THE USE OF NEUTRAL LEACHATE TEST DATA IN INDIANA'S COAL COMBUSTION BY-PRODUCT DISPOSAL PROGRAM

Deborah A. Dale[1]

[1]Indiana Department of Natural Resources, Division of Reclamation, R.R. #2, Box 129, Jasonville, IN 47438

KEYWORDS: CCB Placement, Coal mining, Water quality

ABSTRACT

The disposal of coal combustion by-products in active coal mines has been occurring in southwestern Indiana since 1989. During this 15-year time period, a total of over seven million tons of ash material has been deposited in nine surface mines. The approval to dispose of coal combustion by-products is an arduous process including characterization of the disposal site's hydrogeologic setting, a qualitative and quantitative analysis of the effects of ash placement within that setting and characterization of the coal combustion by-products through bulk, 18-hour and 30-day neutral leachate tests. Quarterly evaluation of the ash, as well as monitoring of the surface and ground water at the site, is maintained throughout the active disposal phase and through final bond release.

Results of surface and ground water data collected from the Universal Ash Site in Terre Haute, Indiana, suggest the neutral leachate test ASTM D 3987-85, "Shake Extraction of Solid Waste With Water" can generally provide reliable information on anticipated concentrations of the eight Resource Conservation and Recovery Act metals. However, when comparing the leachate test results for other metals (i.e. boron and molybdenum) with results from water samples collected at the Universal site, some of the field samples contain higher concentrations than indicated in the leachate analysis.

INTRODUCTION

Nationwide, the state of Indiana is second only to Texas as the largest generator of Coal Combustion By-products (CCBs). This distinction is directly related to the fact that approximately 98 percent of Indiana's residents rely on coal for their electrical needs. This dependency results in a CCB production of roughly six million tons per year that must be either beneficially used or disposed of in a suitable environment.

In 1988, the Indiana General Assembly passed Public Law 103 exempting the disposal of CCBs from solid waste regulations administered by the Indiana Department of Environmental Management when disposal occurred at surface coal mines regulated by the Indiana Department of Natural Resources (IDNR) under the Surface Mining Control and Reclamation Act (SMCRA). The Assembly recognized the general characteristics of the CCBs did not warrant the material

being regulated under stringent solid waste (landfill) regulations, and by placing the ash in active surface mines rather than landfills, much needed landfill space would be retained for municipal waste. It was also recognized coal mines could provide a more desirable environment for ash disposal when compared to floodplain areas utilized by some powerplants for the siting of CCB holding ponds and storage cells. The practice of constructing ash disposal areas in floodplains in Indiana resulted from powerplants being located adjacent to major rivers; however, the hydrologic characteristics of these floodplains can often result in the dissemination of ash constituents into the ground water if proper controls are not in place.

Active coal mines located within the southwestern portion of Indiana (Figure 1) were recognized as a suitable alternative to floodplains and landfills for the placement of CCBs. The process of coal extraction fractures bedrock strata within the mined area increasing the surface area of the rocks exposed to weathering. The weathering process generally results in an increase in the mineralization of water recharging within the mined area restricting its usage as a potable water source. In addition, limited amounts of ground water from the bedrock strata in this region[1], and the fact that water quality decreases with depth, [2, 3] generally result in few bedrock residential wells located within the vicinity of coal mines.

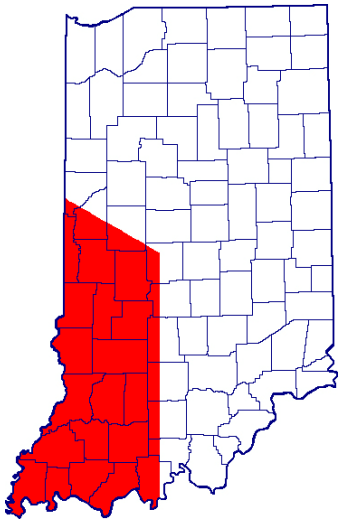


Figure 1. Red area denotes coal-mining region in SW Indiana.

ASH DISPOSAL PERMITTING

The IDNR is the agency responsible for the regulation of coal mining and reclamation operations, including the disposal of CCBs in surface coal mines, in the state of Indiana. The disposal of CCBs at mine sites can only be achieved through a new coal-mining permit or a significant revision to an existing permit issued by the IDNR. Both types of permits require public notice with the opportunity for public comments and appeals.

