.

Arcadis G&M, Inc (Arcadis). 2006. Letters to 18 residents south of the Lincoln Quarry Landfill, giving results of well sampling for boron (May 26, 2006) (written on behalf of Midwest Generation).

C&E. 2008. Civil & Environmental Consultants, Inc. (C&E), Memorandum from John Hock and Brad Renwick, C&E, to Alan Keller, Permit Section, IEPA Division of Water Pollution Control, Re: Comments to KPRG Modeling Addendum (Sept. 30, 2008).

Driver. 2009. Letter from LaDonna Driver, Hodge, Dwyer and Driver, to Sanjay Sofat, Acting Division Manager, IEPA Division of Water Pollution Control, Re: Brandon Road Properties and Lincoln Quarry Ash Landfill (Dec. 3, 2009).

IGQS. 2002. Illinois Environmental Protection Agency (IEPA), Illinois Groundwater Quality Standards (IGQS), 35 Ill. Admin. Code Chpt. 620.210, Class I Potable Resource Water.

IEPA. 2010. Email from Amy Zimmer, Environmental Protection Geologist, Groundwater Section, IEPA, to Bill Buscher, Bureau of Water, IEPA, Re: Attorney Letter Regarding Midwest Site (Jan, 12, 2010) [Note: this email is apparently addressing questions raised by Driver (2009)].

IEPA. 2009a. Violation Notice, Midwest Generation – Joliet #9 Station (Aug. 31, 2009).

IEPA. 2009b. Memorandum from Ricardo Ng, Des Plaines Office, IEPA, to Region File, Re: Inspection Report on Midwest Generation Joliet Station 9 (Unit 6) NPDES No. IL0002216 (July 9, 2009).

IEPA. 2009c. Memorandum from Marcia Willhite, Chief, Bureau of Water, IEPA, to Douglas Scott, Director, IEPA, Re: Assessment of Ash Impoundments Permitted Within the State of Illinois (Feb. 3, 2009).

IEPA. 2007. Letter from Stephen Nightingale, Manager, Permit Section Bureau of Land, IEPA, to Land Trust #724 and Midwest Generation, Re: Lincoln Stone Quarry Permit Modification No. 10 Approval (Jan. 31, 2007).

KPRG and Associates, Inc. (KPRG). 2008a. Memorandum from Richard Gnat, KPRG, to William Buscher, Division of Public Water Supply, Re: Transmittal of Additional Hydrogeologic Model Runs (Boron) – Lincoln Quarry/Boyd's Quarry (Aug. 14, 2008).

KPRG. 2008b. Technical Summary of Hydrogeologic Evaluation – Impacts of Proposed Boyd's Quarry Dewatering. Technical Memorandum prepared for Midwest Generation (June 13, 2008).

KPRG. 2008c. Lincoln Stone Quarry IEPA Meeting, Technical Support Handout (June 11, 2008).

KPRG. 2006. Application for Significant Modification to Permit, Joliet/Lincoln Stone Quarry, Midwest Generation EME, LLC, Joliet Illinois (submitted to IEPA) (May 30, 2006).

Midwest Generation. 2009. Letter from Maria Race, Environmental Program Manager, Midwest Generation, to Bill Buscher, Bureau of Water, IEPA, Re: Residential Well Sampling in Vicinity of Lincoln Quarry Landfill (Sept. 9, 2009).

Thompson, Tammy. 2010. Email communication (Aug. 6, 2010) (former resident in the area of the Landfill).

Entity/Company – Location

Southern Illinois Power Cooperative - Marion Plant
11543 Lake of Egypt Road
Marion, IL 62959
Williamson County
Latitude: 37.620103 Longitude: 88.953467

Determination

Demonstrated damage to groundwater moving off-site to surface water (discharging into Saline Creek on the northern edge of the site)

Probable Cause

Leaching of CCW contaminants from unlined CCW landfill and ponds

Summary

At the Southern Illinois Power Cooperative's (SIPC) Marion Power Plant, coal fly ash, bottom ash, and flue gas desulfurization (FGD) sludge have been placed in six unlined ponds, one unlined landfill and one lined pond since 1963. Groundwater monitoring has been required in the vicinity of the landfill and ponds since 1994, and high concentrations of the toxic heavy metal cadmium were first detected in 1997. The 2004 to 2009 average concentrations of cadmium exceeded the Illinois Class I Groundwater Standards in six of eight monitoring wells with maximum concentrations reaching 10 to 18 times the federal Maximum Contaminant Level (MCL). The two wells with the highest average concentrations of cadmium (3 to 4 times the MCL) are adjacent to Saline Creek and discharging into the creek. At 0.088 mg/L, the maximum concentration in these wells is 35 to 352 times higher than federal acute and chronic water quality standards, respectively. These two wells also have high concentrations of iron that have exceeded the Class I Groundwater Standards since monitoring began in 1994. Recent data on pond discharges to Saline Creek show high concentrations of aluminum, boron, and manganese.

Groundwater sampling since 1994 at the Marion Plant has tested only a limited suite of parameters that includes boron, cadmium, iron, and sulfate. All quarterly sampling data for cadmium collected from 2004 to 2009 were analyzed (the fourth quarter of 2004 was omitted because detection limits were above the MCL of 0.005 mg/L).

- **Cadmium.** The Illinois standard for cadmium in Class I Groundwater is 0.005 mg/L. The 5-year average concentration for cadmium equaled or exceeded this standard in six of the eight wells for which data are available since 2004. The highest average concentrations are in S1 (0.015 mg/L, 3 times the MCL, maximum of 0.088 mg/L, 17.6 times the MCL) and S2 (0.02 mg/L, 3.9 times the MCL, maximum of 0.052 mg/L, more than 10 times the MCL). Both of these wells are between the CCW ponds and landfill and Saline Creek, so the highest concentrations of cadmium at the site are discharging to Saline Creek. The next highest concentrations are in C1 (location not known) with an average concentration of 0.01 mg/L, twice the MCL. Other wells where average concentrations were equal to or in excess of the MCL for cadmium include S3 (0.006 mg/L), S5 (0.007 mg/L), and S6 (0.0054 mg/L). The two remaining wells for which data are available for the last five years have elevated levels of cadmium, but their averages are below the MCL: C3 (0.004 mg/L) and S4 (0.003 mg/L).
- **Boron.** The Illinois standard for boron in Class I Groundwater is 2.0 mg/L. Groundwater sampling data from 1994 to 2009 shows occasional exceedances of boron in more than one well, dating back to 1994, but no consistent pattern of exceedances. Recent samples of ash pond effluent discharged to Saline Creek contained high boron (7.9 mg/L).
- **Iron.** The Illinois Class I groundwater standard for iron in is 5 mg/L. Recent sampling has shown exceptionally high concentrations of iron (more than 400 mg/L in S1 and more than 100 mg/L in S2), but this has been attributed to rusting well covers (SIPC, 2010). However, sample data going back to 1994 shows that most wells exceeded the MCL in most sampling events and S1, S2, and S3 commonly had concentrations exceeding 30 mg/L. The extremely high recent values may be due to rusting well covers, but it is also clear that the CCW disposal areas are contributing high concentrations of iron to the groundwater.
- **Sulfate.** Well data from 1994 to 2009 show sulfate concentrations that occasionally exceeded the USEPA secondary drinking water MCL of 250 mg/L, but not the Illinois Class I groundwater standard of 400 mg/L.

A sample of effluent collected in March 2009 from Ash Pond #4 (NPDES Outfall #002), which discharges to Saline Creek, showed high concentrations of aluminum (0.33 mg/L, 3.8 times the EPA water quality criteria of 0.087 mg/L for chronic exposure to aquatic life, although Illinois has not set WQC for aluminum), boron (7.9 mg/L, more than ten times USEPA's surface water criteria of 0.75 mg/L for protection of sensitive crops by long-term irrigation),. IEPA's response to a FOIA request did not include effluent quality data other than that for 2009. There does not appear to be any sampling to determine actual impacts of the discharges on Saline Creek.

Boron, cadmium, iron, aluminum, and manganese

There are three wells within a one-mile radius of the CCW disposal areas (IEPA, 2009b). Exact locations were not acquired because well locations are given in section, township, and range with a one- to five-mile variance. Illinois private and public well data are maintained on a county by county basis via an online database operated by the Illinois State Water Survey. It is unknown how many wells are downgradient of the site.

The first groundwater sampling in 1994 found high concentrations of iron in several wells (up to 24.5 mg/L). Boron was found above the IL MCL in several wells (maximum of 2.53 mg/L) in 1995. Cadmium was first measured above the MCL in two wells in November 1997 (0.012 to 0.013 mg/L).

Regulatory Action

SIPC began reporting groundwater monitoring data to the IEPA in 1994, and by 1997 the data showed significant cadmium contamination. However, IEPA's Hydrogeology and Compliance Unit did not review this data until 2009. IEPA found elevated boron, cadmium, and iron above Illinois Class I Groundwater Standards and asked SIPC to submit a "hydrogeologic assessment plan" to determine the source and extent of elevated iron and cadmium contamination at the site (IEPA, 2009a). IEPA approved a plan that includes measures to refurbish seven existing wells and replace two groundwater monitoring wells that have been out of service, but the plan does not require groundwater monitoring for parameters other than boron, cadmium, iron, and sulfates (IEPA, 2010).

Bottom ash, fly ash, and scrubber sludge

Seven ash ponds that receive fly ash and/or bottom ash from Units 1, 2 and 3 are located throughout the facility. Only one of these is lined.

Dry fly ash and scrubber sludge are mixed and placed in an unlined solid waste landfill with a capacity of 1,137,359 cubic yards that is located between the confluence of Saline Creek and the South Fork of Saline Creek (SIPC, 1993 and IEPA, 2009b).

Active

Detailed hydrogeologic investigations were recently initiated at the site (SIPC, 2010). Review of the Marion and Goreville USGS topographic maps shows that the spillway elevation of the dam for Lake of Egypt located just east of the Marion plant is 500 feet and that most of the ash ponds are located in upland positions a little above or below this elevation. The CCW landfill is located at an elevation of about 460 feet in the floodplain between the confluence of Saline Creek and South Fork Saline Creek. The main direction of groundwater flow from the various CCW ponds and landfill, assuming topographic control of flow, is to the north toward Saline Creek, which is a discharge point for shallow groundwater.

Illinois Environmental Protection Agency (IEPA). 2010. Letter from Allen Keller, Permit Section, Division of Water Pollution Control, IEPA, to Jason McLaurin, Environmental Coordinator, South Illinois Power Cooperative, Re: Groundwater Monitoring Data (Apr. 26, 2010).

IEPA. 2009a. Letter from Allen Keller, Permit Section, Division of Water Pollution Control, IEPA, to Jason McLaurin, Environmental Coordinator, South Illinois Power Cooperative, Re: Groundwater Monitoring Data (Dec. 10, 2009).

IEPA. 2009b. Memorandum from Marcia Willhite, Chief, Bureau of Water, IEPA, to Douglas Scott, Director of IEPA, Re: Assessment of Ash Impoundments Permitted Within the State of Illinois (Feb. 3, 2009).

Illinois Groundwater Quality Standards. 2002. IEPA, 35 Ill. Admin. Code § 620.210, Class I Potable Resource Water.

Southern Illinois Power Cooperative (SIPC). 2010. Letter from Jason McLaurin, Environmental Coordinator, SIPC, to Carl Kamp, Permit Section, Division of Water Pollution Control, IEPA, Re: Groundwater Monitoring Data (Jan. 11, 2010).

SIPC. 2004–2009. SIPC, Quarterly Groundwater Monitoring Data (2004–2009).

SIPC. 1993. SIPC, Annual Facility Report for On-Site Facilities (submitted to IEPA) (1993).

Entity/Company – Location

Union Electric Company/Ameren Energy d/b/a AmerenUE - Venice Power Station Ash Ponds
701 Main St
Venice, IL 62090
St. Clair and Madison Counties
Latitude: 38.653694 Longitude: -90.172728

Determination

Demonstrated damage to groundwater off-site (400 feet east of ash ponds & beyond property line)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants from unlined CCW ponds

Summary

Inactive and unlined coal ash ponds at the AmerenUE Venice power plant on the east side of the Mississippi River created a contaminant plume of boron that exceeds Illinois Class I (potable) groundwater standards, extending 475 feet south of the ponds. A contaminant plume of arsenic that exceeds Class I standards extends beyond the boron plume and contains concentrations as high as 38 times the federal MCL, 400 feet beyond the ash ponds. The ash ponds stopped receiving CCW in 1977 when the plant switched from burning coal to oil. The contaminant plumes were discovered in the late 1990s when groundwater monitoring was required as part of a permit to resume operation of the Venice Plant in 1995. AmerenUE has proposed a state "Groundwater Management Zone" (outlined in red on the map below) to contain contaminant plumes within the property.

Test of Proof

A review of groundwater monitoring data submitted by AmerenUE to the Illinois Environmental Protection Agency (IEPA) from 1996 to 2009 found the following:

- **Arsenic.** The Illinois Class I groundwater standard for arsenic is 0.05 mg/L, five times higher than the federal Maximum Contaminant Level (MCL) of 0.01 mg/L. The average concentration of arsenic exceeded the Illinois standard in MW5 (0.054 mg/L) and MW6 (0.077 mg/L) on the north and south edges of the ash ponds, respectively. MW7, set 200 feet south of the edge of the ash ponds, had even higher average arsenic concentrations (0.086 mg/L, 8.6 times the MCL, with a maximum of 0.215 mg/L, 21 times the MCL). Other monitoring wells where average concentrations exceeded the MCL included MW1 on the north edge of the ash pond (0.026 mg/L) and MW4 on the east edge (0.024 mg/L). Arsenic concentrations in monitoring wells west of the ash ponds and east of the river were lower, suggesting that the dominant flow of groundwater is to the east away from the river (MW2 exceeded the MCL in 3 out of 30 samples, with a maximum of 0.24 mg/L, and MW3 exceeded the MCL in 2 out of 24 samples, with a maximum of 0.26 mg/L). A dominant flow to the east away from river is also suggested by common, and in some cases substantive, exceedances of the arsenic MCL in MW8 (7 out of 39 samples, maximum of 0.31 mg/L) and MW9 (11 out of 39 samples, maximum of 0.38 mg/L, 38 times the MCL). Both MW8 and MW9 are off-site about 400 feet east of the CCW ponds, and, as discussed below, concentrations of contaminants are affected by seasonal changes in flow direction.
- **Boron.** The standard for boron in Illinois for Class I (potable) water is 2.0 mg/L. The average concentration of boron exceeded the state standard in all monitoring wells set at the northern (MW1, 22.5 mg/L, more than 10 times the MCL), eastern (MW4, 19.2 mg/L and MW5 5.2 mg/L) and southern (MW6, 3.8 mg/L) edges of the ash ponds. MW7, set 200 feet south of the edge of the ash ponds, had a somewhat lower average boron concentration (2.6 mg/L). MW2, west of the ash ponds, also had a high boron concentration (5.4 mg/L). Wells MW3 (west) and off-site MW8/MW9 (east) had one or zero exceedances of the state standard since monitoring began, although these wells show concentrations of boron above what would be expected natural background levels. As discussed later, elevated boron both east and west of the ash pond system can be explained by seasonal variations in groundwater flow direction.
- **Cadmium.** The MCL for cadmium (0.005 mg/L) was exceeded three times in early sampling of MW1, but has not been exceeded since April 1999. There were no other MCL exceedances for cadmium in other wells.
- **Iron.** The Illinois Class I groundwater standard for iron in is 5.0 mg/L. Iron concentrations have exceeded this standard at MW6 (maximum of 27.5 mg/L), MW7 (maximum of 17.8 mg/L) and MW9 (maximum of 23.3 mg/L).
- **Manganese.** The Illinois Class I groundwater standard for manganese is 0.015 mg/L. Manganese concentrations have exceeded this standard in all wells. Wells with exceptionally high manganese concentration (more than 1.5 mg/L, 100 times the standard) include: MW1 (maximum of 4.82 mg/L), MW4 (maximum of 4.25 mg/L), MW6 (maximum of 3.56 mg/L), and MW7 (maximum of 5.59 mg/L.
- **Total Dissolved Solids (TDS).** The Illinois Class I groundwater standard for TDS is 1,200 mg/L, more than twice as high as the Secondary MCL (SMCL) of 500 mg/L. The Illinois standard for TDS was consistently exceeded in MW1 (maximum of 2,656 mg/L), and regularly exceeded in MW4 (maximum of 2090 mg/L). These exceedances are more than five and four times the federal SMCL, respectively.

