

## **Permit Review 11**

### **TDK MINING, SANDY HOLLOW MINE (PERMIT # 16910104)**

#### **Site Summary**

The Sandy Hollow Mine is located in Madison Township, Clarion County, Pennsylvania, in the Mahoning Creek Priority Watershed 17D. The coal seam mined was the Upper Freeport, and 342,000 tons of FBC and conventional (PC) fly and bottom ash were placed at this site. The placement started in August 1996 and finished in September 2000 according to inspection reports and confirmed by personnel at the PA DEP Knox District Office.

The FBC ash was from the Piney Creek Limited Partnership in Pennsylvania, and the conventional ash source is the Jamestown Board of Public Utilities, S.A. Carlson Generating Station, Jamestown, New York. The ash was placed incrementally as strip-mining operations proceeded to prevent acid mine drainage through alkaline addition. The acreage covered by ash placement was not specified in the permit.

#### **Geology**

The geology of the site consists of the Upper Freeport Coal and its overburden rocks. Many of the overburden beds at this site are naturally cemented with calcite, increasing the neutralization potential (NP) and decreasing the potential for acid mine drainage. The sedimentary beds at the Sandy Hollow Mine are nearly flat-lying, except for a very slight dip to the south, which reflects the geometry of the original depositional basin.

#### **Topography**

The topography of the site is typical for the Pittsburgh Plateau province in Pennsylvania; steep valleys with relatively flat-topped hills that represent the old plateau surface before uplift and erosion. The surface water drainage is a radial pattern, with small streams running off the site in many different directions due to the mine being placed at the tops of the hills where the coal outcrops. (See map below.)

#### **Groundwater**

Groundwater flow follows topography closely except where the land has been disturbed by mining. In mined areas like Sandy Hollow, surface water and groundwater will tend to run through the spoil, due to its higher secondary porosity, down to the level of the Upper Freeport Coal and exit at this elevation on the downgradient side of the hill in question.

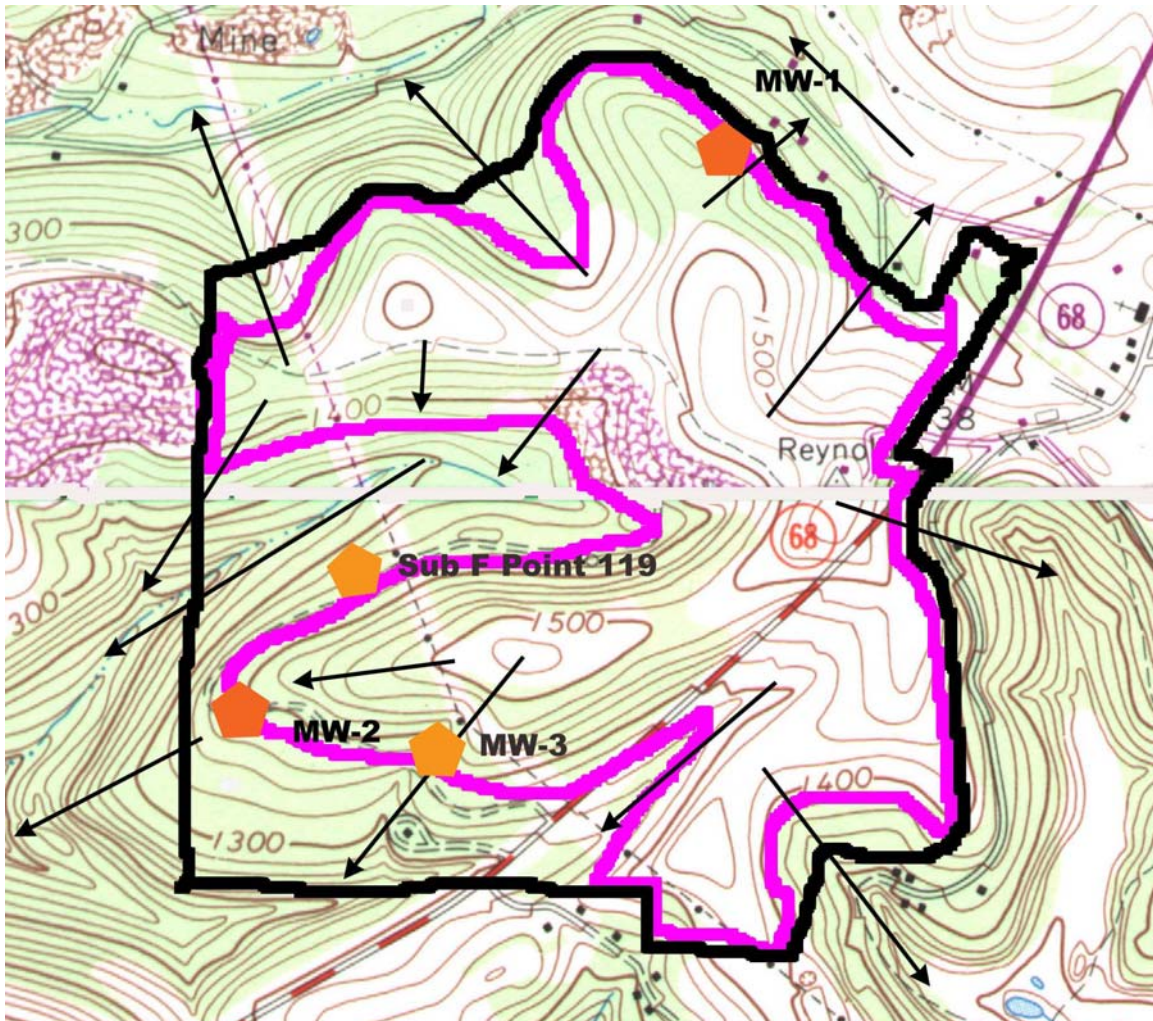
#### **Monitoring data: Discussion**

Four ash groundwater monitoring wells were installed on this site, one upgradient well, MW-1 and three downgradient wells, MW2, MW3 and MW-4. MW-1 and MW-3 were selected for study, to include one upgradient point and the downgradient sampling





point with the most complete data set. Water level elevations from five measurements taken on identical dates from May 1999 to May 2000 place the water at MW-1 about 71 feet above the water at MW-3. Both wells were drilled down to the first aquifer below the coal seam to be mined. Nonetheless there is some question as to whether MW1 is actually upgradient of the influence of mining and ash placement given its placement inside the mining and ash placement areas. The elevation of its screen according to CONSTRUCTION DETAILS on pages 25-27 and 25-29 in the permit's Module 25 Section B-2 is at 1337 feet above sea level, about 140 feet below the land surface at the well. The elevation of the screen for MW3 is 1294.7 feet above sea level, about 53.3 feet below the surface of the ground. The depth of the mining above these levels, the slope of the ground from the ridge going downhill to the northeast past MW-1 and the incremental placement of ash authorized throughout the area to be mined leaves some question about whether flows from mined ground containing AMD and ash leachate could not reach the screen of MW1. Thus the placement of the arrow by MW1 on the map below indicating this possibility.

There were four Subchapter F monitoring points at this site and of these, Point 119 has been selected for loading discussions because it is the most downgradient and has a relatively complete data set. This point is monitoring a seep in the southwest portion of the site about a thousand feet northeast of MW-2 (see map). MW-1 and MW-3 were monitored from 1996 to 2001 with a baseline monitoring period from January 1996 to June 1996. Point 119 was monitored from April 1994 to December 2003. This monitoring point was not designated in the permit as an ash monitoring point, and thus has no data for more exclusive ash parameters monitored under Module 25 such as trace RCRA elements, calcium and magnesium making its data more useful for looking at general trends from the mining operation as a whole rather than measuring ash impacts specifically.