As part of the coal-mining permitting process, thus the CCB disposal permitting process, the applicant must obtain and submit detailed geological and hydrogeological information regarding the proposed mine site and vicinity. Included in this information is a lithologic description of the subsurface; a chemical analysis of the overburden material and the coal seam(s) planned for extraction; and a characterization of aquifers located above, below (if the IDNR determines a lower aquifer could be impacted by mining), and including, the target coal seam(s). The applicant must also identify all surface and ground water users in and within 1,000 feet of the proposed permit boundary and provide documentation concerning the existing quality and quantity of the water supply.

In addition to site characterization, the applicant must provide specific CCB disposal information including, but not limited to: disposal method(s); landowner notification and approval; disposal volumes (total and annual); identification of ash type(s) (flyash, bottom ash, mixture, etc.); and CCB characterization. The ash characterization must include bulk analyses and 18-hour and 30-day leachate test results for over 30 parameters for each waste stream and ash type planned for disposal. Although several different leachate test methods were originally considered, ASTM D 3987-85, "Shake Extraction of Solid Waste With Water" was found to be a more appropriate and reliable test method with regard to CCBs.[4] Although this test method has been found to provide dependable information on anticipated concentrations of other parameters including the eight Resource Conservation and Recovery Act (RCRA) metals, some water samples obtained from the Universal Ash Site suggest boron and molybdenum leachate levels may not correlate well with actual field samples.

UNIVERSAL ASH SITE

The Universal Ash Site, owned by Cinergy Corp, is located in Vigo County approximately two miles southeast of New Goshen, Indiana (Figure 2). Permit approval for surface coal mining in this area was granted in 1985 to Peabody Coal Company who owned and operated the mine as Snow Hill Area No. 14. Disposal of CCBs, consisting of a fly ash/bottom ash mixture and a limited amount of ash from coal gasification, began in the early part of 1989 with all material deposited within one final-cut monofill (Figure 3). Disposal was completed in October of 2001 with a total of 1,644,923 tons of CCBs placed into the monofill.

Currently, there are nine wells located in the vicinity of the disposal operations that monitor the surficial ground water in the unconsolidated material, the ground water within the bedrock or the pore water within the spoil/ash material (active pit disposal area) (Figure 3). There have been as many as 12 monitoring wells at this location; however, damage required the abandonment of three of the wells. In addition to the wells, there are currently five surface water points (Figure 3). A sixth point, monitoring the water within the disposal area, was eliminated as the disposal pit was filled in.