The Supplemental Hydrogeological Assessment of the site performed by a consultant for AmerenUE states that there is little correlation between arsenic and boron concentrations in groundwater samples collected at the site, and uses this evidence, along with the fact that arsenic concentrations in field leachate samples collected at the ash ponds are a factor of 4 to 5 lower than observed in groundwater, to argue that the main source of the arsenic is not from the coal ash ponds (NRT, 2010). The Supplemental Hydrogeological Assessment for the site also identifies MW8 and MW9 east of the ash ponds as "upgradient" wells, apparently on the assumption that the dominant direction of groundwater flow is west toward the river (NRT, 2010).

However, several lines of evidence suggest that the ash ponds *are* the main source of arsenic, and that off-site MW8 and MW9 are not truly upgradient and are affected by contaminants from the ash ponds:

- Boron tends not to interact with aquifer solids and serves as a good indicator of the zone of influence of ash leachate on groundwater. Arsenic, on the other hand, is sensitive to redox conditions in the ash pore waters and aquifer, so a correlation between arsenic and boron in the same sample would not necessarily be expected.
- In Pleistocene aquifers, groundwater containing boron concentrations greater than 0.5 mg/L can be considered affected by leachate (Schleyer et al., 1992). In MW8, the average concentration of boron in samples taken from 1999 to 2009 was 0.68 mg/L and more recent sampling in MW8P averaged 1.48 mg/L, suggesting that this well, 400 feet "upgradient," has been affected by the ash ponds.
- This influence can be explained by the fact that when the Mississippi River is high, the groundwater gradient to the east is much steeper (river 8.34 feet higher than MW8 on July 26, 2008) than when the river is at normal flow (river 3.93 feet lower than MW8 on September 26, 2008), making it entirely possible for contaminants to reach these wells and farther east before the lower westward gradient is reestablished.
- The interpretation that the dominant direction of the flow of contaminants is to the east rather than the west is confirmed by the fact that the monitoring wells set between the ash ponds and the river (MW2 and MW3) have lower average concentrations of arsenic and boron than the wells east of the ash ponds (MW4 and MW5).

  Although the consultant raises the possibility that there may be some contribution of arsenic from another source, none has been identified.

The boron contaminant plume with concentrations up to 2.0 mg/L extends a maximum of 475 feet south of the ponds. A contaminant plume of arsenic that exceeds Illinois Class I standards extends a bit beyond the boron plume. The "Groundwater Management Zone" (GMZ) proposed by AmerenUE extends somewhat beyond the boundaries of the contaminant plume and is located within the property boundaries of the power plant.

Arsenic, boron, cadmium, iron, manganese, total dissolved solids

A potable well survey conducted within a 2,500-foot radius of the ash pond system boundaries has been performed (NRT 2009a). The map showing the locations of these wells was withheld by IEPA when it responded to the Freedom of Information Act (FOIA) request for information about the site, so the results of this survey cannot be reported here. AmerenUE (2010) notes that the City of Venice and Village of Brooklyn have enacted ordinances prohibiting the use of groundwater as a potable water supply, because the presence of industrial facilities in the area since the early 1900s has created multiple potential sources for groundwater contamination. However, the analysis presented here suggests that most, if not all, contaminants are being detected in monitoring wells associated with the ash pond system and come from the unlined ash ponds. Private and public well data for the state of Illinois is maintained on a county by county basis via an online database operated by the Illinois State Water Survey. Wells locations fall in a one- to five-mile area arranged by section, township, and range. It is not possible to plot well locations or distinguish which wells are downgradient of the site.

Arsenic and boron exceeded MCLs and SMCLs in the first round of groundwater sampling on July 27, 1996. When MW4, MW5, and MW6 were added to the network in December 1997, arsenic and boron also exceeded Illinois Class I groundwater standards in all three wells.

When the Venice Plant resumed operations in 1995, a condition for the operating permit was that hydrogeologic investigations be initiated to evaluate the impact of the ash pond system on groundwater. These investigations were initiated in 1996 with the installation of three monitoring wells, and the monitoring well network was eventually expanded to include 17 monitoring wells at varying depths and locations in and around the ash pond system. As discussed above, contaminant plumes containing arsenic and boron at levels that exceed ILEPA Class I groundwater standards and federal MCLs have been defined within the boundaries of the Venice Plant facility.

In March 2010, as part of the plan for final closure of the ash ponds, AmerenUE proposed final capping and establishment within their property boundaries of a Groundwater Management Zone (GMZ) for containing the contaminant plumes.

Coal ash and other CCW from boilers, wastewaters from the boilers and water treatment plant, and various other process waters plus storm water runoff

A series of unlined ponds, referred to as Ash Pond Nos. 2 and 3 and collectively as the "ash pond system," was constructed in the 1950s to receive wet-sluiced coal ash and other CCW from boilers, wastewaters from the boilers, water treatment plant, and various other process waters plus storm water runoff. When the plant stopped burning coal in 1977, the ash pond system contained about 1,425,500 cubic yards of waste. The ash pond system continued to receive process wastewater and storm water runoff until a new water treatment facility and outfall was constructed in 2005. The ash pond system has been out of service since 2005 (AmerenUE, 2010).

Inactive

The ash pond system is underlain by about 80 feet of alluvial deposits associated with the Mississippi River. The upper 20 to 30 feet of alluvium contain alternating layers of silt, sand, and clay. The lower 60 to 50 feet consist primarily of sand and gravel. Groundwater flow in the region is controlled by the Mississippi River. During normal river stage, which lasts the majority of the year, groundwater flows west and discharges into the river. During high river stage, groundwater flow is reversed, flowing east, with the river recharging the aquifer. There is also a perched water table that is influenced by infiltration of precipitation that tends to dilute the concentrations of contaminants from the ash pond system in the shallower wells. As discussed above in the Test of Proof section, even though the seasonal eastward flow inland from the Mississippi River is of shorter duration than the westward flow toward the river, the higher gradient of the eastward flow has carried contaminants farther inland (400 feet to MW8 and MW9) than has been acknowledged by AmerenUE's consultants (Hanson Engineering, 2000).

The 500-MW Venice plant burned coal until it was converted to an oil-burning facility in the late 1970s. The plant's capacity dropped off in the 1980s, but it was reconditioned and reopened in 1995. AmerenUE was formed in 1998 with the merger of Union Electric and Illinois Public Service. A catastrophic fire in 2003 resulted in abandonment of the original power plant building and associated generating equipment. Beginning in 2004, three additional single-cycle combustion turbine generators (Units 3, 4, and 5) were installed north of the ash pond system, and the plant was reopened in 2005. The plant now operates only intermittently as a peaking facility.

AmerenUE. 2010. Memorandum from AmerenUE to Bill Buscher, Groundwater Protection, Division of Water Pollution Control, Illinois Environmental Protection Agency, Re: Ash Pond Closures at AmerenUE's Venice Plant (Mar. 25, 2010).

Hanson Engineering. 2000. Hanson Engineering, Hydrogeologic Investigation, Former Ash Disposal Pond System, AmerenUE Venice Power Plant (Appendix A to Venice Ash Pond Closure Memorandum, AmerenUE, 2010).

Natural Resource Technology (NRT). 2010. Supplemental Hydrogeological Assessment, Technical Memorandum No. 2 (Mar. 3, 2010) (Appendix C to Venice Ash Pond Closure Memorandum, AmerenUE, 2010).

NRT. 2009. NRT, Potable Well Survey, Hydrogeological Assessment, and Modifications to the Groundwater Monitoring Program, Technical Memorandum No. 1 (Sept. 17, 2009) (Appendix B to Venice Ash Pond Closure Memorandum, AmerenUE, 2010).

Schleyer, Ruprecht, Helmut Kerndorff, and Gerald Milde. 1992. Detection and Evaluation of Groundwater Contamination Caused by Waste Sites, *in* Suzanne Lesage and Richard E. Jackson (eds.), Groundwater Contamination and Analysis at Hazardous Waste Sites, CRC Press 273–91.

Entity/Company - Location

E.ON U.S. d/b/a Louisville Gas & Electric (LG&E) - Mill Creek Plant
14660 Dixie Highway
Louisville, KY 40272
Jefferson County
Latitude: 38.049444 Longitude: -85.9075

Determination

Demonstrated damage to groundwater moving off-site (Ohio River)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants to groundwater from three CCW landfill areas (A, B, and C) and the coal ash pond

Summary

Groundwater has been contaminated with arsenic at 1.5 times the federal Maximum Contaminant Level (MCL) in three wells downgradient from a CCW landfill and pond adjacent to the Ohio River at the Mill Creek Plant, approximately 15 miles south of downtown Louisville. Concentrations of total dissolved solids (TDS) have been up to 1,280 mg/L, more than 2.5 times the federal Secondary MCL (SMCL), and sulfate has been up to 717 mg/L, nearly 3 times the SMCL. Nine wells have groundwater parameter concentrations that have exceeded one or more drinking water standards. Although groundwater flows to the Ohio River, the horizontal extent of the contamination is approximately one-mile wide potentially affecting off-site human use of shallow groundwater in this urban area. Nevertheless, the Kentucky Division of Waste Management waived groundwater monitoring for CCW metals, has not required any assessment or corrective action, and has not conducted or required any off-site groundwater monitoring.

The Mill Creek Plant became operational in 1972, and the Kentucky Division of Waste Management (KDWM) originally permitted the 185-acre CCW landfill in 1982, and horizontal expansions of the landfill occurred in 1990 and in 2009. The first two phases of the CCW landfill (Sites A and B) were permitted as an "inert" landfill, and the KDWM did not require a liner. The most recent expansion in 2009 was constructed with a clay liner that was designed to allow CCW leachate seepage but attenuate metals and other CCW contaminants (LG&E, 2005). CCW disposed of in the landfill includes fly ash, bottom ash, and FGD gypsum.

A "significant hazard" 79-acre coal ash pond was built in 1972, and four other process water ponds were commissioned in the late 1970s and early 1980s. The Mill Creek Power Plant disposed of bottom ash, fly ash, boiler slag, flue gas desulfurization (FGD) sludge, coal fines, process water drainage, and pyrites in the ash pond. Neither the KDWM nor the Kentucky Division of Water (KDOW) requires groundwater monitoring of the ash pond; however, plant production wells (PW-1, PW-2, and PW-3) south of the pond can be used as indicators of CCW constituent migration from the ash pond.

The KDWM requires groundwater monitoring of the CCW landfill and that monitoring shows that the groundwater contamination correlates chronologically with horizontal expansions of the landfill, and that concentrations of parameters have increased over time. The oldest groundwater data in the KDWM landfill file that includes any heavy metal concentrations in groundwater monitoring results date back to an August 1994 (LG&E, 1994) sampling event. Its results showed the following:

- **Arsenic** – exceeded the EPA MCL (0.01 mg/L) in three wells just south of the ash pond and between the oldest part of the ash landfill (Site B) and the Ohio River: MW-02 (0.014 mg/L); PW-1 (0.014 mg/L); and PW-3 (0.013 mg/L).
- **Sulfate** – the highest concentrations were in one well (PW-1) near the ash pond and the Site B landfill and in one well near the Site A ash landfill (MW-6). MW-6 is located adjacent to the Ohio River.
- **Calcium** – often a highly soluble parameter in CCW, the highest concentrations for calcium were in the two wells with the highest sulfate (PW-1 and MW-6), providing further evidence of contamination from ash or other CCW.

Groundwater monitoring results for a November 1995 sampling event also showed arsenic concentrations exceeding the MCL downgradient from the ash disposal areas. The MCL for arsenic was exceeded again in MW-2 (0.015 mg/L) and PW-1 (0.014 mg/L).

In June 1996, groundwater monitoring omitted arsenic and only included the following parameters: temperature, chloride, conductivity, chemical oxygen demand (COD), total organic carbon (TOC), sulfate, TDS, calcium, sodium, and copper (LG&E, 1996). The June 1996 results still indicated that the areas downgradient from the CCW landfill (Sites A and B) and nearest the coal ash pond had the highest concentrations of contaminants:

- **TDS** – concentrations exceeded the EPA SMCL (500 mg/L) at: MW-6 (959 mg/L, Site A landfill area); PW-1 (591 mg/L, Site B landfill and ash pond area); PW-2 (689 mg/L, Site B landfill and ash pond area); and PW-3 (910 mg/L, Site B landfill and ash pond area).
- **Sulfate** – concentrations exceeded the SMCL (250 mg/L) in MW-6 (383 mg/L) and PW-3 (439 mg/L).
- **Calcium** and **sodium** – the highest concentrations were associated with MW-6, PW-1, PW-2, and PW-3 that also had the highest sulfate, and TDS – like calcium, sodium is often a highly soluble parameter in CCW.

- **Copper** – concentrations were relatively unchanged between all wells, indicating that copper is not a good indicator for coal combustion wastes at this site.

A 1997 statistical analysis of groundwater compared the results of all monitoring wells to a designated background (also called "upgradient") well, MW-1 (LG&E, 1997). MW-1 is to the west the Site B landfill, which is the oldest landfill at the site and is the most northwestern monitoring well at the site, likely placing it at the most upgradient position for shallow groundwater movement. The results indicated statistically significant increases (SSIs) in downgradient wells that are indicative of a release of CCW parameters to the groundwater as follows:

- **TDS** – statistical increases in MW-2, MW-3, MW-4, PW-1, and PW-3. MW-2, MW-4, and PW-1 are located between the Site B landfill and the Ohio River.
- **Sulfate** – statistical increases in MW-2, MW-4, MW-6, PW-1, and PW-3. MW-6 is located between the Site A landfill and the Ohio River.
- **Calcium** – statistical increases in MW-6 and PW-1.
- **Sodium** – statistical increases in MW-2, MW-3, MW-4, MW-5, MW-6, PW-1, and PW-3.

While MW-5 (east of Site A) and MW-3 (east of Site B) are located on the "upgradient" side of CCW disposal areas, they are located close to the CCW disposal areas and south of MW-1, and the significant increases in TDS at MW-3 and sodium at MW-3 and MW-5 may reflect the outward spread of contamination.

By 2006, LG&E had redefined what it considered to be a statistically significant increase in constituent concentrations. The file review did not indicate if the KDWM concurred with this re-definition. LG&E also concluded that the list of monitoring parameters being tested for each well was not reflective of CCW. A summary of the key LG&E conclusions for the November 2005 sampling event is as follows (LG&E, 2006):

- Production wells PW-1, PW-2, and PW-3 would no longer be sampled, even though they had exceedances above groundwater standards in the past.
- LG&E would continue voluntarily monitoring for calcium, sodium, and sulfate because they believed these parameters are more indicative of CCW than those required by the KDWM.
- The average concentrations of three wells (MW-1, MW-3, and MW-5) would now be used as "background" instead of just MW-1 – even though LG&E concluded in 1997 that MW-3 and MW-5 had already been affected by CCW contamination from the landfills, as indicated by statistically significant increases in sodium and TDS.
- A statistically significant determination should not be based on sampling results because the results might be "indicative of a flaw within either the sample collection or analytical processes."
- The results of assessment monitoring "indicated minimal effects on human health and the environment" and that only "effects on human health and the environment" should be the basis for requiring an assessment of contamination, not the results of statistical analyses.
  LG&E would no longer notify the KDWM within 48 hours of determining that a statistical increase (or MCL exceedance) occurred, as required in the permit. Instead, notices would be made in semi-annual sampling reports that are submitted to the KDWM.

The current CCW landfill permit requires that groundwater be monitored semi-annually (KDEP, 2009). The permit requires that "groundwater assessment activities" be performed when an MCL is exceeded or if statistical analyses indicate a statistically significant increase over background occurs. However, none of the monitored parameters has an MCL; therefore, the first condition would never apply.