**Site Map: Sandy Hollow**



**Map Symbol Key**

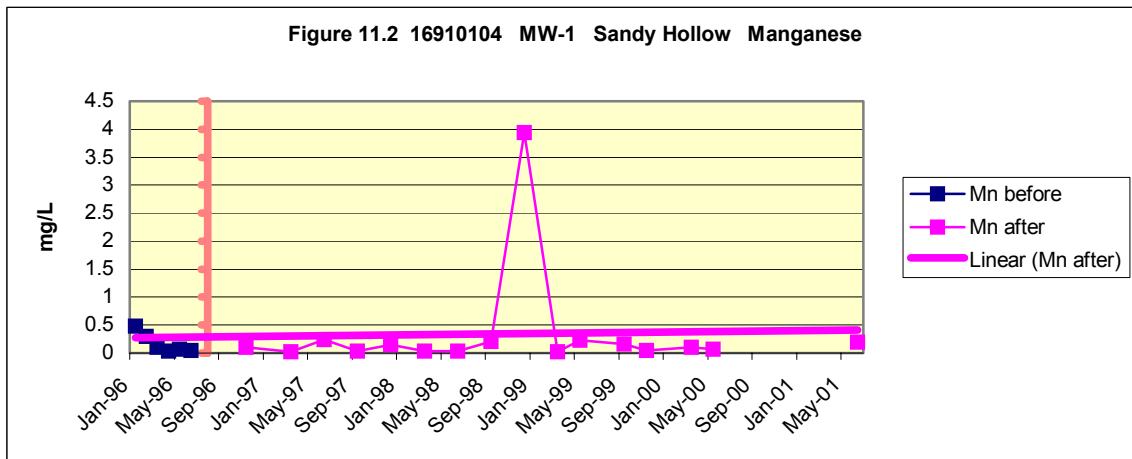
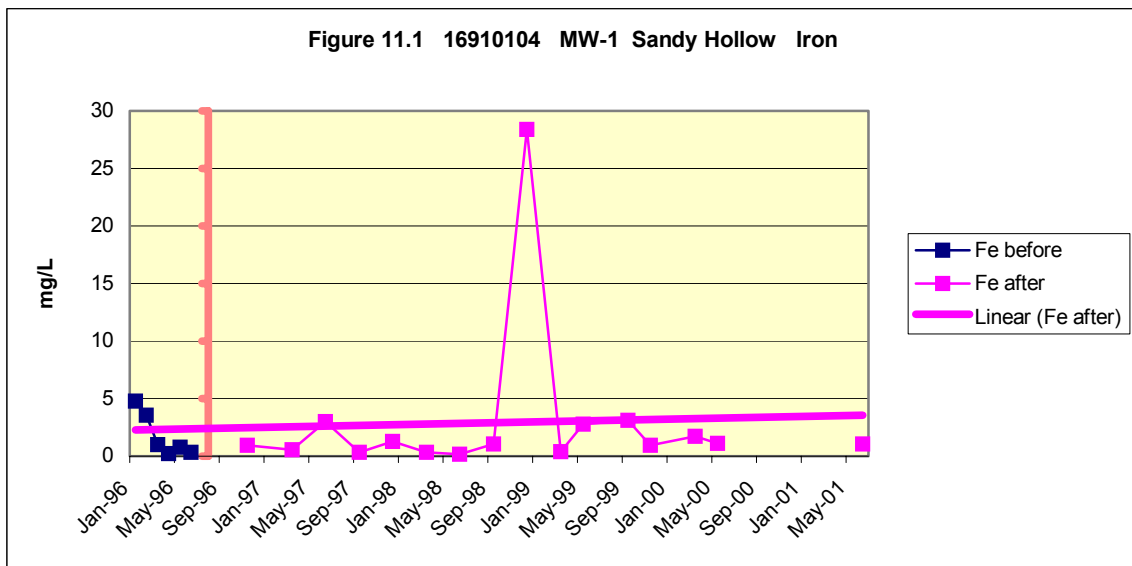
<b>Permit Boundary</b>	
<b>Ash Placement Area</b>	
<b>Monitoring Point</b>	
<b>Groundwater Flow</b>	

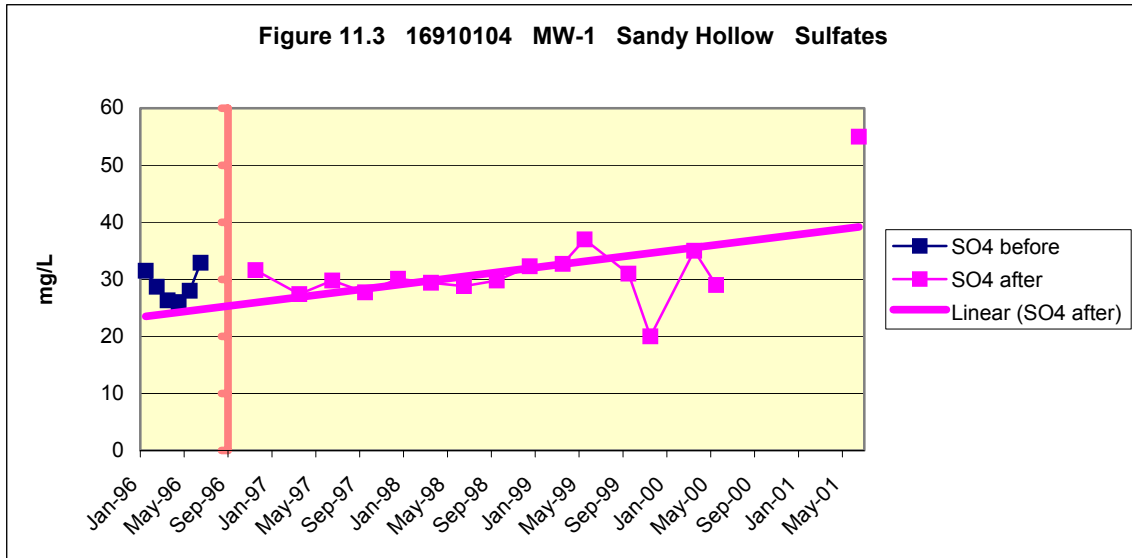


**TDK Coal Company, Sandy Hollow Operation (Permit # 16910104)**  
**Scale: 1" = Approximately 1000'**

**MW-1**

MW-1, the only upgradient monitoring well, showed little sign of degradation with the exception of minimal impacts possibly due to coal mining and/or coal wastes (gob). Figure 11.1 is a graph of iron concentrations; a rising trend was evident from an average concentration increasing from 2.5 to 4.0 mg/L with an anomously high value of 28.40 mg/L in late December 1998. The manganese concentrations (figure 11.2) had a flat, or very slightly rising trend, averaging between 0.3 and 0.4 mg/L with an anomously high value of 3.90 mg/L also in the late December 1998 sampling. The sulfate values rose after ash placement (figure 11.3) from an average of 25 up to 40 mg/L. All of the sulfate values are well below the PA MCL (DWS) standard of 250 mg/L and do not reflect badly degraded water.





The pH rose slightly after ash placement and then fell toward the end of the monitoring period (figure 11.4). Field pH values are used in this report, as they more accurately reflect field conditions, even though the instrumentation that generates field pH values can be slightly less accurate than laboratory pH measurements. At MW-1, the field pH and the laboratory pH have similar overall trends, and there is usually not more than 0.2 pH units difference between the two. The average trend is downward from baseline values, but levels fluctuated greatly from 6.4 s.u. in May 1999 to 7.8 s.u. in September 1999 (above all baseline values) before falling to 6.0 s.u. in March 2000. This indicates a temporary neutralizing of AMD from some source of alkalinity. The alkalinity could have been coming from the coal ash through an unknown groundwater pathway to this upgradient monitoring point, from placement of ash very close to the monitoring point, or from calcium sources in the surrounding rock and spoil activated by the mining.

The TDS (figure 11.5) fell during ash placement below levels measured in the baseline monitoring period. Even though the sulfate concentrations were rising at MW-1 (figure 11.3), the values of the remaining dissolved material were falling, except for a large spike to 877 mg/L in June, 2001 at the end of the monitoring period.