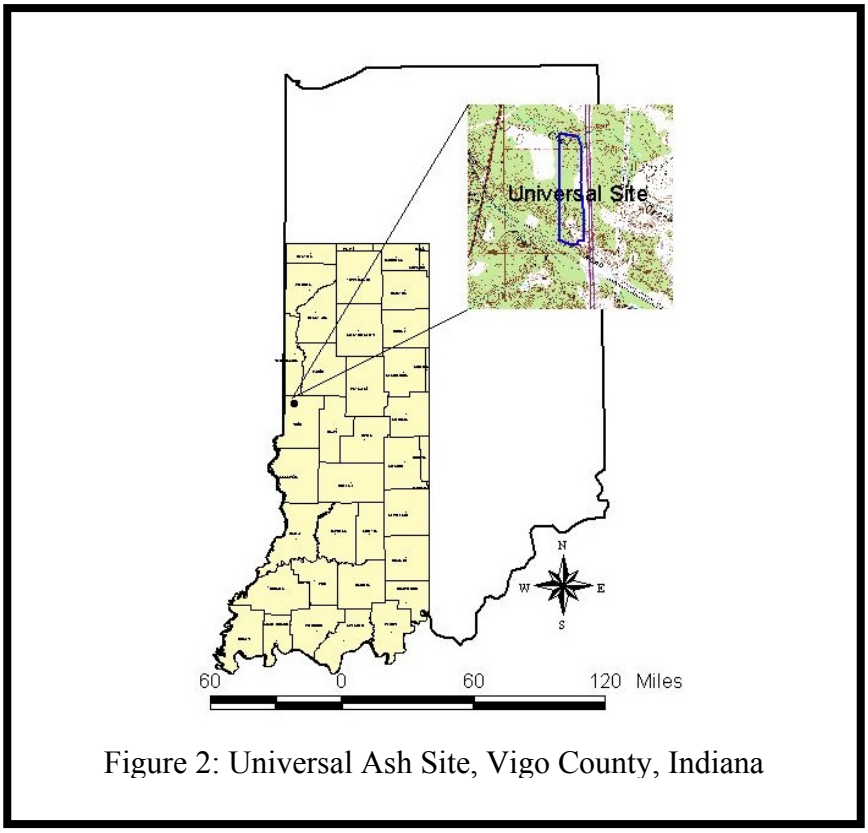


Figure 2: Universal Ash Site, Vigo County, Indiana

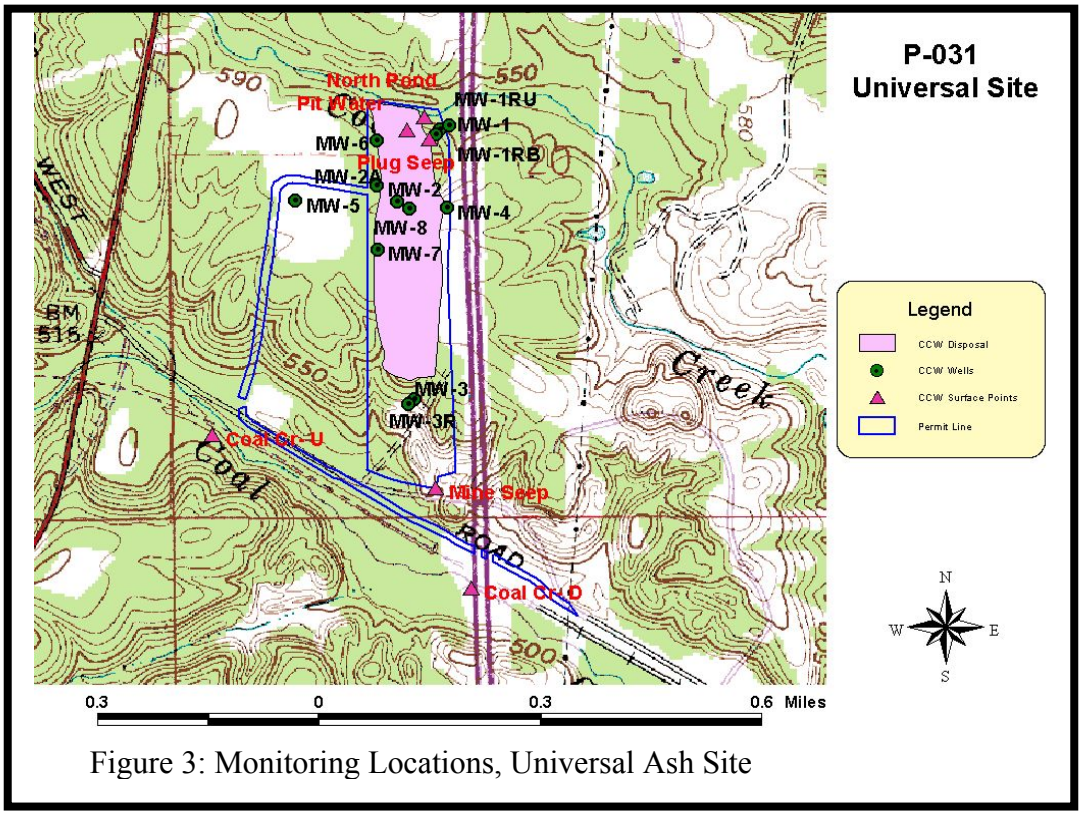


Figure 3: Monitoring Locations, Universal Ash Site

DISCUSSION

The IDNR ash database contains over 3,000 entries of bulk and leachate (18-hour and 30-day) data for the Universal site. Focusing on the eight RCRA metals, boron and molybdenum, Table 1 below presents the highest bulk, 18-hour leachate and 30-day leachate values reported for the ash material disposed of at the site. In addition, Table 1 includes the highest detected concentrations of these metals in monitoring wells MW-8, MW-1RU and MW-1RB. Well MW-8 was selected for comparison due to its location within the disposal pit (within the ash material itself)(Figure 3). Wells MW-1RU and MW-1RB were selected because these wells contain the highest boron concentrations as compared to the remaining wells (with the exception of MW-8). Please note, well MW-2 was formerly located within the ash disposal area; however, this well was damaged beyond repair and replaced with MW-8 in 1997. Likewise, MW-1 was replaced by MW-1RU and MW-1RB in 2001 when MW-1 was found to have a leaking seal.