By 2009, groundwater monitoring data indicated that the horizontal extent of contamination had increased and that concentrations of parameters previously reported had also increased in certain wells. Sampling included a new well (MW-11 also called IW-11) that was installed downgradient from the newest landfill horizontal expansion area (Site C) where disposal began in 2009. Data from a May 2009 sampling event indicated the following:

- **Chloride** – the concentration of 211 mg/L in MW-6 downgradient from the Site A landfill was substantially higher than concentrations in all other wells which ranged from 9.4 to 55.1 mg/L.
- **TDS** – concentrations exceeded the EPA SMCL (500 mg/L) in wells monitoring all three of the landfill Sites. The concentration for the Site A landfill well adjacent to the Ohio River, MW-6, was 1,280 mg/L (compared to 959 mg/L in June 1996 at MW-6). The concentrations for the three Site B landfill wells were 508 mg/L at MW-1, 596 mg/L at MW-2, and 1,234 mg/L at MW-4. The concentration in newly installed MW-11 monitoring Site C was 585 mg/L.
- **Sulfate** – concentrations exceeded the EPA SMCL (250 mg/L) at Site A landfill well MW-6, at 499.5 mg/L (compared to 383 mg/L in MW-6 in June 1996) and at Site B landfill well, MW-4 at 716.6 mg/L.
- **Calcium** and **sodium** – the highest concentrations were generally associated with the wells with the highest sulfate and TDS.

When the results of 2009 data are compared to the 1996 results, the data and associated file material indicate that:

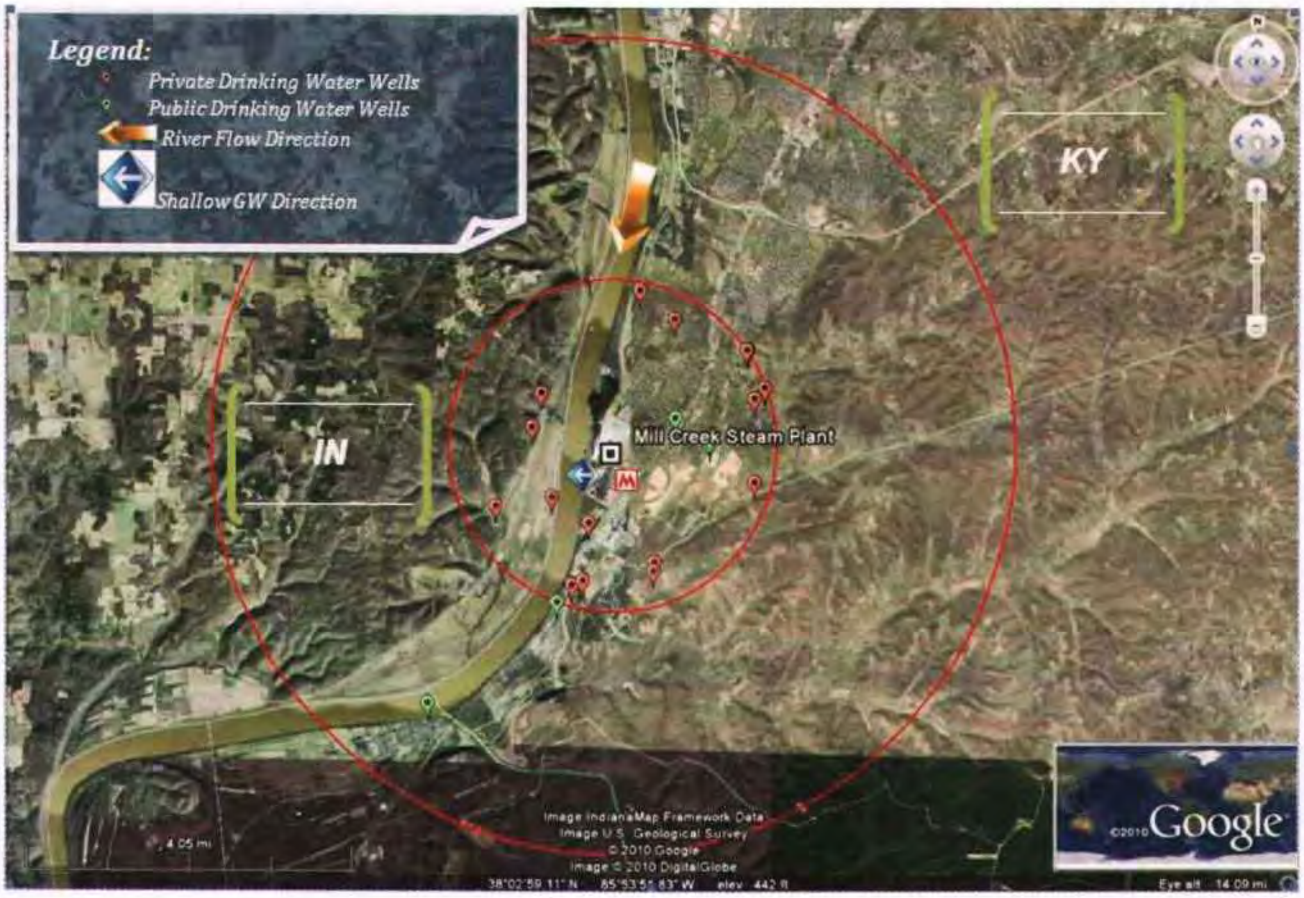
- The horizontal extent of groundwater contamination above regulatory standards has progressed according to the approval of horizontal landfill expansions – from Site B, to Site A, and now Site C. The high levels of coal-ash-related constituents in MW-6, downgradient from the Site C landfill indicate that the liner is leaking and not preventing contaminant escape to underlying groundwater. The liner was designed as a leachate "seepage treatment system" (LG&E, 2005) and assumes that toxic metals will be removed by attaching to soil particles. However, monitoring for metals is not required, so the KDWM does not know if the liner is preventing metals migration from the disposal unit.
- The absence of heavy metal testing in the current permit fails to recognize the occurrence of arsenic MCL exceedances in the past. As a result, that documented threat is not defined from any of the disposal units despite the clearly documented spread of contamination across the site.
- Wells downgradient of the CCW landfill areas continue to indicate a release of CCW contaminants to the groundwater, as indicated by elevated levels of chloride, sulfate, pH, calcium, sodium, and TDS and exceedances of SMCLs for sulfate, chloride, and TDS.
- The parameters selected by LG&E as being good indicators of a release of CCW (calcium, sulfate, and sodium) are in fact, good indicators of a release; yet, KDWM has not required an assessment of on-site contamination since 1996 or any off-site assessment to determine the nature and extent of those contamination by those parameters or any heavy metals associated with the CCW.
- Long-term contamination at MW-6 within 175 feet of the Ohio River suggests that contaminants are reaching the river.
- Without sampling for trace elements and metals typically found in CCW such as arsenic, antimony, cadmium, selenium, thallium, or mercury that are harmful to humans and/or fish and aquatic life at extremely low levels, the potential impact of this contamination to the Ohio River and its water quality and ecosystem is unknown.
- Plant production wells (PW-1 through PW-3) are no longer sampled even though they repeatedly provided an indication of CCW contaminant release to groundwater.
- Groundwater monitoring results of four wells (IW-7 through IW-10) that are located between the Ohio River and the Gypsum Processing Plant and the Site A landfill are apparently not reported to the KDWM.

Constituents Involved

Arsenic, chloride, sodium, sulfate, and total dissolved solids

At Risk Population

Private and public drinking well data was obtained for Mill Creek Plant from Kentucky's Well Log GIS layer. In addition, well data was obtained from Indiana's Department of Natural Resources Private and Public Well GIS layer to provide comprehensive well location results for both states. There are 15 private wells within a two mile radius and 4 public wells within a five mile radius of the Mill Creek Plant. Given the evidence that the production wells at Mill Creek Plant are capturing contaminants from the ash pond and CCW landfill, the two public supply wells about 2,000 to 3,000 feet east of these disposal areas may be close enough that they are also capturing contaminants, depending on how much water is being pumped from them. Two other public and four private drinking water wells are clearly downstream of the site. It is possible that data may be inconclusive or missing in both GIS layers presented.



Mounding of groundwater in the disposal area may cause localized flow in other directions.

Incident and Date Damage Occurred / Identified

Parameter concentrations greater than MCLs and SMCLs have occurred since 1994.

Regulatory Actions

KDWM required Mill Creek Plant to conduct groundwater assessment monitoring in October 1996 due to elevated indicator parameters (LG&E,. 2005). A groundwater assessment report was submitted on

September 10, 1997. By November 12, 1997, the Mill Creek Plant had returned to normal detection monitoring (LG&E, 2005). There was no indication in the file that the KDWM has ever required any off-site sampling, any off-site drinking water well investigations, or on-site corrective actions.

Fly ash and bottom ash are disposed in the landfill. FGD scrubber sludge was disposed of in the landfill from 1982 to 1999 (FMSM, Nov. 2003). Fly ash, bottom ash, boiler slag, coal pile runoff, FGD gypsum, and pyrites have been disposed of in the ash pond (EPA, 2009; O'Brien & Geri, 2009).

The Mill Creek Plant includes a 185-acre CCW landfill, a 79-acre ash pond, and four flue gas desulfurization (FGD) processing ponds. According to the KDWM, CCW in landfill Sites A, B, and C will eventually cover the entire property except where the plant structures and ash pond exist (Brandenburg, Apr. 2010). Site B was the original landfill that was constructed in 1980 and was operated until 1990 (Puckett, 2010). Disposal in Site A, situated along the Ohio River, began in 1990 and is still active.

The KDWM permitted Sites A and B as an "inert" landfill and did not require liners under them (Brandenburg, July 2010). File photographs indicate that no daily or interim cover is placed on ash in Site A. LG&E applied for a permit modification in March 2003 to vertically expand the Site A landfill (FMSM, Dec. 2003), and KDWM approved that application on January 14, 2004 (KDEP, 2009). LG&E later applied for a horizontal expansion (Site C) of the landfill, and KDWM approved that expansion on September 13, 2006 (KDEP, 2006). Site C will connect disposal Sites A and B. The Site C landfill was not constructed until 2009 (Puckett, 2010). Gypsum was placed over the Site C clay liner and drainage blanket during the construction to prevent erosion; however, as of July 2010, Site A remained the main disposal area.

The 79-acre ash pond was built in 1972. The KDWM does not regulate the ash pond, and the KDWM file review did not determine if the ash pond is lined. No groundwater monitoring system exists at the pond. The pond's west embankment (closest to the Ohio River) is approximately 77 feet higher than the normal pool of the river, and that embankment failed in 1978 during a spring flood; however, there was no release of CCW (O'Brien & Gere, 2009). The pond was rated a high hazard pond because of its proximity (less than 150 feet) to a residential development and a school, and failure of the pond embankment can potentially result in loss of human life, damage to wildlife and habitat, and threaten downstream drinking water supplies (O'Brien & Gere, 2009).

Four wastewater treatment and solids settling ponds have also existed on-site since the late 1970s and early 1980s, and they receive wastes associated with the FGD system, a gypsum processing unit, cooling tower blowdown, and storm water runoff (O'Brien & Gere, 2009). Solids are periodically removed from at least one of the ponds that takes gypsum waste water and disposed in the on-site landfills. The KDWM does not regulate these ponds and as a result, no monitoring data or information on whether they are lined was available from the file review.

Active

The average depth to the static water level in wells on-site is approximately 43 feet below the top of each well (FMSM, 2005). The groundwater generally flows from east to west towards the Ohio River.

Brandenburg. July 1010. Email correspondence from Mike Brandenburg, P.G., Division of Waste Management (July 15, 2010).

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EPA 2009. Response of Louisville Gas and Electric Company and Kentucky Utilities Company to EPA Request for Information under Section 104(e) of the CERCLA (Mar. 2009). *Available at:* http://www.epa.gov/osw/nonhaz/industrial/special/fossil/surveys/louisville-ge.pdf

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FMSM. Nov. 2003. Letter from Kathryn Aguilar, Project Engineer, FMSM, to John Lewis, Division of Waste Management, Re: Special Waste Landfill Permit Application, Mill Creek Special Waste Landfill (Nov. 4, 2003).

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LG&E. 2006. Letter from David Smith, Senior Environmental Scientist, LG&E, to Gary Straub, Division of Waste Management, Re: Semi-Annual Groundwater Monitoring Report, 2nd Event, 2005 (Jan. 19, 2006).

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LG&E. 1997. Letter from W. Paul Puckett, Environmental Scientist, LG&E, to the Division of Waste Management, Re: Semi-Annual Groundwater Monitoring Related to the Groundwater Assessment Project (Aug. 5, 1997).

LG&E. 1996. Robert Ehrler, LG&E, Water Monitoring Results Form, Quarterly Report, Tabulation of Results (submitted to Solid Water Branch) (July 26, 1996).

LG&E. 1994. John Voyles, Jr., LG&E, Water Monitoring Results Form, Quarterly Report, Tabulation of Results (submitted to Solid Water Branch) (Oct. 27, 1994).

O'Brien & Gere. 2009. Dam Safety Assessment of CCW Impoundments, LG&E Mill Creek Station Report, Lockheed Martin, Contractor for the U.S. EPA (Oct. 2009).

Puckett. 2010. Telephone conversation with Paul Puckett, E-On, Environmental Specialist (July 9, 2010).

Entity/Company - Location

Tennessee Valley Authority - Shawnee Fossil Plant
7900 Metropolis Lake Road
Paducah, KY 42086
McCracken County
Latitude: 37.156667 Longitude: -88.783611

Determination

Demonstrated damage to groundwater moving off-site (into Little Bayou Creek and Ohio River)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants to groundwater from unlined disposal units

Summary

Two unlined coal ash ponds and two unlined coal ash landfills at Shawnee Fossil Plant have been contaminating shallow groundwater feeding the Ohio River since at least the 1980s. Contaminants in the alluvial aquifer include selenium at concentrations almost twice the federal Maximum Contaminant Level (MCL), arsenic slightly exceeding the MCL, boron up to 2.5 times higher than the EPA Lifetime Health Advisory Level, total dissolved solids up to 4 times the Secondary MCL(SMCL), and sulfate up to 5.6 times the SMCL. Despite these exceedances, the Kentucky Division of Waste Management (KDWM) recently permitted Shawnee Fossil Plant to expand its CCW landfill without a liner. Contaminated groundwater wells are located within 500 feet of the Ohio River, and groundwater discharges to surface water via an on-site creek.

Test of Proof

Shawnee Fossil Plant monitored groundwater in only three wells from 2003 to September 2008. Since September 2008, groundwater monitoring was expanded to fourteen wells, and included more parameters (TVA, 2008b). Since September 2008, the sampling program has included boron, molybdenum, vanadium, sulfate, fluoride, copper, chloride, total dissolved solids (TDS), specific conductance, pH, chemical oxygen demand (COD), total organic carbon (TOC), and occasionally arsenic and selenium. According to the KDWM, higher than normal concentrations of TOC and chemical oxygen demand (COD) are commonly found in groundwater associated with CCW sites in Kentucky (Hendricks, 2010).

TVA is required to perform a statistical analysis of its groundwater data to determine if statistically significant increases (SSIs) of parameters occur compared to their concentrations in background wells. Groundwater monitoring of the original three wells from 2003 - 2008 found the following exceedances of SMCLs and SSIs:

Groundwater Monitoring at Shawnee Fossil Plant, 2003-2008	
Parameter / Standard (mg/L)	**Well Exceedances or SSIs (mg/L, except pH)**
TDS (500)	D-30 (1,810, 3.6 times std.); SSI
pH (6.5 to 8.5)	D-11 (<6); D-27 (<6); and D-30 (<6)
TOC	D-11; SSI
COD	D-11; SSI

Groundwater monitoring Wells D-11, and D-30 are located between the disposal areas and the Ohio River and within approximately 500 feet of the Ohio River.

