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A White Paper on Environmental Damage from Coal Combustion Waste: The Cost of Poisoned Fish and Wildlife

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Summary

This paper reports the monetary cost of ecological damage from coal combustion waste (CCW) at 22 sites. Five of these cases resulted from structural failure of disposal ponds, two were caused by unpermitted discharge of ash pond effluent, two occurred at unregulated impoundments, and twelve, which includes the most costly cases, happened because of legally permitted releases allowed by the National Pollutant Discharge Elimination System (NPDES). Only one case, which was a landfill, resulted from exceedance of specified contaminant limits of an NPDES permit. The sites range from locations where historical poisoning has led to corrective actions that have greatly improved environmental conditions to those where contamination has just recently been discovered and the level of ecological damage has yet to be determined. The total cost of poisoned fish and wildlife at the surface impoundment sites is $2.31 billion (2010 dollars). This is enough money to construct 155 landfills with state-of-the-art composite liners and leachate collection systems. Evidence revealed through this study indicates that: (1) For the past 43 years, environmental damage has been a recurring theme with surface impoundment of CCW, (2) The NPDES, which was created as part of the federal Clean Water Act in 1972, has not been effective in preventing serious environmental damage from coal combustion waste, (3) EPA's Regulatory Impact Analysis of the benefits of pollution control afforded by a RCRA Subtitle C hazardous waste designation for CCW fails to include benefits of avoided damages to natural resources, specifically, poisoned fish and wildlife, (4) Surface impoundments pose unacceptably high ecological risks regardless of location or design, and (5) Use of constructed wetlands to treat FGD wastewater may be the start of a new chapter in the CCW pollution story. Regulators should no longer ignore rigorous science and the lessons learned from multiple case examples. EPA and the United States need to show leadership on this issue by prohibiting surface impoundments, particularly since the rise in coal use in developing countries is leading to the same CCW pollution problems on a global scale.

Introduction

There has been a long history of environmental damage caused by surface impoundment of coal combustion waste (CCW). The first widely recognized case, which has become a landmark example of the ecological hazard of CCW, was the catastrophic toxic event at Belews Lake, NC, beginning in 1976. Since that time, fish and wildlife have been poisoned at numerous other locations due to pollutants leached from surface impounded CCW. A substantial amount of information useful for evaluating environmental risks and impacts of wet disposal practices has been gained. EPA has recognized some of the ecological impacts in its 2007 damage case assessment (1). However, there is also a wide range of negative economic impacts associated with ecological effects. Until now, those costs have not been tabulated. It is important for EPA

to understand the full economic and environmental implications of continued use of surface disposal in the context of its proposed regulations for CCW (2). This report summarizes the ecotoxicology of scientifically documented cases and applies principles of natural resource damage assessment (3, 4) to estimate the economic losses associated with contaminated and poisoned fish and wildlife (in 2010 dollars). This procedure includes the following value components:

Ecological – value to a healthy, self-sustaining ecosystem that supports a diverse fish and wildlife community; direct value of contaminated or lost fish and wildlife on population and community integrity

Recreational – value to sport fishing and hunting (loss of recreation, lost expenditures for gas, food, bait, tackle, ammunition, licenses, and guides), boating, swimming, and other leisure activities; avoidance of recreational activities due to health and safety issues from pollution

Real Estate – depreciated value due to stigma of environmental pollution

Aesthetic – intrinsic scenic and posterity value to non-sportsmen/recreators

Human Health – value of unconsumed fish and wildlife (negative value of contaminated fish and wildlife); impact of consumption restriction advisories; stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened

Results of Case Study Investigations

A total of 22 cases of CCW impacts to fish and wildlife were identified in this review. Of those, five cases resulted from ash pond or FGD pond structural failures, two were caused by unpermitted discharge of ash pond effluent, two occurred at unregulated impoundments, and twelve, which includes the most costly cases, happened because of legally permitted releases allowed by the National Pollutant Discharge Elimination System (NPDES). Only one case, which was a landfill, resulted from exceedance of specified contaminant limits of an NPDES permit. The sites range from locations where historical poisoning has led to corrective actions that have greatly improved environmental conditions to those where contamination has just recently been discovered and the level of ecological damage has yet to be determined. The value of losses at these sites varies tremendously, and depends on the extent, severity, and duration of contamination. The total value of fish and wildlife losses in the 22 damage cases was $2.32 billion. A detailed analysis of each case is presented, followed by references and a summary table.

Case 1 – Belews Creek Steam Station, NC (Duke Energy)

Location of Damage: Belews Lake

Period of Damage: 1976-2006*
(*The last biological effects assessment was in 1996. It showed that poisoning of fish was still occurring and projected to continue. Selenium levels in fish tissue remained above a toxic threshold in 2006, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from a coal ash disposal basin was discharged into Belews Lake. This discharge was authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. The trace element selenium bioaccumulated in aquatic food chains and caused severe poisoning and reproductive failure in fish. Of the twenty primary species of fish present, seventeen were rapidly eliminated (including all sport fish) and two were rendered sterile but persisted as adults for a few years. Extensive population and community-level impacts were sufficient to cause local extinction of species. Selenium poisoning was still evident 21 years after first being detected, and 10 years after selenium inputs to Belews Lake were markedly reduced. Concentrations of selenium in fish tissues remained above a toxic threshold (4 parts per million whole-body, dry weight, 24) in 2006, 31 years after selenium impacts first began, due to movement of the element from contaminated sediments into benthic food chains. Fish diversity and relative dominance remained substantially altered in 2004. A consumption restriction advisory for selenium contamination of fish in Belews Lake was issued by the North Carolina Department of Health and Human Services from 1993-2000.

Scientific evidence: References 5-26

Corrective Action Taken: The electric utility company began to landfill coal ash in 1986 and selenium inputs to Belews Lake were markedly reduced. However, EPA's Toxics Release Inventory reported that there were substantial discharges of contaminants, including selenium and arsenic, to surface water in 2009, which was the latest reporting year available (5).

Monetized Value of Damage

Ecological: (A) Period of fish extirpation (1976-1986) = 11 years X pre-pollution standing crop of all species = 11 X 13,630 = 149,930 individuals per hectare X 781 hectares (half the total lake surface area) = 117,095,330 individuals lost. (B) Period of partial recovery (1987-1996) = 10 years X 25% of pre-pollution standing crop = 10 X 3,407 = 34,070 individuals per hectare X 781

hectares = 26,608,670 individuals lost. Total individuals lost X value per individual = 143,704,000 X $1.00 = $143,704,000. (C) Added damage cost from local extinction of species = aggregate value (A+B) X the % of total species represented by one species X number of extirpated species = $143,704,000 X 5% = $7,185,200 X 17 = $122,148,400 (D) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) during initial period of partial recovery (1987-1996) = 10 years X 70% of pre-pollution standing crop = 10 X 9,576 X 781 = 74,788,560 individuals exceeding toxic threshold X $0.50 = $37,394,280. (E) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic threshold of 4 ppm) during 1997-2006 = 10 years X 50% of pre-pollution standing crop = 10 X 6,815 X 781 = 53,225,150 individuals exceeding toxic threshold X $0.50 = $26,612,575.
Total ecological damage value = $329,859,255.00

Recreational: (A) Value of harvestable-size sport fish lost during period of extirpation = number of species X average pre-pollution standing crop per species X 50% = 8 X 1,237 X 50% = 4,948 individuals per hectare X 781 hectares = 3,864,388 X 11 years = 42,508,268 individuals X $1.00 = $42,508,268. (B) Value of harvestable-size sport fish lost during period of partial recovery = 8 X 1,237 X 10% = 989 X 781 = 772,409 X 10 years = 7,724,090 X $1.00 = $7,724,090. (C) Lost value from fishing trips not taken during period of extirpation = 14,400 angler days per year (average of 300 angler days per week X 48 weeks) X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $1,440,000 per year X 11 years = $15,840,000. (D) Lost value from fishing trips not taken during period of partial recovery = 7,200 angler days per year X $100 per day = $720,000 X 10 years = $7,200,000. (E) Lost value of other recreational trips not taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) during 1976-1996 = 300 recreation days per week X 48 weeks = 14,400 X $100 per day inclusive of meals, gas, and gear associated with recreational activity = $1,440,000 per year X 21 years = $30,240,000. (F) Lost value of fishing and other recreational trips not taken during post-1996 years when consumption restriction advisory remained in effect (1997-2000) = 100 recreation days per week X 48 weeks = 4,800 X $100 per day = $480,000 X 4 years = $1,920,000.
Total recreational damage value = $105,432,358.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners (in 1990) X approximate property value X 5% depreciation X number of years fish poisoned and public health fish consumption advisories in effect = 250 X $250,000 = $62,500,000 X 5% = $3,125,000 X 25 years = $78,125,000.00

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1990 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 476,403 X 20% = 95,280 X $100 = $9,528,060.

Human Health: (A) Value of unconsumed contaminated fish = number of angler days during the period of state-issued consumption restriction advisory (14,400 angler days per year X 16 years, 1993-2000, (22)) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, no consumption for children (22), subtract 720 for each adult) X $7.50 per meal = 14,400 X 8 = 115,200 X 4 = 460,800 – 1,440 (two adults and two children per family) = 459,360 X $7.50 = $3,445,200.00 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (1990 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 476,403 X 20% = 95,280 X $50 = $4,764,000.
Total human health damage value = $8,209,200.00

Total Case Damage Value = $531,153,873.00

Case 2 – Roxboro Steam Electric Plant, NC (Progress Energy)

Location of Damage: Hyco Reservoir

Period of Damage: 1978-2005*
(*The last biological effects assessment was in 1983 and it showed massive fish reproductive failure. Fish tissue selenium remained above a toxic threshold in 2005, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Hyco Reservoir. These discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. The trace element selenium bioaccumulated in aquatic food chains and caused poisoning and reproductive failure in fish. Three species of sport fish (largemouth bass, striped bass, chain pickerel) were virtually eliminated and severe reductions occurred in 12 other major taxa. Extensive population and community-level impacts were sufficient to cause local extinction of species and shifts in dominance of other species. Concentrations of selenium in fish tissues remained above a toxic threshold (4 parts per million whole-body, dry weight, 24) in 2005, 31 years after depressed fish populations were first noted and 15 years after selenium inputs to Hyco Reservoir were markedly reduced, due to movement of the element from contaminated sediments into benthic food chains. A consumption restriction advisory for selenium contamination of fish in

Hyco Reservoir was issued by the North Carolina Department of Health and Human Services from 1988-2001.

Scientific Evidence: References 22, 25, 27-39

Corrective Action Taken: The electric utility company began to landfill coal ash in 1990 and selenium inputs to Hyco Reservoir were markedly reduced. However, EPA's Toxics Release Inventory reported that there were substantial discharges of contaminants, including selenium and arsenic, to surface water in 2009, which was the latest reporting year available (27).

Monetized Value of Damage

Ecological: (A) Period of major impacts on fish (1978-1991) = 14 years X 50% of pre-pollution standing crop = 14 X 27,235 = 381,290 individuals per hectare X 880 hectares (half the total lake surface area) = 335,535,200 individuals lost. (B) Period of partial recovery (1992-1997) = 6 years X 25% of pre-pollution standing crop = 6 X 13,617 = 81,702 individuals per hectare X 880 hectares = 71,897,760 individuals lost. Total individuals lost X value per individual = 407,432,960 X $1.00 = $407,432,960. (C) Added damage cost from local extinction of species = aggregate value (A+B) X the % of total species represented by one species X number of extirpated species = $407,432,960 X 4% = $16,297,318 X 3 = $48,891,954. (D) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) during period of partial recovery (1992-1997) = 6 years X 70% of pre-pollution standing crop = 6 X 38,129 X 880 ha = 201,321,120 individuals exceeding toxic threshold X $0.50 = $100,660.560. (E) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic threshold of 4 ppm) during 1998-2006 = 9 years X 50% of pre-pollution standing crop = 9 X 27,235 X 880 ha = 215,701,200 individuals exceeding toxic threshold X $0.50 = $107,850,600.
Total ecological damage value = $664,836,074.00

Recreational: (A) Value of harvestable-size sport fish lost during period of major impacts = number of species X average pre-pollution standing crop per species X 50% = 8 X 1,722 X 50% = 6,888 individuals per hectare X 880 hectares = 6,061,440 X 14 years = 84,860,160 individuals X $1.00 = $84,860,160. (B) Value of harvestable-size sport fish lost during period of partial recovery = 8 X 1,722 X 10% = 1,377 X 880 = 1,211,760 X 6 years = 7,270,560 X $1.00 = $7,270,560. (C) Lost value from fishing trips not taken during period of major impacts = 9,600 angler days per year (average of 200 angler days per week X 48 weeks) X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $960,000 per year X 14 years = $13,440,000. (D) Lost value from fishing trips not taken during period of partial recovery = 4,800 angler days per year X $100 per day = $480,000 X 6 years = $2,880,000. (E) Lost value of other recreational trips not

taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) during 1978-1997 = 200 recreation days per week X 48 weeks = 9,600 X $100 per day inclusive of meals, gas, and gear associated with recreational activity = $960,000 per year X 20 years = $19,200,000. (F) Lost value of fishing and other recreational trips not taken during post-1997 years when consumption restriction advisory remained in effect (1998-2001) = 100 recreation days per week X 48 weeks = 4,800 X $100 per day = $480,000 X 4 years = $1,920,000.
Total recreational damage value = $129,570,720.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners (in 1990) X approximate property value X 5% depreciation X number of years fish poisoned and public health fish consumption advisories in effect = 250 X $250,000 = $62,500,000 X 5% = $3,125,000 X 24 years = $75,000,000.00.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1990 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 109,925 X 20% = 21,985 X $100 = $2,198,500.

Human Health: (A) Value of unconsumed contaminated fish = number of angler days during the period of state-issued consumption restriction advisory (9,600 angler days per year X 14 years, 1988-2001, (22, 38)) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, no consumption for children (22), subtract 720 for each adult) X $7.50 per meal = 9,600 X 14 = 134,400 X 4 = 537,600 – 1,440 (two adults and two children per family) = 536,160 X $7.50 = $4,021,200.00 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (1990 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 109,925 X 20% = 21,985 X $50 = $1,099,250.
Total human health damage value = $5,120,450.00

Total Case Damage Value = $876,725,744.00

Case 3 – Mayo Steam Electric Plant, NC (Progress Energy)

Location of Damage: Mayo Reservoir

Period of Damage: 2000-2007*
(*Biological effects were found in the ash basin discharge arm of the lake. Fish tissue selenium levels remained above a toxic threshold in 2007, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from a coal ash disposal basin was discharged into Mayo Reservoir. This discharge was authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2009, the Mayo Plant discharged 96,676 pounds of contaminants into surface water (44), and 2009 discharges were the highest of record. The resultant pollution caused reduced aquatic communities in the ash basin discharge area of the lake. The trace element selenium bioaccumulated in aquatic food chains and reached levels exceeding a toxic threshold (4 parts per million whole-body, dry weight, 24) in fish. All major sport fish (e.g., largemouth bass, bluegill, catfish) were contaminated. In 2007, concentrations of selenium in some fish samples were over twice the toxic threshold at a site 5 miles uplake of the ash basin discharge, and all fish sampled exceeded the threshold at a site 1.75 miles uplake. Those selenium levels (5-15 ppm dw) are within the range associated with impaired blood chemistry and health indicators, teratogenic deformities, and reproductive failure in the same species naturally exposed to coal ash discharges at other locations (19-20, 49-53). However, no detailed biochemical or reproductive assessment has been done for Mayo Reservoir. Since 2000, there has been an upward trend in selenium concentrations at all sampling stations. In its 2005 evaluation, the State of NC placed Mayo Reservoir in the category of "Waters with Noted Impacts" due to elevated selenium and arsenic concentrations in water and biota (47).

Scientific Evidence: References 40-47

Corrective Action Taken: As of 2003, most of the coal ash was being disposed in a landfill but EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including arsenic and mercury (selenium not reported), to surface water continued in 2009, which was the latest reporting year available (44).

Monetized Value of Damage

Ecological: (A) Value of reduction in aquatic communities = area affected X 50% of the value per hectare X percent negative change X number of years = 113 ha (10% of lake area) X $50,000 X 50% X 8 = $22,600,000. (B) Value of damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) = standing crop of fish X area affected X number of years affected X $0.50 = 34, 050 per ha (average of piedmont NC reservoirs with similar area and species composition, and the same trophic status) X 1020 ha (90% of lake area) X 2 years (2006-2007) X 0.50 = $34,731,000; for 2000-2001 = 1% of lake area affected (11 ha) = $374,550; for 2002-2003 = 10% of lake area affected (113 ha) = $3,847,650; for 2004-2005 = 50% of lake area affected (566 ha) = $19,272,300.
Total ecological damage value = $80,825,500.00

Recreational: The contamination at this site is known from scientific studies and internal state and utility company reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred.

Real Estate: Same as for recreation

Aesthetic: Same as for recreation

Human Health: Concentrations of selenium in muscle tissue of sport fish in 2006-2007 have reached consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisory has been issued so associated negative human health values could not be calculated. Also, public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $80,825,500.00

Case 4 – General James M. Gavin Power Plant, OH, and John E. Amos Power Plant, WV (American Electric Power)

Location of Damage: Stingy Run and Kyger Creek OH, Little Scary Creek, WV

Period of Damage: 1974-2006*
(*The last biological effects assessment was in 1996. It showed that fish were being poisoned by fly ash effluent. Concentrations of selenium in fish from Little Scary Creek remained above a toxic threshold in 2006, which was the last reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Ash pond discharges contaminated streams and increased the concentration of 5 trace metals (cadmium, chromium, copper, lead, zinc) and 2 metalloids (selenium, arsenic) in fish. These discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2009, the Gavin Plant discharged 265,284 pounds of contaminants into surface waters, and the Amos Plant discharged 122,770 pounds of contaminants into surface waters (54-55). Selenium bioaccumulated in aquatic food chains and fish tissues, and reached levels exceeding a toxic threshold (4 parts per million whole-body, dry weight, 24) in fish. Physiological and biological changes indicated that fish were poisoned by fly ash effluent, and that some reproductive impairment occurred, although no detailed reproduction studies were conducted at either site to quantify the levels of impairment. The numbers of mature fish in Little Scary Creek were reduced. Although fish poisoning was still occurring at the end of

scientific studies in 1996, no additional monitoring or biological assessment has been reported for Stingy Run or Kyger Creek. Concentrations of selenium in Little Scary Creek remained elevated (up to 58 ppm, dw) in 2006. Selenium in muscle tissue of sport fish sampled in 1993-2006 exceeded West Virginia consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisories were issued.

Scientific Evidence: References 49-60, 220

Corrective Action Taken: The electric utility company began using a dry ash handling system at the Gavin Power Plant in 1994 to improve SO_2 and particle removal from stack emissions (not in response to ecotoxicity) and selenium inputs to Stingy Run and Kyger Creek were reduced. As of 2010, some ash from the Amos Power Plant was being disposed in a landfill on the property but discharges to Little Scary Creek continued. The West Virginia Department of Environmental Protection has issued a variance in the water quality standard for Little Scary Creek, raising it from the USEPA national criterion value of 5 ug/L to a permissible level of 62 ug/L (215). This action was not approved by EPA, nor was it based on a site-specific standard development process that included supporting biological studies. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including selenium and arsenic, to surface waters continued in 2009 at both the Gavin Plant and Amos Plant, which was the latest reporting year available (54-55).

Monetized Value of Damage

Ecological: (A) Damage to fish poisoned but not eliminated in Kyger Creek and Stingy Run = average standing crop in 25 m unit sampled X length of stream X number of years X $0.50 = 255/25 m X 40 = No./km = 10,200 X 8 km X 23 years = 1, 876,000 X $0.50 = $938,400. (B) Damage to fish poisoned but not eliminated in Little Scary Creek = 10,200 X 4 km X 33 years = 1,346,400 X $0.50 = $673,200.
Total ecological damage value = $1,611,600.00

Recreational: The contamination at these sites is known from scientific studies and internal state and utility company reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred.

Real Estate: Same as for recreational

Aesthetic: Same as for recreational

Human Health: Concentrations of selenium in muscle tissue of sport fish sampled in 1993-2006 exceeded consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisory has been issued so associated negative human health values could not be calculated. Also, public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $1,611,600.00

Case 5 – Martin Lake Steam Electric Station, TX (Texas Utilities Electric)

Location of Damage: Martin Lake

Period of Damage: 1978-1997*
(*The last biological effects assessment was in 1986. It showed that the overall health and reproductive status of fish were still seriously impaired. Selenium levels in fish remained above a toxic threshold in 1997, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Periodic uncontrolled, unpermitted discharges of contaminated effluent from coal ash holding ponds into Martin Lake took place from May 1978-May 1981. Fish kills occurred in 1978 and 1979. The trace element selenium bioaccumulated in aquatic food chains and caused severe tissue pathology and reproductive failure in fish. Total fish standing crop biomass was reduced by 72%. Extensive population and community-level impacts were sufficient to cause near-extinction of some species and long-term changes in the relative dominance of other species. Barn swallows nesting near the lake contained elevated concentrations of selenium and their eggs were contaminated with enough selenium to cause 20% embryo mortality. Concentrations of selenium in some fish species remained above a toxic threshold (4 parts per million whole-body, dry weight, 24) in 1997, 20 years after ash pond effluent first entered the lake and 16 years after selenium inputs were curtailed, due to movement of the element from contaminated sediments into benthic food chains. A consumption restriction advisory for selenium contamination of fish in Martin Lake was issued by the Texas Department of Health from 1992-2003.

Scientific Evidence: References 61-80, 99-100

Corrective Action Taken: Modifications in the design and operational parameters of the power plant's wastewater disposal system were implemented in the early 1980's to prevent uncontrolled, unpermitted discharges; selenium inputs to Martin Lake were markedly reduced. As of 2005, coal ash was being disposed in a landfill. EPA's Toxics Release Inventory reported

that significant discharges of contaminants, including selenium, to surface waters continued at the Martin Lake plant through 2002 (61).

Monetized Value of Damage

Ecological: (A) Period of major impacts on fish (1978-1986) = 9 years X 25% of pre-pollution standing crop X number of hectares = 9 X 6,230 individuals per hectare X 1015 hectares (half the total lake surface area) = 56,911,050 individuals lost. (B) Period of partial recovery (1987-1992) = 6 years X 10% of pre-pollution standing crop X number of hectares = 6 X 2,492 = 14,952 individuals per hectare X 1015 hectares = 15,176,280 individuals lost. Total individuals lost X value per individual = 72,087,330 X $1.00 = $72,087,330. (C) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) during period of partial recovery (1987-1992) = 6 years X 70% of pre-pollution standing crop = 6 X 17,443 X 1015 ha = 106,227,870 individuals exceeding toxic threshold X $0.50 = $53,113,935. (D) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic threshold of 4 ppm) during 1993-1997 = 5 years X 50% of pre-pollution standing crop = 5 X 12,459 X 1015 ha = 63,229,425 individuals exceeding toxic threshold X $0.50 = $31,614,712. (E) Damage to wildlife (barn swallows) = average number of eggs per clutch X average number of nests X percentage of eggs exceeding toxic threshold (5 ppm dw) X years of major pollution = 4.5 X 95 X 10% X 15 = 641 individuals lost X $10 = $6,410.
Total ecological damage value = $156,822,387.00

Recreational: (A) Value of harvestable-size sport fish lost during period of major impacts = number of species X average pre-pollution standing crop per species X 25% = 8 X 1,125 X 25% = 2,250 individuals per hectare X 1015 hectares = 2,283,750 X 9 years = 20,553,750 individuals X $1.00 = $20,553,750. (B) Value of harvestable-size sport fish lost during period of partial recovery = 8 X 1,125 X 10% = 900 X 1015 = 913,500 X 6 years = 5,481,000 X $1.00 = $5,481,000. (C) Lost value from fishing trips not taken during period of major impacts = 9,600 angler days per year (average of 200 angler days per week X 48 weeks) X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $960,000 per year X 9 years = $8,640,000. (D) Lost value from fishing trips not taken during period of partial recovery = 4,800 angler days per year X $100 per day = $480,000 X 6 years = $2,880,000. (E) Lost value of other recreational trips not taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) during 1978-1997 = 200 recreation days per week X 48 weeks = 9,600 X $100 per day inclusive of meals, gas, and gear associated with recreational activity = $960,000 per year X 20 years = $19,200,000. (F) Lost value of fishing and other recreational trips not taken during post-1997 years when consumption restriction advisory remained in effect (1998-2003) = 100

recreation days per week X 48 weeks = 4,800 X $100 per day = $480,000 X 6 years = $2,880,000. Total recreational damage value = $59,634,750.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners (in 1990) X approximate property value X 5% depreciation X number of years fish poisoned and public health fish consumption advisories in effect = 10 X $250,000 = $2,500,000 X 5% = $125,000 X 26 years = $3,250,000.00.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1990 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 210,001 X 20% = 42,000 X $100 = $4,200,000.

Human Health: (A) Value of unconsumed contaminated fish = number of angler days during the period of state-issued consumption restriction advisory (9,600 angler days per year X 12 years, 1992-2003, (79-80)) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, no consumption for children (80), subtract 720 for each adult) X $7.50 per meal = 9,600 X 12 = 115,200 X 4 = 460,800 – 1,440 (two adults and two children per family) = 459,360 X $7.50 = $3,445,200.00 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (1990 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 210,001 X 20% = 42,000 X $50 = $2,100,000.
Total human health damage value = $5,545,200.00

Total Case Damage Value = $229,452,337.00

Case 6 – J. Robert Welsh Power Plant, TX (American Electric Power)

Location of Damage: Welsh Reservoir

Period of Damage: 1981-2007*
(*Fish populations were reduced by 1981 but no detailed biological effects studies of fish tissue pathology or reproductive failure were conducted. Selenium levels in fish were elevated and remained above a toxic threshold in 1998, which was the latest reporting year available. Fish populations continued to be reduced in 2007.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Welsh Reservoir. This discharge was authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. The resultant pollution coincided with reduced fish communities. EPA's Toxics Release Inventory reported that from

1998-2009, the Welsh Power Plant discharged 308,379 pounds of contaminants, including arsenic and mercury (selenium not reported), into surface waters (81). The trace element selenium bioaccumulated to levels exceeding a toxic threshold in fish tissues (4 parts per million whole-body, dry weight, 24). Total standing crop was reduced by up to 75% for some species. Analysis revealed that the levels of selenium and associated changes in fish populations were consistent with those occurring at three sister lakes (Martin Lake, TX, Hyco Reservoir, NC, Belews Lake, NC), which were also polluted by coal ash effluent during the same time period. Several fish kills were reported by Texas Parks and Wildlife Department from 1989-1999, and were attributed to elevated summer water temperatures associated with the heated discharge from Welsh Power Plant. However, the thermal tolerance limit of fish (38^0C for largemouth bass and crappie, 40^0C for catfish, 41^0C for green sunfish, 42^0C for bluegill, 82-86) was not attained in ambient areas of the reservoir and no other potential causes were examined. Metals and other pollutants in coal ash effluent are known to reduce lethal temperatures for fish and also modify their behavior in a way that would make them less likely to avoid lethal temperature zones in a heated reservoir (88-90, 96). Therefore, it is reasonable to conclude that coal ash pollution, in combination with elevated water temperature, caused the kills. Concentrations of selenium in some fish species remained above a toxic threshold in 1998, 22 years after ash pond effluent first entered the lake, and were the same as levels recorded in 1986, 12 years earlier. Fish populations were still reduced in 2007, despite changes in angler harvest regulations and artificial stocking to enhance standing crop and diversity of species. A consumption restriction advisory for selenium contamination of fish in Welsh Reservoir was issued by the Texas Department of Health from 1992-2003.

Scientific Evidence: References 81-100

Corrective Action Taken: Ash basin discharges to Welsh Reservoir were within applicable state permit limits throughout the period of damage. Some modifications in plant design and operations were done to ensure that unpermitted, uncontrolled ash basin discharges, such as those known to have occurred at a sister lake (Martin Lake) would not happen. However, as these changes did not affect permitted discharges, selenium levels in water, sediment, and fish tissues remained unchanged throughout the reporting period (1986-1998). As of 2005, some of the coal ash was being disposed in a landfill. EPA's Toxics Release Inventory reported that substantial discharges of contaminants (selenium not reported) to surface waters continued through 2009, which was the latest reporting year available (81).

Monetized Value of Damage

Ecological: (A) Value of reduction in fish populations = pre-pollution standing crop X area affected (half the total lake surface area) X percent reduction X number of years = 43,200 X 296

X 25% X 27 = 86,313,600 individuals lost X $1.00 = $86,323,600. (B) Value of damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) = pre-pollution standing crop of fish X area affected X 25% X number of years affected X $0.50 = 43,200 X 296 X 25% X 27 = 86,313,600 individuals contaminated X $0.50 = $43,156,800.
Total ecological damage value = $129,480,800.00

Recreational: The contamination at Welsh Reservoir was known from scientific studies and internal state and utility company reports, but was not disclosed to the public in popular media outlets prior to the issuance of a fish consumption advisory for selenium in 1992. After that time, a significant impact on fishing effort was acknowledged by Texas Parks and Wildlife, which stated "a fish consumption advisory issued by TDH in 1992 has contributed to low utilization of the resource by the public" (91). Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, were calculated only for the advisory period (1992-2003). (A) Value of harvestable size sport fish lost = number of species X average pre-pollution standing crop per species X area affected (one half of total lake surface area) X 25% X number of years = 8 X 1,728 X 296 X 25% = 1,022,976 X 12 years = 12,275,712 individuals X $1.00 = $12,275,712. (B) Lost value from fishing trips not taken = 4,800 angler days per year X $100 per day = $480,000 X 12 years = $5,760,000. (C) Lost value of other recreational trips not taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) = 4,800 recreational days per year X $100 per day X 12 years = $5,760,000
Total recreational damage value = $23,795,712.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners (in 1990) X approximate property value X 5% depreciation X number of years public health fish consumption advisories in effect = 20 X $250,000 = $5,000,000 X 5% = $250,000 X 12 years = $3,000,000.00.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1990 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 123,818 X 20% = 24,763 X $100 = $2,476,300.

Human Health: (A) Value of unconsumed contaminated fish = number of angler days during the period of state-issued consumption restriction advisory (4,800 angler days per year X 12 years, 1992-2003, (92, 98)) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, no consumption for children (98), subtract 720 for each adult) X $7.50 per meal = 4,800 X 12 = 57,600 X 4 = 230,400 – 1,440 (two adults and two children per family) = 228,960 X $7.50 = $1,717,200 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of

population within 30 miles (1990 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 123,818 X 20% = 24,763 X $50 = $1,238,150.
Total human health damage value = $2,955,350.00

Total Case Damage Value = $161,708,162.00

Case 7 – Henry W. Pirkey Power Plant, TX (American Electric Power)

Location of Damage: Brandy Branch Reservoir

Period of Damage: 1987-2007*
(*Fish populations were reduced by 1987 but no detailed biological effects studies of fish tissue pathology or reproductive failure were conducted. Selenium levels in fish were elevated and remained above a toxic threshold in 1997, which was the latest reporting year available. Fish populations continued to be reduced in 2007.)

Source of Damage: Surface impounded coal ash and the power plant's coal storage pile

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins and drainage from the plant's coal storage pile were discharged into Brady Branch Reservoir. Discharges from the ash pond were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2009, the Pirkey Plant discharged 49,522 pounds of contaminants, including arsenic and selenium, into surface waters (106). The trace element selenium bioaccumulated to levels exceeding a toxic threshold in fish tissues (4 parts per million whole-body, dry weight, 24). Texas Parks and Wildlife determined that during 1986-1989, average fish tissue selenium levels increased from 3.24 to 11.6 ppm dw. During 1986-2003, Texas Department of Health reviewed all data from fish monitoring over an 18-year period (1986-2003) and determined that the average concentration was 8.92 ppm dw. The levels found (8-11 ppm) are within the range associated with impaired blood chemistry and health indicators, teratogenic deformities, and reproductive failure in the same species naturally exposed to coal ash discharges at other locations (19, 50-53). However, no detailed biochemical or reproductive assessment has been done for Brandy Branch Reservoir. Changes in fish populations (reduced standing crop) were documented in a scientific study; the State concluded that those changes were due to coal ash basin discharges. Populations of some predatory sport fish (e.g., largemouth bass) continued to be reduced in 2007. A consumption restriction advisory for selenium contamination of fish in Brandy Branch Reservoir was issued by the Texas Department of Health from 1992-2003.

Scientific Evidence: References 1, 93, 99-109

Corrective Action Taken: In 1998 the power plant altered its coal storage practices to prevent discharge of stormwater runoff into the reservoir. As of 2005, some of the coal ash was being disposed in a landfill. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including arsenic and selenium, to surface waters continued in 2009, which was the latest reporting year available (106).

Monetized Value of Damage

Ecological: (A) Value of reduction in fish populations = pre-pollution standing crop X area affected (half the total lake surface area) X percent reduction X number of years = 39,620 X254 X 25% X 21 = 52,833,270 individuals lost X $1.00 = $52,833,270. (B) Value of damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) = pre-pollution standing crop of fish X area affected X 25% X number of years affected X $0.50 = 39,620 X 254 X 25% X 21 = 52,833,270 individuals contaminated X $0.50 = $26,416,635.
Total ecological damage value = $79,249,905.00

Recreational: The contamination at Brandy Branch Reservoir was known from scientific studies and internal state and utility company reports, but was not disclosed to the public in popular media outlets prior to the issuance of a fish consumption advisory for selenium in 1992. After that time, a significant impact on fishing effort was acknowledged by Texas Parks and Wildlife, which stated "public use of the fishery has been low due to poor fishing quality and the TDH advisory" (105). Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, were calculated only for the advisory period (1992-2003). (A) Value of harvestable size sport fish lost = number of species X average pre-pollution standing crop per species X area affected (one half of total lake surface area) X 25% X number of years = 8 X 1,307 X 254 X 25% = 663,956 X 12 years = 7,967,472 individuals X $1.00 = $7,967,472. (B) Lost value from fishing trips not taken = 4,800 angler days per year X $100 per day = $480,000 X 12 years = $5,760,000. (C) Lost value of other recreational trips not taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) = 4,800 recreational days per year X $100 per day X 12 years = $5,760,000
Total recreational damage value = $19,487,472.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners (in 1990) X approximate property value X 5% depreciation X number of years public health fish consumption advisories in effect = 20 X $250,000 = $5,000,000 X 5% = $250,000 X 12 years = $3,000,000.00.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1990 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 173,992 X 20% = 34,798 X $100 = $3,479,800.

Human Health: (A) Value of unconsumed contaminated fish = number of angler days during the period of state-issued consumption restriction advisory (4,800 angler days per year X 12 years, 1992-2003, (103, 108-109)) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, no consumption for children (108), subtract 720 for each adult) X $7.50 per meal = 4,800 X 12 = 57,600 X 4 = 230,400 – 1,440 (two adults and two children per family) = 228,960 X $7.50 = $1,717,200 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (1990 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 173,992 X 20% = 34,798 X $50 = $1,739,900.
Total human health damage value = $3,457,100.00

Total Case Damage Value = $108,674,277.00

Case 8 – Savannah River Site D-Area Power Plant, SC (US Department of Energy)

Location of Damage: Beaver Dam Creek and associated wetlands

Period of Damage: 1973-2004*
(*The last biological effects studies were in 2004. A suite of investigations from 1973-2004 showed mortality and a variety of developmental, physiological, and behavioral effects in fish and wildlife. Concentrations of trace elements remained elevated in 2004, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Beaver Dam Creek and associated wetlands. These discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2005, the D-Area Power Plant discharged 25,326 pounds of contaminants to surface waters (110). Concentrations of arsenic, cadmium, chromium, copper, selenium, strontium, and vanadium were elevated in alligators, turtles, snakes, fish, frogs, salamanders, toads, crayfish, rats, raccoons, birds, and clams. Selenium bioaccumulated to levels exceeding a toxic threshold in fish tissues (4 parts per million whole-body, dry weight, 24). A variety of lethal and sublethal effects were documented in the biota of this ecosystem. Populations of benthic invertebrates were reduced. Impacts to

fish included elimination of at least 5 species, fin erosion, reduced swimming performance, and reduced growth. Snakes exhibited liver pathology and elevated metabolic rate. Frogs exhibited axial and oral deformities, increased metabolic rate, reduced swimming performance and reduced predator avoidance. Adult toads had abnormal levels of sex hormones and larval toads experienced 100% mortality. Salamanders experienced an extended larval period and showed reduced recruitment. Cotton rats had a high incidence of malformed DNA strands. The interaction of multiple sublethal effects was sufficient to reduce recruitment and cause population-level impacts in frogs.

Scientific Evidence: References 110-149

Corrective Action Taken: Beginning in 2001, a vegetative cover treatment study was done to develop ways of reducing acid drainage from the ash basin (144). Since that time, the ash basin has been operated as a landfill, with permanent capping and vegetation of filled areas. Final remediation of the site is expected to begin in 2015, concurrent with closure of the coal-fired power plant (145-147). EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including mercury and lead (selenium not reported) continued in 2005, which was the latest reporting year available (110).

Monetized Value of Damage

Ecological: (A) Damage from fish eliminated in wetlands = number of species X average standing crop (estimate for unpolluted Carolina bay wetland, 143-144) X area affected X number of years = 5 X 2,500/ha X 2 ha X 32 = 800,000 individuals X $1.00 = $800,000. (B) Added damage cost from local extinction of species = value loss from (A) X the % of total species represented by one species X number of extirpated species = $800,000 X 10% = $80,000 X 5 = $400,000. (C) Damage to fish contaminated but not eliminated in wetlands (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) = number of species X average standing crop (estimate for unpolluted Carolina bay wetland, 148-149) X 90% X area affected X number of years = 5 X 2,500/ha X 0.9 X 2 ha X 32 = 720,000 individuals contaminated X $0.50 = $360,000. (D) Damage to fish in Beaver Dam Creek = length of stream affected X average standing crop per kilometer X percentage exceeding toxic effects threshold of selenium (4 ppm) X number of years affected = 5 km X 5,100 (half the standing crop of other ash-impacted streams of similar size and species composition, 46-51) X 50% X 32 = 408,000 X $0.50 = $204,000. (E) Damage to frogs from deformities = annual production of tadpoles per hectare (half the total estimated from unpolluted Carolina bay wetland, 149) X percentage deformed X area affected X number of years = 180,000 X 90% X 2 ha X 32 = 10,368,000 X $1.00 = $10,368,000. (F) Damage to toads = annual production of larvae per hectare (half the total estimated from unpolluted Carolina bay wetland, 149) X percentage mortality of larvae X area

affected X number of years = 77,000 X 70% X 2 ha X 32 = 3,449,600 X $1.00 = $3,449,600. (G) Damage to salamanders = annual production of larvae per hectare (half the total estimated from unpolluted Carolina bay wetland, 149) X percentage mortality of larvae X area affected X number of years = 35,000 X 67% X 2 ha X 32 = 1,500.800 X $1.00 = $1,500,800. (H) Value of sublethal physiological damage to fish, snakes, frogs, toads, salamanders, and crayfish = half the aggregate standing crop X area affected X number of years = 1,2,50 (fish) + 30 (snakes) + 2,500 (frogs) + 500 (toads) + 500 (salamanders) + 4,500 (crayfish) = 9,280 X 2 ha X 32 = 593,920 X $0.50 = $296,960. (I) Value of reduction in benthic macroinvertebrate communities = area affected X 50% of the value per hectare X percent reduction X number of years = 3 ha X $50,000 X 50% X 8 = $600,000.
Total ecological damage value = $17,979,360.00

Recreational: Public access is prohibited so there is no recreational value loss.

Real Estate: There is no private ownership of property at this site.

Aesthetic: The contamination at this site is known from scientific studies and internal federal reports, but has not been disclosed to the public in popular media outlets. Therefore, it was not possible to estimate aesthetic value losses, which would be dependent on that knowledge.

Human Health: There is no consumptive use at this site. Lack of public knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $17,979,360.00

Case 9 – Gibson Generating Station, IN (Duke Energy)

Location of Damage: Gibson Lake and Cane Ridge Wildlife Management Area

Period of Damage: 1997-2010*
(*Fish populations in Gibson Lake were severely reduced by 1997 but no detailed biological effects studies of fish tissue pathology or reproductive failure have been conducted. Selenium levels in fish were elevated and remained above a toxic threshold in 2010.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Gibson Lake. These discharges were exempt from regulation under the federal-state National Pollutant Discharge Elimination System because Gibson Lake is on company property and is hydrologically closed (does not discharge to state waters). Water from the reservoir was used to maintain 80 hectares of “moist soil” wetland habitat and a 25 hectare

nesting pool for endangered birds at a nearby federal wildlife management area, which also became contaminated. The trace element selenium bioaccumulated in fish to levels exceeding a toxic threshold (4 parts per million, whole-body, dry weight, 24). The levels found (9-30 ppm) are within the range associated with impaired blood chemistry and health indicators, teratogenic deformities, and reproductive failure in the same species naturally exposed to coal ash discharges at other locations (19, 50-53). However, no detailed biochemical or reproductive assessment has been done for Gibson Lake. By 1997, fish populations were severely reduced and at least eight selenium-sensitive species had disappeared from the reservoir (largemouth bass, bluegill, pumpkinseed, warmouth, longear sunfish, white crappie, black crappie, white bass). Fishery biologists with the Indiana Department of Natural Resources attributed this loss to increased water temperature associated with heated water discharges from Gibson Generating Station. However, the thermal tolerance limit of these species (e.g., 38^0C for largemouth bass and crappie, 42^0C for bluegill, 82-85) was not attained in ambient areas of the reservoir and no other potential causes were examined. Metals and other pollutants in coal ash effluent are known to reduce lethal temperatures for fish and also modify their behavior in a way that would make them less likely to avoid lethal temperature zones in a heated reservoir (88-90, 96). Therefore, it is reasonable to conclude that coal ash pollution, in combination with elevated water temperature, eliminated the fish. In order to reduce threats to endangered birds at Cane Ridge Wildlife Management Area, 105 hectares of wetlands and ponds on the refuge were drained, which eliminated all aquatic life. A consumption restriction advisory for selenium contamination of fish in Gibson Lake was issued by Duke Energy in 2007, and the lake was closed to fishing that same year.

Scientific Evidence: References 145-161

Corrective Action Taken: Duke Energy paid for construction of a pipeline to deliver low-selenium water pumped from the Wabash River to Cane Ridge Wildlife Management Area, which began operation in late 2008. Prior to this transfer of clean water, refuge managers drained wetlands and ponds (eliminating all aquatic life in the process), and tilled bottom soils in an effort to bury selenium-laden sediment and reduce toxic hazards to endangered birds. The utility company is converting one of its six ash ponds to a landfill by 2013 and is scheduled to close it by 2020. Other ponds still handle liquid waste.

Monetized Value of Damage

Ecological: (A) Damage to reservoir fisheries = pre-pollution standing crop per hectare X area affected X percentage reduction X number of years = 12,129 X 708 ha (half the surface area of the lake) X 50% X 14 = 60,111,324 individuals lost X $1.00 = $60,111,324. (B) Added damage cost due to local extinction of species = value loss from (A) X the % of total species represented

by one species X number of extirpated species = $60,111,324 X 5% X 8 = $24,044,529. (C) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic threshold of 4 ppm) = 14 years X pre-pollution standing crop X 708 ha X 25% = 30,055,662 individuals X $0.50 = $15,027,831. (D) Damage to Cane Ridge Wildlife Management Area = number of least tern fledglings prevented due to habitat loss or degradation X value per fledgling per Endangered Species Act violation year (different cost per fledgling for 2007 and 2008, 154) = 50 X $3,500 for 2007 = $175,000; 50 X $7,500 for 2008 = $375,000; total = $550,000. (E) Value of destroyed aquatic life and ecosystems at Cane Ridge during management actions to reduce contamination = area destroyed X value per hectare X number of years = 105 ha X $100,000 X 2 = $21,000,000.
Total ecological damage value = $120,733,684.

Recreational: (A) Value of harvestable-size sport fish lost at Gibson Lake during 1997-2010 = number of species X average pre-pollution standing crop per species X 50% = 8 X 860 X 50% = 3,440 individuals per hectare X 708 hectares = 2,435,520 X 14 years = 34,097,280 individuals X $1.00 = $34,097,280. (B) Lost value from fishing trips not taken following closure of lake = 2,800 angler days per year X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $280,000 per year X 4 years = $1,120,000
Total recreational damage value = $35,217,280.00

Real Estate: There is no public ownership of property at this site.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 338,415 X 20% = 67,683 X $100 = $6,768,300.

Human Health: (A) Value of unconsumed contaminated fish at Gibson Lake = number of angler days during the period of utility-issued consumption restriction advisory (2,800 angler days per year X 4 years, 2007-2010 (156-157) X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per week per adult, I meal per month for children (156-157), subtract 720 for each adult, 180 for each child) X $7.50 per meal = 2,800 X 4 = 11,200 X 4 = 44,800 – (1,440 + 360) (two adults and two children per family) = 43,000 X $7.50 = $322,500 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 338,415 X 20% = 67,683 X $50 = $3,384,150.
Total human health damage value = $3,706,650.00

Total Case Damage Value = $166,425,914.00

Case 10 – Oak Ridge Y-12 Steam Plant, Chestnut Ridge Operable Unit 2, TN
(US Department of Energy)

Location of Damage: McCoy Branch and Rogers Quarry

Period of Damage: 1967-2009*
(*Ash pond overflow began entering McCoy Branch in 1967. Biological monitoring studies began in 1989 and continued, periodically, through 2009. Contamination and impacts on fish populations were still evident in 2009, which was the latest reporting year available.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated slurry water in a coal ash disposal basin overflowed a retention dam and entered a steam/quarry pond ecosystem. The trace element selenium bioaccumulated in aquatic food chains and reached levels exceeding a toxic threshold in fish tissues (4 parts per million whole-body, dry weight, 24). All fish were eliminated from McCoy Branch upstream of Rogers Quarry. Fish in Rogers Quarry and Lower McCoy Branch exhibited high percentages of deformed spines, heads, and fins (up to 73% of some species were deformed). These deformities, in combination with the elevated tissue selenium concentrations found (up to 50 ppm dw) are diagnostic markers of selenium poisoning (24). Benthic macroinvertebrate communities were reduced in McCoy Branch both above and below Rogers Quarry (168). Ash pond effluent was discharged into Rogers Quarry for only one year (mid-1989 to mid 1990), yet concentrations of selenium in fish at that site remained elevated above a toxic threshold in 2009, 19 years later. Efforts to reintroduce fish to Upper McCoy Branch in the mid-1990's were unsuccessful, but were attempted again in 2006-2009. As of 2009, two species were surviving due to stocking, banded sculpin and western blacknose dace. The ecosystem originally supported 15 fish species. Because of concerns about human health, "NO HUNTING" signs were posted along the perimeter of the coal ash pond in 1997. However, no such warnings were posted along McCoy Branch or at Rogers Quarry, which remained open for public access for both fishing and Oak Ridge Reservation game hunts that were held several times a year (177). Concentrations of selenium in muscle fillets of largemouth bass from Rogers Quarry equaled or exceeded consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48) from 1990-2009 (178).

Scientific Evidence: References 1, 167-179

Corrective Action Taken: The ash pond was full by 1967 and no longer met its purpose of removing solids by gravitational settling. In 1989, a bypass pipe was constructed to carry ash slurry directly from the steam plant to Rogers Quarry. Disposal of ash into Rogers Quarry was discontinued in 1990, when a chemical vacuum system and a bottom ash dewatering system

were installed at the plant. Both fly ash and bottom ash were then disposed in a landfill. However, existing ash deposits were left in place and due to erosion of both the spillway and the ash itself, releases of ash into Upper McCoy Branch continued. A remedial action was conducted as part of CERCLA activities to stabilize the filled coal ash pond. McCoy Bridge Dam was renovated to hold ash and contaminated pond sediments in place and a passive treatment system (oxidation pond and constructed wetland) were added to intercept the perpetual drainage expected from the ash, with the intention of reducing contaminant loading to Upper McCoy Branch. A natural wetland which was destroyed during stabilization activities was re-constructed as part of the remedial action. Physical work was completed in March 1997. However, the selected remedy does not satisfy the statutory (CERCLA) preference for treatment, which is to permanently and significantly reduce toxicity, mobility, and volume of the contamination. The preferred outcome is not possible because treatment of the large volume of coal ash at this site was deemed "not practicable". The ash will remain in place at the site, and surface water will receive limited treatment. Institutional controls will restrict access to the contamination and reduce risk to human health. Actions taken to isolate the ash, restrict animal access, and reduce contaminant migration to surface water should reduce risk to ecological receptors. A recurring five year review will be conducted to verify that the remedy continues to protect human health and, to the extent possible, the environment. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including lead and mercury (selenium not reported), to surface waters continued through 2009 (179).

Monetized Value of Damage

Ecological: (A) Damage to fish in Upper McCoy Branch during period of extirpation (1967-2006) = 43 years X average standing crop of all species in Lower McCoy Branch X length of stream affected = 43 X 10,500 per km X 1 km = 451,500 individuals lost X $1.00 = $451,500. (B) Added damage cost from local extinction of species = aggregate value (A) X the % of total species represented by one species X number of extirpated species = $451,500 X 6.67% = $30,250 X 15 = $453,757. (C) Damage to fish deformed in Lower McCoy Branch = number of years X number of fish X $1.00 = 3 years (1989-1991) X 40% of standing crop X length of stream affected = 3 X 4,200 X 1 km = 12,600 X $1.00 = $12,600. (D) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) in Lower McCoy Branch = number of years X 50% of standing crop X length of stream affected X $0.50 = 21 years (1989-2009) X 5,250 X 1 km X $0.50 = $55,125. (E) Damage to fish deformed in Rogers Quarry = number of years X number of fish X $1.00 = 4 years (1990-1993) X 33% of standing crop X $1.00 = 4 X 3,300 X $1.00 = 13,200 X $1.00 = $13,200. (F) Damage to fish contaminated but not eliminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) in Rogers Quarry = number of years X 50% of standing crop X area affected X $0.50 = 21 X 5,000

per hectare X 7 ha X $0.50 = $367,500. (G) Value of reduced benthic macroinvertebrate communities = area affected X 50% of the value per hectare X percent reduction X number of years = 2 ha X $50,000 X 50% X 6 = $300,000
Total ecological damage value = $1,653,682.00

Recreational: Public utilization of areas other than the coal ash pond is not restricted. Moreover, the "NO HUNTING" signs posted at the coal ash pond do not specify dangers from consumption of contaminated game animals. The contamination in McCoy Branch and Rogers Quarry is known from scientific studies and internal federal reports, but has not been disclosed to the public in popular media outlets. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred.

Real Estate: There is no private ownership of property at this site.

Aesthetic: The contamination at this site is known from scientific studies and internal federal reports, but has not been disclosed to the public in popular media outlets. Therefore, it is not possible to estimate aesthetic value losses, which would be dependent on that knowledge.

Human Health: Concentrations of selenium in muscle tissue of sport fish in 1990-2009 have reached consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisory has been issued so associated negative human health values could not be calculated. Similarly, the "NO HUNTING" signs posted at the coal ash pond do not specify a threat from contamination. Public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $1,653,682.00

Case 11 – Clinch River Plant, VA (American Electric Power)

Location of Damage: Clinch River

Period of Damage: 1967-1990*
(*Faunal surveys conducted in 1974 found that the fish community remained altered. Populations of mussels remained reduced in 1990, which was the latest reporting year available prior to the initiation of restocking efforts.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: In June 1967, the dike surrounding a fly ash lagoon collapsed, releasing a slug of coal ash slurry into the Clinch River. The release lasted approximately one hour and was equivalent, in volume, to 40% of the daily flow of the river at that time. Free lime

(CaO) in the ash reacted with water in the lagoon to produce a highly alkaline (pH>12) slurry. Thus, the toxicity observed during the release was due to elevated pH rather than high concentrations of metals or other constituents. At least 217,000 fish were killed from acute toxicity in a 106 km stretch of the river. Benthic macroinvertebrates were completely eliminated for a distance of 6 km below the spill site and drastically reduced in number for 124 km below the site. Mollusks (snails and mussels) were eliminated for 18 km below the power plant. Two years after the spill, fish were completely absent for 2 km downstream and the species composition and relative abundance of fish remained altered 8 years later despite extensive stocking (126,500 individuals representing 6 species) to speed recovery. Mollusk populations remained reduced 24 years later, including several threatened and endangered species of mussels.

Scientific Evidence: References 180-191

Corrective Action Taken: The failed dike was repaired and the impoundment remained in service. As of 2005, some of the coal ash was being disposed in a landfill. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including arsenic and barium (selenium not reported), to surface waters from the Clinch River Plant continued through 2009, which was the latest reporting year available (191).

Monetized Value of Damage

Ecological: (A) Fish killed from acute toxicity = 217,000 X $1.00 = $217,000. (B) Fish lost during 1967-1969 = standing crop X length of river affected X number of years = 15.75 individuals per linear meter X 2,000 meters X 3 = 94,500 individuals X $1.00 = $94,500. (C) Added damage cost from local extinction of species = aggregate value (A+B) X the % of total species represented by one species X number of extirpated species = $311,500 X 6.66 X 15 = $311,500. (D) Mussels killed from acute toxicity = density X length of river affected = 3 per linear meter X 18,000 m = 54,000 X $1.00 = $54,000. (E) Mussels lost during 1967-1969* = density X length of river affected X number of years = 3 per liner meter X 30,000 m X 3 = 270,000 X $1.00 = $270,000. (*Since the coal ash spill occurred prior to 1973, when the federal Endangered Species Act was enacted, no added costs of ESA penalties, which would amount to $3,500 per individual, were added to the damages for mussels). (F) Added damage cost from local extinction of species = aggregate value (D+E) X the % of total species represented by one species X number of extirpated species = $324,000 X 2.44% X 41 = $324,000. (G) Cost of lost mussels during 1970-1990 = pre-pollution density X % reduction in density X length of river affected X number of years X $1.00 = 3 per linear meter X 25% X 30,000 m X 21 X $1.00 = $472,500. (H) Value of lost (6km) and reduced (124 km) benthic macroinvertebrate communities (non-mussels) due to initial spill = area affected X 50% of the value per hectare X percent reduction X number of

years = 124 ha X $50,000 X 50% X 1 = $3,100,000. (I) Value of reduced benthic macroinvertebrate communities after the spill due to chronic discharges = area affected X 50% of the value per hectare X percent reduction X number of years = 3 ha X $50,000 X 50% X 2 = $150,000.
Total ecological damage value = $4,993,500.00

Recreational: (A) Value of harvestable-size sport fish lost during 1967-1969 = standing crop X 20% X length of river affected X number of years X $1.00 = 15.75 individuals per linear meter X 20% X 2,000 m X 3 X $1.00 = $18,900. (B) Replacement cost of fish gained through stocking = number of fish X $1.00 = $126,500. (C) Lost value from fishing trips not taken during 1967-1969 due to concerns about pollution = 500 angler days per year X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $50,000 per year X 3 years = $150,000. (D)) Lost value of other recreational trips not taken due to stigma of pollution or concerns about health and safety issues (camping, boating, swimming, etc) = 400 recreational days per year X $100 per day X 3 years = $120,000.
Total recreational damage value = $415,400.

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of riverfront property owners (in 1970, including 30 km downstream of spill) X approximate property value X 5% depreciation X number of years of primary pollution impact = 100 X $250,000 = $25,000,000 X 5% = $1,250,000 X 3 years = $3,750,000.00.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (1970 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 72,458 X 20% = 14,492 X $100 = $1,449,200.

Human Health: (A) Value of unconsumed fish = number of angler days lost during 1967-1969 X 4 fish meals per angler day = 1,500 X 4 = 6,000 X $7.50 per meal = $45,000 (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (1970 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 72,458 X 20% = 14,492 X $50 = $724,600.
Total human health damage value = $769,600.00

Total Case Damage Value = $11,377,700.00

Case 12 – Bull Run Fossil Plant, TN (Tennessee Valley Authority)

Location of Damage: Melton Hill Reservoir

Period of Damage: 1974-2010*
(*Biological effects studies showed acute toxicity of ash pond seepage to fish in 1974. Monitoring studies showed toxic levels of metals and selenium in fish in 1991-2008. Ash pond effluent and seepage discharge continued in 2010.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent and seepage from coal ash settling ponds was discharged into Upper Melton Hill Reservoir. The effluent discharge was authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2009, the Bull Run Plant discharged 215,483 pounds of contaminants into Melton Hill Reservoir (192). The seepage water was acutely toxic to fish and both the seepage and effluent water contained elevated concentrations of selenium, arsenic, and heavy metals (193). Selenium concentrations were elevated to a toxic threshold (4 parts per million whole-body, dry weight, 24) in some of the fish collected in 1991-2008, and a summary report (196) concluded that the levels of arsenic and selenium in fish warranted further study. Another investigation (194) concluded that "bioaccumulation appears to confirm that exposures to high aqueous concentrations have occurred". Melton Hill Reservoir consistently receives a poor-to-fair ecological health rating for fish and bottom life (204). Fish productivity, species diversity and abundance are lower than expected for local run-of-the-river impoundments (198-199). Poor health and low productivity have been attributed to (hypothesized but not confirmed) fluctuating water temperatures due to cold tailwater releases from an upstream reservoir (Norris Reservoir), thought to possibly affect reproductive success and growth rate of warm-water fish species. However, this explanation is tenuous since the geographic range of the "warm-water" species in question includes waters in northern states that experience far colder temperatures than Melton Hill Reservoir, with no apparent effect on reproduction or productivity (203). Although detailed physiological and reproductive studies of the effects of coal ash contaminants on fish populations in Melton Hill Reservoir have not been conducted, there are six lines of evidence pointing to long-term detrimental effects: (1) Acute waterborne toxicity in fish exposed to near-shore discharges indicates that high concentrations of coal ash contaminants are entering Melton Hill Reservoir in seepage water and ash pond effluent, which would tend to disperse and accumulate over time, (2) Concentrations of selenium in fish have reached a toxic threshold, which indicates that bioaccumulation of dispersed waterborne contaminants has occurred, (3) The fish community of Melton Hill Reservoir includes several species that are extremely sensitive to coal ash pollutants such as selenium (i.e., centrarchids). These fish could experience negative effects from chronic exposure, reflected in depressed populations, even though other measures of ecosystem health may appear normal, (4) The fish community of

Upper Melton Hill Reservoir, which is the ash pond discharge arm of the lake, received a "poor" health rating whereas other areas of the impoundment received a "fair" or "good" rating (198, 204), (5) The current state permit allows Bull Run Fossil Plant to discharge 19 million gallons of contaminated ash pond effluent into Upper Melton Hill Reservoir each day (210). The volume released is equal to the total daily municipal wastewater discharge from a city of approximately 100,000 people (207-208), and resulted in a loading of over 55,000 pounds of toxic materials to the reservoir in 2009 (selenium not inventoried, 192, 209), and (6) seepage of highly contaminated wastewater from the ash ponds into the reservoir has been a documented, chronic occurrence for the past 37 years (1974-2010, 193, 202, 206).