Table 1
RCRA Metals, Boron and Molybdenum
Highest Bulk and Leachate Values vs. Highest Field Values in MW-8, MW-1RU and MW-1RB

Metals	Highest Bulk Value (mg/kg)	Highest 18-Hour Leachate Value (mg/l)	Highest 30-Day Leachate Value (mg/l)	Highest Detected Value in MW-8 (mg/l)	Highest Detected Value in MW-1RU (mg/l)	Highest Detected Value in MW-1RB (mg/l)
Arsenic	160	1.3	0.86	0.26	0.0059	0.0125
Barium	220	0.24	0.37	0.35	0.15	0.05
Cadmium	4.2	0.01	0.007	0.0004	ND	0.0004
Chromium	136	0.17	0.034	0.0084	ND	0.007
Lead	81	0.052	0.075	0.08	ND	ND
Mercury	0.35	<0.002	<0.002	ND	ND	ND
Selenium	9.8	0.17	0.25*	0.006	ND	ND
Silver	1.9	<0.04	<0.04	0.01	ND	0.007
Boron	545	5.5	7.9	82.6	28.2	41.9
Molybdenum	25	0.76	0.77	2.34	0.048	0.6

ND = Non-Detect

*Value represents a single sample at this elevated concentration. This value resulted in a notification letter to Cinergy to stop disposal and verify sample results. Subsequent samples were less than 25% of the RCRA limit. Under the IDNR program, CCB leachate concentrations exceeding one-quarter RCRA levels cannot be disposed.

As noted in Table 1, levels of the RCRA metals detected in the monitoring wells are similar or less than the anticipated concentrations based on the leachate results; therefore, the neutral leachate test ASTM D 3987-85 is a viable test method for predicting field concentrations of these metals. This assumption is supported by data obtained from the remaining eight mine sites in Indiana where ash disposal has occurred. However, when viewing the leachate concentrations for boron, and to a lesser degree, molybdenum, the ash material disposed of at Universal leached

these metals at a much higher concentration than expected based on the laboratory tests. This discussion will focus on boron due to its usefulness as an indicator for CCB leaching.[5]

Boron in ground water

Boron concentrations in the CCBs disposed of at Universal averaged 237 mg/kg until the middle of 1999, at which time, the levels increased maintaining an average of 338 mg/kg throughout the remaining disposal period (42.6 % increase). These higher concentrations were also noted in the leachate analyses with a 78.3 % increase in boron in the 18-hour and a 63.5 % increase in the 30-day. Although these increases are considerable, the absolute boron levels reported in the leachate analyses since the middle of 1999 are substantially lower than the levels detected in the samples from MW-8, MW-1RU and MW-1RB.

The increased boron content in the ash material is presumed to be the source of the boron detected in the water samples at Universal. Although boron increases have not been as conspicuous in other locations at the site, the locations of MW-8, MW-1RU and MW-1RB relative to the ash material impart these wells with direct communication with the water within the ash material. The increased concentration in wells MW-1RU and MW-1RB may be due to, at least in part, the direction of the ash placement within the disposal area. The CCBs were deposited within the disposal area as a progressive sequence from south to north; therefore, the ash containing the highest concentrations of boron was placed in the northern portion of the pit. Well MW-8 is located in the northern region of the ash disposal area, and wells MW-1RU and MW-1RB are proximal to the northeast corner of the pit.

Since MW-8 monitors the water within the ash disposal area (Figure 3), it is expected that samples from this well would contain the highest concentrations of ash constituents. Boron continues to display an increasing trend in this well with a marked increase in concentrations following the completion of the ash disposal activities and the complete covering of the disposal pit at the end of 2001 (Figures 4 and 5). The covering of the pit reduced the influx of atmospheric water to infiltration through the capping material, thus reducing the dilution effect.

Well MW-1RU is located in proximity to the ash monofill and monitors the shallow ground water within the unconsolidated material. Boron concentrations have been steadily increasing in this well, and again, substantial increases in boron levels are evident following the filling in of the disposal pit (Figures 5 and 6).

MW-1RU is presumed to be in direct communication with water in the disposal area through a surficial sampling point referred to as the “Plug Seep”. Water at this location is the result of leakage from the disposal area through the levee surrounding the monofill. Water from the disposal area moves through the levee then migrates into the unconsolidated material and is detected in MW-1RU. A similar increase in boron as seen in MW-1RU is evident in samples obtained from the seep area with concentrations again increasing following completion of the disposal activities (Figure 7).