According to TVA groundwater monitoring reports from 2008, the Shawnee Fossil Plant has three upgradient wells and eleven downgradient wells. Of the three designated upgradient wells, D-19 is located the farthest upgradient from the disposal area. According to potentiometric surface diagrams from June 2000 and December 2004 (Hendricks, 2010), wells D-27 and D-77 are at times, downgradient from coal ash waste disposal areas. A summary of the wells on-site is as follows:

Upgradient Wells	Downgradient Wells	
D-19	D-8A	D-74A
D-27*	D-11	D-74B
D-77*	D-11B	D-75A
	D-30A	D-75B
	D-30B	D-76A
	D-33A	

*As discussed in the text, D-27 and D-77 are incorrectly identified as upgradient.

TVA initiated background monitoring in August and September 2008 (TVA, October 2008a) for the new wells to determine "statistical background" concentrations for constituents of concern, even though there had been documented widespread contamination in the areas where the wells were installed since at least the 1980s. During that background monitoring, the following exceedances of MCLs, SMCLs, and health advisories were found (maximum concentrations in parentheses):

Groundwater Monitoring at Shawnee Fossil Plant, Aug. – Sept. 2008		
Parameter / Standard (mg/L)	**Well Exceedances (mg/L, except pH)**	
TDS (500)	D-11B D-30A D-30B D-74A D-74B	D-75A D-75B D-76A (2,000 maximum)
pH (6.5 to 8.5)	D-8A D-11 D-11B (5.4 minimum) D-19 D-27 D-30A	D-30B D-74A D-75B D-75B D-76A D-77
Boron (6 mg/L – EPA Lifetime Health Advisory Level; 3 mg/L – EPA Child Health Advisory Level)	D-11B D-30A D-33A D-74A (10 maximum)	D-74B D-75A D-75B D-76A (15 maximum)
Sulfate (250)	D-11B D-74A D-74B	D-75A (1,000 maximum) D-75B D-76A (1,400 maximum)
Arsenic (0.01)	D-77 (0.012)	
Selenium (0.05)	D-74A (0.087)	D-74B (0.083)

Wells with the highest concentrations were located the closest to CCW disposal areas. According to the KDWM, there is no well adjacent to CCW disposal areas that has not been affected by CCW because of a radial groundwater flow component from those areas (Hendricks, 2010). Unlike the wells closest to the CCW disposal areas, the background well D-19, located the farthest from the CCW disposal areas, did not exceed any standard other than pH.

Furthermore, a groundwater assessment performed in the 1980s determined that groundwater under the entire site was contaminated by CCW (Hendricks, 2010). Reddish leachate from CCW disposal areas has been seeping into Little Bayou Creek adjacent to the landfill and the ash ponds (Hendricks, 2010).

Constituents Involved

Arsenic, boron, pH, selenium, sulfate, and total dissolved solids

At Risk Populations

Data obtained from Kentucky's Well Log GIS layer show a total of 24 private wells within a two-mile radius of TVA's Shawnee Fossil Plant. Data from the State did not present any public drinking wells within a five-mile radius, however well records may be incomplete.

Mounding of groundwater in the disposal area causes localized flow in all directions.

Incident and Date Damage Occurred

1980s

Regulatory Action

A groundwater assessment was performed at the site in the 1980s (Hendricks, 2010). The exact date of that assessment was not determined because the assessment report was not provided during the file review for this report. KDWM recently permitted Shawnee Fossil Plant to expand its landfill without a liner

Wastes Present

Fly ash and bottom ash from the Shawnee Fossil Plant

Type(s) of Waste Management Unit

The Shawnee Fossil Plant has two contiguous CCW landfills designated as "special waste landfills" under the same permit (Hendricks, 2010) and two coal ash ponds. Neither CCW landfill is lined nor are the coal ash ponds (Hendricks, 2010). The CCW landfill closest to the coal ash ponds has a partial final cover. The southern and eastern boundaries of one CCW landfill are Little Bayou Creek and water lines to the Paducah Gaseous Diffusion Plant (Hendricks, 2010). The CCW landfills and coal ash ponds share a common groundwater monitoring system (Hendricks, 2010).

The two coal ash ponds have historically been very large, and filling has gradually created a smaller wet area on their surfaces. The ponds are located approximately 700 feet from the Ohio River. Like the CCW landfills, information in KDWM files did not differentiate the type(s) of coal ash disposed in the ponds (fly vs. bottom ash).

TVA's March 25, 2009 CERCLA 104(e) response to EPA's request for information (TVA, 2009), indicates that Shawnee Fossil Plant has one (1) coal ash pond commissioned in 1952 for the disposal of fly ash and bottom ash that was expanded in 1971 and 1979; and one (1) "dry stack" commissioned in 1984 for fly ash and bottom ash disposal (TVA, 2009).

Both CCW landfills are active although one is nearing closure, while the other was approved for operation by KDWM in 2007. As of March 2006, the coal ash pond(s) had 287,000 cubic yards capacity remaining (TVA, 2009).

The Shawnee Fossil Plant and its coal ash ponds and CCW landfills are located adjacent to the Ohio River. According the KDWM, the uppermost water-bearing zones are alluvial aquifers consisting of a perched water table and a lower aquifer that intersects the adjacent Little Bayou Creek (Hendricks, 2010). A radial groundwater flow from the waste disposal areas occurs and adjacent stream bank groundwater storage influences groundwater flow directions. The perched water table has a negative groundwater gradient (Hendricks, 2010), which means that the contaminated shallow groundwater migrates into the lower aquifer. Groundwater potentiometric surface diagrams from 2000 and 2004 such as the one below clearly illustrate mounded groundwater beneath the unlined special waste landfills and the radial groundwater flow components from that high point (Hendricks, 2010).

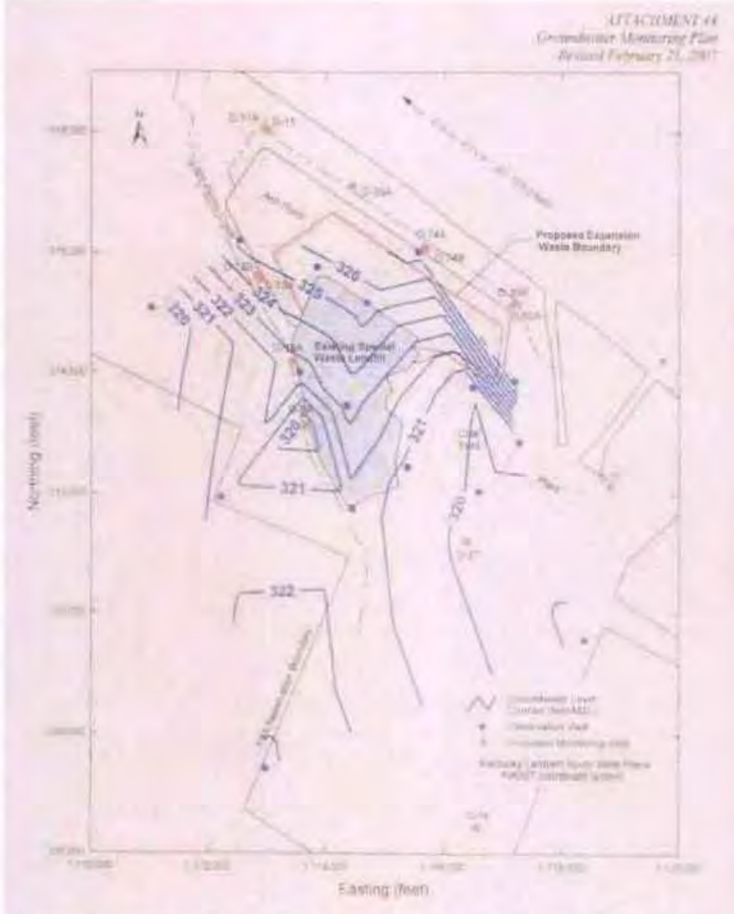

Figure 44-4. December 13, 2004 Groundwater Potentiometric Levels in Landfill Vicinity

Additional Narrative

Metropolis Lake is located adjacent to the power plant. The lake is contaminated with mercury (unknown cause) (Hendricks, 2010). The lake is part of a park owned by the Kentucky State Nature Preserves Commission. The well nearest the lake, well D-77, is at times hydraulically downgradient from the plant and CCW disposal areas. Exceedances of MCLs and SMCLs have been measured at this well.

Sources

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TVA. 2008a. Submittal of Baseline Groundwater Quality Characterization Parameters (Nov. 10, 2008).

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TVA. 2003. Groundwater Monitoring Data – June 2003 (July 23, 2003).

Entity/Company - Location

Eastern Kentucky Power Cooperative - Spurlock Station
Route 8
Maysville, KY 41056
Mason County
Latitude: 38.697222 Longitude: -83.810278

Determination

Demonstrated damage to off-site groundwater (750 feet beyond coal ash landfill boundary)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants into groundwater from the CCW landfill

Summary

Groundwater monitoring data indicate that the CCW landfill at the Spurlock Station has been contaminating underlying groundwater since at least 2005 with concentrations of arsenic up to 16 times the federal Maximum Contaminant Level (MCL), sulfate 3.5 times the Secondary MCL (SMCL), iron 11 times the SMCL, and total dissolved solids (TDS) 4 times the SMCL. Contaminated groundwater has been documented approximately 750 feet beyond the landfill permit boundary, near a receiving stream. Both the concentrations of contaminants and the number of contaminated wells have increased over time. The CCW disposal site is located adjacent to three receiving streams that flow to the Ohio River approximately one mile away.

Test of Proof

One phase of the Spurlock Station ash landfill (Area A) is located on a ridge and two phases (Areas B and C) are located in spring-fed hollows, each containing an intermittent stream. The groundwater monitoring system consists of downgradient wells positioned in topographically low elevations in three adjacent hollows to the northeast (well IW-7), to the east (wells A and IW-8), and to the southeast (well IW-6). According to Eastern Kentucky Power Cooperative (EKPC), once filling began in Area C for a permit expansion granted in 2005, two additional wells, MW-2A and MW-3A, were to be installed in the eastern hollow, and wells A, IW-6, and IW-7 would be removed (EKPC, 2003). Once those wells were closed, groundwater from only one hollow would be monitored. Results for wells MW-2A and MW-3A have not been reported to the Kentucky Division of Waste Management (KDWM) as of 2009 (EKPC, July 2009), indicating that filling in Area C had not yet commenced.

The oldest groundwater data available in State files for the Spurlock Station are from May 2005 (EKPC, 2005). The monitoring system in 2005 was the same as in the first quarter of 2009. According to EKPC, there are no upgradient wells, three downgradient wells, and one side-gradient well (EKPC, 2005; EKPC, 2009).

IW-6 (MW-2) – downgradient, southeast hollow	IW-8 (MW-1) – downgradient, east hollow
IW-7 (MW-3) – downgradient, northeast hollow	Well A – sidegradient, east hollow

Groundwater monitoring in March 2005 indicated multiple exceedances of a federal MCL and SMCLs (EKPC, 2006):

Parameter (EPA Standard in mg/L)	Well (Exceedances of EPA Standards in mg/L)
Arsenic (0.01)	IW-7 (0.022, 2.2 times the standard)
Iron (0.3)	IW-7 (3.29, 11 times the standard)
Sulfate (250)	IW-7 (854, 3.4 times the standard) IW-6 (608)
Total Dissolved Solids (500)	IW-7 (1,850, 3.7 times the standard) IW-8 (632)

Arsenic concentrations in IW-7 have been greater than the MCL for every sampling event since the March 2005 sample, with concentrations ranging from 0.0193 mg/L in November 2008 to 0.16 mg/L in June 2009, 16 times the MCL (EKPC, July 2009).

The only statistical analysis found in State files for the Spurlock Station was for the April 2006 sampling event (EKPC, July 2006). However, EKPC did not make any conclusions of the results, choosing instead to simply present the results. EKPC considered well IW-8 the "base well" to which all other wells are compared, even though IW-8, like the other wells, is downgradient from the CCW disposal areas. Nevertheless, EKPC used the mean concentrations from IW-8 as the baseline for comparison. The results indicated that contaminated groundwater has migrated to hollows to the northeast (IW-7), east (Well A and IW-8), and southeast (IW-6).

IW-8 (mean concentration, mg/L)	Other Well Concentrations (mg/L)
Arsenic (0.001)	IW-6 (0.001) IW-7 (0.121, 12 times the MCL) Well A (0.0014)
Chlorides (14.4)	IW-6 (27.5)IW-7 (18) Well A (20.2)
Conductivity (625)	IW-6 (993) IW-7 (1,662)Well A (776)
Sulfate (130.8)	IW-6 (185); IW-7 (620, 2.5 times the SMCL) Well A (104)
Total Dissolved Solids (490)	IW-6 (705, 1.4 times the SMCL) IW-7 (1,370, 2.7 times the SMCL) Well A (480)

Comparing the results of the June 2009 sampling event with those of the March 2005 sampling event, higher concentrations of TDS and arsenic in 2009 suggest a worsening release of CCW constituents to underlying groundwater. Further, the concentrations continue to exceed MCLs and SMCLs:

Parameter (EPA Standard in mg/L)	Well (Exceedances of EPA Standards in mg/L)
Arsenic (0.01)	IW-7 (0.16, 16 times the standard)
Sulfate (250)	IW-6 (276) IW-7 (870, 3.5 times the standard)
TDS (500)	IW-6 (820) IW-7 (2,190, 4.3 times the standard) IW-8 (505) Well A (533)

The data and information reviewed from state files for the Spurlock Station indicate that:

- Arsenic, TDS, and sulfate concentrations in wells downgradient of the landfill continue to indicate a release of CCW contaminants to groundwater;
- The most contaminated well, IW-7, is located approximately 750 feet northeast of and beyond the landfill permit boundary in a spring-fed hollow (EKPC, 2003), indicating that contaminated groundwater has flowed off the landfill property and likely into the receiving stream;
- The rate and direction of groundwater flow cannot be verified because the KDWM does not require that potentiometric surface diagrams be developed; however, EKPC has concluded that shallow groundwater generally flows towards the receiving streams in the adjacent hollows;
- Although required to do so by their permit, EKPC rarely performs statistical analysis of groundwater data that reflects increasing concentrations of contaminants. When the analysis was performed in 2006, the data indicated that statistically significant increases (SSIs) occurred at the wells – further indicating a release of CCW to the underlying groundwater, yet no assessment monitoring was required at the landfill;
- There is no unaffected upgradient well at the landfill. All wells are downgradient and contain at least one CCW constituent concentration above an EPA standard. Thus the 2006 statistical analysis

compared contaminated water to other contaminated downgradient water to confirm downgradient contamination.

Constituents Involved

Arsenic, sulfate, iron, and total dissolved solids

At Risk Populations

Private and public drinking well data was obtained for Spurlock Station via Kentucky's Well Log GIS layer. The results were 25 private wells within a two-mile radius and 3 public wells within a five-mile radius of the Spurlock Station. It is possible that data may be inconclusive or missing in both GIS layers presented.

The Spurlock Station and CCW landfill are located in a karst limestone area – where cave systems allow very rapid flow of contaminated groundwater practically any direction.

Incident and Date Damage Occurred/Identified

Exceedances of MCLs and SMCLs were first monitored in groundwater in March 2005.

Regulatory Actions

There was no indication in State files that the KDWM considers the arsenic, sulfate, and TDS exceedances, , EKPC's failure to perform routine statistical analyses, or the results of the statistical analyses to be permit violations. Further, there is no indication that KDWM has required EKPC to conduct assessment monitoring (development of a more comprehensive groundwater monitoring program when contamination has been detected), or off-site surface water monitoring to define the horizontal extent of contamination. In addition, the KDWM has not undertaken its own monitoring of off-site domestic wells or surface waters.

Fly ash, bottom ash, and flue gas desulfurization (FGD) wastes, including FGD gypsum, are disposed of in the landfill (KDWM, 2004).

According to EKPC's March 24, 2009 CERCLA 104(e) response to EPA's request for information (EKPC, March 2009), EKPC operates a 57-acre bottom ash pond, with a capacity of 1,750,000 cubic yard. EKPC estimated that its current storage was 1,500,000 cubic yards as of August 25, 2008. EKPC sluices only bottom ash to this pond, and fly ash and gypsum are landfilled in a dry "special waste" landfill (EKPC, March 2009).