Scientific Evidence: References 192-211

Corrective Action Taken: Inspections dating back to 1974 indicate persistent seepage of highly contaminated ash pond water through retention dikes along the reservoir (193). These structural failures were addressed with various types of grading and patching, with limited success. As recently as 2008, problematic, uncontrolled seepage continued (200-201). A major new regrading effort was completed in 2010 (206), which included the installation of a French drain under the dike surrounding the gypsum disposal area. This action improves dike integrity by removing seepage but does not reduce the amount of contaminated water reaching Melton Hill Reservoir. Instead, the French drain collects and channels water from diffuse sources into a concentrated discharge stream, which may actually increase contaminant loading to the reservoir. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including arsenic and zinc (selenium not reported), to surface waters from the Bull Run Plant continued through 2009, which was the latest reporting year available. Releases for 2009 (55,000 pounds) amounted to more than the previous four years combined (192).

Monetized Value of Damage

Ecological: Value of reduced fish populations = standing crop X area affected (upper third of reservoir) X percent reduction X number of years = 12,390 per ha X 738 ha X 10% X 37 = 33,832,134 individuals lost X $1.00 = $33,832,134.

Recreational: The contamination at this site is known from scientific studies and internal state and federal reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred. (A) Value of harvestable-size sport fish lost during 1974-2010 = total individuals lost X 20% X $1.00 = 33,832,134 X 20% X $1.00 = $6,766,426.

Real Estate: The contamination at this site is known from scientific studies and internal state and federal reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on real estate values, which would be dependent on that knowledge, have not occurred.

Aesthetic: Same as for Real Estate

Human Health: Same as for Real Estate. Also, public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $40,598,560.00

Case 13 – J.R. Whiting Power Plant, MI (Consumers Energy)

Location of Damage: Lake Erie

Period of Damage: 1973-2002*
(*The power plant began discharging ash pond effluent in 1953 but the first contaminant monitoring study was in 1973. The last biological effects assessment was in 1984. It showed contaminated sediments, food-chain, and fish associated with reduced fish and invertebrate populations. Ash pond discharges continued unabated until 2002.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Lake Erie. These discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that from 1998-2009, the Whiting Power Plant discharged 73,723 pounds of contaminants into Lake Erie (212,215). Selenium, arsenic, and several trace metals accumulated in sediments, benthic invertebrates and fish. Concentrations of selenium in fish food organisms were above a chronic dietary toxic level (3 parts per million, dry weight, 24). Concentrations of selenium in fish tissues reached 14 parts per million (whole-body, dry weight), which is three and one-half times a toxic threshold (4 ppm, 24). Numbers of benthic invertebrates and fish were reduced in the area near the discharge.

Scientific Evidence: References 212-217

Corrective Action Taken: The electric utility company began to landfill coal ash in 2002. Consequently, release of ash pond effluent was reduced. As of 2009, the coal ash ponds were in the process of being closed. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including mercury and vanadium (selenium not reported), to

surface waters from the Whiting Plant continued through 2009, which was the latest reporting year available (212).

Monetized Value of Damage

Ecological: Value of reduced aquatic communities = area affected X 50% of the value per hectare X percent reduction X number of years = 2 ha X $50,000 X 50% X 30 = $1,500,000. Total ecological damage value = $1,500,000.00

Recreational: The contamination at this site is known from scientific studies and internal state and utility company reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred. No fish standing crop data were available from which to estimate value of harvestable-size sport fish lost.

Real Estate: Same as for Recreational

Aesthetic: Same as for Recreational

Human Health: Same as for Recreational. Also, no information was available for angler use of the affected area so it was not possible to estimate losses from unconsumed fish. Public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $1,500,000.00

Case 14 – Mitchell Power Plant, WV (American Electric Power)

Location of Damage: Connor Run Creek

Period of Damage: 2005-2010*
(*The power plant began discharging ash effluent in 1971 but no biological monitoring was conducted until 2005-2007. No biological effects studies have been done. Discharge of ash pond effluent continued unabated in 2010.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Contaminated effluent from coal ash disposal basins was discharged into Connor Run Creek, which empties into Fish Creek and then the Ohio River. These discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. EPA's Toxics Release Inventory reported that during 1998-2009, the Mitchell Plant discharged 4,302 pounds of contaminants into surface waters

(218). In addition to ash pond effluent, seepage through ash pond retention dikes also entered Fish Creek and the Ohio River but there has been no reported biological monitoring of these receiving waters. The trace element selenium bioaccumulated in fish to concentrations up to 30 parts per million (average = 26 ppm, 60). These levels are over 7 times the toxic threshold for fish (4 ppm whole-body, dry weight, 24), and have caused selenium poisoning and reproductive failure in sensitive species (centrarchids) in coal-ash impacted streams at other locations in West Virginia (51-53). The West Virginia Department of Environmental Protection has classified Connor Run as a fly ash influenced stream (60). Concentrations of selenium in muscle tissue of sport fish exceed West Virginia's consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisory has been issued.

Scientific Evidence: References 51-53, 60, 218-220

Corrective Action Taken: No action has been taken despite elevated selenium concentrations indicative of toxic impacts. The West Virginia Department of Environmental Protection has issued a variance in the water quality standard for Connor Run, raising it from the USEPA national criterion value of 5 ug/L to a permissible level of 62 ug/L (220). This action was not approved by EPA, nor was it based on a site-specific standard development process that included supporting biological studies. EPA's Toxics Release Inventory reported that substantial discharges of contaminants, including barium and lead (selenium not reported), to surface waters from the Mitchell Plant continued through 2009, which was the latest reporting year available (218).

Monetized Value of Damage

Ecological: Value of fish contaminated in Connor Run = length of stream X standing crop X 100% X number of years X $0.50 = 610 m X 10.2/ m (estimated from other WV coal-ash influenced streams, 49-53) = 6,222 X 100% X 6 = 37,332 individuals X $0.50 = $18,666.

Recreational: The contamination at this site is known from internal state and utility company reports, but has not been disclosed to the public in popular media outlets. Moreover, public access has not been restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, have not occurred.

Real Estate: Same as for Recreational.

Aesthetic: Same as for Recreational

Human Health: Concentrations of selenium measured in muscle tissue of sport fish in 2005-2007 exceeded West Virginia's consumption restriction advisory levels (10 parts per million dry weight, or 2.5 parts per million wet weight, 48). However, no advisory has been issued so associated negative human health values could not be calculated. Also, public lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $18,666.00

Case 15 – Bowen Power Plant, GA (Georgia Power)

Location of Damage: Euharlee Creek and a tributary stream

Period of Damage: 2002, 2008

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: On July 28, 2002, a sinkhole developed in the coal ash disposal pond causing the release of 2.25 million gallons of ash slurry (containing 281 tons of ash) into an unnamed tributary of Euharlee Creek. Ash deposits blanketed approximately 2,500 linear feet of the stream and flowed onto adjacent private property. Approximately 80 tons of ash entered Euharlee Creek through a stormwater drainage pipe, resulting in deposition of an ash blanket up to 8 inches deep over some 1,850 square feet of the stream bottom. Two weeks after the spill, concentrations of arsenic, cadmium, chromium, copper, lead, mercury, and nickel in Euharlee Creek were found to exceed EPA's ecological screening values, indicating a high potential for toxic impacts to aquatic life. Sediment concentrations of arsenic were measured at 14 ppm dw, a level that is over 5 times the toxic threshold. Biological sampling indicated that benthic organisms in the tributary and ash deposition zone of Euharlee Creek were either killed by contaminants or physically smothered. The resident fish community, which consisted of at least 25 species, was displaced due to the irritation of high turbidity in the ash plume as it moved through during the spill event. One month after the spill, concentrations of selenium and cadmium were elevated in crayfish, clams, mollusks, and insects at a downstream site in Euharlee Creek. A second spill occurred following a heavy rain event on September 9, 2008, when a portion of the ash stack in the Bowen Plant ash pond eroded and flowed over the ash pond dike. Approximately 40 tons of ash left plant property and flowed onto nearby residential property, and about 2 tons of ash entered Euharlee Creek. For each of the spills, the Georgia Department of Natural Resources imposed a fine for ecological damage to Euharlee Creek.

Scientific Evidence: References 221-232

Corrective Action Taken: The sinkhole in the ash pond was repaired and ash deposits in Euharlee Creek were removed by suction dredging in 2002. As of 2005, some coal ash from the Bowen Plant was being disposed in a landfill. Following the 2008 spill, ash was removed from residential properties within 30 days but was never removed from Euharlee Creek. EPA's Toxics Release Inventory reported that separate and apart from the spills, the Bowen Plant released 210,337 pounds of contaminants into surface waters from 1998-2009 (232). There was a 20-fold increase in selenium discharges during 2007-2009 (150 to 3,200 pounds).

Monetized Value of Damage

Ecological: Value of aquatic benthic community extirpation and fish community impairment and dislocation = area affected X value per hectare X number of years = 1 hectare X $100,000 X 2 = $200,000.

Recreational: Lost value from fishing trips not taken due to stigma of pollution = 100 angler days X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $10,000.

Real Estate: Depreciated value due physical damage (ash deposition) and stigma of environmental pollution = approximate number of creekfront property owners (in 2002) X approximate property value X 5% depreciation X number of years = 10 X $250,000 = $2,500,000 X 5% X 2 = $250,000.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 188,557 X 20% = 37,711 X $100 = $3,771,100.

Human Health: Losses due to stress and anxiety of knowing ecosystem is polluted, property damaged, and aquatic communities are poisoned = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 188,557 X 20% = 37,711 X $50 = $1,885,550.

Total Case Damage Value = $6,116,650.00

Case 16 – Jim Bridger Power Plant, WY (Pacific Power)

Location of Damage: Wastewater disposal ponds

Period of Damage: 1992-2010

Source of Damage: Surface impounded Flue Gas Desulfurization (FGD) wastewater

Cause and Extent of Damage: FGD water was disposed in two large ponds comprising about 190 hectares in total surface area. The ponds were not subject to regulation under the federal-state National Pollutant Discharge Elimination System because they were on utility company property and did not discharge to state waters. The pond water contained high concentrations of dissolved salts, which formed a crust on the feathers of waterbirds that came in contact with it, destroying their insulation and buoyancy. Affected birds either died from hypothermia or drowned due to accumulation of minerals on their feathers. In addition to physical effects, the amount of salts in brain tissue was elevated above toxic levels within three hours after birds arrived on the ponds. An average of 84 birds died annually from 1992-1996, and 20 per year from 1997-2010.

Scientific Evidence: References 233-237

Corrective Action Taken: In 1992, Pacific Power was notified by the US Fish and Wildlife Service of their liabilities for wildlife damage under the Migratory Bird Treaty Act (MTBA), which prohibits killing of migratory birds. From 1992-1996, utility personnel used boats to rescue wildlife that entered the water and was unable to escape. Captured birds were cleaned of the chemical precipitate and returned to the wild. An elaborate hazing program was initiated in 1997, including loud speakers (acoustic alarm calls), pyrotechnics, chemical repellents (bird tear gas), round-the-clock radar detection/activation, and human surveillance during daylight hours to deter wildlife use. Despite these measures, some birds still utilize the FGD ponds and some die due to the salt accumulation. Moreover, resident species nest in an adjacent freshwater pond (e.g., 140 eared grebe nests documented in a site visit in 2000), some only meters away from the contaminated habitat.

Monetized Value of Damage

Ecological: (A) Value of migratory birds lost before hazing (1992-1996) = average number killed per year X number of years X value per bird = 84 X 5 X $10,000 (MBTA fine, 233) = $4,200,000. (B) Value of migratory birds lost after hazing (1997-1998) = average number killed per year X number of years X value per bird = 20 X 2 X $10,000 (MBTA fine for 1997-1998) = $400,000. (C) Value of migratory birds lost after hazing (1999-2010) = average number killed per year X number of years X value per bird = 20 X 12 X $15,000 (MBTA fine for 1999-2010, 237) = $3,600,000. (D) Cost of wildlife surveillance and rescue from 1992-2010 = number of personnel X hours per day X number of days per year X number of years X cost per hour = 4 people (two 2-person teams) X 4-hr per day X 245 days (non-migration season) + 8-hr per day X 120 days (migration season) X 19 years X $25 per hour = 4 X 980 + 960 X 19 X $25 = $3,686,000. (E) Cost of initial wildlife hazing system = material components + installation and placement + power sources = $250,000 + $120,000 + $5,000 = $375,000. (F) Cost of operation of wildlife hazing

system = replacement of expendable components (pyrotechnics, gas, etc.) + annual skilled labor maintenance + annual skilled labor operation X number of years = $25,000 + $60,000 + $60,000 X 14 = $2,030,000.
Total ecological damage value = $14,291,000.

Recreational: There is no public recreational access to these sites.

Real Estate: There is no private ownership of land bordering affected waters.

Aesthetic: The contamination and mortality of waterbirds at this site is known from internal federal and utility company reports, but has received very limited disclosure to the public in popular media outlets. Therefore, it is not possible to provide a reasonable estimate of the potential negative impacts on aesthetic values, which would be dependent on that knowledge.

Human Health: Access to this site is restricted so there are no human health impacts associated with direct contact or consumptive use. Off-site movement of contaminated waterfowl, and subsequent harvesting/consumption is a possibility, but is not quantifiable with available information. Also, the public's lack of knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $14,291,000.00

Case 17 – Martins Creek Steam Electric Station, PA (Pennsylvania Power and Light)

Location of Damage: Delaware River

Period of Damage: 2005-2006

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: A leak developed in one of the fly ash settling basins at the Martins Creek Station on August 23, 2005. Wooden stop logs holding back water in the 16 hectare basin breached, allowing a discharge of fly ash slurry over land through a dry creek bed and into the Delaware River. There was no gate valve or built-in control structure and it took 4 days for the utility company to stop the flow. By that time, 380 million liters of contaminated water and fly ash was released into the Delaware River, covering the bottom and banks for approximately 2.4 km downstream. Monitoring indicated that waterborne concentrations of arsenic, aluminum, copper, iron, manganese, and silver exceeded EPA water quality criteria (EPA rule doc), prompting the city of Easton, PA, the closest downstream water user, to shut down its water intake and impose water use restrictions. The levels of waterborne contaminants were also above toxicity thresholds for sensitive aquatic invertebrates (Cherry,

and 242). Immediate impacts were dramatic. At least 20 species of fish were dislocated from the spill zone and benthic invertebrates were smothered or poisoned from ash-related contaminants. In the longer term (6-12 months), suction dredging activities resuspended ash, exacerbated fish dislocation, and removed benthic invertebrates from the river bottom. Four years after the spill, concerns were expressed over possible long-term impacts to anadromous American shad…… "The shad fry that were migrating to the sea during the spill have yet to return to the Delaware to spawn. The ash may have clogged their gills, killing them by the time they reached the ocean. The effect of losing a good portion of one year's class of shad can have a huge ripple effect for this species" (249). Although Pennsylvania Fish and Boat Commission reports show a precipitous decline in returning shad in years following the spill (250), no follow-up biological studies have been done. From August 2005-April 2006, the boating access ramp on the Delaware River at the Martins Creek site was closed to the public.

Scientific Evidence: References 238-250

Corrective Action Taken: Pennsylvania Power and Light used contractors to remove fly ash from the river bottom (suction dredge) and other impacted areas (the dry bed of Oughoughton Creek). Those efforts were completed in 2006. A new stop-log assembly made of steel-reinforced concrete was installed along with two shutoff valves. In 2007, the two coal-fired units at Martins Creek were permanently taken out of service. The ash basin was closed and covered with a geosynthetic membrane to seal it and reduce infiltration of water. Final reclamation will consist of a soil cap layer and vegetation. The Pennsylvania Department of Environmental Protection fined the utility company for polluting the Delaware River.

Monetized Value of Damage

Ecological: Value of aquatic benthic community extirpation and fish community impairment and dislocation = area affected X value per hectare X number of years = 37 hectares X $100,000 X 2 = $7,400,000.

Recreational: (A) Lost value of fishing trips not taken due to lack of public boat ramp access or stigma of pollution = 4,800 angler days per year (average of 100 angler days per week X 48 weeks) X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $480,000 per year X 2 years = $960,000. (B)) Lost value of other recreational trips (boating, swimming, camping) not taken due to concerns about health and safety issues = 100 recreational days per week X 48 weeks X $100 per day = $480,000 per year X 2 years = $960,000.
Total recreational damage value = $1,920,000.

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of riverfront property owners (in 2005) X approximate property value X 5% depreciation X number of years = 100 X $250,000 = $25,000,000 X 5% X 2 = $2,500,000.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 654,171 X 20% = 130,834 X $100 = $13,083,400.

Human Health: Losses due to stress and anxiety of knowing ecosystem is polluted, property damaged, and aquatic communities are dislocated and poisoned = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 654,171 X 20% = 130,834 X $50 = $6,541,700

Total Case Damage Value = $31,445,100.

Case 18 – Glen Lyn Plant, VA (American Electric Power)

Location of Damage: Adair Run

Period of Damage: 1978-1981*
(*There have been no biological effects studies since 1981 but coal waste was discharged to surface waters through 2008, according to EPA's Toxics Release Inventory.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: From 1978-1980, effluent from a fly ash settling pond was discharged into Adair Run, a second-order tributary of the New River, under permits issued as part of the federal-state National Pollutant Discharge Elimination System. The effluent contained high pH (up to 9.5), total suspended solids (102 mg/L), cadmium (90 ug/L), chromium (70 ug/L) zinc (73 ug/L), arsenic (110 ug/L) and selenium (85 ug/L). Populations of benthic macroinvertebrates and fish were dramatically reduced during the period of ash pond discharge, as were microbial measures of aquatic ecosystem function and overall health. No biological studies were conducted on the New River or East River, which continued to receive effluent from heavy (bottom) ash disposal basins. EPA's Toxics Release Inventory reported that 21,587 pounds of toxic contaminants were discharged into surface waters at the Glen Lyn Plant from 1998-2008 (261).

Scientific Evidence: References 251-266

Corrective Action Taken: The fly ash pond began operation in 1978, was rapidly filled, and ceased operation in 1980 due to ineffective settling of ash (not because of aquatic impacts). Fly

ash was then disposed in heavy ash ponds and a landfill on utility company property. As of 2005, the on-site landfill was nearly full and most of the ash was being hauled away for disposal at a mine site in West Virginia. In 2007, a new off-site landfill was constructed nearby in Giles County, VA. Promoted as a community development project called Cumberland Park, the landfill is located in the floodplain of the New River and is unlined because it is technically classified as a structural fill (a beneficial use designation) rather than a waste disposal landfill, and is thereby exempt from liner requirements (262). The fill raises grade by 30 feet, making it level with a nearby highway, and will provide a "prime 7+ acre building site suitable for hotel, light industry, and/or retail businesses" (264). The fill contains approximately 100,000 cubic yards of ash hauled by truck from the plant, and was completed in November 2010. Risks of long-term contamination at this site are evident. Coal ash from the Glen Lyn Plant is known to leach arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver at concentrations that are as much as 500 times the toxic threshold for aquatic life (24, 260). Ash placement began in 2008 and monitoring during 2008-2009 showed marked increases in concentrations of boron, chromium, and mercury (260, 263), suggesting that leaching of coal ash contaminants into groundwater has already begun. The New River, which is hydrologically down-gradient, lies only 100 meters away. It is classified as a "national scenic river" by the US National Park Service in recognition of its "outstandingly remarkable" fish and wildlife communities (256). EPA's Toxics Release Inventory reported that as recently as 2008, substantial discharges of contaminants, including arsenic and barium (selenium not reported), to surface waters was occurring at the Glen Lyn Plant (261).

Monetized Value of Damage

Ecological: Value of reduced fish and benthic communities = area affected X 50% of value per hectare X percent reduction X number of years = 1 hectare X $50,000 X 80% X 4 = $160,000.

Recreational: The impacted section of Adair Run is on utility company property and there is no recreational use at this site.

Real Estate: There is no private ownership of property at this site.

Aesthetic: The contamination at this site is known from scientific studies and internal federal reports, but has not been disclosed to the public in popular media outlets. Therefore, it was not possible to estimate aesthetic value losses, which would be dependent on that knowledge.

Human Health: There is no consumptive use at this site. Lack of public knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $160,000.00

Case 19 – Columbia Energy Center, WI (Alliant Energy)

Location of Damage: Rocky Run Creek

Period of Damage: 1978-1980*
(*No biological studies were conducted in Rocky Run Creek after 1980 but direct discharges to surface water continued through 2004 according to EPA's Toxics Release Inventory. Monitoring showed that movement of polluted groundwater beneath the ash pond was transporting contaminants into off-site wetlands in 1984. No biological studies have been conducted at these wetlands or in the Wisconsin River, which received drainage from the wetlands and Rocky Run Creek.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: Beginning in 1975, ash pond effluent was released into Rock Run Creek, a third-order tributary of the Wisconsin River, under permits issued as part of the federal-state National Pollutant Discharge Elimination System. The effluent contained high suspended solids and metals, which polluted Rocky Run Creek with cadmium, chromium, barium, aluminum and copper (arsenic and selenium were not measured). Populations of benthic macroinvertebrates and fish were dramatically reduced for at least 3.5 km downstream, as were microbial measures of aquatic ecosystem function and overall health. Some species of macroinvertebrates were totally eliminated. Crayfish exhibited markedly elevated tissue concentrations of selenium, zinc, and iron as well as impaired metabolic rates in areas below the discharge. EPA's Toxics Release Inventory reported that from 1998-2004, the Columbia Energy Center released 5,362 pounds of contaminants into surface waters (276).

Scientific Evidence: References 267-277

Corrective Action Taken: The power plant modified its waste treatment process to improve effluent quality from the ash ponds in 1979 and some recovery of the benthic macroinvertebrate community occurred in 1980, although total numbers remained reduced and community composition was altered. As of 2010, coal ash was being disposed in a landfill, and discharges to surface water were probably reduced. However, EPA's Toxics Release Inventory indicates that Alliant Energy did not report its releases to surface water from the Columbia site after 2005 (276). A 1984 study revealed that polluted groundwater containing elevated concentrations of boron, sodium, and sulfate was moving off-site and into wetlands adjacent to the Wisconsin River (272). Boron and sulfate are known tracers of CCW-associated groundwater pollution (273), and elevated sodium was attributed to Na_2CO_3 used to condition fly ash to enhance sulfate removal from flue gas (272). A 2004 report showed that arsenic, selenium, lead, and manganese were leaching at concentrations toxic to aquatic life (273).

Selenium, in particular, poses a high bioaccumulation hazard in wetlands (24). Although the ash ponds are now closed, they are unlined and continue to leach contaminants into groundwater (265). Collectively, this information indicates that a significant legacy pollution risk to fish and wildlife exists at the Columbia Energy Center site. The affected wetlands have been identified as a key natural resource feature of lower Rocky Run Creek and the Wisconsin River (274).

Monetized Value of Damage

Ecological: Value of reduced fish and benthic communities = area affected X 50% of value per hectare X percent reduction X number of years = 2 hectares X $50,000 X 80% X 3 = $240,000.

Recreational: The contamination of Rocky Run Creek is known from scientific studies and internal state and federal reports, but was not disclosed to the public in popular media outlets. Moreover, public access was not restricted. Therefore, potential negative impacts on recreational use, which would be dependent on that knowledge, did not occur.

Real Estate: Same as for Recreational

Aesthetic: Same as for Recreational

Human Health: Same as for Recreational. Also, lack of public knowledge of contamination prevented estimation of stress and anxiety value losses.

Total Case Damage Value = $240,000.00

Case 20 – Widows Creek Fossil Plant, AL (Tennessee Valley Authority)

Location of Damage: Widows Creek

Period of Damage: 2009-2010*
(*No biological effects studies were conducted after 2009. However, a consumption restriction advisory for mercury contamination in fish was issued in 2010.)

Source of Damage: Surface impounded flue gas desulfurization (FGD) waste and coal ash

Cause and Extent of Damage: On January 9, 2009 the cap on a discharge control pipe failed, causing an unintended release of approximately 5,000 cubic yards of FGD slurry into Widows Creek, a third-order tributary of the Tennessee River. Some of the material also made its way into the Tennessee River as well, but the volume was not estimated. The primary impact zone was a “triangle area” of relatively shallow water adjacent to a settling pond, where most of the slurry entered the creek. The waste contained elevated concentrations of metals, including mercury (282), and other trace elements such as selenium and arsenic. The spill blanketed

about 6 hectares of creek bottom, smothering and poisoning benthic macroinvertebrates (278), and dislocating the resident fish community. Concentrations of mercury were elevated above consumption advisory levels in fish (286).

Scientific Evidence: References 278-287

Corrective Action Taken: TVA undertook a cleanup action that included suction dredging of the creek bottom in the affected area. Remaining benthic organisms were removed in the process. Resuspension of contaminated sediments occurred (attempts were made to minimize downstream impacts by deploying silt fences) as well as continued dislocation of resident fish. Dredging operations were completed by the end of 2009. There was no subsequent biological monitoring of Widows Creek to determine the rate or degree of recolonization by aquatic fauna. In 2010, the Alabama Department of Public Health issued a consumption restriction advisory for mercury contaminated fish in Widows Creek in and near the "triangle area" (286). EPA's Toxics Release Inventory reported that from 1998-2009, the Widows Creek Plant discharged 1,053,173 pounds of contaminants, including arsenic and zinc, into surface waters (selenium not reported, 287). Ash and FDG ponds are the only disposal method currently in use. Releases of effluent to the Tennessee River are permitted through the National Pollutant Discharge Elimination System. There have been no biological studies to ascertain possible chronic effects of the releases on aquatic life in Widows Creek or the Tennessee River.

Monetized Value of Damage

Ecological: Value of aquatic benthic community extirpation and fish community impairment and dislocation = area affected X value per hectare X number of years = 6 hectares X $100,000 X 1 = $600,000.

Recreational: Lost value of fishing trips not taken due to concerns about pollution = 10 angler days per week X 48 weeks X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $48,000 per year X 2 years = $96,000.

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of creekfront property owners (in 2010) X approximate property value X 5% depreciation X number of years habitat polluted and public health fish consumption advisories in effect = 10 X $250,000 = $2.500,000 X 5% = $125,000 X 2 years = $250,000.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 96,791 X 20% = 19,358 X $100 = $1,935,800.

Human Health: (A) Value of unconsumed fish = number of angler days during the period of state-issued consumption restriction advisory (480 angler days per year X 1 year X 4 fish meals per angler day – number of meals allowed (limit of 1 meal per month per adult non-reproductive woman, no consumption for children and reproductive women (286), subtract 12 for each non-reproductive female adult) X $7.50 per meal = 480 X 4 = 1,920 (two adults and two children per family) – 240 = 1,680 X $7.50 = $12,600. (B) Losses due to stress and anxiety of knowing ecosystem is polluted and public health threatened = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 96,791 X 20% = 19,358 X $50 = $967,900.
Total human health damage value = $980,500.00

Total Case Damage Value = $3,849,700.00

Case 21—Hatfield's Ferry Power Station, PA (Allegheny Energy)

Location of Damage: Little Whiteley Creek and tributaries

Period of Damage: 2005-2010*
(*Untreated discharges to Little Whiteley Creek began in 1984. As of 2001, all discharges received primary treatment (settling pond) and secondary wetland treatment. Biological effects studies were conducted only in 2005; discharges continued in 2010.)

Source of Damage: Landfilled coal ash and FGD sludge

Cause and Extent of Damage: The Hatfield's Ferry CCW landfill was permitted as a 40-acre unlined disposal site in May, 1984. Although unlined, the landfill did have an under-drain system to remove CCW leachate and groundwater from the coal ash. From 1984 until 2001, this wastewater was directed, without any treatment, to an earthen impoundment, and then discharged into an unnamed tributary of Little Whiteley Creek, which is a third-order stream that empties into the Monongahela River. Allegheny Energy began operating a passive wetland treatment system for CCW leachate in Spring 2001. The wetland treatment system was designed to remove or reduce concentrations of iron, aluminum, manganese, and total suspended solids and to control pH, but was not specifically designed to treat other problematic constituents in CCW leachate. In addition to coal ash, the landfill began receiving FGD sludge from the Hatfield Plant in 2007. Monitoring during 2002-2006 indicated that elevated concentrations of aluminum, boron, manganese, molybdenum, and thallium were being discharged from the wetland treatment system and were contaminating Little Whiteley Creek and four unnamed tributaries, all of which have designated use as warm water fishery habitat (290, 293-294). A biological study in 2005 found sharply reduced populations of benthic macroinvertebrates in locations with the highest metals concentrations (289). Some sections of

the streams exhibited “concreted bottoms” due to deposition of chemical compounds. The report concluded that conditions in these streams were indicative of “polluted water and disturbed habitat”.

Scientific Evidence: References 288-295

Corrective Action Taken: The Pennsylvania Department of Environmental Protection (PADEP) determined that CCW leachate discharges were causing exceedances of the effluent limitations in the NPDES permit for the landfill. The PADEP issued a Consent Order and Agreement in March 2008 because of continued violations of aluminum, manganese, and thallium NPDES effluent limits from November 2003 to August 2007 associated with the wetland treatment system (there are no permit limits for selenium). As of October 2009, the landfill had been expanded by 106 acres (Phase 3) and the addition has a composite liner system designed to reduce leachate to shallow groundwater, and a lined leachate storage impoundment. The older Phase 1 and 2 sections of the landfill have been closed. Leachate from the entire landfill is still being treated using the passive wetland treatment system. The effectiveness of these measures in meeting NPDES permit limits are unclear, and will be understood only through continued chemical and biological monitoring of the Hatfield site. EPA’s Toxics Release Inventory reported a 10-fold increase in the amount of contaminants released into surface waters at the Hatfield Plant from 2002-2009 (295).

Monetized Value of Damage

Ecological: Value of reduced benthic macroinvertebrate communities = area affected X 50% of value per hectare X percent reduction X number of years = 5 hectares X $50,000 X 50% X 6 = $750,000.

Recreational: Lost value of fishing trips not taken due to concerns about pollution = 10 angler days per week X 48 weeks X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $48,000 per year X 2 years (public recognition of pollution was primarily after 2008) = $96,000.

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of creekfront property owners (in 2010) X approximate property value X 5% depreciation X number of years habitat polluted = 3 X $250,000 = $750,000 X 5% = $37,500 X 2 years = $75,000.

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 168,871 X 20% = 33,774 X $100 = $3,377,400.

Human Health: Losses due to stress and anxiety of knowing ecosystem is polluted and aquatic ecosystem health threatened = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when seeing or reading news stories describing damage = 168,871 X 20% = 33,774 X $50 = $1,688,700.

Total Case Damage Value = $5,987,100.00

Case 22 – Kingston Fossil Plant, TN (Tennessee Valley Authority)

Location of Damage: Upper Watts Bar reservoir

Period of Damage: 1999-2010*
(*Monitoring and toxicity studies indicated that pollution from permitted discharges was detrimentally affecting fish and invertebrates as early as 1999 but the extent and severity of impacts was not assessed. Concentrations of selenium in fish, and arsenic and selenium in sediments, remained above a toxic threshold in 2010. Long-term biological studies will continue to determine residual impacts of the 2008 ash spill on aquatic life.)

Source of Damage: Surface impounded coal ash

Cause and Extent of Damage: On December 22, 2008 an ash pond retention dam broke, releasing approximately 1.1 billon gallons (4.1 million cubic meters) of ash and slurry water. This was by far the largest spill of CCW ever recorded. About 90% of the release went into the Emory River, inundating the channel with up to 10 meters of ash for a distance of over 6 km. Ash made its way into the Clinch River, which joins with the Emory downstream, and was also found 16 km downstream in the Tennessee River, which joins with the Clinch. Together, the three rivers form the upper end of Watts Bar Reservoir. It was estimated that the initial ash flow into the Emory River contained about 3,830 tons of the 10 most toxic elements present in fly ash. The spill's immediate impact killed approximately 5,000 fish, although unknown numbers were stranded or buried under as much as 10 meters of ash. Birds, mammals, amphibians, and reptiles were exposed to toxic ash in the spill area and sluice pond, and some were killed (306). Mussels and other benthic macroinvertebrates were smothered. At least 33 hectares of aquatic ecosystems in an embayment area were completely destroyed during the initial release (320). Eighteen days after the spill, concentrations of arsenic, barium, cadmium, lead, and selenium were elevated above state and federal water quality standards in the immediate spill zone. Levels of arsenic and selenium were elevated above toxic thresholds in river sediments for a distance of at least 4.8 km downstream, and fish tissues contained toxic concentrations of selenium (above 4 mg/kg whole-body, dry weight, 24) in this zone (303). At least 23 fish species were dislocated from a 95 hectare area around the spill and those that were collected outside that zone had ingested ash and showed signs of stress such as abrasions

and discolored gills. Closer analysis revealed pathological changes in gill tissue consistent with toxic exposure to ash (303). Seven months following the spill, all fish collected had concentrations of selenium above a toxic threshold (303), and most were still contaminated at that level 14 months after the spill (323). Ash-laden sediments were toxic to mussels and other benthic macroinvertebrates (307). Eighteen months after the spill, concentrations of arsenic in sediment pore waters were over 10 times the toxic level for sensitive benthic invertebrates at sites 12 km downstream (297, 302, 327). Twenty-one months after the spill, a high percentage of fish exhibited symptoms of "very extreme stress [lesions, deformities, infections] which you would expect with an event like this" (333). The Tennessee Department of Health and the Tennessee Department of Environment and Conservation (TDEC) issued a recreation advisory for Watts Bar Reservoir in June 2009, warning the public against boating, swimming, and fishing in the Emory River section of the reservoir (311), and restated a consumption advisory for mercury contaminated fish (331-332). Prior to the spill, EPA's Toxics Release Inventory reported that from 1998-2007, the Kingston Fossil Plant discharged 615,948 pounds of contaminants into surface waters (329). In 2008, the year of the spill, 2,765,700 pounds were released into surface water. In the year following the spill an additional 49,080 pounds were discharged, as the operation of the power plant continued uninterrupted. With the exception of the spill, these discharges were authorized by permits issued through the federal-state National Pollutant Discharge Elimination System. Fish tissue sampling conducted upstream of the spill zone revealed contaminant levels indicative of legacy pollution from previous, permitted discharges that took place prior to the spill (305, 310). As of October 11, 2010, the NPDES permit for the Kingston Fossil Plant did not contain effluent limits for 16 primary toxic elements, including arsenic, mercury and selenium (330), despite prior, persistent toxicity of discharges to fish and invertebrates (298). The NPDES permit for the period 2004-2008 stated that " The discharge from Outfall 002 may contain several different pollutants, the combined effect of which has a reasonable potential to be detrimental to fish and aquatic life"……."As presented with the TVA's permit application, fish survival [1999-2003] has been problematic in Outfall 002 and the Emory and/or Clinch River". The permit was renewed without modification or establishment of discharge limits for the 16 primary toxic elements.

Scientific Evidence: References 296-340

Corrective Action Taken: A massive federal effort was implemented to remove ash from upland and aquatic areas (318-320, 325-326). The aquatic portion of cleanup is to be done in 3 phases: (1) suction dredging of 62 hectares of river channel and transport of ash by rail to a landfill disposal site in Alabama (completed), (2) excavation and/or dredging of 33 hectares of embayment area and on-site disposal at the Kingston Fossil Plant, and (3) excavation and/or suction dredging of 20 hectares of perimeter areas and on-site disposal at the Kingston Plant.

Phase 2 and 3 operations will continue until 2014, and TVA acknowledges that despite the effort, a large amount of ash will remain in the rivers and resuspended ash will move further downstream (325, 335). Following Phase 1 ash removal, immigration facilitated recovery of fish populations (abundance and diversity but not necessarily health) but benthic macroinvertebrates remained reduced, even in areas outside the dredge zone (326). Efforts to clean and restore upland areas have been more successful but were still incomplete as of December 2010. The ash disposal cell that failed and the adjacent ash pond are to be closed and a new disposal cell constructed to receive remaining ash from the cleanup. These efforts are projected to take up to 4 years to complete (340). Future ash generated by the power plant is to be wet sluiced from the plant to a processing area, dried and prepared for off-site disposal in a landfill (335). There has been no modification of NPDES permit requirements to address legacy and non-spill pollution issues. The Tennessee Department of Environment and Conservation fined TVA for violating state environmental laws.

Monetized Value of Damage

Ecological: (A) Value of fish killed during initial spill = 5,000 X $1.00 = $5,000. (B) Value of fish displaced during initial spill = standing crop per hectare (mean of 1970-1992 for Chickamauga Reservoir, 296, which is adjacent and has same ecological trophic status and species composition) X area affected – number killed X $0.50 = 29,538 X 62 ha – 5,000 X $0.50 = $1,826,356. (C) Value of fish displaced during river dredging operations = half the standing crop per hectare X area X $0.50 = 14,769 X 62 ha X $0.50 = $457,839. (D) Value of fish contaminated (individuals with tissue selenium exceeding toxic effects threshold of 4 ppm) during 2009-2010 = half standing crop X area X $0.50 = 14,769 X 62 ha X $0.50 = $457,839. (E) Value of aquatic ecosystems destroyed inside Swan Pond embayment = area X value per hectare X number of years = 33 ha X $100,000 X 2 = $6,600,000. (F) Value of benthic macroinvertebrate communities destroyed outside embayment during initial spill = area X half the value per hectare = 62 ha X $50,000 = $3,100,000. (G) Value of benthic macroinvertebrate communities reduced during river dredging operations = area X half the value per hectare X percent reduction = 62 ha X $50,000 X 50% = $1,550,000. (F) Value of shoreline and upland habitat destroyed (covered with ash) during initial spill = area X value per hectare X 1 year = 10 ha X $100,000 X 1 = $1,000,000.
Total ecological damage value = $14,997,034.

Recreational: (A) Value of harvestable sport fish killed or displaced during initial spill = standing crop of harvestable fish X area X $1.00 = 1,728 per hectare X 95 ha X $1.00 = $164,160. (B) Value of harvestable sport fish displaced during dredging operations = half the standing crop per hectare X area X $0.50 = 864 X 62 ha X $0.50 = $26,784. (C) Lost value of fishing trips not

taken due to recreational advisory and concerns about pollution = 9600 angler days per year (average of 200 angler days per week X 48 weeks) X $100 per day inclusive of meals, gas, bait, tackle, and licenses = $960,000 per year X 2 years = $1,920,000. (D) Lost value of other recreational trips (boating, swimming, camping) not taken due to recreational advisory and concerns about health and safety issues = 200 recreational days per week X 48 weeks X $100 per day = $960,000 per year X 2 years = $1,920,000.
Total recreational value damage = $4,030,944.00

Real Estate: Depreciated value due to stigma of environmental pollution = approximate number of lakefront property owners near spill (in 2010) X approximate property value X 5% depreciation X number of years lake polluted = 100 X $250,000 = $25,000,000 X 5% = $1,250,000 X 2 years = $2,500,000 (This number does not include $46,139,375 in damages reported by TVA through July 2010 for direct impacts of ash deposited onto private property).

Aesthetic: Intrinsic value to non-sportsmen/recreators = assuming 20% of population within 30 miles (2000 census) believe degradation of individual non-use values equals $100 or more for scenic and posterity considerations = 245,307 X 20% = 49,061 X $100 = $4,906,100.

Human Health: (A) Value of unconsumed fish = number of angler days lost during 2009-2010 X 4 fish meals per angler day = 19,200 X 4 = 76,800 X $7.50 per meal = $576,000. (B) Losses due to stress and anxiety of knowing ecosystem is polluted, fish and wildlife are poisoned, and public health threatened = assuming 20% of population within 30 miles (2000 census) expresses strong negative sentiments when viewing or reading news stories describing damage = 245,307 X 20% = 49,061 X $50 = $2,453,050.
Total human health damage value = $3,029,050.00

Total Case Damage Value = $29,463,128.00

Grand Total Damage Value for all 22 Cases = $2,321,258,053.00

Discussion

Regulatory implications

Surface impoundment of CCW is widely practiced, accounting for about 21% of current disposal facilities, or some 629 impoundments (341-342). However, less than 5% of these have undergone detailed biological evaluation to determine impacts to fish and wildlife, usually following catastrophic failure of containment dams or because there was outwardly visible poisoning that triggered public demands for investigation. My synopsis here covers only a small portion of the total damage and economic costs resulting from this waste management

technique. Yet, the value of that fraction of losses is over $2.3 billion, which is enough money to construct 155 landfills with state-of-the-art composite liners and leachate collection systems (15 million each, 343-344). The Electric Power Research Institute, the scientific arm of the coal power industry, has known the inherent environmental hazards from surface disposal of CCW for decades, and has held workshops to inform the electric utility industry about those toxic threats (345). Electric utilities themselves acknowledge the need to switch from wet to dry storage in order to protect shareholders from significant financial risks (346-347). Yet, little has changed from either an operational or regulatory perspective. Continued use of surface impoundments would be allowed by EPA under Resource Conservation and Recovery Act (RCRA) Subtitle D of its proposed regulations for CCW disposal (348). This would be a grave mistake for five reasons. First, the "D Prime" option allows continued operation of impoundments without liners, which leads to substantial pollution of groundwater, some of which can be expected to reach the surface and expose fish and wildlife to toxins (272-273, 349-350). Second, although other provisions of Subtitle D do require composite liners, it should be noted that liners are designed to protect groundwater and would have little effect on the direct surface water exposure pathway (348). That is, liners do not reduce above-ground leachate, precipitation runoff and slurry discharges that pollute surface water and poison fish and wildlife. Third, there are serious liner performance issues which indicate that groundwater protection is not assured (351-352). Therefore, exposure of fish and wildlife to contaminated groundwater that reaches the surface is a distinct possibility even at lined sites. Fourth, the possibility of structural failure has not been given adequate consideration as a serious drawback of surface impoundments. For example, in the supporting material for its proposed rule, EPA states that "The more recently documented damage cases provide evidence that current management practices can pose additional risks that EPA had not previously studied, that is, from catastrophic releases due to the structural failure of CCR surface impoundments "(348). Fifth, and perhaps most importantly, current state-administered regulatory controls would not prevent discharge of toxic CCW effluent to surface waters. For example, the National Pollutant Discharge Elimination System (NPDES), a federal-state regulatory mechanism for controlling point-source pollution (e.g., coal ash effluent), has been in effect since the enactment of the federal Clean Water Act in 1972 (353). NPDES is the principal tool that states use to address toxic industrial discharges (354). However, it did not identify or correct any of the twelve surface impoundment regulated-release CCW damage cases reviewed in this report. This is because of lack of federal oversight combined with inadequate monitoring, risk assessment, and enforcement at the state level (352, 355-356). EPA recognized these deficiencies in a recent study of steam-electric plant discharges (357) which concluded that:

> "Despite current regulatory controls and wastewater treatment methods, pollutants from power plant wastewater still make their way into the environment. Many of these

> pollutants, such as selenium, arsenic, mercury, total dissolved solids, and nutrients, have an impact on wildlife. The primary routes by which coal combustion wastewater impacts the environment are through discharges to surface waters, leaching to ground water, and by surface impoundments and constructed wetlands acting as attractive nuisances that increase wildlife exposure to the pollutants contained in the systems. EPA found the interaction of coal combustion wastewaters with the environment has caused a wide range of environmental effects to aquatic life."

EPA's own findings point out quite clearly that implementing Subtitle D would not change the flawed regulatory system that has led to pollution of surface water and toxic impacts to fish and wildlife for the past 38 years. Yet despite these revelations, EPA still put forward the Subtitle D surface impoundment disposal option for consideration by the US Office of Management and Budget, which has statutory authority to examine a proposed regulation, review cost-benefit information, and make a controlling decision on the final rule (358-360). As part of this process, EPA conducted a Regulatory Impact Analysis (RIA) for use in comparing benefits and costs of the three options in its proposed rule (Subtitle C, regulation as hazardous waste with no use of surface impoundments; Subtitle D, regulation as a non-hazardous waste with use of surface impoundments; Subtitle D Prime, continued use of unlined surface impoundments, 348, 361). That analysis shows the annualized benefits of pollution control to be much greater for Subtitle C regulation than either Subtitle D option (Table 10 in 348). However, RIA only estimated benefits of avoiding human cancer deaths, groundwater pollution, and cleanup costs of impoundment dam failure…. "RIA did not quantify or monetize several other additional benefits consisting of future avoided social costs associated with ecological and socio-economic damages. These included avoided damages to natural resources". In order for RIA to be thorough and complete, and thus provide the most accurate information to OMB for weighing in its decision, EPA needs to add the substantial economic benefit of avoiding damages to natural resources, specifically poisoning of fish and wildlife. Based on the losses documented by scientific investigation since 1967 (which examined less than 5% of CCW surface impoundments), protection of fish and wildlife will add at least $46 million per year ($2.3 billion total cost savings spread across 50 year future period-of-analysis 2012 to 2061) to the total annualized benefit value of regulation under RCRA Subtitle C.

Emerging threat from "Green Treatment"

Although surface impoundment of CCW solids (ash) has a long and well known history of environmental problems, there is another, more insidious threat that is beginning to appear. Many coal-fired power plants have installed flue gas desulfurization (FGD) systems to reduce vapor-phase stack emissions of this key contributor to acid rain. These systems effectively

remove sulfur but they also produce a liquid waste that is highly enriched with many of the same problematic contaminants that are in fly ash slurry, notably selenium, mercury, and arsenic (362-363). At most locations, FGD wastewater must be treated in some way before being released into the environment (364). An emerging trend is to use constructed wetlands to treat raw FGD water directly, or to "polish" it after initial processing. Wetland treatment is generally viewed as an environmentally friendly "green" option that reduces the need for more costly physical or chemical methods of pollution control (364-365). Some electric utility companies have even promoted the use of FGD treatment wetlands for wildlife habitat in their public relations literature (366-368). However, selenium and other contaminants in FGD water may accumulate within the wetland to concentrations that can poison fish and wildlife. Engineering success doesn't necessarily mean ecological success. Just because the effluent from a treatment wetland is "clean" doesn't mean that all is well. In fact, the success of a wetland in removing pollutants can be inversely related to the biological hazard it creates. More contaminants retained may translate to more concentrated exposure of fish and wildlife (369-370). This risk can partially or wholly defeat the purpose of the wetland from the outset. Utility companies need to be aware of this inherent danger and understand its full ramifications before they consider a wetland treatment option. A wide variety of fauna will rapidly colonize treatment wetlands, even small wetland cells, and the accumulated contaminants provide a direct pathway for high exposure (371-373). It makes no difference if a wetland was created with the intent of providing wildlife habitat or is managed to keep it out……..simply construct one and they will come. For example, Duke Energy quickly saw the attractiveness of their "controlled" treatment wetlands at the Belews Creek Steam Station, NC. A flock of geese consumed and destroyed vegetation plantings before they became established (374-375). A few utilities have recognized the pollution dangers and attempted to exclude wildlife with fencing or netting. However, wildlife exclusion cannot be done effectively. Fencing and netting may keep out large mammals and birds but small species will get in with little effort (e.g., frogs, toads, snakes, lizards, salamanders, turtles, crayfish, mice, rats, minnows, small birds, etc.). Moreover, contaminated insects produced in the wetland will emerge and be a source of dietary exposure to birds and other insectivorous wildlife on the outside. This is especially true for bioaccumulative contaminants in FGD wastewater, such as selenium and mercury (78, 376). The need to employ elaborate techniques such as hazing to deter wildlife usage may offset the cost savings associated with wetland treatment (235, 377). Beyond the fact that wildlife attracted to these constructed wetlands are in danger of poisoning, some species are also protected under various state and federal laws, for example, the Migratory Bird Treaty Act (MBTA). The maximum criminal penalty for electric utilities unlawfully killing a protected migratory bird is a $15,000 fine, or six months in jail, or both for each count (each dead bird, 237). There is no "allowable take" under the MBTA, killing just one bird is a violation of the Act.

The wetland owner is liable for any "take" that occurs regardless of whether or not the wetland was intended to provide wildlife habitat (378). EPA recognized this liability in its recent analysis of power plant discharges….. "constructed wetlands act as attractive nuisances that increase wildlife exposure to the pollutants contained in the systems" (357, 379). With respect to fish and wildlife health risks, FGD treatment wetlands are functionally analogous to surface impoundments used to dispose coal fly ash. Both provide pathways for bioaccumulation, exposure, and toxicity. In addition to contaminant exposure risks within the wetlands themselves, some pollutants may not be effectively removed at all, which creates toxic hazards to aquatic life in downstream receiving waters (see Case 21 – Hatfield's Ferry). Also, over time, wetlands may become "saturated", thereby exceeding their assimilation capacity and reducing their effectiveness in removing contaminants from FGD water (369, 379). Thus, for a variety of reasons, the promise that constructed wetlands seem to hold for treating CCW wastewater may not be realized.

Conclusions

A large body of scientific evidence from confirmed damage cases indicates that wet disposal of CCW, in any form, is not environmentally or economically prudent. In that regard, EPA's regulatory proposal for CCW under RCRA Subtitle D, which would allow continued use of surface impoundments, is inappropriate with respect to fish and wildlife health. Moreover, going all the way back to the Belews Lake era of the 1970's, the corrective action at problematic surface sites has been to switch to landfill disposal. Surface impoundment of CCW unnecessarily jeopardizes fish and wildlife populations, causes significant long-term environmental damage, and results in high economic costs that could be avoided or minimized if other disposal practices were used. Other experts on CCW impacts have also reviewed the technical information and reached similar conclusions (349, 373, 380). Regulators should no longer ignore rigorous science and the lessons learned from multiple case examples. EPA and the United States need to show leadership on this issue by prohibiting surface impoundments, particularly since the rise in coal use in developing countries is leading to the same CCW pollution problems on a global scale (381-384). In addition to the surface impoundment issue, there are two other fish and wildlife concerns that need further investigation from a regulatory perspective. First is the need for a full analysis of the threat posed by landfills. Unlined landfills are creating pools of polluted water underground. For example, dozens of CCW landfills have contaminated groundwater to levels that, if released to surface water, would be acutely and/or chronically toxic to aquatic life (1, 349, 385). Case 21 of this review details one such example (Hatfield's Ferry, 386). Landfills at the Belews Creek site (Case 1) and other locations are leaching selenium at concentrations in the hundreds of parts-per-billion range, which is as high as levels in the effluent that extirpated 19 species of fish at Belews Lake in the 1970's (387-

389). Moreover, there are serious questions about how well liners work (351-352, 390), which brings risks from lined landfills into consideration as well. Second is the need to evaluate risks to fish and wildlife from constructed wetlands. The recent trend of using wetlands as a "green" way to treat FGD wastewater may be the start of a new chapter in the CCW pollution story.

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Table 1. Summary of fish and wildlife damage cases from disposal of coal combustion waste.

Case	Location	CCW Disposal Method	Cause of Water Pollution	Damage Value ($US)
1	Belews Lake, NC	Impoundment	NPDES permitted releases	531,153,873
2	Hyco Reservoir, NC	Impoundment	NPDES permitted releases	876,725,744
3	Mayo Reservoir, NC	Impoundment	NPDES permitted releases	80,825,500
4	Gavin, OH/Amos, WV	Impoundment	NPDES permitted releases	1,611,600
5	Martin Lake, TX	Impoundment	Unpermitted discharge	229,452,337
6	Welsh Reservoir, TX	Impoundment	NPDES permitted releases	161,708,162
7	Brady Branch, TX	Impoundment	NPDES permitted releases	108,674,277
8	Beaver Dam Creek, SC	Impoundment	NPDES permitted releases	17,979,360
9	Gibson Lake, IN	Impoundment	Unregulated discharge	166,425,914
10	McCoy Branch, TN	Impoundment	Unpermitted discharge	1,653,682
11	Clinch River, VA	Impoundment	Structural failure	11,377,700
12	Melton Hill Reservoir, TN	Impoundment	NPDES permitted releases	40,598,560
13	Lake Erie, MI	Impoundment	NPDES permitted releases	1,500,000
14	Connor Run, WV	Impoundment	NPDES permitted releases	18,666
15	Euharlee Creek, GA	Impoundment	Structural failure	6,116,650
16	Bridger Plant, WY	Impoundment	Unregulated discharge	14,291,000
17	Delaware River, PA	Impoundment	Structural failure	31,445,100
18	Adair Run, VA	Impoundment	NPDES permitted releases	160,000
19	Rocky Run Creek, WI	Impoundment	NPDES permitted releases	240,000
20	Widows Creek, AL	Impoundment	Structural failure	3,849,700
21	Hatfield's Ferry, PA	Landfill	NPDES limits exceeded	5,987,100
22	Kingston, TN	Impoundment	Structural failure	29,463,128
			Total ……	$ 2,321,258,053.00

Illinois Pollution Control Board
R2014-10

T. Barkley: Exhibit B

W1550100002

2013 Closure Work Plan
Annual Report

Hennepin Power Station
Dynegy Midwest Generation, LLC
West Ash Pond System: Nos. 1 and 3

October 2013

Environmental Compliance Group
Dynegy Operating Company
604 Pierce Boulevard
O'Fallon, Illinois 62269

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1.0 INTRODUCTION

In accordance with the Closure Work Plan (CWP) approved by the Illinois Environmental Protection Agency (IEPA) on November 8, 1996, the Dynegy Operating Company is submitting this annual report on behalf of Dynegy Midwest Generation, LLC (DMG) Hennepin Station of groundwater quality near its downriver ash ponds nos. 1 and 3 for Year 2013 by the required submittal date of October 30.

This annual report describes and evaluates the changes occurring to groundwater quality near the west ash pond system. Documents provided to the IEPA on November 6, 2002 which support this annual groundwater update report include:

- An evaluation of model performance by Natural Resource Technology, Inc. (NRT), including whether or not the groundwater quality is improving as predicted by the original model (***Model Recalibration and Prediction of Closure Options for the West Ash Impoundment, Hennepin Power Station, October 2002***); and,
- Results of the research conducted by the Electric Power Research Institute, Inc. (EPRI) on the occurrence and geochemistry of manganese in groundwater near three of DMG's coal ash facilities, including Hennepin (***Manganese Occurrence Near Three Coal Ash Impoundments in Illinois, Final Report, June 2002***).

The two required semi-annual monitoring events for this annual report were for Quarter 1 and Quarter 3, 2013. In addition, a voluntary third quarterly monitoring event was conducted during June 2013 (i.e., Quarter 2) in order to collect additional groundwater quality data to evaluate future pond closure options.

1.1 Background

In 1997 a model was prepared for the Hennepin Power Station's West Ash Pond System (Figure 1) to compare several closure options for the impoundment. At that time, it was determined that concentrations of boron, sulfate, and TDS were higher than the Class I groundwater standard, and were attributable to ash leachate released from the impoundment. Elevated concentrations of manganese, iron, and pH were also observed, although the source of these elevated concentrations was uncertain.

The model indicated that several scenarios involving removal of the impoundment from service and dewatering of the ash would improve

downgradient groundwater quality and cause boron concentrations to fall below the standard over a period of about five years. DMG removed the impoundment from service in December 1996, although the pond was not fully dewatered until summer 1998.

Since groundwater near the impoundment had elevated levels of several constituents at the time of closure, DMG applied for a groundwater management zone (GMZ), which was approved by IEPA in December 1997. One condition of the groundwater management zone was that DMG submit annual reports to the IEPA documenting changes in groundwater quality near the impoundment. More recently, a notice of intent to modify the original West Ash Pond System GMZ, in accordance with 35 IAC Part 620.250, was sent to the IEPA on July 9, 2013. This revised GMZ will be based upon the results of a hydrogeologic investigation, groundwater quality assessment, and re-calibrated groundwater model being prepared as part of a Corrective Action Plan for closure of the West Ash Pond System.

Groundwater monitoring through 2001 indicated that boron concentrations in some monitoring wells were not decreasing as predicted by the 1997 model. Additional data were collected from the former impoundment and the model was recalibrated by NRT in 2002 and the results submitted in the report, ***Model Recalibration and Prediction of Closure Options for the West Ash Impoundment, Hennepin Power Station, October 2002***.

The new recalibrated model predicted the following:

- Continuing decreases in boron concentrations in the downgradient wells south of the impoundment (wells 25, 26, 27, 30, and 31), with the wells meeting the Class I boron standard within 10 years; and,
- Very slow to negligible decreases in boron concentrations in wells adjacent to the impoundment (wells 21, 22, 23, and 24), with boron concentrations in some wells possibly not meeting the standard for more than 20 years.

This annual report evaluates the performance of the 2002 recalibrated model along with an evaluation of groundwater flow and groundwater quality for the two required semi-annual monitoring events and additional voluntary quarterly event in 2013. Thirty-six quarterly rounds and eighteen semi-annual rounds of groundwater samples have been collected since the impoundment was removed from service in December 1996.