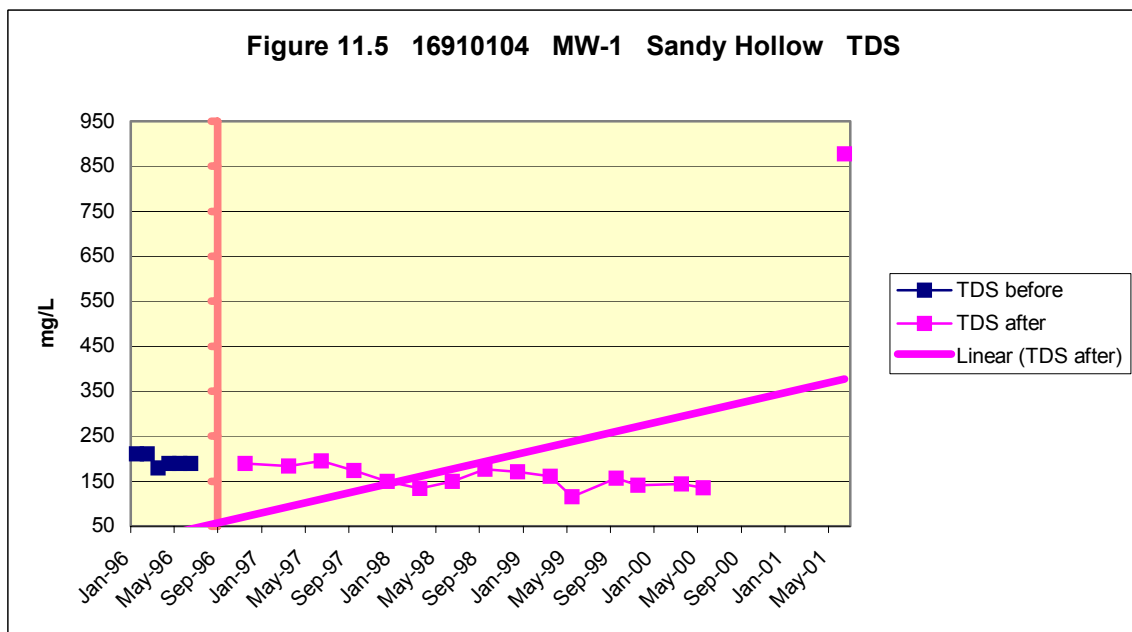
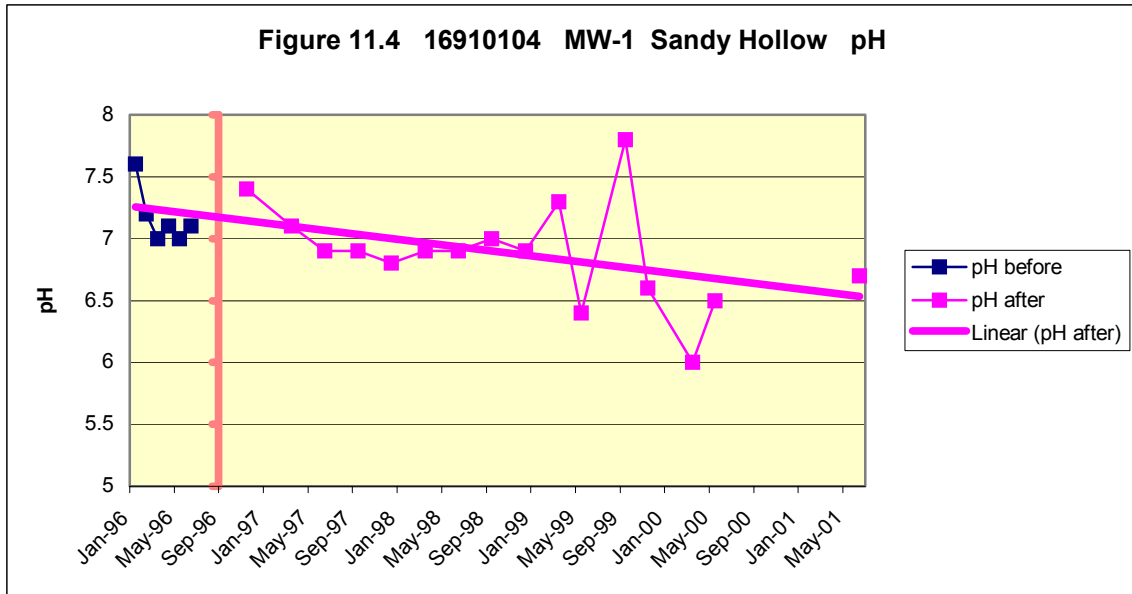
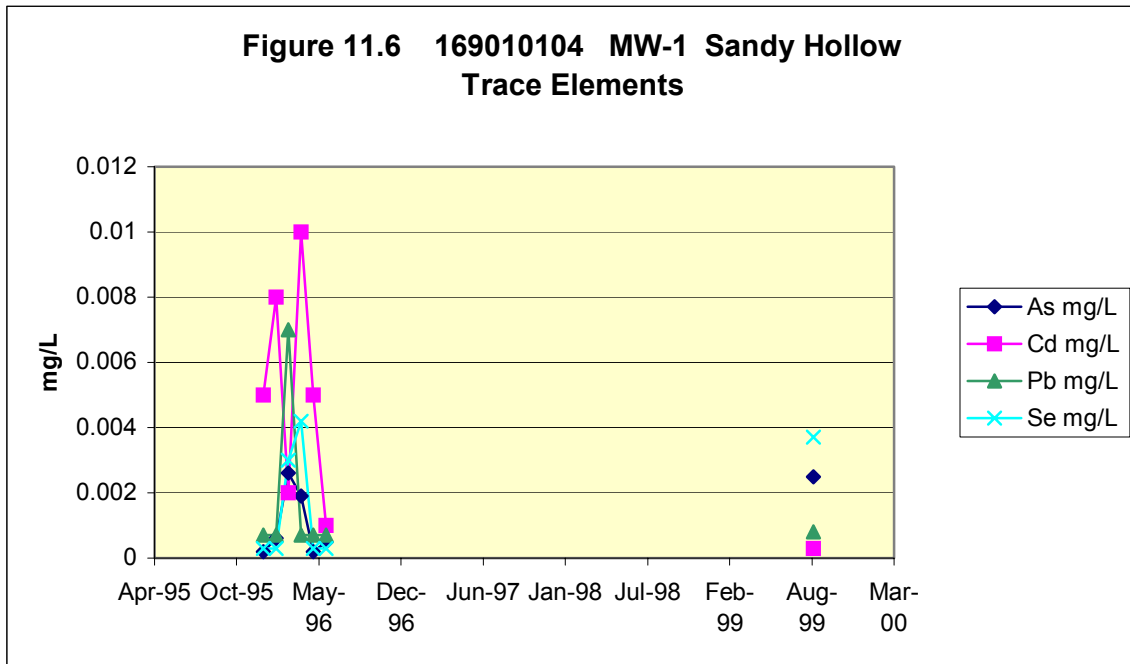


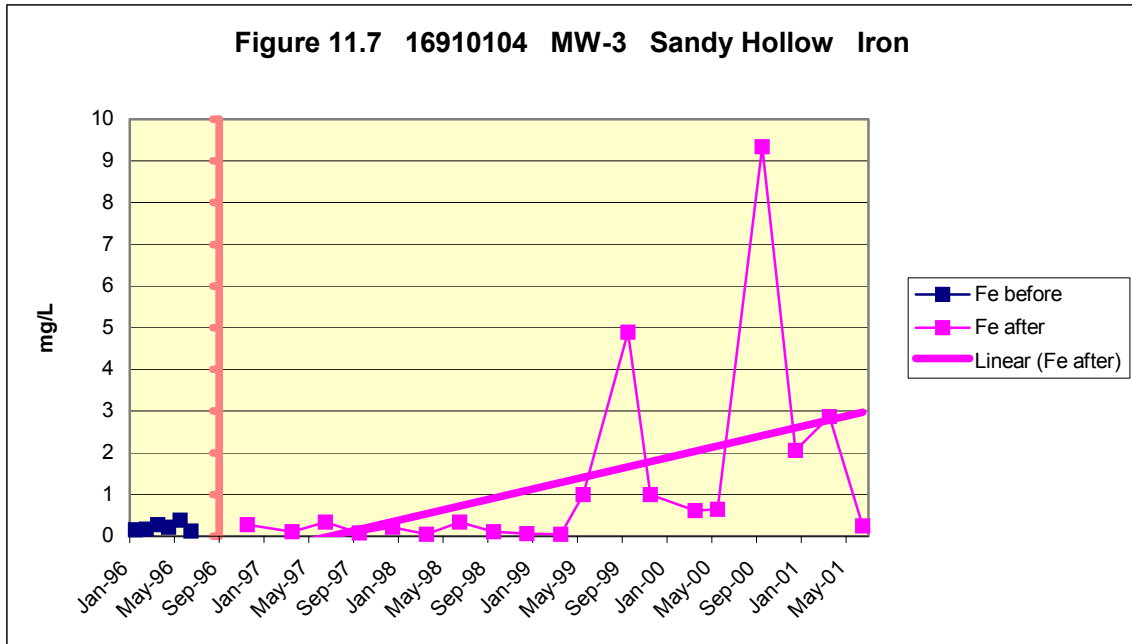
Figure 11.6 shows a plot of dissolved concentrations for four trace elements at MW-1 revealing that only one measurement from September 1999 could be found in the monitoring reports during the entire mining and ash placement period. Four of the six cadmium concentrations in the baseline period equaled or exceeded the DWS with the highest being twice the DWS, 0.01 mg/L in April 1996 while the cadmium measured in September 1999 was less than a tenth the DWS. There was a high concentration of total arsenic (0.023 mg/L) in the first sampling of the baseline period (Jan. 1996) but dissolved arsenic values stayed well below the DWS in baseline measurements, and the September 1999 measurement was below the limit of detection at <0.0025 mg/L for both total and

dissolved arsenic. Most lead and selenium measurements were below the limit of detection in the analyses and all levels were well below the DWS. Only one measurement during the ash placement period at this upgradient monitoring point greatly hinders a meaningful assessment of impacts from ash by eliminating the ability to compare downgradient concentrations of trace elements that could be coming from ash to upgradient concentrations that would not be.