One special waste landfill that contains CCW is permitted at the Spurlock Station. The landfill was originally permitted as an "inert landfill" in 1979 (KDWM, 2005). According to the KDWM, a construction/operation permit was issued on September 20, 1982. The permit was renewed in 1996, and the KDWM approved a horizontal expansion of 389 acres for Areas A, B, and C on February 22, 2005. The horizontal landfill expansion areas have a 2-foot thick compacted clay liner with a permeability of 1×10^{-7} cm/sec (EKPC, 2003). The file review was unable to determine if a liner is present in the originally permitted disposal areas.

EKPC performed a "liner risk analysis" as part of their application for a horizontal expansion further into adjacent hollows. The risk analysis included a Synthetic Precipitation Leaching Procedure (SPLP) for fly ash and bottom ash. The result of that test showed arsenic leaching from the ash at 0.066 mg/L, or 6.6 times higher than the current EPA MCL. That result is consistent with arsenic being found above the EPA standard in one on-site well (IW-7) since at least 2005. EKPC was not concerned about the SPLP result, concluding that the proposed liner meets permit standards (EKPC, 2003).

The Spurlock Station also has a bottom ash pond that is approximately 3,800 feet (0.7-mile) long and approximately 200 feet from the Ohio River and was commissioned in 1976. No monitoring data or other information for the ash pond was available for this report.

Active

Shallow groundwater conditions exist in weathered, fractured bedrock, and the flow direction is a reflection of the surface topography (EKPC, 2003). Groundwater flows in secondary fractures and joints in a karst limestone and shale aquifer. The soil above the bedrock is less than one foot deep along the sideslopes of the hollows (EKPC, 2003); therefore, there is little naturally-occurring pollutant attenuation beneath the liner. The groundwater flow velocity at Spurlock Station is very high – up to 400 feet per year (EKPC, 2003). A dye trace investigation performed at the landfill showed that groundwater from the landfill area emerges at springs in the hollows (EKPC, 2003). Groundwater flow directions in karst limestone areas can be highly unpredictable, sometimes changing direction in response to heavy rainfall events. The dominant direction of groundwater flow is probably to the northeast toward the Ohio River.

All wells on-site are shallow and screened in fractured bedrock. Well IW-6 is 33.8 feet deep, and the depth to water is 21.8 feet; IW-7 is 32.5 feet deep, and the depth to water is 19.4 feet; and IW-8 is 28.5 feet deep, and the depth to water is 22.5 (EKPC, 2003). No well depth was provided in the file for Well A but it, too, is expected to be shallow. No potentiometric surface diagrams, which can be used to determine the direction of groundwater flow, were found in the file. KDWM does not require that they be prepared.

EKPC. 2003. Letter from Robert Hughes, Manager, Environmental Affairs, EKPC, to Merle Wasson, P.E., Solid Waste Branch, KDWM, Re: Horizontal Expansion - Notice of Deficiency Response Letter (Mar. 18, 2003).

EKPC. 2005. Robert Hughes, EKPC, Groundwater and Surface Water Monitoring Sample Data Reporting Form, March 15, 2005 event (May 26, 2005).

EKPC. 2006. Robert Hughes, EKPC, Groundwater and Surface Water Monitoring Sample Data Reporting Form, March 15, 2005 event (Jan. 20, 2006).

EKPC. July 2006. Robert Hughes, EKPC, Groundwater and Surface Water Monitoring Sample Data Reporting Form, April 28, 2006 event (July 13, 2006).

EKPC. 2009. James Binkley, EKPC, Groundwater and Surface Water Monitoring Sample Data Reporting Form, November 24, 2008 event (Jan. 27, 2009).

EKPC. March 2009. Letter from Jerry Purvis, EKPC, to EPA, Re: CERCLA 104(e) Request for Information (Mar. 24, 2009).

EKPC. July 2009. James Binkley, EKPC, Groundwater and Surface Water Monitoring Sample Data Reporting Form, June 24, 2009 event (July 27, 2009).

KDWM. 2004. KDWM, Fact Sheet, Permit No. 081-00005, AI #3004, Application No. APE20020001 (Dec. 8, 2004).

KDWM. 2005. KDWM, Solid Waste Permit History Summary, Spurlock Station Landfill for permit issued February 22, 2005 (Feb. 22, 2005).

Entity/Company – Location

NRG Energy d/b/a Louisiana Generating, LLC - Big Cajun 2 Power Plant
10431 Cajun Road
New Roads, LA 70760
Pointe Coupee Parish
Latitude: 30.727778 Longitude: -91.376667

Determination

Demonstrated damage to groundwater moving off-site (at property boundary)

Probable Cause(s)

Leaching of coal combustion waste (CCW) constituents from one or more ponds to groundwater

Summary

The Big Cajun 2 Power Plant has five CCW ponds that are contaminating underlying groundwater. Selenium concentrations in the groundwater from 1994 to 1999 exceeded the federal Maximum Contaminant Level (MCL) in all five monitoring wells at concentrations up to 1.32 mg/L (26.4 times the MCL). Concentrations of other toxic metals have not been measured in the monitoring wells. Since at least 1989, total dissolved solids (TDS) in the groundwater have been greater than the Secondary MCL (SMCL), with a maximum concentration of 1,800 mg/L (3.6 times the SMCL). Louisiana Department of Environmental Quality (LDEQ) determined that the groundwater monitoring system was grossly inadequate and required NRG to install 10 additional downgradient wells. However, none of the new wells are off-site, even though one existing well adjacent to the property line shows that contamination is moving off-site.

Test of Proof

Since November 1989, five groundwater monitoring wells have been sampled for pH, selenium, calcium, and total dissolved solids (TDS). Sampling results since 1989 (the oldest noted in the file review) showed TDS concentrations that exceeded the SMCL (500 mg/L) in the two most hydraulically downgradient wells: MW-85C (944 mg/L) and MW-85D (1,024 mg/L) (Environmental Management, 1992). Those concentrations were over two times higher than TDS concentrations in the most upgradient well. MW-85C and MW-85D are downgradient of the coal ash ponds near the Primary Treatment Pond and the Surge Pond.

Groundwater sampling revealed that selenium concentrations were repeatedly greater than the MCL (0.05 mg/L) from November 1994 to November 1999 for all wells on-site: the designated "upgradient" well MW-85A (10 events, maximum 0.3 mg/L); MW-85B (9 events, maximum 0.39 mg/L); MW-85C (9 events, maximum 1.32 mg/L); MW-85D (9 events, maximum 0.333 mg/L); and MW-85E (9 events, maximum 1.23 mg/L) (NRG, 2009a).

By 2001, TDS concentrations in downgradient wells, and the number of wells with TDS concentrations greater than the SMCL, had increased (Shaw, 2007a). For the period from March 2000 to March 2007, MW-85C had TDS concentrations greater than the SMCL in 12 of 15 monitoring events; MW-85D had concentrations greater than the SMCL in 10 of 15 events; and MW-85E had concentrations greater than the SMCL in all 15 events, with the highest concentrations reported at up to 1,800 mg/L. MW-85E is located adjacent to the Bottom Ash Pond.

The trend of ever increasing TDS concentrations continues into current monitoring periods. For the five groundwater sampling events from September 2007 to September 2009, TDS concentrations in MW-85C were greater than the SMCL for every event, and the average concentration was 842 mg/L (17% increase since 2007); MW-85D TDS concentrations were greater in every event, and the average concentration was 899 mg/L (30% increase); and MW-85E TDS concentrations were also greater than the SMCL in every event with the average concentration being 1,662 mg/L (11% increase).

Increased calcium concentrations correspond to increased TDS concentrations, and calcium, often a highly soluble constituent in CCW, is indicative of CCW leachate from The Big Cajun 2 Power Plant's CCW disposal ponds. When the results for calcium concentrations averaged from the first two sampling events in August 1989 and March 1990 are compared to average concentrations for two recent events in March and September 2009, the data indicate little change in the designated upgradient well MW-85A (79 mg/L in 2009 compared to 76 mg/L in 1989/1990, a 4% increase), but significant changes in downgradient wells. For example, data show a substantive increase in MW-85B, located adjacent to the fly ash pond (87 mg/L in 2009 compared to 62 mg/L in 1989/1990, a 40% increase); a substantive increase in downgradient well MW-85C (139 mg/L compared to 109 mg/L, a 28% increase); a slight increase in downgradient well MW-85D (133 mg/L compared to 121 mg/L, a 10% increase); and the most substantive increase in MW-85E (256 mg/L compared to 96 mg/L, a 167% increase) (Environmental Management, 1992; NRG, 2009a).

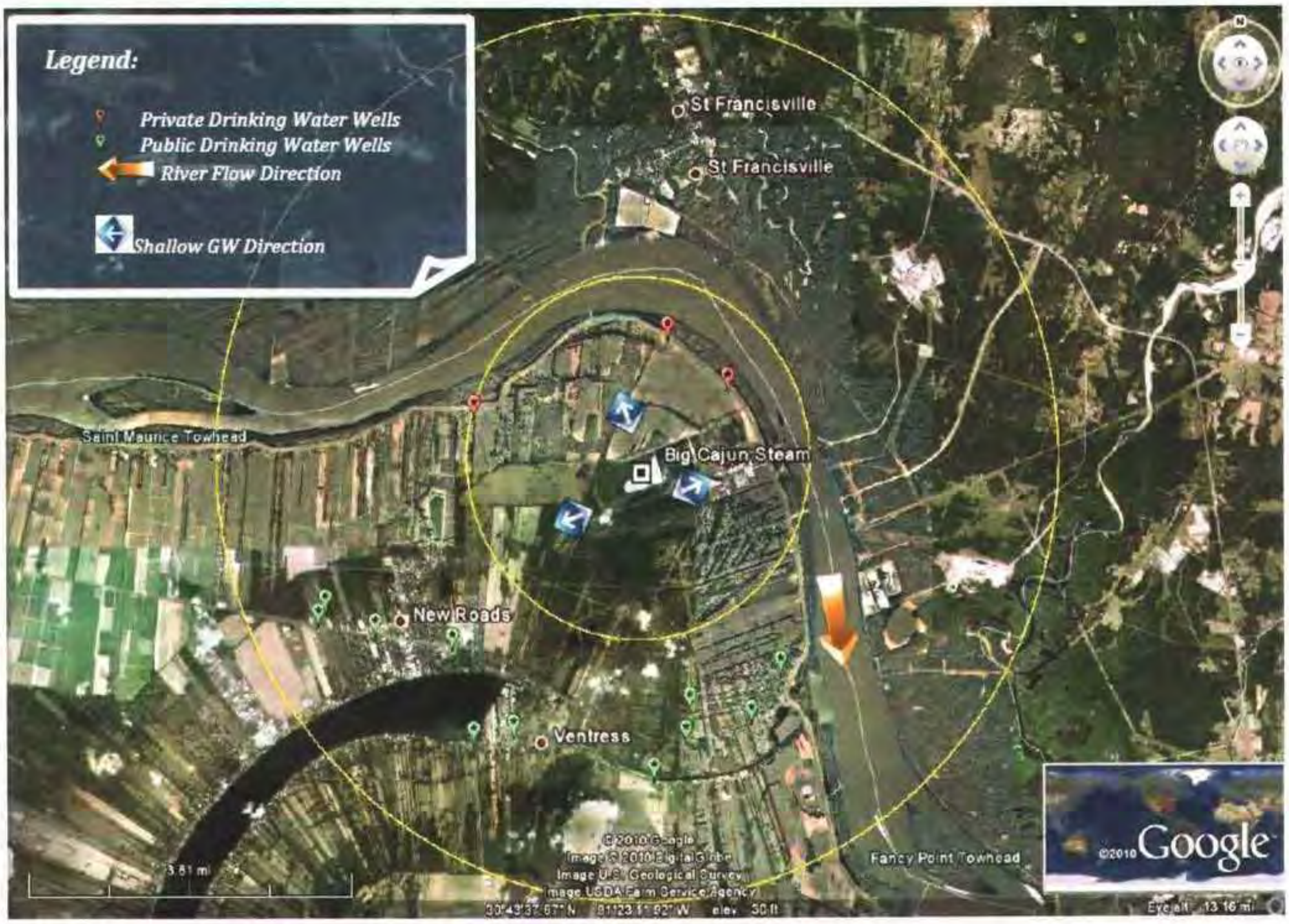
NRG consultants conducted extensive statistical analyses of groundwater monitoring data collected between October 1993 and March 2009. The consultants found statistically significant increases (SSIs) of calcium and TDS in wells MW-85C, MW-85D, and MW-85E using three different statistical methods (NRG, 2009b).

Constituents Involved

Selenium, total dissolved solids (TDS), and calcium (as an indicator parameter)

At Risk Population

There are eleven public drinking water sources within five miles of the Big Cajun 2 Power Plant, which lies on the border of the Point Coupee and West Feliciana parish. Each of these public drinking water wells serves local developments of at least 60 citizens. Four of the public drinking water wells are downgradient of the Big Cajun 2 Power Plant. Three private drinking water wells are within two miles of Big Cajun and serve private residences. Well data was obtained from the Louisiana Department of Natural Resources (DNR) GIS Well Log Data Layer, and some well records may be missing or incomplete.



Incident and Date Damage Occurred – Identified

Exceedances of the MCL for selenium in groundwater date to November 1994. The SMCL for TDS has been exceeded by increasing degrees since 1989.

Regulatory Actions

LDEQ issued a Notice of Deficiency to NRG with regard to its CCW ponds and permit renewal at Big Cajun 2 Power Plant, and determined that the groundwater monitoring system for the CCW ponds was grossly inadequate. LDEQ required NRG to install 10 additional wells in downgradient directions from the CCW ponds (Shaw, 2010). Further, LDEQ is requiring that a true background well be installed, although NRG Big Cajun concluded that "it is not possible at this time to conclusively specify an upgradient . . . well" (Shaw, 2010). Of the ten new wells, seven wells are required for the extreme western edge of the fly ash pond in an area that was once believed to be "upgradient" and three are required along the eastern boundary of the primary treatment and surge ponds. The additional downgradient wells along the western boundary confirm that well MW-85A, which is located at the western property line and at times has exceeded groundwater standards (most notably for selenium), is not an "upgradient" but rather downgradient, and has been affected by CCW. The location of well MW-85A at the western property line suggests that contaminated groundwater above regulatory standards has migrated off-site. Despite this evidence, LDEQ has never required any off-site groundwater sampling (Guilliams, 2010).

Fly ash, bottom ash, and unspecified wastewater treatment pond solids

The Big Cajun 2 Power Plant includes these land disposal units: a fly ash pond, bottom ash pond, a surge pond, and 2 "treatment" ponds (NRG, 2009d). CCW was reportedly first placed in the 175-acre fly ash pond and the 66-acre bottom ash pond in 1980. The combined CCW pond complex is over one-mile long. The 25.4-acre "primary treatment" pond and the 7.1-acre "secondary treatment" pond were commissioned in 1979 (NRG, 2009d). The permit application for the bottom ash and fly ash ponds was submitted to LDEQ in 1982, and the permit was issued on June 20, 1986.

As of June 2009, the fly ash pond was 65 percent full, and the bottom ash pond was 54 percent full (NRG, 2009c).

Cajun Electric applied for a Type I landfill permit in March 2007 for a new solid waste landfill to dispose of gypsum, a by-product of the plant's flue gas desulfurization (FGD) air pollution control waste (Shaw, 2007b). LDEQ identified numerous deficiencies in that application in a letter dated March 2, 2009, and NRG responded to those deficiencies in June 2009 (Shaw, 2009). NRG later rescinded that application in August 2009 (Guilliams, 2010).

Active

Big Cajun 2 Power Plant CCW disposal areas are located adjacent to the Mississippi River, and groundwater levels range from 8 to 14 feet below the top of the well casing (NRG, 2009). Five groundwater monitoring wells were installed in 1985 (LDEQ, 1986).