2.0 POTENTIOMETRIC SURFACE ELEVATIONS AND GROUNDWATER FLOW

Figures 2, 3, and 4 show the groundwater elevations, potentiometric contours, and groundwater flow directions for Quarter's 1, 2 and 3 of monitoring in 2013.

Groundwater elevation is usually slightly higher in the central portion of the site than toward the east, west, and south (off site). Groundwater flow is generally towards the west adjacent to the river and toward the southwest in off-site locations away from the river.

The Illinois River was in flood stage during most of the period from April through June 2013, with stream gage stations upstream and downstream from the Hennepin Power Station recording some of their highest elevations over the past decade. Numerous wells were inaccessible during this period due to flooding of low lying areas. Wells 27, 30, 31, 32, and 33 could not be accessed for sampling until late June of the 2nd Quarter (Figure 3). Well 34, located closest to the Illinois River, was inaccessible from April through the entire month of June due to flooding.

3.0 COMPARISON OF MODEL PREDICTIONS TO OBSERVED BORON CONCENTRATIONS

During the 2002 model recalibration, boron transport was modeled at the Hennepin west ash impoundment and predicted concentrations were tabulated for selected monitoring wells. The model was calibrated to groundwater elevation and concentration distribution while the impoundment was active and for the period from 1997 to 2002, and then used to predict concentrations of boron in groundwater after removing the impoundment from service. The model scenario used for this comparison assumed that the impoundment was removed from service and dewatered, with no cap.

Boron concentrations in downgradient wells 21, 22, 23, and 24 are generally following model predictions (Figure 5a). Boron concentrations in Well 21 were increasing through December of 2004, whereas the model predicted a steady trend. However, concentrations have been gradually decreasing at a rate greater than predicted by the model since that time and decreased to below the model-predicted boron concentration in September 2010, contrary to modeling results. Measured boron concentrations in Well 21 have remained below model predictions from 2011 through 2013.

Boron concentrations in downgradient Well 23 are lower than predicted by the model, although with significant seasonal variation in response to flooding along the Illinois River. The second and third lowest boron concentrations observed at Well 23 occurred in April 2011 and June 2013 during sustained flooding along the Illinois River. Concentrations in Well 22 are higher than predicted but continue to trend downward from the peak concentrations, as predicted by the model. Boron concentrations in Well 24 have been significantly below the model predictions from 2009 through 2013, although with large upward and downward

fluctuations. Overall, median boron concentrations at wells 21 through 24 have declined by 12 to 70 percent from peak concentrations (Table 1).

South of the impoundment, median boron concentrations at wells 25, 26, and 30 have decreased by 84 to 92 percent (Table 1), which is close to model predictions (Figure 5b). The model was unable to fully reproduce the concentrations observed in Well 27; however, concentrations have decreased at a trend similar to model predictions, and median concentrations in Well 27 have decreased by 45 percent since the peak observed in 1997 (Table 1). Extrapolation of the observed data regression suggests that boron concentration in well 27 will decrease to 2 mg/L in 2022.

4.0 GROUNDWATER QUALITY DATA SUMMARY

The required annual groundwater monitoring data were collected for the following inorganic parameters: boron, chloride, iron, manganese, sulfate, total dissolved solids (TDS), and the field parameters pH and groundwater elevation. In addition, the field parameters of specific conductance (SC) and temperature were collected but are not reported. The groundwater samples were collected from 10 semi-annual and two annual wells for this annual report as follows:

- Quarter 1, 2013 – March 8 (required sampling of 10 semi-annual and two annual wells);
- Quarter 2, 2013 – June 7 and 26 (voluntary sampling of 10 semi-annual and 1 annual well; one annual well was inaccessible as a result of flooding along the Illinois River); and,
- Quarter 3, 2013 – September 3 (required sampling of 10 semi-annual wells and voluntary sampling of two annual wells).

The semi-annual and annual data evaluated in this report for Quarter's 1 and 3 were submitted to the IEPA as required by the 1996 CWP and are provided in Appendix A. The Quarter 2 voluntary sampling data for the required parameters are also provided in Appendix A.

4.1 Groundwater Quality Exceedances of Standards

Groundwater quality exceedances of Class I standards from December 1994 through September 2013 are tabulated in Appendix B. A summary of the number of exceedances at each well, and the date of the last exceedance, are provided in Table 3.

The parameters with exceedances of Class I standards during the period covered by this annual report are boron, chloride, iron, manganese, and sulfate. Boron exceeded the 2 milligrams per Liter (mg/L) standard at 5 of the 12 monitoring wells (downgradient wells 21 through 24 and south Well 27). Wells

21 through 24 are located immediately adjacent to the west impoundment. Well 27 is located south of the secondary pond. None of the other monitoring wells have had a boron exceedance since 1996, or prior to the removal of the west impoundment from service.

The Class I standard of 400 mg/L for sulfate was exceeded at well 23 during 2013. This well is located between Pond 1 and the Illinois River. With the exception of exceedances of the sulfate standard at Well 22 in 2010 and Well 27 in 1996, none of the other monitoring wells at the West Ash Pond System have exceeded the sulfate standard since monitoring began in 1994. Sulfate concentration trends (Table 2) in impacted wells have behaved similarly to boron.

Manganese concentrations have exceeded the Class I standard of 0.15 mg/L at monitoring wells 23, 25, 27, 31, 32, 33, and 34 during this reporting period (Table 3). Well 27 is located in a low lying area between background wells 32, 33, and 34 and has consistently had elevated manganese concentrations. Well 31 typically had manganese concentrations below 0.01 mg/L through 2007, but in the past seven years (2008 – 2013) concentrations have steadily increased so that they now remain above 0.15 mg/L. The occurrence of manganese exceedances at only three of nine monitoring wells closest to the impoundment, and regularly at one or more background wells, is indicative that elevated manganese concentrations are a naturally occurring condition. Median manganese concentrations in background wells 33 and 34 over the past six years (Table 4) are 0.22 and 1.1 mg/L, respectively, versus median concentrations of 0.62 and 0.32 mg/L at south wells 27 and 31.

Manganese concentrations in groundwater are not directly related to the activities at the impoundment and have not decreased in conjunction with the ash-indicator parameters boron and sulfate. The occurrence and distribution of manganese concentrations at the West Ash Pond System are discussed in greater detail in the EPRI manganese report (EPRI, 2002).

Iron concentrations exceeded the Class I standard of 5 mg/L at one south well (Well 25) and one background monitoring well (Well 34) during 2012. The only other wells that have had an exceedance of the Class I iron standard since monitoring began in 1994 are Well 24 (last exceedance in 2000), Well 26 (one exceedance in 2005), and background Well 33 (last exceedance in 2006). Iron exceedances and/or elevated concentrations at some of the downgradient and south monitoring wells appear to be correlated to those with high manganese concentrations and are unrelated to activities at the impoundment. Well 25 had its first recorded manganese and iron exceedances in June 2013, which corresponds to both record flooding on the Illinois River and the highest observed groundwater elevations at this location (see time-series graph in Appendix C).

Well 34 continues to yield iron concentrations above and below the standard with no apparent trend; low boron concentrations indicate that this well is not

impacted by the impoundment. Iron is affected by pH and redox conditions similar to manganese. Based on the temporal and spatial distribution of iron concentrations in groundwater at the west ash impoundment it can be concluded that high iron concentrations in a few wells are naturally occurring.

TDS concentrations did not exceed the 1,200 mg/L standard at any of the 12 monitoring wells in 2013. In 19 years of monitoring there has been only one TDS exceedance at one monitoring well, which occurred in 1996 at downgradient Well 23. No other exceedances of the TDS standard have occurred at any of the other wells since monitoring began in 1994.

Until 2013, chloride concentrations in groundwater had never exceeded the Class I standard of 200 mg/L in any of the 12 monitoring wells since monitoring began in 1994, a period of 18 consecutive years without an exceedance. However, during March 2013 a first time chloride exceedance occurred at Well 31, located south of the impoundment. A concentration of 244 mg/L was observed in groundwater at this well (Table 4), which was significantly greater than the 6-year median concentration of 69 mg/L and the previous maximum observed concentration of 110 mg/L in 2008 (Appendix C). The two subsequent samples from this monitoring well had chloride concentrations of 48 and 57 mg/L. This one-time chloride exceedance is an outlier concentration of unexplained derivation that is unrelated to the West Ash Pond System. The four downgradient monitoring wells (21, 22, 23, and 24) have median chloride concentrations ranging from 39 to 62 mg/L, all of which are less than the median concentration of 69 mg/L at Well 31 (Table 4).

Groundwater did not exceed the lower or upper limit pH standards of 6.5 and 9.0 S.U. at any monitoring wells during the 2013 reporting period. The last pH exceedance occurred in downgradient monitoring Well 24 in 2010.

4.2 Groundwater Quality Statistical Analysis and Trends for Selected Parameters

A statistical summary for selected inorganic groundwater quality parameters for the preceding six years is provided in Table 4. Each of the parameters is discussed below.

Boron

Median boron concentrations (Table 4) from 2008 to 2013 ranged from less than 0.1 to 7.5 mg/L in the 10 semi-annual and two annual monitoring wells. Boron has exceeded the 2 mg/L Class I standard in all four downgradient wells (21 to 24) and one south well (27). Concentrations in three of the four downgradient wells with exceedances (wells 21, 22 and 24) are trending downward between 0.1 and 0.4 mg/L per year. Downgradient Well 23 has had boron concentrations remaining between 2.9 and 8 mg/L, with no significant upward or downward trend. South of the impoundment, boron concentrations are also staying

relatively constant, with no upward or downward trend except for well 27, which has a slight downward trend. The lack of trend in wells 25, 26, 30, and 31 is an artifact of the 6-year statistical evaluation period; concentrations in these wells decreased by 53 to 92 percent in the years immediately after the west impoundment system was removed from service and concentrations since then have remained steady at less than 0.5 mg/L (Table 1).

Chloride

Median chloride concentrations in the 10 semi-annual and two annual monitoring wells range from 25 to 97 mg/L, with the lowest and highest median concentrations occurring in background wells. Chloride has exceeded the 200 mg/L Class I standard in one well in one sampling event in 19 years of monitoring. The one chloride exceedance occurred in well 31, located south of the impoundment. As discussed earlier this one-time exceedance is an outlier concentration unrelated to any groundwater impacts attributed to the West Ash Pond System. Median chloride concentrations over the past six years in downgradient and south wells range from 38 to 69 mg/L and are significantly below background median concentrations at Well 34 of 97 mg/L. Chloride is not an inorganic parameter of concern at the west ash impoundment and occurs in groundwater in downgradient wells at concentrations below background.

Iron

Median iron concentrations in the four downgradient monitoring wells closest to the impoundment are as follows:

- Well 21 median is 2.8 mg/L;
- Well 22 median is 0.03 mg/L;
- Well 23 median is 0.03 mg/L; and,
- Well 24 median is 0.6 mg/L.

Median iron concentrations in the background monitoring wells 33 and 34 are 2.1 and 6.8 mg/L, respectively. The remaining wells at the site (25, 26, 27, 30, 31, and 32) have median iron concentrations ranging from 0.03 to 0.37 mg/L.

The median iron concentration in groundwater at the West Ash Pond System varies by over two orders of magnitude. Similar to manganese, these highly variable iron concentrations appear to be related to naturally occurring conditions and unrelated to the ash ponds. Background wells 33 and 34 have higher maximum iron concentrations in groundwater than any other wells at the site. Iron exceedances of the 5 mg/L Class I standard have occurred at only one downgradient well (24) from the impoundment, with the last exceedance occurring in 2000. Well 25 had its only recorded exceedance, and highest observed iron concentration, in June 2013 during a period of flooding along the Illinois River. The median iron concentration at Well 25 is 0.03 mg/L. The only other exceedances since 1994 have occurred in the background wells 33 and 34 along with an outlier concentration at Well 26 in 2005.

Elevated concentrations of iron do not correlate to the main ash leachate indicator parameters of boron and sulfate, and do not appear to be related to the impoundment. The observed differences in iron concentrations in groundwater sampled from different parts of the area appear to be primarily controlled by natural variations in groundwater geochemistry unrelated to the ash ponds.

Manganese

Trends in manganese concentrations have generally been flat, no significant change, in all of the monitoring wells with the exception of wells 23 and 31. Well 23 has a slight upward trend of 0.03 mg/L per year over the last six years. Well 31 has a downward trend of 0.09 mg/L per year. Manganese trends in wells at the site have been up or down for reasons that appear to be unrelated to the ash ponds. The highest manganese concentrations have occurred in groundwater at downgradient Well 23, south wells 25, 27 and 31, and background wells 32, 33, and 34.

During the last six years the lowest median manganese concentrations (i.e., at or below 0.01 mg/L), and the highest percentage of concentrations below the method detection limit for manganese, have occurred at wells 25, 26, and 30, all of which are located south of the impoundment. Similarly, downgradient wells 21, 22, 23 and 24, located between the impoundment and the Illinois River, have had median manganese concentrations at or below 0.10 mg/L. Median manganese concentrations in the high manganese background wells (32, 33, and 34) have ranged from 0.11 to 1.1 mg/L.

Elevated concentrations of manganese do not correlate to the main ash leachate indicator parameters of boron and sulfate, and are not related to the impoundment. Detailed discussions of the manganese geochemistry in wells at the west ash pond system are provided in the EPRI manganese research report submitted to the IEPA on November 6, 2002 (EPRI, 2002).

Sulfate

The highest sulfate concentrations occur in wells 22 and 23, located adjacent to the Illinois River and downgradient from the west ash ponds. Median sulfate concentrations in these two wells over the past six years are 341 and 450 mg/L, respectively, with maximum concentrations of 480 and 590 mg/L. The Class I standard for sulfate is 400 mg/L. Sulfate concentrations in three of the four downgradient wells (21, 22 and 23) have slight downward trends of 3 to 15 mg/L per year. Well 24, with a median sulfate concentration of 108 mg/L, has a slight upward trend of 0.7 mg/L per year over the past six years; however, the trend is downward since 1997 (Table 2).

Since the impoundment was removed from service in 1996, sulfate concentrations at the four downgradient wells have decreased from their peak by 20 to 76 percent (Table 2). Sulfate concentrations in four of the five wells to the south (wells 25, 26, 27, and 30) have declined by 44 to 62 percent from their

peak (i.e., post-1996) concentrations. South Well 31 has not had a decrease in concentration relative to the in-service period of the impoundment, because concentrations at this monitoring well are at background levels. The median sulfate concentration at Well 31 ranged from 43 to 57 mg/L from 2008 through 2013, versus median concentrations of 12, 72, and 98 mg/L in the background wells over the same period.

Total Dissolved Solids

TDS concentration trends generally mirror those of sulfate, which is the major inorganic parameter contributing to the TDS concentration. As discussed earlier, none of the wells monitored have had a TDS exceedance of Class I standards other than one 1996 exceedance at monitoring well 23.

pH

Median pH values during the last six years at the 12 monitoring wells range from 7.0 to 7.9 S.U. There have been no pH exceedances at any monitoring wells since 2010 (Table 3). Some of the earlier pH exceedances occurred at background wells 32, 33, and 34. However, there are no indications of ash impacts at wells 32, 33, and 34, indicating that any pH exceedances at these wells would be due to natural variations. The higher pH values observed at downgradient wells 21, 22, and 24 during variable periods of time prior to 2011 are no longer elevated as of 2011, 2012, and 2013 (Appendix C).

5.0 ASH MINING

No ash from the west ash pond system was mined during the current reporting period. However, marketing of the ash continues to be pursued.

6.0 CONCLUSIONS

Groundwater quality at the West Ash Pond System has improved since the ash ponds were removed from service in 1996. From the time that the ash ponds were closed, the number of exceedances of Class I groundwater standards for boron, iron, manganese, sulfate, TDS, and pH has declined.

The only exceedances of groundwater standards that have occurred in downgradient wells during the current monitoring period of 2013 have been for the parameters boron, manganese, and sulfate. Chloride has only had one exceedance, an outlier concentration unrelated to the ash impoundment, since monitoring began in 1994. Iron has only had downgradient exceedances in Well 24, the last of which occurred in 2000, and that is attributed to natural groundwater geochemistry. Manganese has had exceedances at several wells – all attributed to naturally occurring conditions. TDS has had only one exceedance at one well (23) and that occurred in 1996.

Although boron concentrations are still elevated above Class I standards in several monitoring wells, it is important to note that all but one of these monitoring wells are located immediately adjacent to the ash ponds. Monitoring wells located further from the ash ponds, specifically wells 25, 26, 30, and 31 to the south, no longer exceed the Class I standard for boron and have not had an exceedance since 1996. Based on these observations, it is believed that the total mass-loading of coal-ash leachate on the groundwater system continues to decline.

Chloride and TDS do not exceed groundwater quality standards in downgradient wells, while iron and manganese concentrations in downgradient wells are unrelated to leachate from the ash ponds. Well 24 had exceedances of the upper pH standard in 2009 and 2010 but had significantly lower pH values in 2011 through 2013 with no exceedances. The only remaining parameters of concern related to leachate from the West Ash Pond System are boron and sulfate.

As was requested in the 2012 Closure Work Plan Annual Report, it is again requested that the parameters of chloride, iron, and TDS be discontinued from further groundwater monitoring and reporting at the West Ash Pond System. It is also requested that manganese be removed from further monitoring as concentrations observed at the West Ash Pond System are below background levels. Boron, sulfate, and pH will continue to be monitored semi-annually.

TABLES

Tables 1 and 2. Comparison of Median Boron and Sulfate Concentrations

2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

Table 1. Comparison of Median Boron Concentrations

		Median Boron Concentration (mg/L)[1]																		% Change Since	
Well	Position	In Service[2]	1997	1998	1999	2000	2001	2002	2003	2004	2005*	05-06	06-07	07-08	08-09	09-10**	2011	2012	2013	In Service[3]	Peak[4]
21	Downgradient	4.85	5.75	6.70	6.70	6.20	6.40	6.70	7.35	7.65	7.40	7.35	7.10	6.90	6.30	6.10	5.25	4.80	5.09	5%	-33%
22	Downgradient	8.00	9.00	10.00	11.00	9.75	9.65	9.20	8.80	8.25	8.00	7.70	7.70	8.00	8.40	7.20	7.35	7.40	7.51	-6%	-32%
23	Downgradient	7.00	5.95	5.70	5.80	6.50	6.85	7.65	8.05	7.15	5.40	6.60	5.90	5.20	6.50	6.80	5.05	7.55	7.05	1%	-12%
24	Downgradient	7.80	7.55	8.30	9.05	9.60	10.00	9.75	9.85	9.10	9.10	8.55	8.30	8.10	3.90	2.30	3.90	4.90	3.02	-61%	-70%
25	South	2.00	1.80	1.15	0.99	0.82	0.54	0.57	0.53	0.49	0.37	0.44	0.36	0.42	0.22	0.24	0.27	0.28	0.24	-88%	-88%
26	South	1.10	1.01	0.54	0.56	0.52	0.37	0.35	0.33	0.31	0.18	0.24	0.22	0.23	0.24	0.25	0.20	0.19	0.18	-84%	-84%
27	South	6.00	7.90	7.80	7.20	6.25	5.65	5.80	5.15	4.35	3.90	4.70	4.65	4.40	5.20	5.00	4.70	4.80	4.31	-28%	-45%
30	South	2.40	1.50	1.10	0.89	0.70	0.59	0.55	0.40	0.40	0.43	0.29	0.29	0.16	0.16	0.16	0.19	0.19	0.20	-92%	-92%
31	South	0.17	0.07	0.09	0.10	0.10	0.07	0.09	0.07	0.07	0.05	0.08	0.08	0.17	0.10	0.09	0.08	0.07	0.08	-53%	-53%
32	Background	0.12	0.05	0.07	0.11	0.10	0.09	0.11	0.10	0.13	0.11	0.13	0.14	0.12	0.09	0.08	0.07	0.07	0.08	-33%	-41%
33	Background	0.10	0.05	--	0.05	0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.09	<0.05	<0.05	<0.05	-47%	-47%
34	Background	0.10	0.05	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.07	0.09	0.09	0.09	0.09	0.13	0.09	0.11	0.10	-5%	-27%

1. Shading indicates concentrations that are greater than Class I boron standard of 2.0 mg/L. Blank indicates no samples taken during that year.
2. Impoundment removed from service in December 1996.
3. In Service difference based on change in median concentration from In Service to 2012.
4. Peak difference based on change in median concentration from highest median observed during any period prior to 2012.
*March 2005 data through 2009, medians are calculated from July to June of the next year.

Table 2. Comparison of Median Sulfate Concentrations

		Median Sulfate Concentration (mg/L)[1]																		% Change Since	
Well	Position	In Service[2]	1997	1998	1999	2000	2001	2002	2003	2004	2005*	05-06	06-07	07-08	08-09	09-10**	2011	2012	2013	In Service[3]	Peak[4]
21	Downgradient	225	260	285	305	305	300	310	280	245	200	210	200	200	145	140	130	110	149	-34%	-52%
22	Downgradient	370	660	585	525	415	435	335	300	315	310	275	340	370	410	370	280	210	341	-8%	-48%
23	Downgradient	480	510	445	510	570	565	525	515	445	280	420	340	210	520	540	385	300	456	-5%	-20%
24	Downgradient	390	430	450	445	415	335	275	300	255	220	220	220	230	127	35	123	325	108	-72%	-76%
25	South	97	100	66	59	52	54	47	47	47	40	47	50	55	56	51	46	39	38	-61%	-62%
26	South	57	65	54	37	45	41	38	39	40	36	43	41	42	46	36	34	33	29	-49%	-55%
27	South	315	340	345	325	285	245	230	250	270	230	235	205	155	165	170	190	190	192	-39%	-44%
30	South	140	120	100	95	100	91	81	86	86	75	86	73	81	70	68	77	86	72	-49%	-49%
31	South	43	49	44	46	38	35	31	35	37	29	36	39	35	47	45	43	57	54	26%	-5%
32	Background	91	96	83	83	105	83	68	88	81	77	79	81	61	65	61	65	77	102	12%	-3%
33	Background	8	10	--	<5	6	<5	5	<5	<5	<5	<5	8	11	<5	13	16	12	10	32%	-38%
34	Background	190	160	150	130	130	110	98	110	110	85	82	120	90	100	96	100	98	96	-49%	-49%

1. Shading indicates concentrations that are greater than Class I sulfate standard of 400 mg/L. Blank indicates no samples taken during that year.
2. Impoundment removed from service in December 1996.
3. In Service difference based on change in median concentration from In Service to 2012.
4. Peak difference based on change in median concentration from highest median observed during any period prior to 2012.
*March 2005 data through 2009, medians are calculated from July to June of the next year.
** 2009-2010 median based on samples collected in September 2009, June 2010, and August 2010.

Table 3. Summary of Exceedances of Class 1 Groundwater Standards

2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

Parameters Submitted to the IEPA for Routine Groundwater Monitoring	Class 1 Standard	unit	Number of exceedances of Class 1 Groundwater Standards between December 1994 and September 2013 (and year of last exceedance)											
			Downgradient Wells				South Wells					Background Wells		
			21	22	23	24	25	26	27	30	31	32	33	34
Boron	2	mg/L	**64 (2013)**	**65 (2013)**	**64 (2013)**	**64 (2013)**	4 (1996)	0	**57 (2013)**	9 (1996)	0	0	0	0
Chloride	200	mg/L	0	0	0	0	0	0	0	0	**1 (2013)**	0	0	0
Iron	5	mg/L	0	0	0	25 (2000)	**1 (2013)**	1 (2005)	0	**0**	0	0	8 (2006)	**17 (2013)**
Manganese	[a] 0.15	mg/L	7 (1997)	0	**49 (2013)**	1 (1994)	**1 (2013)**	1 (2005)	**57 (2013)**	0	**10 (2013)**	**33 (2013)**	**12 (2013)**	**23 (2013)**
Sulfate	400	mg/L	0	25 (2010)	**47 (2013)**	22 (2012)	0	0	1 (1996)	0	0	0	0	0
Total Dissolved Solids	1,200	mg/L	0	0	1 (1996)	0	0	0	0	0	0	0	0	0
pH	6.50 / 9.00	Std. Units	1 (2003)	9 (2002)	0	3 (2010)	**0**	0	0	0	**0**	1 (2003)	1 (2000)	2 (2007)

Note: Bold notation for number of exceedances indicates the latest exceedance occurred during the current reporting period of Quarter 1, Quarter 2, or Quarter 3, 2013.

Table 4. Statistical Summary of Groundwater Monitoring Parameters for Previous Six Years:
April 2008 to August 2013

2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

BORON (dissolved - mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	**5.6**	**5.4**	**6.8**	**4.6**	0.8	0	-0.4
22	13	**7.5**	**7.5**	**8.4**	**6.9**	0.4	0	-0.1
23	13	**6.2**	**7.1**	**8.0**	**2.9**	1.8	0	0.1
24	13	**4.2**	**3.9**	**8.1**	2.0	1.9	0	-0.4
South Wells								
25	12	0.28	0.26	0.44	0.22	0.07	0	0.0
26	12	0.21	0.20	0.28	0.17	0.03	0	0.0
27	11	**4.6**	**4.7**	**5.2**	**3.5**	0.5	0	-0.1
30	11	0.18	0.19	0.23	0.05	0.05	9.1	0.0
31	11	0.09	0.09	0.23	0.05	0.05	0	0.0
Background Wells								
32	11	0.09	0.08	0.12	0.07	0.02	0	0.0
33	8	0.05	0.05	0.09	0.04	0.01	50.0	0.0
34	7	0.10	0.09	0.13	0.09	0.02	0	0.0

CHLORIDE (dissolved - mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	50	47	65	39	8.9	0	-2.5
22	13	41	39	55	31	6.4	0	-1.8
23	13	59	62	86	22	19.3	0	-3.8
24	13	53	48	77	38	12.7	0	-3.1
South Wells								
25	12	45	43	58	27	8.0	0	-1.6
26	12	42	38	67	30	12.8	0	-2.1
27	11	52	49	85	38	12.4	0	-2.9
30	11	49	48	93	17	19.1	0	-0.9
31	11	85	69	**244**	34	58.5	0	-4.1
Background Wells								
32	11	61	54	119	30	25.1	0	3.3
33	8	26	25	47	13	10.6	0	-4.2
34	7	94	97	110	81	9.6	0	-2.6

Notes: Sen Slope Trend is in milligrams per Liter per year; negative value (-) is downward trend; positive value is upward trend.
Sample results below the method detection limit (MDL) for that parameter have been replaced by the detection limit.

Table 4. Statistical Summary of Groundwater Monitoring Parameters for Previous Six Years:
April 2008 to August 2013

2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

IRON (dissolved - mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	2.5	2.8	4.0	0.9	1.0	0	0.3
22	13	0.04	0.03	0.11	0.03	0.03	84.6	0.0
23	13	0.07	0.03	0.05	0.03	0.12	76.9	0.0
24	13	1.1	0.6	3.0	0.03	1.1	15.4	0.1
South Wells								
25	12	0.56	0.03	**5.1**	0.03	1.5	83.3	0.0
26	12	0.15	0.03	0.09	0.03	0.29	75.0	0.0
27	11	0.68	0.19	4.3	0.03	1.3	0	0.1
30	11	0.34	0.04	1.4	0.03	0.53	27.3	0.0
31	11	0.77	0.37	3.6	0.03	1.1	36.4	-0.2
Background Wells								
32	11	0.49	0.10	2.2	0.03	0.74	27.3	0.0
33	8	2.4	2.1	4.9	0.97	1.4	0	0.5
34	7	**6.5**	**6.8**	**8.0**	4.5	1.2	0	0.3

MANGANESE (dissolved - mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	0.085	0.085	0.11	0.025	0.02	0	0.00
22	13	0.046	0.037	0.14	0.019	0.03	0	0.01
23	13	**0.16**	0.056	**0.60**	0.005	0.20	7.7	0.03
24	13	0.037	0.030	0.089	0.005	0.03	23.1	0.00
South Wells								
25	12	0.024	0.005	**0.19**	0.005	0.05	83.3	0.00
26	12	0.009	0.005	0.040	0.005	0.01	83.3	0.00
27	11	**0.61**	**0.62**	**0.72**	**0.50**	0.08	0	0.00
30	11	0.014	0.005	0.050	0.005	0.02	72.7	0.00
31	11	**0.38**	**0.32**	**1.0**	0.030	0.30	0.0	-0.09
Background Wells								
32	11	**0.19**	0.11	**1.2**	0.005	0.34	18.2	0.01
33	8	**0.22**	**0.22**	**0.32**	0.10	0.08	0	0.00
34	7	**1.1**	**1.1**	**1.3**	**0.86**	0.17	0	0.01

Notes: Sen Slope Trend is in milligrams per Liter per year; negative value (-) is downward trend; positive value is upward trend.
Sample results below the method detection limit (MDL) for that parameter have been replaced by the detection limit.

Table 4. Statistical Summary of Groundwater Monitoring Parameters for Previous Six Years: April 2008 to August 2013

2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

SULFATE (dissolved - mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	143	144	180	110	24	0	-3.4
22	13	333	341	**480**	140	86	0	-8.6
23	13	394	**450**	**590**	152	165	0	-15
24	13	141	108	**490**	27	121	0	0.7
South Wells								
25	12	46	48	59	32	7.6	0	-2.8
26	12	35	35	51	21	8.1	0	-2.8
27	11	175	190	**219**	120	29	0	7.5
30	11	75	74	132	29	25	0	1.5
31	11	56	51	148	33	32	0	2.8
Background Wells								
32	11	79	72	146	56	25	0	5.3
33	8	22	12	100	5	32	25	0.5
34	7	96	98	111	80	9.6	0	1.3

TOTAL DISSOLVED SOLIDS (mg/L)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Percent Non-Detects	Sen Slope Trend
Downgradient Wells								
21	13	520	518	618	470	44	0	0
22	13	705	690	810	640	60	0	-4
23	13	834	900	1,100	500	225	0	-15
24	13	429	376	900	230	197	0	4
South Wells								
25	12	418	407	466	360	32	0	-1
26	12	383	380	442	340	31	0	0
27	11	577	570	654	520	44	0	22
30	11	481	470	564	430	49	0	11
31	11	452	434	726	310	105	0	10
Background Wells								
32	11	491	480	652	410	71	0	10
33	8	344	336	388	300	35	0	9
34	7	765	754	800	720	31	0	3

Notes: Sen Slope Trend is in milligrams per Liter per year; negative value (-) is downward trend; positive value is upward trend.
Sample results below the method detection limit (MDL) for that parameter have been replaced by the detection limit.

Table 4. Statistical Summary of Groundwater Monitoring Parameters for Previous Six Years:
April 2008 to August 2013

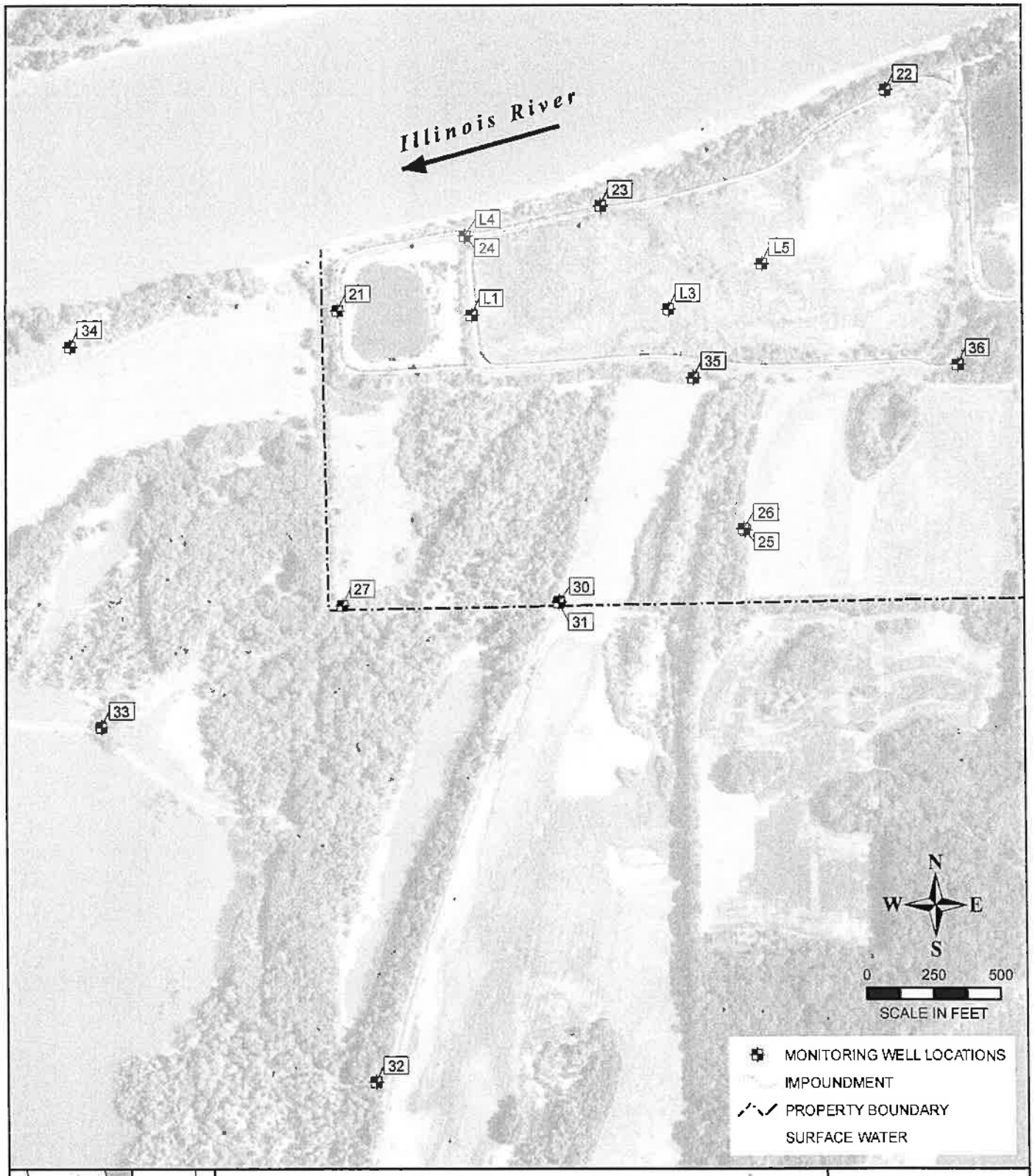
2013 Closure Work Plan Annual Report
Hennepin Power Station West Ash Pond System: Nos. 1 and 3

pH (Field / Standard Units)

Monitoring Well Number	Number of Data Points	Mean	Median	Maximum	Minimum	Standard Deviation	Sen Slope Trend
Downgradient Wells							
21	13	7.41	7.35	7.96	7.06	0.27	-0.02
22	13	7.92	7.91	8.52	7.31	0.29	-0.10
23	13	7.39	7.36	7.71	7.08	0.21	-0.03
24	13	8.19	7.78	**10.07**	7.28	0.86	-0.28
South Wells							
25	12	7.19	7.16	7.71	6.95	0.20	0.03
26	12	7.20	7.18	7.56	6.73	0.22	0.04
27	11	7.28	7.20	7.97	6.83	0.32	0.05
30	11	7.13	7.15	7.34	6.74	0.18	-0.01
31	11	7.00	6.99	7.29	6.75	0.19	-0.01
Background Wells							
32	11	7.21	7.17	7.52	6.95	0.18	0.03
33	8	7.43	7.40	7.63	7.29	0.14	-0.01
34	7	7.11	7.08	7.61	6.62	0.31	0.05

Notes: Sen Slope Trend is in milligrams per Liter per year; negative value (-) is downward trend; positive value is upward trend.

FIGURES



HENNEPIN WEST MONITORING WELLS

HENNEPIN WEST
DYNEGY MIDWEST GENERATION, LLC
PUTNAM COUNTY, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO: 1645
FIGURE NO: 1

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CHECKED BY/DATE: JJW 10/24/11
APPROVED BY/DATE:

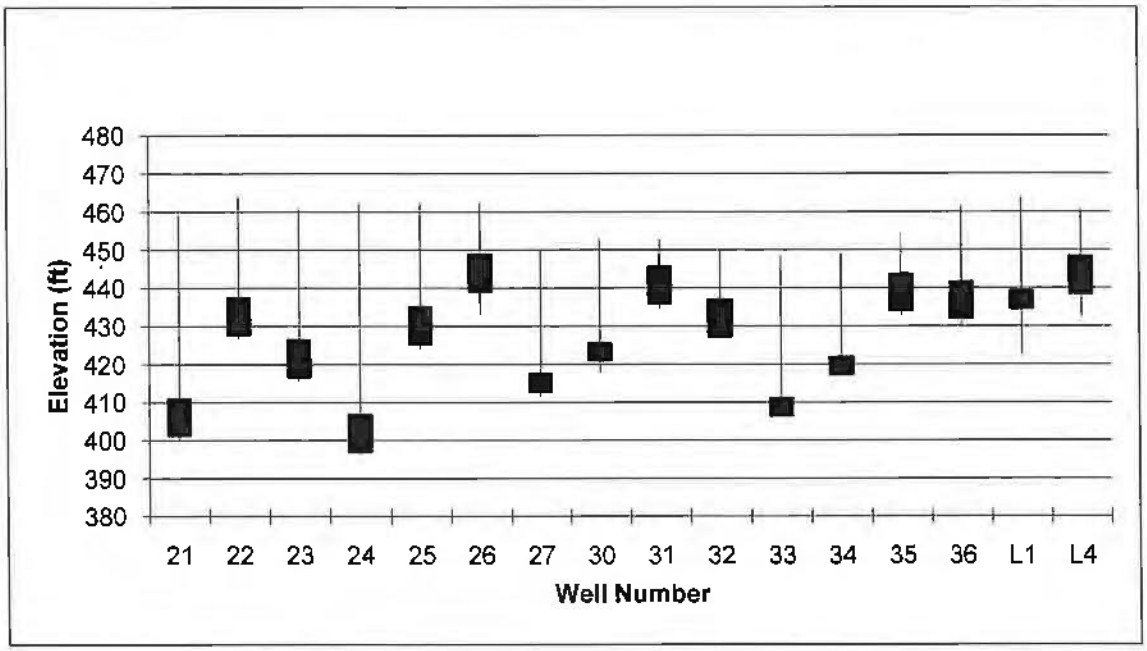
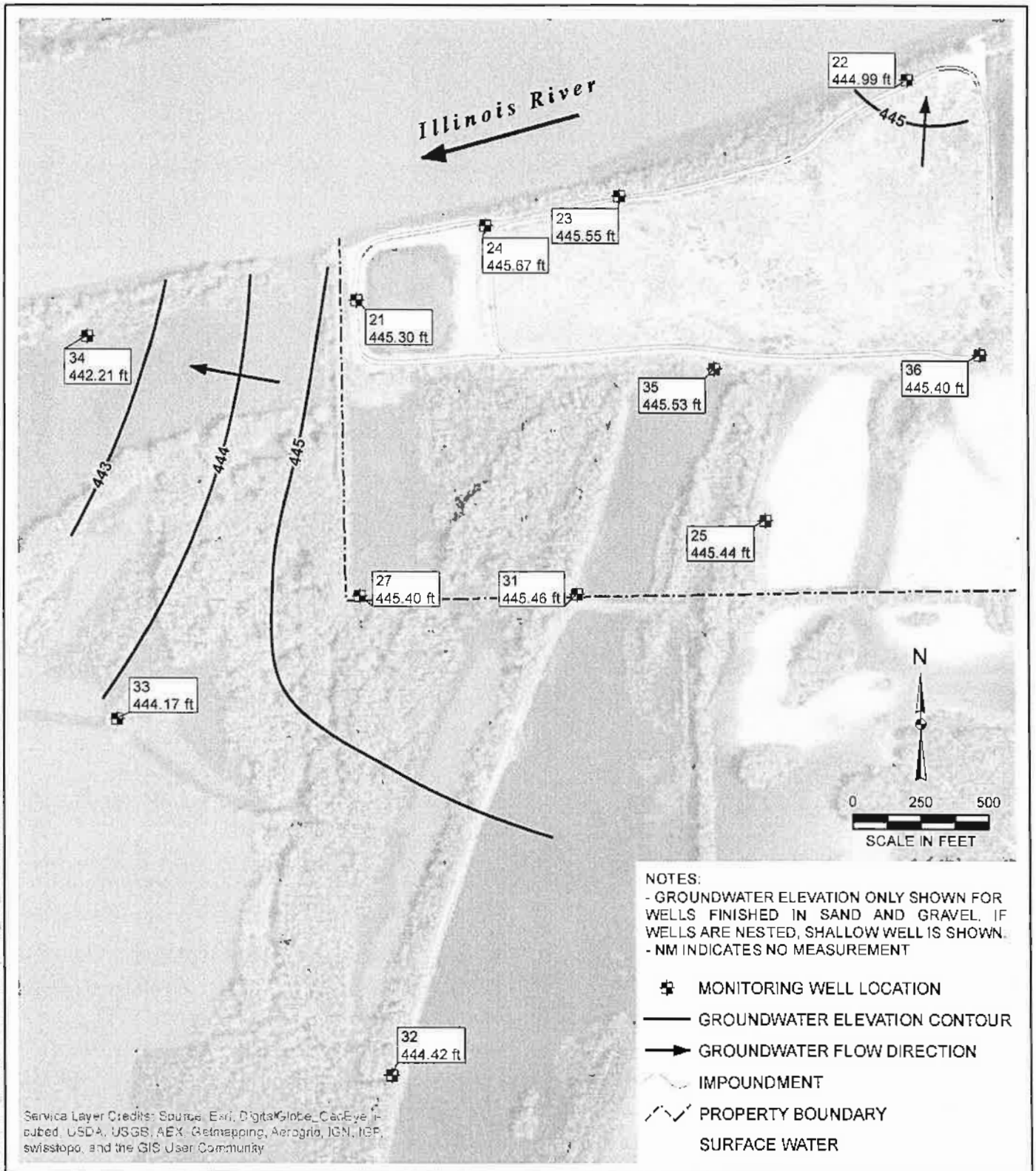


Figure 1a. Hennepin West Well Screen Elevations.



NOTES:
- GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, SHALLOW WELL IS SHOWN.
- NM INDICATES NO MEASUREMENT

MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
IMPOUNDMENT
PROPERTY BOUNDARY
SURFACE WATER

DRAWN BY/DATE:
TDC 10/16/13
REVIEWED BY/DATE:
BRH 10/16/13
APPROVED BY/DATE:
BRH 10/16/13

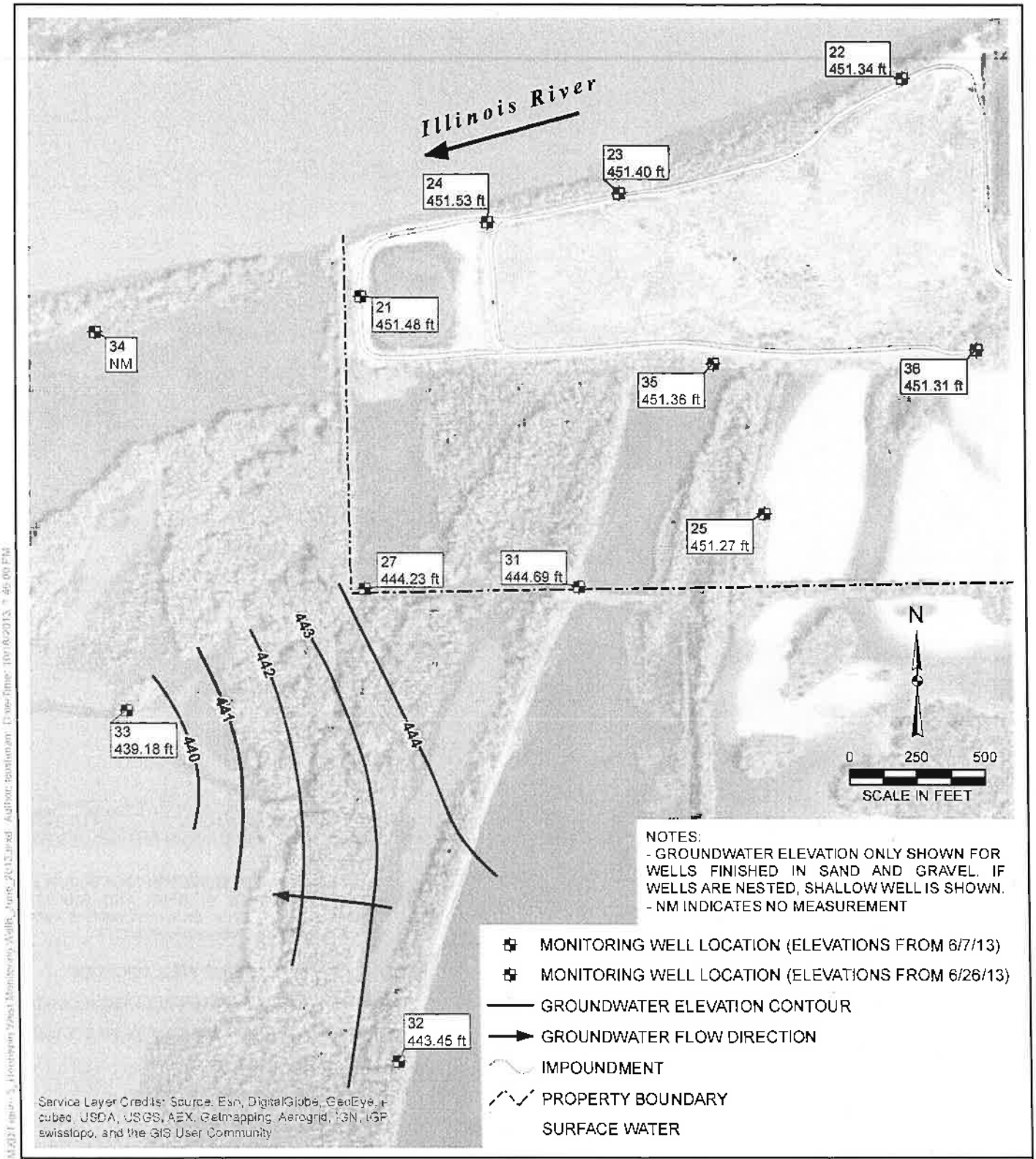
HENNEPIN WEST MONITORING WELLS
MARCH 8, 2013

HENNEPIN WEST
DYNEGY MIDWEST GENERATION, LLC
PUTNAM COUNTY, ILLINOIS

PROJECT NO: 1645

FIGURE NO: 2

NATURAL RESOURCE TECHNOLOGY



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TDC 10/16/13
REVIEWED BY/DATE:
BRH 10/16/13
APPROVED BY/DATE:
BRH 10/16/13

HENNEPIN WEST MONITORING WELLS
JUNE 7 AND 26, 2013

HENNEPIN WEST
DYNEGY MIDWEST GENERATION, LLC
PUTNAM COUNTY, ILLINOIS

PROJECT NO: 1645

FIGURE NO: 3

NATURAL RESOURCE TECHNOLOGY

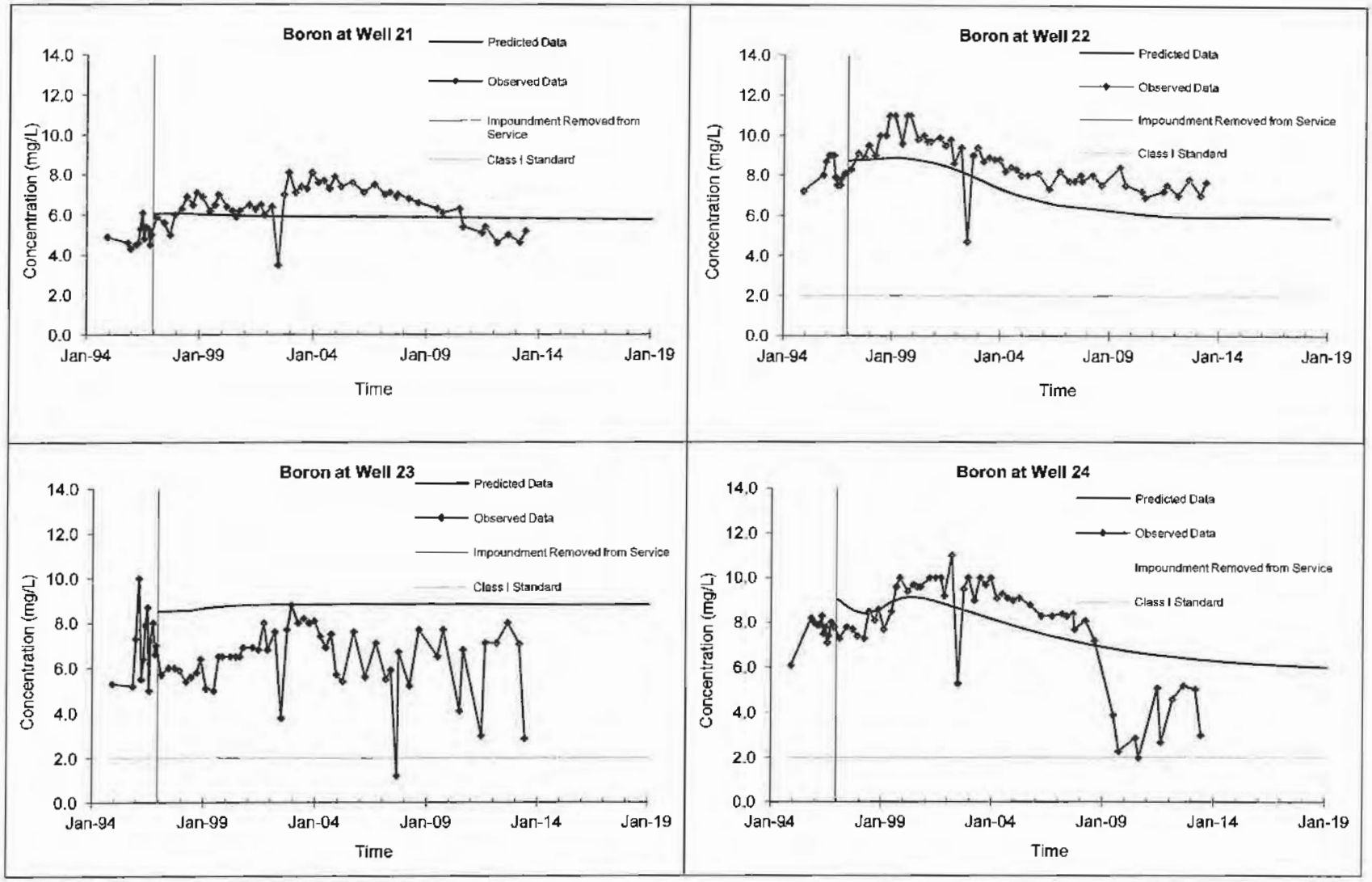
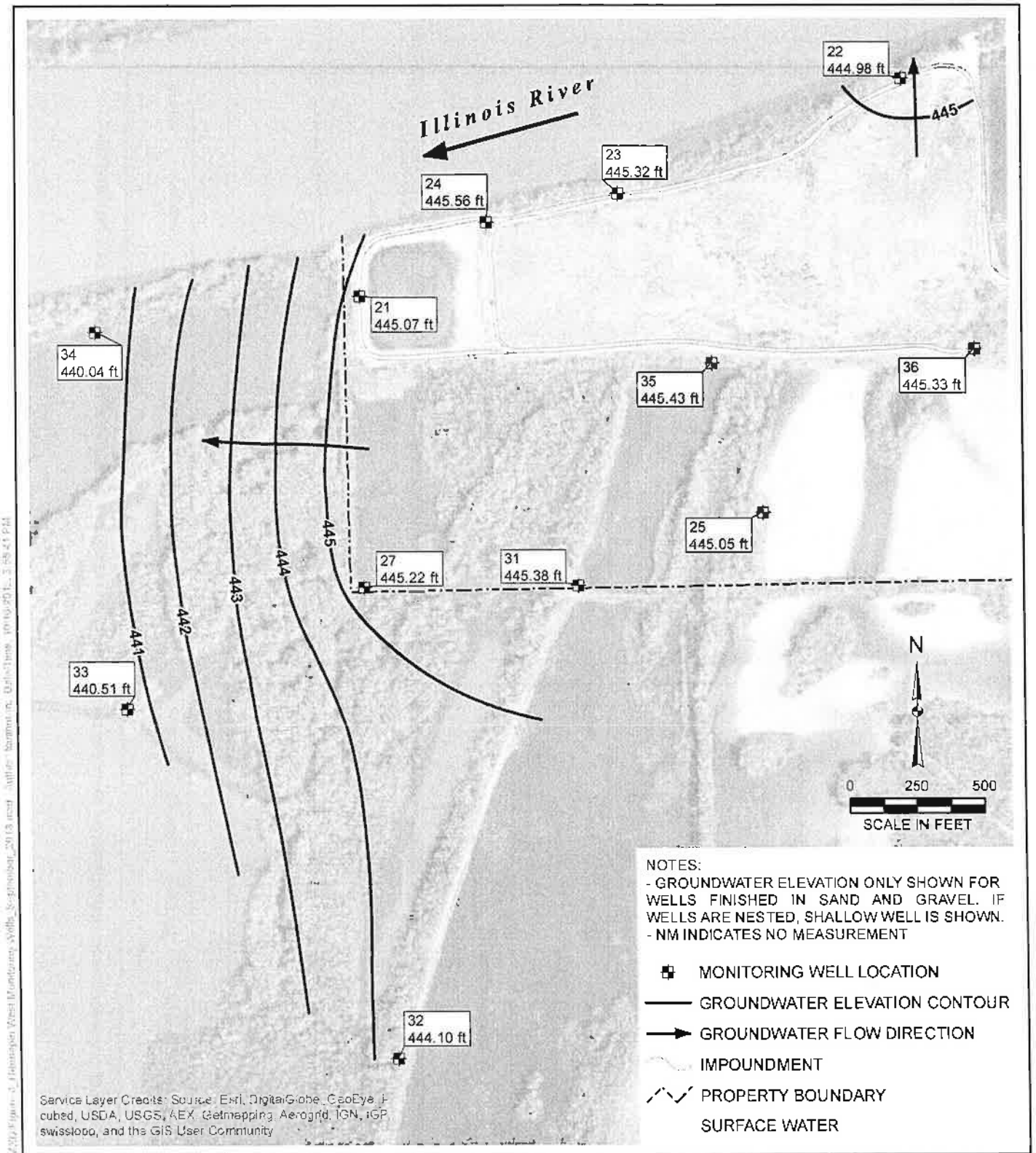


Figure 5a. Comparison of observed boron concentrations to model predictions in downgradient wells at the Hennepin west ash impoundment.



NOTES:
- GROUNDWATER ELEVATION ONLY SHOWN FOR WELLS FINISHED IN SAND AND GRAVEL. IF WELLS ARE NESTED, SHALLOW WELL IS SHOWN.
- NM INDICATES NO MEASUREMENT

MONITORING WELL LOCATION
GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
IMPOUNDMENT
PROPERTY BOUNDARY
SURFACE WATER

DRAWN BY/DATE:
TDC 10/16/13
REVIEWED BY/DATE:
BRH 10/16/13
APPROVED BY/DATE:
BRH 10/16/13

HENNEPIN WEST MONITORING WELLS
SEPTEMBER 3, 2013

HENNEPIN WEST
DYNEGY MIDWEST GENERATION, LLC
PUTNAM COUNTY, ILLINOIS

PROJECT NO: 1645

FIGURE NO: 4

NATURAL RESOURCE TECHNOLOGY

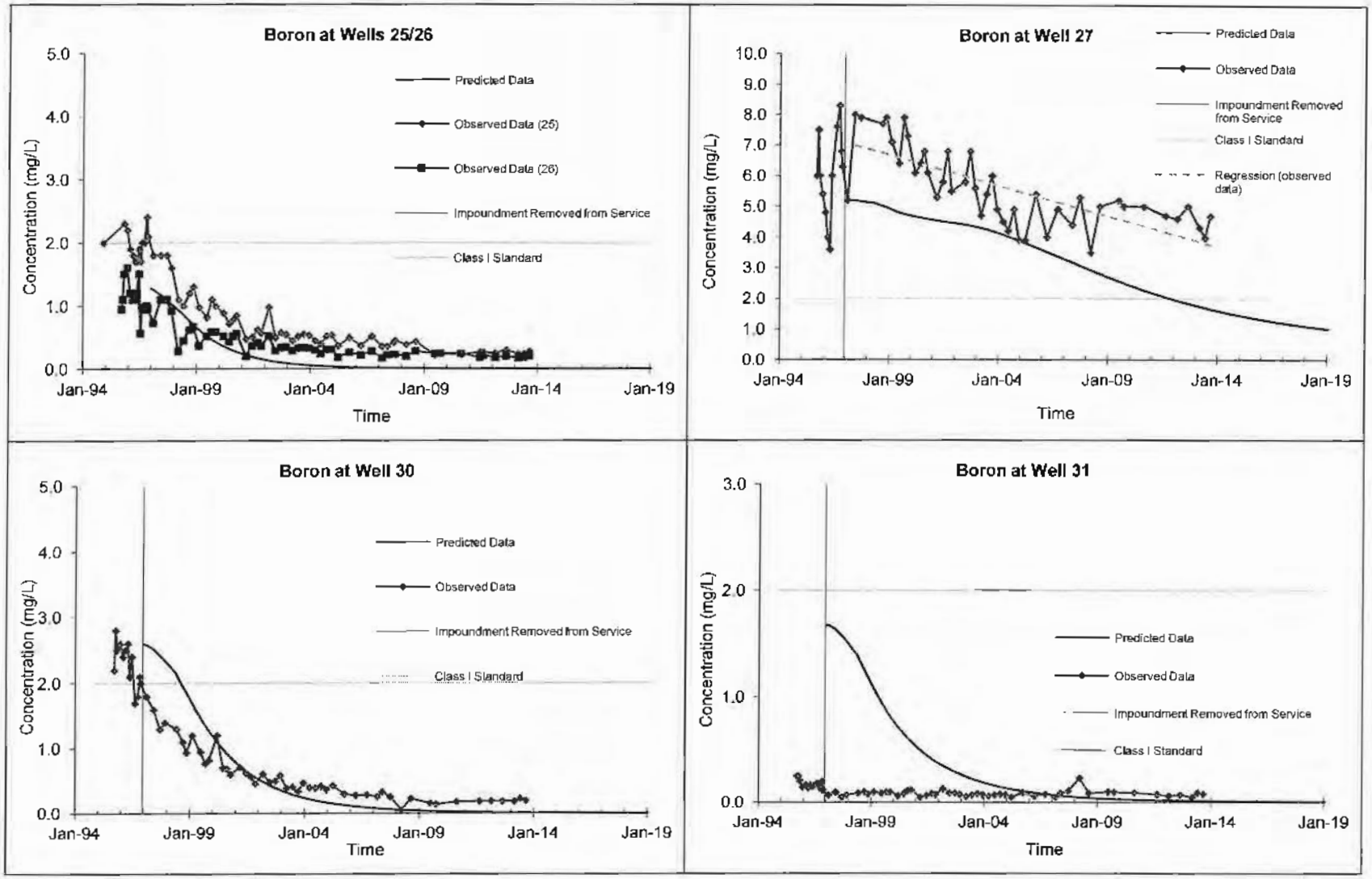


Figure 5b. Comparison of observed boron concentrations to model predictions in wells south of the Hennepin west ash impoundment.