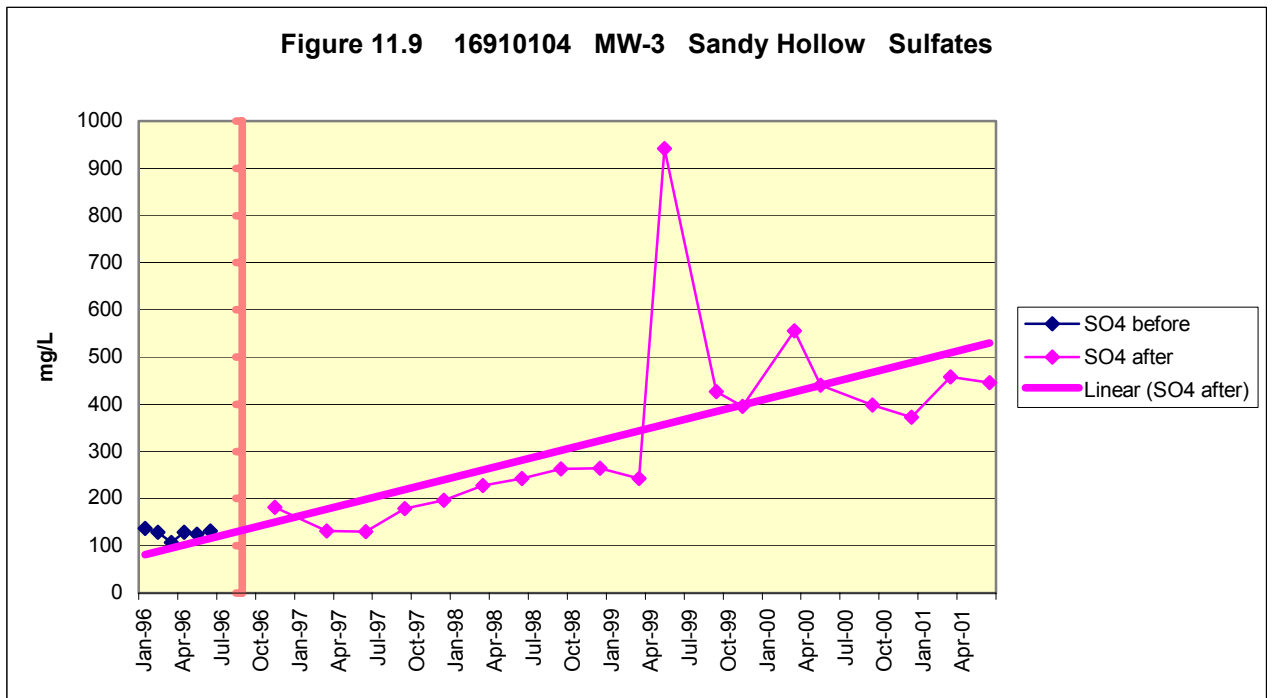
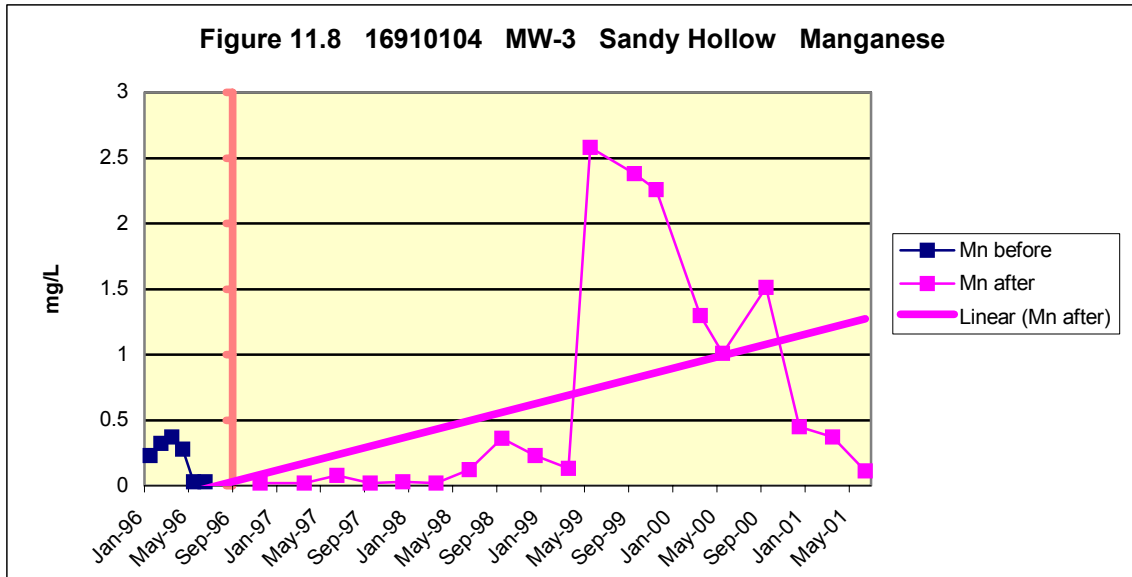
**MW-3**

The downgradient monitoring well, MW-3, showed an increasing concentration of iron with time suggesting some mobilization from the ash and/or the disturbance of material during mining operations (figure 11.7). These iron values were slightly higher than those at MW-1, with average concentrations about 3.0 mg/L at the end of monitoring. Unlike MW-1, however, the highest iron values occurred after mining and ash placement at MW-3, although the concentrations did not rise above baseline values until the spring of 1999. The upward trend in those values was somewhat steeper than the trend at MW-1, however. The result shows more apparent degradation at MW-3 as iron rose from concentrations roughly equal to or below the DWS during baseline monitoring to levels as high as 9.34 mg/L, 31 times the DWS, in September 2000, before declining ultimately to baseline levels in the last data collected in June 2001.



Manganese concentrations (figure 11.8) had a trend similar to iron. Subsequent to the beginning of mining and ash placement, manganese levels remained at or below the DWS and baseline concentrations for a year and a half before starting to rise in June 1998. Levels increased sharply to 2.58 mg/L in May 1999, 7 times the highest baseline concentration (0.37 mg/L) and 52 times the DWS (0.050 mg/L). For the next two and a half years, manganese remained above 1.00 mg/L before dropping down to baseline levels in the last six months of monitoring.

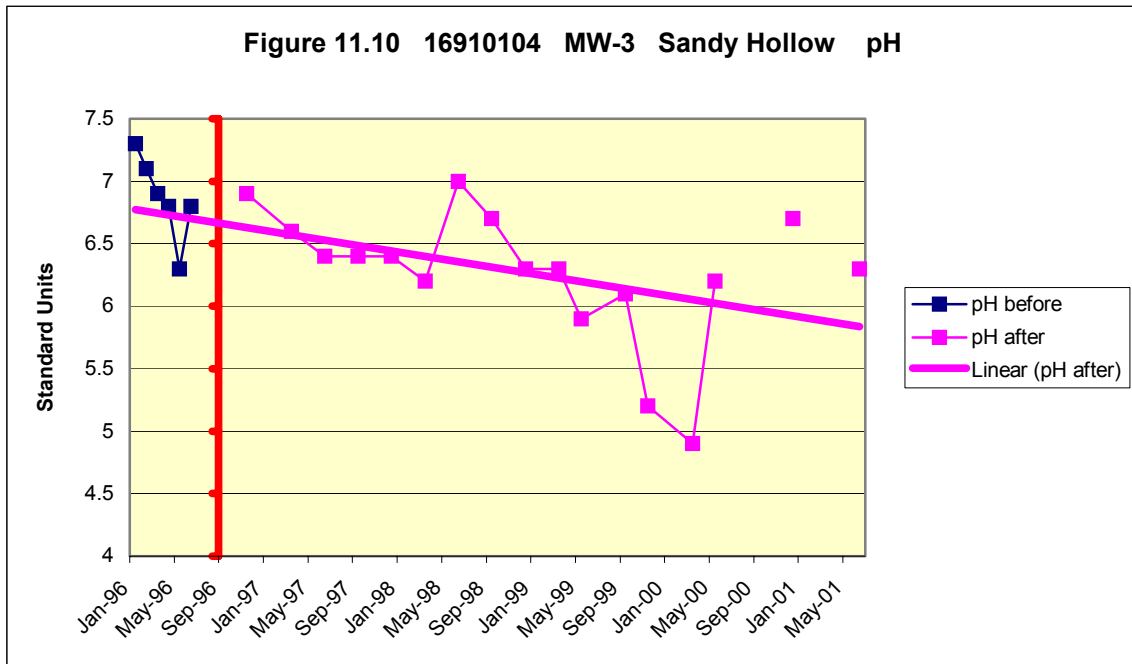
The sulfate trend at MW-3 was upward and similar to the sulfate trend at MW-1, but with concentrations that were 10 times higher (figure 11.9). Degradation of groundwater was occurring at MW-3 as sulfates rose from baseline levels around half the DWS in 1996 to levels substantially exceeding the standard from March 1999 to the end of monitoring in June 2001. This was unlike the degradation from manganese and iron whose concentrations declined to baseline levels in the last six months of monitoring.