Potentiometric surface diagrams from November 1992 (Environmental Management, 1992) illustrated a flow direction towards the Mississippi River for all wells, with MW-85C and MW-85D being the most hydraulically downgradient wells. These eastern-most wells, located on the eastern-most edge of all ponds, are located almost one mile west of the Mississippi River.

Beginning in approximately 1998 (Benchmark, 1998), Cajun Electric began reporting that at times the groundwater flowed west and away *from the river*. This westerly trend, for wells that are located almost a mile or more away from the river, continues. Shaw Environmental concluded in 2007 on behalf of Cajun Electric that the flow away from the river was due to higher river stages (Shaw, 2007a). This conclusion was not supported by their own data which indicates the surface water elevations measured at the river were 13 feet (Mar. 2007) to 15 feet (Sept. 2007) *lower* in elevation than the potentiometric surface elevations reported one mile west at the treatment pond area wells. Historically, the highest groundwater elevations have been found at MW-85C and MW-85D, which are downgradient of all ponds and are located nearest the Primary Treatment Pond, the Surge Pond, and the Bottom Ash pond. Big Cajun most recently recognized that "divergent flow exists to the east and west originating from the center of the ash impoundment area" (Shaw, 2010). The higher groundwater elevations in pond area wells suggest groundwater mounding beneath the ponds due to leakage from one or more of those ponds, causing localized reversal of groundwater flow to the west away from the river, and invalidating MW85A as an "upgradient" monitoring well.

Beginning in 2006, LDEQ approved requests to fill hollow barge mooring cells in the Mississippi River with bottom ash and fly ash (NRG, 2008). Over 11,500 cubic yards of fly ash and bottom ash from Big Cajun 2 Power Plant were placed in barge mooring cells in the Mississippi River as a "beneficial use" project. The barge mooring cells are positioned approximately 100 to 400 feet from shore in the river and were initially filled with sand and limestone but over time, large gaping holes (several feet wide) were created from barge impacts – resulting in the loss of sand and limestone into the river. LDEQ approved placing 4,050 cubic yards of fly ash and bottom ash in the cells in 2006 as a "beneficial use" of that material. LDEQ later approved another request for the same use for 7,500 cubic yards of fly ash and bottom ash in October 2008 (LDEQ, 2008).

Big Cajun 2 Power Plant presented analytical data to LDEQ in its 2006 (NRG, 2008) "beneficial use" application showed that the fly ash used in the mooring cells contained the following metals concentrations: arsenic (16 mg/kg); barium (666 mg/kg); cadmium (0.39 mg/kg); chromium (21.7 mg/kg); manganese (161 mg/kg); nickel (22.5 mg/kg); selenium (5.16 mg/kg); vanadium (92.7 mg/kg); and zinc (59.8 mg/kg).

LDEQ could not confirm if any water or sediment is monitored in the Mississippi River near the mooring cells to ensure that toxic metals or other harmful constituents are not leaching from the coal ash (Guilliams, 2010).

Benchmark Laboratories. 1998. Monitoring Groundwater Report for Cajun Electric Power Cooperative, Big Cajun #2, First Half 1998 (June 25, 1998).

Environmental Management. 1992. Environmental Management, Inc., Monitoring Well Report, Cajun Electric Power Cooperative Big Cajun No. 2(prepared for Cajun Electric, Gary Ellender) (Dec. 1992).

Guilliams. 2010. Phone conversation with Scott Guilliams, Senior Technical Advisor, Waste Permits Division, LDEQ (May 24, 2010).

LDEQ. 2008. Letter from Bijan Sharafkhani, LDEQ, to Gary Ellender, Louisiana Generating, LLC, Re: Request for Beneficial Use of Bottom and / or Fly Ash (Oct. 28, 2008).

LDEQ. 1986. Letter from James Brent, Solid Waste Division, LDEQ, to Marcus Hart, Cajun Electric, Re: Big Cajun #2 Power Plant Inspection Report (Sept. 8, 1986).

NRG. 2009a. Letter from M.S. Environmental Consultants, Inc., to Office of Environmental Services, DEQ, Re: Semi-Annual Groundwater Monitoring Report, Big Cajun Power Plant, Second Half 2009 (Oct. 20, 2009).

NRG. 2009b. Letter from Gary Ellender, NRG, to Thomas Harris, Administrator, LDEQ . Re: Statistical Evaluation of Groundwater Analytical Data, Big Cajun Power Plant (performed by M.S. Environmental Consultants, Inc.) (Sept. 22, 2009).

NRG. 2009c. Letter from Gary Ellender, NRG, to Financial Services Division, Re: Disposer Annual Report (July 24, 2009).

NRG. 2009d. Letter from Jeff Baudier, NRG, to Richard Kinch, US EPA, Re: Request for Information Under Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act, Big Cajun Power Station (Mar. 30, 2009).

NRG. 2008. Letter from Gary Ellender, NRG, to Bijan Sharafkhani, Administrator, Waste Permits, LDEQ, Re: Request for Beneficial Use of Bottom and / or Fly Ash, (Aug. 21, 2008).

Shaw. 2010. Response to Notice of Deficiencies – Technical Review #2, Letter from Deborah Saxton, Client Program Manager, Shaw Environmental, to Sam Phillips, Administrator, LDEQ (May 12, 2010).

Shaw. 2009. Letter from Valeria Mayhall, Shaw Environmental, to Thomas Harris, Administrator, LDEQ, Re: Response to Notice of Deficiency, Big Cajun II, Unit 4, Type I Solid Waste Landfill (June 15, 2009).

Shaw. 2007a. Letter from Shaw Environmental, Inc., to Office of Environmental Compliance, Re: Semi-Annual Groundwater Monitoring Report, Big Cajun Power Plant, First Half 2007 (May 8, 2007).

Shaw. 2007b. Letter from Boyd Boswell, Shaw Environmental, Inc., to Bijan Sharafkhani, Administrator, Waste Permits, LDEQ, Re: Type I Solid Waste Facility Permit Application, Gypsum Landfill Application (Mar. 19, 2007).

Entity/Company – Location

CLECO Power LLC - Dolet Hills Power Station
963 Power Plant Road
Mansfield, LA 71052
De Soto Parish
Latitude: 39.0325 Longitude -93.5675

Determination

Demonstrated damage to groundwater moving off-site (half mile from coal ash disposal sites)

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants from CCW ponds, and from a CCW landfill

Summary

Nine CCW ponds and one CCW landfill have contaminated four distinct groundwater zones above Maximum Contaminant Levels (MCLs) for more than one parameter at the Dolet Hills Power Plant. Groundwater monitoring has documented MCL exceedances for arsenic in one surge pond compliance well and lead in one well at a metal cleaning waste pond that also receives fly ash. Selenium has been reported at the CCW landfill monitoring wells at 3.5 times the MCL in a groundwater zone that discharges to the surface water. Total Dissolved Solids (TDS) have exceeded the Secondary MCL (SMCL) in 28 of 30 coal ash pond-area wells at up to a half-mile from the nearest disposal unit and at concentrations up to 28 times the SMCL. Sulfate has also exceeded the SMCL in 20 of 30 pond area compliance wells at concentrations 16 times the SMCL a half-mile from the nearest CCW disposal unit. Contaminated wells exist at each compliance boundary with no additional downgradient monitoring wells. No off-site groundwater monitoring or surface water sampling has occurred

Test of Proof

There are at least 36 groundwater monitoring points (wells and piezometers) associated with six groups of solid waste disposal units (CLECO, May 2008). The current groundwater monitoring program includes these parameters: pH, specific conductance, total dissolved solids (TDS), alkalinity, sulfates, chlorides, iron, copper, calcium, phosphorus, and zinc, but does not routinely monitor for other metals present in coal ash.

Semi-annual groundwater sampling in April 2008 found substantial SMCL exceedances in the most downgradient wells at every CCW disposal unit and one major exceedance of the MCL for the trace element selenium (CLECO, May 2008). CLECO Power, LLC concluded that the results were consistent with the results of previous sampling events, indicating that exceedances are routine. Exceedances were as follows (TDS SMCL = 500 mg/L, sulfate SMCL = 250 mg/L and EPA Health Advisory Level = 500 mg/L):

- 3 Bottom Ash Ponds – TDS was greater than the SMCL in seven of nine compliance wells (3,839 mg/L average, 13,900 mg/L max). Sulfate exceeded the SMCL in four compliance wells (1,274 average, 1,640 mg/L max) and was highest in wells with the highest TDS. The most hydraulically downgradient compliance well (MW-28) is located approximately 0.5-mile from the nearest bottom ash pond, and concentrations of TDS (2,390 mg/L) and sulfates (1,080 mg/L) were more than four times higher than the SMCLs. MW-28 is approximately 125 feet from the property line (LDEQ, 1992).
- 3 Surge and Auxiliary Surge Ponds – The average TDS concentration was six times higher than the SMCL in ten of ten compliance wells (3,001 mg/L average, 6,690 mg/L max). Sulfate was the highest in wells with the highest TDS. Sulfate exceeded the SMCL in eight compliance wells (1,698 mg/L average, 3,860 mg/L max). The pH in one well (OW-4, 5.9 units) was less than the SMCL.
- Metal Cleaning Waste Pond – Average TDS of two compliance wells was more than ten times higher than the SMCL (5,200 mg/L average, 5,250 mg/L max). Sulfate also exceeded the SMCL by a similar magnitude in both compliance wells (2,465 mg/L average, 3,580 mg/L max). The SMCL for chloride was also exceeded in one well by nearly six times (1,480 mg/L max). The SMCL for iron was also exceeded in both wells (43.3 mg/L average, 86 mg/L max, 287 times higher than the SMCL). The pH in one well (OW-7, 5.05 units) was less than the SMCL.
- Plant Discharge Collection Pond– TDS was greater than the SMCL in all five compliance wells (2,071 mg/L average, 4,670 mg/L max). Sulfate also exceeded the SMCL in three compliance wells (1,209 mg/L average, 2,150 mg/L maximum). The SMCL for chloride was also exceeded in three wells (335 mg/L average, 385 mg/L maximum).

At the disposal sites above, wells with the highest TDS and sulfate concentrations also had high specific conductance, calcium, and alkalinity concentrations.

- Lignite Runoff Pond – TDS was greater than the SMCL in all four compliance wells (1,735 mg/L average, 2,390 mg/L max). Sulfate also exceeded the SMCL in three compliance wells (1,877 mg/L average, 3,900 mg/L max). High specific conductance and calcium concentrations corresponded to the highest TDS and sulfate concentrations. The most hydraulically downgradient compliance well (OW-28) for this area is located approximately 0.4-mile away. Groundwater in this well exceeds SMCLs for TDS (2,390 mg/L) and sulfates (1,080 mg/L).
- Fly Ash / Scrubber Sludge Landfill:
    - Groundwater Zone 1 that discharges to surface water – TDS was up to 5.3 times higher than the SMCL in one of three compliance wells (MW-2A, 2,660 mg/L maximum). Selenium was reported in that well at 0.173 mg/L, 3.5 times higher than the MCL. The pH in all wells (4.82 average, 4.06 lowest) was less than the SMCL.
    - Groundwater Zone 3 (deeper) – the only compliance well in that zone (MW-4), had a TDS concentration of 16,000 mg/L maximum, 32 times higher than the SMCL. Sulfate, at 9,830

mg/L maximum was also more than 39 times the SMCL. The pH for that well (3.74 units) was much less than the SMCL. Selenium was not reported at a meaningful concentration because the report limit of the analysis (<1.25 mg/L) was 25 times higher than the MCL (0.05 mg/L).

- Groundwater Zone 4 (deepest) – in the only compliance well in that zone (MW-8A), TDS was greater than the SMCL (1,450 mg/L max). Sulfate was also greater than the SMCL (768 mg/L max). The pH was less than the SMCL (6.05 units).
- Unspecified Groundwater Zones – three wells (MW-5, MW-6A, and MW-7) were sampled; however, CLECO concluded that the wells monitor "in between" zones of groundwater. Potentiometric surface data from those wells were not used to develop area groundwater flow diagrams. One well (MW-5) that is situated in the most hydraulically downgradient position along a stream valley centerline substantially exceeded the SMCL for TDS (4,970 mg/L max), sulfates (3,200 mg/L max), and pH (5.67). CLECO concluded that MW-5 is upgradient of the landfill; however, potentiometric surface diagrams clearly show that it is not upgradient.

When the April 2008 compliance well groundwater results are compared to the sole "reference well" or background well (OW-27, Zone 4) at the site, the reported groundwater values far exceeded the reference values, which are as follows: TDS, 513 mg/L; sulfates, 224 mg/L; chlorides, 17 mg/L; iron, 0.522 mg/L; and pH, 6.82 units. CLECO concluded that the high concentrations in the downgradient wells may be due to lignitic clays and lignite beds that are present in the subsurface, and promised to evaluate the trend further in future sampling events.

The extremely low pH in the CCW landfill wells has been problematic since at least 1992 (LDEQ, 1992). A reduction of pH from 6 units to 4 units from 1986 to 1992 in eight of nine wells indicated a decisive shift to more acidic conditions that do not meet the SMCL of 6.5 to 9.5.

CLECO does not normally sample heavy metals in CCW pond/impoundment groundwater monitoring; however, some metals were tested as part of Initial Sampling Events (ISEs) of 34 wells in August and December 2009 after issuance of a new permit and the installation of new wells (OW-31 – OW-37) (CLECO, 2010a). The Louisiana Department of Environmental Quality (LDEQ) also required that a statistical analysis be performed for CCW pond-area wells (but not the landfill) for pH, specific conductance, alkalinity, copper, and zinc. The analysis found statistically significant increases (SSIs) for specific conductance and alkalinity. CLECO argued that the SSIs were not relevant because nether parameter was included in the LDEQ Risk Evaluation/Corrective Action Program (RECAP), the SMCLs are not enforceable, and the SMCLs are only "guidelines" (Eagle, 2010). CLECO concluded that CCW ponds have not adversely affected the groundwater at the site. However, when the results of the ISE are closely evaluated, the sampling event found that:

- The MCL of 0.01 mg/L for arsenic was exceeded in one new surge pond well (OW-33) at 0.0156 mg/L in the December sampling event.
- The MCL of 0.015 mg/L for lead was exceeded in the one new metal cleaning waste pond well (OW-36), monitoring Groundwater Zone 4 (deepest) at 0.023 mg/L and 0.019 mg/L respectively in the August and December sampling events.
- No wells are downgradient of wells with SSIs. There are no wells further downgradient from metal cleaning waste pond wells OW-35 and OW-36 that had SSIs for alkalinity or surge pond Well OW-1 that had a SSI for specific conductance. Thus, the results documented the spread of contamination to the farthest points at which it could be monitored.
- Excessively high report (detection) limits were used. The laboratory report limits were above the typical method report limit, resulting in incomplete and indeterminate statistical determinations. The

report limits used by CLECO were too high to observe changes in groundwater quality between wells and from previous sampling events. For example:

- Using the same laboratory method (EPA 6020), the Report Limit used for selenium in the 2009 ISE Event was 9 times higher than what the laboratory used in April 2008 (0.045 mg/L for the ISE versus 0.005 mg/L in April 2008).
- The Report Limits used in the 2009 ISE event were sometimes virtually the same as the MCL for other metals. For example, arsenic (0.009 mg/L versus 0.01 mg/L MCL); lead (0.014 mg/L versus 0.015 mg/L MCL); and thallium (0.002 mg/L versus 0.002 mg/L MCL). Such limits do not allow reviewers to detect whether contamination is occurring until after pollutant levels have already exceeded or virtually exceeded the MCLs.