APPENDIX A

Groundwater Monitoring Data: Quarter's 1 – 3, 2013

Hennepin West
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 01/01/2013 to 03/30/2013

Well Id	Date Sampled	Lab Id	Boron, dissolved, mg/L	Chloride, total, mg/L	Iron, dissolved, mg/L	Manganese, dissolved, mg/L	pH (field), SU	Residue, total filtrable, mg/L
21	03/08/2013		4.610	41	0.880	0.080	7.210	518
22	03/08/2013		7.020	31	<0.025	0.050	7.310	646
23	03/08/2013		7.050	57	<0.025	0.600	7.080	840
24	03/08/2013		5.050	45	2.390	0.050	7.280	578
25	03/08/2013		0.240	27	<0.025	<0.005	7.130	404
26	03/08/2013		0.170	39	0.050	<0.005	7.140	442
27	03/08/2013		4.310	49	1.130	0.660	7.200	654
30	03/08/2013		0.190	93	0.030	<0.005	7.150	562
31	03/08/2013		0.050	244	<0.025	0.030	7.060	726
32	03/08/2013		0.080	119	0.100	1.190	7.170	652
33	03/08/2013		<0.050	23	4.040	0.290	7.290	382
34	03/08/2013		0.090	97	6.820	1.120	7.170	754

Hennepin West
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 01/01/2013 to 03/30/2013

Well Id	Date Sampled	Lab Id	Sulfate, total, mg/L	Water level, relative to, ft
21	03/08/2013		144	445.30
22	03/08/2013		339	444.99
23	03/08/2013		478	445.55
24	03/08/2013		192	445.67
25	03/08/2013		32	445.44
26	03/08/2013		35	445.51
27	03/08/2013		219	445.40
30	03/08/2013		132	445.51
31	03/08/2013		148	445.46
32	03/08/2013		146	444.42
33	03/08/2013		<10	444.17
34	03/08/2013		111	442.21

Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 06/01/2013 to 06/30/2013

Well Id	Date Sampled	Lab Id	Boron, total, mg/L	Chloride, dissolved, mg/L	Iron, total, mg/L	Manganese, total, mg/L	pH (field), SU	Residue, total filtrable, mg/L
21	06/07/2013		5.180	43.000	3.180	0.110	7.960	564
22	06/07/2013		7.660	38.000	0.110	0.140	7.830	702
23	06/07/2013		2.880	22.000	0.450	0.090	7.150	574
24	06/07/2013		3.020	38.000	0.680	0.030	7.780	376
25	06/07/2013		0.240	46.000	5.060	0.190	7.260	444
26	06/07/2013		0.180	50.000	0.580	0.020	7.410	408
27	06/26/2013		3.980	46.000	4.320	0.540	7.310	600
30	06/26/2013		0.230	51.000	1.370	0.050	6.740	564
31	06/26/2013		0.090	48.000	0.950	0.120	6.810	486
32	06/26/2013		0.080	69.000	1.240	0.110	7.520	592
33	06/26/2013		0.040	15.000	4.920	0.140	7.290	388

Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 06/01/2013 to 06/30/2013

Well Id	Date Sampled	Lab Id	Sulfate, dissolved, mg/L	Water level, relative to, ft
21	06/07/2013		161.000	451.48
22	06/07/2013		346.000	451.34
23	06/07/2013		152.000	451.40
24	06/07/2013		108.000	451.53
25	06/07/2013		38.000	451.27
26	06/07/2013		21.000	451.30
27	06/26/2013		152.000	444.23
30	06/26/2013		72.000	444.70
31	06/26/2013		33.000	444.69
32	06/26/2013		102.000	443.45
33	06/26/2013		<100.000	439.18

Hennepin West
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 09/01/2013 to 09/30/2013

Well Id	Date Sampled	Lab Id	Boron, total, mg/L	Chloride, dissolved, mg/L	Iron, total, mg/L	Manganese, total, mg/L	pH (field), SU	Residue, total filtrable, mg/L
21	09/03/2013		5.090	40.000	3.880	0.110	7.060	618
22	09/03/2013		7.510	34.000	0.070	0.090	7.910	784
23	09/03/2013		7.430	62.000	0.160	0.060	7.550	1,030
24	09/03/2013		2.900	40.000	0.580	0.020	7.840	324
25	09/03/2013		0.280	43.000	1.360	0.050	7.710	466
26	09/03/2013		0.200	31.000	0.900	0.040	7.560	408
27	09/03/2013		4.680	38.000	0.810	0.720	7.970	618
30	09/03/2013		0.200	17.000	1.090	0.030	7.320	502
31	09/03/2013		0.080	57.000	0.190	0.190	6.830	434
32	09/03/2013		0.080	54.000	2.180	0.230	7.430	486
33	09/03/2013		0.040	21.000	2.590	0.290	7.600	342
34	09/04/2013		0.100	81.000	7.970	1.330	7.330	798

Hennepin West
Analysis Results by Parameter (column), Location (row), and Date (row)

Date Range: 09/01/2013 to 09/30/2013

Well Id	Date Sampled	Lab Id	Sulfate, dissolved, mg/L	Water level, relative to, ft
21	09/03/2013		149.000	445.07
22	09/03/2013		341.000	444.98
23	09/03/2013		456.000	445.32
24	09/03/2013		75.000	445.56
25	09/03/2013		49.000	445.05
26	09/03/2013		29.000	445.24
27	09/03/2013		192.000	445.22
30	09/03/2013		29.000	445.40
31	09/03/2013		54.000	445.38
32	09/03/2013		83.000	444.10
33	09/03/2013		<10.000	440.51
34	09/04/2013		80.000	440.04

APPENDIX B

Groundwater Standards Exceedances

Limit Exceptions (Count)

Date Range: 12/01/1994 to 09/04/2013

Location: 21

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	pH (field), SU	6.500 to 9.000	1	03/24/2003	0		64
	Boron, dissolved, mg/L	0.000 to 2.000	0		64	09/03/2013	64
	Manganese, dissolved, mg/L	0.000 to 0.150	0		7	09/17/1997	64

Location: 22

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	pH (field), SU	6.500 to 9.000	0		9	03/13/2002	65
	Sulfate, total, mg/L	0.000 to 400.000	0		25	08/25/2010	65
	Boron, dissolved, mg/L	0.000 to 2.000	0		65	09/03/2013	65

Location: 23

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Residue, total filtrable, mg/L	0.000 to 1,200.000	0		1	02/07/1996	65
	Sulfate, total, mg/L	0.000 to 400.000	0		47	09/03/2013	65
	Boron, dissolved, mg/L	0.000 to 2.000	0		64	09/03/2013	65
	Manganese, dissolved, mg/L	0.000 to 0.150	0		49	03/08/2013	65

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11:07:51 AM

Limit Exceptions (Count)

Date Range: 12/01/1994 to 09/04/2013

Locatinn:24

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	pH (field), SU	6.500 to 9.000	0		3	08/25/2010	65
	Sulfate, total, mg/L	0.000 to 400.000	0		22	02/29/2012	65
	Boron, dissolved, mg/L	0.000 to 2.000	0		64	09/03/2013	65
	Iron, dissolved, mg/L	0.000 to 5.000	0		25	08/16/2000	64
	Manganese, dissolved, mg/L	0.000 to 0.150	0		1	12/01/1994	65

Lncation:25

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Boron, dissolved, mg/L	0.000 to 2.000	0		4	11/13/1996	64
	Iron, dissolved, mg/L	0.000 to 5.000	0		1	06/07/2013	63
	Manganese, dissolved, mg/L	0.000 to 0.150	0		1	06/07/2013	64

Location:26

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Iron, dissolved, mg/L	0.000 to 5.000	0		1	09/22/2005	65
	Manganese, dissolved, mg/L	0.000 to 0.150	0		1	09/22/2005	65

Limit Exceptions (Count)

Date Range: 12/01/1994 to 09/04/2013

Location:27

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Sulfate, total, mg/L	0.000 to 400.000	0		1	09/25/1996	57
	Boron, dissolved, mg/L	0.000 to 2.000	0		57	09/03/2013	57
	Manganese, dissolved, mg/L	0.000 to 0.150	0		57	09/03/2013	57

Location:30

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Boron, dissolved, mg/L	0.000 to 2.000	0		9	10/30/1996	61

Location:31

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	Chloride, total, mg/L	0.000 to 200.000	0		1	03/08/2013	61
	Manganese, dissolved, mg/L	0.000 to 0.150	0		10	09/03/2013	61

Location:32

Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	

Limit Exceptions (Count)

Date Range: 12/01/1994 to 09/04/2013

Class I							
	pH (field), SU	6.500 to 9.000	1	03/24/2003	0		50
	Manganese, dissolved, mg/L	0.000 to 0.150	0		33	09/03/2013	50

Location: 33

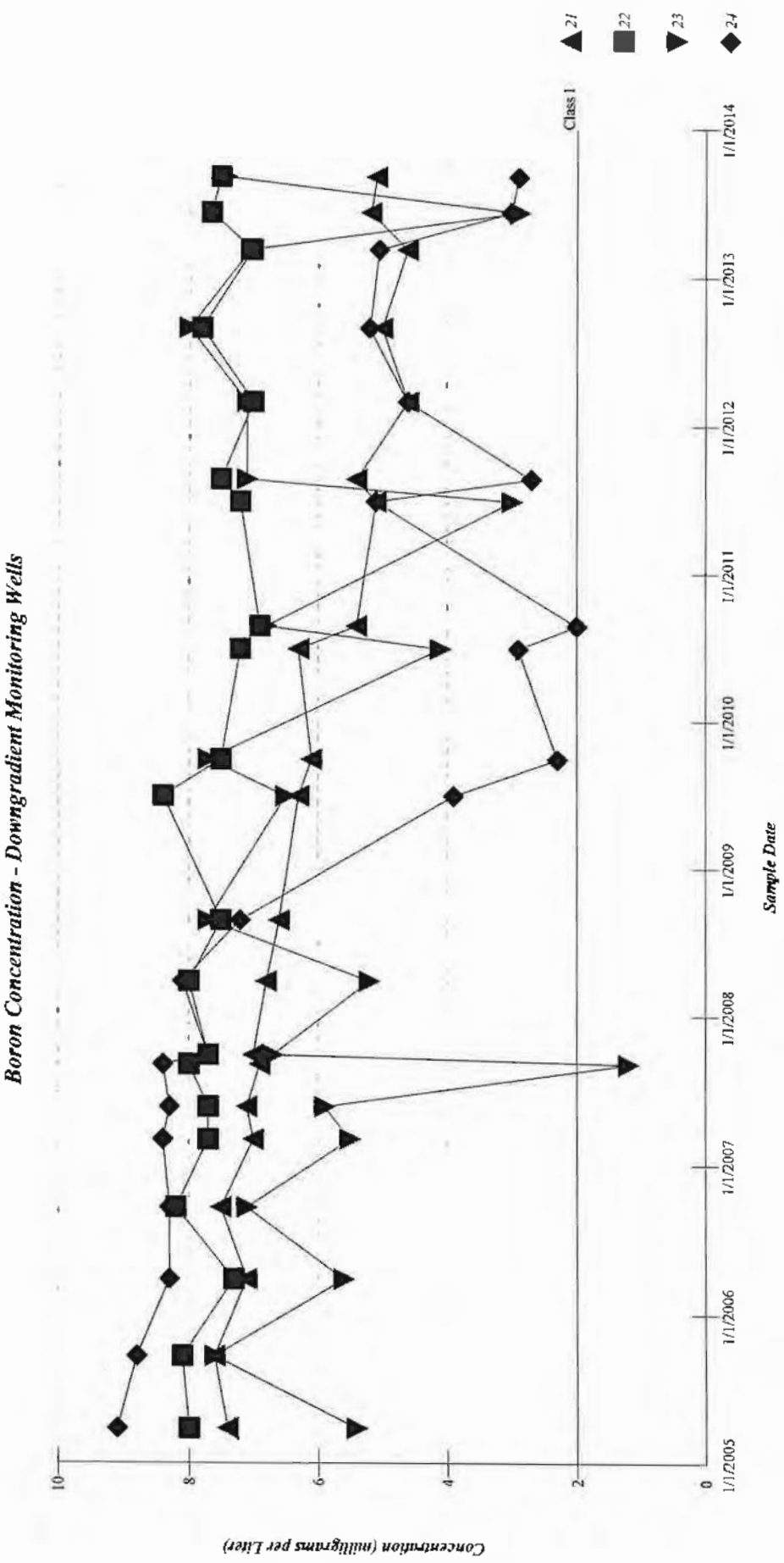
Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	pH (field), SU	6.500 to 9.000	0		1	08/15/2000	28
	Iron, dissolved, mg/L	0.000 to 5.000	0		8	03/29/2006	28
	Manganese, dissolved, mg/L	0.000 to 0.150	0		12	09/03/2013	28

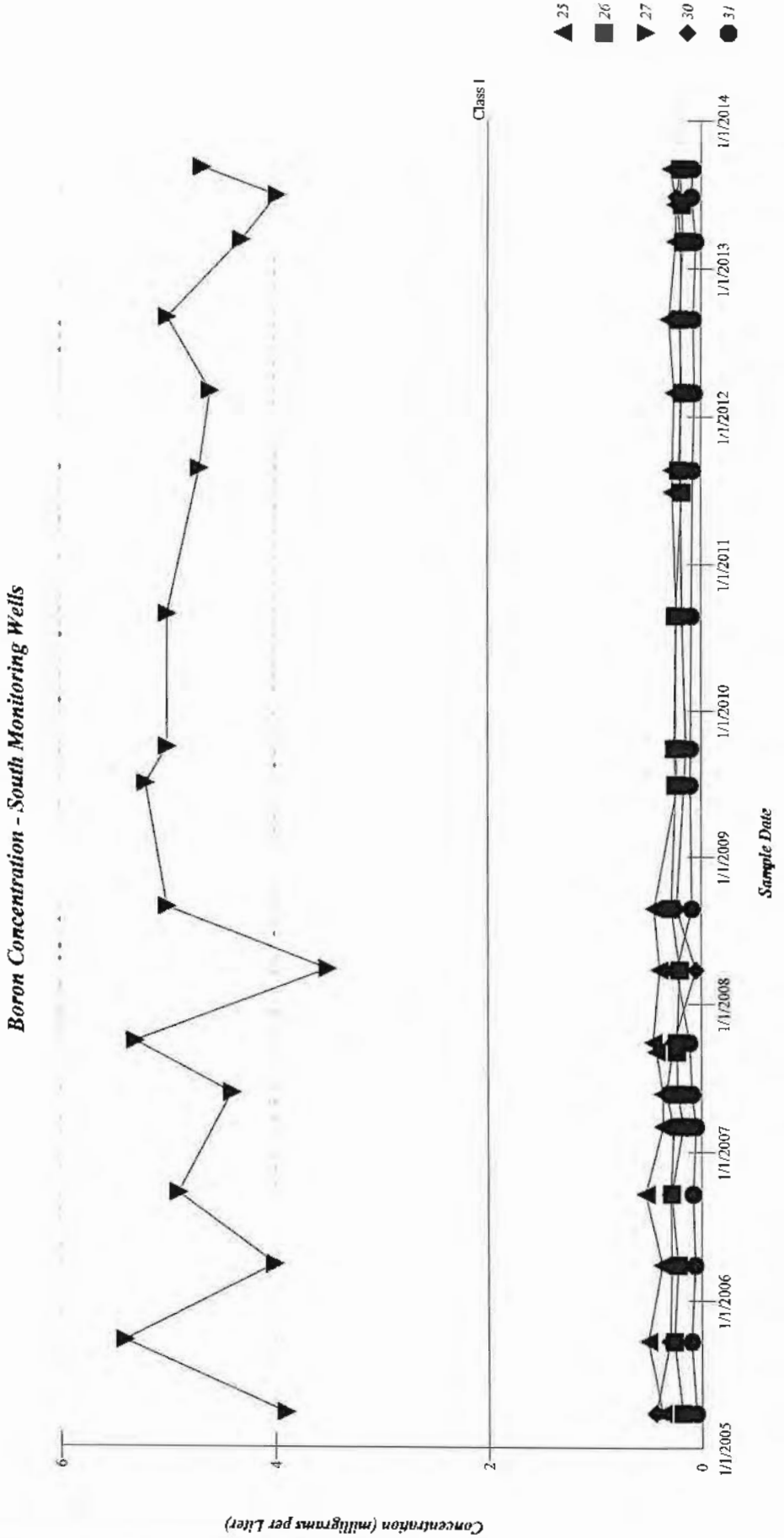
Location: 34

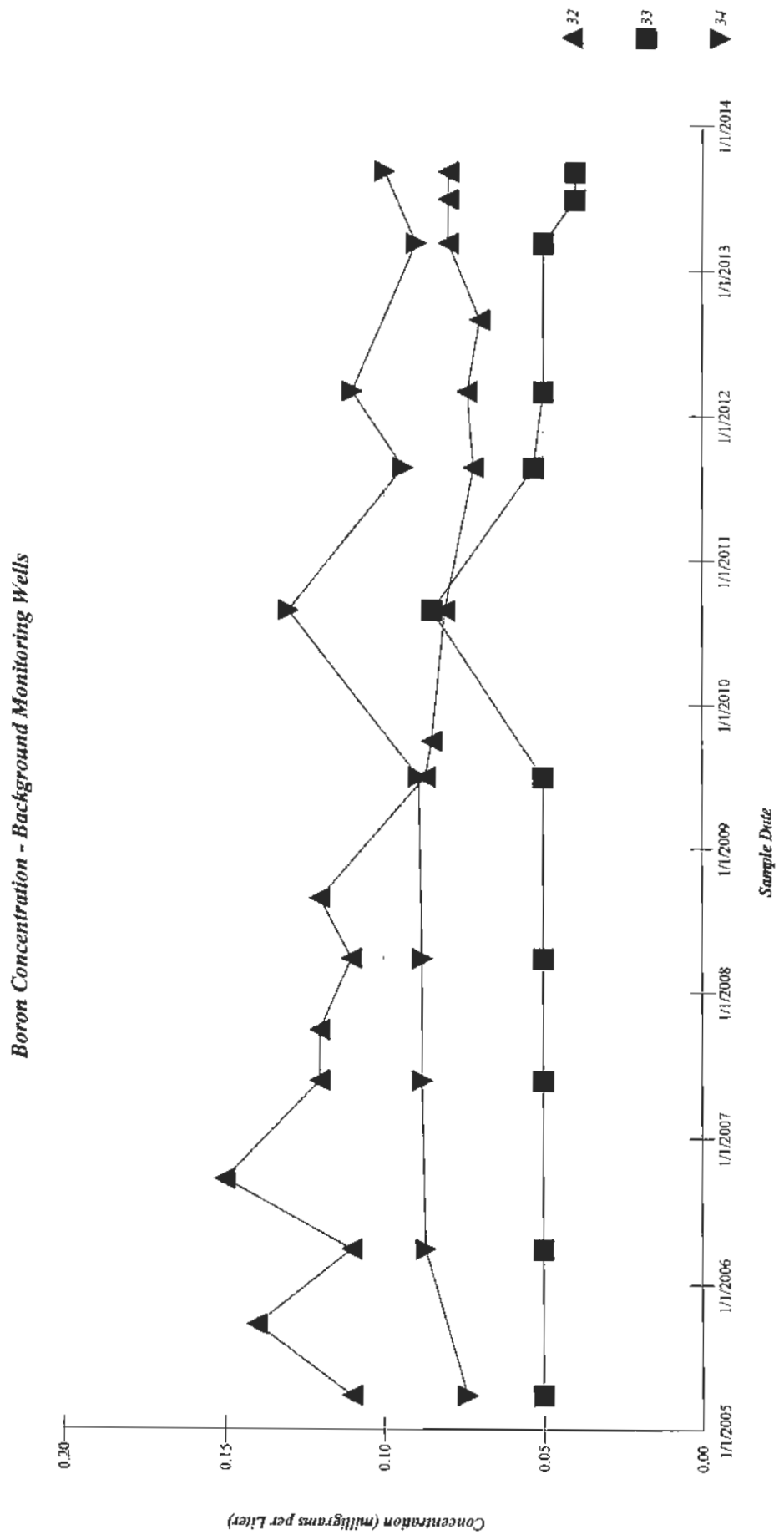
Limit	Parameter	Limit Range	Lower Exceedance		Upper Exceedance		# of Sample Results
			Count	Last Exceedance	Count	Last Exceedance	
Class I							
	pH (field), SU	6.500 to 9.000	2	05/24/2007	0		23
	Iron, dissolved, mg/L	0.000 to 5.000	0		17	09/04/2013	23
	Manganese, dissolved, mg/L	0.000 to 0.150	0		23	09/04/2013	23

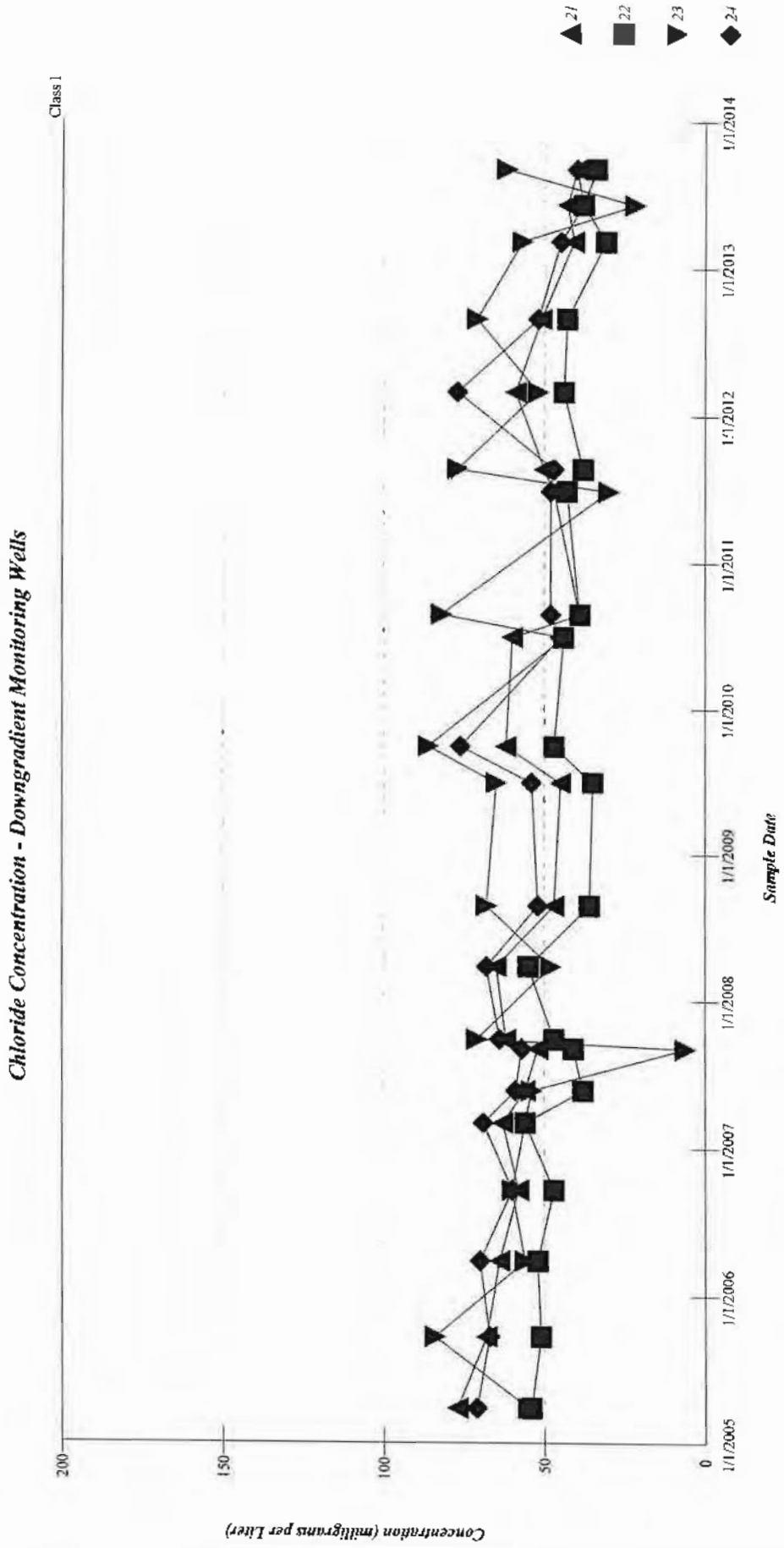
APPENDIX C

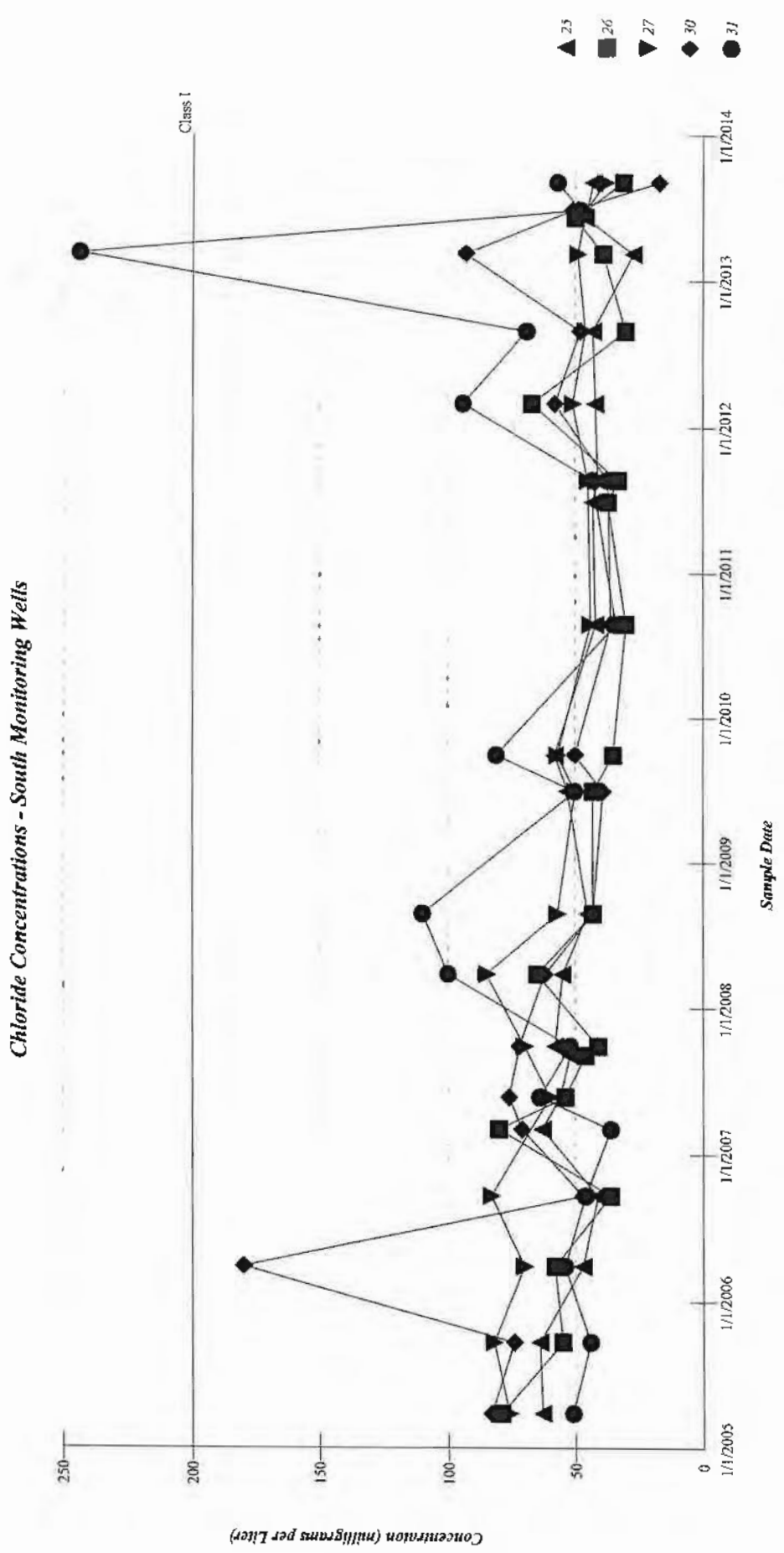
Time – Concentration Plots for Monitored Parameters

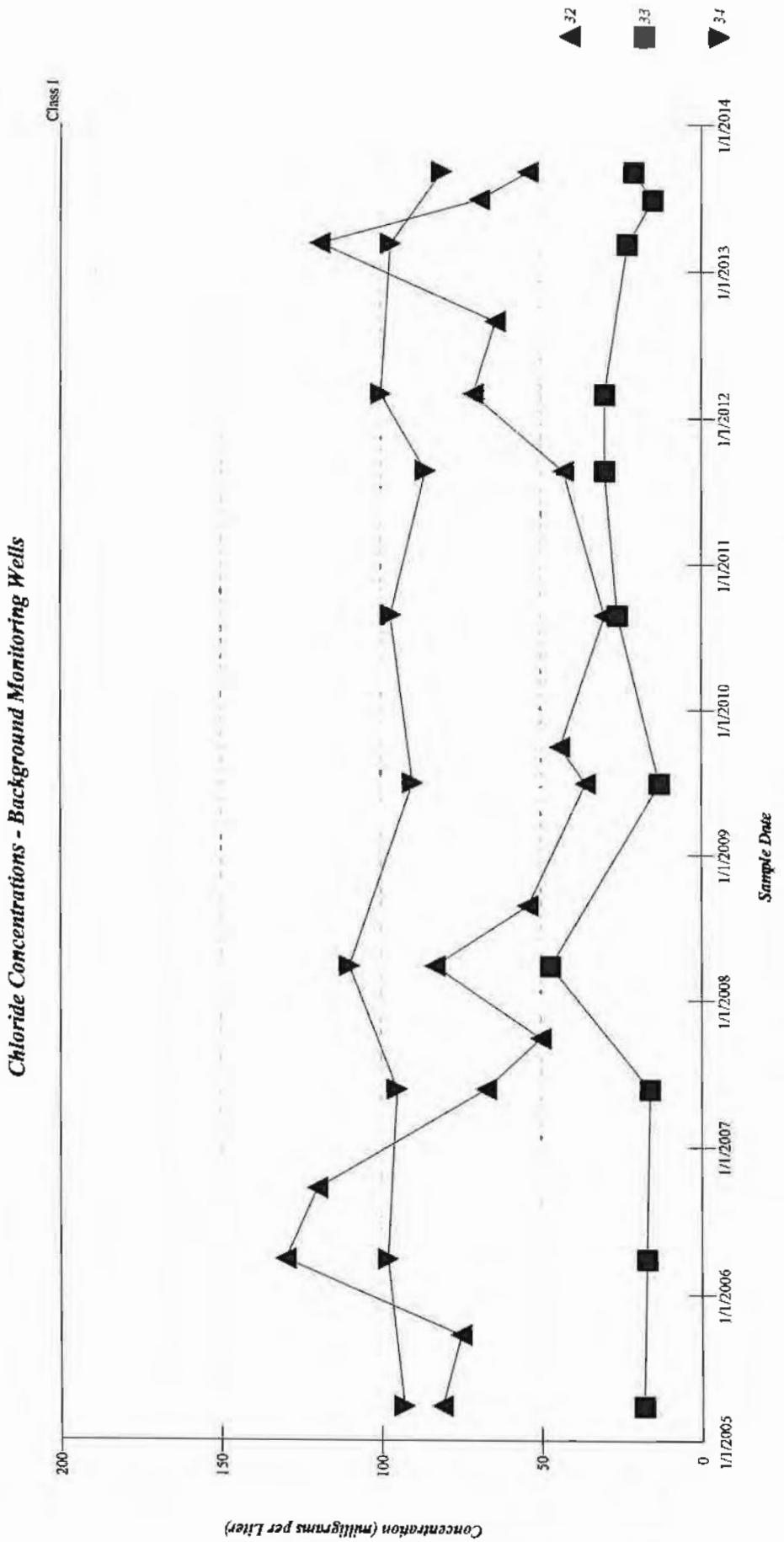

Boron Concentration - Downgradient Monitoring Wells
Concentration (milligrams per Liter)
Sample Date
Class 1
21
22
23
24
0
2
4
6
8
10
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

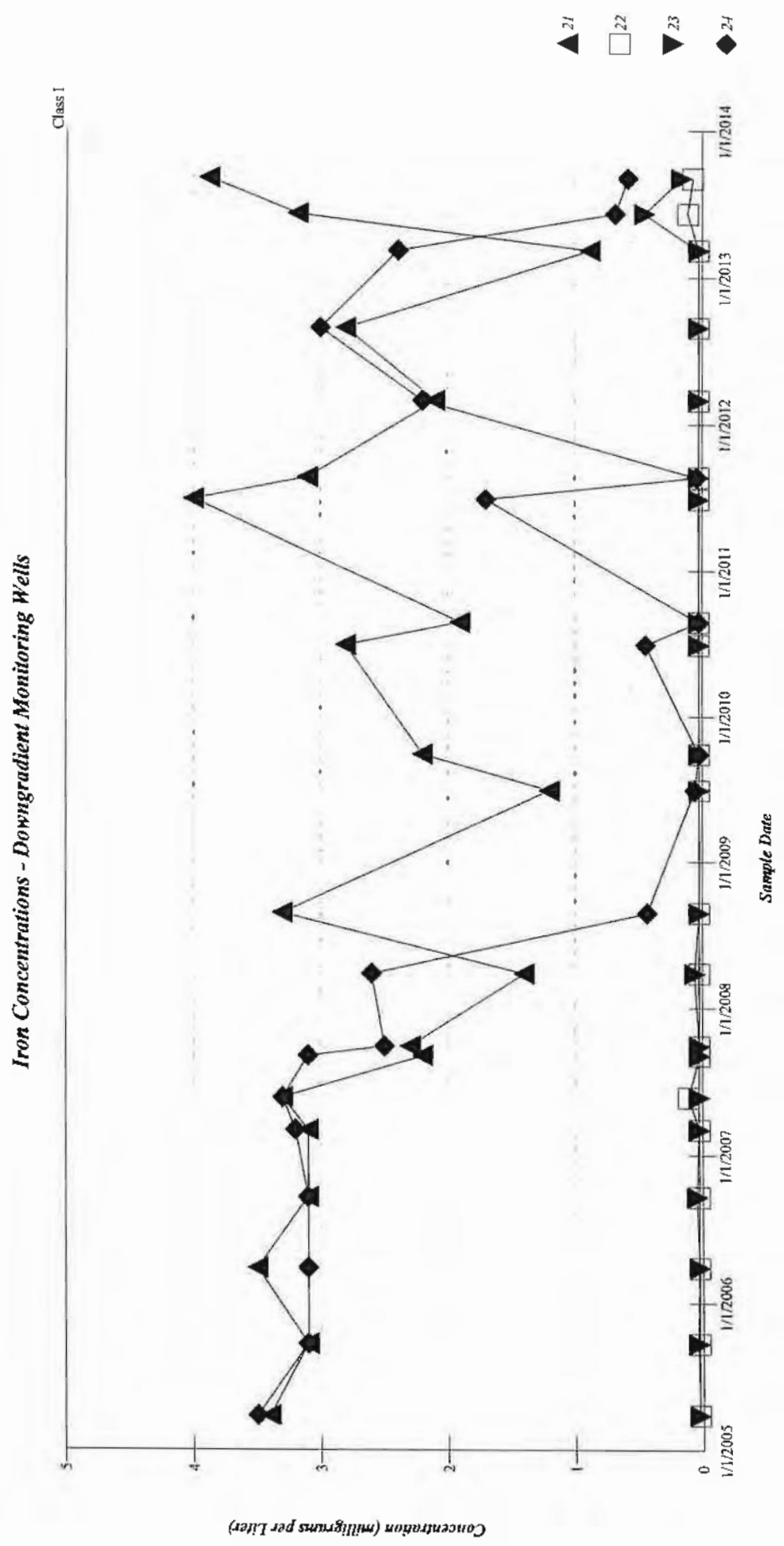

Boron Concentration - South Monitoring Wells
Concentration (milligrams per Liter)
Sample Date
Class I
25
26
27
30
31
0
2
4
6
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

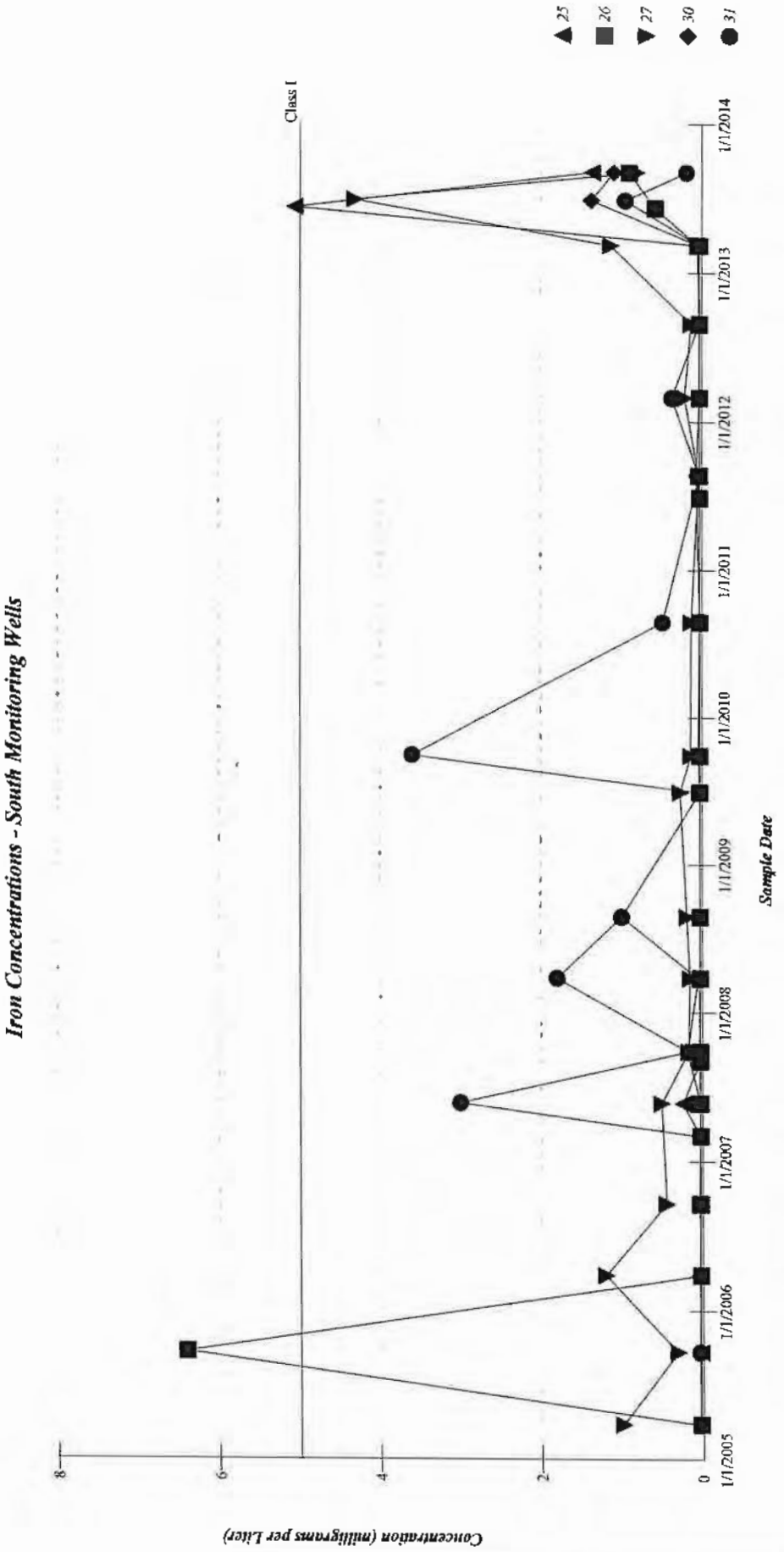

Boron Concentration - Background Monitoring Wells
Concentration (milligrams per Liter)
0.20
0.15
0.10
0.05
0.00
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
32
33
34

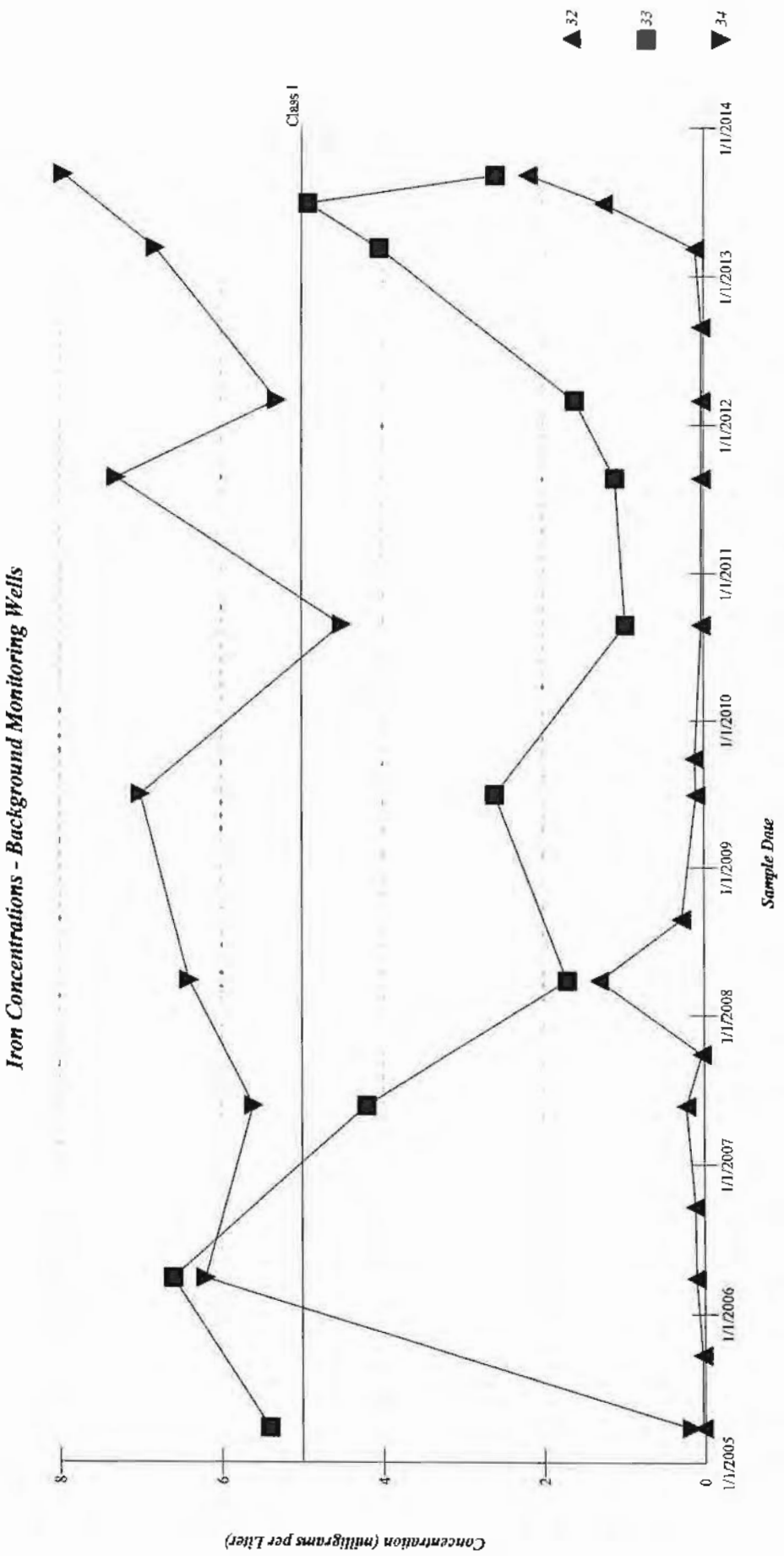

Chloride Concentration - Downgradient Monitoring Wells
Class I
21
22
23
24
200
150
100
50
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

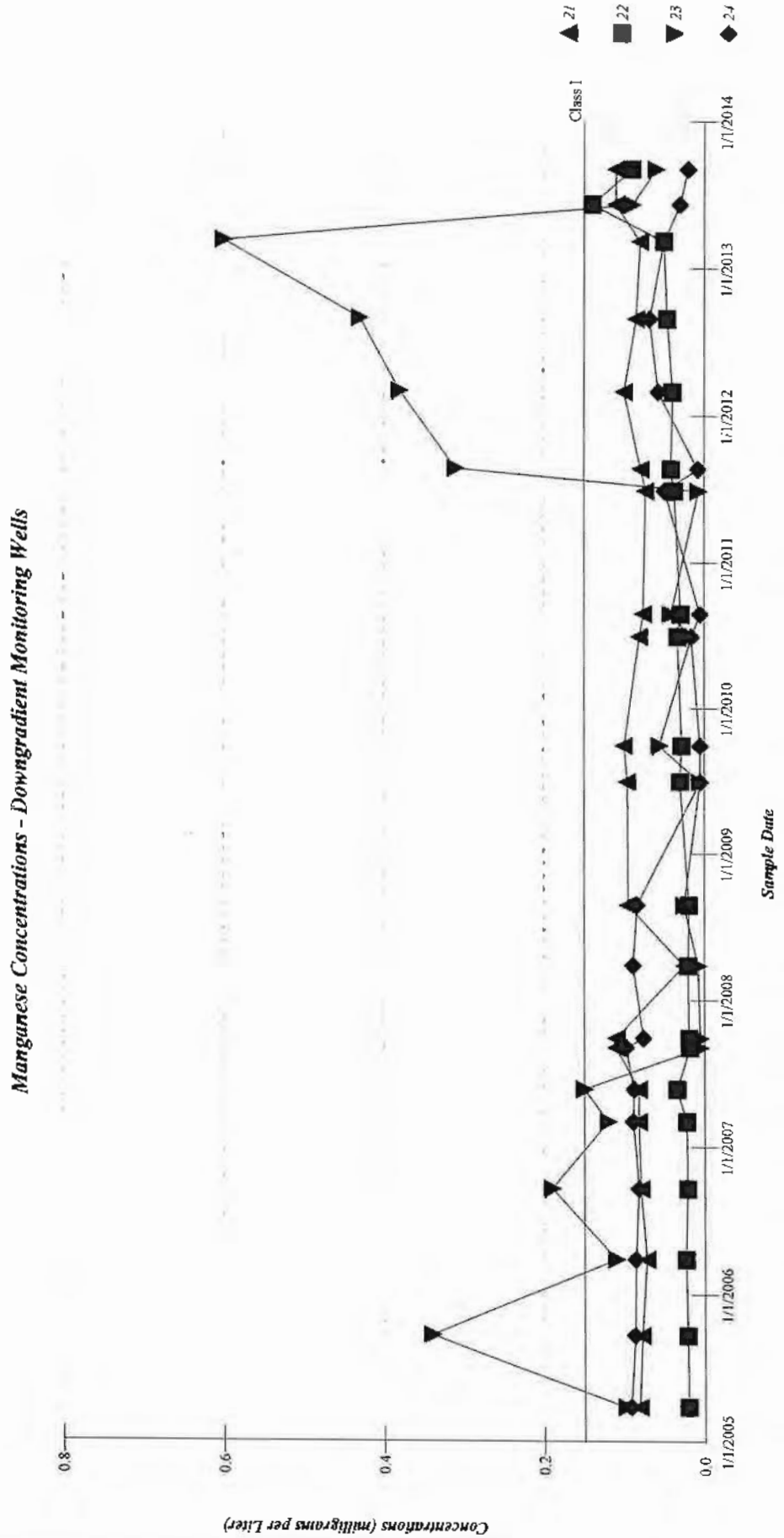

Chloride Concentrations - South Monitoring Wells
Class I
25
26
27
30
31
250
200
150
100
50
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

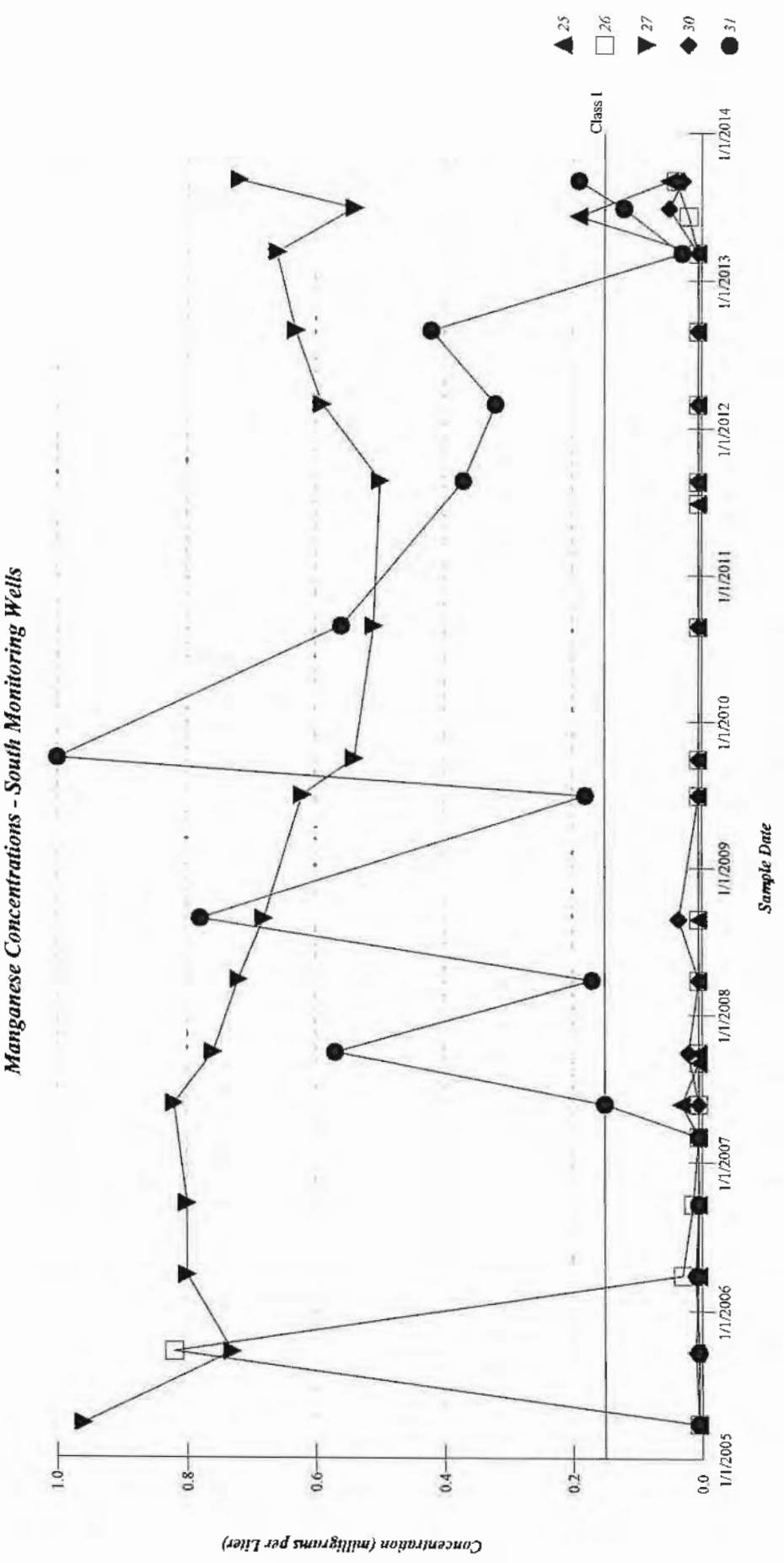

Chloride Concentrations - Background Monitoring Wells
Class I
32
33
34
200
150
100
50
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

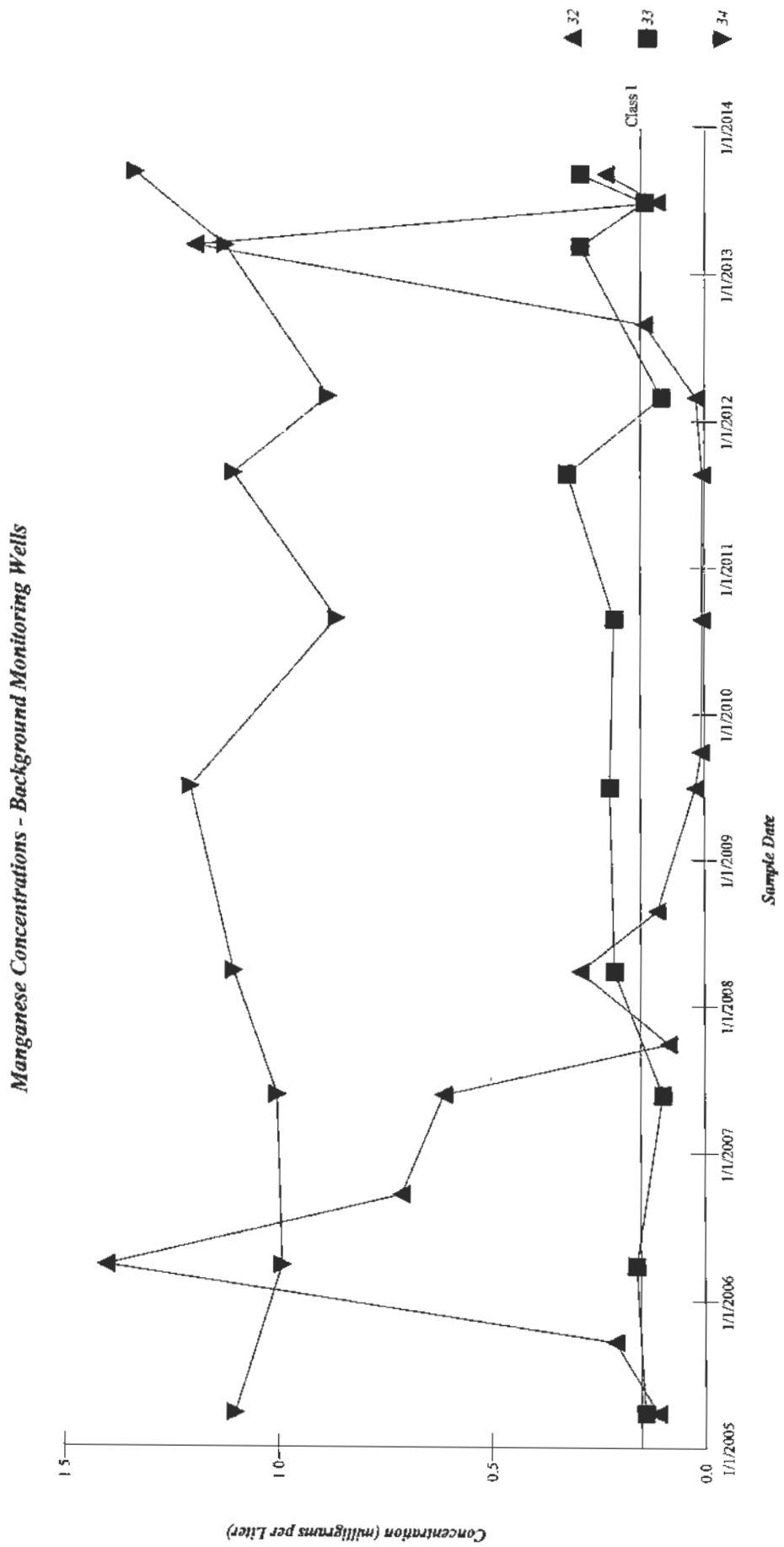

Iron Concentrations - Downgradient Monitoring Wells
Class I
Concentration (milligrams per Liter)
Sample Date
21
22
23
24
0
1
2
3
4
5
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