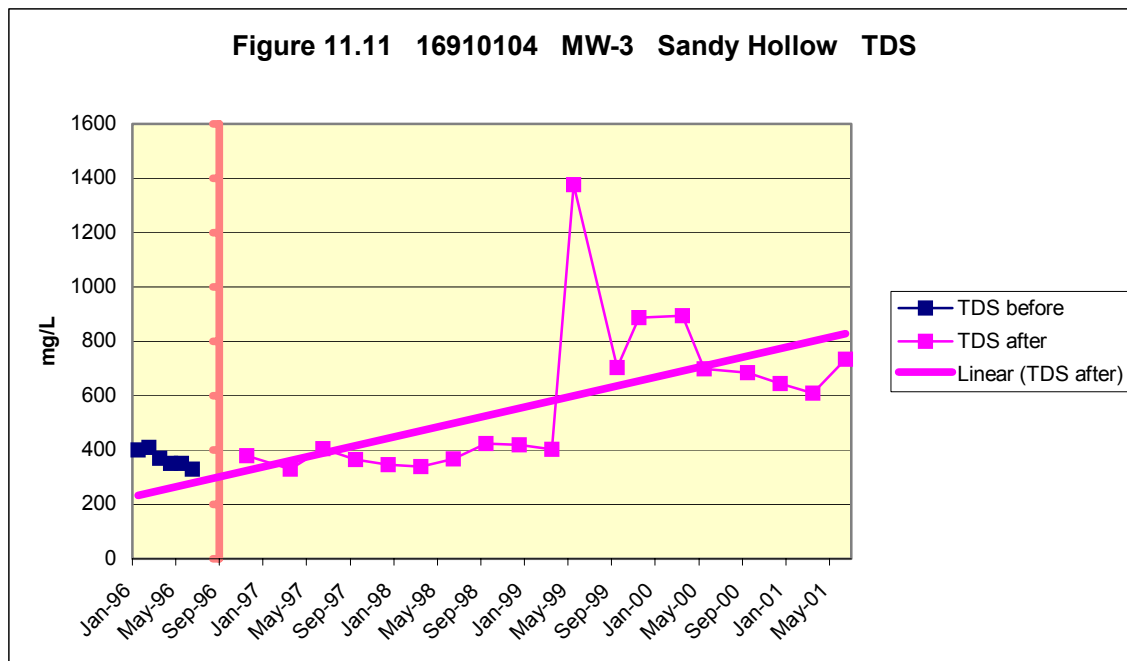


The data shows a spike in sulfate that occurred simultaneously with the jump in the manganese concentration at MW-3 in May 1999, when the sulfate level reached 942 mg/L, nearly 4 times the DWS. This “spike” in sulfate and manganese was measured during a period of sustained, declining flow at the site and thus did not appear to have resulted from heavy precipitation. A major site disturbance or input from ash leachate could have caused this rise.

The trend of pH at MW-3 decreased from an average of 6.8 units to about 5.8 units (figure 11.10). Alkaline buffering from ash placement was not visible through any overall rising pH trend during ash placement although there was a rise of 1.2 to 1.8 units in pH values in the last four measurements at MW-3 .

TDS rose at MW-3 (figure 11.11), in contrast to their declining trend at MW-1, and followed a concentration pattern very similar to the pattern for sulfates, inferring that sulfates are the major contributors to TDS at MW-3. TDS levels rose from around 400 mg/L, below the DWS (500 mg/L), during baseline monitoring and the first two years of ash placement to 1377 mg/L in May 1999 and then remained above 600 mg/L until the end of monitoring, reflecting the spike in sulfate and higher levels of sulfate that persisted through the end of monitoring.





Calcium and magnesium (unplotted) both rise after ash placement at MW-3 although the scant amount of data collected for these constituents that are good signatures of the alkalinity from FBC ashes prevents a more clear picture from emerging that would implicate the ash in the rises of sulfate and manganese occurring at the same time. The data set has only 1996 baseline values, and concentrations from one sampling in 1999, and another in 2001. Nonetheless, the baseline concentrations for calcium (dissolved values) at MW-3 average 50.41 mg/L compared to 114.14 mg/L in September 1999, and 128 mg/L in September 2001 at MW-3. Magnesium has similar behavior, with a baseline average value of 11.57 mg/L at MW-3, increasing to measured concentrations of 30.56 mg/L in September 1999, and 32.58 mg/L in September 2001. Large increases in these elements in the absence of major limestone deposits would suggest contamination of groundwater from ash placement.

On the other hand concentrations of chloride and sodium which are also often seen as ash indicator parameters are plotted in figure 11.11A and their trends at MW-3 do not corroborate what the higher calcium and magnesium concentrations might suggest. The chloride concentrations stay below baseline values, even though they increase slightly over the monitoring period. Sodium values stay in the general baseline range after ash placement, and then decrease over time. *If* chloride and sodium are ash indicator parameters at MW-3, then ash placement has had little effect on groundwater.

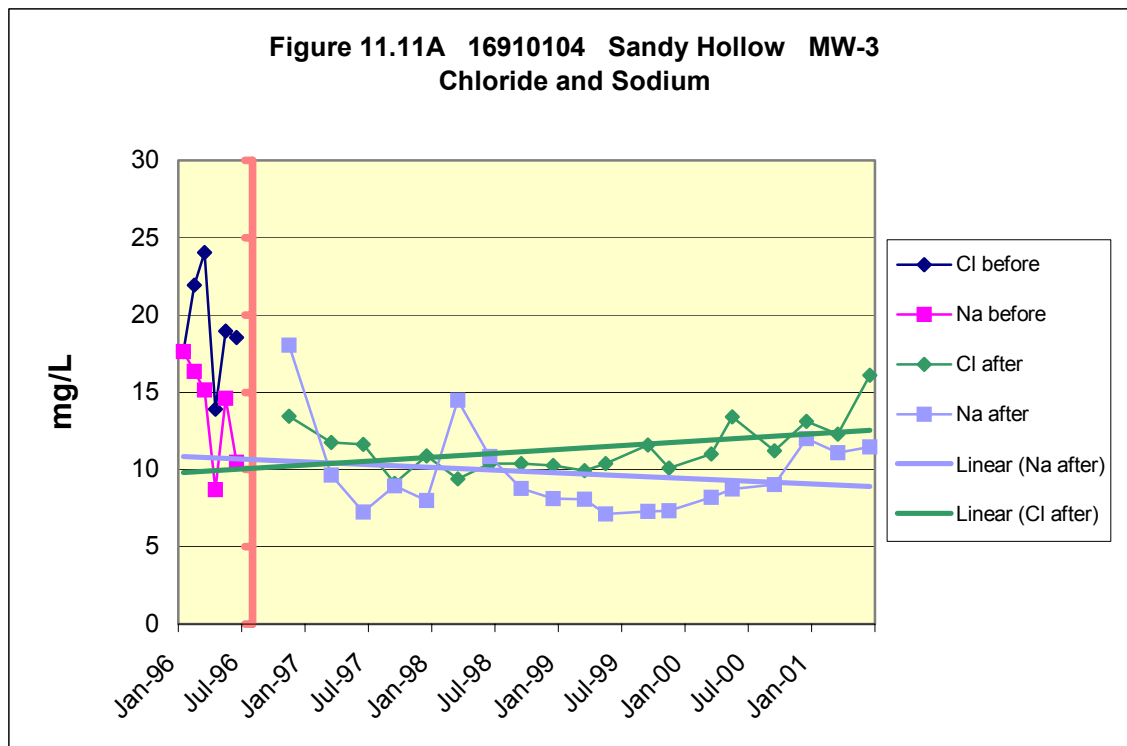
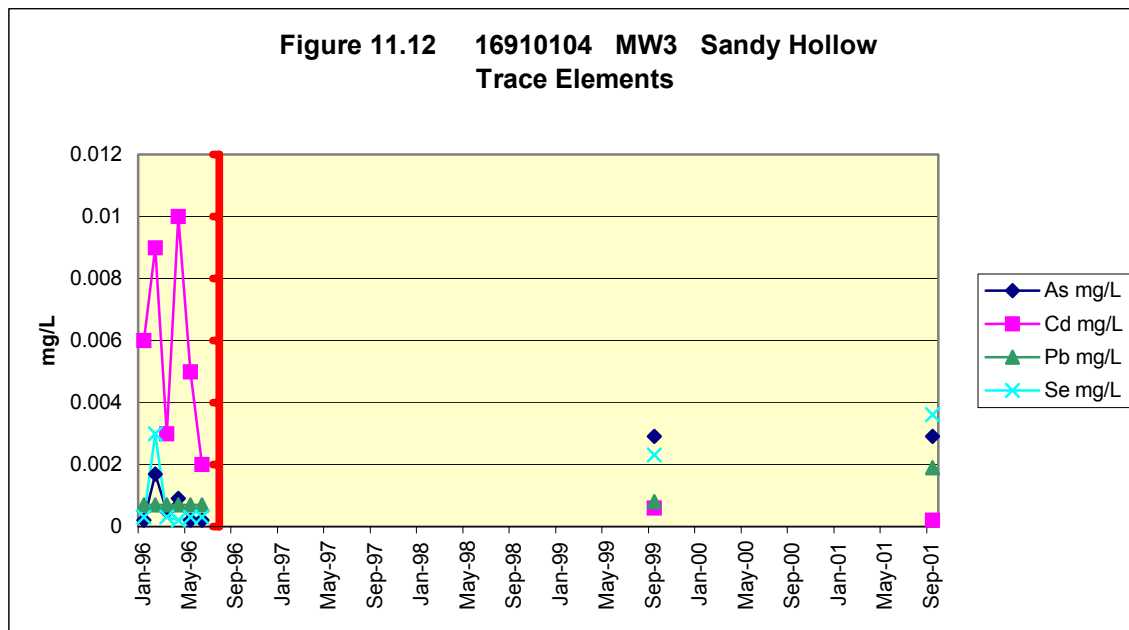


Figure 11.12 shows the MW-3 trace element concentrations for selenium, lead, cadmium, and arsenic. As is the case for calcium and magnesium, the monitoring reports contain trace element data for only the six-month baseline monitoring period in 1996 and two samplings in September 1999 and September 2001. Dissolved values are usually below detection limits of analyses, except for cadmium concentrations which are above detection limits during the baseline period and equal to or above the DWS in 4 of the 6 baseline samplings. The highest arsenic measurement occurs during mining and ash placement in September 1999 at 0.0029 mg/L. Lead and selenium concentrations are below detection limits in all measurements except for one of selenium during the baseline period, but this measurement (0.0030 mg/L in February 1996) and all detection limit values for these trace elements are well below the DWS.