Figure 4

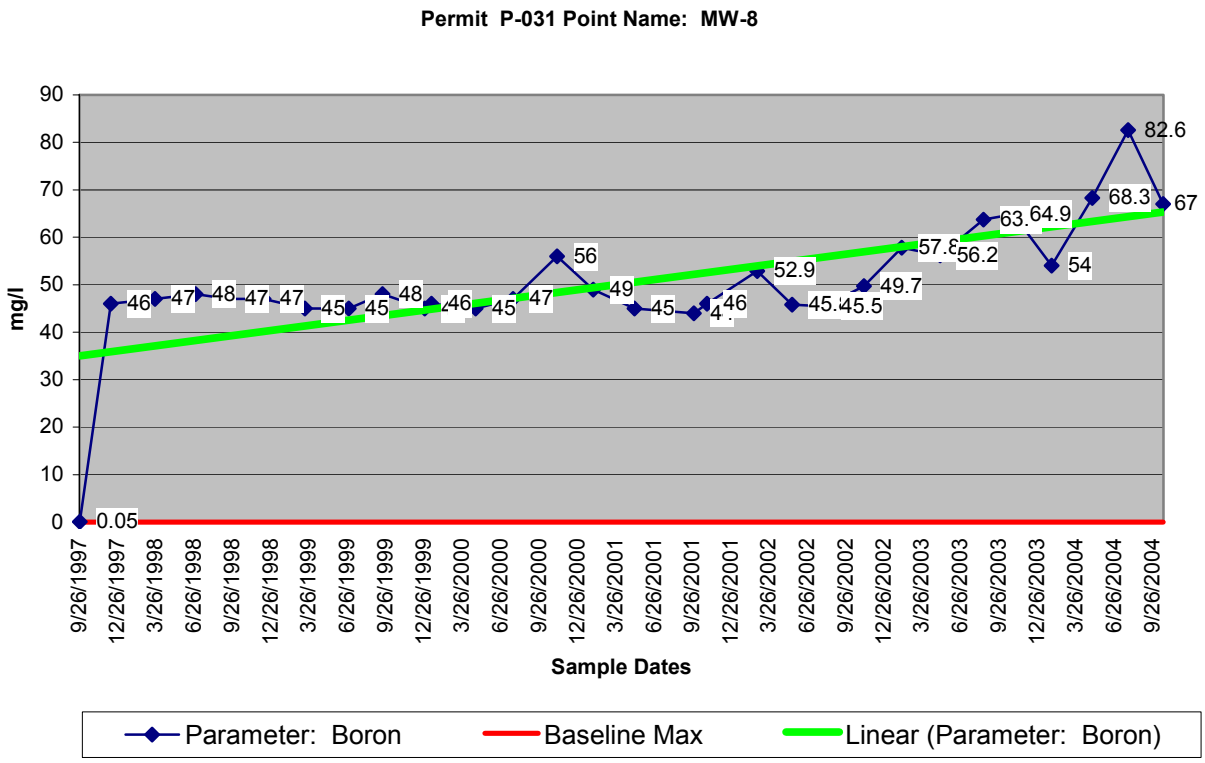


Figure 5