Comparing the results of groundwater sampling of the reported first year of monitoring in 1986 (CLECO, 2000), the year when ash ponds were commissioned, to the April 2008 sampling event (CLECO, 2008) show substantial changes in groundwater quality that indicate a release of CCW contaminants:

Ash Pond Parameter (OW-16)	1986 (Jan., July, Dec. average)	April 2008	Change from 1986-2008
TDS	1,523	13,900	+812%
Sulfate	615	1,380	+124%

Constituents Involved

Arsenic, lead, selenium, chlorides, TDS, sulfate, iron, and pH; SSIs for specific conductance and alkalinity; calcium as an indicator parameter

At Risk Population

There are two private drinking water wells for domestic use within a two mile radius. These private wells are located approximately 1.5 miles northwest of the Dolet Hills Station. In addition, there is one public drinking water well located 4.5 miles southwest of the Dolet Hills Station. This public water source serves approximately 60 citizens on a yearly basis. Data was obtained from the Louisiana Department of Natural Resource's (DNR) GIS Well Log Data Layer. This data layer is constantly being updated as Louisiana DNR is in the process of converting paper well logs to digitized records that can be mapped. It is possible that some well data is missing as the Well Log Data Layer is still being updated.

[illegible]

Ongoing exceedances of groundwater standards since at least 1992

Regulatory Actions

In 2008, LDEQ required that assessment monitoring activities be conducted at the bottom ash ponds, the surge/ auxiliary pond, the metal cleaning waste pond, the plant discharge pond, the lignite runoff pond, and the fly ash-scrubber sludge landfill (LDEQ, 2008). However, no assessment activities have included any off-site or off-property sampling points (Trahan, 2010). LDEQ later approved a return to detection monitoring and the revised groundwater sampling and analysis plan submitted in May 2009 (LDEQ, 2010b). SSIs for specific conductance and alkalinity for the August and December 2009 sampling events required that the facility initiate re-sampling and assessment monitoring, and/or demonstrate that the contamination was due to an alternate source or natural variation (LDEQ, 2010a). The status of that assessment remains unclear.

Bottom ash, fly ash, flue gas desulfurization (FGD) sludge, limestone pile runoff solids, metal cleaning wastes, and lignite runoff solids

Dolet Hills Power Station has ten permitted CCW disposal units: Fly Ash/Scrubber Sludge landfill; Ash Basin No. 1 (bottom ash); Ash Basin No. 2 (bottom ash); Secondary Basin (bottom ash); Surge Pond No. 1 (scrubber sludge and unspecified ash); Surge Pond No. 2 (scrubber sludge and unspecified ash); Auxiliary Surge Pond (scrubber sludge and unspecified ash); metal cleaning waste pond; plant discharge collection pond; and lignite runoff pond (CLECO, Mar. 2009 and CLECO, May 2008). A limestone runoff pond also exists but it is not permitted as a solid waste disposal unit. CCW was placed in the following disposal units beginning in 1986: Ash Basin No. 1, Ash Basin No. 2, Secondary Basin, Surge Pond No. 1, Surge Pond No. 2, and Auxiliary Surge Pond (CLECO, Mar. 2009).

The metal cleaning waste pond receives two liquid waste streams: fly-ash laden wash water from the air heater system, and boiler and turbine wash water (Eagle, 2007a). The primary solid collected in the pond is fly ash. CLECO considers storage of the fly ash in the pond to be "temporary," even though the pond has 25 years of additional capacity before the solids have to be removed. The liquid contents of the metal cleaning waste pond are routed to the waste water treatment system.

The discharge collection pond receives effluent from the wastewater treatment plant, neutralized demineralizer regeneration wastes, cooler tower blowdown, demineralizer pretreatment filter backwash, and clarifier blowdown (Eagle, 2007b). CLECO also considers this pond to provide "temporary" storage of any solids deposited in this pond without specifying how often the solids are removed.

Active

Four distinct permeable zones of groundwater exist at the site in predominantly sandy soils (CLECO, May 2008). Groundwater Zone 4 (the deepest) is present beneath all surface impoundments and ponds in the plant area and beneath the landfill. Groundwater Zone 3 is found predominantly beneath the metal cleaning pond. The upper-most zones (Groundwater Zones 1 and 2) are only located south at the FGD landfill, and Zone 1 discharges to surface water. Although six piezometers are used at the landfill to determine the direction of groundwater flow in Groundwater Zone 2 (beneath Zone 1), no monitoring wells exist in this zone to determine groundwater quality. Although two wells and six piezometers exist at the landfill in Groundwater Zone 3, only one of the wells is sampled and it is not located in the most hydraulically downgradient position or able to monitor groundwater from the western side of the landfill.

CLECO. 2010. Groundwater Monitoring Report, Second Half 2009 (prepared by Eagle Environmental Services, Inc.) (Mar. 2010).

CLECO. 2009. Letter from Steve Carter, CLECO, to Richard Kinch, U.S. EPA, Re: Request for Information under Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (Mar. 24, 2009).

CLECO. 2008. Groundwater Monitoring Report, First Half 2008 (prepared by Eagle Environmental Services, Inc.) (May 2008).

CLECO. 2000. Letter from Fred Holt, CLECO, to Michael Vince, LDEQ, Re: Semi-Annual Groundwater Detection Monitoring Report (prepared by Mid-South Analytical Labs, Inc.) (May 24, 2000).

Eagle. 2010. Letter from Jared Mayeaux, Eagle Environmental Services, Inc., to LDEQ, Waste Permits Division, Re: March 16, 2010 Meeting Summary, Groundwater Monitoring Programs, Dolet Hills Power Station (and also Rodemacher Power Station) (Mar. 25, 2010).

Eagle. 2007a. Letter from Ray Sturdivant, P.G., Eagle Environmental Services, Inc., to LDEQ, Re: Final Copies for Updated Mandatory Modification Document for Metal Cleaning Waste Pond (Aug. 20, 2007).

Eagle. 2007b. Letter from Ray Sturdivant, P.G., Eagle Environmental Services, Inc., to LDEQ, Re: Final Copies for Updated Mandatory Modification Document for Plant Discharge Collection Pond (Aug. 20, 2007).

LDEQ. 2010a. Email correspondence from Dru Trahan, Waste Permits Division, LDEQ, to Jared Mayeaux, Eagle Environmental Services, Inc., Re: Dolet Hills Groundwater Report (Mar. 11, 2010).

LDEQ. 2010b. Letter from Cheryl Sonnier Nolan, LDEQ, to Brent Croom, CLECO Power, Re: Approval of Detection Monitoring Groundwater Sampling and Analysis Plan, Fly Ash / Scrubber Sludge Landfill and Surface Impoundment (Feb. 5, 2010).

LDEQ. 2008. Letter from Estuadro Silva, LDEQ, to Brent Croom, CLECO Power, Re: Notice of Deficiencies – Assessment Monitoring Required (Dec. 19, 2008).

LDEQ. 1992. Memorandum from David McKenzei, LDEQ Regional Geologist, to Tom Ashby, LDEQ Geologist Supervisor (July 21, 1992).

Trahan. 2010. Email correspondence from Drukell Trahan, Waste Permits Division, Geological Services Section (May 25, 2010).

Entity/Company – Location

CLECO Power, LLC - Rodemacher Power Station
275 Rodemacher Road
Lena, LA 71447
Rapides Parish
Latitude: 31.393889 Longitude: -92.709167

Determination

Demonstrated damage to groundwater moving off-site (to Lake Rodemacher, Bayou de Jean, and the Red River)

Probable Cause(s)

Leaching of coal combustion waste (CCW) constituents from CCW ponds, a coal ash management area and landfill, and coal storage pile into underlying groundwater

Summary

Groundwater monitoring wells at compliance boundaries for a a CCW landfill, seven ponds, and a coal pile at the Rodemacher Station have been contaminated with arsenic up to 5.75 times the federal Maximum Contaminant Level (MCL) and lead exceeding the MCL. The contamination is documented at multiple groundwater wells in two areas separated by Lake Rodemacher. Contamination is moving beyond compliance boundaries for the CCW units, with no other monitoring wells between the boundary, domestic water wells, and nearby waterbodies and no sampling of surface waters. Off-site surface waters are as close as 50 feet from CCW disposal units, and 36 registered water wells exist within a one-mile radius of Rodemacher Station.

Test of Proof

Arsenic and lead were found in groundwater downgradient of multiple CCW disposal units exceeding drinking water standards in wells located at the point of compliance (an imaginary line that connects each monitoring well associated with each disposal unit and beyond which groundwater standards should be met) (CLECO, 2009a&b). There are no monitoring wells downgradient of the contaminated compliance boundary wells and thus between these compliance wells and domestic water wells and nearby surface waterbodies. The contamination is flowing from two distinctly separate areas: 1) the power plant, coal pile area and runoff pond, sludge pond and metal cleaning ponds on the north side of Lake Rodemacher; and 2) the coal ash ponds and CCW landfill area east of the Lake.

Heavy metals are not normally sampled in groundwater monitoring at the Rodemacher Station; however, some metals were tested as part of Initial Sampling Events (ISEs) in September and November 2009 after issuance of a new landfill permit and the installation of new wells. Arsenic sampling was not required, however, for metal cleaning waste pond wells. Groundwater sampling for these two 2009 events found arsenic and lead concentrations greater than the MCL, and greater than the secondary MCLs (SMCL) for chloride and pH, with statistically significant increases (SSIs) as follows (CLECO, Jan. 2010):

- **Arsenic** – in four landfill compliance wells (W-4 southeast side, W-15 south side, W-17 southeast side, and W-18 east side) was measured at 0.0413 mg/L average and 0.0575 mg/L maximum;
- **Arsenic** – in one bottom ash pond compliance well (W-21, north side) was measured at 0.0121 mg/L average and 0.0131 mg/L maximum;
- **Arsenic** – in one coal runoff sedimentation pond compliance well (W-7) was measured at 0.0377 mg/L average and 0.0437 mg/L maximum;
- **Arsenic** – in one "background" well located downgradient of the coal pile (W-1) was measured at 0.0546 mg/L maximum;
- **Lead** – in one well at metal cleaning waste pond #1 (W-9) was measured at 0.0209 mg/L max;
- **Lead** – in one well at metal cleaning waste pond #2 (W-10) was measured at 0.0156 mg/L max;
- SSIs were recorded for specific conductance, chloride, and sulfate (all indicators of CCW leachate) for four wells associated with the two metal cleaning waste ponds;
- **Chloride** – a concentration of 392 mg/L was measured in one metal cleaning pond #1 compliance well (W-9), exceeding the SMCL (250 mg/L); and
- **pH** – was less than 6.5 (the minimum SMCL) in 15 of 21 wells on-site.

Semi-annual groundwater sampling in November 2007 (CLECO, Feb. 2008) of eight wells for a parameter list that included no heavy metals and only a few CCW indicator parameters resulted in SMCL exceedances for the most downgradient well from the fly ash and bottom ash ponds. TDS exceeded the SMCL in compliance well (W-3) at 728 mg/L, and the highest specific conductance, alkalinity, and calcium concentrations were also reported in that well. TDS also exceeded the SMCL in the compliance well at the coal sedimentation pond. Levels of pH were measured below the SMCL minimum of <6.5 standard units in six of eight wells on-site.

Comparing results of groundwater sampling at ash pond monitoring well W-3 from the first year during waste placement (1982–1983) to results in 2007 show substantial changes in groundwater quality, which indicate CCW disposal unit leakage (CLECO, 1984 and 2008):

Ash Pond Parameter (W-3)	June 9, 1982	August 2, 1983	November 20, 2007	Change from Avg. 1982–1983
pH	-	9.21	6.73	2.5 unit decline
Alkalinity (mg/L)	239	282	386	+48%
TDS (mg/L)	400	408	728	+80%
Calcium (mg/L)	8.2	23.9	67.7	+332%

Constituents Involved

Arsenic, lead, pH, TDS, specific conductance, chloride, and sulfate

At Risk Population

There are 36 registered water wells within a one-mile radius of the plant (CLECO 2007). However, Louisiana's Department of Natural Resources' (DNR) Well Log GIS Layer indicated that there are 12 private drinking water wells within a two -mile radius of the site. Louisiana DNR also indicated three public drinking water sources exist within a five-mile radius. Data obtained from DNR's GIS Well Log could be incomplete.

Exceedances of the SMCL for TDS were first documented in November 1983 and July 1984. Concentrations of pH outside the 6.5 to 8.5 SMCL range were found throughout the site in 1983. In September and November 2009, concentrations of arsenic and lead were found to be exceeding the MCLs.

The Louisiana Department of Environmental Quality (LDEQ) required Rodemacher Power Station to complete "assessment monitoring" for groundwater constituent concentrations that may have been affected by CCW ponds (LDEQ, Dec. 2008). LDEQ allowed a return to detection monitoring in February 2010 (LDEQ, Feb. 5, 2010).

Rodemacher Station submitted a request for a major permit modification of the coal ash management area to construct a Type I landfill, which included a request for a 60-foot height increase in the existing CCW disposal unit, use of coal ash as protective cover, and use of an alternate liner (3 composite liner options proposed) (CLECO, Nov. 2009). LDEQ deemed the request technically complete and publicly noticed the modification in February 2010 (LDEQ, Feb. 17, 2010).

Bottom ash, fly ash, metal cleaning wastes, clarifier sludge, coal pile runoff

The Rodemacher Power Station has been operational since the mid-1970s (LDEQ, Feb. 2010). The facility includes the following land disposal units: a fly ash pond, a bottom ash pond, an ash management area/Type I landfill, two metal cleaning waste ponds, a coal sedimentation pond, a landfill leachate collection pond, and a clarifier sludge sedimentation pond (CLECO, 2010). The clarifier sludge pond does not have a permit (CLECO, 2009a&b). Waste was first placed the 109-acre fly ash pond in 1982 (CLECO, May 2009). Waste was also first placed in the 36-acre bottom ash pond in 1982. The combined ash pond complex is nearly ¾-mile long. The current coal ash management area/Type I landfill seems to have been constructed over an old coal ash pond (CLECO, 2007).

Active

There are no downgradient, off-property monitoring wells to monitor contamination between CCW disposal areas and Lake Rodemacher, the Red River, the Bayou de Jean, or off-site domestic water wells – nor has any off-site sampling of domestic wells or surface water monitoring occurred (Trahan, 2010). CLECO has concluded that the groundwater in the vicinity of the plant is "most likely connected to the Red River to the north and Bayou Jean de Jean to the east at shallow depths" (CLECO, 2007).

Lake Rodemacher and the Bayou Jean de Jean are located approximately 50 feet from CCW disposal units. The uppermost aquifer beneath the waste management units flows towards those surface water bodies (CLECO, January 2010). Groundwater in the power station area where the metal cleaning ponds, the coal sedimentation pond, and a sludge pond are located flows towards Lake Rodemacher. Groundwater beneath the ash ponds and the ash management area/landfill area flows towards Bayou Jean de Jean to the west and south and the Red River to the north. The groundwater gradient is steep – up to approximately 13 percent – and is the steepest nearest the receiving waterbodies (CLECO, Feb. 2008). CLECO Power, LLC has determined that the groundwater seepage velocity is the greatest (3.5 feet per day) at the bottom ash and fly ash ponds where the property line is adjacent to the CCW disposal units and where groundwater discharges towards Bayou Jean de Jean and the Red River (CLECO, 2007).

CLECO. 2010. CLECO, Groundwater Monitoring Report, Second Half 2009 (prepared by Eagle Environmental Services, Inc.) (Jan. 2010).

CLECO. 2009a. Letter from Brent Croom, CLECO, to LDQEQ, Waste Permit Division, Re: Solid Waste Permit Modification, Ash Management Area (Nov. 18, 2009).

CLECO. 2009b. Letter from Jared Mayeux, CLECO, to LDEQ, Waste Permits Division, Re: Request for Acceptance for Change to Groundwater Monitoring Program (July 9, 2009).

CLECO. 2008. CLECO, Groundwater Monitoring Report, Second Half 2007 (prepared by Eagle Environmental Services, Inc.) (Feb. 2008).

CLECO. 2007. CLECO, Unit 1 Metal Cleaning Waste Pond, Solid Waste Standard Permit Renewal Application, Rodemacher Power Station (Mar. 9, 2007).

CLECO. 1984. Letter from P. J. Turregano, Environmental Specialist, CLECO, to John Koury, Office of Solid and Hazardous Waste, Re: Groundwater Monitoring Results (Sept. 4, 1984).

LDEQ. 2010a. LDEQ, Public Notice, Type I Industrial Landfill, Technically Complete Solid Waste Permit Modification (Feb. 17, 2010).