Very little data for the period in which ash was placed could be found in the permit file. Monitoring reports indicate there was insufficient water to sample at MW-3 for the September 2000 sampling for annual ash parameters.

Given that PADEP apparently did not require that sampling results be submitted in monitoring reports for trace elements between 1996 and September 1999 or that any monitoring results be recorded for trace elements after the September 2001 sampling, it is not possible to determine the ash’s effect on trace element concentrations in downgradient waters.



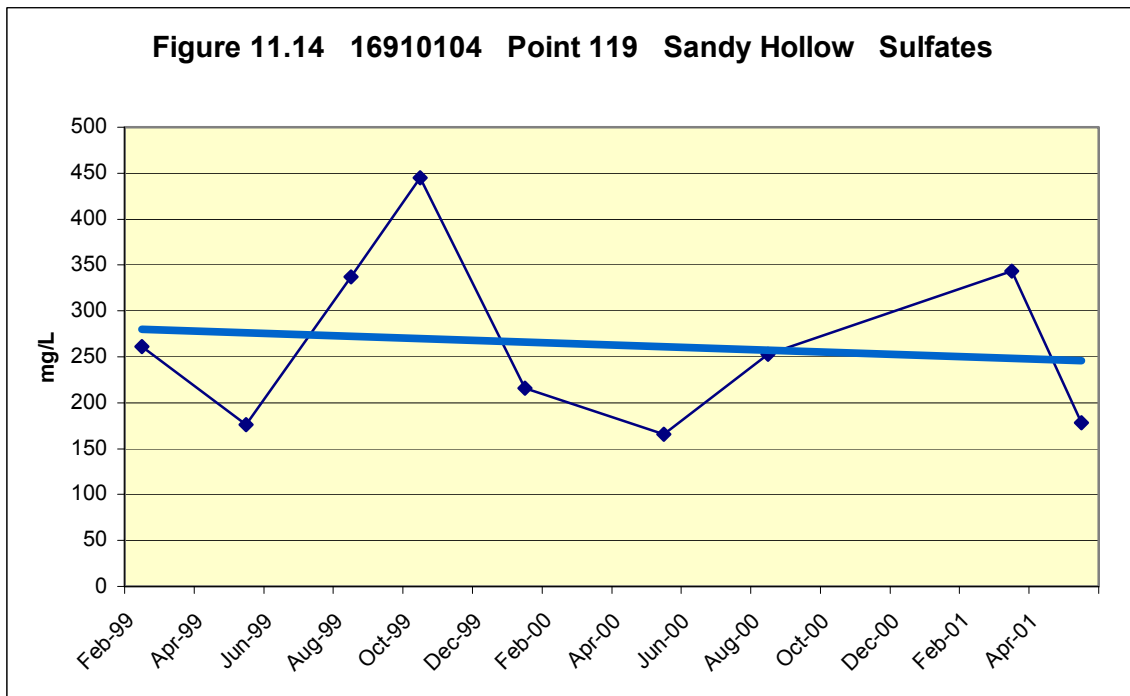
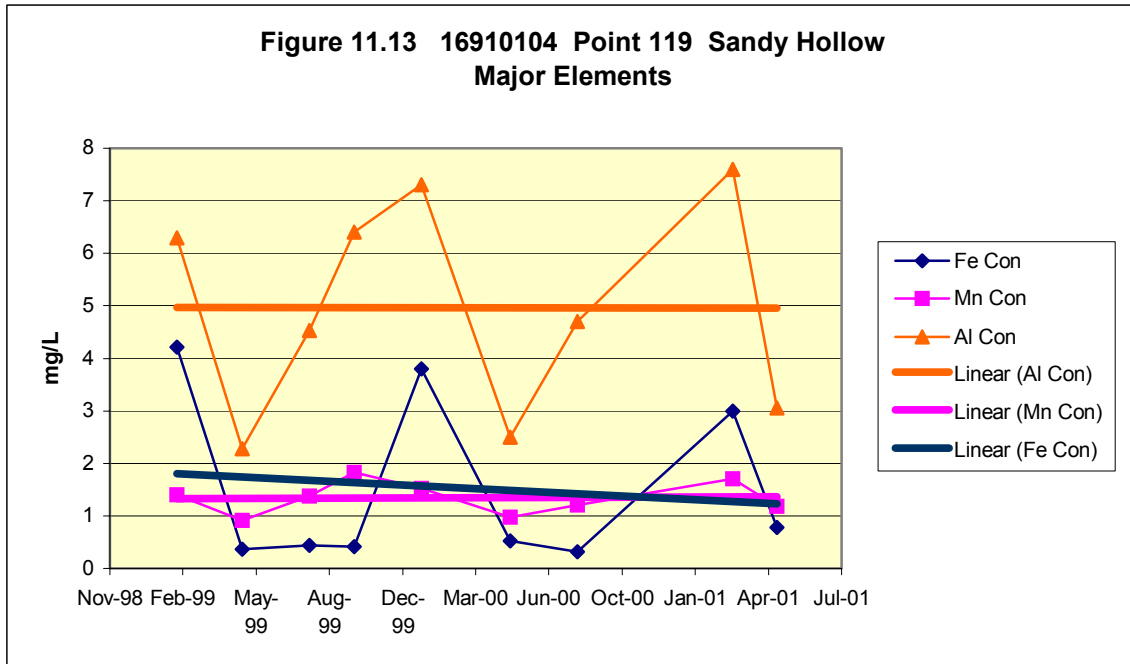
**Subchapter F Point 119**

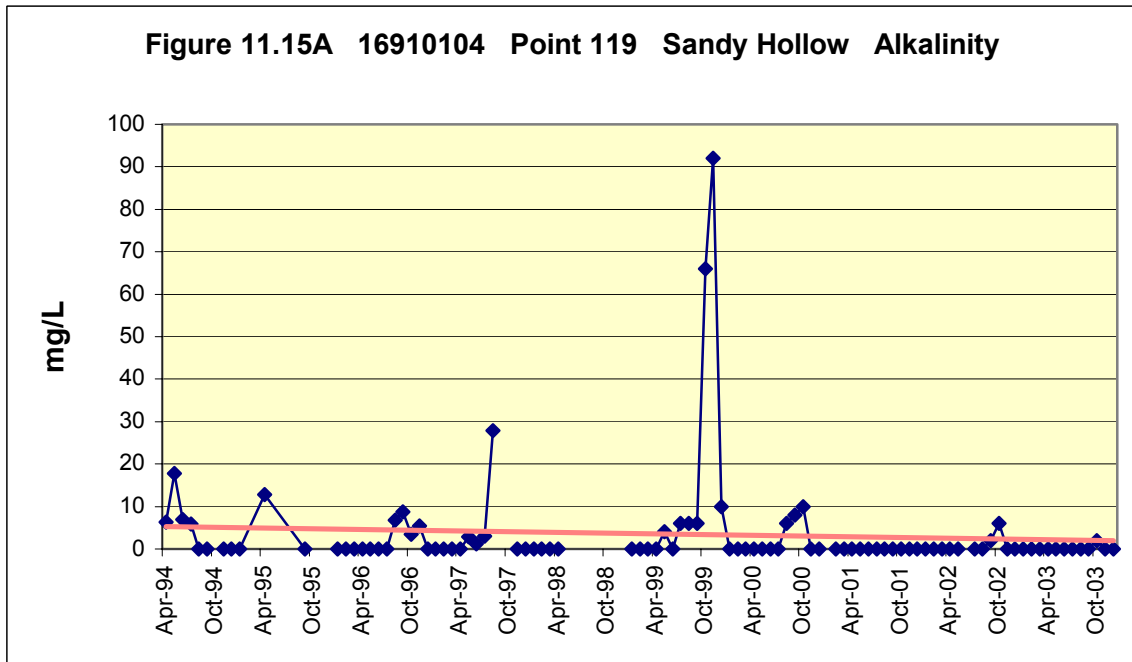
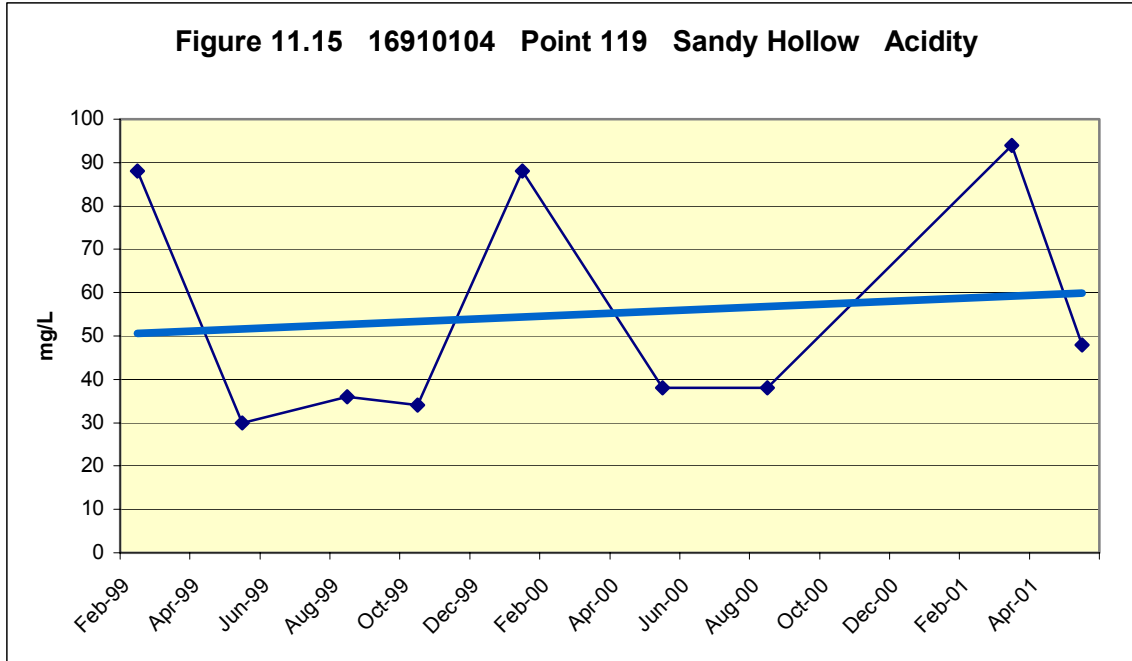
The major element concentrations (iron, manganese, and aluminum) are graphed in figure 11.13 at Subchapter F Point 119, the previously described seep that drains part of the southwestern portion of the site. Data for elemental concentration and load monitoring were available from February 1999, until May 2001. Data for alkalinity extends from April 1994 to December 2003.