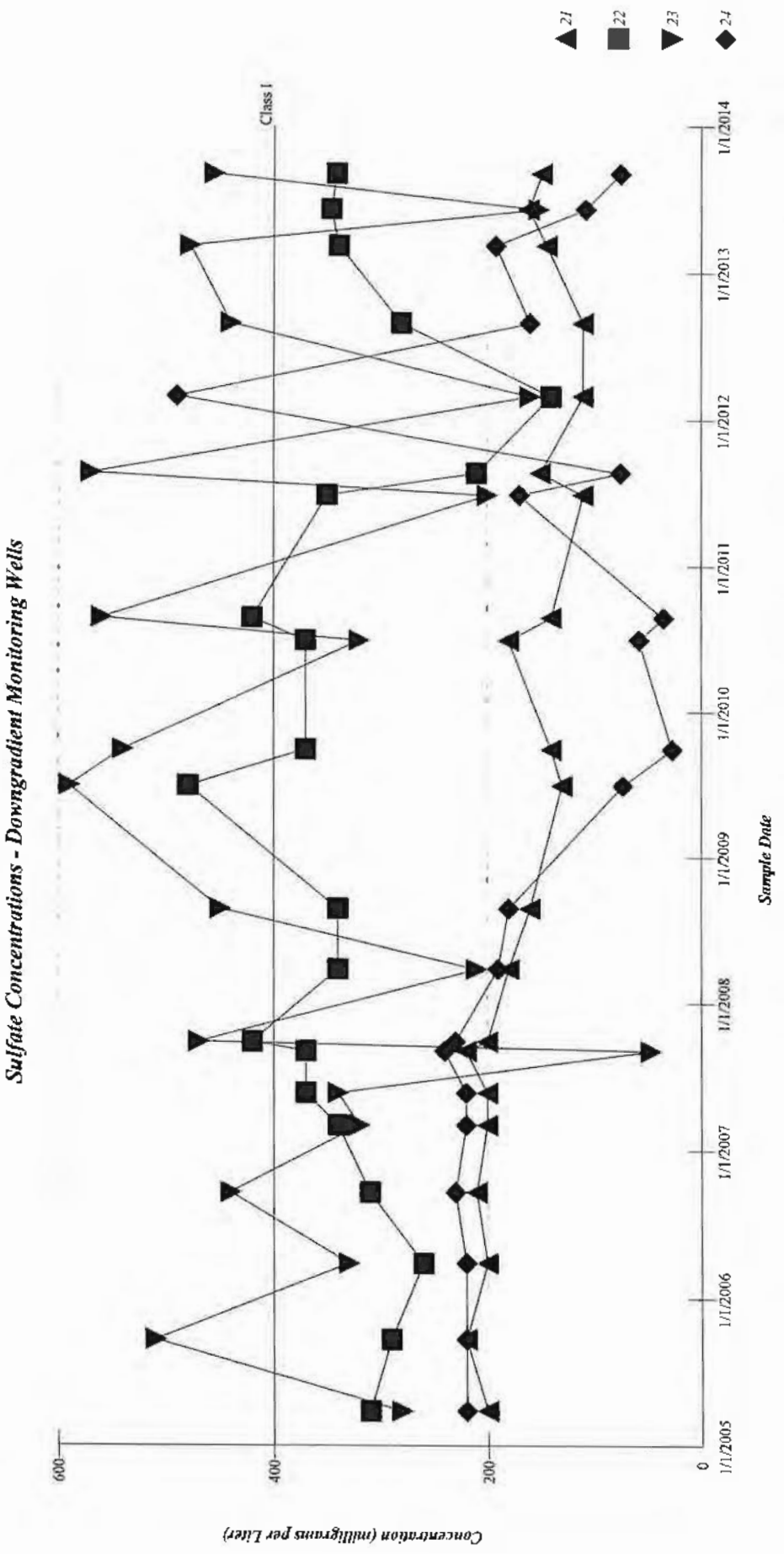

Iron Concentrations - South Monitoring Wells
Class I
25
26
27
30
31
Concentration (milligrams per Liter)
Sample Date
0
2
4
6
8
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

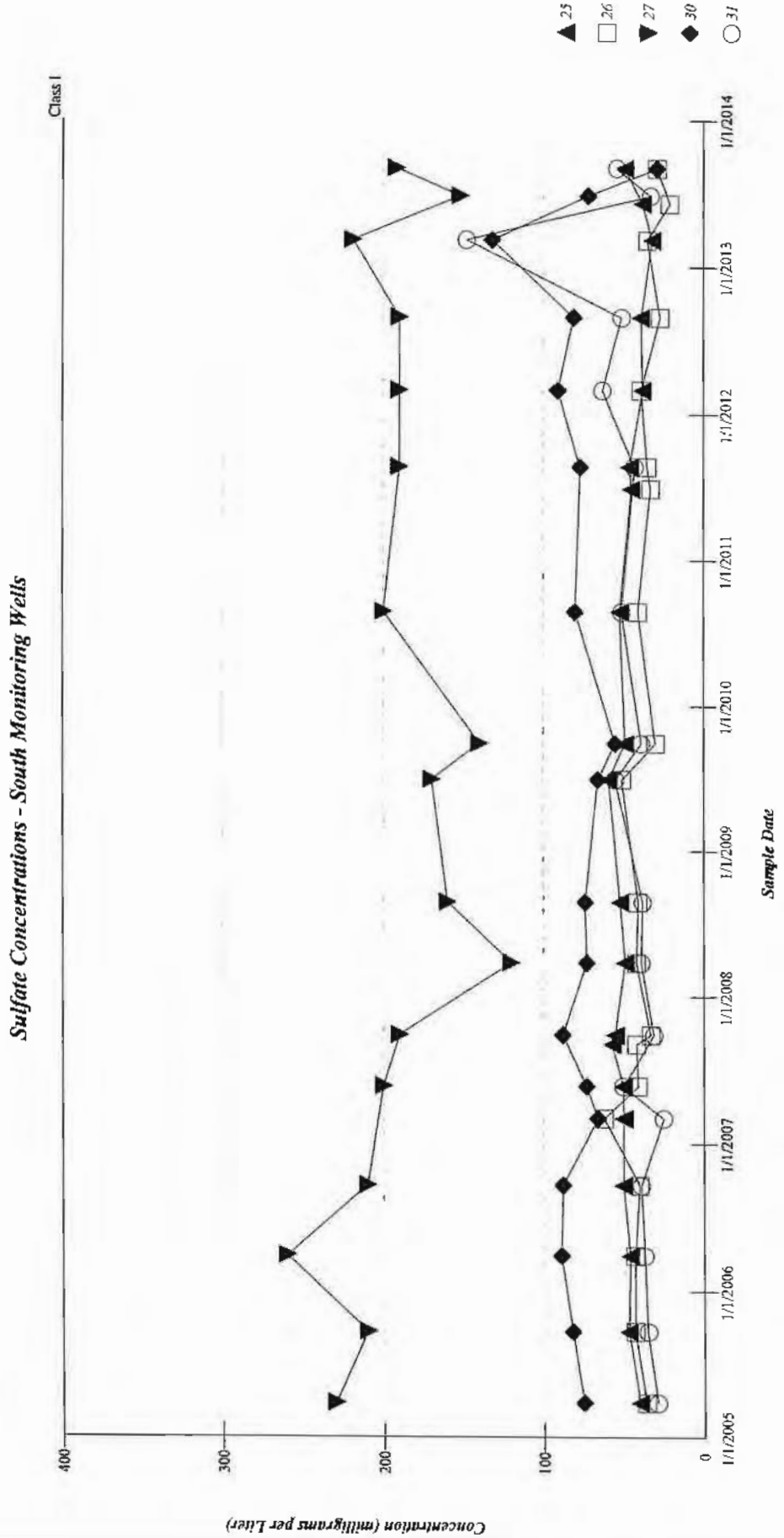

Iron Concentrations - Background Monitoring Wells
Class I
32
33
34
Concentration (milligrams per Liter)
Sample Date
0
2
4
6
8
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

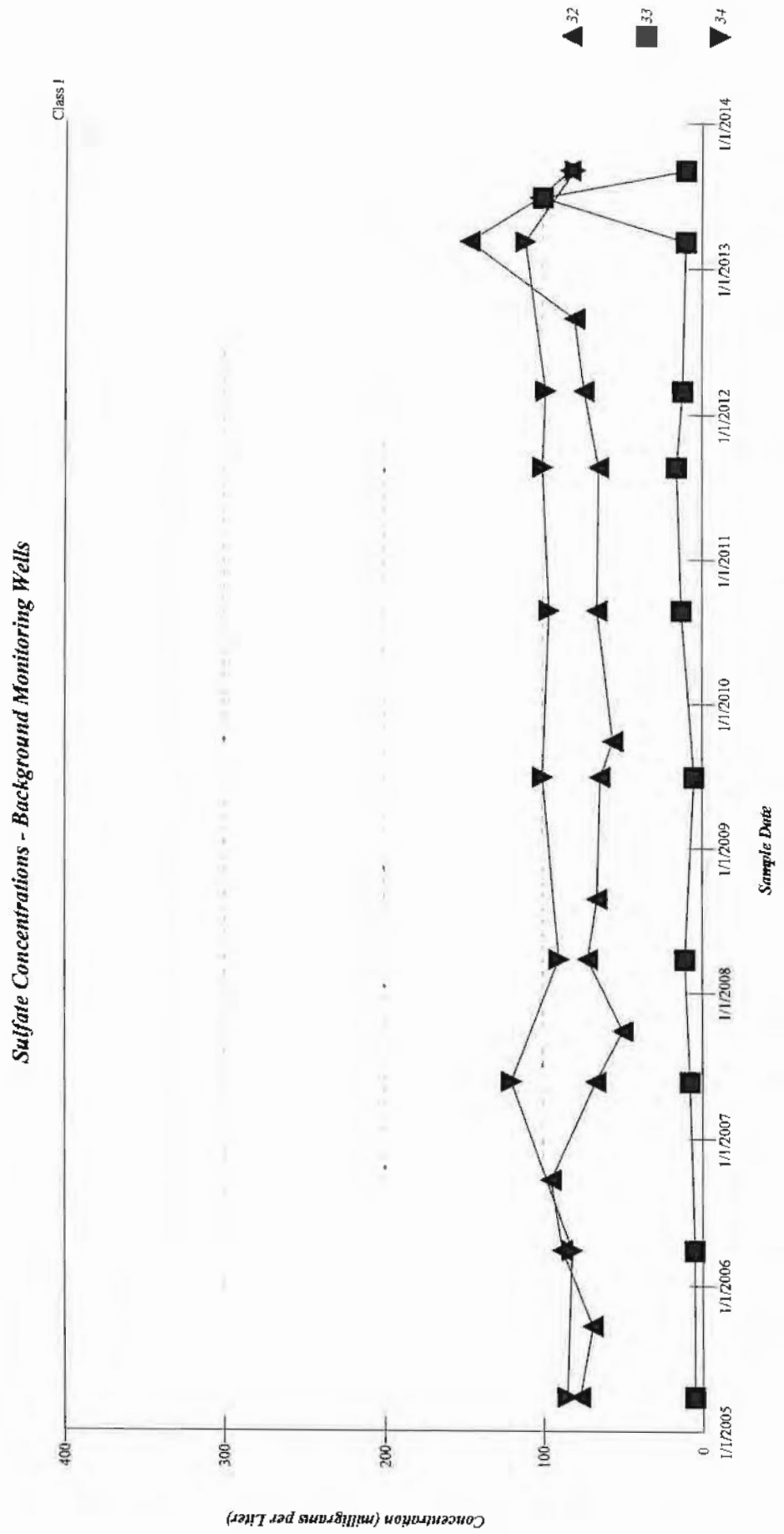

Manganese Concentrations - Downgradient Monitoring Wells
Concentrations (milligrams per Liter)
Sample Date
Class 1
21
22
23
24
0.0
0.2
0.4
0.6
0.8
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

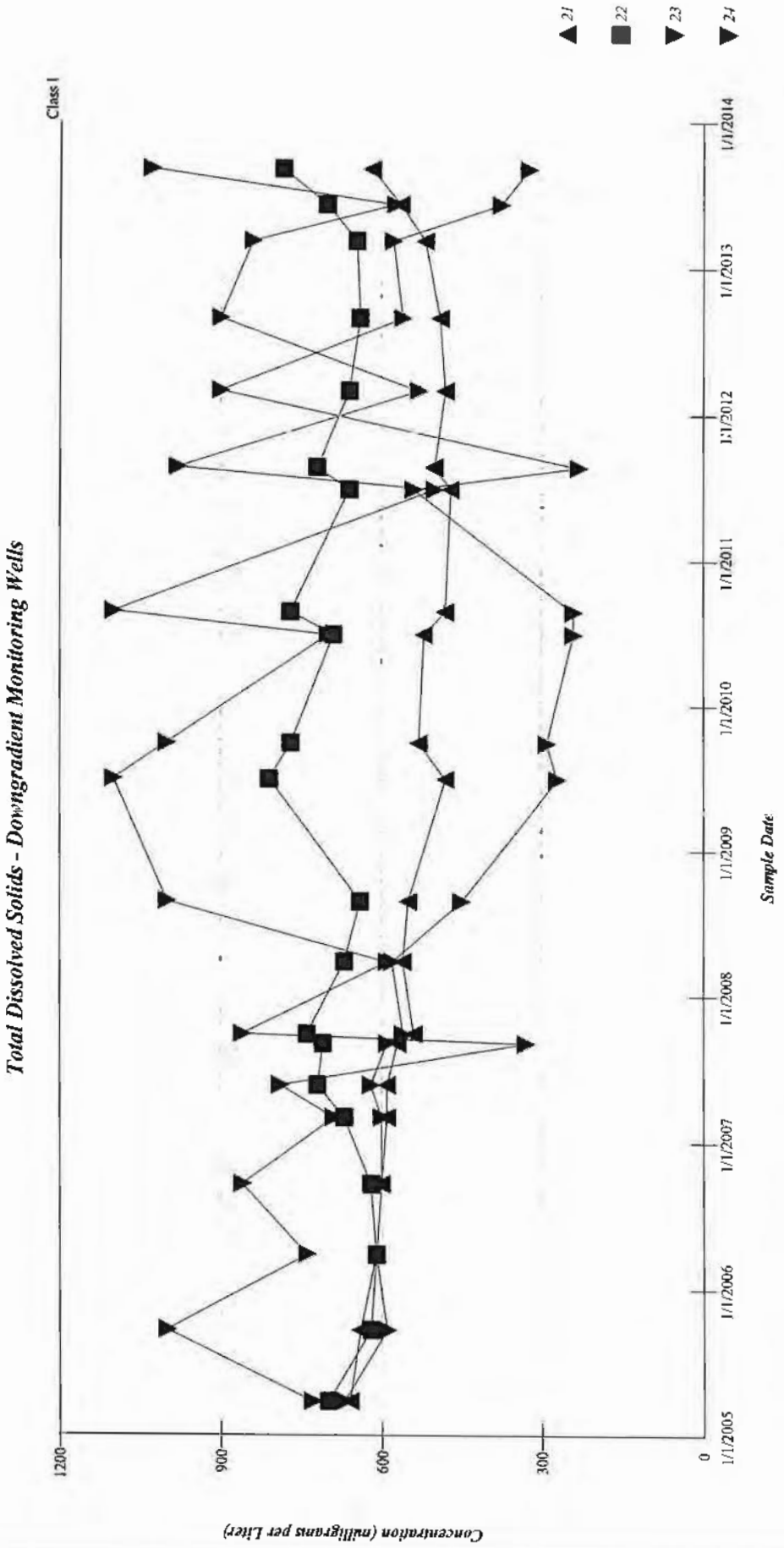

Manganese Concentrations - South Monitoring Wells
Concentration (milligrams per Liter)
Sample Date
Class I
25
26
27
30
31
1.0
0.8
0.6
0.4
0.2
0.0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

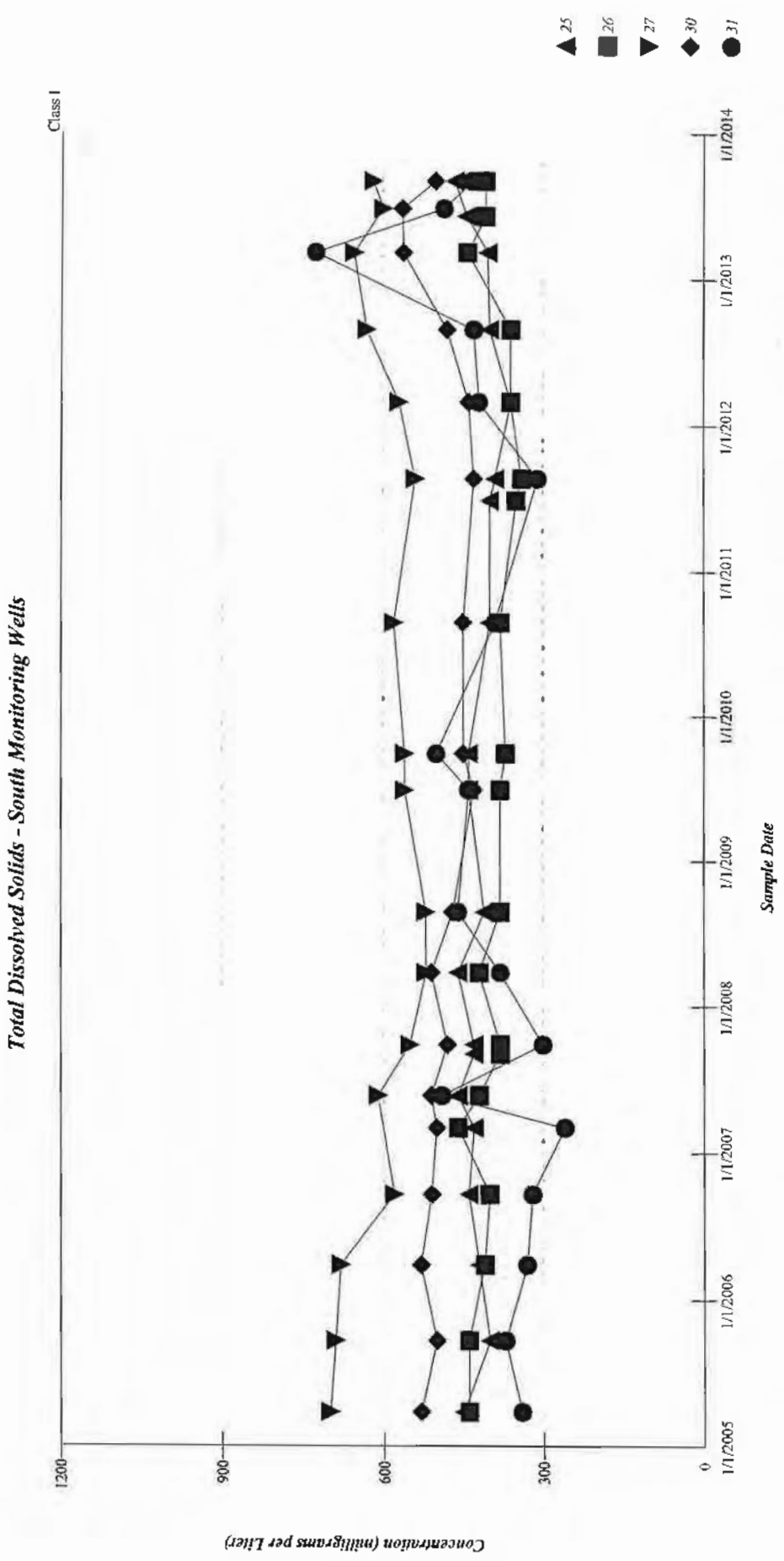

Manganese Concentrations - Background Monitoring Wells
Concentration (milligrams per Liter)
Sample Date
Class 1
32
33
34
1.5
1.0
0.5
0.0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014

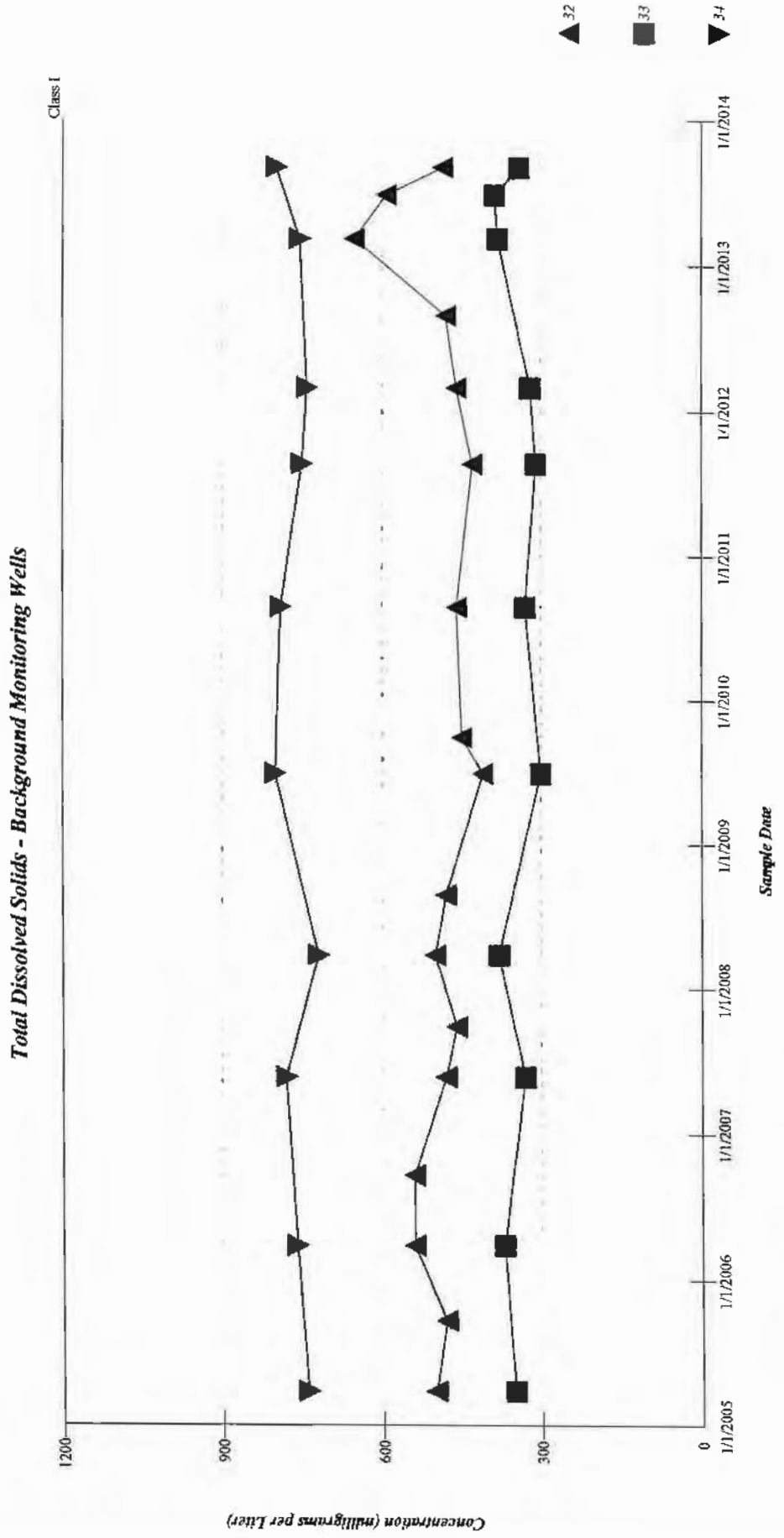

Sulfate Concentrations - Downgradient Monitoring Wells
Class I
21
22
23
24
600
400
200
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

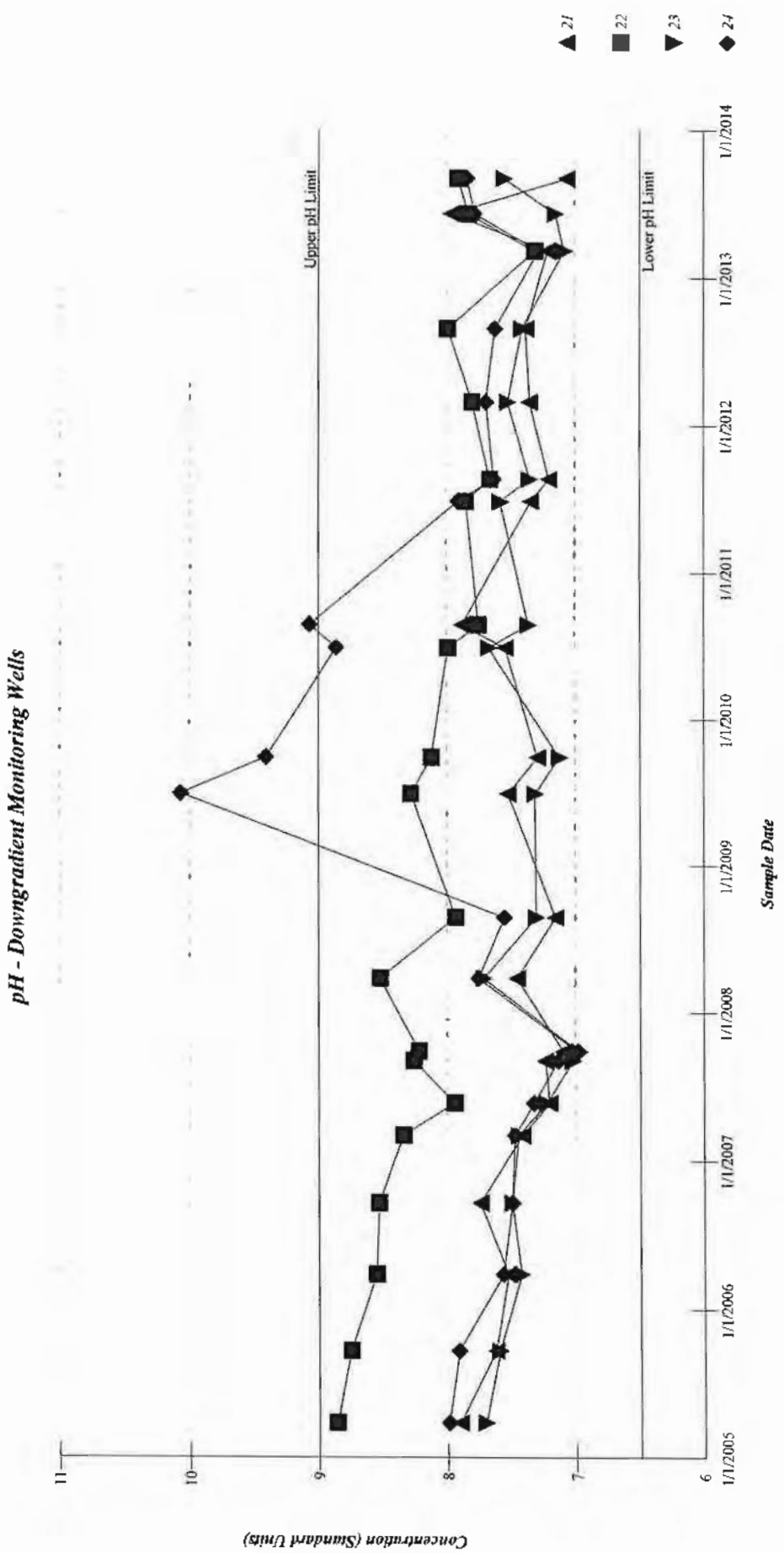

Sulfate Concentrations - South Monitoring Wells
Class I
25
26
27
30
31
400
300
200
100
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

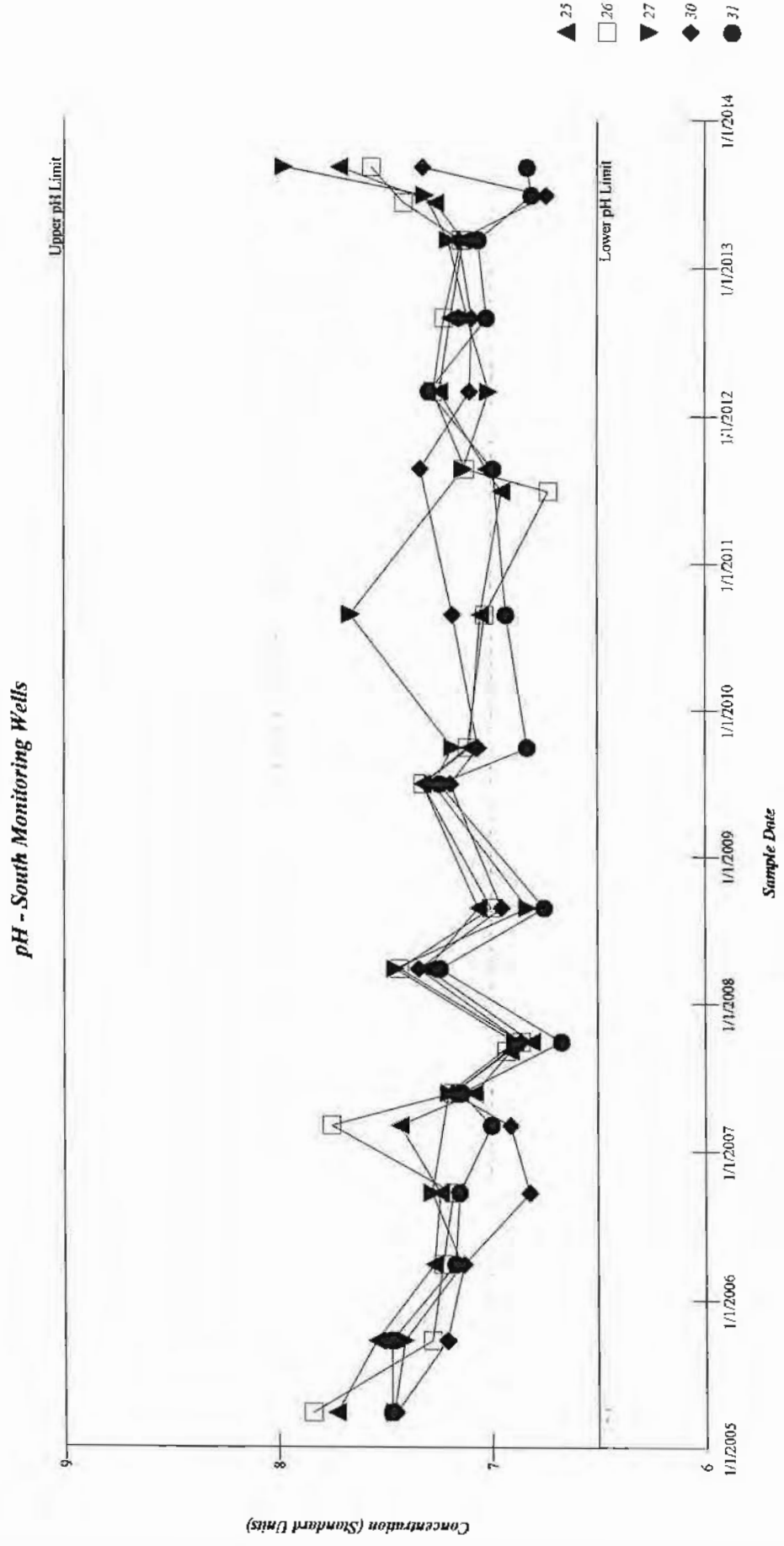

Sulfate Concentrations - Background Monitoring Wells
Class I
32
33
34
400
300
200
100
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Concentration (milligrams per Liter)
Sample Date

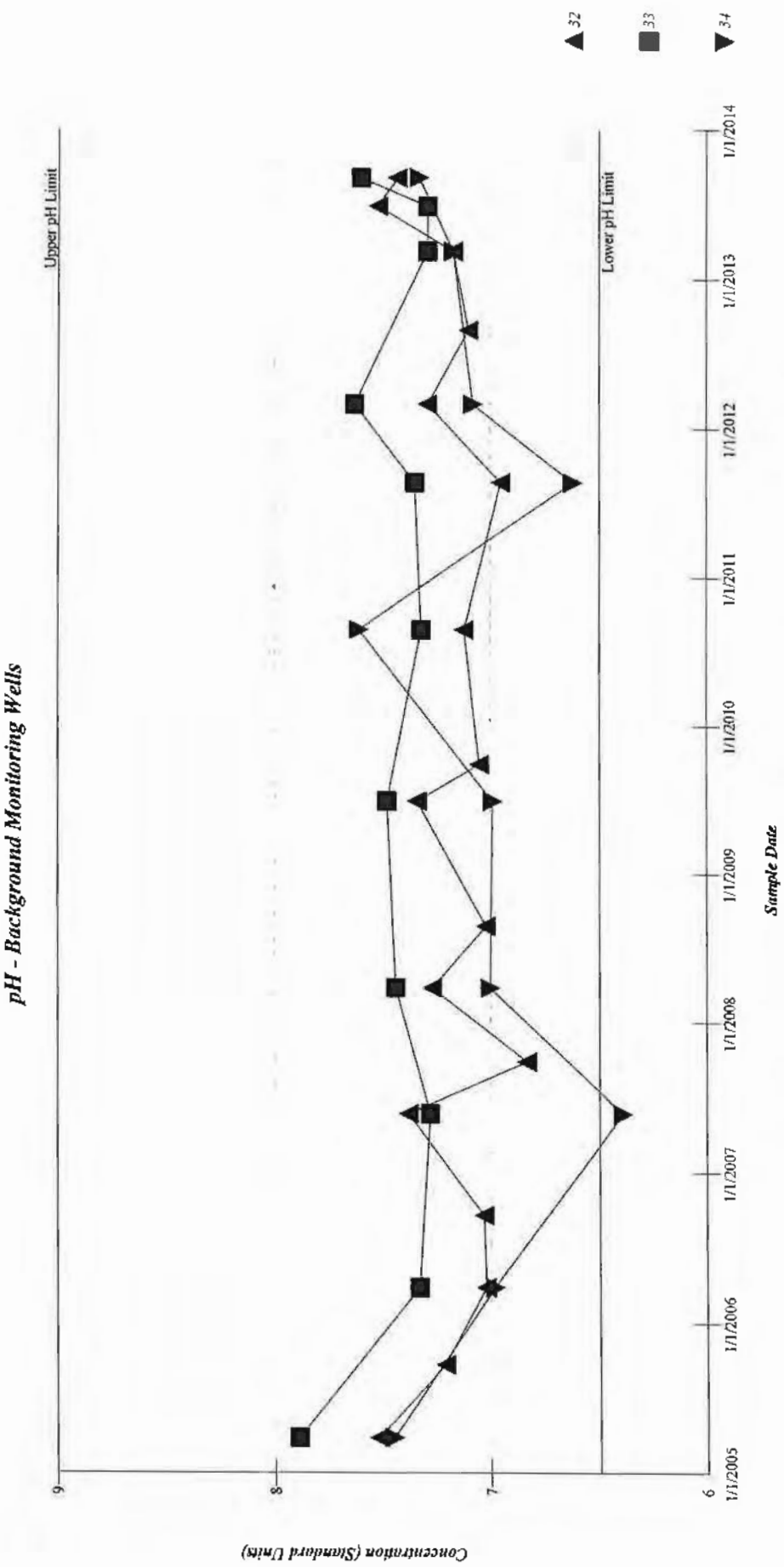

Total Dissolved Solids - Downgradient Monitoring Wells
Class I
21
22
23
24
1200
900
600
300
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1:1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

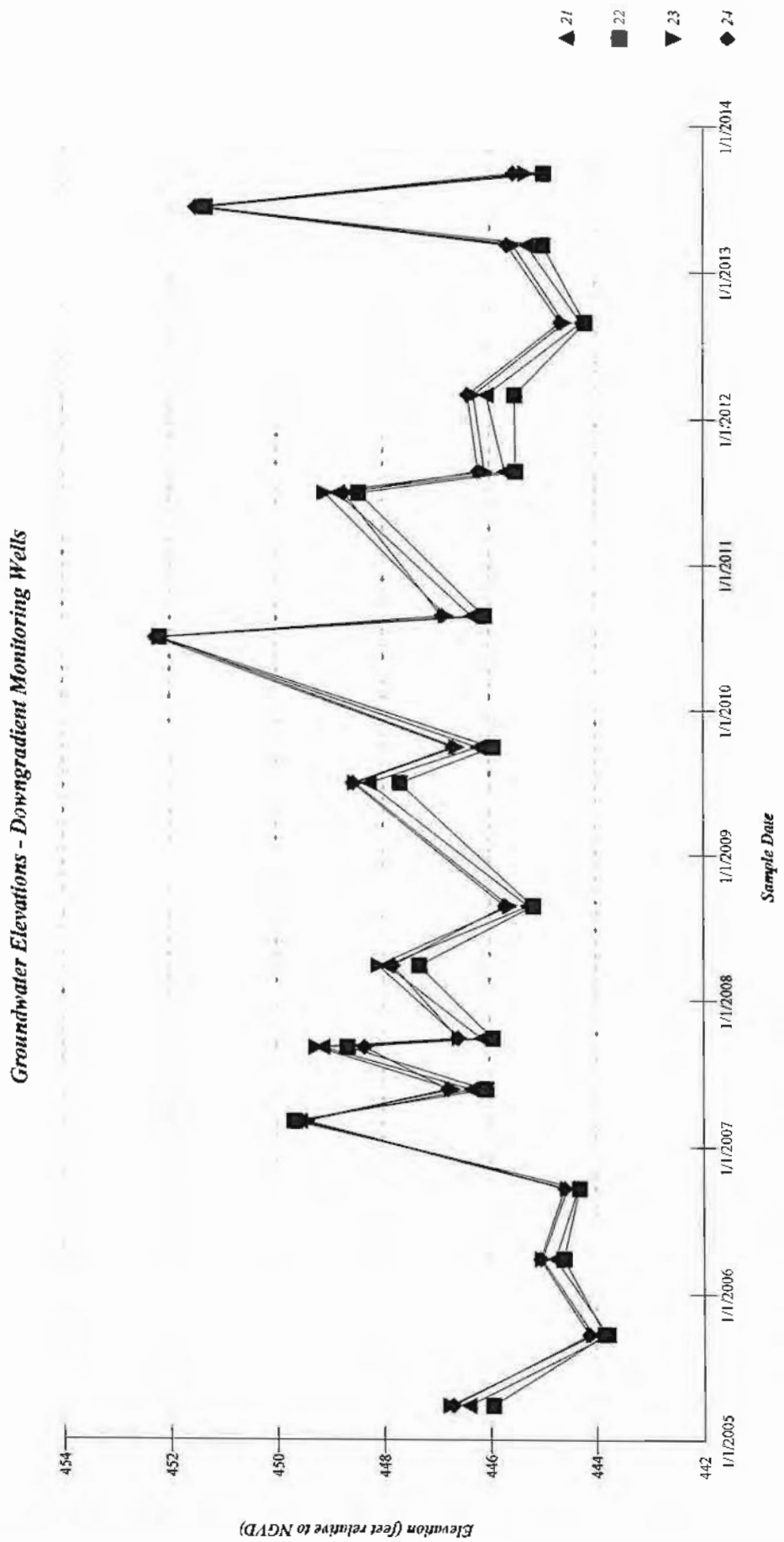

Total Dissolved Solids - South Monitoring Wells
Class I
25
26
27
30
31
1200
900
600
300
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (milligrams per Liter)

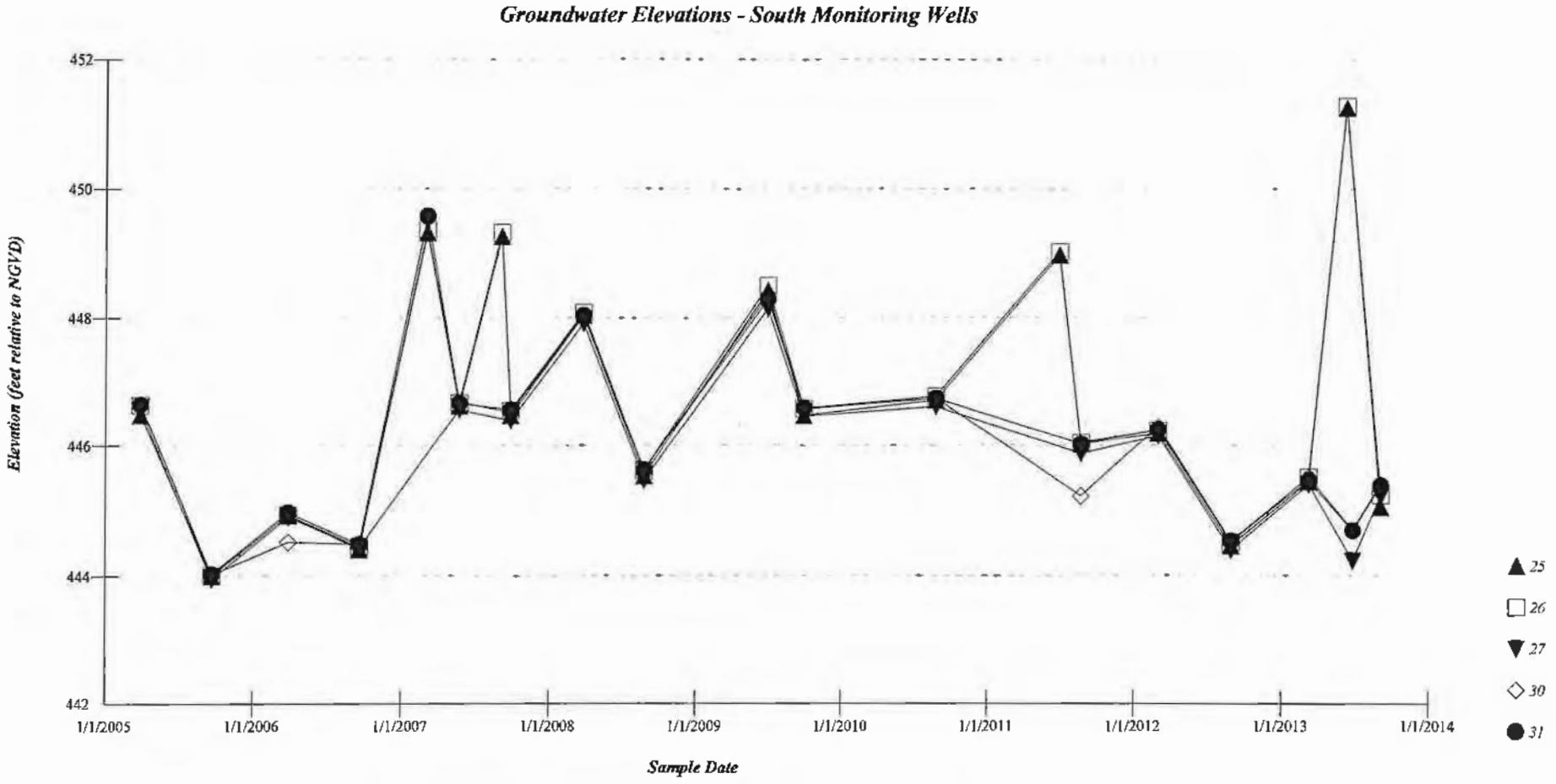

Total Dissolved Solids - Background Monitoring Wells
Class I
32
33
34
1200
900
600
300
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Concentration (milligrams per Liter)
Sample Date


pH - Downgradient Monitoring Wells
Upper pH Limit
Lower pH Limit
21
22
23
24
11
10
9
8
7
6
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (Standard Units)


pH - South Monitoring Wells
Upper pH Limit
Lower pH Limit
25
26
27
30
31
9
8
7
6
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Concentration (Standard Units)


pH - Background Monitoring Wells
Upper pH Limit
Lower pH Limit
32
33
34
9
8
7
6
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Concentration (Standard Units)
Sample Date


Groundwater Elevations - Downgradient Monitoring Wells
21
22
23
24
454
452
450
448
446
444
442
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
Elevation (feet relative to NGVD)


Groundwater Elevations - South Monitoring Wells
Elevation (feet relative to NGVD)
452
450
448
446
444
442
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
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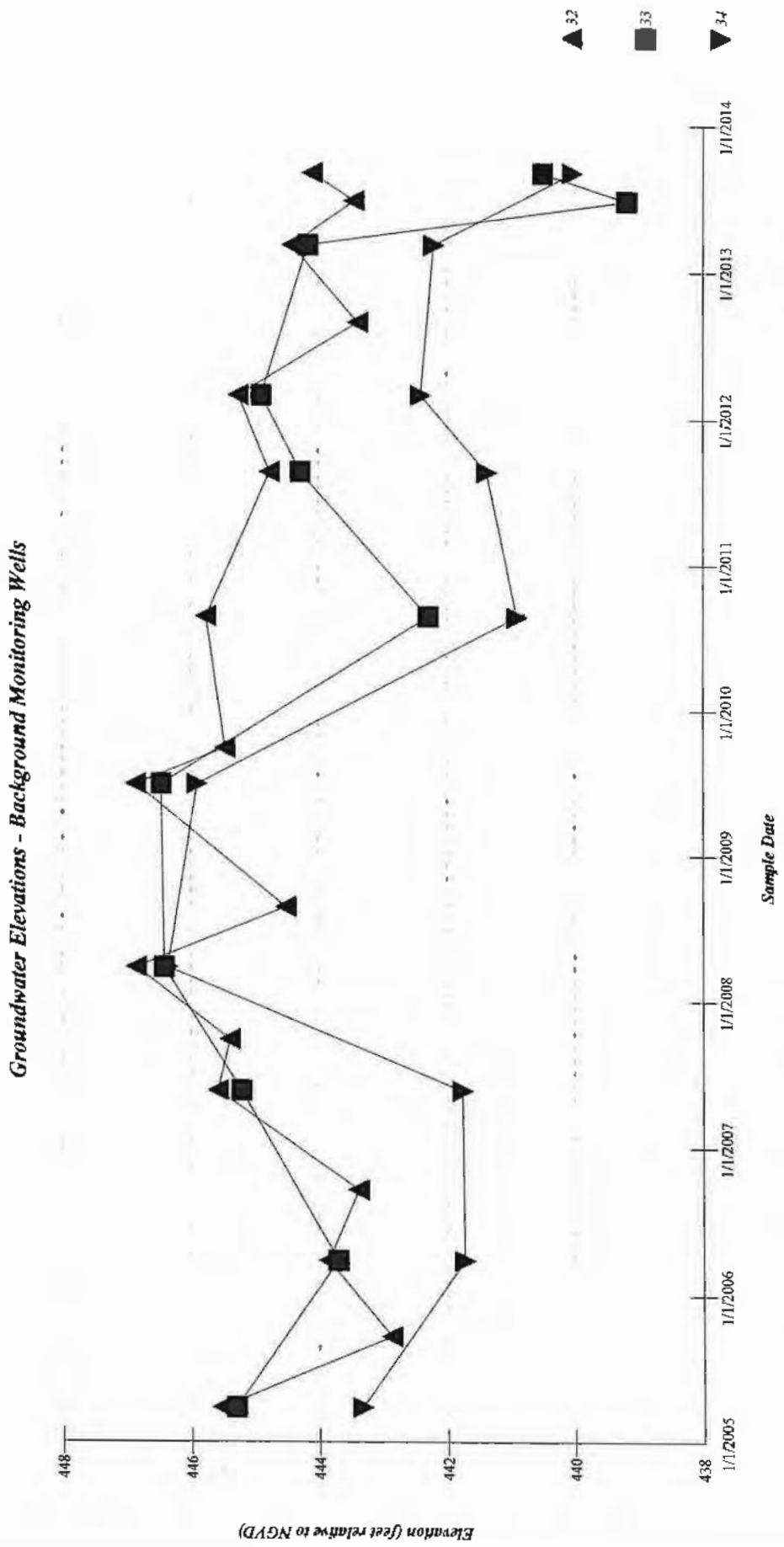
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Sample Date
25
26
27
30
31


Groundwater Elevations - Background Monitoring Wells
Elevation (feet relative to NGVD)
Sample Date
448
446
444
442
440
438
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
32
33
34

Illinois Pollution Control Board
R2014-10

T. Barkley: Exhibit C

IL 555 810 0002

GROUNDWATER MONITORING REPORT: 4TH QUARTER, 2013

EXISTING EAST ASH POND AND COAL COMBUSTION WASTE (CCW) LANDFILL SYSTEMS

Hennepin Power Station
Hennepin, Illinois
Dynegy Midwest Generation, LLC

February 15, 2014

By Its Agent: Dynegy Operating Company
604 Pierce Boulevard
O'Fallon, Illinois 62269

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GROUNDWATER MONITORING REPORT: QUARTER 4, 2013
EXISTING EAST ASH POND AND COAL COMBUSTION WASTE (CCW) LANDFILL SYSTEMS

Hennepin Power Station; Hennepin, Illinois

Dynegy Midwest Generation, LLC

1.0 INTRODUCTION

This quarterly report, consisting of an assessment of the monitoring results for the 4th Quarter 2013, is being submitted by Dynegy Midwest Generation, LLC (DMG) pursuant to DMG's November 10, 2009 Modified Closure Work Plan (approved by the Bureau of Water, Division of Public Water Supplies, Groundwater Section on March 3, 2010), and the December 10, 2010 Initial Facility Report (IFR) prepared for the new Coal Combustion Waste (CCW) Landfill at the Hennepin Power Station in Hennepin, Illinois. A Groundwater Management Zone (GMZ) extends around the entire perimeter of the East Ash Pond and CCW Landfill systems.

Detection groundwater monitoring was initiated during the 1st Quarter of 2011, following the completion of Phase I of the CCW Landfill construction. The final stage of the Phase I construction required placement of two feet of bottom ash (approximately 7,500 cubic yards) for frost protection of the leachate collection system. This work commenced on February 9, 2011 and was completed on February 24, 2011. No other ash has been placed in the landfill since then. The landfill has not yet been placed into service. Groundwater monitoring of the Phase I wells was initiated on March 16, 2011. The existing East Ash Pond System remains in service for the treatment of bottom ash transport waters and miscellaneous low volume wastewater streams, and unsold fly ash.

The groundwater monitoring program for the CCW Landfill is detailed in Section 28 of the IFR. The groundwater monitoring program for the East Ash Pond System, including the Leachate Collection and Stormwater Runoff Pond (Pond 2E) is listed under Special Condition 4 of operating permit number 2009-EA-2645, issued on October 16, 2009 with expiration of September 30, 2014. The design, construction and operation of the groundwater monitoring system at the CCW Landfill and East Ash Pond System, along with the detection monitoring program, were prepared in accordance with the requirements of 35 Ill. Adm. Code Part 811, Sections 317 through 319. Monitoring points for Phase I of the CCW Landfill are displayed on **Figure 1** along with the water table map and groundwater flow direction for the 4th Quarter 2013. Groundwater sampling for the CCW Landfill was performed according to the schedule provided in **Table 1**. Phase I monitoring well locations and completion details are listed in **Table 2**. Constituents monitored in the detection monitoring program, along with field and laboratory methods, are provided in **Table 3**.

2.0 GROUNDWATER MONITORING RESULTS

Collection of groundwater samples from the required 20 monitoring wells at the East Ash Pond System and CCW Landfill was performed on December 11, 2013. Groundwater sample analyses were completed by Teklab, Inc., located in Collinsville, Illinois. Eight monitoring wells – five background and three downgradient – are currently required for the CCW Landfill monitoring program. An additional 12 wells are required for the East Ash Pond System monitoring program.

2.1 Potentiometric Surface Elevations and Groundwater Flow

The potentiometric surface map (**Figure 1**) for the East Ash Pond System and CCW Landfill in the 4th Quarter 2013 shows elevation highest in upgradient well 07 to the south, and lowest in the downgradient monitoring wells near the Illinois River. The available data indicate that groundwater elevations in monitoring wells 10 and 12 are high relative to the closest upgradient and downgradient wells. These data will be reviewed in future quarters to determine whether this measurement is a transient phenomena captured on the day of measurement or a continuing condition.

2.2 Groundwater Quality Results

Table 4 provides the groundwater data for the required field parameters, quarterly (routine) general chemistry parameters, and quarterly metals in the background wells and Phase I downgradient wells at the CCW Landfill. The model-calculated Maximum Allowable Predicted Concentrations (MAPCs) for Year 3 (2013) of detection monitoring, along with the statistically-derived Applicable Groundwater Quality Standards (AGQSs) are provided in Table 4 for comparison.

The constituents with exceedances of their respective MAPCs in the 4th Quarter 2013 were:

- Dissolved barium in background well 08 at a concentration of 0.16 mg/L versus an MAPC and AGQS of 0.15 mg/L and a Class I groundwater standard of 2.0 mg/L.

No other constituents in background or downgradient wells had concentrations exceeding their respective MAPCs in the 4th Quarter 2013.

Table 5 provides the 4th Quarter 2013 groundwater data for the East Ash Pond System wells as compared to the groundwater standards for Class I, Potable Resource Groundwater (IAC 35 Part 620 Section 410) with the exception of radium 226/228. Parameters in the East Ash Pond System wells listed in Table 5 that exceeded Class I standards were: dissolved boron in downgradient wells 04, 05, 18S, 18D, 19S, and 19D; dissolved cadmium in downgradient wells 03, 05, 06, and 18S; dissolved manganese in downgradient well 18D; dissolved chloride

in upgradient well 08, and, nitrate in upgradient well 02 and downgradient wells 03 and 06.

The dissolved boron concentrations in the four downgradient wells with exceedances ranged from 2.6 to 5.3 mg/L versus a Class I groundwater standard of 2.0 mg/L. These concentrations are within the historical range for boron at the East Ash Pond System and have been trending downward.

The dissolved cadmium concentrations, ranging from 0.0051 to 0.0075 mg/L in downgradient wells 03, 05, 06 and 18S, are above the Class I standard of 0.005 mg/L. There were dissolved cadmium exceedances of the Class I standard at wells 03, 05, 06, 10, and 18S during prior monitoring events in 2011, 2012, and 2013.

Dissolved manganese regularly exceeds the Class I standard of 0.15 mg/L at downgradient well 18D, which had a 4th Quarter 2013 concentration of 0.18 mg/L. Although downgradient well 05 exceeded the Class I standard in the 3rd Quarter with a concentration of 0.23 mg/L, in the 4th Quarter the manganese concentration decreased to 0.12 mg/L. No groundwater samples from the other 16 monitoring wells at the East Ash Pond System have had a manganese exceedance in either 2012 or 2013.

Chloride concentrations in well 08 began increasing, and first exceeded the Class I groundwater standard, in March 2012. The elevated chloride concentrations can be attributed to surface drainage changes from off-site road improvements and annual winter salting to de-ice County Road 875E.

Nitrate concentrations have been consistently above the Class I standard of 10 mg/L at upgradient, mid-gradient, and downgradient wells during past monitoring events. During the 4th Quarter 2013 nitrate concentration exceeded the standard at upgradient well 02 with a concentration of 11.3 mg/L and downgradient wells 03 and 06 with concentrations of 10.3 and 10.6 mg/L, respectively.

3.0 SUMMARY

A Groundwater Management Zone extends around the entire perimeter of the East Ash Pond and the CCW Landfill. The CCW Landfill had exceedances of the model-calculated MAPCs in the 4th Quarter 2013 only for dissolved barium in background well 08.

The East Ash Pond System monitoring wells sampled for comparison to the Class I groundwater standards had the following exceedances: dissolved chloride in one upgradient well, dissolved nitrate in one upgradient well and two downgradient wells; dissolved boron in six downgradient wells; dissolved cadmium in four downgradient wells; and dissolved manganese in one downgradient monitoring well. These exceedances are within the historically observed range for these parameters and monitoring wells. Chloride and nitrate

exceedances in all monitoring wells are attributable to upgradient (i.e., offsite) activities.

The 1st Quarter 2014 groundwater monitoring event will be conducted in late February or March for the following:

- CCW Landfill: routine quarterly parameters (**Table 3**); and
- East Ash Pond System: general chemistry parameters and metals as listed in 35 Ill. Adm. Code 620.410(a) and (d).

TABLES

Table 1. Phase I Groundwater Monitoring Wells and Installation Schedule for CCW Landfill
Groundwater Monitoring Report: Quarter 4, 2013
Coal Combustion Waste Landfill
Hennepin Power Station; Dynegy Midwest Generation, LLC

Subset	Default Wells	Alternative Wells	Schedule for Installation
Background Wells	08, 08D, 10, 12, 13	same	Completed as of October 2010
Phase 1 Downgradient Monitoring Wells	05, 05D, 40S	same	Completed as of October 2010
Phase 2 Downgradient Monitoring Wells	18D*, 18S*, 41S	same	At least one year before Phase 2 is placed in service
Phase 3 Downgradient Monitoring Wells	42S, 43D, 43S	03*, 03D, 42S	At least one year before Phase 3 is placed in service
Phase 4 Downgradient Monitoring Wells	44S, 45D, 45S	06*, 06D, 44S	At least one year before Phase 4 is placed in service
Phase 5 Downgradient Monitoring Wells	Will use Phase 1 through 4 wells	same	At least one year before Phase 4 is placed in service
Quality Control	1 blind replicate / day; 1 field blank / day; 1 equipment blank / day if dedicated equipment not used.	same	not applicable

Notes:
See Initial Facility Report Section 28.1.2 for discussion of this table.
* indicates existing monitoring well downgradient from Phases 2 through 5.

NATURAL RESOURCE TECHNOLOGY

Table 2. Phase I Monitoring Well Locations and Completion Details for CCW Landfill
Groundwater Monitoring Report: Quarter 4, 2013
Coal Combustion Waste Landfill
Hennepin Power Station; Dynegy Midwest Generation, LLC

Well	State Plane North[1]	State Plane East[1]	Phase I Wells Gradient Position[2]	Well Top Elv[1]	Ground Elv[1]	Screen Top Elv.	Screen Bot Elv.	Total Depth Elv.	Stick Up	Screen Length[3]	Depth to Screen Bottom	Total Boring Depth
08	1688880	2533477	u	501.18	499.00	448	438	437	2.2	10	62	62
08D	1688932	2533463	u	501.45	499.23	416	411	379	2.2	5	88	120
10	1689661	2532595	u	494.56	495.30	447	437	438	-0.7	10	59	57
12*	1689975	2533513	u	498.61	495.20	446	436	435	3.4	10	59	60
13*	1689977	2533516	u	498.70	495.20	428	426	420	3.5	2	69	75
05	1690545	2533212	d	483.99	484.10	445	435	434	-0.1	10	49	50
05D	1690520	2533205	d	488.42	485.34	415	410	410	3.1	5	75	76
40S	1690567	2533492	d	484.42	484.75	445	435	434	-0.3	10	50	51

Notes:

* Well casing and protector raised on September 14, 2011 from flushmount to above-ground.