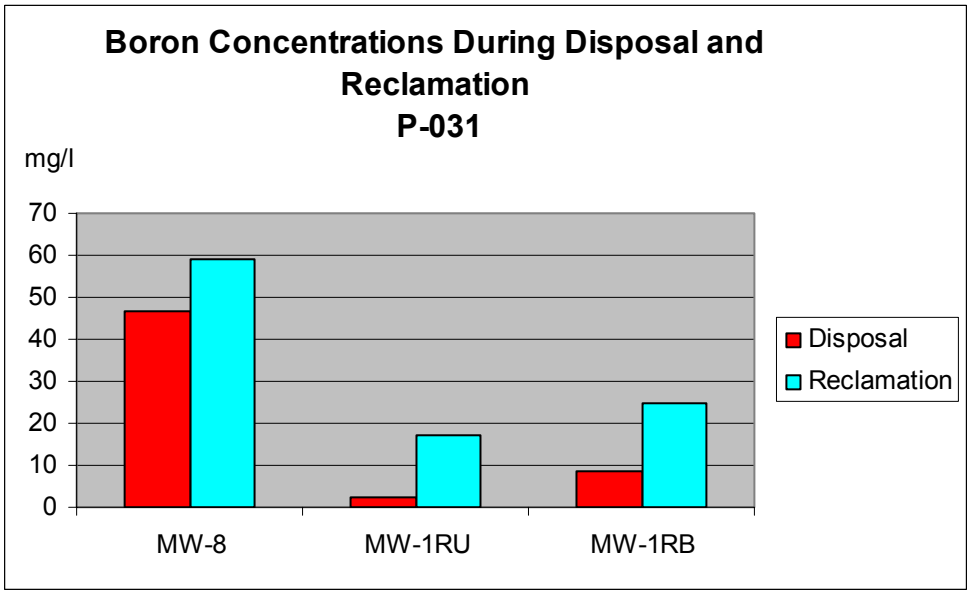


Figure 6