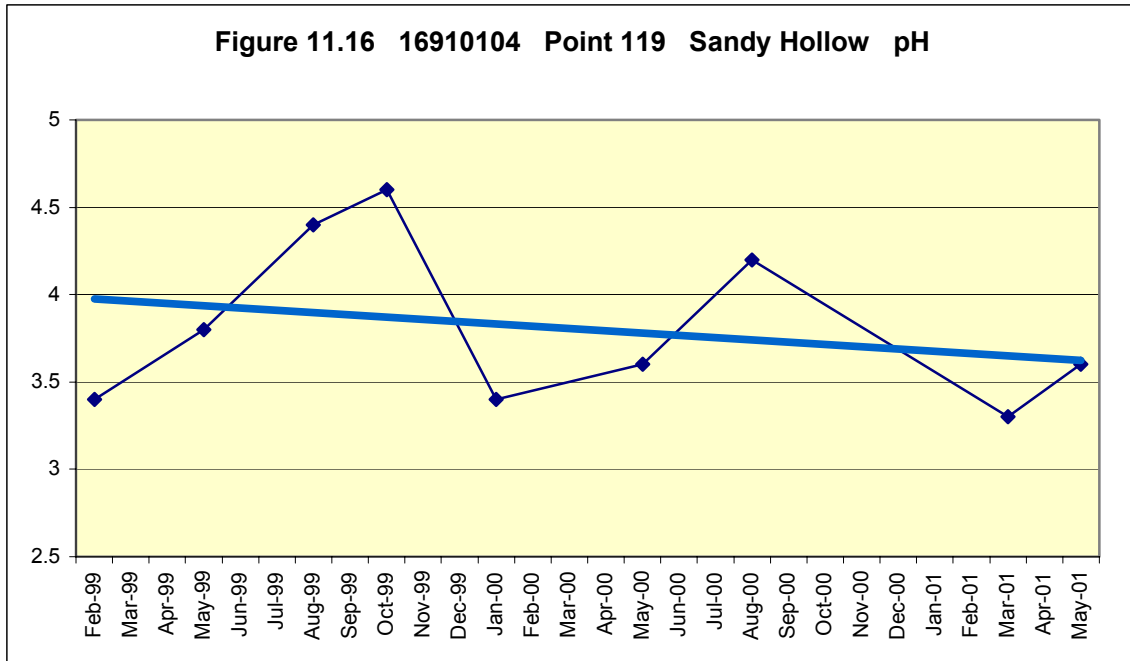
The trend for iron concentrations dropped, and average manganese concentrations were static with a horizontal trendline. The average values were between 1.0 mg/L and 2.0 mg/L for both of these elements. The aluminum had a flat average trend at 5.0 mg/L. There is fairly close correlation between rising and falling concentrations of these constituents (iron, aluminum, and manganese) suggesting a seasonal influence on their concentrations. The sulfate values at Point 119 were lower than those at MW-3 and showed a slightly falling trend (figure 11.14). The acidity trend was the opposite of sulfates (figure 11.15) and was rising. The pH was dropping (figure 11.16) in agreement with the rising acidity.

Alkalinity data was found for Point 119 starting in April 1994 and extending to December 2003, and sampled on a monthly basis (figure 11.15A). Much of the data was zero, or below the detection capability of the analyses. There are also many data gaps, further complicating interpretation. The trendline shows a slowly falling alkalinity at Point 119, and the highest concentrations in a “spike” to 66 mg/L in October 1999 and 92 mg/L in November 1999. This is the same period in which the highest values were recorded for pH at Point 119 (4.4-4.6 units). None of the concentration data sets for other parameters at this monitoring point included any data for the pre-ash baseline monitoring period or the first two and a half years of ash placement. While the distance and

hydrologic connection between this subchapter F Point and ash at the site is not clear, the water quality appears to be neither improving nor deteriorating to any significant degree for these parameters in surface waters at this point.

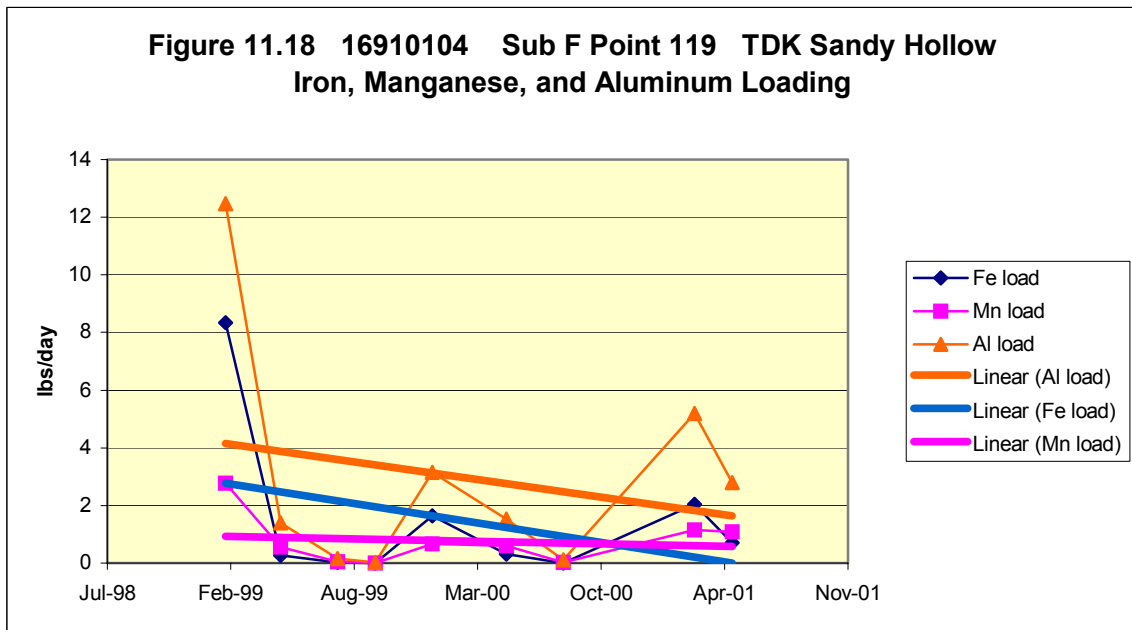
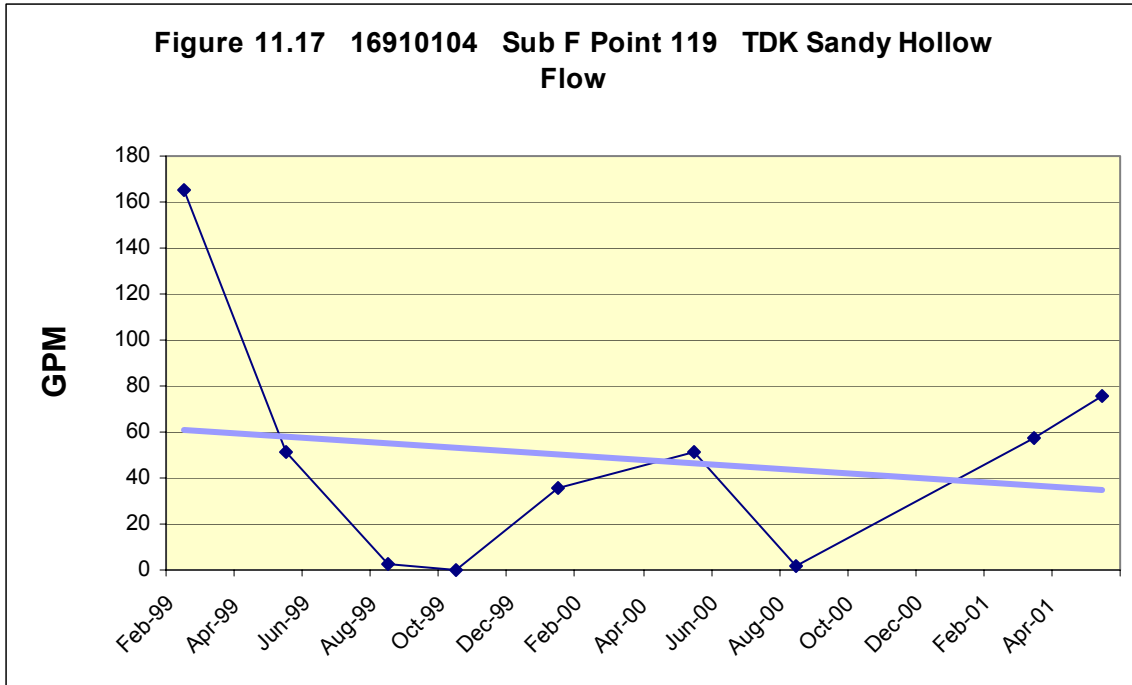