1 Wells resurveyed on June 13, 2006.
Well 08D was surveyed April 30, 2009 by Chastain and Associates, LLP
Wells 05D and 40S were surveyed October 29, 2010 by Illinois Valley Surveying and Consultants Inc.
Wells 12 and 13 were surveyed for new elevation on September 14, 2011 by Kelron Environmental.

2 Gradient position is relative to the Site; u = upgradient, d = downgradient

3 All wells are constructed from 2 inch PVC with 0.01 inch slotted screens
See Initial Facility Report Section28.1 2 for discussion of this table.

Table 3. Groundwater Monitoring Constituents, Analytical Methods, and Schedule for CCW Landfill
Groundwater Monitoring Report: Quarter 4, 2013
Coal Combustion Waste Landfill
Hennepin Power Station; Dynegy Midwest Generation, LLC

Constituent	Method	Detected in Leachate 811.319(a)(2)(A)(i)	Listed in 811.319(a)(2)(A)(ii)	Listed in 811.319(a)(3)	Schedule Group*
FIELD PARAMETERS					
GW Elev	(Field Measured)	n/a			Routine
pH, Specific Conductance, Temp	(Field Measured)	n/a			Routine
Well Depth	(Field Measured)	n/a			every 5 years
GENERAL CHEMISTRY					
Alkalinity, total (CaCO3)	(m-o alkalinity)	> AGQS			Routine
Ammonia, as N	(SM 18th ed 4500 NH3 H mod)	< AGQS	Yes		Routine
Chemical Oxygen Demand	(SM 18th ed 5220 D)	no			x
Chloride	(SM 18/19/20th 4500 CLD)	< AGQS			Group B
Cyanide	(9012A mod)	no	Yes		Routine
Fluoride	(ASTM D1179-93B)	> AGQS			Routine
Nitrate as N	(SM 18th ed 4500 NO3 F)	< AGQS	Yes		Routine
Phosphorus	(EPA 365.4)	no			x
Phenolics	(9066)	> AGQS			Routine
Sulfate	(EPA 375.4)	< AGQS	Yes		Routine
TDS (1 micron filtered)	(SM 2540 C 19th ed)	< AGQS	Yes		Routine
Total Organic Carbon	(9060)	no			x
Total Organic Halogen	(9020B)	no			x
METALS					
Aluminum	(6010B) ICP	> AGQS			Routine
Antimony	(3005A) GFAA	no			x
Arsenic	(3005A) GFAA	no	Yes		Routine
Barium	(6010B) ICP	> AGQS			Routine
Beryllium	(6010B) ICP	no			x
Boron	(6010B) ICP	> AGQS	Yes		Routine
Cadmium	(6010B) ICP	no	Yes		Routine
Calcium	(6010B) ICP	> AGQS			Routine
Chromium	(6010B) ICP	> AGQS	Yes		Routine
Cobalt	(6010B) ICP	no			x
Copper	(6010B) ICP	< AGQS			Group B
Iron	(6010B) ICP	< AGQS			Group B
Lead	(3005A) GFAA	no	Yes		Routine
Magnesium	(6010B) ICP	no	Yes		Routine
Manganese	(6010B) ICP	no			x
Mercury	(7470A)	no	Yes		Routine
Molybdenum	(6010B) ICP	> AGQS			Routine
Nickel	(6010B) ICP	no			x
Potassium	(6010B) ICP	< AGQS			Group B
Selenium	(3005A) GFAA	> AGQS			Routine
Silver	(6010B) ICP	no			x
Sodium	(6010B) ICP	< AGQS			Group B
Thallium	(3005A) GFAA	no			x
Tin	(6010B) ICP	no			x
Vanadium	(6010B) ICP	< AGQS			Group B
Zinc	(6010B) ICP	no	Yes		Routine
ORGANICS					
1,1,1,2-Tetrachloroethane	8260B	n/a		Yes	Group C
1,1,1-Trichloroethane	8260B	n/a		Yes	Group C
1,1,2,2-Tetrachloroethane	8260B	n/a		Yes	Group C
1,1,2-Trichloroethane	8260B	n/a		Yes	Group C
1,1-Dichloroethane	8260B	n/a		Yes	Group C
1,1-Dichloroethylene	8260B	n/a		Yes	Group C
1,1-Dichloropropene	8260B	n/a		Yes	Group C
1,2,3-Trichlorobenzene	8260B	n/a		Yes	Group C
1,2,3-Trichloropropane	8260B	n/a		Yes	Group C
1,2,4-Trichlorbenzene	8260B	n/a		Yes	Group C
1,2,4-Trimethylbenzene	8260B	n/a		Yes	Group C

Notes:
Constituents in Group x were not detected in leachate and will not be monitored
See Initial Facility Report Section 28.2.1 for discussion of this table

* Schedule Groups: Routine parameters are general chemistry and metal constituents monitored quarterly.
Group B parameters are general chemistry and metal constituents monitored annually during the 2nd Quarter.
Group C parameters are organic compounds monitored on a biennial schedule (alternating years) during the 2nd Quarter.

Table 3 (continued). Groundwater Monitoring Constituents, Analytical Methods, and Schedule for CCW Landfill
Groundwater Monitoring Report: Quarter 4 2013
Coal Combustion Waste Landfill
Hennepin Power Station; Dynegy Midwest Generation, LLC

Constituent (Organics continued)	Method	Detected in Leachate 811.319(a)(2)(A)(i)	Listed in 811.319(a)(2)(A)(ii)	Listed in 811.319(a)(3)	Schedule Group*
1,2-Dibromo-3-chloropropane	8011	n/a		Yes	Group C
1,2-Dibromoethane	8011	n/a		Yes	Group C
1,2-Dichlorobenzene	8260B	n/a		Yes	Group C
1,2-Dichloroethane	8260B	n/a		Yes	Group C
1,2-Dichloropropane	8260B	n/a		Yes	Group C
1,3,5-Trimethylbenzene	8260B	n/a		Yes	Group C
1,3-Dichlorobenzene	8260B	n/a		Yes	Group C
1,3-Dichloropropane	8260B	n/a		Yes	Group C
1,3-Dichloropropene	8260B	n/a		Yes	Group C
1,4-Dichlorobenzene	8260B	n/a		Yes	Group C
2,2-Dichloropropane	8260B	n/a		Yes	Group C
2-Hexanone; Methyl butyl ketone	8260B	n/a		Yes	Group C
4-Methyl-2-pentanone	8260B	n/a		Yes	Group C
Acetone	8260B	n/a		Yes	Group C
Acrylonitrile	8260B	n/a		Yes	Group C
Benzene	8260B	n/a		Yes	Group C
Bromobenzene	8260B	n/a		Yes	Group C
Bromochloromethane	8260B	n/a		Yes	Group C
Bromodichloromethane	8260B	n/a		Yes	Group C
Bromoform; Tribromomethane	8260B	n/a		Yes	Group C
Carbon disulfide	8260B	n/a		Yes	Group C
Carbon tetrachloride	8260B	n/a		Yes	Group C
Chlorobenzene	8260B	n/a		Yes	Group C
Chloroethane	8260B	n/a		Yes	Group C
Chloroform; Trichloromethane	8260B	n/a		Yes	Group C
cis-1,2-Dichloroethylene	8260B	n/a		Yes	Group C
cis-1,3-Dichloropropene	8260B	n/a		Yes	Group C
Dibromochloromethane	8260B	n/a		Yes	Group C
Dichlorodifluoromethane	8260B	n/a		Yes	Group C
Dichloromethane	8260B	n/a		Yes	Group C
Ethylbenzene	8260B	n/a		Yes	Group C
Hexachlorobutadiene	8260B	n/a		Yes	Group C
Isopropylbenzene	8260B	n/a		Yes	Group C
Methyl bromide; Bromomethane	8260B	n/a		Yes	Group C
Methyl chloride; Chloromethane	8260B	n/a		Yes	Group C
Methyl ethyl ketone	8260B	n/a		Yes	Group C
Methyl iodide; Iodomethane	8260B	n/a		Yes	Group C
Methylene bromide; Dibromomethane	8260B	n/a		Yes	Group C
Naphthalene	8260B	n/a		Yes	Group C
n-Butylbenzene	8260B	n/a		Yes	Group C
n-Propylbenzene	8260B	n/a		Yes	Group C
o-Chlorotoluene	8260B	n/a		Yes	Group C
p-Chlorotoluene	8260B	n/a		Yes	Group C
p-Isopropyltoluene	8260B	n/a		Yes	Group C
sec-Butylbenzene	8260B	n/a		Yes	Group C
Styrene	8260B	n/a		Yes	Group C
tert-Butylbenzene	8260B	n/a		Yes	Group C
Tetrachloroethylene	8260B	n/a		Yes	Group C
Tetrahydrofuran	8260B	n/a		Yes	Group C
Toluene	8260B	n/a		Yes	Group C
trans-1,2-Dicloroethylene	8260B	n/a		Yes	Group C
trans-1,3-Dichloropropene	8260B	n/a		Yes	Group C
trans-1,4-Dichloro-2-butene	8260B	n/a		Yes	Group C
Trichloroethylene	8260B	n/a		Yes	Group C
Trichlorofluoromethane	8260B	n/a		Yes	Group C
Vinyl acetate	8260B	n/a		Yes	Group C
Vinyl chloride	8260B	n/a		Yes	Group C
Xylenes	8260B	n/a		Yes	Group C

Notes:
Constituents in Group x were not detected in leachate and will not be monitored
See Initial Facility Report Section 28.2.1 for discussion of this table.
* Schedule Groups: Routine parameters are general chemistry and metal constituents monitored quarterly
Group B parameters are general chemistry and metal constituents monitored annually during the 2nd Quarter.
Group C parameters are organic compounds monitored on a biennial schedule (alternating years) during the 2nd Quarter

Table 4. Comparison of Monitored Parameter Concentrations Versus AGQSs and MAPCs
Groundwater Monitoring Report: Quarter 4, 2013
New Coal Combustion Waste Landfill
Hennepin Power Station; Dynegy Midwest Generation, LLC

Routine Quarterly Monitoring Parameters

Parameter, Unit	Upper Limit / AGQS	Year 3 (2013) MAPC	Background Wells					Phase I Downgradient Wells		
			08	08D	10	12	13	05	05D	40S
Field Parameters										
Groundwater Elevation, ft	N/A	N/A	446.44	446.51	447.13	447.49	446.66	445.99	446.23	446.28
pH, std units	6.5 / 9.0*	N/A	7.06	7.33	7.10	7.38	7.34	7.24	7.52	7.64
Specific Conductance, umhos/cm	N/A	N/A	1,590	1,340	995	1,620	1,030	851	1,130	1,030
Temperature, deg C	N/A	N/A	11.2	9.7	10.1	9.8	9.7	10.8	8.9	9.9
General Chemistry Parameters										
Alkalinity, lab, mg/L	614	614	460	450	312	328	264	284	356	296
NH3 as N, tot, mg/L	19	19	<0.1	0.50	9.22	5.6	0.62	0.62	1.74	3.2
NO3, tot, mg/L	23	23	9.66	7.05	8.38	8.9	8.8	6.71	11.2	7.43
CN, total, mg/L**	0.12	0.13	0.01	0.01	0.04	<0.007	<0.007	0.04	0.05	0.02
F, diss, mg/L	0.54	0.54	0.12	0.14	0.38	0.38	0.19	0.12	0.10	0.17
Phenols, ug/L	5.0	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
SO4, diss, mg/L**	137	164	118	118	104	90	122	132	121	103
TDS, mg/L	1,101	1,101	996	948	702	618	600	654	732	572
Metals										
Al, diss, mg/L	0.050	0.050	<0.020	0.020	<0.020	<0.020	<0.020	<0.020	0.030	<0.020
As, diss, mg/L**	0.0030	0.0030	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
B, diss, mg/L**	1.6	5.4	0.11	0.11	0.37	0.62	1.33	3.5	1.96	2.07
Ba, diss, mg/L	0.15	0.15	0.16	0.11	0.08	0.07	0.07	0.06	0.09	0.05
Ca, diss, mg/L	255	255	177	163	107	108	104	99.3	105	72.8
Cd, diss, mg/L	0.0080	0.0080	<0.0020	<0.0020	0.0035	0.0022	<0.0020	0.0073	0.0021	<0.0020
Cr, diss, mg/L	0.011	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Hg, diss, mg/L	0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Mg, diss, mg/L	74	74	54.5	48	34	32.4	34.5	33	43.2	37.9
Mo, diss, mg/L**	0.055	0.332	0.005	0.005	0.02	0.02	0.005	0.06	0.0075	0.03
Pb, diss, mg/L	0.004	0.004	<0.002	<0.002	0.005	<0.002	<0.002	<0.002	<0.002	<0.002
Se, diss, mg/L**	0.006	0.0234	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Zn, diss, mg/L	0.11	0.11	<0.005	<0.005	0.050	0.020	0.010	<0.005	0.010	<0.005

Notes:

Samples collected for analysis on December 11, 2013
AGQS = Applicable Groundwater Quality Standard
MAPC = Maximum Allowable Predicted Concentration
Concentration Exceeds Year 3 (2013) MAPC

N/A = not applicable
< = Below method reporting limit
-- = Not analyzed.
[1] = insufficient water in well for collection of groundwater samples

* Lower and Upper limits for pH is the Class I groundwater quality standard of 6.5 and 9.0 Standard Units.
** Potentially affected by residual release from Pond 2; see Section 28 (Table 28-3) for MAPC values and schedules.
Refer to IFR Section 27.3 for discussion of this table

NATURAL RESOURCE TECHNOLOGY

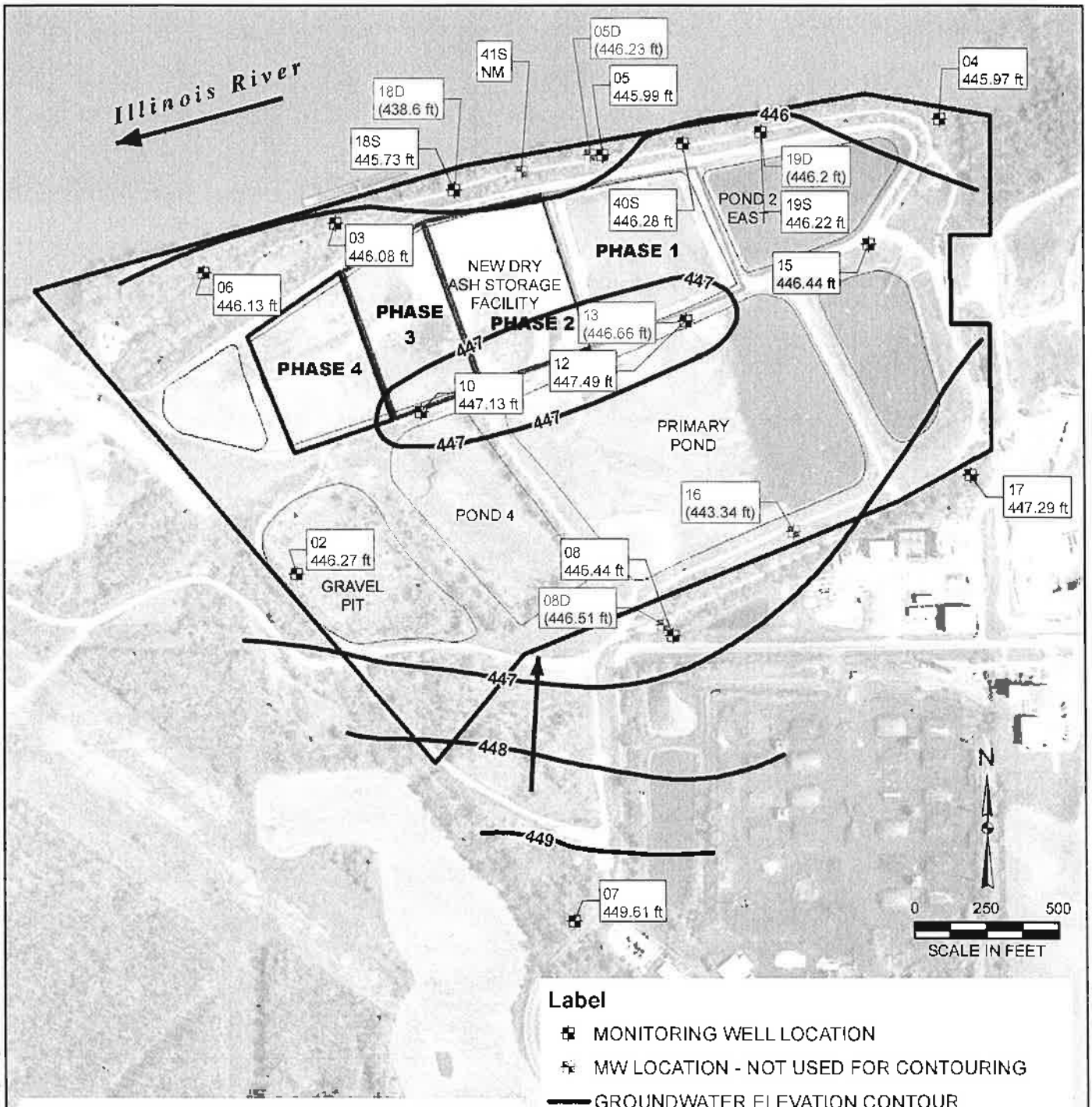
Table 5. Comparison of Monitored Parameter Concentrations at East Ash Pond System to Class I Groundwater Standards
Groundwater Monitoring Report: Quarter 4, 2013
East Ash Pond System
Hennepin Power Station; Dynegy Midwest Generation, LLC

	Class I GW	Upgradient Wells						Mid-Gradient Wells				Downgradient Wells							
Parameter, Unit	Standard	02	07	08	08D	16	17	10	12	13	15	03	04	05	06	18S***	18D***	19S***	19D***
Field Parameters																			
Groundwater Elevation, ft	N/A	446.27	449.61	446.44	446.51	443.34	447.29	447.13	447.49	446.66	446.44	446.08	445.97	445.99	446.13	445.73	438.6	446.22	446.20
pH, Std Units	6.5 / 9.0*	7.23	7.24	7.06	7.33	7.49	7.52	7.10	7.38	7.34	7.25	7.20	7.99	7.24	7.18	7.23	7.28	8.24	6.92
General Chemistry Parameters																			
Cl, diss, mg/L	200	39	25	**220**	154	46	64	98	74	73	70	78	43	81	76	77	68	57	56
CN, total, mg/L	0.2	<0.008	<0.008	0.01	0.01	<0.007	<0.007	0.04	<0.007	<0.007	<0.007	0.03	<0.007	0.04	0.03	0.04	0.04	0.01	0.02
F, diss mg/L	4	0.12	0.1	0.12	0.14	0.2	0.27	0.38	0.38	0.19	0.17	0.14	0.29	0.12	0.21	0.15	0.16	0.12	0.18
NO3, tot, mg/L	10	**11.3**	8.23	9.66	7.05	5.91	4.84	8.38	8.9	8.8	3.77	**10.3**	4.8	6.71	**10.6**	8.08	5.77	6.87	7.56
SO4, diss, mg/L	400	67	56	118	118	70	81	104	90	122	96	65	162	132	110	188	162	120	120
TDS, mg/L	1,200	538	592	996	948	400	412	702	618	600	552	744	422	654	688	750	618	398	372
Metals																			
Sb, Diss, mg/L	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
As. Diss, mg/L	0.01**	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Ba, Diss, mg./L	2	0.07	0.08	0.16	0.11	0.05	0.07	0.08	0.07	0.07	0.07	0.09	0.02	0.06	0.07	0.10	0.09	0.02	0.02
Be, Diss, mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
B, diss, mg/L	2	0.05	0.03	0.11	0.11	0.06	0.08	0.37	0.62	1.33	0.86	1.04	**5.24**	**3.50**	0.88	**2.97**	**2.60**	4.83	**5.30**
Cd, diss, mg/L	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.0035	0.0022	<0.002	<0.002	**0.0070**	<0.002	**0.0073**	**0.0075**	**0.0051**	<0.002	<0.002	<0.002
Cr, diss, mg/L	0.1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Co, diss, mg/L	1.0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.0052	<0.005	<0.005	0.0081	<0.005	0.0093	0.0093	0.0077	0.0093	<0.005	<0.005
Cu, diss, mg/L	0.65	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.03	0.01	0.009	<0.005	0.03	<0.005	0.01	0.03	0.03	<0.005	<0.005	<0.005
Fe, diss, mg/L	5	<0.020	<0.020	<0.020	0.030	<0.020	<0.020	0.09	<0.020	<0.020	0.020	0.03	0.02	0.03	0.02	0.02	0.02	0.11	0.02
Pb, diss, mg/L	0.0075	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Mn, diss, mg/L	0.15	<0.005	<0.005	<0.005	0.03	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.009	<0.005	0.12	<0.005	0.01	**0.18**	0.008	<0.005
Hg, diss, mg/L	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Ni, diss, mg/L	0.1	<0.002	<0.002	0.02	0.03	<0.002	<0.002	0.07	0.02	0.02	0.01	0.05	0.006	0.05	0.05	0.06	0.04	0.01	0.01
Se, diss, mg/L	0.05	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.006	<0.006	0.03	<0.006	<0.006	0.03	<0.006	<0.006	<0.006
Ag, diss, mg/L	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Tl, diss, mg/L	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zn, diss, mg/L	5	<0.005	<0.005	<0.005	<0.002	<0.005	<0.005	0.05	0.02	0.01	<0.005	0.02	<0.005	<0.005	0.05	0.01	<0.005	0.0098	0.01

Notes:
Samples collected for analysis on December 11, 2013
Groundwater quality standards for Class I: Potable Resource Groundwater (IAC 35 Part 620 Section 410).
Exceeds Class I Groundwater Quality Standard.
CCW Landfill monitoring wells. See Table 4 for comparisons to AGQSs and MAPCs.
N/A = not applicable.
< = Below method reporting limit.

* Lower and Upper limits for pH is the Class I groundwater quality standard of 6.5 and 9.0 Standard Units.
** Class I groundwater standard for Arsenic changed from 0.05 to 0.01 mg/L on 10/05/12.
*** Monitoring started in Quarter 2, 2011
- - = Not analyzed.
[1] = insufficient water in well for collection of groundwater samples.

FIGURES



Label

- MONITORING WELL LOCATION
- MW LOCATION - NOT USED FOR CONTOURING
- GROUNDWATER ELEVATION CONTOUR
- INFERRED GROUNDWATER ELEVATION CONTOUR
- GROUNDWATER FLOW DIRECTION
- GROUNDWATER MANAGEMENT ZONE

NM INDICATES NO MEASUREMENT
( ) INDICATES MW LOCATION NOT USED FOR CONTOURING
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

DRAWN BY/DATE:
MDM 1/28/14
REVIEWED BY/DATE:
NDK 1/28/14
APPROVED BY/DATE:
BRH 1/28/14

GROUNDWATER ELEVATION CONTOURS
DECEMBER 11, 2013

NEW CCW LANDFILL - HENNEPIN POWER STATION
DYNEGY MIDWEST GENERATION, LLC
PUTNAM COUNTY, ILLINOIS

PROJECT NO: 1645

FIGURE NO: 1

NATURAL RESOURCE TECHNOLOGY

Illinois Pollution Control Board
R2014-10

T. Barkley: Exhibit D

Name of Facility	Owner	NPDES Number	Location	Number of Ash Ponds	Number Active (A)	Number Lined (Active)	Number Inactive (I)	Number Lined (Inactive)	Volume/ Other Information	Number of Wells Within 1 Mile	U.S. EPA Hazard Potential Classification	U.S. EPA Condition Assessment	Groundwater Contamination?
Will County Station	Midwest Generation	IL0002208	Joliet	4	2	2	2	0	No. Pond - 3M gal. (A) So. Pond 1 - 3.4M gal. (A) So. Pond 2 - 3M gal. (A) So. Pond 3 - 4M gal. (A)	69			IEPA
Waukegan Station	Midwest Generation	IL0002259	Waukegan	2	2	2	0	0	East Pond - 52M gal. (A) West Pond - 52M gal. (A)	11			IEPA
Powerton	Midwest Generation	IL0002232	Pekin	5	4	4	1	0	Ash Basin - 31M gal. (A) Sec. Basin - 7.5M gal. (A) Bypass Basin-2.2Mgal.(A)	25			IEPA
Joliet 29	Midwest Generation	IL0064254	Joliet	3	3	3	0	0	Pond 1 - 15M gal. (A) Pond 2 - 15M gal. (A) Pond 3 - 8.2M gal. (A)	94			IEPA
Joliet 9	Midwest Generation	IL0002216	Joliet	0	0	0	0	0	Quarry No. - 3.1M gal. (A) LSQ- 288M gal.(permitted as landfill) (A)	94			IEPA
Crawford	Midwest Generation	IL0002186	Crawford	1	0	0	0	0	Basin 16-.13 million gallon	1			IEPA
Electric Energy Inc.	Electric Energy Inc.	IL0004171	Joppa	2	1	0*	1	0	1.024 Billion Gallons (A)	23			IEPA
Baldwin Energy Cen.	Dynegy	IL0000043	Baldwin	7 cells	6	0	1	0	Total Storage volume of 17,250 acre-feet (5.62 billion gallons)	1	PFAP-Significant SFAP-Significant SP- low APD- low SPD-Significant	(All) Poor	IEPA
Havana Station	Dynegy	IL0001571	Havana	4	4	4	South Pond (1 cell)	0	East Pond(4 cells) – total volume of 2,376 ac-ft South Pond 540 ac-ft	36	East Pond-High	Satisfactory	EPA 2007
Hennepin Station	Dynegy	IL0001554	Hennepin	7	3	3	4	0	West pond (I)- 900 ac-ft East Pond (I) - 1600 ac-ft New East (A) - 425 ac-ft Volume: 953 MGD	9	(All) Significant	(All) Poor	EPA 2007
Wood River Station	Dynegy	IL0000701	Alton	5	3	3	2	0	2 cells of West Pond closed. 2 cells of of West lined and 250 ac-ft. East Pond lined and 425 ac-ft	59	E.Pond-High, W.Pond-Low	Satisfactory	EPA 2007
Vermillion Station	Dynegy	IL0004057	Oakwood	3 w/5 cells	2 w/ 4 cells	1 w/ 2 cells	1	0	New East – 500 ac-ft North- 2400ac-ft East-closed prior to 1980 Volume of ponds- 945 MGD	20	Significant	Satisfactory	EPA 2007, IEPA
Newton Station	Illinois Power Holdings (Dynegy)	IL0049191	Newton	2	2	0	0	0	Primary: 400 acre Secondary: 9 acre	1	Significant	Fair	IEPA
Edwards Station	Illinois Power Holdings (Dynegy)	IL0001970	Bartonville	1	1	0	0	0		6	Significant	Fair	AMEREN

Duck Creek Station	Illinois Power Holdings (Dynegy)	IL0055620	Canton	5	3	3	2	0	Ash ponds 1&2 are inactive and unlined	0	AP1- Low; AP2- Low	Fair	EPA 2007
Coffeen Station	Illinois Power Holdings (Dynegy)	IL0000108	Montgomery County	5	4	3	1	0	Ash Ponds A, B, and C are active and synthetic lined, Ash Pond D is out of service, Bottom ash pond is active and unlined.	7	Significant	Fair	EIP3, EPA, IEPA
Meredosia Station	Ameren Medina Valley	IL0000116	Meredosia	4	2	0	2	0		68	Significant	Fair	IEPA
Hutsonville Station	Ameren Medina Valley	IL0004120	Hutsonville	5	4	3	1	0		17	A- Low C-Low D- Low	Poor	EPA 2007
Venice	Ameren Medina Valley	IL0000175		2	0	0	2	0		13			IEPA
Grand Tower	Ameren Medina Valley	IL0000124		1	1	0	0	0		1			IEPA
Kincaid Generation	Kincaid Generation	IL0002241	Kincaid	1	1	0	0	0		6	Low	Fair	: monitoring under
City Water Light and Power	City Water Light and Power	IL0024767	Springfield	2	2	0	0	0		1			IEPA
Pearl Station	Prairie Power Inc.	IL0036765		1	1	0	0	0		8			IEPA
Marion Plant	Southern Illinois Power Co-op.	IL0004316	Marion	12	10	0	2	0		3	Pond 1- Low Pond 2- Low Pond 4- Low	Pond 1- Poor Pond 2- Poor Pond 4- Poor	IEPA

Legend for Groundwater Contamination column -- source indicates presence of present and/or past groundwater contamination:

IEPA = Monitoring results attached to 1-15-2014 Cobb Testimony and Ash Impoundment Strategy Status Report (Oct.2011)

EPA 2007 = EPA, Coal Combustion Damage Case Assessments (2007)

Illinois Pollution Control Board
R2014-10

T. Barkley: Exhibit E

DRAFT MEMORANDUM

DATE: February 3, 2009

TO: Douglas Scott, Director

FROM: Marcia Willhite, Chief, Bureau of Water

SUBJECT: Assessment of Ash Impoundments Permitted Within the State of Illinois

I. PURPOSE:

The purpose of this memorandum is to provide you with current information on the assessment of the threat posed by ash impoundments permitted at power plants within the State of Illinois.

II. ISSUE:

In response to the massive ash impoundment failure in Tennessee, Governor Pat Quinn and subsequently Illinois Environmental Protection Agency ("Illinois EPA") Director Scott has asked the Bureau of Water ("BOW") to assess ash impoundments permitted at power plants and evaluate their potential threat. The BOW permits the ash impoundments through it's Nation Pollution Discharge Elimination System (" NPDES") program. There are two issues at these facilities which need to be addressed. First, the integrity of these impoundments needs to be assessed to determine the potential for failure of the impounding structure. These impoundments are considered to be dams. The Illinois Department of Natural Resources ("DNR") Office of Water Resources ("OWR") is the lead agency in the state for dam safety. Second, the potential for leakage from these impoundments to impact groundwater needs to be assessed, including the potential for the leakage to affect potable wells.

III. DISCUSSION:

Since the early 1990's, new ash impoundments have been required to be lined and groundwater monitoring wells have been installed at many of these new ash impoundments. There are also older ash ponds at several of these facilities. Staff developed a summary of the ash ponds that is provided in Attachment I. Attachment I includes a summary of the following:

1. An inventory of power plants (24) with (83) ash impoundments which are permitted by the Illinois EPA under NPDES state construction/operating permits;
2. Information about dam safety classification information obtained from the DNR's OWR; and
3. Groundwater assessment data for these facilities.

Attachment I also provides the statistics on the number of impoundments which are active (68), inactive (15), that have low permeability liners (31), and the number of impoundments which have groundwater monitoring (28).

Six (6) power plants have known groundwater contamination issues. Four of these facilities have built lined ash impoundments. One has permitted a new on-site landfill for ash disposal and one continues to use the leaking impoundment. The regulatory status of these 6 facilities is as follows:

- 3 have Groundwater Management Zones ("GMZ")[1] approved by the BOW for their old impoundments which have been taken out of service;
- 1 facility is working on a remediation plan for the existing impoundments once they are no longer in service;
- 1 has petitioned the Illinois Pollution Control Board ("Board") for regulatory relief from for their old impoundments; and
- 1 facility has permitted its impoundment as landfill and has a GMZ established by the Board for groundwater contamination at the site.

There are groundwater impacts at the facility that was granted a GMZ by the Board. Unfortunately, there is groundwater contamination that has not been addressed by the GMZ.

Environmental Issues

The geologic vulnerability of groundwater at the 24 power plants was assessed using a digital version of *Illinois' Potential for Aquifer Recharge Map* which classifies the potential for precipitation to infiltrate the surface and reach the water table on regional scale. This map can also be used to determine the potential for groundwater contamination on a regional scale. In addition, the digital map of the *Karst*[2] *Areas in Illinois* was utilized for this assessment. The attached map shows the location of each power plant and the potential for aquifer recharge at each plant. This information along with the presence of potable water supply wells identified near the plants was used to determine the potential contamination threat to potable wells near the plants. The contamination potential was classified as, "very low", "low" or "high". Furthermore, each of these facilities was evaluated in relation to potential the *Environmental Justice Areas ("EJ") Map.*

CONTAMINATION POTENTIAL	VERY LOW	LOW	HIGH
NUMBER OF POWER PLANTS	8	7	9

This information is also provided in Attachment I.

[1] 35 Ill. Adm. Code 620.250

[2] "Karst" means a topographic area formed over limestone or dolomite by dissolving or solution that is characterized by closed depressions or sinkholes, or caves, and underground drainage.

In addition, to the 6 facilities with known groundwater contamination issues, further work needs to be completed to determine if groundwater has been impacted at the remaining 18 plants. In particular, further assessment work has been prioritized at the following 9 facilities due to the initial assessment results that indicates a high potential to impact off-site potable water supply wells: 1) Joliet 9; 2) Electric Energy Inc.; 3) Baldwin Energy; 4) Havana Station; 5) Wood River Station; 6) Vermilion Station; 7) Edwards Station; 8) Coffeen Station; and 9) Meredosia Station. The BOW is requesting these facilities to conduct a water well survey to determine how many of the potable water supply wells are being utilized.

Dam Safety

DNR OWR administers the regulations contained in 17 Ill. ADM. Code Title 17: Conservation Chapter I: Department of Natural Resources Subchapter h: Water Resources Part 3702 Construction and Maintenance of Dams. These regulations took effect on September 2, 1980. Impoundments built prior to the effective date of this regulation do not appear to have been classified or inspected. Section 3702.30 of these regulations classifies dams into three categories, Class I, Class II and Class III, as follows:

- **Class I Dam-** Is one located where failure has a high probability for causing loss of life or substantial economic loss in excess of that which would naturally occur downstream of the dam if the dam had not failed;

- **Class II Dam-** Is one located where failure has a moderate probability for causing loss of life or may cause substantial economic loss in excess of that which would naturally occur downstream of the dam if the dam had not failed; or

- **Class III Dam-** Is one located where failure has low probability for causing loss of life, where there are no permanent structures for human habitation, or minimal economic loss in excess of that which would naturally occur downstream of the dam if the dam had not failed.

Nine (9) facilities have impoundments with dam safety permits. These 9 are comprised of: 2 facilities with at least one Class I Dam; 5 with at least one Class III Dam; and 2 facilities with dam safety permits did not have dam classification data available. The impoundments that require dam safety permits are a mix of above-and below- grade impoundments. A total of 25 of the impoundments at 5 facilities are above grade. The dam safety permit information was obtained from Illinois EPA files and correspondence with the DNR, OWR. The most complete dam safety permit information could be obtained from DNR Office of Water Resources.

IV. FURTHER DISCUSSION OF THE ISSUES:

Sixteen of 24 facilities that have impoundments are not been permitted nor have they been inspected by the OWR. The BOW will provide this information to OWR, and they may want to consider further evaluation of the safety of the unpermitted impoundments.

As described above, the BOW is has prioritized 9 facilities for further investigation, and is contacting the power plant owners/operators to obtain the necessary data to assess the potential impact to groundwater. Concurrently, the BOW is also assessing 18 facilities where additional information is also needed from the owner/operators of these facilities.

V. FUTURE ACTIONS:

Violation notices will be issued to facilities that have caused, threatened, or allowed groundwater contamination to occur. Right-to-Know recommendations will be made to the Illinois EPA's Contaminant Evaluation Group where appropriate and potential EJ areas will be considered.

The BOW will share this assessment with DNR, OWR to make sure they are aware of issues that they have the regulatory authority to address.

Discussion has been initiated with the BOL to address groundwater impacts using its permit authority at the impoundment permitted as a landfill.

Attachment I

Name of Facility	NPDES Number	Number of Ash Ponds	Number Active (A)	Number Lined (Active)	Number Inactive (I)	Number Lined (Inactive)	Volume/ Other Information	Number Above vs. Below Grade	Dam Safety Permit Rquired? Y/N	Groundwater Monitoring? Y/N	Groundwater Impacted	Geologic Vulnerability	Potable Well Contamination Potential	Remediation or Action Plan	Number of Wells Within 1 Mile
Midwest Generation															
Will County Station	IL0002208	4	4	4	0	0	No. Pond - 3M gal. (A) So. Pond 1 - 3.4M gal. (A) So. Pond 2 - 3M gal. (A) So. Pond 3 - 4M gal. (A)	Below	No	No	Unknown	Very High	Low	No	69
Waukegan Station	IL0002259	2	2	2	0	0	Eas Pond - 52M gal. (A) West Pond - 52M gal. (A)	Below	No	No	Unknown	Disturbed Land	Very Low	No	11
Powerton	IL0002232	3	3	?	0	0	Ash Basin - 31M gal. (A) Sec. Basin - 7.5M gal. (A) Bypass Basin-2.2Mgal.(A)	Below	No	No	Unknown	Very High	Very Low	No	25
Joliet 29	IL0064254	3	3	3	0	0	Pond 1 - 15M gal. (A) Pond 2 - 15M gal. (A) Pond 3 - 8.2M gal. (A)	Below	No	No	Unknown	Very High	Low	No	94
Joliet 9	IL0002216	1	1				Quarry No. - 3.1M gal. (A) LSQ-	Below	No	Yes	Yes	Very High	High	IPCB GMZ	94
Crawford	IL0002186	1	1	1			Basin 21 – 2.4M gal. (A)	Below	No	No	Unknown	Mod Low-Low	Very Low	No	1

Electric Energy Inc.															
Electric Energy Inc.	IL0004171	2	1	0*	1	0	1.024 Billion Gallons (A)	Above	No	No	Unknown	Mod Low-Low	High	No	23
Dynegy Midwest															
Baldwin Energy Cen.	IL0000043	7 cells	6	0	1	0	Total Storage volume of 17,250 acre-feet (5.62 billion gallons)	All are at or above grade	No	No	Unknown	Very High	High	No	1
Havana Station	IL0001571	3 Ponds (6 Cells)	5 cells	4 of 6 cells	South Pond (1 cell)	0	East Pond(4 cells) – total volume of 2,376 ac-ft South Pond 540 ac-ft	Above	Yes – East Pond is Class 1 – int	South -1/yr East - 1/qr	Yes, South Pond	Very High	High	GMZ, South Pond	36
Hennepin Station	IL0001554	3 Ponds (6 Cells)	1 w/2 cells	1 w/2 cells	2 w/4 cells	0	West pond (I)- 900 ac-ft East Pond (I) - 1600 ac-ft New East (A) - 425 ac-ft	New East – below	New East – Class 3 - small	West – 2/yr East - 1/quar New E - 1/quar	Yes, Unlined Ponds No, Lined Pond	Very High	Low	GMZ, Unlined Ponds	9- Pot to impact 1 off-site well
Wood River Station	IL0000701	2 w/ 6 cells	4 of 6 cells	4 of 6 cells	2 cells	0	2 cells of West Pond closed. 2 cells of of West lined and 250 ac-ft East Pond lined and 425 ac-ft	West- Below East- Above	West – Class 3	East – 1/quar West - 2 yr	Yes, Unlined West Ponds. Yes, Prior to Construction East Pond	Very High	High	GMZ, Unlined West Ponds Annual Evaluation East Pond	59
Vermilion Station	IL0004057	3 w/5 cells	2 w/ 4 cells	1 w/ 2 cells	1	0	New East – 500 ac-ft North- 2400ac-ft East-closed prior to 1980	New East-above North – above	New East – Class 3	Yes, New East – 1/quarter	Insufficient data, MW System May be Inadequate	Low	High	No	20

Ameren Energy															
Newton Station	IL0049191	2	2	0	0	0			No	Unknown	Low	Very Low	No	1
Edwards Station	IL0001970	1	1	0	0	0			No	Unknown	Very High	High	No	6
Duck Creek Station	IL0055620	6	6	3	0	0	Ash ponds 1&2 are active and unlined as is recycle pond****	New bottom ash Class 3	Yes, at 5 of 6	Yes, Unlined Ponds	Very High	Low	Remediation Plan Started	0
Coffeen Station**	IL0000108	4	3	2	1	0	Ash Ponds A, B, and C are active and synthetic lined, Ash Pond D is out of service, and the bottom ash pond is active and unlined	New gypsum stack Class 1	Yes, at the 2 gypsum ponds	Unknown	Mod Mod-Low	High	No	7
Meredosia Station	IL0000116	5	2	0	3	0			No	Unknown	Very High	High		68
Hutsonville Station	IL0004120	5	4	3	1	0		Yes, ash ponds Class 3	Yes, at Ash Pond D	Yes, Unlined Pond	Very High	Very Low	IPCB Petition	17
Venice	IL0000175	2	2	0	0	0			No	Unknown	Very High	Very Low	No	13
Grand Tower	IL0000124	1	1	0	0	0			No		Very High	Very Low	No	1
Kincaid Generation															
Kincaid Generation	IL0002241	1	1	0***	0	0		No	No	Unknown	Low	Low	No	6
City Water Light and Power															
City Water Light and Power	IL0024767	2	2	0	0	0		Lakeside Pond – yes Dallman Pond-No	No	Unknown	Low	Very Low	No	1
Prairie Power Inc.															
Prairie Power Inc	IL0036765	1	1	0	0	0			No	Unknown	Very High	Low	No	8
Southern Illinios Power Co-op.															
Southern Illinios Power Co-op.	IL0004316	7	7	1	0	0		Yes for 2 of the 7	Yes, at 3 of the 7	Unknown, Available Data 15 Years Old	Mod-High Mod	Low	No	3

*While the active ash impoundment at the Electric Energy Facility was not specifically constructed with a liner, the impoundment was constructed with compacted native clay soils

** Coffeen Station has a closed/ inactive ash pond with an unknown liner An ash recycle pond constructed of clay but not specifically lined is currently active A double synthetic lined gypsum impoundment along with a synthetic lined gypsum recycle pond are currently under construction

** *The ash pond at the Kincaid Power Station was not constructed with an engineered liner, but the bottom of the impoundment is clay

****Duck Creek Station is currently constructing a double synthetic lined gypsum impoundment, a synthetic lined gypsum recycle pond, and a synthetic and concrete lined bottom ash pond.

It should be noted that a majority of the stations and their active ash pond have a program for beneficial re-use of at least a portion of their ash. Some are able to market all of the ash they generate for beneficial reuse, and others only a portion of their fly ash. The ability of a facility or generator to beneficially re-use its ash is highly market dependent.

Illinois Pollution Control Board
R2014-10

T. Barkley: Exhibit F

Coal Combustion Waste Damage Case Assessments

U.S. Environmental Protection Agency
Office of Solid Waste

July 9, 2007

With the exception of the documents listed below, the documents referenced throughout this assessment are available from the docket to the Notice of Data Availability on the Disposal of Coal Combustion Wastes in Landfills and Surface Impoundments at www.regulations.gov, docket ID EPA-HQ-RCRA-2006-0796, through internet links provided, or from other identified sources.

1. Application of Don Frame Trucking, Inc. Petitioner for a Judgment Pursuant to Article 78 of the CPLR against the New York State Department of Environmental Conservation Respondent; Supreme Court of the State of New York County of Chautauqua (July 22, 1988). Order G11278.

2. Selenium Posting on Hyco Lake Rescinded, North Carolina Department of Health and Human Services (NCDHHS), August 2001.

3. Feasibility Study for the Y-12 Chestnut Ridge Operable Unit 2 Filled Coal Ash Pond, Oak Ridge, Tennessee. DOE/OR/02-1259&D1. August 1994.

4. Final Site Investigation Report on Groundwater Contamination, Township of Pines, Porter County, Indiana. December 2002.

5. Texas Bureau of Health (TBH). 1992. Fish Advisory: Brandy Branch Reservoir. May 1992.

6. Texas Commission on Environmental Quality (TCEQ). 2003. Improving Water Quality in Brandy Branch Reservoir; One TMDL for Selenium. February 2003.

7. Report: Sulfate Investigation, Miamiview Landfill, Hamilton County, Ohio. Prepared for the Cincinnati Gas & Electric Company by Dames & Moore. December 13, 1994. Available in the docket titled Availability of Report to Congress on Fossil Fuel Combustion; Request for Comments and Announcement of Public Hearing, EPA-HQ-RCRA-1999-0022-0632.

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Summary of Coal Combustion Waste Damage Case Assessments

I. Summary

Under the Bevill Amendment for the "special waste" categories of the Solid Waste Disposal Act, EPA was statutorily required to examine "documented cases in which danger to human health or the environment has been proved" from the disposal of coal combustion wastes. The criteria used to determine whether danger to human health and the environment has been proven are described in detail in the May 2000 Regulatory Determination at 65 FR 32224. For the May 2000 Regulatory Determination for Wastes from the Combustion of Fossil Fuels (Regulatory Determination), the Agency determined there were approximately 300 CCW landfills and 300 CCW surface impoundments used by 440 coal fired utilities.

In comments on the March 1999 Report to Congress on Wastes from the Combustion of Fossil Fuels, public interest groups identified 59 cases in which they alleged damage to human health or the environment had been caused by fossil fuel combustion wastes[1]. The Agency reviewed each of the cases. That review resulted in identifying nine of the 11 damage cases cited in the May 2000 Regulatory Determination[2] (see Table 1 below for complete listing of the 11 proven damage cases[3]). Of the remaining 50 cases, 25 were classified as "potential" damage cases as

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[1] Letter from the Hoosier Environmental Council to the RCRA Docket Information Center regarding the CCW RTC, June 11, 1999, Letter from the Hoosier Environmental Council and the Citizens Coal Council to the RCRA Docket Information Center regarding the CCW RTC, June 14, 1999 and Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[2] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[3] Per the May 2000 Regulatory Determination, 65 FR 32224 (http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2000_register&docid=fr22my00-22.pdf) and Section 1.4.4 of the 1999 Report to Congress (http://www.epa.gov/epaoswer/other/fossil/volume_2.pdf), proven damage cases are those with (i)documented exceedances of primary MCLs or other health-based standards measured in ground water at sufficient distance from the waste management unit to indicate that hazardous constituents have migrated to the extent that they could cause human health concerns, and/or (ii) where a scientific study demonstrates there is documented evidence of another type of damage to human health or the environment (e.g., ecological damage), and/or (iii) where there has been an administrative ruling or court decision with an explicit finding of specific damage to human health or the environment. In cases of co-management of CCWs with other industrial waste types, CCWs must be clearly implicated in the reported damage.

The May 2000 Regulatory Determination falls short of providing a comprehensive definition of the review criteria ("test of proof") for assessing the validity of damage case allegations; it only discusses the review criteria in response to public comments on the review process of the Cement Kiln Dust (CKD) proposed rule, and focuses only on the location of the exceedance point with respect to the source term (32224 CFR 65):

"Proven damage cases were those with documented MCL exceedances that were measured in ground water at a sufficient distance from the waste management unit to indicate that hazardous constituents had migrated to the extent that they could cause human health concerns."

The "test of proof" criteria were fully defined on pp. 3-4 of the *Technical Background Document to the Report to Congress on Remaining Waste from Fossil Fuel Combustion: Potential Damage Cases* (1999):

defined in the Regulatory Determination[4] and five cases were determined to be not applicable to the Regulatory Determination. Four of these five cases could not be linked to coal combustion wastes and the other was at a coal mine, which is outside the scope of this NODA. Of the remaining 20 cases, one damage case was the result of wastes other than coal combustion wastes; one was not considered because it was an illegal, unpermitted dump; and 18 cases were indeterminate due to insufficient information[5].

Table 1. Eleven Damage Cases Cited in the May 2000 Regulatory Determination

Damage Case	Wastes Present	Event	Criteria (Test of Proof)	Comment
Coal-Fired Utility Comanaged Wastes				
Chisman Creek (VA)	Coal ash and petroleum coke landfill.	Se primary MCL exceedance; V, Se, and sulfate in residential drinking water wells.	Scientific[6]/Administrative[7]	Was put on NPL. EPA required remediation: new water supply to nearby residents, capping disposal area, ground water treatment, relocation of surface water tributary; other possible sources of contamination.

http://www.epa.gov/epaoswer/other/fossil/ffc2_397.pdf. This language, in turn, is derived from the 1993 *Report to Congress on Cement Kiln Dust Waste*: http://www.epa.gov/epaoswer/other/ckd/cement2.htm.

According to the 1993 CKD Report to Congress (Chapter Five), Section 8002(o)(4) of RCRA requires that EPA's study of CKD waste examine "documented cases in which danger to human health or the environment has been proved." In order to address this requirement, EPA defined danger to human health to include both acute and chronic effects (e.g., directly observed health effects such as elevated blood lead levels or loss of life) associated with management of CKD waste. Danger to the environment includes the following types of impacts: (1) Significant impairment of natural resources; (2) Ecological effects resulting in degradation of the structure or function of natural ecosystems and habitats; and (3) Effects on wildlife resulting in damage to terrestrial or aquatic fauna.

[4] Per the May 2000 Regulatory Determination, 65 FR 3224, potential damage cases are those with (1) documented exceedances of primary MCLs or other health-based standards only directly beneath or in very close proximity to the waste source, and/or (2) documented exceedances of secondary MCLs or other health-based standards on-site or off-site.

[5] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[6] Where a scientific study demonstrates there is documented evidence of damage to human health or the environment other than ground water contamination (e.g., ecological damage).

[7] Where there has been an administrative ruling by a state or federal agency, or court decision with an explicit finding of specific damage to human health or the environment [e.g., listing on EPA's National Priorities List (NPL)].

Damage Case	Wastes Present	Event	Criteria (Test of Proof)	Comment
Faulkner Offsite Disposal Facility (MD)	Coal ash and pyritic mill rejects.	Low pH; exceedance of State standard; landfill and collection pond seepage and discharges resulted in plant and fish impacts to adjacent wetlands.	Scientific/Administrative	State required remediation included pond liners, landfill cover, and sequestration of pyrites.
DPC – Old E.J. Stoneman Ash Pond (WI)	Coal ash, demineralizer regenerant, other water treatment wastes.	Cd and Cr primary MCL exceedance; 'gross contamination' by pond cited by State – Elevated levels of Zn and sulfate; Boron near 5 mg/L in private drinking water well.	Administrative	State required Closure plan and relocation of town water supply well.
Basin Electric W.J. Neal Station (ND)	Coal ash and sludge; comanaged wastes probable.	Cr exceeded state standard and other metals detected at elevated levels in downgradient sediments and ground water.	Administrative (limited information available)	State required the site closed and capped, NFRAP (No Further Remedial Action Planned).
VEPCO – Possum Point (VA)	Coal ash, pyrites, oil ash, water treatment wastes, and boiler cleaning wastes	Cd primary MCL exceedance in ground water; ground water contaminated with Cd and Ni, attributed to pyrites and oil ash.	Administrative	Response included sequestration of oil ash, pyrites, and metal cleaning wastes to separate lined units.
WEPCO Hwy 59 Ash Landfill (WI)	Coal ash and mill rejects; other comanaged wastes probable.	Boron exceedance of state standard in down gradient ground water; elevated levels of As, Fe, Se, Mn, sulfate in private drinking water wells.	Scientific / Administrative	State required additional monitoring for problem/damage assessment.
Alliant Nelson Dewey (WI)	Coal ash, comanaged wastes.	Boron exceedance of state standard in down gradient ground water; elevated levels of As, Se, Fl, sulfate in ground water.	Administrative	State required company to investigate and assess problem; remedial action change to dry ash handling and modify landfill cover to reduce infiltration.

Damage Case	Wastes Present	Event	Criteria (Test of Proof)	Comment
Coal Creek Station (ND)	Coal ash, comanaged wastes.	Se and As exceedance of primary MCL in ground water on site; elevated sulfate and chloride levels in down gradient ground water.	Administrative	Impacted shallow ground water aquifer. State required additional impoundment liners.
Non-Utility Coal Combustion Waste Sites				
Salem Acres (MA)	Large volume; many other wastes present including municipal solid waste and industrial solid waste.	PAHs, VOCs, PCBs, metals including As and Cr; in soils, surface-waters, and ground water.	Administrative (on NPL)[8]	Contribution of FFC wastes to damage not separable from other wastes. Remedial measures taken including excavation, treatment, removal of sludges and soils.
Lemberger Landfill, Inc.[9] (WI)	Comanaged wastes; many other materials including municipal solid waste; adjacent site contains industrial solid waste.	Elevated levels of As, Cr, and Pb onsite, VOCs, PCBs. VOCs in private water wells initiated action.	Administrative (on NPL)[10]	Contribution of FFC wastes to damage not separable from other wastes.
Don Frame Trucking Fly Ash Landfill (NY)	Coal ash, other materials.	Pb exceedance of primary MCL action level in down gradient ground water; elevated levels of Mn, sulfate, TDS in a water supply well.	Administrative	State required remedial action: site closure landfill cover; post-closure care and monitoring.

Soon after the publication of the Regulatory Determination, the Agency conducted a reevaluation of the damage cases identified in the Regulatory Determination, including the 11 proven damage

8 http://yosemite.epa.gov/r1/npl_pad.nsf/f52fa5c31fa8f5c885256adc0050b631/C8A4A5BEC0121F048525691F0063F6F3?OpenDocument

9 Reclassified as a potential damage case. See Section III., Potential Damage Cases. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

10 http://www.epa.gov/superfund/sites/npl/nar735.htm

cases, the four additional ecological damage cases[11] which were identified in comments on the 1999 Report to Congress, the illegal disposal case, and the two potential damage cases attributed to non-utility coal combustion waste in the 1999 Report to Congress. As a result of this review, one of the cases identified in the Regulatory Determination as an ecological damage case, and the case identified as an illegal disposal case were reclassified as proven damage cases due to contamination of ground water from the disposal of CCW in sand and gravel pits and another site, the Lemberger Landfill, was reclassified as a potential damage case [12].

In October 2000, the Agency began collecting additional information from its own experience, from state agencies, and from commenters to clarify the details of the 18 previously indeterminate cases, which were included as part of the 59 cases identified by the public interest groups in their comments on the March 1999 Report to Congress. After analyzing this additional information, EPA classified three of the 18 cases as proven damage cases, nine as potential damage cases, and six as cases without documented evidence of proven or potential damage or where the damage could not be clearly attributed to CCW. Two of the three proven damage cases involved management of CCW in sand and gravel pits and the third - a surface impoundment[13].

Finally, in February 2002, environmental- and citizen-organizations submitted to the Agency 16 alleged cases of damage[14]. Some of these cases had been submitted to EPA previously and evaluated for the 1999 Report to Congress. The Agency evaluated ten of the 16 cases[15]; one case was not evaluated because it involves minefilling of CCW, which, while under the scope of the 2000 Regulatory Determination, is outside the scope of this NODA that deals exclusively with surface disposal. The other five cases were not evaluated because they involved allegations with little or no supporting information. Of the ten cases evaluated, one case has been categorized as a proven damage case with documented off-site damages to ground water, while six cases were categorized as potential damage cases due to on-site exceedances of primary or secondary MCLs[16]. Another damage case was determined to be a proven ecological damage case as a result of documented impacts to fish and other wildlife on-site; this case also has been categorized as a potential (human health) damage case due to documented exceedances of primary and secondary MCLs attributable to an inactive CCW surface impoundment detected in on-site monitoring wells. Finally, one case was rejected because monitoring data for the site

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[11] Ecological damages are damages to mammals, amphibians, fish, benthic layer organisms and plants.

[12] Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[13] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[14] Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[15] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[16] See Potential DCs, Section III of this document.

revealed no exceedances of primary or secondary MCLs attributable to coal combustion waste placement at the site, while another site is an oil burning facility and, therefore, is not covered by the May 2000 Regulatory Determination[17].

In August 2005, another damage case was recorded when a dam confining a surface impoundment in eastern Pennsylvania failed. This damage case resulted in discharge of coal-ash contaminated water into the Delaware River and concomitant pollution of ground water when an unlined surface impoundment was temporarily used to divert the ash from the breached impoundment. Other than obtaining verification of the event from state authorities, the Agency did not conduct an independent evaluation of this case[18].

In summary, EPA gathered or received information on 135 possible damage cases and has evaluated 85 of these cases. Six of the 50 cases that were not evaluated were minefills and outside the scope of this NODA. The remaining 44 cases that were not evaluated involved allegations with little or no supporting information. (See Table 2: Fossil Fuel Combustion (FFC) Damage Case Resolution, excluding minefills)

Of the 85 cases evaluated, EPA determined that 24 were proven cases of damage[19]. Sixteen were determined to be proven damages to ground water and eight were determined to be proven damages to surface water. Four of the proven damages to ground water were from unlined landfills, five were from unlined surface impoundments, one was due to a liner failure at a surface impoundment, and the remaining six were from unlined sand and gravel pits. Another 43 cases were determined to be potential damages to ground water or surface water. Four of the potential damage cases were attributable to oil combustion wastes. The remaining 18 alleged damage cases were not considered to be proven or potential damage cases; they were, therefore, rejected due to either (1) lack of any evidence of damage or (2) lack of evidence that damages were uniquely associated with CCW[20].

Of the 16 proven cases of damages to ground water, the Agency has been able to confirm that corrective actions have been completed in six cases and are ongoing in nine cases. The Agency has not received information regarding the one remaining case. Corrective actions measures at these CCW management units vary depending on site specific circumstances and include formal closure of the unit, capping, the installation of new liners, ground water treatment, ground water monitoring, and combinations of these measures.

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[17] Status of Alleged Damage Cases Submitted by HEC, et. al., to Dennis Ruddy, February, 2002.

[18] PA DEP Press Release, December 27, 2005.

[19] See Proven Damage Cases, Section II of this document. In addition to the documents previously cited, additional discussions of proven damages can be found in the Memorandum from SAIC to Dennis Ruddy regarding Additional Information Regarding Fossil Fuel Combustion Waste Damage Cases, April 20, 2000; and Ecological Assessment of Ash Deposition and Removal, Euharlee Creek, Georgia Power Bowen Plant.