LDEQ. 2010b. Letter from Cheryl Sonnier Nolan, Assistant Secretary, LDEQ, to Brent Croom, CLECO Power, Re: Approval of Detection Monitoring Groundwater Sampling and Analyses Plan, (Feb. 5, 2010).

LDEQ. 2008. Letter from Estuardo Silva, Geologist Supervisor, Waste Permits Division, LDEQ, to Brent Croom, CLECO Power, Re: Assessment Monitoring Required (Dec. 3, 2008).

Trahan. 2010. Email correspondence from Drukell Trahan, LDEQ Waste Permits Division, Geological Services Section (May 26, 2010).

Entity/Company - Location

CMS Energy d/b/a Consumers Energy - J.R. Whiting Generating Plant
4525 East Erie Road
Erie, MI 48133
Monroe County
Latitude: 41.794635 Longitude: -83.445971

Determination

Demonstrated off-site ecological damage to aquatic life

Probable Cause

Effluent discharges to surface water from coal combustion waste (CCW) ponds

Summary

A two-year study by the U.S. Fish and Wildlife Service in the early 1980s examined the effect of effluent discharges from a coal ash basin adjacent to Lake Erie and found elevated concentrations of trace elements identified as potentially harmful in sediments (arsenic, cobalt, possibly nickel, and selenium) and aquatic biota (arsenic, selenium, bromine, possibly cobalt, nickel, and chromium). The study concluded that chronic exposure to higher concentrations could undermine population fitness through increased susceptibility to disease, predation, and reduced reproductive capacity. Organisms identified as especially at risk are those whose mobility is restricted, such as oligochaetes (freshwater worms) and early life stages of fish. No follow-up studies were conducted. The coal ash disposal area involved in this study was in the process of being closed as of 2009.

The U.S. Fish and Wildlife Service evaluated the effects of a coal ash disposal basin at Consumer's Power J. R. Whiting Power Plant on the western shore of Lake Erie during 1983 and 1984 (Hatcher et al. 1992). Analysis involved the use of neutron activation analysis (NAA) to determine if potentially toxic trace elements were present in higher concentrations in samples of sediment, fish and benthic macroinvertebrates near a coal ash basin compared to reference stations about 1.8 miles away.

Arsenic and cobalt concentrations (maximum of 0.15 mg/kg and 0.012 mg/kg respectively) were found to be significantly higher in sediments near the primary outfall of the coal ash basin than at the reference stations, and selenium and nickel were more concentrated in sediments examined from at least one of the nearby sampling stations (identified as "proximal" or "affected" in the study). Maximum concentrations for all four trace elements in sediment were below Michigan Department of Environmental Quality criteria for soil cleanup (MDEQ, 2006).

Selenium was significantly more concentrated in both oligochaetes (freshwater worms) and chironomids (non-biting midges) near the coal ash basin outfall than at reference stations, but variations occurred seasonally between the taxa. Arsenic concentrations were higher in oligochaetes near the outfall and were correlated with sediment concentrations, but were below detection limits in fish. Bromine was significantly higher in oligochaetes from nearby stations in both years, but bromine in oligochaetes at all stations was lower in 1984 than in 1983. The oligochaetes, as obligate permanent residents of the sediment, were consistently less dense at proximal stations compared to reference stations over the full course of the study. The study authors found this observation consistent with the conclusion of Bamber (1984) that benthic organisms residing closest to coal ash basin may be incapable of sustaining high population densities in the face of the addition of trace elements from the coal ash.

Selenium, bromine, cobalt, nickel, and chromium were more concentrated in young of the year brown bullheads collected near the coal ash basin in the fall of 1983. Selenium was more concentrated in adult spottail shiners near the coal ash basin in the spring of 1984 when compared with reference sites. Bromine was more concentrated in yearling white bass nearer the basin in the fall of 1983 and 1984. Fish collections found fewer fish near the coal ash basin; specifically, fewer spottail shiners and yearling white bass were caught close to the coal ash basin than at the reference site. The study authors concluded that fish avoidance of increased trace metal concentrations may be occurring. In regard to food chain bioaccumulation dynamics, oligochaetes, chironomids, young of year brown bullheads, and fish in younger stages of development are more at risk from contaminated sediments due to their dependence upon bottom sediments for habitat and food.

Hatcher et al. (1992) (emphasis added) concluded:

> Elevated concentration of particular trace elements identified as potentially harmful exist in sediments (arsenic, cobalt, possibly nickel and selenium) and aquatic biota (arsenic, selenium, bromine, possibly cobalt, nickel and chromium) adjacent to a coal ash disposal basin. **These elevated concentrations are the result of the transport of coal ash residue from the disposal basin to the surrounding aquatic environment.**[boldface added]...[T]he documented toxicity of these elements and the disparity between coal ash and sediment concentrations (especially with respect to selenium) raise questions about the long-term effects of continual exposure to higher than background levels (Lemly, 1985a and 1985b). Chronic exposure to higher concentrations could undermine population fitness through increased susceptibility to disease, predation, and reduced reproductive capacity. Organisms especially at risk are those whose mobility is restricted, such as oligochaetes and early life stages of fish.

The final conclusion of this study was:

> In light of the possible risk to organisms, the siting of coal ash disposal basin immediately adjacent to the Great Lakes shoreline and the use of coal ash residue as a major constituent of blocks for the creation of near shore artificial reefs in Great Lakes waters needs reevaluation.

Constituent(s) Involved

Arsenic, cobalt, possibly nickel, and selenium (elevated concentrations found in sediments of trace elements identified as potentially harmful to aquatic biota)

Arsenic, bromine, chromium, cobalt, nickel, selenium (elevated concentrations found in aquatic biota)

Scientific study summarized here was conducted in 1983 and 1984. There were no follow-up studies (Poe, 2010).

Available information indicated no regulatory actions

Ponds 3, 4 and 5 received fly ash and some co-disposed liquid waste (low volume plant wastes, treated boiler cleaning wastes from the plants chemical treatment facility, and treated sewage waste from the Plant's sanitary sewage treatment facility).

Pond 1 - receives bottom ash and, as of June 1, 2008, co-disposed liquid wastes regulated by the site's NPDES permit, MIO001864.

Pond 2 - is separated into two sub-ponds; one for fly ash deposition in the event that the dry fly·ash collection system temporarily fails or is down for maintenance

Ponds 3, 4, and 5 - prior to June 1, 2008, received both fly ash and other wastewaters. Since June 1, 2008, these ponds receive only fly ash that is excavated and then trucked from Pond 6 or fly ash collected in a dry silo, moistened to allow compaction to a specified density, and then trucked to these ponds.

Pond 6 - receives fly ash only (EPA, 2009).

Since the JR Whiting Plant went online in 1952, at least six impoundments have been constructed to receive bottom ash and fly ash (and co-disposed liquid wastes). Ponds 3 to 5 were involved in the ecological studies summarized here. Ponds 3 and 4 were constructed in 1959, Pond 4 was expanded in 1966, Pond 5 was constructed in 1974 and all were operated as a unit since the late 1970s. They have a total acreage of 82.4 acres. Final Closure for these ponds was approved by MDEQ in 2005. In recent years fly ash disposal at the plant has been minimal, with almost all ash collected dry and sold for cement manufacture (Consumers Energy, 2009).

The coal ash ponds are located on Woodtick Peninsula, over shoreline alluvial deposits on the west side of Lake Erie.

USEPA (2007) rejected this damage case (#76 Lake Erie, Ohio) because of "insufficient evidence to confirm that fossil fuel combustion wastes are the source of contamination in this case." It is clear that USEPA never actually bothered to look review the information because this study was a carefully designed examination by the U.S. Fish and Wildlife Service that was published in a peer-reviewed scientific journal and was specifically designed to evaluate the effects of coal ash disposal at the power plant.

Bamber, R.N. 1984. The Benthos of a Marine Fly Ash Dumping Ground, *J. Mar. Biol. Ass. (UK)* 64:211-226.

Consumers Energy. 2009. JR Whiting Plant, Response to U.S. EPA Coal Combustion Residue Impoundment Survey (Mar. 26, 2009), *avalable at* http://www.epa.gov/waste/nonhaz/industrial/special/fossil/surveys/cec.pdf.

Hatcher, C. O., R. E. Ogawa, T.P. Poe and J. R. P. French, III. 1992. Trace Elements in Lake Sediment, Macrozoobenthos, and Fish Near a Coal Ash Disposal Basin, *J. Freshwater Ecol.* 7:257-269 (1992) (all authors of this paper were at the U.S. Fish and Wildlife Service Great Lakes National Fisheries Research Center at Ann Arbor, MI at the time of the study).

Lemly, A.D. 1985a. Toxicology of Selenium in a Freshwater Reservoir: Implications for Environmental Hazard Evaluation and Safety, *Ecotoxicol. Environ. Saf.* 10:314-338 (1985).

Lemly, A.D. 1985b. Ecological Basis for Regulating Aquatic Emissions from the Power Industry: The Case with Selenium, *Reg. Toxicol. Pharmacol.*, 5:465-486 (1985).

MDEQ. 2006. Michigan Department of Environmental Quality (MDEQ), Soil Residential and Commercial Cleanup Criteria and Screening Levels, RRD Operational Memo No. 1, *available at* www.michigan.gov/documents/deq/deq-rrd-OpMemo_1-Attachment1Table2SoilResidential_283553_7.pdf - 2009-06-23.

Poe. 2010. Email communication from Thomas Poe, Co-Investigator for the JR Whiting Coal Ash Basin Aquatic Impact Study and Fisheries Research Consultant (Mar. 30, 2010).

USEPA. 2007. U.S. Environmental Protection Agency (USEPA) Coal Combustion Waste Damage Case Assessments, Office of Solid Waste (July 9, 2007).

Entity Company – Location

Duke Energy - Dan River Steam Station
524 S Edgewood Rd
Eden, NC 27288
Rockingham County
Latitude: 36.489495 Longitude: -79.715427

Determination

Demonstrated on-site damage to groundwater

Probable Cause(s)

Leaching of coal combustion waste (CCW) contaminants into groundwater

Summary

Voluntary groundwater monitoring at Duke Energy's Dan River Steam Station's coal ash ponds has detected levels of chromium, iron, lead, manganese, silver, and sulfate that exceed state groundwater standards and federal Maximum Contaminant Levels (MCLs) and Secondary MCLs (SMCLs). Dan River Steam Station has two unlined coal ash ponds as well as an unlined dry ash landfill. Fifteen years of sporadic voluntary monitoring beginning in November 1993 indicates that there is on-site groundwater contamination that is likely migrating outside of the state-designated "compliance boundary" for Dan River's CCW impoundments. EPA ranked both wet CCW ponds at Dan River Steam Station as "high hazard" surface impoundments, meaning that their failure will probably cause loss of life (USEPA, 2009).

Groundwater monitoring found exceedances of groundwater standards, such as North Carolina standards, federal MCLs, and federal SMCLs (Duke Energy and NC DENR, 1993–2009). For example:

- **Chromium** was reported at 0.0611 mg/L in April 2008, over the state groundwater standard of 0.05 mg/L.
- **Iron** exceedances ranged from 0.32 mg/L to 69.73 mg/L between November 1993 and April 2008, the latter being over 232 times the SMCL and state groundwater standard of 0.3 mg/L.
- **Lead** exceedances ranged from 0.01522 mg/L to 0.0392 mg/L between April 1998 and April 2008, the latter being over twice the MCL and state groundwater standard of 0.015 mg/L.
- All recorded **manganese** values exceeded SMCLs and state groundwater standards. Manganese concentrations ranged from 0.32 mg/L to 7.058 mg/L, the latter being over 141 times the SMCL and state groundwater standard of 0.05 mg/L.
- **Silver** was reported at 0.0411 mg/L in April 2008, over twice the state groundwater standard of 0.0175 mg/L.
- **Sulfate** exceedances ranged from 510 mg/L to 560 mg/L between November 1993 and April 1996, more than twice the SMCL and state groundwater standard of 250 mg/L (DENR).

The full extent of the groundwater contamination is unknown. Groundwater testing was only conducted within the boundaries of the CCW impoundment structure because the impoundment extends all the way to the Dan River, making downgradient groundwater monitoring difficult. No off-site monitoring has been conducted.

High levels of iron, lead, and manganese in wells presumed to be "background" indicate possible contamination from the on-site dry coal ash storage facilities and warrant further investigation. Groundwater monitoring has only targeted the wet CCW storage site, ignoring the dry CCW landfill.

Chromium, iron, lead, manganese, silver, and sulfate

The Dan River Steam Station is located in a fairly densely populated area. Private well data is supposed to be archived at the county level; however, Rockingham had only an incomplete list of registered wells from the 1970s, without the geospatial data necessary to map wells in relation to the Dan River Steam Station. Although not an exhaustive list, the private well data available showed that there are over a dozen private suburban residences within two miles of the CCW impoundments at Dan River. In addition, public well data available through the North Carolina Department of Natural Resources, shows five public drinking water wells within a five-mile radius of Dan River that serve over 60 citizens.

Incident and Date Damage Occurred / Identified

Exceedances of groundwater standards were first documented in November 1993

Regulatory Action

The North Carolina Department of Environment and Natural Resources (DENR) is aware of existing groundwater contamination at levels that exceed state groundwater standards at the Dan River Plant. However, DENR has not required a corrective action plan to restore contaminated groundwater at the Dan River Plant and has no plans to take action to eliminate the source of contamination until it reaches the "compliance boundary." DENR plans to require groundwater monitoring outside of the compliance boundary upon permit renewal for all coal ash ponds (Henderson, 2010), but this may be difficult in the case of the Dan River Steam Station because its coal ash impoundments abut the Dan River.

Despite evidence of groundwater contamination, DENR has not required Duke Energy to take any remedial action. Under North Carolina law, a company is only required to take cleanup action if contamination is spreading outside of a designated "compliance boundary." As long as Duke Energy continues to monitor only inside the compliance boundary at the Dan River Plant, they will not produce data sufficient to trigger cleanup.

Wastes Present

Fly ash, bottom ash, boiler slag, and flue gas emission residuals from the Dan River Steam Station (Duke Energy, 2009)

Two unlined wet coal ash impoundments and one unlined dry coal ash landfill

Two active wet coal ash impoundments and one inactive, capped dry landfill

The CCW impoundments abut the Dan River, indicating that shallow off-site groundwater contamination may be diluted. Further hydrogeologic information was unavailable.

The Dan River Steam Station began operation in 1949. The CCW storage imopundment was originally built in 1956, seven years after the plant began operating. The embankment walls were raised in 1967. In 1977, the embankment walls were raised again, and an interior dike was built to divide the impoundment into the two that exist today. It should be noted that the western dike walls of the primary and secondary ash ponds were constructed on top of existing coal ash deposits. The two impoundments together cover 39 acres, with a total storage capacity of 664 acre feet. The impoundments have been periodically dredged and the dredged ash spoils are stored in an unlined dry ash landfill just north of the ponds. The last dredging occurred in 2007. Another dredging is unlikely because the plant is expected to be decommissioned soon.

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USEPA. 2009. Fact Sheet: Coal Combustion Residues (CCR) – Surface Impoundments with High Hazard Potential Ratings. EPA530-F-09-006 (updated Aug. 2009). *available at:* *http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccrs-fs/index.htm*

Entity/Company – Location

Basin Electric Power Cooperative - Antelope Valley Station
294 County Rd. 15
Beulah, ND 58523
Mercer County
Latitude: 47.367903 Longitude: -101.837286

Determination

Demonstrated damage to on-site groundwater

Probable Cause

Groundwater contamination from coal combustion waste (CCW) landfill

Summary

A closed, clay-lined CCW landfill used by the Antelope Valley Station has contaminated underlying groundwater with arsenic. Arsenic has increased at three downgradient wells to levels exceeding the federal Maximum Contaminant Level (MCL), up to 0.03 mg/L. These three wells are also among the four highest for boron concentrations.

Test of Proof

Arsenic levels have risen dramatically at three downgradient groundwater monitoring wells (MP-12A, MP-13B, MP-22) at the CCW landfill from 1984 through 2010 (BEPC, 2009). For example, in Well MP-12A,