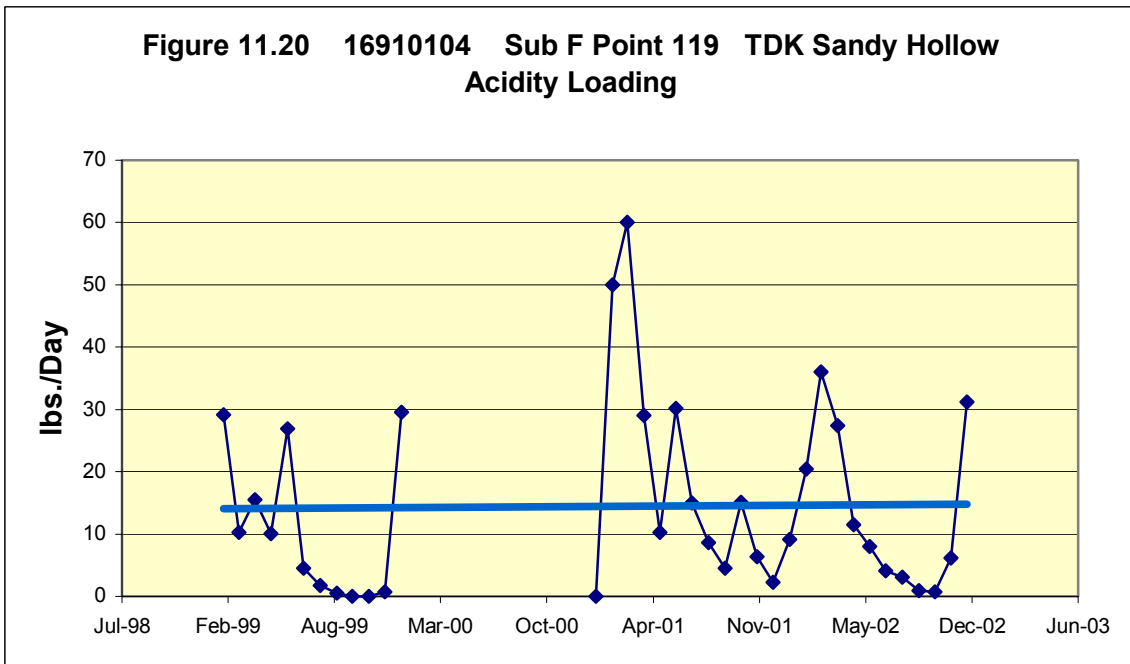
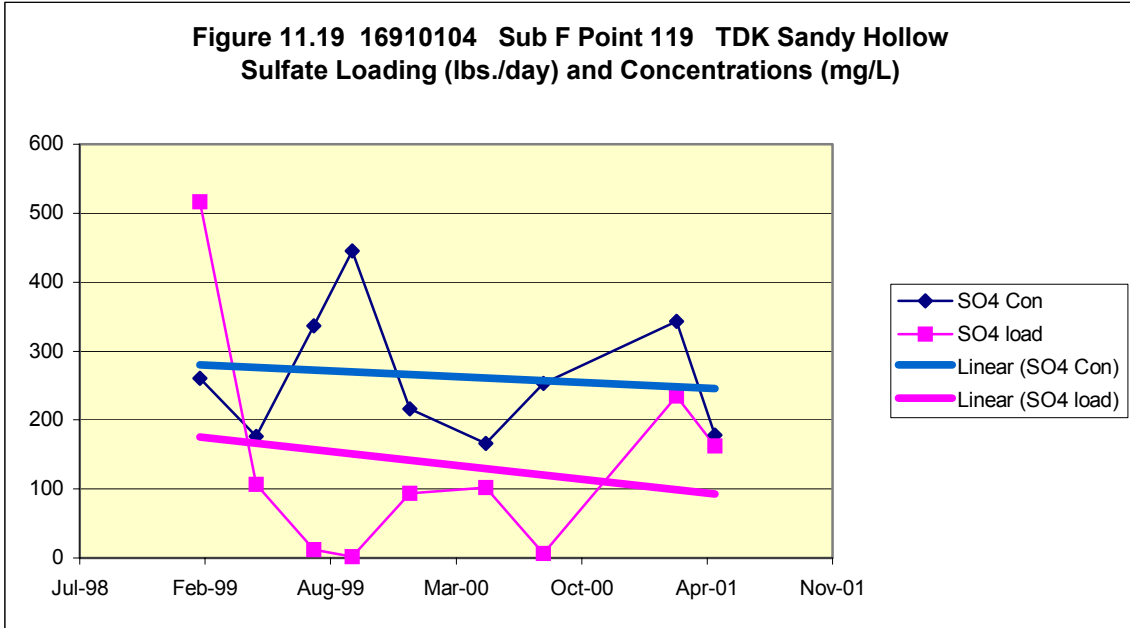




**Subchapter F Point 119 – Loading**

Figure 11.17 is a graph of flow volume from Point 119. Figure 11.18 is a graph of loading values for iron, manganese, and aluminum at Point 119. The range of loads was greatest for aluminum, followed by iron and then manganese, but all three elements had downward average trend lines, indicating less flow, lower concentrations, or a combination of these occurring at Point 119. The major variant appeared to be seasonal flow with concentration having a secondary effect. Figure 11.19 graphs both sulfate concentration and loading; both average trends fell, and there was an inverse relationship between the two, i.e. the load increasing while the concentration was declining, until August 2000 when their trends became parallel. This relationship therefore is probably controlled by precipitation amounts that have seasonal variation. Given many samples were apparently assessed for acidity with flow alone at Point 119, the acidity loading data (figure 11.20) have more data points than the sulfate, iron, manganese, and aluminum data. The acidity data was recorded monthly, but all data from year 2000 were missing from the permit file. The overall average trend was flat, and the variations were controlled more by seasonal water flow rates than changing acidity concentrations, i.e., loads were higher generally when flow was higher.





## **Conclusion**

The flat trends associated with MW-1 versus the general rise in contaminants at MW-3 show a definite degradation of groundwater at the Sandy Hollow Mine downgradient of the mining and ash placement operations. Groundwater was degraded to levels substantially above baseline concentrations and several to many times over secondary drinking water standards for iron, manganese, sulfates, and TDS. Concentrations of manganese, sulfates and TDS rose sharply in the spring of 1999 at downgradient MW-3 when flows were declining precipitously at Subchapter F Monitoring Point 119 in the southwest quadrant of the mine where MW-3 is located. However, it is difficult to determine the degree to which ash placement or AMD from mining activity is contributing to this increasing degradation with the information at hand. Loading data suggests the amount of material leaving the Sandy Hollow site in surface waters during most of the monitoring period has been controlled more by the volume of water flow than by concentration trends.

The source of groundwater contamination could be better pinpointed if more than one or two samplings for trace elements and other ash parameters such as calcium and magnesium had been reported in permit monitoring reports during and after the ash placement period. Rechecking of monitoring reports reveals slightly more data for these parameters from three samplings at MW-2 and MW-4, although three samplings over five years is still too deficient to identify trends definitively. Monitoring for certain trace elements such as boron, molybdenum, and antimony, known to be markers for ashes generated from Pennsylvania coals and waste coals and which are analyzed in PADEP's permit leach tests, would have also enhanced the understanding of the contribution ash may be making to the water quality degradation. As at other sites in this report, a post-ash placement monitoring program that analyzes for ash-specific parameters including boron, molybdenum and antimony at appropriate (at least quarterly) frequencies and at adequate upgradient and downgradient locations as well as in the ash itself would explain some of these earlier trends and show which constituents in the ash and mine materials are stable or mobile over a longer period of time than the five years for which monitoring data was collected from ash monitoring points. The volume of ash placed along with the degradation seen at MW-3 appear to warrant such expansion of the monitoring at this site.

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