[20] See Rejected Cases Excluding Minefills, Section IV of this document.

Table 2. Fossil Fuel Combustion (FFC) Damage Case Resolution, excluding minefills (Updated 2/03/05)

Occurence	State	Final Proven	Final Potential	Final Rejected	Indeter-minate	Not re-evaluated	Non-FFC	Sand & Gravel Pit	Non-Utility	Oil Comb. Waste	Eco-Damage
TVA Widows Creek	AL		X								
TVA Colbert Plant	AL		X								
Arizona Public Serv Cholla Station	AZ		X								
Comanche, PSCC	CO				X						
Pierce Site	CT				X						
Hunts Brook Watershed (3 sites)	CT				X						
FP&L - Lansing Smith Plant (part 1)	FL		X								
TECO Big Bend Electric Plant	FL										
TECO Polk Power Station	FL										
FP&L Port Everglades (EPRI #6)	FL		X (oil)							X	
FP&L Riviera (EPRI #10)	FL		X (oil)							X	
FPC P.L. Bartow (EPRI #66)	FL		X (oil)							X	
Georgia Power Bowen	GA	X									
Muscatine County	IA		X								
American Coal Corp. #5 CCR Landfill	IA			X							
Star Coal Co. #6 CCR Landfill	IA			X							
Star Coal Co. #14 CCR Landfill	IA			X							
Powerton Plant	IL		X					X			
Central IL Light Duck Creek	IL		X								
IL Power Hennepin Station	IL		X								
IL Power Havana Plant	IL		X								
IL Power - Vermillion	IL		X								
Cent. IL PSC - Hutsonville Station	IL		X								
IL Power - Wood River	IL		X								
Cofeen, White, Brewer Ash Landfill	IL		X								
Turris Coal Company Elkhart Mine	IL			X							
Michigan City Site	IN		X								
Bailly Station	IN		X								
RM Schaffer Station (Schahfer)	IN		X								
SIGECO - AB Brown	IN		X								
IP&L - Petersburg Station	IN		X								
Hoosier Energy Merom Landfill	IN		X								
Yard 520 Landfill Pines	IN	X									
Indiana-Kentucky Electric Clifty Creek Station	IN				X						
Cinergy/Cinn. G&E - East Bend/Boon County - FGD	KY		X								
LG&E Mill Creek Plant	KY				X						
LG&E Cane Run Plant	KY				X						
Salem Acres	MA	X									
Vitale Fly Ash Pit	MA	X						X			
Rezendes Ash Landfill (South Main Street Site/Freetown)	MA		X					X			
Copicut Road Monofill, Freetown	MA			X				X			
PG&E Salem Harbor, Salem	MA				X						
Brayton Point (EPRI #27)	MA		X (oil)							X	

Table 2. Fossil Fuel Combustion (FFC) Damage Case Resolution, excluding minefills (Updated 2/03/05)

Occurence	State	Final Proven	Final Potential	Final Rejected	Indeter-minate	Not re-evaluated	Non-FFC	Sand & Gravel Pit	Non-Utility	Oil Comb. Waste	Eco-Damage
PEPCO Faulkner	MD	X									
Constellation Energy Crofton	MD				X						
Brandywine Disposal Site	MD				X						
Lansing Board P&L - N. Lansing Landfill	MI	X						X			
Thompson Landfill	MI			X							
Motor Wheel, Inc	MI							X			
Dagget Sand & Gravel, Inc	MI				X			X			
Sherburne County Plant	MN		X								
Colstrip Power Plant	MT										
Hyco Lake (CP&L Roxboro)	NC	X									X
Belews Lake	NC	X									X
Duke Power - Allen Plant	NC		X								
Ecusta Ash Monofill	NC					X			X		
BASF Industrial Landfill	NC					X			X		
Neal Station BESI	ND	X									
Coop Power & United Power - Coal Creek	ND	X									
Montana-Dakota - Heskett Station	ND		X								
Stanton Site, United Power	ND				X						
Leland Olds Site, Basin Electric	ND				X						
Don Frame Trucking	NY	X									
AES Creative Weber Site	NY		X								
Central Hudson G&E - Danskammer Site	NY		X								
C.R. Huntley Ash Landfill	NY		X								
Cinergy/Cinn. G&E - Miamiview Landfill	OH		X					X			
Cinergy/Cinn. G&E - Beckjord Station	OH		X								
Muskingum River Power Plant Impoundments	OH			X							
Cardinal Fly Ash Reservoir II Impoundment	OH			X							
Cardinal PFBC Monofill	OH			X							
Stuart Station Monofill	OH			X							
Gavin Impoundments	OH			X							
Kyger Creek Power Plant Impoundments	OH			X							
Lake Erie	OH			X							X
Conesville FGD Landfill (part 1)	OH		X								
Tristate Asphalt Flyash Landfill	OH				X						
Muskogee Env. Ash Site	OK			X							
Western Farmers Ash Site	OK			X							
Public Service Ash Site	OK			X							
Fort Gibson Fly Ash Monofill	OK				X						
Grand River Dam Authority	OK				X						
IMCO	OK				X						
Elrama Plant	PA		X								
Hatsfield Ferry Power Plant, Greene County	PA				X						
Zullinger Quarry	PA				X						

Table 2. Fossil Fuel Combustion (FFC) Damage Case Resolution, excluding minefills (Updated 2/03/05)

Occurence	State	Final Proven	Final Potential	Final Rejected	Indeter-minate	Not re-evaluated	Non-FFC	Sand & Gravel Pit	Non-Utility	Oil Comb. Waste	Eco-Damage
Veterans Quarry, Domino Salvage	PA				X						
Shawville Site, Penelec	PA				X						
Montour Ash Disposal Area	PA				X						
SC Elec & Gas Canadys Plant	SC	X									
Savannah Riv. Project	SC	X									X
SCE&G McMeekin Station	SC				X						
Chestnut Ridge Y-12 Steam Plant Operable Unit 2	TN	X									X
TVA Bull Run Steam Plant	TN		X								
Brandy Branch Reservoir	TX	X									X
Welsh Reservoir	TX	X									X
Martin Creek Reservoir	TX	X									X
JT Deely Power Plant, San Antonio Public Services	TX				X						
VEPCO Possum Pt (Virginia Power)	VA	X								OCW & CCW	
VEPCO Chisman (Virginia Power)	VA	X						X			
Clinch River (part 1)	VA			X							X
Dixie Caverns Landfill	VA			X			X				
Chesterfield, Virginia Power	VA				X						
Georgia Pacific Industrial Waste Landfill, Big Island	VA					X			X		
Dairyland Power Stoneman (Old E.J. Stoneman)	WI	X									
WEPCO Hwy 59	WI	X						X			
Alliant Nelson Dewey	WI	X									
WEPCO Cedar Sauk Landfill (part 1)	WI	X						X			
WEPCO Port Washington	WI	X						X			
Alliant Rock River	WI		X								
Alliant Edgewater 1-4	WI		X								
Wisconsin Power Pulliam Ash	WI		X								
Dairyland Power Alma On-site Landfill	WI		X								
Dairyland Power Alma Off-site Landfill	WI		X								
Lemberger Landfill	WI		X					X			
Genoa #3, Dairyland Power Cooperative (DPC)	WI				X						
Old Columbia, WPL	WI				X						
Oak Creek, WEPCO	WI				X						
New Columbia, WPL	WI				X						
Locks Mill Landfill	WI					X			X		
Biron On-site Landfill	WI					X			X		
Kraft Division Off-site Landfill	WI					X			X		
Niagara of Wisconsin Paper Corporation Flyash Landfill	WI					X			X		
RPC Landfill #1	WI					X			X		
RPC Landfill #2	WI					X			X		
RPC Pine Lake Landfill	WI					X			X		
Ward Paper Company Landfill	WI					X			X		
Pleasant Prairie, WEPCO	WI				X						
Dave Johnston Power Plant	WY		X								

Proven Coal Combustion Waste Damage Cases

II. Proven Damage Cases

Per the 2000 Regulatory Determination, 65 FR 32224 and the *Technical Background Document to the Report to Congress on Remaining Waste from Fossil Fuel Combustion: Potential Damage Cases* (1999), classifying damage to groundwater as a proven damage case requires the satisfaction of at least one of the following "tests of proof"[21]:

> 1) Scientific investigation: Damages that are found to exist as part of the findings of a scientific study. Such studies should include both formal investigations supporting litigation or a state enforcement action, and the results of technical tests (such as monitoring of wells). Scientific studies must demonstrate that damages are significant in terms of impacts on human health or the environment. For example, information on contamination of drinking water aquifer must indicate that contaminant levels exceed drinking water standards.
> (2) Administrative ruling. Damages are found to exist through a formal administrative ruling, such as the conclusions of a site report by a field inspector, or through existence of an enforcement that cited specific health or environmental damages.
> (3) Court decision. Damages are found to exist through the ruling of a court or through an out-of-court settlement.
> (4) As a practical matter, EPA employed a fourth criterion in determining whether damages are proven: available information needed to clearly implicate fossil fuel combustion wastes in the damage observed.

The above definition does not limit proven damage cases only to those sites with a primary MCL exceedance(s) in ground water distant from the waste management unit. A case still may be considered proven under the scientific investigation test if a scientific study demonstrates there is

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[21] The May 2000 Regulatory Determination falls short of providing a comprehensive definition of the review criteria ("test of proof") for assessing the validity of damage case allegations; it only discusses the review criteria in response to public comments on the review process of the Cement Kiln Dust (CKD) proposed rule, and focuses only on the location of the exceedance point with respect to the source term (32224 CFR 65):

"Proven damage cases were those with documented MCL exceedances that were measured in ground water at a sufficient distance from the waste management unit to indicate that hazardous constituents had migrated to the extent that they could cause human health concerns."

The "test of proof" criteria were fully defined on pp. 3-4 of the *Technical Background Document to the Report to Congress on Remaining Waste from Fossil Fuel Combustion: Potential Damage Cases* (1999): http://www.epa.gov/epaoswer/other/fossil/ffc2_397.pdf. This language, in turn, is derived from the 1993 *Report to Congress on Cement Kiln Dust Waste*: http://www.epa.gov/epaoswer/other/ckd/cement2.htm.

According to the 1993 CKD Report to Congress (Chapter Five), Section 8002(o)(4) of RCRA requires that EPA's study of CKD waste examine "documented cases in which danger to human health or the environment has been proved." In order to address this requirement, EPA defined danger to human health to include both acute and chronic effects (e.g., directly observed health effects such as elevated blood lead levels or loss of life) associated with management of CKD waste. Danger to the environment includes the following types of impacts: (1) Significant impairment of natural resources; (2) Ecological effects resulting in degradation of the structure or function of natural ecosystems and habitats; and (3) Effects on wildlife resulting in damage to terrestrial or aquatic fauna.

documented evidence of another type of damage to human health or the environment (e.g., ecological damage).

1. Salem Acres Site, Massachusetts[22]

History: Fly ash disposal occurred at this site from at least 1952 to 1969. The site was originally contaminated by fly ash, sewage sludge, tannery waste and materials from a landfill on the site. The contamination was confined to the southernmost 13 acres of the 235 acre parcel and consisted of polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins/furans, volatile organic compounds (VOCs), chromium, arsenic, beryllium, vanadium and thallium.

EPA proposed adding the Salem Acres site to the NPL on October 15, 1984, and added it to the final list on June 10, 1986[23]. On May 26, 1987, EPA signed a Consent Order with the South Essex Sewerage District (SESD) to perform the studies to examine the nature and extent of contamination and present technical options for cleanup. In December 1993, EPA signed a Consent Decree with the SESD to clean up the lagoons. The EPA also signed a separate Consent Decree with the Massachusetts Electric Company to clean up the fly ash pile on site. In October 1994, the EPA signed a Consent Order with DiBase Salem Realty Trust, the owner of the property and remaining party, to clean up the landfill and three debris piles.

Cleanup of the site was addressed in two stages: initial actions and a long-term remedial phase focusing on cleanup of the entire site. In 1987, lagoon water was removed and disposed of, the slurry wall at the disposal areas was capped and a fence was installed. In 1988, EPA covered the sludge pits with a high density polyethylene synthetic cap, removed the liquid wastes from the disposal pits to an off-site storage facility, and constructed concrete cut-off walls to prevent further releases into the wetlands. In 1990, repairs were made to a monitoring well and a security fence on site, and signs were posted to further restrict access.

The South Essex Sewerage District completed an investigation into the nature and extent of the soil and sludge contamination in early 1993. The investigation defined the contaminants of concern and recommended alternatives for final cleanup. Ground water at the site and adjacent wetlands demonstrated only minor contamination and therefore, no further remedial actions were planned. EPA selected a final remedy for the site, including sludge-fixation with fly ash and other substances such as cement and soil, as necessary and disposed of off-site to a secured landfill. A contingent remedy includes the installation of an EPA-approved cap. In 1995, the fly ash area and "old landfill" on site were excavated and the contaminated material was taken off site to a municipal landfill. Final site restoration of these areas occurred in 1996. The sludge lagoon cleanup was completed in the fall of 1997 and final site restoration was completed in the

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[22] Memorandum from SAIC to Dennis Ruddy regarding Additional Information Regarding Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[23] http://yosemite.epa.gov/r1/npl_pad.nsf/f52fa5c31fa8f5c885256adc0050b631/C8A4A5BEC0121F048525691F0063F6F3?OpenDocument

spring of 1998. In the summer of 1999, fly ash was removed from the wetland adjacent to the former fly ash pile. The wetland was restored at this time. The site was officially deleted from the National Priorities List (NPL) effective July 23, 2001[24]. The site now allows for unrestricted land use

Basis for Consideration as a Proven Damage Case: The criteria for classifying this site as a proven damage case were (1) Scientific – Arsenic and chromium exceeded (health-based) primary MCLs, and (2) Administrative – The site has been placed on the NPL list, and EPA signed a Consent Order with the owner to clean up the lagoons.

2. City of Beverly/Vitale Brothers Fly Ash Pit, Massachusetts[25]

History: This site is an abandoned gravel and sand mine that was used as an unpermitted landfill from the 1950's until the mid-1970s. The site was operated by the Vitale Brothers until 1980, when the City of Beverly Conservation Commission gained ownership because of failure to pay property taxes. On the site, the Vitale Brothers accepted and disposed saltwater-quenched fly ash from New England Power Company along with other wastes. Leaking underground storage tanks containing petroleum products were also located at the site. In 1973, fly ash at the site eroded into a nearby swamp and a stream that is a tributary to a surface drinking water supply. The erosion created a damming effect and resulted in flooding of neighboring property. In 1988, surface water sampling of the stream revealed levels of iron and manganese significantly greater than upstream levels. Additionally, there were complaints of fugitive dust from the site from neighbors located 500 feet away. Air sampling on one occasion in 1988 revealed arsenic concentrations of 2 parts per billion. Finally, 1988 ground water sampling found arsenic and selenium in excess of their primary MCLs and aluminum, iron, and manganese in excess of secondary MCLs. According to the State, fly ash is the suspected source of contamination in all of these media.

Fly ash is disposed at the site at depths from 14 to 36 feet. Not only is the site unlined, but ground water depth at the site is between 10 and 21 feet, indicating the likelihood of direct contact with fly ash. Fly ash also is observed to be present at the surface of the site with no cover or other surface runoff, erosion, or fugitive dust controls. Finally, the site is located in close proximity to a wetland and a surface water body.

The site has a long history of noncompliance with local and State laws and regulations. Following the completion of a Comprehensive Site Assessment and Risk Characterization in preparation for potential remedial action under Massachusetts regulations for the assessment and cleanup of hazardous waste sites, the fly ash was removed and the site was redesigned with special attention to protecting the adjacent water courses from erosion[26]. The Vitale Flyash site

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[24] Ibid

[25] Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[26] http://www.erosioncontrol.com/ecm_0603_erosion.html

submitted a site closure report February 1, 2007, and a preliminary screening of the site closure report is underway[27].

Basis for Consideration as a Proven Damage Case: This case was not counted as a proven damage case in the 1999 Regulatory Determination because it was a case of illegal disposal not representative of historical or current disposal practices. The case, however, otherwise meets the criteria for a proven damage case for the following reasons: (1) Scientific – (i) selenium and arsenic exceeded (health-based) primary MCLs, and (ii) there is evidence of contamination of nearby wetlands and surface waters; and (2) Administrative - the facility was the subject of several citations and the State has enforced remedial actions.

3. Don Frame Trucking, Inc. Fly Ash Landfill, New York[28]

History: This solid waste management facility had been used for disposal of fly ash, bottom ash, and other material including yard sweepings generated by the Niagara Mohawk Power Corporation's Dunkirk Steam Station. The age of the facility was not identified in the materials provided. The available monitoring data for this facility include quarterly water quality analysis and various miscellaneous data collected at the facility from March 1989 through September 1998. These data show down-gradient levels of lead greater than the primary MCL Action Level. These exceedances occurred in 1989 and 1996. The data also document elevations from background of sulfate, total dissolved solids, and manganese, including levels of manganese in a water supply well greater than the secondary MCL.

As a result of the contamination, Don Frame Trucking recommended to the New York State Department of Environmental Conservation (NYSDEC) that the affected water supply well should immediately be connected to a public water supply. Also, on September 16, 1988, Don Frame Trucking, Inc. was directed to cease receiving the aforementioned wastes at the facility no later than October 15, 1988, in accordance with the standards contained in 6 NYCRR Part 360.[29] The site was divided into five separate sections. The NYSDEC directed Don Frame Trucking, Inc. to place two feet of a "final cover" over Section I. The soil should have a coefficient of permeability of 1×10^{-5} cm/sec. NYSDEC directed Section II to be covered with 18 inches of clay cover with a coefficient of permeability of 1×10^{-7} in two shifts. Once the permeability was tested and considered acceptable, NYSDEC directed Don Frame Trucking, Inc. to place six additional inches of topsoil was over the clay cover and then seed and mulch the section. Eighteen inches of clay with a coefficient of permeability of 1×10^{-7} was also directed to be placed on Sections III, IV, and V, followed by reseeding and mulching. Don Frame Trucking, Inc. was instructed to finish all remediation procedures by October 15, 1988, and then provide

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[27] MADEP tracking number 3-00230; email message from Patricia Donahue, MADEP, July 9, 2007.

[28] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[29] Application of Don Frame Trucking, Inc. Petitioner for a Judgment Pursuant to Article 78 of the CPLR against the New York State Department of Environmental Conservation Respondent; Supreme Court of the State of New York County of Chautauqua (July 22, 1988). Order G11278.

certification by a licensed professional engineer that the facility was closed in accordance with the rules and regulations as stipulated by the NYSDEC by October 21, 1988. Post-closure ground water and surface water monitoring and maintenance were also expected to continue for 30 years after final closure of the entire facility.

Basis for Consideration as a Proven Damage Case:(1) Scientific - The lead levels found in down-gradient wells exceed the primary MCL Action Level; (2) Administrative - The State has required remedial action as a result of the contamination; and (3) Court order – The owner was directed, by the Supreme Court of the State of New York County of Chautauqua (July 22, 1988), to cease receiving the aforementioned wastes at the facility no later than October 15, 1988.

4. Virginia Electric Power Co. (VEPCO) Possum Point, VA[30]

History: EPA identified this site as a proven damage case in the March 1999 Report to Congress. It is described in detail in the Report and supporting technical background documents in the rulemaking docket.

The technical background document[31] states: "One additional documented damage case is the Virginia Electric and Power Company (VEPCO) Possum Point Site, described in the 1993 Regulatory Determination. This is an active facility with 40-acre unlined ash ponds with solids dredged to 80-acre lined ponds. These ponds received coal ash, pyrites, water treatment wastes, boiler cleaning wastes, and oil ash. Ground water monitoring found cadmium at concentrations 3.6 times and nickel, at 26.4 times the primary MCLs. Monitoring for vanadium was conducted but no results were given. The elevated concentrations were attributed to the pyrites and oil ash. These wastes, along with metal cleaning wastes, were ordered sequestered to separate lined units."

The 1999 Report to Congress[32] states: "**Possum Point, Virginia** (described in the 1993 Supplemental Analysis). At this site, oil ash, pyrites, boiler chemical cleaning wastes, coal fly ash, and coal bottom ash were comanaged in an unlined pond, with solids dredged to a second pond. Levels of cadmium above 0.01 mg/L were recorded prior to 1986 (the primary MCL is 0.005 mg/L). After that time, remedial actions were undertaken to segregate wastes (oil ash and low volume wastes were believed to be the source of contamination). Following this action, cadmium concentrations were below 0.01 mg/L."

Basis for Consideration as a Proven Damage Case: Based on evidence on exceedances of cadmium and nickel, the State pursued an Administrative Action by requiring the removal of the waste, thus qualifying it as a proven damage case.

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[30] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[31] Technical Background Document For the Report to Congress On Remaining Wastes from Fossil Fuel Combustion: Potential Damage Cases, March 15, 1999 (http://www.epa.gov/epaoswer/other/fossil/ffc2_397.pdf)

[32] http://www.epa.gov/epaoswer/other/fossil/volume_2.pdf

5. PEPCO Morgantown Generating Station Faulkner Off-site Disposal Facility, Maryland[33]

History: Landfills at this site manage fly ash, bottom ash, and pyrites from the Morgantown Generating Station starting in 1970. Unlined settling ponds also are used at the site to manage stormwater runoff and leachate from the ash disposal area. In 1991, the State found that water quality was degraded in the underlying aquifer and that ground water contamination had migrated to nearby surface waters (including a stream and a wetland area). The impacts included vegetative damages, orange staining from iron precipitation, and low pH. Because of the ground water migration, the operator was cited for unpermitted discharges to surface water. The low pH impacts are believed to have resulted from pyrite oxidation. The low pH may also have contributed to the migration of other contaminants. Additionally, ground water beneath the facility is shallow. Documentation shows the water table is very close to the bottom of the ash disposal area at the down-gradient end of the facility and well above the base of the settling ponds used to manage stormwater runoff and leachate from the ash disposal area.

Remedial measures at the site included closure and capping of older units, installation of liners in newer units, installation of a slurry wall to prevent ground water migration, and sequestration of pyrites. EPA identified this site as a proven damage case in the March 1999 Report to Congress. It is described in detail in the Report and supporting technical background documents in the rulemaking docket.

Basis for Consideration as a proven Damage Case: EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific - Ground water contamination migrated off-site; and (2) Administrative - The State required remedial action.

6. Virginia Power Yorktown Power Station Chisman Creek Disposal Site, Virginia[34]

History: This site consists of three parcels of land that cover 27 acres. Between 1957 and 1974, abandoned sand and gravel pits at the site received fly ash from the combustion of coal and petroleum coke at the Yorktown Power Station. Disposal at the site ended in 1974 when Virginia Power began burning oil at the Yorktown plant. In 1980, nearby shallow residential wells became contaminated with vanadium and selenium. Water in the wells turned green and contained selenium above the primary MCL and sulfate above the secondary MCL. Investigations in response to the discolored drinking water found heavy metal contamination in the ground water around the fly ash disposal areas, in onsite ponds, and in the sediments of Chisman Creek and its tributaries. Arsenic, beryllium, chromium, copper, molybdenum, nickel, vanadium, and selenium were detected above background levels.

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[33] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[34] Ibid. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

The contamination at the site's vicinity was caused by the combination of several factors: (i) The facility was operated with no dust or erosion controls; (ii) The facility is unlined and located in close proximity to drinking water wells, and ground water at the site was very shallow and possibly in contact with disposed waste.; (iii) A surface water tributary passed through or near the disposal areas.

In September 1983, EPA added the site to the National Priorities List (NPL)[35] under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA). Cleanup began in late 1986 and was conducted in two parts. The first part addressed the fly ash pits and contaminated ground water and included the following steps:

- Extension of public water to 55 homes with contaminated well water,
- Capping the disposal pits with soil (2 pits) or compacted clay (1 pit) overlain with topsoil and vegetative growth,
- Ground water and leachate collection for treatment and to lower the water table beneath the pits, and
- Post-closure monitoring.

The second part addressed the onsite ponds, a freshwater tributary stream, and the Chisman Creek estuary and included the following steps:

- Relocation of a 600-foot portion of the tributary to minimize contact with the fly ash disposal areas,
- Diversion of surface runoff, and
- Long-term monitoring for the ponds, tributary, and estuary.

Construction of all cleanup components was completed on December 21, 1990. The site has been redeveloped as a public park. Following the completion (in December 2006) of its third five-year review of the site, EPA determined that the remedial action at Operable Unit 1 is protective in the short term because the extent of the vanadium contamination in the shallow ground water aquifer is not presently known. EPA is presently working with Virginia Power to determine the extent of the vanadium contamination and to amend the restriction to make sure it provides the necessary assurance that it will be protective over time.

Basis for Consideration as a Proven Damage Case: EPA identified this site as a proven damage case in the March 1999 Report to Congress. It is described in detail in the Report and supporting technical background documents in the rulemaking docket. EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific – (i) Drinking water wells contained selenium above the (health-based) primary MCL and (ii) There is evidence of surface water and sediment contamination; and (2) Administrative - The site was remediated under CERCLA.

[35] http://epa.gov/reg3hwmd/npl/VAD980712913.htm

7. Hyco Lake, Roxboro, North Carolina[36]

History: This case was originally identified by a public interest group in a table alleging selenium contamination, and a selenium fish consumption advisory[37].

Hyco Lake was constructed in 1964 as a cooling water source for the CP&L Roxboro Steam Electric Plant. The lake received discharges from the plant's ash-settling ponds containing high levels of selenium. The selenium accumulated in the fish in the lake, affecting reproduction and causing declines in fish populations in the late 1970s and 1980s. The North Carolina Department of Health and Human Services issued a fish consumption advisory in 1988[38].

In 1990, CP&L installed a dry ash handling system to meet new permit limits for selenium. To determine the effectiveness of the new handling system, the Department of Water Quality is requiring long-term monitoring of the lake. Based on the results of fish tissue sampling, the fish consumption advisory has been rescinded in stages starting in 1994[39]. It was completely rescinded in August, 2001[40].

Basis for Consideration as a Proven Damage Case: This case is categorized as a proven ecological damage case for the following reasons: (1) Scientific - declines in fish populations were observed (1970s & 1980s); (2) Administrative - The State concluded that the impacts were attributable to the ash ponds, and issued a fish consumption advisory as a result of the contamination.

8. Georgia Power Company, Plant Bowen, Cartersville, GA[41]

History: This unlined CCW management unit was put in service in 1968. On July 28, 2002, a sinkhole developed in the (coal) ash pond of the Georgia Power Company - Plant Bowen Facility (coal-fired generating facility). The sinkhole ultimately reached four acres and a depth of thirty

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[36] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[37] Letter from the Hoosier Environmental Council to the RCRA Docket Information Center regarding comments on the May 2000 Regulatory Determination, September 19, 2000.

[38] Selenium Posting on Hyco Lake Rescinded, North Carolina Department of Health and Human Services (NCDHHS), August 2001.

[39] Roanoke River Basinwide Water Quality Plan, Section B, Chapter 5: Roanoke River Subbasin 03-02-05, North Carolina Department of Environment and Natural Resources (NCDENR), July 2001. Available at http://h2o.enr.state.nc.us/basinwide/roanoke/2001/2001_Roanoke_wq_management_plan.htm

[40] Selenium Posting on Hyco Lake Rescinded, North Carolina Department of Health and Human Services (NCDHHS), August 2001.

[41] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007. Ecological Assessment of Ash Deposition and Removal, Euharlee Creek, Georgia Power Bowen Plant, available in the docket to the CCW NODA (EPA-HQ-RCRA-2006-0796).

feet. The integrity of the ash pond dikes did not appear to be compromised. The company estimated that 2.25 million gallons of ash/water mixture was released to an unnamed tributary of the Euharlee Creek, containing 281 tons of ash. Georgia's Department of Natural Resources alleges an unpermitted discharge of water containing approximately 80 tons of ash slurry entered Euharlee Creek through a stormwater drainage pipe resulting in a temporary degradation of public waters.

Georgia Department of Natural Resources issued a consent order on November 20, 2002. The order contained the following provisions:

- Fine of $31,250 was imposed;
- Company to perform ecological impact study of the ash discharge into Euharlee Creek and recommend remedial action;
- Company to submit proposed dredging plan if necessitated by impact study;
- Company to submit report on actions taken to fill sinkhole and grout fissures under the dike;
- Company to perform geological engineering assessment of the ash pond stability and recommend corrective actions to address future sinkhole development;
- Company to submit a revised ash water management plan;
- Georgia EPD approved corrective action plans shall be implemented; and
- Company shall submit interim progress report and final schedule for completion of implementation of corrective action plans.

Basis for Consideration as a Proven Damage Case: (1) Scientific - unpermitted discharge of water containing ash slurry into the Euharlee Creek resulting in a temporary degradation of public waters; and (2) Administrative - Georgia Department of Natural Resources issued a consent order requiring, among others, a fine and corrective action.

9. Department of Energy - Oak Ridge Y-12 Plant Chestnut Ridge Operable Unit 2 DOE Oak Ridge Reservation, Oak Ridge, Tennessee[42]

History: This case was originally identified by public commenters in a table that alleged aluminum, arsenic, iron, and selenium contamination, as well as fish deformities and a region of a stream where no fish are found[43].

Chestnut Ridge Operable Unit (OU) 2 consists of Upper McCoy Branch, the Filled Coal Ash Pond (FCAP), and the area surrounding the sluice channel formerly associated with coal ash disposal in the FCAP. Upper McCoy Branch runs from the top of Chestnut Ridge across the FCAP into Rogers Quarry. The FCAP is an 8.5 acre area. The sluice channel area extends approximately 1,000 feet from the crest of Chestnut Ridge to the edge of the FCAP.

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[42] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[43] Letter from HEC et. al., to Dennis Ruddy, February, 2002.

The FCAP is an ash retention impoundment used to dispose of coal ash slurry from the Y-12 steam plant. It was constructed in 1955 by building an earthen dam across a northern tributary of Upper McCoy Branch, and was designed to hold 20 years of ash. By July of 1967, the impoundment was filled to within four feet of the top of the earthen dam. Once the impoundment was no longer able to retain the ash solids, the slurry was released directly into Upper McCoy Branch through direct flow over the earthen dam. In 1967 and 1968, Upper McCoy Branch was diverted into Rogers Quarry. Between 1967 and 1989, the ash slurry flowed directly from the FCAP into Upper McCoy Branch and then into Rogers Quarry. In 1989, a bypass pipe was constructed to carry the slurry directly from the steam plant to Rogers Quarry. Disposal of ash into Rogers Quarry was discontinued in 1990, when a chemical vacuum system and a bottom ash dewatering system were installed at the plant. Both fly ash and bottom ash are now disposed in a landfill. Existing ash deposits were left in place. Erosion of both the spillway and the ash itself has occurred, leading to releases of ash into Upper McCoy Branch[44].

In the mid-1980s, the Y-12 plant began investigation and ground water monitoring at a number of locations within its boundaries, as required under RCRA and by the Tennessee Department of Environmental Conservation (TDEC). The entire Oak Ridge Reservation was placed on the NPL in 1989. CERCLA requires all sites under investigation to complete a remedial investigation to determine the nature and extent of contamination, evaluate the risks to public health and the environment, and determine remedial action goals. The Remedial Investigation for OU conducted in two phases. Phase I was conducted by CH2M Hill in the Upper McCoy Branch zone. Phase II was conducted by CDM Federal in the FCAP and sluice area zones. Both investigations consisted of surface and ground water, soil, and ash sampling. The table below shows a summary of the results of the monitoring programs[45].

Table 3. Oak Ridge Y-12 Plant Chestnut Ridge Operable Unit 2 Surface and Ground Water Monitoring Programs

Monitoring type	Monitoring location	Constituents with exceedances of ambient/ reference/background concentrations	Constituents with exceedance of MCLs or SMCLs
Surface Water	Upper McCoy Branch (Phase I)	Al, Fe, Cu	Al, As, Fe, Mn
	Upper McCoy Branch (Phase II)	Al, As, Ca, Mn, K, Na	Al, As, Mn
	FCAP Pond Water	Al, As, Ba, Ca, Cr, Cu, Fe, Pb, Mg, Mn, K, Na, V, Zn	Al, As, Fe, Mn

[44] Feasibility Study for the Y-12 Chestnut Ridge Operable Unit 2 Filled Coal Ash Pond, Oak Ridge, Tennessee. DOE/OR/02-1259&D1. August 1994.

[45] Ibid.

Monitoring type	Monitoring location	Constituents with exceedances of ambient/ reference/background concentrations	Constituents with exceedance of MCLs or SMCLs
	Spring Water	Al, As, Ba, Ca, Pb, Mn, Hg, K, V, Zn	Al, As, Fe, Pb, Mn
Ground Water	Upper McCoy Branch (Phase I)	Al, Ba, Ca, Co, Cu, Fe, K, Mg, Mn, Na, Se, Zn	Al, Fe, Mn
	Upper McCoy Branch (Phase II)	information not provided	Mn
	Sluice Channel Area	information not provided	Mn
Soil	Near Upper McCoy Branch (Phase II)	Al, As, Ba, Fe, Mn, K, Na	Not applicable
	Near FCAP	Al, As, K, Na	Not applicable
Ash	Entire Site	No background data	Not applicable

Biological monitoring has also been conducted at the site as part of a RCRA Facility Investigation (RFI) required by the 1984 Hazardous and Solid Waste Amendments to RCRA, and as part of the Phase I Remedial Investigation. The biological monitoring conducted for the RFI included toxicity testing, bioaccumulation studies, fish community assessments, and a benthic macro-invertebrate community assessment. Biological monitoring for the Phase I RI consisted of toxicity testing, a benthic macro-invertebrate assessment, a soil (ash) invertebrate survey, and bioaccumulation studies[46].

The conclusions for the RFI biological monitoring programs were as follows:

- Toxicity testing: The results of the toxicity testing did not show significant evidence for toxic conditions in Upper McCoy Branch.
- Bioaccumulation studies:
    - Concentrations of selenium, arsenic, and possibly thallium were elevated in largemouth bass from Rogers Quarry, relative to bass from another nearby site;
    - Arsenic exceeded screening criteria;
    - Some fish from Rogers Quarry had deformed bony structures (these effects were not described in literature as effects of arsenic or selenium); and
    - Bioaccumulation was not indicated in Upper McCoy Branch discharge

[46] Ibid.

- Fish community assessment: The results indicate that Upper McCoy Branch is under severe stress:
    - No fish populations were found above Rogers Quarry; and
    - Downstream sunfish populations had high percentages of deformed heads and eroded fins.
- Benthic Macro-invertebrate Community Assessment: The results were indicative of moderate stress. The stress appears to be habitat alteration as a result of ash deposition within the stream channel and possibly leaching of potential toxicants from the ash.

The conclusions for the RI biological monitoring programs were as follows:

- Toxicity testing: The results did not show toxic conditions in Upper McCoy Branch.
- Benthic Macro-invertebrate Assessment: The results exhibited no strong evidence of impact at Upper McCoy Branch. There were some differences in July samples, which could be due to natural variations between the two locations, or could be due to low flow conditions increasing concentrations of contaminants from the ash.
- Soil (ash) Invertebrate Study: No invertebrates were found in samples from the sluice channel area or the FCAP, indicating this is not a possible pathway for contamination of the food chain.
- Bioaccumulation Studies:
    - Vegetation: The results show that selenium uptake into plants is a possible source of exposure to soil invertebrates and small mammals.
    - Small mammals: The study found higher concentrations of arsenic, selenium and lead in animals from the FCAP than in animals from a reference site.

A remedial action was conducted to stabilize the filled coal ash pond, McCoy Bridge dam holding contaminated pond sediments in place. A wetland, removed during stabilization activities, was re-constructed as part of the remedial action. Physical work was completed in March 1997. The remedial action report was approved in May 1997[47].

Basis for Consideration as a Proven Damage Case: This case has been categorized as a proven ecological damage case based on scientific documentation of impacts to fish and other wildlife on-site. This case has also been categorized as a potential (human health) damage case based on (1) Scientific basis - Exceedances of primary and secondary MCLs were detected in on-site monitoring locations, and (2) Administrative grounds - Federal RCRA and the Tennessee Department of Environmental Conservation (TDEC) requirements, including placement of the entire Oak Ridge Reservation on the NPL.

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[47] http://www.epa.gov/region4/waste/npl/npltn/oakridtn.htm

10. South Carolina Electric & Gas Canadys Plant, South Carolina[48]

History: This facility is a coal-fired power plant located along the Edisto River approximately 10 miles south of St. George, South Carolina. Ash from the power plant is mixed with water and managed in an ash storage pond. The facility operated an unlined, 80-acre ash pond from 1974 to 1989. A new, 95-acre ash pond lined with a bentonite slurry wall began operation in 1989.

Since 1982, arsenic has consistently been found in monitoring wells surrounding the old ash pond at levels above the MCL. Nickel also has occasionally been found above a State standard in a single monitoring well adjacent to the old ash pond. Because of these results, DHEC required the facility to delineate the extent of the contamination surrounding the old ash pond. The contamination was found to extend beyond the original property boundary of the facility, but the operator was allowed to buy neighboring property under State policy at the time. The investigation also showed that the contamination was not reaching the Edisto River and that its vertical extent was limited by a confining geologic unit 15 to 30 feet below the property. The facility is currently deactivating the old ash pond, with ash being removed and sold to a cement company. DHEC concluded that further migration of contaminants was not likely given the ground water conditions and the ongoing deactivation. In 1996, therefore, DHEC approved a mixing zone with ongoing monitoring around the old ash pond. The mixing zone establishes a compliance boundary around the old ash pond. Arsenic concentrations above the MCL are permitted within the mixing zone, but not at or outside of the compliance boundary.

The new ash pond extends beyond the compliance boundary of the old ash pond. Sampling in May 2000 found arsenic above its MCL at, and external to, the compliance boundary in wells that are adjacent to the new ash pond. Resampling in June 2000 confirmed the noncompliance. The facility's engineering contractor and DHEC suspect this arsenic contamination is associated with a separate plume originating from the new ash pond. DHEC suspects improper anchoring or a breach of the slurry wall surrounding the new ash pond. Based on a geophysical investigation, the facility's engineering contractor concluded that the slurry wall appears to have failed in various locations, allowing multiple seeps. The contractor noted that drought-like conditions during the preceding three years have caused a site-wide decrease in the water table. The increase in potentiometric head between the new ash pond and the falling water table may be a contributing factor to the breaches in the slurry wall. The facility has proposed additional monitoring to delineate the extent of the new arsenic plume and an extension of the compliance boundary to encompass the new ash pond. The facility also is evaluating possible corrective action alternatives for repairing or replacing the slurry wall. The extent of the new plume has not yet been fully delineated and DHEC has not yet determined what response may be required of the facility.

This site was initially classified as indeterminate because there was no information on the extent of the contamination (on-site or off-site), quantitative data on whether arsenic levels exceeded State standards, or confirmation that the contamination was attributable to fossil fuel combustion waste. In a follow-up assessment conducted after the Regulatory Determination, a representative

[48] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

from South Carolina's Department of Health and Environmental Control (DHEC) confirmed that there is arsenic contamination attributable to two coal combustion waste (CCW) management units at this site. According to the DHEC contact, it is unlikely that there are any ground water supply wells or other human exposure points in the vicinity of the facility. Furthermore, ground water supply wells in the region typically are drilled beneath the underlying confining geologic unit.

Basis for Consideration as a Proven Damage Case: Scientific - There are exceedances of the health-based standard for arsenic at this site. While there are no known human exposure points nearby, some recent exceedances have been detected outside an established regulatory boundary.

11. Belews Lake, North Carolina[49]

History: This Lake was impounded in the early 1970s to serve as a cooling reservoir for a large coal-fired power plant. Fly ash produced by the power plant was disposed in a settling basin, which released selenium-laden effluent in return flows to the Lake. Due to the selenium contamination, 16 of the 20 fish species originally present in the reservoir were entirely eliminated, including all the primary sport fish. The pattern of selenium contamination from the plant and fish impacts persisted from 1974 to 1985. In late 1985, under mandates from the State of North Carolina, the power company changed operations for fly ash disposal, and selenium-laden effluent no longer entered the Lake.

A fish advisory was issued for selenium in 1993 which was rescinded December 31, 2000[50].

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven ecological damage case for the following reasons: (1) Scientific evidence of extensive impacts on fish populations due to direct discharge to a surface water body, and (2) Administrative - The State required changes in operating practices to mitigate the contamination.

12. U.S. Department of Energy Savannah River Project, South Carolina[51]

History: The Savannah River Project commenced operations and disposal of ash in 1952. At this site, a coal-fired power plant sluices fly ash to a series of open settling basins. A continuous flow of sluice water exits the basins, overflows, and enters a swamp that in turn discharges to Beaver Dam Creek. Observations of bullfrogs of all developmental stages in the settling basins and swamp suggest that the mixture of pollutants that characterize the site does not prevent

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[49] Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[50] http://134.67.99.49/scripts/esrimap.dll?Name=Listing&Cmd=NameQuery&Left=-178.215026855469&Right=-52.6202812194824&Top=83.1083221435547&Bottom=-14.3755550384521&shp=3&shp=6&idChoice=3&loc=on&NameZoom=NC%20-%20Belews%20Lake

[51] Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

completion of the life cycle. However, bullfrog tadpoles inhabiting the site have oral deformities and impaired swimming and predator avoidance abilities. There also is evidence of metabolic impacts on water snakes inhabiting the site.

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven ecological damage case for the following reasons: (1) Scientific evidence of impacts on several species in a nearby wetland caused by releases from the ash settling ponds.

13. Dairyland Power Cooperative E.J. Stoneman Generating Station Ash Disposal Pond, Wisconsin[52]

History: This facility is an unlined pond that managed ash, demineralizer regenerant, and sand filter backwash from the 1950's until 1987. During the facility's operating life, ground water monitoring of on-site wells around the pond found cadmium and chromium in excess of primary MCLs and sulfate, manganese, iron, and zinc in excess of secondary MCLs. Nearby private drinking water wells showed levels of sulfate and boron elevated from background. As a result, the State concluded that other constituents could reach the drinking water wells in the future.[53] Because of the evidence of ground water contamination and because the facility violated State location standards, the State denied the operator's proposal to continue operation of the pond. The State also required the operator to close the facility and provide alternative drinking water to the affected residences. The history of contamination also led the State to require a new landfill on the site to be constructed with a double liner and leachate collection.

In addition to being unlined, the unconsolidated soils beneath the site consist of highly permeable sand and gravel (estimated permeability of 10^{-2} cm/sec). The pond was located close to the Mississippi River, in violation of the State's requirement for 300 feet of separation from navigable rivers. The proximity to the river caused variable water table levels and periods of ground water mounding, during which the depth of ground water beneath the unit was very shallow (possibly as low as 1 foot). Finally, the pond was located closer to 15 water supply wells than allowed by State standards.

Basis for Consideration as a Proven Damage Case: EPA identified this site as a proven damage case in the March 1999 Report to Congress. It is described in detail in the Report and supporting technical background documents in the rulemaking docket. EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific - Cadmium and chromium exceeded (health-based) primary MCLs, and contamination migrated to nearby, private drinking water wells; and (2) Administrative - The State required closure of the facility.

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[52] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[53] More recent monitoring data confirm this conclusion, with cadmium exceeding the primary MCL and iron and manganese exceeding secondary MCLs in the drinking water wells.

14. WEPCO Highway 59 Landfill, Wisconsin[54]

History: This site is located in an old sand and gravel pit and received fly ash and bottom ash between 1969 and 1978. Ground water monitoring between 1988 and 1998 found sulfate, boron, manganese, chloride, and iron above the State's Enforcement Standards (ES) and arsenic above the State's Preventive Action Level (PAL) in nearby private wells. Other down-gradient monitoring wells showed sulfate, boron, iron, and manganese in excess of the ES and selenium and chloride in excess of PALs. State agency staff considered this site one of the most seriously affected coal ash sites in the State. The State required a continuation of monitoring at this closed facility in 1982 and an investigation into ground water contamination in 1994.

The facility is unlined and the soil underlying the site consists of fine to coarse sands and gravel with minor amounts of silt and clay and is believed to be relatively permeable. The original sand and gravel pit included an area of standing water. The presence of the standing water is attributed to the elevation of the ground water table exceeding the base of the pit in this area. Waste was disposed directly into this area to a depth of 5 to 10 feet below the water table. (Note also that the facility is located in close proximity to a wetland, although there is no documentation of impact to flora in the wetland.)

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven damage case of the following reasons: (1) Scientific - Although the boron standard was not health-based at the time of the exceedances, the boron levels reported for the facility would have exceeded the State's recently promulgated health-based ES for boron; and contamination from the facility appears to have migrated to off-site private wells; and (2) Administrative - As a result of the various PAL and ES exceedances, the State required a ground water investigation.

15. Alliant (formerly Wisconsin Power & Light) Nelson Dewey Ash Disposal Facility, Wisconsin[55]

History: This facility was originally constructed in the early 1960's as a series of settling basins for sluiced ash and permitted by the State in 1979. Waste disposal at the site resulted in exceedances of the State's Preventative Action Levels (PALs) for arsenic, selenium, sulfate, boron, and fluoride. These exceedances occurred within the design management zone of the facility. Waste disposal also has resulted in exceedances of the State's Enforcement Standards (ES) for boron, fluoride, and sulfate outside the design management zone of the facility. As a result of these exceedances, the State required an investigation of ground water contamination in 1993. In 1996, the facility began converting to dry ash management and covering/closing phases of the facility.

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[54] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[55] Ibid.

Soil underlying the site consists of unconsolidated glacial outwash deposits of relatively high permeability (estimated between 10^{-2} and 10^{-5} cm/sec). The facility is not only unlined, but was originally designed to allow sluiced liquids to infiltrate to ground water, with direct discharge to surface water occurring only occasionally. For much of their life, the basins operated with a relatively high hydraulic head. In fact, in 1986, the facility began using direct discharge to reduce the hydraulic head in response to PAL exceedances for sulfate. This combination of conditions resulted in a ground water mound beneath the ash disposal area. While depth to ground water at the site is generally approximately 10 feet, the height of the ground water mound was estimated at 5 to 8 feet, resulting in an estimated effective depth to ground water of only 2 to 5 feet underneath the disposal area.

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific - Although the boron standard was not health-based at the time of the exceedances, the boron levels reported for the facility would have exceeded the State's recently promulgated health-based ES for boron; and (2) Administrative - As a result of the various PAL and ES exceedances, the State required a ground water investigation, and the facility took action to remediate ground water contamination and prevent further contamination.

16. WEPCO Cedar-Sauk Landfill, Wisconsin[56]

History: This facility is an abandoned sand and gravel pit that received coal combustion waste from the WEPCO Port Washington Power Plant from 1969 to 1979. After closure of the facility, ground water monitoring revealed exceedances of the primary MCL for selenium, the State standard for boron, and the secondary MCL for sulfate. Vegetative damage resulting from boron uptake also was observed in a nearby wetland. Presumably, this damage is the result of ground water migration to the wetland. As a result, the State required installation of relief wells to confine and remediate the contamination plume and installation of an upgraded cover at the site. The facility is not only unlined, but was constructed over shallow ground water[57] in highly permeable (10^{-3} to 10^{-2} cm/sec) media. Some time after closure, the water table rose, saturating portions of the ash fill. Furthermore, the original soil cover installed at closure -- less than 2 feet in places -- was found to be insufficient. Finally, the site was located in close proximity to a wetland.

EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants and analyzed it further in the supplemental analysis conducted for its 1993 Regulatory Determination[58]. This case was not counted as a

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[56] Ibid.

[57] Quantitative data on the original depth to ground water are not available, but documentation on the site reports that the water table was near the base of the original pit.

[58] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA., July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

proven damage case in the 1999 Report to Congress, however, because there was no evidence of comanagement of low-volume wastes at the site.

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific - Selenium in ground water exceeded the (health-based) primary MCL, and there was clear evidence of vegetative damage; and (2) Administrative - The State required remedial action.

17. Wisconsin Electric Power Co. (WEPCO) Port Washington Facility, Wisconsin[59]

History: Originally, the commenters identified this Wisconsin site in a table that alleged fly ash contaminated several drinking water wells with boron and selenium. Following a preliminary evaluation by the EPA, this site was initially classified as indeterminate because (i) the commenters did not identify the source of the information, and (ii) No quantitative data or further information about this site was available.

In the course of reassessment conducted following the Regulatory Determination, a copy of the original Water Well Journal article cited by the commenters was obtained from the National Ground Water Association (NGWA). The article presented instances in which boron and selenium concentrations exceeded standards in a well located down-gradient of the CCW disposal site. Contact was established with Wisconsin Department of Natural Resources (DNR) Waste Management Program. The DNR representative reported that the site affects a residential, private water well supply. He located the well at about 250 feet south of an old quarry that was filled to 40-60 feet in depth with fly ash from the Wisconsin Electric Power Company. The power company placed fly ash in the quarry from 1948-1971, so the ash had been there at least 20 years prior to the contamination described by the article.

In lieu of providing up-gradient well monitoring data, the DNR representative stated with certainty that in his best professional judgment the boron levels reported for the well are not naturally occurring. He also is confident that the contaminants come from the quarry because of the proximity to the monitoring well. He added that boron is characteristic of coal ash and that geologically there is no naturally-occurring source in that area of Wisconsin that would produce boron levels that high. However, he was not aware that a boron standard existed at the time of the exceedances. He reiterated that the selenium concentration exceeds the selenium standard reported in the article. Based on today's standard of 50ug/L, the levels of selenium reported would not be considered a compliance problem.

Based on the information provided by the State, contamination from this facility appears to have migrated to off-site private wells. Documentation to confirm this analysis was received in the form of a laboratory report from the State Laboratory of Hygiene. Samples collected at the John & Dolly Keating Port Washington Sample Tap Pit (an off-site drinking water well) showed very high concentrations of boron. Although the State did not have a health-based standard for boron at the time of the exceedances, the boron levels reported for the facility would have exceeded the State's recently promulgated health-based enforcement standard for boron. Samples collected

[59] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

also showed elevated selenium concentrations, but the levels detected would not exceed the current primary MCL.

Basis for Consideration as a Proven Damage Case: This case is categorized as a proven damage case based on a scientific observation - The off-site exceedance of a health-based standard for selenium, caused by the fact that the site is an unlined former sand and gravel quarry and is in close proximity to drinking water wells.

18. Lansing Board of Water & Light (LBWL) North Lansing Landfill, Michigan[60]

History: The North Lansing Landfill (NLL), a former gravel quarry pit, was licensed in 1974 for disposal of inert fill materials including soil, concrete, and brick. From 1980 to 1997, the NLL was used for disposal of coal ash from the Lansing Board of Water and Light (LBWL) electric and steam generating plants. The NLL has three disposal areas, two of which were used for coal ash disposal. Filling of Area I ceased in 1988 and a temporary cover was placed over the ash. Area III was the active disposal area from 1988 to January 1997. A temporary cover was placed over Area III in September 1998 and grass was planted on this cover. Area II was not actively used for disposal, although some ash has washed into this area. Since 1992, Area II has usually contained standing water from on- and off-site storm water runoff.

Among the damages that commenters alleged existed at this site were down-gradient selenium and arsenic exceeding their MCLs and down-gradient sulfate greater than "allowable water quality standards." The commenters also stated that an adjacent municipal well field is "threatened."

The site owner claimed that sulfate contamination is due to wastes other than fly ash in the landfill or else is due to off-site sources. The Michigan Department of Environmental Quality (MDEQ) confirmed in writing that ground water contamination had occurred at this historic landfill, which was constructed before current State regulations were in place. The site was eventually closed because the inadequate control of contamination violated current regulatory requirements. According to the letter, the NLL was forced to take remedial action to address the contamination.

This site was initially classified as indeterminate because (i) the documents and quantitative data supporting the alleged damages were not available; (ii) information was needed to positively identify the source of the contamination; and (iii) more information was needed to describe the extent of ground water contamination and to establish whether this contamination extends off-site.

In an effort to reassess this alleged damage case, EPA's contractor contacted MDEQ and found that this site was in the process of a Remedial Investigation (RI) and Feasibility Study (FS). The following information is based on the RI Report, published in May 1999 and revised in December 1999.

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[60] Ibid.

There are two aquifers beneath the NLL. The upper aquifer is highly permeable, but is not used for drinking water. The lower aquifer (the Saginaw), however, supplies the City of Lansing with drinking water. Fill underlying the ash has lower hydraulic conductivity than the underlying aquifer, but does not constitute a liner. The underlying fill has settled in places and the water table has risen, so that lower portions of the ash are now saturated in Areas I and III. The standing water in Area II has merged with ground water, forming a mound in the water table. According to the Lansing Board of Water and Light North Lansing Landfill Remedial Investigation Report (the RI Report), this mounding effect likely extends laterally into the ash, thereby increasing the saturated ash thickness, and consequently the volume of ash subject to leaching in Areas I and III. Because of the rise in the water table, the facility no longer meets the State's requirement for a 4-foot isolation distance between wastes and ground water. Moreover, in mid- to late-1993, abrupt increases were observed in sulfate and selenium concentrations in an on-site monitoring well. As a result, LBWL was required to perform a remedial investigation and feasibility study. The RI Report concluded that the timing of the increase in contamination indicated that leachate released from the saturated fly ash was the source of the contamination.

The objectives of the RI included characterization of site conditions, definition of the nature and extent of ground water impacts, and estimation of future migration. This analysis is complicated by the presence of other known or potential sources of ground water contamination both up-gradient and down-gradient of the NLL site. Therefore, the remedial investigation used statistical comparisons (i.e., tolerance intervals calculated from up-gradient and background monitoring data) to delineate ground water impacts from the NLL. Ground water concentrations were compared to Michigan's Part 201 criteria. The Part 201 standards for ground water identify contaminant concentrations that are safe for long-term, daily consumption. The investigation's statistical analysis, modeling results, and conclusions form the basis for the analysis of the NLL as a damage case.

For a variety of reasons, the RI Report concluded that boron, iron, pH, strontium, selenium, and sulfate are of little concern. The RI Report concluded that the constituents of the most concern are lithium, manganese, and potassium. Based on statistical analysis and consideration of site-specific factors, however, the following cannot be conclusively linked to the NLL: boron, iron, pH, and sulfate. Of the remaining contaminants of concern:

- Lithium appears to be attributable to the NLL and concentrations are above health-based standards off-site;
- Manganese contamination on-site appears to be attributable to the NLL and concentrations are above non-health based-standards. (Note that off-site concentrations of manganese also are above non-health-based standards, but do not appear to be attributable to the NLL);
- Potassium appears to be attributable to the NLL, but has no regulatory standard;
- Selenium appears to be attributable to the NLL and concentrations are above health-based standards on-site, but not off-site;
- Strontium appears, based on statistics, to be attributable to the NLL, but concentrations are below health based standards.

Basis for Consideration as a Proven Damage Case: This site was classified as a proven damage case based on a scientific observation of off-site exceedances of the State's health-based standard

for lithium. The exceedance was caused by the fact that the site is an unlined former gravel quarry with an elevated ground water table leading to ground water contact.

19. Northern Indiana Public Service Corp. (NIPSCO) Yard 520 Landfill Site (Brown's Landfill) Township of Pines, Porter County, IN[61]

History: NIPSCO's Bailly and Michigan City power plants have deposited an estimated 1 million tons of fly ash in the Town of Pines since 1983. Fly ash was buried in the landfill and used as construction fill in the town. The ash is pervasive on site, visible in roads and driveways[62].

Pines is located near the Indiana Dunes National Lakeshore, about 2 miles south of Lake Michigan. This is a region of sand dune ridges which separate low-lying, poorly drained wetland areas. The soil is very sandy, unconsolidated, highly-acidic, and with a high organic content. These sands overlie a less permeable clay-rich unit. The ground water flows in a northerly direction from the Yard 520 landfill toward the town[63].

In April 2000, Indiana DEM received a complaint from a Pines resident that water from her private well tasted foul. IDEM conducted sampling and found residential wells contaminated with elevated levels of benzene, arsenic, manganese, and VOCs including benzene. In 2001, EPA's Superfund program conducted a preliminary assessment and site investigation, and found elevated levels of MTBE, boron, manganese, and molybdenum. In January 2002, IDEM recommended the site for EPA's National Priorities List[64].

Additional site investigations indicate that the Pines Yard 520 Landfill site is the likely source of contamination of residential water wells, caused by leaching of heavy metals (manganese, boron, molybdenum, arsenic, lead) from fly ash that was buried in the landfill and used as construction fill. The presence of elevated levels of contaminants that are not associated with coal ash, such as volatile organic compounds (VOCs) and MTBE, indicate that there are additional sources of contamination that are not related to coal ash[65].

EPA and the responsible parties signed an Administrative Order of Consent effective January 2003 to cover costs of connecting the affected areas to Michigan City's water system (USEPA 2003a). In April 2004, EPA and IDEM negotiated an Administrative Order of Consent with the

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[61] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[62] Tim Drexler, Remedial Project Manager, telephone communications with Bonnie Robinson, USEPA. June 5, 2003.

[63] Final Site Investigation Report on Ground water Contamination, Township of Pines, Porter County, Indiana. December 2002.

[64] EPA Announces Investigation Results at Pines Site (Fact Sheet). January 2003.

[65] Final Site Investigation Report on Ground water Contamination, Township of Pines, Porter County, Indiana. December 2002.

responsible parties for continued work at the site[66]. . In January 2004, the Hoosier Environmental Council, Inc. filed a complaint for declaratory and injunctive relief against NISOURCE, the parent company of NIPSCO (U.S. District Court).

Basis for Consideration as a Proven Damage Case: This site was classified as a proven damage case based on (1) Scientific evidence for boron, molybdenum, arsenic and lead exceeding health-based standards in water wells away from the Pines Yard 520 Landfill site, and (2) Administrative Orders of consent signed between the EPA and IDEM with responsible parties for continued work at the site.