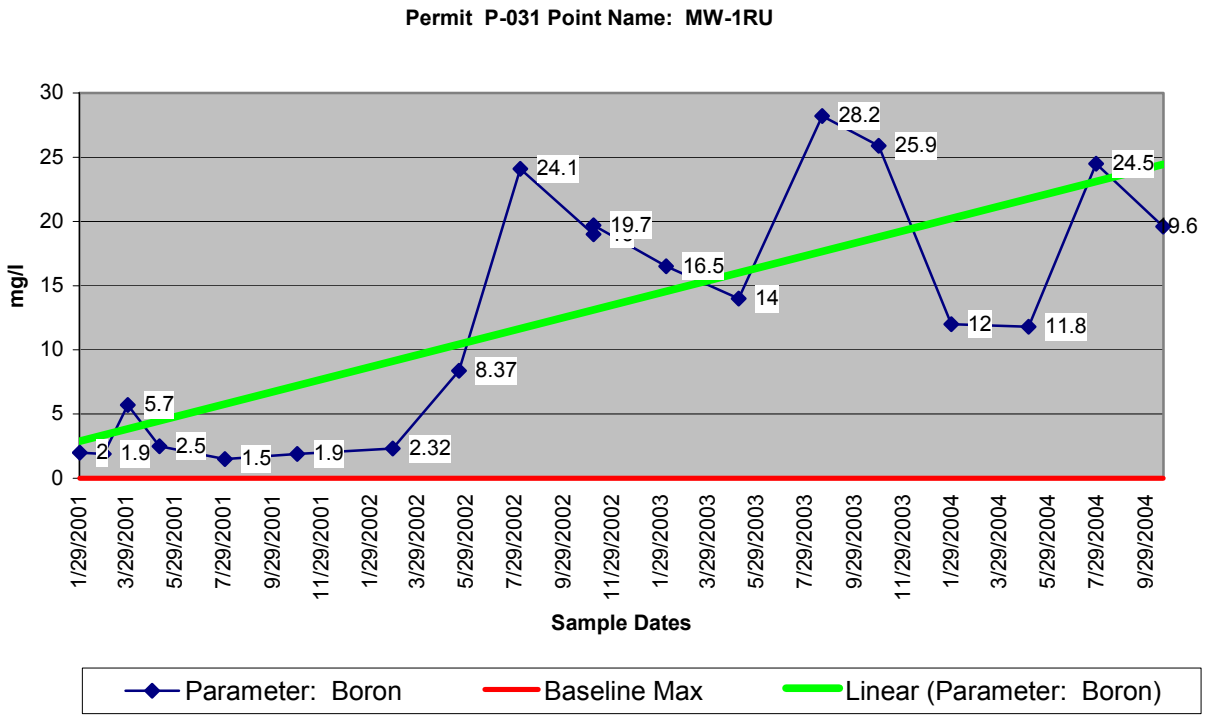
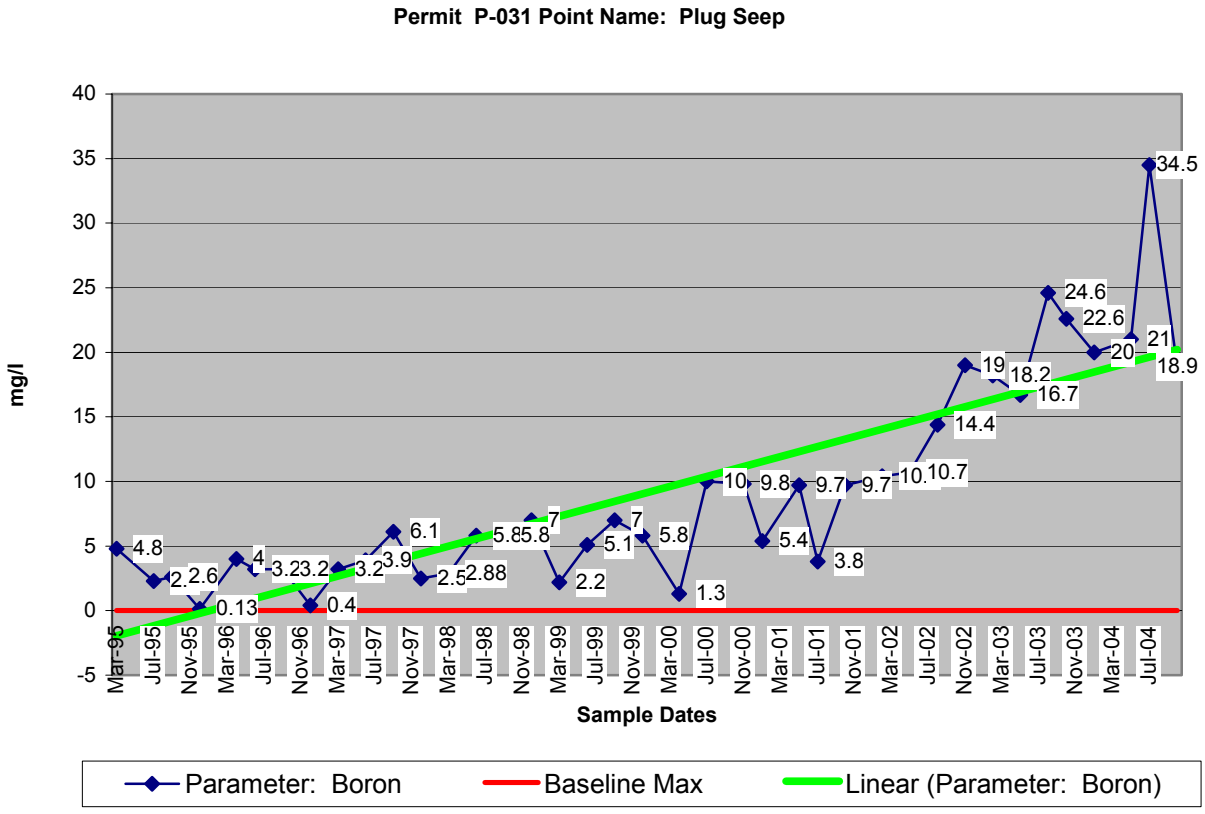