20. Brandy Branch Reservoir, Texas[67]

History: This case was originally identified by a public interest group in a table alleging selenium and chromium contamination, and a selenium fish consumption advisory[68].

The Brandy Branch Reservoir is a power plant cooling reservoir built in 1983 for Southwestern Electric Power Company's Pirkey Power Plant. The cooling reservoir received discharges from ash ponds containing elevated levels of selenium, resulting in increased selenium concentrations in fish from the reservoir. From 1986 to 1989, the Texas Parks and Wildlife Department reported that average selenium concentrations in fish from the Brandy Branch Reservoir increased from 0.81 to 2.29ppm[69]. In 1992, the Texas Department of Health (TDH) issued a fish consumption advisory for the reservoir[70].

The advisory recommended that adults consume no more than eight ounces of fish from the reservoir per week; children seven years and older - no more than four ounces/week; and children under six and pregnant women or women who may become pregnant should not consume any fish from the reservoir. In 1996 and 1997, TDH collected 17 fish from the reservoir. Selenium concentrations in these fish ranged between 0.46 and 1.79ppm, with an average concentration of 0.87ppm (ATSDR 1998).

A total maximum daily load (TMDL) project has been initiated by the Texas Commission on Environmental Quality (TCEQ) to determine the necessary steps to improve water quality in Brandy Branch reservoir. The project involved a fish sampling and analysis program and a

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[66] http://www.epa.gov/region5/sites/pines/

[67] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[68] Letter from the Hoosier Environmental Council to the RCRA Docket Information Center regarding comments on the May 2000 Regulatory Determination, September 19, 2000.

[69] Agency for Toxic Substances and Disease Registry (ATSDR), 1998. Health Consultation: Brandy Branch Reservoir, Marshall, Harrison County, Texas. September 1998. Available at http://www.atsdr.cdc.gov/HAC/PHA/marshall/mar_toc.html.

[70] Texas Bureau of Health (TBH). 1992. Fish Advisory: Brandy Branch Reservoir. May 1992.

human health risk assessment, and was completed in August 2003[71]. Based on its findings, The Texas Commissioner of Health fish advisory was lifted in March 2004[72].
Basis for Consideration as a Proven Damage Case: This case is categorized as a proven ecological damage case for the following reasons: (1) Observations of impacts on fish populations were confirmed by scientific study, based on which the State concluded that the impacts were attributable to the ash ponds; and (2) Administrative - The State issued a fish consumption advisory as a result of the contamination.

21. Southwestern Electric Power Company Welsh Reservoir, Texas[73]

History: This Lake was constructed in 1976 to serve as a cooling reservoir for a power plant and receives discharges from an open ash settling pond system. The Texas Parks and Wildlife Department's (TPWDs) monitoring program documents elevated levels of selenium and other metals in fish. In 1992 the Texas Commissioner of Health issued a fish consumption advisory for selenium similar to the one issued for the Brandy Branch Reservoir described above[74]. The TPWD's report concludes that "discharges from the open ash settling ponds may be a source for the elevated levels of selenium in fish." The Texas Commissioner of Health fish advisory was lifted in March 2004[75].

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven ecological damage case for the following reasons: (1) the State concluded that, based on scientific evidence, selenium accumulation in fish may be attributable to the ash settling ponds; and (2) Administrative - The State has issued a fish consumption advisory as a result of the contamination.

22. Texas Utilities Electric Martin Lake Reservoir, Texas[76]

History: This Lake was constructed in 1974 to serve as a cooling reservoir for a power plant and was the site of a series of major fish kills in 1978 and 1979. Investigations determined that unpermitted discharges from ash settling ponds resulted in elevated levels of selenium in the

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[71] Texas Commission on Environmental Quality (TCEQ). 2003. Improving Water Quality in Brandy Branch Reservoir; One TMDL for Selenium. February 2003.

[72] Assessing the Fish Consumption Use, Water Quality in Brandy Branch Reservoir, TCEQ, March 2004.

[73] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[74] http://www.tceq.state.tx.us/implementation/water/tmdl/14-welshreservoir.html

[75] Assessing the Fish Consumption Use, Water Quality in Welsh Reservoir, TCEQ, March 2004.

[76] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

water and fish. The State's monitoring program continues to document elevated levels of selenium and other metals in fish at the Lake. The Texas Commissioner of Health issued a fish consumption advisory for this Lake similar to the one issued for the Brandy Branch Reservoir described above in 1992[77]. There also is evidence of elevated selenium concentrations in birds nesting near the Lake. The Texas Commissioner of Health fish advisory was lifted October 14, 2004[78].

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven ecological damage case for the following reasons: (1) Scientifically based evidence of adverse effects on wildlife - impacts on fish populations were observed, and the State concluded that the impacts were attributable to the ash setting ponds; and (2) Administrative - The State has issued a fish consumption advisory as a result of the contamination.

23. Basin Electric Power Cooperative W.J. Neal Station Surface Impoundment, North Dakota[79]

History: This site was an unlined, 44-acre surface impoundment that received fly ash and scrubber sludge from a coal-fired power plant, along with other wastes (including ash from the combustion of sunflower seed hulls), from the 1950's until the late 1980's. Sampling in 1982 found chromium at 8.15 parts per million in the pond sediment and in excess of the primary MCL in down-gradient ground water. The State issued a special use disposal permit to allow disposal to continue, but required a continuation of monitoring and began negotiations for closure of the site. The facility was closed between 1989 and 1990, when the impoundment sediments were consolidated to a 22-acre area and capped. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the site underwent a preliminary assessment (PA) in 1990 and a site inspection (SI) in 1995. The PA found sediments in a marshy area adjacent to the closed facility with antimony, arsenic, chromium, manganese, selenium, and sodium elevated above background. The PA also found arsenic in excess of the primary MCL and aluminum in excess of the secondary MCL in down-gradient ground water. The SI found arsenic elevated above background in the marsh sediments and in surface water passing through the wetland. The SI also found cadmium and lead in excess of primary MCLs and zinc in excess of the secondary MCL in a public water supply well. The SI concluded that releases had occurred from the surface impoundment to ground water and surface water.

Soils underlying the facility are characterized by one source as relatively permeable (10^{-4} cm/sec). Regionally, the surficial aquifer varies in depth from 3 to 25 feet below the surface. While a precise mapping of the water table at the site is not available, the SI characterizes ground water beneath the closed, unlined impoundment as "very shallow." Other information in the literature confirms this and possibly suggests ground water may directly contact the disposed material, specifically:

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[77] http://www.tceq.state.tx.us/implementation/water/tmdl/12-martincreekreservoir.html

[78] Assessing the Fish Consumption Use, Water Quality in Martin Creek Reservoir, TCEQ, March 2004.

[79] Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

- Depth to water in the monitoring wells surrounding the facility ranges from 5.5 to 16 feet, while the depth of the ash fill is estimated at approximately 10 feet.
- According to the PA, regionally, "many lakes and potholes represent "windows" into the water table ..." and an on-site pond located directly up-gradient and adjacent to the disposal area may be "a surface expression of the ground water onsite."

Additionally, the site was operated without any control of surface waters from the impoundment. A tributary to the marsh and a nearby creek formerly flowed through the ash disposal areas. Even as late as 1989, surface water ran directly off the site from the surface impoundment dike into the marsh. This direct discharge was not documented as being permitted under State or Federal regulations.

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific investigation - Several constituents have exceeded their (health-based) primary MCLs in down-gradient ground water, and the site inspection found documentation of releases to ground water and surface water from the site; and (2) Administrative - The State required closure of the facility.

24. Cooperative Power Association/United Power Coal Creek Station Surface Impoundments, North Dakota[80]

History: This site includes a number of evaporation ponds and ash storage/disposal ponds that were constructed in 1978 and 1979. The ponds were originally lined but developed severe leaks in the late 1970's. The ponds are operated as a zero discharge facility. While quantitative data on the depth to ground water are not available, documentation from the State agency indicates that the ponds were constructed "directly over and adjacent to" the Weller Slough Aquifer, suggesting the presence of shallow ground water. Ground water monitoring at the site showed arsenic in excess of the primary MCL in 1987 and selenium in excess of the primary MCL in 1992 and 1993. Down-gradient monitoring data also have shown sulfate and chloride above secondary MCLs and elevated levels of boron. In the facility's 1990 permit application, the State required relining of the ponds with a composite liner.

Basis for Consideration as a Proven Damage Case: EPA has categorized this case as a proven damage case for the following reasons: (1) Scientific evidence - Arsenic and selenium exceeded (health-based) primary MCLs, and (2) Administrative - The State required remedial action.

[80] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

Potential Coal Combustion Waste Damage Cases

III. Potential Damage Cases

According to 65 FR 32224, "Potential damage cases were those with documented MCL exceedences that were measured in ground water beneath or close to the waste source. In these cases, the documented exceedences had not been demonstrated at a sufficient distance from the waste management unit to indicate that waste constituents had migrated to the extent that they could cause human health concerns. State regulations typically use a compliance procedure that relies on measurement at a receptor site or in ground water at a point beyond the waste boundary (e.g., 150 meters)." In addition, groundwater contamination would be considered as a potential damage case also where there are documented exceedances of secondary MCLs or other non-health based standards on-site or off-site.

25. K.R. Rezendes South Main Street Ash Landfill, Freetown, Massachusetts[81]

History: This case was originally identified through contacts with State regulators.

This site consists of an ash monofill located in a former sand and gravel quarry located in Freetown, Massachusetts. The landfill began operation in 1976 and has an area of approximately 35 acres. It was originally approved as a 14-acre monofill by the Freetown Board of Health and by permit from the MADEP. The Board of Health granted approval for the remaining 21 acres in 1990, and approved a request for expansion to within 250 feet of Assonet Bay in 1993. The final permit for the site was issued by MADEP in 1994.

The site accepted ash from PG&E's Salem Harbor (approximately 250,000 tons/year) and Brayton Point Plants (approximately 140,000 tons/year). According to PG&E estimates, a total of 2,500,000 tons of ash have been disposed at the K.R. Rezendes South Main Street Ash Landfill.

Ground water monitoring at the site has detected levels of selenium above the primary MCL. Elevated levels of sulfates, total dissolved solids, manganese, iron, and aluminum have also been detected at the site, although levels are below the relevant secondary MCLs. All of the monitoring wells at the site are located on-site. There are no down-gradient drinking water sources, because the landfill is adjacent to a down-gradient water body (Assonet Bay), which is not used as a drinking water source due to its brackish water.

In early 2001, MADEP required modifications to the ground water monitoring program, including:

- Increase in sampling from annual to semi-annual;
- Semi-annual surface water sampling;
- Evaluation of wells to ensure the wells yield representative samples;
- Installation of additional monitoring wells; and

[81] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

- Evaluation of ground water discharge to the adjacent Assonet Bay.

Operations at the landfill ended in 2001 as the result of a bylaw passed by the Town of Freetown. The bylaw bans the disposal of coal combustion wastes within the town. It was appealed by the landfill operator and PG&E, but upheld by the State Attorney General.

Basis for Consideration as a Potential Damage Case: This case has been categorized as a potential damage case for the following reasons: (1) Scientific - Selenium exceeded its primary MCL in on-site monitoring wells; and (2) Administrative - The State required modification to the site's ground water monitoring program.

26. New England Power, Brayton Point, Massachusetts[82]

History: Associated with the largest coal- and oil- powered generating station in New England, this is one of nine sites managing oil combustion wastes that have ground water contamination identified for the 1999 Report to Congress. Seven of the nine, including this site, were documented in EPRI's oil ash report; the two other sites were found in the 1993 Regulatory Determination and in RCRA Corrective Action records. Most of the nine sites evaluated were solid settling basins, while one site had a landfill and a second site had a solids disposal pond. At each of the nine sites, the waste management unit was found to negatively impact ground water in one of the following ways: (1) at least one constituent was found in down-gradient ground water monitoring wells above its MCL, but was not present in up-gradient wells above its MCL, or (2) a constituent exceeded its MCL both up-gradient and down-gradient, but the down-gradient concentrations were noticeably higher than the up-gradient concentrations. These constituents most often include manganese and nickel. Other parameters (including arsenic, cadmium, chromium, selenium, silver, and zinc) exceeded their MCL in down-gradient wells at only one of the sites. Although vanadium does not have an MCL, the parameter was found in ground water down-gradient of waste management units.

At several of the sites reviewed, EPA found that the waste management unit very likely contributes to the contamination of constituents, such as manganese, nickel, and vanadium, into ground water. Many of these sites are located next to the ocean or other large bodies of water where such releases can be diluted and no drinking water wells would be located between the management unit and the surface water. EPA did not find any cases of drinking water contamination or other environmental damages resulting from these releases. Additionally, most or all unlined units are operated under state permit allowing exceedances of ground water standards close to the management unit, but which must be met outside the zone of discharge.

Basis for Consideration as a Potential Damage Case: This case has been categorized as a potential damage case for the following reasons: exceedance of one or more MCL standards

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[82] Technical Background Document for the Report to Congress on Remaining Wastes from Fossil Fuel Combustion: Potential Damage Cases, March 15, 1999 (http://www.epa.gov/epaoswer/other/fossil/ffc2_397.pdf). Status of Alleged Damage Cases Submitted by HEC, et. al., to Dennis Ruddy, February, 2002. Brayton Point Administrative Consent Order (ACO-BO-00-2002, undated), Brayton Point Administrative Consent Order Timetable, August 22, 2006.

down flow from the plant's unlined wastewater treatment basins that does not impact drinking water wells offsite.

27. AES Creative Resources Weber Ash Disposal Site, New York[83]

History: Monitoring data at this site from between 1991 and 1998 show levels of sulfate, total dissolved solids, manganese, iron, aluminum, and pH in down-gradient wells in excess of their secondary MCLs. There is no information available on the location of these wells relative to the waste management units.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site: sulfate, total dissolved solids, manganese, iron, aluminum, and pH, are of non-health-based standards. Therefore, this case is a potential damage case.

28. Central Hudson Gas and Electric Corporation Danskammer Waste Management Facility, New York[84]

History: There were exceedances of State non-health-based standards for sulfate, sulfide, total dissolved solids, turbidity, iron, magnesium, manganese, sodium, boron, and pH attributable to CCW at the site. It is unclear whether the exceedances of health-based standards were attributable to CCW.

Basis for Consideration as a Potential Damage Case: The contamination at the site: sulfate, sulfide, total dissolved solids, turbidity, iron, magnesium, manganese, sodium, boron, and pH did not appear likely to threaten human health or the environment. Therefore, this case was determined to be a potential damage case.

29. C. R. Huntley Flyash Landfill, New York[85]

History: There were exceedances of State health-based standards for arsenic and non-health-based standards for iron, manganese, sulfate, and total dissolved solids at this site's down-gradient wells. While there also were exceedances in up-gradient wells, there was statistical evidence of significant increases over up-gradient concentrations for several of these constituents. In addition, the State regulatory agency and the site contractor identified some of these constituents as potential indicators of leachate.

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[83] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[84] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[85] Ibid.

Basis for Consideration as a Potential Damage Case: All of the exceedances were in wells located on-site, close to the waste management unit. Therefore, this case was determined to be a potential damage case.

30. Elrama Plant, Pennsylvania[86]

History: EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants. It is described in detail in that document. In the 1988 Report, EPA found concentrations of cadmium in down-gradient wells above the primary MCL; the highest concentrations were found in the well closest to the landfill. EPA concluded that coal combustion wastes have been a source of contamination at the site, but also concluded that exceedances for many contaminants were probably due to concurrent contamination from acid mine drainage.

Basis for Consideration as a Potential Damage Case: While levels of cadmium exceed the primary MCL, the contamination appears to be at least partially attributable to sources other than coal combustion wastes. Therefore, this case is a potential damage case.

31. Tennessee Valley Authority - Bull Run Steam Plant, Oak Ridge, Tennessee[87]

Basis for Consideration as a Potential Damage Case: This case was categorized as a potential damage case for the following reasons: (1) exceedances of the secondary MCLs for aluminum, calcium, iron, and sulfate were detected in on-site surface water; (2) a toxicity study indicates the potential for ecological impacts; and (3) these impacts appear to be directly attributable to CCW management.

32. Tennessee Valley Authority Widows Creek Fossil Fuel Plant, Alabama[88]

History: Monitoring data at this site show lead in excess of the primary MCL Action Level. This exceedance, however, occurred in an on-site well that appears to be opposite the direction of ground water flow. Still, in a 1993 memorandum, the Alabama Department of Environmental Management (ADEM) expressed concern with this exceedance and elevated levels of cadmium and chromium (which did not exceed their primary MCLs) in this well and recommended that corrective action measures be established.

Basis for Consideration as a Potential Damage Case: While the ADEM has expressed concern with on-site contamination and recommended that corrective action measures be established,

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[86] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[87] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[88] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

there is no evidence available of off-site migration of contaminants. Therefore, this case is a potential damage case.

33. Tennessee Valley Authority Colbert Fossil Fuel Plant, Alabama[89]

History: Only limited information on this site was available from the commenters. The commenters' summary of monitoring data shows no exceedances of primary MCLs in ground water at the site. The only primary MCL exceedances (for sulfate, chromium and selenium) reported by the commenters are found in a well installed within the saturated ash of the surface impoundment. A 1998 letter from the facility owner to the ADEM, however, does indicate some exceedances of primary MCLs in on-site wells that the owner proposes to eliminate from its sampling program. The only constituent identified in this letter is cadmium. The commenters report that ADEM believes ground water contamination has resulted from the disposal of coal combustion wastes at this facility. An ADEM geologist also reported to the commenters that the disposal area has been subject to collapse into a karst sinkhole.

Basis for Consideration as a Potential Damage Case: While some primary MCL exceedances (for sulfate, chromium and selenium) appear to have occurred in on-site wells, there is no evidence available of off-site migration of contaminants. Therefore, this case is a potential damage case.

34. Duke Power Allen Steam Generating Plant, North Carolina[90]

History: The Allen Plant of Duke Power Company was included in a study of waste disposal at coal-fired power plants conducted by Arthur D. Little, Inc (ADL) in 1985. ADL conducted ground water sampling in 18 monitoring wells installed on-site, detecting exceedances of manganese and iron, both secondary water quality standards.

Contact was made with North Carolina Department of Environment and Natural Resources (DENR). According to those contacted, the State has only surface water discharge information for this facility. There is no record of ground water monitoring at the facility, and no indication that violations or enforcement actions occurred at the facility. A permit check determined that ground water monitoring at the site is not required by the facility permit. There is no indication that any ground water samples have been tested since the 1985 study.

Basis for Consideration as a Potential Damage Case: According to the 1985 data, there were documented exceedances of manganese and iron, non-health-based standards, in wells downstream from the waste management unit. Therefore, this site is categorized as a potential damage case.

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[89] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. TVA Colbert ground water data, undated.

[90] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

35. Cinergy East Bend Scrubber Sludge Landfill, Kentucky[91]

History: Commenters identified this site in a table that alleged an estimated 300 tons of sulfate per year is leaking into the Ohio River from this site. This site was initially classified as indeterminate because the commenters did not identify the source of the information and no quantitative data or further information about this site was available.

Subsequently, additional information was obtained through the Kentucky Department of Environmental Protection (DEP). According to the DEP, there were on-site exceedances of non-health-based standards for total dissolved solids, iron, and sulfate at this site. The State has taken regulatory action based on these exceedances.

Basis for Consideration as a Potential Damage Case: Based on the on-site exceedances of non-health-based standards for total dissolved solids, iron, and sulfate at this site, and subsequent State regulatory action based on these exceedances, this case is a potential damage case.

36. Florida Power and Light Lansing Smith Plant, Florida[92]

History: EPA initially identified this site in the supplemental analysis conducted for its 1993 Regulatory Determination[93]. As a result of this analysis, EPA rejected this site as a damage case because there was no evidence that coal combustion wastes were comanaged with low-volume wastes at this site. A subsequent evaluation of the information for this site indicates that there were documented exceedances of primary drinking water standards for cadmium, chromium and fluoride and secondary drinking water standards for sulfate, chloride, manganese and iron in on-site ground water attributable to CCW.

Basis for Consideration as a Potential Damage Case: This site has been reclassified as a potential damage case Based on documented exceedances of primary drinking water standards for cadmium, chromium and fluoride and secondary drinking water standards for sulfate, chloride, manganese and iron in on-site ground water attributable to CCW.

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[91] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[92] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Status of Alleged Damage Cases Submitted by HEC, et. al., to Dennis Ruddy, February, 2002. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[93] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA. July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

37. Florida Power and Light Port Everglades Plant, Florida[94]

History: This is one of nine sites managing oil combustion wastes that have ground water contamination identified for the 1999 Report to Congress. Seven of the nine, including this site, were documented in EPRI's oil ash report; the two other sites were found in the 1993 Regulatory Determination and in RCRA Corrective Action records. Most of the nine sites evaluated were solid settling basins, while one site had a landfill and a second site had a solids disposal pond. At each of the nine sites, the waste management unit was found to negatively impact ground water in one of the following ways: (1) at least one constituent was found in down-gradient ground water monitoring wells above its MCL, but was not present in up-gradient wells above its MCL, or (2) a constituent exceeded its MCL both up-gradient and down-gradient, but the down-gradient concentrations were noticeably higher than the up-gradient concentrations. These constituents most often include manganese and nickel. Other parameters (including arsenic, cadmium, chromium, selenium, silver, and zinc) exceeded their MCL in down-gradient wells at only one of the sites. Although vanadium does not have an MCL, the parameter was found in ground water down-gradient of waste management units.

At several of the sites reviewed, EPA found that the waste management unit very likely contributes to the contamination of constituents, such as manganese, nickel, and vanadium, into ground water. Many of these sites are located next to the ocean or other large bodies of water where such releases can be diluted and no drinking water wells would be located between the management unit and the surface water. EPA did not find any cases of drinking water contamination or other environmental damages resulting from these releases. Additionally, most or all unlined units are operated under state permit allowing exceedances of ground water standards close to the management unit, but which must be met outside the zone of discharge.

Basis for Consideration as a Potential Damage Case: This case has been categorized as a potential damage case for the following reasons: exceedance of one or more MCL standards down flow from the plant's disposal facility that does not impact drinking water wells offsite.

38. Florida Power and Light Riviera Plant[95]

See the preceding description for the Port Everglades Plant.

39. Florida Power and Light P.L. Bartow Plant[96]

See the preceding description for the Port Everglades Plant.

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[94] Technical Background Document for the Report to Congress on Remaining Wastes from Fossil Fuel Combustion: Potential Damage Cases, March 15, 1999 (http://www.epa.gov/epaoswer/other/fossil/ffc2_397.pdf).

[95] Ibid.

[96] Ibid.

40. Commonwealth Edison Powerton Plant - Mahoney Landfill, Pekin, Tazewell County, Illinois[97]

History: This case was originally identified during the review of candidate damage cases for the 1988 Report to Congress on Wastes from the Combustion of Coal by Electric Utility Power Plants. Although it was rejected as a proven damage case in EPA's 1993 Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste (EPA 1993), this case was re-examined in light of EPA's subsequently developed criteria for categorizing cases as "potential" damage cases.

There were exceedances of primary MCLs for cadmium, lead, and nitrate and secondary MCLs for iron, manganese, and sulfate in ground water and surface water at the site. The exceedances of secondary MCLs in ground water appear attributable to management of CCW.

Basis for Consideration as a Potential Damage Case: All the reported exceedances that are attributable to management of CCW are for constituents with non-health-based standards and are located in on-site wells. Therefore, this case was categorized as a potential damage case.

41. Xcel Energy/Southern Minnesota Municipal Power Agency - Sherburne County (Sherco) Generating Plant Becker, Minnesota[98]

History: This case was originally identified during the review of candidate damage cases for the 1988 Report to Congress on Wastes from the Combustion of Coal by Electric Utility Power Plants. Although it was rejected as a proven damage case in EPA's 1993 Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste (EPA 1993), this case was re-examined in light of EPA's subsequently developed criteria for categorizing cases as "potential" damage cases.

There were exceedances of primary MCLs for arsenic, cadmium, chromium, fluoride, lead, and nitrate and secondary MCLs for chloride, copper, iron, manganese, sulfate, and zinc at the site, at least some of which appear attributable to management of CCW. While a scientific study indicated the potential for future increases in contamination, more recent data were not available.

Basis for Consideration as a Potential Damage Case: The reported exceedances of both primary and secondary MCLs were located in on-site wells and the potential for off-site migration of contamination may be limited. Therefore, this case was categorized as a potential damage case.

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[97] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[98] Ibid.

42. Alliant Rock River Ash Disposal Facility, Wisconsin[99]

History: Monitoring data at this site show down-gradient levels of arsenic and mercury that would exceed the Wisconsin Department of Natural Resources (WDNRs) drinking water enforcement standard (ES) levels (equivalent to primary MCLs). The data also show down-gradient levels of sulfate and iron that would exceed their ES levels (equivalent to secondary MCLs for these constituents). According to information provided by WDNR, however, the site has no down-gradient ES points of standards application due to its proximity to the Rock River (i.e., all wells are within the design management zone of the landfill). Thus, the State considers the preventive action limit (PAL) exceedances, not ES exceedances. The preventive action limit represents a lesser concentration of the substance than the enforcement standard[100]. In 1996, as a result of the PAL exceedances for sulfate and iron, WDNR required the company to begin submitting biennial ground water reports evaluating causes and trends relating to the continued PAL exceedances. Ongoing monitoring at the site includes indicator parameters and iron.

Basis for Consideration as a Potential Damage Case: Whereas the levels of arsenic and mercury in down-gradient wells exceed health-based enforcement standards, these exceedances are within the design management zone of the landfill and there is no evidence available of off-site migration of contaminants. Therefore, this case was determined to be a potential damage case.

43. Michigan City Site, Michigan City, Indiana[101]

History: EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants. It is described in detail in that document. In the 1988 Report, EPA concluded that ash ponds at the site are responsible for arsenic concentrations above the primary Maximum Contaminant Limit (MCL). EPA also concluded, however, that effects on ground water appeared to be limited to areas within the facility boundaries.

Basis for Consideration as a Potential Damage Case: While levels of arsenic found on-site exceed the primary MCL, there was no evidence available of off-site migration of contaminants. Therefore, this case is a potential damage case.

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[99] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[100] The PAL is either 10%, 20%, or 50% of the enforcement standard as specified by statute based on the health-related characteristics of the particular substance. Ten percent is used for cancer-causing substances, 20% for substances with other health effects and 50% for substances having aesthetic or other public-welfare concerns.

[101] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

44. Bailly Generating Station, Indiana[102]

History: EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants. The site is identified as the "Bailly Site, Dune Acres, Indiana" and described in detail in that document. In the 1988 Report, EPA concluded that leachate from ash disposal ponds was the most probable contributor to concentrations of arsenic and lead that were found above the primary MCL and primary MCL Action Level, respectively, in on-site, down-gradient wells. EPA also observed, however, that cadmium was the only constituent whose down-gradient off-site concentration exceeded the primary MCL. Elevated cadmium concentrations also were found in samples taken from the background well, leading EPA to conclude that the elevated down-gradient concentrations of cadmium may not have been caused by leachate from the coal ash.

Basis for Consideration as a Potential Damage Case: While levels of arsenic and lead found on-site exceed health-based standards, the only off-site exceedances of health-based standards (for cadmium) are not shown to be attributable to coal combustion waste. Therefore, this case is a potential damage case.

45. Alliant Edgewater 1-4 Ash Disposal Site, Wisconsin[103]

History: Monitoring data at the site show down-gradient levels of boron that exceed WDNR's health-based ES level[104]. Additional data shows that private water supply wells have shown ES exceedances for sulfate and iron (equivalent to secondary MCLs for these contaminants) and PAL exceedances for chloride. As a result of these exceedances, WDNR required a series of investigations from 1988 to 1997. The investigations found that cessation of ash sluicing and capping of the landfill had effectively controlled the contamination of ground water and no additional remedial actions were required. Ongoing monitoring at the site (including monitoring of the private wells) includes boron, sulfate, and arsenic. Previous monitoring included selenium, iron, fluoride, and chloride.

Basis for Consideration as a Potential Damage Case: The level of boron found down-gradient exceeds a health-based standard. It is unclear, however, whether this exceedance is in an off-site monitoring location. The exceedances found in off-site private wells are for constituents without health-based standards. Therefore, this case is a potential damage case.

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[102] Ibid.

[103] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[104] As of January 1, 2000, Wisconsin elevated boron to the status of a human health-related parameter.

46. Wisconsin Power Supply Co. (WPSC) Pulliam Ash Disposal Site, Wisconsin[105]

History: Monitoring data at this site showed down-gradient levels of sulfate and manganese that would exceed WDNR's ES levels (equivalent to secondary MCLs for these constituents) and levels of iron that exceed WDNR's PAL. According to information provided, however, the site had no down-gradient ES points of standards application (i.e., all wells are within the design management zone of the landfill). Thus, the State would consider the sulfate and manganese exceedances to be PAL, not ES, exceedances. Further review by WDNR found an inadequate monitoring network at the facility. Therefore, in 1994, WDNR required an investigation of the ground water contamination and an upgrade of the monitoring network. Ongoing monitoring at the site includes indicator parameters plus boron, selenium, manganese, and iron.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, manganese and iron, are within the design management zone of the landfill and are for constituents without health-based standards. Therefore, this case is a potential damage case.

47. Central Illinois Light Co. Duck Creek Station, Illinois[106]

History: Monitoring data at this site from April 1999 showed levels of sulfate, total dissolved solids, chloride, manganese, and iron in excess of their secondary MCLs. There is no clear indication of down-gradient wells or whether these wells are on-site or off-site.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids, chloride, manganese and iron, are of non-health-based standards. Therefore, this case is a potential damage case.

48. Illinois Power Co. Hennepin Power Station, Illinois[107]

History: Monitoring data at this site from between 1997 and 1999 showed levels of sulfate and total dissolved solids in down-gradient wells in excess of their secondary MCLs. There is no information available on the location of these wells relative to the waste management units. There is no monitoring data for metals at this site.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate and total dissolved solids, are of non-health-based standards. Therefore, this case is a potential damage case.

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[105] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[106] Ibid.

[107] Ibid.

49. Illinois Power Co. Havanna Power Plant, Illinois[108]

History: Monitoring data at this site between 1997 and 1999 showed levels of manganese down-gradient of the south ash impoundment in excess of the secondary MCL. The data also show levels of sulfate down-gradient of the east ash impoundment greater than up-gradient levels, but within the secondary MCL. There is no information available on the location of the monitoring wells relative to the waste management units.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, manganese and sulfate, are of non-health-based standards. Therefore, this case is a potential damage case.

50. Dairyland Power Alma On-site Fly Ash Landfill, Wisconsin[109]

History: EPA initially identified this site in the supplemental analysis conducted for its 1993 Regulatory Determination[110]. This analysis, along with additional information submitted by commenters, shows down-gradient levels of sulfate and manganese that would exceed WDNR's ES levels (equivalent to secondary MCLs for these constituents). According to information provided by WDNR, however, there are no ES points of standards application at the site (i.e., all wells are within the design management zone of the landfill). Thus, the State considers these exceedances PAL, not ES exceedances. In 1975, WDNR issued an administrative order as a result of an inspection that disclosed a number of operational and locational problems at the facility. Among other things, the order required submission of a closure plan and an in-field conditions report. The closure plan was approved in 1981 and included ground water monitoring. In 1986, the Department required the company to install additional monitoring wells and to monitor seven private water supply wells for two rounds of monitoring. Ongoing monitoring at the site includes indicator parameters plus manganese and boron.

Basis for Consideration as a Potential Damage Case: While the State has taken regulatory action at this site, the action appears to be based on operational and locational problems, not evidence of contamination. The exceedances found at the site, sulfate and manganese, are of non-health-based standards. Therefore, this case is a potential damage case.

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[108] Ibid.

[109] Ibid.

[110] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA. July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

51. Dairyland Power Alma Off-site Fly Ash Landfill, Wisconsin[111]

History: EPA initially identified this site in the supplemental analysis conducted for its 1993 Regulatory Determination[112]. This analysis, along with additional information submitted by commenters, shows down-gradient levels of sulfate and manganese that would be in excess of WDNR's ES levels (equivalent to secondary MCLs for these constituents). The monitoring data also show levels of boron that exceed WDNR's PAL. According to information provided by WDNR, however, the sulfate and manganese exceedances were not found at ES points of application; they were found in an on-site well within the design management zone of the landfill. Thus, the State considers the exceedances PAL, not ES, exceedances. None of the ES wells for the site have shown exceedances. Because of the PAL exceedances and a proposal by the owner to expand the ash disposal area, WDNR required an analysis of the performance of the existing landfill along with an upgraded liner system and other design improvements for the new facility on the site. Ongoing monitoring at the site includes indicator parameters plus iron and boron, although the company has monitored some wells for a list of metals as part of the siting for the expansion.

Basis for Consideration as a Potential Damage Case: While the State has taken regulatory action at the site, the exceedances found at this site, sulfate and manganese, are within the design management zone of the landfill and are for constituents without health-based standards. Therefore, this case is a potential damage case.

52. Illinois Power Vermillion Power Station, Illinois[113]

History: Monitoring data at this site showed levels of sulfate and total dissolved solids in down-gradient wells in excess of their secondary MCLs. No monitoring data for metals, trace elements, or organics were available.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate and total dissolved solids, are of non-health-based standards. Therefore, this case is a potential damage case.

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[111] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[112] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA. July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

[113] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

53. Central Illinois Public Service Company Hutsonville Power Station, Illinois[114]

History: Monitoring data at this site showed levels of sulfate, total dissolved solids, and manganese in excess of their secondary MCLs. These exceedances were in wells that were presumed by the commenters to be down-gradient. There is no clear indication of down-gradient wells or whether these wells are on-site or off-site. No monitoring data for metals, trace elements, or organics were available.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids and manganese, are of non-health-based standards. Therefore, this case is a potential damage case.

54. Illinois Power Company Wood River Power Station, Illinois[115]

History: Monitoring data at this site showed levels of sulfate, total dissolved solids, chloride, manganese, and iron in excess of their secondary MCLs. It is unclear from the information provided whether these exceedances were observed in wells close to the waste management unit boundaries or in more distant wells. All of the monitoring wells, however, appear to be within the property boundary. There is insufficient information to designate wells at this site as up-gradient or down-gradient.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids, chloride, manganese and iron, are of non-health-based standards. Therefore, this case is a potential damage case.

55. R.M. Schahfer Generating Station, IN[116]

History: EPA initially identified this site in the supplemental analysis conducted for its 1993 Regulatory Determination[117]. This analysis, along with additional information submitted by commenters, showed down-gradient levels of sulfate in excess of its secondary MCL. EPA concluded in the supplemental analysis that other pollutant exceedances at the site appeared to be outliers or were for up-gradient wells only.

Basis for Consideration as a Potential Damage Case: The sulfate exceedances found at this site are of non-health-based standards. Therefore, this case is a potential damage case.

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[114] Ibid.

[115] Ibid.

[116] Ibid.

[117] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA. July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

56. Coffeen/White & Brewer Trucking Fly Ash Landfill, Illinois[118]

History: Monitoring data at this site showed levels of sulfate, total dissolved solids, and manganese in down-gradient wells in excess of their secondary MCLs. Two of the three wells for which the commenters provided data appear to be located directly underneath the landfill area. A May 18, 1995 memorandum from the Illinois Environmental Protection Agency (IEPA) documents areas of dead or distressed grass on-site, apparently due to ground water seepage.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids and manganese, are of non-health-based standards. Therefore, this case is a potential damage case.

57. Southern Indiana Gas and Electric Company (SIGECO) A.B Brown Generating Station, Indiana[119]

History: EPA initially identified this site in the supplemental analysis conducted for its 1993 Regulatory Determination[120]. This analysis, along with additional information submitted by commenters, shows down-gradient levels of sulfate, total dissolved solids, chloride, and pH in excess of their secondary MCLs.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids, chloride and pH, are of non-health-based standards. Therefore, this case is a potential damage case.

58. Cincinnati Gas & Electric Co. Miamiview Landfill, Ohio[121]

History: Monitoring data at this site from 1994 show levels of sulfate in excess of its secondary MCL. This exceedance was identified in a well near the boundary of the landfill. An investigation of the site estimates that the sulfate plume extends to an area approximately 400 feet south of the site[122]. No data are available for other constituents for the site.

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[118] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[119] Ibid.

[120] Supplemental Analysis of Potential Risks to Human Health and the Environment from Large-Volume Coal Combustion Waste. U.S. EPA. July 30, 1993. Available from the docket for the 1993 Regulatory Determination for Fossil Fuel Combustion (Part 1), EPA-HQ-RCRA-1993-0042-1642.

[121] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[122] Report: Sulfate Investigation, Miamiview Landfill, Hamilton County, Ohio. Prepared for the Cincinnati Gas & Electric Company by Dames & Moore. December 13, 1994. Available in the docket titled Availability of Report to Congress on Fossil Fuel Combustion; Request for Comments and Announcement of Public Hearing, EPA-HQ-RCRA-1999-0022-0632.

Basis for Consideration as a Potential Damage Case: The sulfate exceedances found at this site are of non-health-based standards. Therefore, this case is a potential damage case.

59. Indiana Power & Light Petersburg Generating Station, Indiana[123]

History: Monitoring data at this site showed levels of sulfate and total dissolved solids in down-gradient wells in excess of their secondary MCLs. There is no information available on the location of these wells relative to the waste management units.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate and total dissolved solids, are of non-health-based standards. Therefore, this case is a potential damage case.

60. Hoosier Energy Mermon Generating Station Coal Combustion Waste Landfill, Indiana[124]

History: The historical exceedances of health-based standards (primary MCLs for barium, chromium, cadmium, and lead and secondary MCLs for sulfate and chloride) at this site are correlated with up-gradient exceedances and occur in on-site wells.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, primary MCLs for barium, chromium, cadmium, and lead and secondary MCLs for sulfate and chloride, are all confined to on-site wells. . Therefore, this case is a potential damage case.

61. Cinergy W.C. Beckjord Station, Ohio[125]

History: There were exceedances of non-health-based standards (secondary MCL for sulfate) and a single exceedance of a health-based standard (primary MCL for selenium) at this site. There was no evidence available of off-site migration. A public water supply well within the property boundary was shut down and can no longer be used as a drinking water supply as a direct or indirect result of the contamination due to exceedance of sulfate.

Basis for Consideration as a Potential Damage Case: While a public water supply well within the property boundary was shut down, the contaminant of concern (sulfate) in the water supply well does not have a health-based standard. Therefore, this case is a potential damage case.

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[123] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[124] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[125] Ibid.

62. Lemberger Landfill, Wisconsin[126]

History: The 21-acre Lemberger Landfill, Inc. site is located in Manitowoc County. The Township of Franklin used the site, an old gravel pit, as an open dump from 1940 to 1970. Lemberger Landfill, Inc. operated the site as a sanitary landfill under a license from the Wisconsin Department of Natural Resources (WDNR) from 1969 to 1976. From 1976 to 1977, the Wettencamp and Brunner Excavating Company transported fly ash from Manitowoc Public Utilities to the Lemberger facility. An estimated 1,750 to 2,500 cubic yards of fly ash were disposed of monthly. Past WDNR inspections showed that Lemberger used fly ash and bottom ash as cover, instead of burying them along with the refuse.

Damages at the site include the seepage of landfill leachate onto adjacent property. Ground water at the site is contaminated with volatile organic compound (VOC) and inorganic constituents including arsenic, barium, chromium, cadmium, and lead. VOCs were present in residential wells in the vicinity of the site, according to monitoring conducted by the State in 1984 and 1985; and a river near the site also is impacted by VOCs, cadmium and lead. A group of potentially responsible parties (PRPs) entered into a consent decree (CD) with U.S. EPA in 1992 to perform design and remedy implementation activities. Construction was completed in September 1996. The five-year review of September 2000 identified that the groundwater extraction system was not capturing the entire contaminant plume. In order to correct this problem, modifications to the groundwater extraction system were constructed in winter 2001.

On June 15, 2006, U.S. EPA and WDNR approved the PRP's workplan for the monitored natural attenuation pilot study and gave approval to shut down the groundwater pump and treat system. The pump and treat system was shut down on August 1, 2006[127].

Basis for Consideration as a Potential Damage Case: Because the available documentation does not clearly implicate, or rule out, coal combustion waste as a source of the contamination, this case is a potential damage case.

63. Conesville Fixed FGD Sludge Landfill, Ohio[128]

History: EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants. Ground water monitoring data are described in detail in the report.

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[126] Memorandum from SAIC to Dennis Ruddy regarding Additional Information Regarding Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[127] http://www.epa.gov/R5Super/npl/wisconsin/WID980901243.htm

[128] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

Thirty-four monitoring wells were installed (two up-gradient) to monitor the effectiveness of a Poz-O-Tec fixation process (fluidized gas desulfurization (FGD) sludge mixed with fly ash and lime) to stabilize and thus immobilize potential contaminants. The stabilized FGD sludge was deposited next to the fly ash pond.

Two sets of samples were collected, one between February 27 and April 12, 1979 and the other between December 4, 1979 and July 10, 1980. Samples from the first set of data contained lead concentrations which exceeded the primary drinking water standard (PDWS) in two on-site wells and three off-site wells. Samples from on-site wells in the first set of data also showed increases above background levels in the secondary drinking water standards (SDWS) of calcium, magnesium, total dissolved solids (TDS), sulfate and iron.

In the second set of data, samples from on-site wells showed increases in calcium, magnesium, TDS and sulfate relative to the first set of data. Exceedances of the PDWS for arsenic, cadmium, chromium and selenium were found in on-site wells and exceedances of the PDWS for chromium were found in off-site wells. Lead was not detected in any of the second set of samples.

Elevated levels of selenium were detected in up-gradient wells in both the first and second sets of samples suggesting that selenium is originating from indigenous sediments rather than coal combustion wastes. The only constituents that appeared to be migrating off-site were lead in the first set of sampling and chromium in the second set of sampling.

Based on data collected, there appeared to be a temporal change in ground water quality at this site, and potential adverse impacts from constituents migrating off-site appeared to be limited. While the data indicated that lead and chromium appeared to be migrating off-site, EPA rejected this site as a damage case due to apparent limited potential adverse impacts. Subsequent to the March 2000 Regulatory Determination, this site was reevaluated and rejected as a damage case because there was no evidence that coal combustion wastes were comanaged with low-volume wastes at this site so the site was not covered by that Regulatory Determination[129]. Since then, the Agency has learned that the site receives various types of coal combustion wastes, including fly ash, and is covered by the March 2000 Regulatory Determination.

Basis for Consideration as a Potential Damage Case: Based on the on-site ground water contamination of the cited secondary drinking water standards (calcium, magnesium, total dissolved solids, sulfate and iron), and of primary drinking water standards (arsenic, cadmium, chromium and selenium) and the limited potential for the off-site migration of contaminants, this site has been reclassified as a potential damage case.

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[129] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

64. Muscatine County Landfill, Iowa[130]

History: It is not clear, based on the available data, if the currently active facility was constructed on the same site as the older, closed landfill. However, the issue of whether or not the sites are the same does not affect the analysis here, because the available data for the active site do not cover the constituents of concern (sulfate and selenium) for the older site. Further research is unlikely to find any additional information about the old facility. Therefore, conclusions about this site are based on the limited historical data.

Basis for Consideration as a Potential Damage Case: The exceedances of non-health-based standards (secondary MCL for sulfate) and possibly a single health-based standard (primary MCL for selenium) at this site are in wells located on-site, close to the waste management unit. Therefore, this case is a potential damage case.

65. Dave Johnston Power Plant, Wyoming[131]

History: Exceedances of the primary MCL for cadmium and the secondary MCLs for manganese and sulfate were observed in ground water up-gradient and down-gradient of the site. Interpretations of sampling results were difficult to make because other potential sources of contamination exist, such as other waste disposal areas at the site; contaminants naturally occurring in the soil which is highly mineralized around the Johnston site; and uncertainties with regard to what degree leachate from the two landfills had reached the down-gradient wells.

Basis for Consideration as a Potential Damage Case: Whereas exceedances of the primary MCL (cadmium) and the secondary MCLs (manganese and sulfate) were observed in ground water down-gradient of the site, the natural occurrence of mineralization products in the local soils and possible and other potential sources of contamination Therefore, this case is a potential damage case.

66. Montana-Dakota Utilities R.M. Heskett Station, North Dakota[132]

History: Monitoring data at this site from 1998 show levels of sulfate and boron immediately down-gradient of an old ash pile in excess of the secondary MCL. According to the NDDOH, the State required the company "... to install ground water monitoring wells and implement a closure plan. Since that time, the site has been effectively closed and is currently revegetated

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[130] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[131] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[132] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

with a good stand of growth. The ground water monitoring data indicate that impact to ground water has been reduced since closure of the site[133]."

Basis for Consideration as a Potential Damage Case: While the State has taken regulatory action at this site, the sulfate and boron exceedances found are of non-health-based standards. Therefore, this case is a potential damage case.

67. Arizona Public Service Co. Cholla Steam Electric Generating Station, Arizona[134]

History: Monitoring data at this site show levels of sulfate, total dissolved solids, chloride, and fluoride in excess of their secondary MCLs. These exceedances are found in a well located directly at the foot of the fly ash pond. The affected aquifer has "naturally poor water quality," but no background or up-gradient data are available. The commenters use a comparison to distant alluvial ground water to implicate pond leachate as a source of contamination. The commenters also allege that construction of the waste management units has caused naturally poor quality water from upper aquifers to contaminate the pristine lower aquifer, regardless of leachate contamination.

Basis for Consideration as a Potential Damage Case: The exceedances found at this site, sulfate, total dissolved solids, chloride and fluoride, are of non-health-based standards and are in a well directly at the foot of a waste management unit. Therefore, this case is a potential damage case.

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[133] Attachment B to the letter from the Hoosier Environmental Council to Dennis Ruddy regarding damage case sites, November 11, 1999, Document ID # EPA-HQ-RCRA-1999-0022-1235 in the docket titled Comments In Response To The April 28, 1999 Federal Register: Availability Of Report To Congress On Fossil Fuel Combustion; Request For Comments And Announcement Of Public Hearing, Attachment B: Report On R.M. Heskett Station. The Report On R.M. Heskett Station is accessible at: http://www.hecweb.org/ProgramsandInitatives/CCW/heskett.pdf

[134] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

Rejected Coal Combustion Waste Damage Cases (Excluding Minefills)

IV. Rejected Damage Cases

The following alleged damage cases were rejected due to either (1) lack of any evidence of damage or (2) lack of evidence that damages were uniquely associated with CCW.

68. American Coal Corporation #5 Landfill[135]

No information available

69. Cardinal PFBC Monofill[136]

According to Ohio EPA representatives, the Cardinal PFBC Monofill is used for the disposal of bed ash from the Ohio Power Cardinal Power Plant. The monofill was constructed on top of the closed Fly Ash Reservoir I Impoundment. The State has ground water monitoring data for the site, but the representatives could not confirm the presence of any suspected impacts. The data do not show any exceedences of primary or secondary MCLs. Furthermore, according to the State's hydrogeologists, interpretation of the data is occluded by mining impacts in the area. There are no exceedences of primary or secondary MCLs at this site. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

70. Cardinal Fly Ash Reservoir II Impoundment[137]

According to Ohio EPA representatives, the Cardinal Fly Ash Reservoir II Impoundment is used for the disposal of fly ash from the Ohio Power Cardinal Power Plant. The State has ground water monitoring data for the site, but the representatives could not confirm the presence of any suspected impacts. The data do not show any exceedences of primary or secondary MCLs. Furthermore, according to the State's hydrogeologists, interpretation of the data is occluded by mining impacts in the area. There are no exceedences of primary or secondary MCLs at this site. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

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[135] Memorandum from SAIC to Dennis Ruddy regarding Revised Identification of New Candidate Damage Cases, December 7, 2001.

[136] Ibid.

[137] Ibid.

71. Clinch River, Virginia[138]

EPA identified this site in its original 1988 Report to Congress on Wastes from the Combustion of Fossil Fuels by Electric Utility Power Plants. It is described in detail in that document. EPA concluded that this site represented a proven damage case for purposes of the 1993 Regulatory Determination. In conducting its analysis for the 1999 Report to Congress, however, EPA concluded that there was no evidence of comanagement at this site. EPA therefore rejected this site as a damage case for purposes of the 1999 Report to Congress.[139]

72. Copicut Road[140]

Monitoring results do not document any exceedances of federal or state standards (Ruddy 2001), except for pH. The ground water pH was below (more acidic than) its minimum secondary MCL both prior to and during placement (PG&E undated). Because acidic ground water was present prior to ash placement, this exceedance cannot be attributed to ash placement. Monitoring data for the site reveal no exceedances of primary or secondary MCLs attributable to coal combustion waste placement at the site. Therefore, this case is categorized as a case without documented evidence of proven or potential damage to human health or the environment.[141]

73. Dixie Caverns County Landfill, Virginia[142]

Dixie Caverns Landfill was operated by Roanoke County, Virginia, as a disposal site for municipal refuse, solvents, and fly ash. When the landfill was closed in 1976, it was not capped and an intermittent stream on the site flowed through a large drum pile and the fly ash pile and emptied into the Roanoke River, approximately two miles southeast of the landfill. There was also a sludge disposal pit on site. The contaminants identified on site include lead, cadmium, zinc, silver, iron, benzene, substituted benzene, chlorinated ethane, and polynuclear aromatic hydrocarbons (PAHs). Based on review of the materials provided by the commenters, it is apparent that the fly ash disposed at the site is emission control dust from an electric arc furnace,

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[138] Letter from the Hoosier Environmental Council to the RCRA Docket Information Center regarding the CCW RTC, June 11, 1999, Letter from the Hoosier Environmental Council and the Citizens Coal Council to the RCRA Docket Information Center regarding the CCW RTC, June 14, 1999 and Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[139] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000. Memorandum from SAIC to Dennis Ruddy regarding Review of Causative Factors for Coal Combustion Waste Damage Cases, November 29, 2000.

[140] Letter from HEC, et. al., to Dennis Ruddy, February, 2002.

[141] Compendium of nineteen alleged coal combustion wastes damage cases, May 3, 2007.

[142] Letter from the Hoosier Environmental Council and the Citizens Coal Council to the RCRA Docket Information Center regarding the CCW RTC, June 14, 1999 and Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

not fossil fuel combustion waste. This site did not receive fossil fuel combustion waste and therefore is not applicable.[143]

74. Gavin Impoundments[144]

According to Ohio EPA representatives, the Gavin Plant ash ponds are used for the disposal of ash from the Ohio Power Gavin Plant. The fly ash pond is no longer receiving ash, but has not yet been closed. The facility has not conducted ground water monitoring, but has submitted a ground water monitoring plan and will be required to monitor as part of their closure activities for the fly ash pond. The bottom ash pond is still receiving wastes. There is no ground water monitoring for the bottom ash pond. The representatives could not confirm the presence of any suspected impacts and the State has not undertaken any regulatory action at the site. There is no evidence of damage at this site. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

75. Kyger Creek Power Plant Impoundments[145]

According to Ohio EPA representatives, the Kyger Creek Plant surface impoundments are used for the disposal of ash from the Ohio Valley Electric Kyger Creek Power Plant. Bottom ash is disposed of in the bottom ash pond, although most of the facility's bottom ash is used by Black Beauty, an on-site company which sells products containing bottom ash. While there is no ground water monitoring around the bottom ash pond, Ohio EPA staff are unaware of any issues related to this pond.

76. Lake Erie, Ohio[146]

Commenters provided a study of trace element concentrations in sediments, surface water, and biota in proximity to an ash disposal basin along the shore of Lake Erie. The study noted that sediment concentrations in the proximity of the basin had the potential for adverse effects on benthos (*oligochatetes*) and fish in early life stages. In addition, the study observed changes in fish behavior (e.g., possibly due to avoidance) near the basins. The study findings, however, do not conclusively implicate coal combustion waste as the source of the observed behavioral changes. There is insufficient evidence to confirm that fossil fuel combustion wastes are the source of contamination in this case.

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[143] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[144] Memorandum from SAIC to Dennis Ruddy regarding Revised Identification of New Candidate Damage Cases, December 7, 2001.

[145] Ibid.

[146] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

77. Muskingum River Power Plant Impoundments[147]

According to Ohio EPA representatives, the Ohio Power Muskingum River Power Plant disposes of bottom ash in ponds located next to the plant. The representatives confirmed that there are no monitoring wells at the site. They indicated, however, that elevated levels of iron and manganese have been detected in facility production wells. These observations have led the State's hydrogeologists to suspect that there might be some impacts from the bottom ash ponds. The representatives, however, stated that the levels of iron and manganese detected are below the relevant secondary MCLs. Because there are no exceedances of primary or secondary MCLs at this site, the evidence is not sufficient to categorize this case as a proven or potential damage case under EPA's definitions. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

The fly ash pond originally consisted of two ponds in series. One of the ponds has recently been closed and capped, while the other continues to accept waste. At the time that the fly ash pond was closed, the facility installed ground water monitoring wells around the perimeter of the entire fly ash disposal area and five years of monitoring data now are available. According to the Ohio EPA representatives, monitoring has detected some statistically "out of range" values for iron, manganese, and TDS. These observations have led the State's hydrogeologists to suspect that there might be some impacts from the fly ash ponds. The representatives, however, stated that the levels detected are below the relevant secondary MCLs. Because there are no exceedances of primary or secondary MCLs at this site, the evidence is not sufficient to categorize this case as a proven or potential damage case under EPA's definitions. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

78. Muskogee Environmental Fly Ash Disposal Site, Oklahoma[148]

Commenters provided a printout from the Superfund Archive identifying this site as a Superfund site. The information provided, however, does not identify the constituents of concern, the reason for inclusion of this site in the Superfund database, or otherwise indicate that any contamination at this site is associated with fossil fuel combustion wastes. There is insufficient information available to identify the extent and nature of damages present and attribute them to fossil fuel combustion wastes.[149]

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[147] Ibid.

[148] Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[149] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

79. Public Service Co Fly Ash Disposal Site, Oklahoma[150]

Commenters provided a printout from the Superfund Archive identifying this site as a Superfund site. The information provided, however, does not identify the constituents of concern, the reason for inclusion of this site in the Superfund database, or otherwise indicate that any contamination at this site is associated with fossil fuel combustion wastes. There is insufficient information available to identify the extent and nature of damages present and attribute them to fossil fuel combustion wastes.[151]

80. Star Coal Company #6 Landfill[152]

No information available

81. Star Coal Company #14 Landfill[153]

No information available

82. Stuart Station Impoundments[154]

According to Ohio EPA representatives, the Stuart Station ash ponds are used for the disposal of ash from the Dayton Power & Light Stuart Station. The State has ground water monitoring data for wells near the ash ponds and older data from facility production wells. According to the State's hydrogeologists, the facility relocated their production wellfield due to ground water quality impacts of "undetermined origin." The monitoring data also show a statistical increase over background concentrations. The specific constituents showing increases were not identified, but there are no exceedances of primary or secondary MCLs at the site, according to the Ohio EPA representatives. The State's hydrogeologists also indicated that the impacts observed may be either from the ash ponds or from coal piles located in the area. Because there are no exceedances of primary or secondary MCLs at this site, the evidence is not sufficient to categorize this case as a proven or potential damage case under EPA's definitions. Therefore, this site is categorized as a case without documented evidence of proven or potential damage to human health or the environment.

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[150] Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[151] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[152] Memorandum from SAIC to Dennis Ruddy regarding Revised Identification of New Candidate Damage Cases, December 7, 2001.

[153] Ibid.

[154] Ibid.

83. Thompson Landfill, Michigan[155]

This site is an abandoned landfill. Commenters cited a MDEQ study that allegedly shows arsenic greater than Michigan "cleanup criteria" attributable to the landfill. This document and quantitative data supporting the alleged damages were not available. Recent information from the MDEQ, however, confirms that ground water contamination is present and that the site is being remediated. There is no information on whether wastes other than coal combustion wastes might be present that could contribute to the contamination. There is no information on whether the alleged contamination extends off-site. There is insufficient information available to identify the extent of ground water contamination, or to positively identify the source of the contamination.[156]

84. Turris Coal Company Elkhart Mine, Illinois[157]

This site is an underground mine that disposes of coal processing waste and coal combustion waste in a diked surface lagoon. Commenters provided monitoring data showing exceedances of the secondary MCLs for sulfate, chloride, and total dissolved solids in a single well at the site. The data for this well also show an increase in these concentrations since the placement of coal combustion waste began. The other wells at the site do not show similar exceedances or trends. There is no quantitative data on the presence of other constituents at the site. There is insufficient data on hydrogeology at the site, the location of coal combustion waste placement at the site, or on activities other than coal combustion waste placement at the site to conclude that the impacts identified are due to coal combustion waste placement. Although there is some quantitative evidence of contamination, the available data are limited to a small number of constituents. There also is insufficient information to identify the extent of the contamination or confirm the source of the contamination.[158]

85. Western Farmers Electrical Fly Ash Site, Oklahoma[159]

Commenters provided a printout from the Superfund Archive identifying this site as a Superfund site. The information provided, however, does not identify the constituents of concern, the reason for inclusion of this site in the Superfund database, or otherwise indicate that any

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[155] Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

[156] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[157] Memorandum from SAIC to Dennis Ruddy regarding Rationale and Conclusions Regarding Commenter-Identified Fossil Fuel Combustion Waste Damage Cases, April 20, 2000.

[158] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.

[159] Letter from the Hoosier Environmental Council, et. al., to Dennis Ruddy regarding the CCW RTC, September 24, 1999.

contamination at this site is associated with fossil fuel combustion wastes. There is insufficient information available to identify the extent and nature of damages present and attribute them to fossil fuel combustion wastes.[160]

[160] Memorandum from SAIC to Dennis Ruddy regarding Final Revised Report on Resolution of 18 Previously Indeterminate Candidate Damage Cases, March 5, 2003.