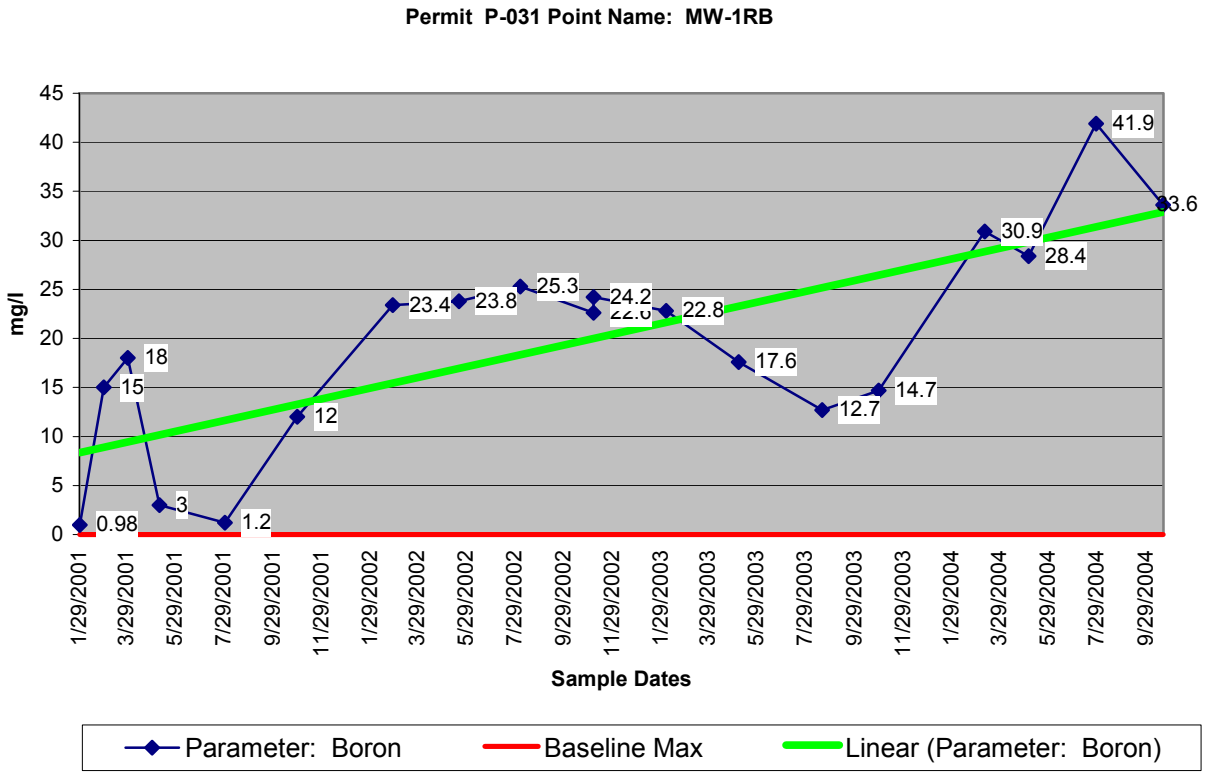
Figure 7



Well MW-1RB is located in proximity to the ash monofill and to MW-1RU and monitors the ground water within the bedrock strata above, and including, the Indiana VI Coal seam that was mined in this location in the 1980's. As seen in MW-1RU, boron concentrations have been steadily increasing in this well, and again, substantial increases in boron levels are evident following the filling in of the disposal pit (Figures 5 and 8).

MW-1RB is presumed to be in direct communication with water in the disposal area through a series of auger holes located in the consolidated strata along the eastern boundary of the ash disposal area (Figure 3). During active mining operations, the Indiana VI Coal was extracted from the highwall (eastern pit boundary) using augers that extended about 46 meters into the undisturbed bedrock. These auger holes, some emanating from the disposal area, provide a direct conduit for the ash water to migrate in the vicinity of MW-1RB. During drilling activities for the installation of MW-1RB, a void space was penetrated that was at the approximate depth of the Indiana VI Coal. Rather than installing the well in this void area (auger hole), the drill hole was sealed, and an additional boring was completed nearby. The Indiana VI Coal was encountered in this boring, and the well was installed through the base of the coal seam. Thus, it is plausible that water from within the pit migrates through an auger hole adjacent to MW-1RB and into this well through the Indiana VI seam.

Figure 8



CONCLUSIONS

Boron concentrations in excess of what was anticipated based on leachate analyses have been documented at the Universal Ash Site in west-central Indiana. The leachate test method ASTM D 3987-85, "Shake Extraction of Solid Waste With Water" provided reliable data concerning post-placement leaching of the eight RCRA metals; however, boron levels in some surface water and ground water monitoring locations far exceed expected concentrations based on laboratory testing.

Leachate analyses of CCBs at the other eight ash disposal sites in Indiana have not experienced a discrepancy in laboratory and field leachate concentrations as significant as those seen at Universal while utilizing the same test method (ASTM D 3987-85). Water quality research is currently ongoing at Universal for boron and other constituents.

REFERENCES

[1] Fenelon, J.M., Bobay, K.E. and others, 1994, Hydrogeologic atlas of aquifers in Indiana: U.S. Geological Survey, Water-Resources Investigations Report 92-4142, 196 p.

[2] Wangsness, D.J., and others, 1983, Hydrology of area 30, eastern region, Interior Coal Province, Illinois and Indiana: U.S. Geological Survey, Water-Resources Investigations Open-File Report 82-1005, 82 p.

[3] Wangsness, D.J., Miller, R.L., Bailey, Z.C. and Crawford, C.G., 1981, Hydrology of area 32, eastern region, Interior Coal Province, Indiana: U.S. Geological Survey, Water-Resources Investigations Open-File Report 81-498, 76 p.

[4] Hassett, D.J., 1991, Evaluation of leaching potential of solid coal combustion wastes, final report: Energy and Environmental Research Center, Mining and Mineral Resources Research Institute, University of North Dakota

[5] Branam, T.D., Smith, R.T., Ennis, M.V., Rybarczyk, J.P., and Comer, J.B., 1999, Trace element partitioning in ground water at an abandoned mine-land site reclaimed with coal combustion products: 1999 International Ash Utilization Symposium, Center for Applied Energy Research, University of Kentucky, Paper #68